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William K. Hayes

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VERTEBRATE FAUNAL REMAINS FROM THE MINNIS-WARD SITE (SS-3), SAN SALVADOR, BAHAMAS: PRE-COLUMBIAN SUBSISTENCE AND FISHING TECHNIQUES

Jeffrey P. Blick and David Brinson
Department of Government and Sociology, Georgia College and State University, 320 North Wayne Street, Milledgeville, Georgia 31061 USA

ABSTRACT

Archaeological investigations on San Salvador, The Bahamas, in May 2004 included archaeological excavation at the Minnis-Ward site. Approximately 10 m^3 of earth were excavated and passed through fine mesh (2 mm) window screen, yielding a total of 31,408 artifacts, including some 9228 vertebrate faunal remains. Analysis of the vertebrate faunal remains at the comparative zooarchaeological collections at the University of Florida and the University of Georgia Museums of Natural History indicates the presence of some 19 different taxa, including: *Tylosurus* (needlefish), *Epinephelus* and *Mycteroperca* (grouper), *Caranx* (jack), *Lutjanus* (snapper), *Haemulon* (grunt), *Calamus* (porgy), *Halichoeres* (pudding-wife, wrasse), *Scarus* and *Sparisoma* (parrotfish, about 3-4 different species), *Acanthurus* (surgeonfish), Scombridae (various scombrids), *Balistes* (triggerfish), *Diodon* (porcupinefish), Aves (bird, a possible seagull), and *Rattus* (Old World rat). Identifications were made by the authors aided by the assistance of zooarchaeologists Dr. Elizabeth Reitz and Nanny Carder (both of whom are specialists in Caribbean and Latin American fishes) at the University of Georgia in the summer of 2004; the primary author was aided by the assistance of Dr. Irvy Quitmyer at the University of Florida in the summer of 2005. Analysis of the vertebrate fauna is still in progress at the time of this writing. The vertebrate taxa, their sizes, and habitats reveal a great deal about pre-Columbian diet, fishing techniques, and location of capture. Fishing techniques indicated by the fauna suggest a variety of harvesting methods including beach capture of egg-laying sea turtles and the use of hook and line, nets, traps, spears, and even accidental catches of fish in traps. Of the general categories of taxa identified to date, ca. 61.1% are coral reef taxa, 16.7% are shallow/inshore water taxa, and 11.11% are pelagic or open ocean taxa. These figures indicate that some 78% of the archaeological fauna was taken at the beach (e.g., sea turtle), in shallow inshore waters (e.g., jack, porgy), or from the coral reef (e.g., grouper, snapper, parrotfish, etc.). This pattern of near-shore resource utilization confirms a widespread pattern observed by previous researchers in the Caribbean and Bahamas and is reflective of the optimal foraging strategy utilized by the Lucayans, Taíno, and other prehistoric cultures of the Greater Caribbean.

INTRODUCTION

Stratigraphic excavation of a 25 m^2 area at the Minnis-Ward site was conducted to follow up on the shovel-testing program carried out in May 2003 (Blick, 2003; Blick & Bovee, 2005, this volume). The main goal of the 2004 excavation at Minnis-Ward was to confirm the presence of at least one of the hypothesized pre-Columbian houses that had been inferred on the basis of artifact distribution patterns generated from artifact counts derived from the 2003 shovel-testing program (Blick, 2003). The exercise was, at least in part, a success in that obviously domestic artifacts were recovered in the 2004 excavation. For example, significant quantities of pottery, bone, molluscan remains, coral manioc graters, beads, and worked shell indicated that the 25 m^2 excavation unit was located at or near a residential site (a.k.a. "household cluster" or "household unit;" see Winter, 1974, 1976; Flannery, 1976; Flannery & Marcus, 1983) that engaged in its own domestic activities, including food processing, cooking, consumption, disposal, and bead and shell working (see Blick, 2003). Information regarding the location of the Minnis-Ward site, its vegetation, topography, and soils has been presented elsewhere (Blick, 2003; Blick & Bovee, 2005, this volume) so is not repeated here. Likewise, presentation of the history of previous work at the Minnis-Ward site has been provided in the aforementioned references.

RESEARCH METHODS

The primary driving force in conducting area excavations at the Minnis-Ward site in 2004 was to attempt to determine if Blick's (2003) hypothesis regarding the presence of pre-Columbian houses could be verified. In 2003, a systematic shovel-testing program of an area of ca. 2700 m^2 was conducted on the northern portion of the Minnis-Ward site which, until that time, had not been subject to extensive investigations (Gerace, pers. comm., 2003). A series of some 105 shovel tests was excavated, yielding approximately 14,223 artifacts and ecofacts (see Blick, 2003; Blick & Bovee, this volume). Using Surfer 8.0 computer mapping software (Golden Software, Inc., 2003), a series of maps was created depicting the various artifact types recovered and the spatial distributions of those artifacts across the area of the site that had been tested (Blick, 2003, Figures 6-21). Based upon previous work in locating pre-Columbian household clusters in Colombia, South America (Blick, 1993), Blick hypothesized that pre-Columbian houses would be characterized by what might be called the "doughnut effect," i.e., a low density of artifacts near the center or living floor of the house surrounded by a high-density "ring" of artifacts around or outside of the house. This pattern is believed to be caused by prehistoric peoples sweeping or clearing the floors of their houses and patios, thereby creating a higher density area of artifacts (refuse) on the periphery of their living and work spaces (Blick, 1993; Blick & Bovee, this volume). Using the Surfer 8.0 computer-generated artifact-density distribution maps, Blick inferred the presence of some six pre-Columbian household clusters at Minnis-Ward. The 2004 area excavation conducted by Blick and students was performed in an area located on or adjacent to the hypothesized Household 1 (see Blick, 2003:34, Figure 6; Blick & Bovee, this volume, Figures 3 and 4). It was deemed necessary to excavate a fairly large area to detect house-related features such as post molds and pits, so an area of 25 m^2 was settled upon as being large enough to contain at least a portion of the house and some of its household features. In Colombia and Mesoamerica, average household clusters seem to occupy an area of about 50 m^2 (Blick, 1993); Keegan (1997:24) reported that a pre-Columbian "house" at the Coralie site, Grand Turk, appears to have been ca. 15 m long.

Household 1 was in one of the most, if not the most, high-density artifact areas based on the 2003 shovel-testing program (see Blick, 2003, Figures 6-21). Therefore, it was deemed likely that a large inventory of household artifacts would be recovered (which, with some 31,408 artifacts recovered, was indeed the case). The 25 m^2 excavation unit was placed near the hypothesized southwest corner of Household 1 at unit E10N5 (Figure 1; see also Blick, 2003:34, Figure 6). The excavation was carried out within natural stratigraphy and attempts were made to restrict levels to 10 cm in thickness. Eventual total depth of the excavation reached ca. 40 cm and appeared to reach the interface between the cultural bearing deposits and the sterile white subsoil below (more details of the excavation, site stratigraphy, and general findings are provided in Blick, 2003).

RESULTS OF THE ANALYSIS OF THE VERTEBRATE FAUNA

During the excavation of the 25 m^2 excavation unit at Minnis-Ward, vertebrate faunal remains were recovered in 1/16" (2 mm) fine mesh window screen, allowing for recovery of very small samples, fine pieces of bone, and shell beads. Vertebrate materials recovered were studied by Blick and Brinson using the comparative skeletal collections at the University of Georgia Museum of Natural History in the summer of 2004 and by Blick using the comparative collection at the University of Florida Museum of

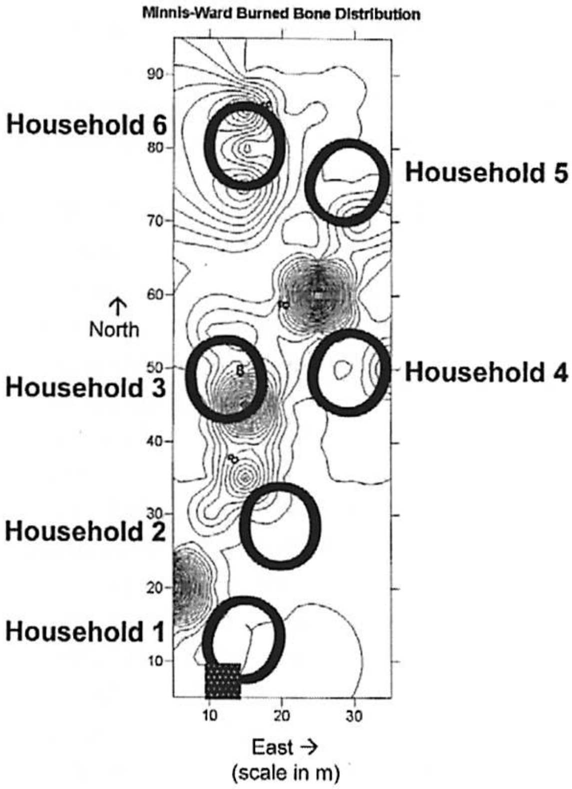

Figure 1. Map of the Minnis-Ward shovel test grid system showing the location of the 2004 25 m^2 excavation unit (stippled area) in relation to the southwest corner of Household 1.

Natural History in the summer of 2005. Blick and Brinson were aided by Dr. Elizabeth J. Reitz and Nanny Carder at the Georgia facility and Blick was aided by Dr. Irvy Quitmyer at the Florida facility. Identification and calculation of NISP (number of identifiable specimens), MNI (minimum number of individuals), and weights are still in progress at the time of this writing (in 2005). Modifications to the bones (primarily burning and cut marks) and measurements of diagnostic bones (e.g., atlases, premaxillae, dentaries, etc.) are also being recorded but are not reported here. The vertebrate fauna identified to date include 19 different taxa: *Tylosurus* (needlefish), *Epinephelus* and *Mycteroperca* (grouper), *Caranx* (jack), *Lutjanus* (snapper), *Haemulon* (grunt), *Calamus* (porgy), *Halichoeres* (puddingwife, wrasse), *Scarus* and *Sparisoma* (parrotfish, about 3-4 different species), *Acanthurus* (surgeonfish), Scombridae (various scombrids), *Balistes* (triggerfish), *Diodon* (porcupinefish), Aves (bird, a possible seagull), and *Rattus* (Old World rat). Each of the organisms is presented in taxonomic order (fishes first) and discussed in greater detail below.

Family Belonidae: *Tylosurus* (needlefish). Needlefishes belong to the family Belonidae. According to Hoese & Moore (1998:177), "The needlefishes are elongate fishes with both jaws extended into a beak. The jaws are well supplied with teeth, indicating the carnivorous habits of all the species." The most likely candidate represented by the *Tylosurus* remains recovered at Minnis-Ward is the *T. crocodilus* (also known as the houndfish; Hoese & Moore, 1998). "This fish is primarily found in offshore waters, but it ventures inshore occasionally" (Hoese & Moore, 1998:178). It is circumtropical and occurs from Massachusetts through the Caribbean to eastern Brazil and can reach a length of 61 cm (Hoese and Moore, 1998). On the other hand, Froese & Pauly (2005) report that *Tylosurus* can reach lengths of 153 cm and weigh up to 37.1 kg. Elizabeth Reitz (pers. comm.) suggests that the needlefish is most likely an accidental catch in the fish traps of prehistoric Caribbean fisherfolk and that *Tylosurus* is attracted to fish in traps into which it can penetrate due to its extremely thin body morphology. *Tylosurus* is of minor commercial interest today (Froese & Pauly, 2005) and was likely a nuisance to pre-Columbian fishermen.

Family Serranidae: *Epinephelus*, *Mycteroperca* (grouper). Today, grouper are found in shallow to deep waters in and around coral reefs and rocky areas. Grouper has been discovered on sites throughout San Salvador. In the Palmetto Grove site midden, sea bass (grouper is considered a sea bass species) made up the second-most abundantly found vertebrate, with the Nassau grouper being the most common (Wing, 1969). Gnivecki & Berman (1997) also discovered grouper at the Pigeon Creek and Three Dog sites. Previous excavations at the Minnis-Ward site have found grouper in abundance (Winter and Wing, 1995; Winter, 1997). Of the four known species of grouper found around San Salvador, the Nassau grouper (*Epinephelus striatus*) is the largest (up to 1.3 m in length) and the most common

(Ostrander & Brocksmith, 1997). While the other groupers in the area are found in medium to deep waters, the Nassau grouper prefers shallow waters in and around coral reefs. Because they are found in those areas, they are easy to catch, thus making them the most common grouper served to eat today (Ostrander & Brocksmith, 1997). The other three types of grouper also prefer coral reefs and rocky shelters; however, they tend to stay in deeper waters (Ostrander & Brocksmith, 1997). The red grouper (*Epinephelus morio*) and the tiger grouper (*Mycteroperca tigris*) both get their name from the markings they bear, with the red grouper having a reddish-brown coloring and the tiger grouper having eight to eleven "tiger" stripes ranging in color from white to light blue (Ostrander & Brocksmith, 1997). Both of these species average 1 m in length and, as with all grouper, are highly prized for food (Ostrander & Brocksmith, 1997). The only grouper not sought after for food is the yellowfin grouper (*Mycteroperca venenosa*). This grouper shares the same habitat and size as the red and tiger groupers, but is believed to be the only grouper in San Salvador that causes ciguatera poisoning (Ostrander & Brocksmith, 1997). Grouper feeding habits make them most likely to have been captured by hook and line. They tend to wait in a reclusive manner, hidden in the rocks or coral of the ocean floor, and when their prey swims by they lunge from their hiding spot to make the kill (Ostrander & Brocksmith, 1997).

Family Carangidae: *Caranx* (jack). There are three species of jacks found around the deep reefs of San Salvador (Ostrander & Brocksmith, 1997). The most common of the three is the bar jack (*Caranx ruber*). This species reaches up to 60 cm in length and constantly patrols fringing and barrier reefs in search of food (Ostrander & Brocksmith, 1997). However, they do not limit themselves to these habitats; they can also be found along flats of turtle grass (Ostrander & Brocksmith, 1997). It was this species of jack that was recovered at the Palmetto Grove site, just a relatively short distance to the north of the Minnis-Ward site (Wing, 1969). This may be because they are inhabitants of the deep reefs, causing indigenous peoples to go after shallower reef species out of shear convenience. The blue runner (*Caranx fusus*) has a very similar body morphology to that of the bar jack. It grows up to 1 m long and has coloration known as countershadowing; this coloration scheme tends to allow the fish to blend in with the ocean floor when viewed from above (Ostrander & Brocksmith, 1997). The blue runner is common from the West Atlantic to the Mediterranean, but it is not common around San Salvador. The prime place to catch a glimpse of these fish is in Graham's Harbor (Ostrander & Brocksmith, 1997). The rarest of the jacks to inhabit the waters of San Salvador is the yellow jack (*Caranx bartholomaei*), which gets its name from its yellow caudal fins. The reason for the scarcity of this fish in archaeological deposits is because it generally stays in the deeper waters along the west side of the island or along the wall (Ostrander & Brocksmith, 1997). A conclusion can be made that the indigenous people of the island did not often capture jack due to the fact that they frequent deep reef zones as opposed to the shallower near-shore reefs. Scarcity of jack can be observed in the faunal remains recovered in Berman and Gnivecki's excavation at the Three Dog Site. Here, of the 425 faunal remains reported, only 1 was identified as jack. At the same site, 230 of the 425 faunal specimens were parrotfish, a close reef species (Berman, 1994).

Family Lutjanidae: *Lutjanus* (snapper). There are three known species of snapper found in the reefs around San Salvador (Ostrander & Brocksmith, 1997). The gray snapper (*Lutjanus griseus*) can be differentiated from the other snappers by its steep snout and shallow body with pectoral fins. As the name implies, it is gray in color (Ostrander & Brocksmith, 1997). Ostrander & Brocksmith also report that the meat of this snapper is especially good and the fish is often sought after for sport. While mature snapper venture out to reefs, juvenile gray snapper can often be seen utilizing the protection given by mangroves, for example, near Pigeon Creek. They also feed on the roots of these aquatic plants (Ostrander & Brocksmith, 1997). The most abundant snapper found in the Bahamas is the schoolmaster snapper (*Lutjanus apodus*). It, like most snappers, has a triangular-shaped head at the meeting point of its forehead and snout (Ostrander & Brocksmith, 1997). Growing in size from 30-60 cm, this snapper hides among the reefs in daytime and can be found feeding at night, usually in the mangroves. The reefs and mangroves provide great protection, as well as ideal hunting grounds for these carnivores since many small schools of fish occupy these areas (Ostrander & Brocksmith, 1997). The yellowtail snapper (*Ocyurus chrysurus*) is a common snapper of San Salvador. What sets this snapper apart from the other snappers is that it is "not as restricted to night feeding as most snappers" (Ostrander & Brocksmith, 1997). They are also more "social" or "curious" than other species, as they are known to make close passes next to divers, making them easily observed (Ostrander & Brocksmith, 1997). During analysis of the Palmetto Grove site materials, Wing (1969) discovered that snappers were abundant in the Graham's Harbor area. Snapper was also reported in abundance from the Three Dog site (Berman, 1994; Berman & Gnivecki, 1997).

Family Haemulidae: *Haemulon* (grunt). Known as grunts, these fish make sounds by grinding their pharyngeal teeth together; this sound can be heard below and above the water (Ostrander & Brocksmith, 1997). It is the finding of these peculiar teeth that indicate that the inhabitants of the Minnis-Ward site exploited the grunt as a source of food. Grunts do not seem nearly as abundant as the parrotfish; however, they share the same general habitat. The striped grunt (*Haemulon striatum*) is a small grunt (15-27 cm) rarely seen because of its preference for medium to deep waters, where they are sometimes found in large schools (Ostrander & Brocksmith, 1997). The tomtate (*Haemulon aurolineatum*) is the smallest of the Bahamian grunts (13-26 cm) and is common and easily observed in shallow, open waters, such as turtle grass beds or sand flats around San Salvador (Ostrander & Brocksmith, 1997). The French grunt (*Haemulon flavolineatum*) is the most common grunt in the waters around San Salvador. It reaches a maximum of 30 cm in length and can be seen on any shallow water reef around the island (Ostrander & Brocksmith, 1997). The cottonwick grunt (*Haemulon metanuvum*) grows to 18-33 cm, and although not a common species of San Salvador, its easily recognizable markings enable it to be sighted occasionally (Ostrander & Brocksmith, 1997). As juveniles, cottonwick grunts are reported to school on deep, offshore reefs. When they mature, they move inshore and form small schools (Ostrander & Brocksmith, 1997). The smallest grunt found around San Salvador is the bluestriped grunt (*Haemulon sciurus*). It reaches a maximum of 25 cm and is primarily found in schools that feed on coral reefs by day and on crustaceans by night. Its abundance is moderate, with the most likely place to observe this species being in the area of Graham's Harbor (Ostrander & Brocksmith, 1997). The white grunt (*Haemulon plumieri*) is a shallow water species that forms schools in the day along patch reefs, splitting up to feed at night. These grunts are relatively large (20-35 cm) in length. Ostrander & Brocksmith (12997:41) report that, "as with other grunts...around San Salvador, these fish will sometimes exhibit a 'kissing behavior'...a mild form of aggression" that is "frequently associated with the acquisition of mates, as well as territory and social dominance." The smallmouth grunt (*Haemulon chrysargyreum*) is another common species found in the reefs of San Salvador. This is another large grunt (20-35 cm), mature individuals of which are found in small schools in reefs, with juveniles found more commonly in inshore waters (Ostrander & Brocksmith, 1997). Other reef dwelling species were abundant at the Palmetto Grove site, but no grunts were found (Wing, 1969). Wing's (1969) research revealed that grunts were abundant at Graham's Harbor, suggesting that the procurement of fish for dietary purposes was likely restricted to local areas in close proximity to the prehistoric habitation sites.

Family Sparidae: *Calamus* (porgy). According to Hoese & Moore (1998:234-235), "The porgies are a family of moderately sized fish, some of which resemble the grunts. They are best characterized by their anteriormost teeth, which are either flattened incisors or peglike canines. Most species are omnivorous, feeding on attached vegetation or invertebrates." *Calamus* is considered an excellent food fish; however, there are reports of ciguatera poisoning associated with the eating of this fish (Froese & Pauly, 2005). *Calamus* reaches ca. 76 cm full length and ca. 10.6 kg in weight and was likely taken with a hook and line or trap according to the literature (Froese & Pauly, 2005). Porgies reported in the Bahamas include the sheepshead porgy (*C. penna*), the saucereye porgy (*C. calamus*), the jolthead porgy (*C. bajonado*), and the pluma (*C. pennatula*); all are considered occasional (Humann & Deloach, 2002). *Calamus* is reported from the Palmetto Grove site on San Salvador (one premaxilla; Wing, 1969).

Family Labridae: *Halichoeres* (puddingwife and other wrasses). According to Hoese & Moore (1998), "The wrasses are an abundant family of tropical and temperate fishes related to the parrottfishes, from which they differ by having individual teeth not fused into a beak." *Halichoeres* (puddingwife) and other wrasses are reported as having no modern fisheries interest due to their generally small size (Froese & Pauly, 2005). *Halichoeres* as a genus is reported to reach ca. 20 cm total length and its method of capture was likely with nets or traps (Froese & Pauly, 2005). The puddingwife is the largest member of *Halichoeres*, reaching some 51 cm, and is found from North Carolina and Bermuda south through the Caribbean to Brazil (Hoese& Moore, 1998). The puddingwife is reported as occasional to the Bahamas and to be constantly swimming about the reef (Humann & Deloach, 2002). Puddingwife has been identified in the vertebrate remains from Minnis-Ward based on its distinctive premaxillae and dentaries. Remains of other wrasses are also reported from Minnis-Ward by Winter & Wing (1995).

Family Scaridae: *Scarus*, *Sparisoma* (parrotfish). By far the most common faunal remains are those of the parrotfishes. There are five species of parrotfish that inhabit the waters of San Salvador, four of which are included in the genus *Scarus* and one that belongs to the *Sparisoma* genus. The queen parrotfish (*Scarus vetula*), rainbow parrotfish (*Scarus guacamaia*), and the stoplight parrotfish (*Sparisoma viride*) are the most abundant species found in the waters of San Salvador. The princess parrotfish (*Scarus taeniopterus*) and the midnight parrotfish (*Scarus coelestinus*) are less common, with the latter being the most rare (Ostrander & Brocksmith, 1997). These animals' teeth fuse to produce a "parrot-like" beak, an attribute that has given them their common name. The shape and function of these premaxillae and dentaries allow the fish to graze on coral heads (Ostrander & Brocksmith, 1997). The parrotfishes are considered to be quintessential reef inhabitants (Choate & Bellwood, 1991; Bellwood, 1994), but are sometimes found along the tidal flats (Keegan, 1982). The abundance of parrotfish remains at many sites on San Salvador indicates that this fish was a staple of the Lucayan diet. For example, parrotfish dominated the assemblage of faunal remains at the Three Dog site, with evidence of three species exploited (Berman & Gnivecki, 1997). At Three Dog, Berman (1994) reported that of the 425 faunal specimens, 230 were those of parrotfish. Previous work by John Winter at the Minnis-Ward site (Winter and Wing, 1995; Winter, 1997) revealed similar findings; most of the fauna recovered was "composed of species...found in coral reefs. Parrotfish...are the most widely represented species at this site" (Winter, 1997:37-38). Furthermore, at the nearby Palmetto Grove site, where fish bones accounted for more than 99% of fauna recovered, 66% of the fish were parrotfish (Wing, 1969; Hoffman, 1997). The parrotfish habitat includes the coral reefs and sometimes the tidal flats of San Salvador. The island is completely surrounded by these reefs and flats; therefore, the heavy exploitation of these reef-dwelling fish was likely due to convenience (see discussion in Wing & Reitz, 1982). Blick (2003) reported that the local populace of San Salvador does not eat parrotfish because it decomposes quickly once removed from the sea (Don Gerace, 2003, pers. comm.).

Family Acanthuridae: *Acanthurus* (surgeonfish). The genus *Acanthurus* is represented by two species around San Salvador: the blue tang (*Acanthurus coeruleus*) and the doctorfish (*Acanthurus chirurgicus*) (Ostrander & Brocksmith, 1997). Tang and doctorfish are also known as surgeonfish. They get their common name due to a hinged spine that is like that of a surgeon's scalpel, which functions like a hypodermic needle. This spine is capable of excreting a toxin into whatever enemy comes into contact with it (Ostrander & Brocksmith, 1997). The blue tang is the most common *Acanthurus* found in the waters of San Salvador and may grow between 30-35 cm. Like the doctorfish, it is herbivorous, staying in shallow waters around reefs and other structures. While both species may occupy deeper waters, they will travel into shallow waters at dusk to feed primarily on algae (Berman, 1994). The two species differ in that the blue tang tends to swim high in the water column, whereas the doctorfish remains close to the reef (Ostrander & Brocksmith, 1997). Excavations at both the Three Dog (Gnivecki & Berman, 1997) and Minnis-Ward sites (Winter & Wing, 1995; Winter, 1997) revealed remains of *Acanthurus*. Wing (1969) reported blue tang in abundance off of Polaris Point, not far from the Palmetto Grove site, from which she was able to identify 25 archaeological specimens of *Acanthurus*.

Family Scombridae (mackerels and tunas). Scombrids are members of the mackerel/tuna family. These fishes are "typified as fast-swimming oceanic fishes [with] streamlined body, stiff fins, and rigid caudle peduncle, [which] enable these fishes to swim constantly at high speeds" (Hoese & Moore, 1998:275). These animals generally feed on smaller fishes and squid, and many genera are highly desirable as game fish (Hoese & Moore, 1998; Froese & Pauly, 2005). Their carnivorous nature makes them more likely to take a hook and line, which is how they were likely caught in pre-Columbian times (Wing & Reitz, 1982). Sizes of the scombrids are highly variable, but generally range between 70-183 cm, with weights ranging between ca. 16.5-77.6 kg (Froese & Pauly, 2005). Scombrids are rare at the Trants site in Montserrat, making up only 1% of the individuals recovered in the 1/8" screens (1 mackerel; Reitz, 1994). No scombrids are reported by Wing (1969) from the Palmetto Grove site on San Salvador, although scombrids are indeed reported from Minnis-Ward (Winter & Wing, 1995). Throughout the Greater Caribbean, records of scombrids reported from prehistoric archaeological sites include such fishes as *Auxis* sp. (mackerel), *Euthynnus* sp. (tuna), *Scomberomorus* sp. (mackerel), *S. regalis* (cero), and *Thunnus* sp. (tuna; Wing & Reitz, 1982; Winter & Wing, 1995). It appears that the offshore-pelagic nature of these fishes would place them outside the ordinary range of pre-Columbian fisherfolk, who seem to exploit near-shore resources much more commonly (Wing & Reitz, 1982).

Family Balistidae: *Balistes* (triggerfish). There are two species of triggerfish in the waters of San Salvador: *Balistes* and *Canthidermus*. The queen triggerfish (*Balistes vetula*) is more than likely the species exploited by the indigenous peoples of the island, since it is more common around the easily accessible reefs. The queen triggerfish grows up to 50 cm in length, with its main diet consisting of sea urchins (Ostrander & Brocksmith, 1997). The ocean triggerfish (*Canthidermus sufflamen*) was not as accessible to pre-Columbian peoples, for its habitat is of a pelagic nature and the fish is rarely found inshore. *Canthidermis* is the largest of the triggerfish, growing up to 60 cm in length, and is found around offshore reefs or along the edges of banks (Ostrander & Brocksmith, 1997). Ostrander & Brocksmith (1997:27) report that triggerfish are named for a "modification of dorsal and anal spines into triggers. When threatened the fish will swim in crevices and erect these spines to 'lock' themselves into place. The harder a would-be predator pulls on the fish, the tighter it is wedged into place." Triggerfish remains have been recovered at numerous sites on the island, including Pigeon Creek (Gnivecki & Berman, 1997), Three Dog (Berman, 1994; Berman & Gnivecki, 1997), and the Minnis-Ward site (Winter & Wing, 1995; Winter, 1997). Furthermore, Wing (1969) reported 49 specimens of triggerfish from the nearby Palmetto Grove site, readily identifiable by its distinct dorsal spine.

Family Diodontidae: *Diodon* (porcupinefish). *Diodon hystrix* is reported as the "largest Bahamian species of puffer or porcupine fish growing to nearly a meter" (more often about 50 cm; Ostrander & Brocksmith, 1997:29). On San Salvador, these animals are recorded as common under the reef, in particular at Dump Reef. According to Ostrander & Brocksmith (1997:29), "Members of this species possess powerful jaws, which allows them to feed on various species of mollusks.... When threatened the animal can rapidly inflate their bodies with water (or air if removed from the water), thereby causing all the spines to become erect. This serves as an effective means for discouraging potential predators." Hoese & Moore (1998:312) report that *Diodon* typically reaches 61 cm in length and is circumtropical "from Massachusetts through the Caribbean to Brazil." The fish is listed as occasional in the Bahamas. Another species of *Diodon* is the balloonfish, *D. holocanthus*, which is reported as uncommon in the Bahamas (Humann & Deloach, 2002). Wing (1969:27) reports porcupinefish from the Palmetto Grove site on San Salvador and notes that "Their internal organs are poisonous to man." Winter (1981) has reported *Diodon* jaw to be the source of a polished pendant recovered at the Minnis-Ward site, and Winter & Wing (1995) report the presence of triggerfish among the reef-dwelling species recovered from Minnis-Ward.

Family Cheloniidae: *Chelonia* (green sea turtle). The overwhelming majority of faunal remains recovered from Minnis-Ward were those of bony fishes. However there is evidence of reptilian fauna in the form of sea turtle remains. The exact species of turtle is undetermined, but the most likely species is that of *Chelonia mydas*, or the green sea turtle. The green sea turtle feeds on sea grass that is abundant in the shallow waters around San Salvador (Jackson, 1997, Keegan, 1992). The presence of turtle remains is relatively common on sites around San Salvador. Berman (1994) reports marine turtle as well as a possible fresh water turtle (*Trachemys*) found at the Palmetto Grove, Minnis-Ward, Three Dog, and Long Bay sites. The reason the green sea turtle is the more probable species exploited is that it is the most common and has the most desirable meat for dietary purposes (Keegan, 1992). Other sea turtles that inhabit the waters of San Salvador were less likely to have been exploited. For example, the loggerhead turtle (*Caretta caretta*) has a poor shell and less than desirable meat, and the hawksbill turtle (*Eretmochelys imbricata*) is far less common (Keegan, 1992). Blick suggests that, due to large quantities of burned turtle shell found at the Minnis-Ward site in 2003, the animal was more than likely cooked while still in its own shell, with the fire closest to the underbelly of the turtle (Blick, 2003). In support of this statement, it has been ethnographically reported that the Satawal (Yap) islanders of the Pacific cook sea turtles by building a fire on top of the turtle, which is itself placed belly up (upside down) on the ground (Pacific Worlds & Associates, 2003); the meat is then divided up among households or clans, a scenario also proposed for prehistoric peoples of the Caribbean (Wing & Wing, 2001). Some modern Australian aborigines cook sea turtles using hot rocks, which they insert into the body cavity of the turtle (another possible use for the fire-cracked rock reported from San Salvador).

The exploitation of the turtles would have been fairly easy, being that they had to come onto the beach to lay their eggs (Reitz, 1994; Winter and Wing, 1995). Also, the shallow sea grass beds close to shore were easily accessible (Keegan, 1992; Jackson, 1997). However, it has been suggested that there may be less turtle remains on archaeological sites than actually procured due to the fact that the meat is attached tightly to the limbs (Wing & Reitz, 1982), and green sea turtles can be very heavy, weighing up to 205 kg (Animal Diversity Web, 2005). In this case, butchering may have taken place at the site of capture and only the meat was taken back to the inhabitant's site (Wing & Reitz, 1982; Wing & Wing, 2001). Either way, there is little doubt that sea turtle was at least an occasional or seasonal part of indigenous Bahamian diet.

Aves: Bird (possible sea gull). According to Wing & Reitz (1982:20), "Birds are relatively scarce in prehistoric sites of this area [the Caribbean]." Keegan (1992) also notes that birds were a very small component of the Lucayan diet in the Bahamas. Ethnohistorically, it is known that the Taíno "kept domesticated Muscovy ducks (*Cairina moschata*)" (Keegan, 1992:126). At the Trants site on Montserrat in the Lesser Antilles, Reitz (1994) recorded the presence of a number of birds, including unidentified bird, ducks, rails, pigeons or doves, and songbirds. These birds made up some 17.8% of the MNI (minimum number of individuals) at Trants recovered in 1/8" screens (Reitz, 1994:307, Table 6). Wing (1969) reports a single specimen of bird from the Palmetto Grove site on San Salvador and also notes that a booby "*Sula* sp. was identified from material excavated by Dr. John M. Goggin" (Wing, 1969:26). Winter and Wing (1995) report a single fragment of bird bone from the Minnis-Ward site. The single fragment of bird recovered by Blick at Minnis-Ward was identified tentatively by Dr. Irvy Quitmyer as a possible seagull.

Mammalia: *Rattus* (Old World rat). One of the most recent identifications made in the laboratory in the summer of 2005 includes a single rat skull, most likely an Old World rat (*Rattus*). Although possibly intrusive into Level 2 (ca. 10-20 cm below surface) at Minnis-Ward, this rat specimen may represent evidence for the arrival of Columbus, since we know almost to the day when Old World rats arrived in the New World (Irv Quitmyer, pers. comm.). This rat specimen may represent the beginning of the great "Columbian Exchange" (Crosby, 1972) of animals, plants, and diseases into the New World that so ravaged Native American populations. In the words of Crosby (1972:97): "The Old World rat...hitched a ride across the Atlantic and became an important pest and carrier of disease in the ports of colonial America. This was probably the black rat, which is more common in the tropics and on board vessels.... rats were not common in the Bermudas before the coming of the Europeans, and when they arrived, set off one of the most spectacular ecological disasters of the age." Radiocarbon dating of the rat skull is planned in the very near future to resolve the question of its age. The black rat (*Rattus rattus*) is reported to be present on San Salvador and has become a pest in modern times (Hall *et al.*, 1998). According to Winter & Wing (1995:427), the rarity of mammals is not unusual; the "scant...or total absence of land vertebrates occurs on other sites on San Salvador."

PRE-COLUMBIAN SUBSISTENCE AND FISHING TECHNIQUES

"From the bounteous sea, close-by everywhere, a boy in a few hours could gather sufficient nutritious protein to feed his household for a week" (Albury, 1975:185). Albury made this statement in reference to modern Bahamians, but this statement was perhaps even more true during pre-Columbian times. Given their maritime adaptation, it is easy to understand how the main staple of the Lucayan diet was marine fish. In fact, it has been suggested that approximately 75% of the meat eaten by the Lucayans was made up of marine fish (Keegan, 1997). The archipelagic nature of their habitat made fish the most convenient and efficient source of subsistence (Wing & Reitz, 1982; Wing & Wing, 2001). Keegan suggests that "subsistence economies are viewed as attempting to minimize the costs of production," and these economies or lifestyles "seek the most resources for the least effort" (Keegan, 1992:114). In fact, many subsistence economies are based around what in modern economic terms we call the "principle of least effort," or what has become known in anthropology and biology as "optimal foraging strategy." Keegan views fishing as a predator-prey interaction, and to capture a fish the human needs to behave in a manner that articulates with the fish's behavior (Keegan, 1982). If this is done appropriately, the capture of fish is expeditious. Simply put, the more we know about the behavior of fish, the more insight we gain regarding this past human subsistence pursuit and the successful catch of fish in pre-Columbian times (Keegan, 1982).

The fishing technologies of the Lucayans were determined by several factors. Fish behavior, morphology, and environmental features all played a large role in which technique was used to capture a certain species of fish (Wing & Reitz, 1982; Berman, 1994). In return, the fish type and size of the species caught are determined by the fishing technique implemented (Berman, 1994). The fishing techniques used by prehistoric peoples are known from the few archaeological implements recovered, early chronicler's descriptions of fishing techniques, and ethnographic studies of native fishing practices (Keegan, 1982; Wing & Reitz, 1982). It is widely understood that the basic fishing techniques of the Lucayans consisted of hook and line, projectile implements (e.g., spear), nets, traps, and weirs (Keegan, 1982, 1986, 1997; Wing and Reitz 1982; Berman, 1994).

The hook-and-line technique was most likely used for deep reef carnivores (Wing & Reitz, 1982; Berman, 1994,). These carnivores are more likely to take a hook than omnivores and herbivores. The reason the deeper reef inhabitants are more likely pursued using this technique is because shallow reef species are more efficiently caught with traps or nets (Keegan, 1986). The hook-and-line technique requires skill and is very time consuming, whereas traps and nets take less skill and time. Also, the yield from the hook-and-line capture technique is considerably lower than capture with traps or nets. Fish will often scatter when the hook enters the water, thus reducing the potential yield (Keegan, 1986). It is a known fact that the Lucayans used the hook-and-line technique. Hooks have been found in the archaeological record throughout the Caribbean (Wing & Reitz, 1982; Keegan, 1986), although hooks are relatively rare. Hooks made of marine shell, tortoise shell, bone, and gold have been found around the Caribbean (Wing & Reitz, 1982). There are also well-documented reports from early chroniclers of the West Indies, including Columbus, of the Lucayans using the hook-and-line technique (Wing & Reitz, 1982). As far as the fauna found at the Minnis-Ward site is concerned, the species that would most likely have been caught using the hook-and-line technique would have been the grouper and the snapper (Wing & Reitz, 1982), but capture of these species is not restricted to this technique, for other techniques could have been implemented as well.

Projectile implements, such as the spear, were most likely used in clear, shallow waters, and used to capture fish of relatively larger size (Berman, 1994, Wing and Reitz, 1982). Various materials may have been used to produce these spear points. Bone or shell points attached to wooden spear shafts or arrows were used (Blick, this volume, Wing and Reitz, 1982), as well as fish teeth and possibly stingray spines (Campbell, 1998, Wing, 1969). Columbus describes in the records of his travels through the West Indies how the Taíno used these "darts" to capture fish (Wing, 1969). The negative side to the use of projectile implements for capture is similar to the negative aspects of the hook-and-line technique. The act of harpooning takes a great deal of skill in order to be successful; in order to become a skillful harpooner, time out of one's life need be set aside in order to train. This takes time away from activities like foraging and other subsistence pursuits. Also, the initial impact of the projectile into the water would likely strike one fish while the others would scatter away, thus decreasing the potential yield (see more details in Keegan, 1986). It is this time consumption and potential low yield that makes the overall efficiency of projectile fishing less than desirable for a subsistence economy. Fish that would be susceptible to harpooning would include the rainbow parrotfish and fish that share characteristics (both physical and behavioral) of the rainbow parrotfish, like drum and snook, for example (Wing and Reitz, 1982). It is also possible that harpooning was one way that sea turtles were captured: the speed and size of the sea turtle makes it an easy target for a harpooner (Wing and Reitz, 1982). Reef omnivores are an unlikely victim of harpooning for they stay hidden among the reef until nighttime, when they come out to feed on algae and sea grasses (Keegan, 1986). Projectile implements, therefore, appear to have had numerous limitations in their use due to the requirements of location, skill, training, and yield.

Nets were also used by the Lucayans for capturing fish. Nets were produced by the weaving of a variety of knotted or woven cordage (Wing and Reitz, 1982). It is known in particular that the Lucayans of the Bahamas had a relatively sophisticated perishable industry centered around basketry and other fiber technology (Berman and Hutcheson, 2000, Hutcheson, 2001). Nets not only varied in their makeup, but also in their uses. Nets weighted on one end and floated on the other were used to capture fish as they swam inadvertently into the net. Small dip nets (woven nets attached to rigid hoops) were also used and were probably used to grab fish and turtles from corrals (Wing and Reitz, 1982). Wing and Reitz (1982) also note that small, baited nets were used like traps and were weighted down by shells. Hoffman (1967:94-97, 95, Figure 14) reports *Strombus* (queen conch) shell weights from the Palmetto Grove site. It is unlikely that tramail nets or cast nets were used since these items were Old World introductions (Wing and Reitz, 1982). Nets are most successful when used in an area where the sea bottom is flat and the sea is calm. Because of this, netting is extremely suitable for the inshore-estuarine habitat, and was more than likely used along the Caribbean mainland coast rather than the islands, at least according to Wing & Reitz (1982). As far as San Salvador is concerned, netting would be a less than adequate way to capture fish. Because the island is completely surrounded by reefs, netting would have been difficult. Nets cannot be maneuvered over the surface of a reef and nets get caught on coral heads, thus allowing an easy escape for fish (Wing & Reitz, 1982; Berman, 1994). Another negative aspect of netting is the fact that benthic species could have escaped through the bottom gaps of the net, thus reducing the yield (Keegan, 1986).

Traps and weirs are suggested to be the most efficient device for fish capture and likely represented the predominant technique of the island fishing economy (Wing & Reitz, 1982). The use of traps would require minimal investment of time: while the traps were left unattended, other foraging activities could be pursued. Also, the task of examining the traps could be combined with other subsistence activities, thus reducing the cost of travel to and from the traps (Keegan, 1986). Traps were likely used by the Lucayans of San Salvador because traps are one of the known technologies used in the prehistoric Caribbean (Keegan, 1982) and also because traps are widely used throughout the Greater Caribbean today (Wing, 1969; Wing & Reitz, 1982). Use of traps is not known through archaeological evidence (their perishable nature makes them unlikely to be preserved), nor through early descriptions of chroniclers (Wing & Reitz, 1982). The use of traps in the prehistoric Caribbean can be inferred by the uniformity of fish sizes from experimental catches and their correspondence with the sizes of fish bones in faunal collections from archaeological sites (Wing & Reitz, 1982; Keegan, 1986; Berman, 1994). This uniformity in fish size is indicative of trap use because trap entrances restrict the maximum size of the fish, and the mesh of the trap sets a minimum by allowing smaller fish to escape (Keegan, 1986; Wing & Reitz, 1982).

Traps are valued for their high yield and low skill requirements for use and maintenance (Keegan, 1986). It is not known precisely why fish enter traps; some have suggested it is to seek shelter and protection from predators (Wing & Wing, 2001), while others note that traps could simply be baited (Wing, 1969). Keegan (1986) suggests that bait does not seem to exert an influence on trap success. Once a fish enters the trap, other fish of the same species will enter, as well as predators looking for prey (Keegan, 1986). Predators (for example, *Tylosurus*) soon find access through the trap openings and the resulting catch includes both herbivores/omnivores and carnivores (the undesirable predators). Predators too large to enter the trap are attracted to the trap, enabling fishermen to capture predatory fish upon recovery or emptying of the trap (Keegan, 1986; Berman, 1994). It is not exactly known where traps were actually placed. During an experiment on Pine Cay in the Turks and Caicos Islands, Keegan (1982) noted that traps on the reef were subject to damage (due to weather, wave action, and sharks) and loss due to natural occurrences or theft. Also, weather and wave action made recovery of traps difficult. Keegan (1982) further explained that traps set on tidal flats suffered similar losses, although not to the extent of traps set on the reef.

Setting traps on the reef is a logical strategy to capture reef fish. Reef fish tend to be completely dependent on the reef for food and protection from predators (Keegan, 1986). However, reef-dwelling species (e.g., parrotfish, doctorfish) venture out of the protection of the reef at dusk and move towards shallow grass flat feeding grounds (Keegan, 1986). These fish migrate to the grass flats along narrowly-defined routes. By setting up traps, weirs, and/or seine nets along these crepuscular migration routes, inhabitants may reap large quantities of fish. Therefore, traps set in the reef and/or nets along these feeding routes are the most probable techniques used for capturing reef-dwelling species (Keegan, 1986). Putting this information in the context of the Minnis-Ward collection is helpful. With the majority of the fauna collected believed to be parrotfish (a primary reef dweller), it can be inferred that traps are likely to have been used by the inhabitants of the site. Once final analysis of the fauna is completed and fish sizes estimated, we will have better evidence for the use of fish traps (and other harvesting techniques). A small variance in the size of the fishes caught (as reflected in the measurements performed on the faunal remains) would suggest that traps were likely the primary fish capture technique.

The final pre-Columbian fishing technique consisted of the use of weirs. Weirs act as traps and as corrals. "Weirs depend upon tidal change or other position-intercepting movement of fishes and as such would be ineffective in catching fishes that move only a few feet from their reef territories regardless of tidal flow" (Wing & Reitz, 1982:26). These capture devices would be effective where fish frequent particular coastal locations (Keegan, 1986). Weirs are areas (sometimes natural areas manipulated by man or constructed devices) where the fish would enter the device upon high tide and become trapped during low tide. Sometimes these corrals would serve as holding pens for fish until sufficient quantities were procured (Wing & Reitz, 1982). Check-dams across the mouths of tidal creeks were also likely constructed. This would allow fish to enter at high tide but prevent their escape at low tide (Keegan, 1997).

Based on an extensive review of the literature and an examination of the types of fishes present in the vertebrate faunal remains recovered from the Minnis-Ward site, the Lucayan fisherfolk of San Salvador clearly had a wide variety of fishing techniques at their disposal. These techniques were flexible and adaptable to the varying behavioral and morphological features of the fish that were exploited, and the fishing methods were also appropriate to the local ecological and bathymetric conditions (reef, sandy bottom, etc.) of the location where the fishing was taking place.

CONCLUSIONS

To date, ca. 19 different taxa have been identified in the vertebrate faunal remains recovered from the May 2004 excavations at the Minnis-Ward site. The fishes identified indicate a heavy reliance on coral reef taxa (e.g., grouper, snapper, parrotfish) and shallow/inshore water taxa (e.g., jack, porgy, sea turtle), with minor reliance upon less accessible pelagic or deep-water taxa. This pattern of coral reef and near-shore resource utilization is repeated at archaeological sites throughout the Greater Caribbean (Wing & Reitz 1982) and reflects the optimal foraging strategy used by the Lucayans and their Caribbean neighbors (Keegan, 1992). Other vertebrate fauna in the Minnis-Ward sample include rare occurrences of bird (possible sea gull) and mammals, another pattern observed in Caribbean archaeological sites and on San Salvador (Reitz, 1994; Winter & Wing, 1995). Lucayan harvesting techniques used to capture fishes and sea turtles were varied and reflected Lucayan adaptability to the species and ecological conditions involved in the catch (Keegan, 1982, 1986). This is no surprise considering that, "At sea, the Lucayans were as much at home as on land" (Albury 1975:18). The vertebrate faunal remains from Minnis-Ward provide an incomplete picture, however, of the total Lucayan subsistence strategy. The Lucayan diet also included numerous invertebrates (e.g., *Cassis*, *Chiton*, *Codakia*, *Strombus*, land crab, and perhaps even gastropods, just to name a few; Keegan, 1992; Blick, 2003), as well as agricultural crops including maize, beans, manioc, sweet potato, peanuts, and other assorted roots and tubers (see Keegan 1992; Berman & Pearsall, unpubl. ms). We must remember that the Lucayans "practiced a mixed economy of root-crop horticulture and hunting-fishing collecting" (Keegan 1992:124) and that the vertebrate faunal remains provide only a small glimpse into Lucayan subsistence practices.

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