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IDENTIFICATION AND AMS DATING OF THE EPIBIONT, *CHELONIBIA TESTUDINARIA* (CIRRIPEDIA: BALANOMORPHA: CORONULOIDEA), ASSOCIATED WITH ARCHAEOLOGICAL REMAINS FROM THE NORTH STORR'S LAKE SITE (SS-4), SAN SALVADOR, BAHAMAS

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ABSTRACT

Excavations at North Storr's Lake (SS-4) on San Salvador, Bahamas have yielded turtle barnacle wall plates (shell compartments) in association with skeletal remains of sea turtle and charcoal dated to ca. A.D. 932-1552. This is one of the few cases in which direct and indirect radiometric dates have been reported for archaeological sea turtle barnacles. The turtle barnacle has been identified as *Chelonibia testudinaria* (Linnaeus, 1758), a widespread, commensal species found on all genera of Cheloniidae in the world's oceans. *Chelonibia testudinaria* is the most often reported sea turtle barnacle and is commonly found on *Caretta caretta* (loggerhead) and *Chelonia mydas* (green turtle) dating as far back as the Miocene epoch. Wall plates of *Chelonibia testudinaria* occur in stratigraphic association with both loggerhead and green sea turtle remains at North Storr's Lake, appearing in the same archaeological strata as the sea turtle, therefore the association is clear. Sea turtle species were identified using DNA and stable isotope analysis (SIA) on bone; barnacles analysis (SIA) on bone; barnacles were identified by one of us (JDZ) using modern biological specimens for comparison. Accelerator Mass Spectrometer (AMS) dates from carbonized wood and bone in site stratigraphy, and dates on the barnacles themselves, span the period ca. A.D. 932-1552, indicating sea turtle exploitation by the indigenous Lucayans several centuries prior to the arrival of Columbus on San Salvador. AMS dates, site stratigraphy, and species identifications suggest that green turtle may have been harvested earlier and over a longer time span (ca. A.D. 1100-1500) than loggerhead (ca. A.D. 1311-1354). Based on these results, this locality at the North Storr's Lake site is interpreted as a traditional sea turtle butchery site where multiple species and individuals were repeatedly butchered over a relatively lengthy time period.

INTRODUCTION

The North Storr's Lake site (SS-4) is located on the northeastern coast of the Island of San Salvador, Bahamas at approximately 24° 05'

00.00''N, 74° 26' 19.00'' W, on a NNE-SSW trending fixed dune between the northern arm of Storr's Lake and the Atlantic Ocean (Figure 1). The site ranges in elevation from about sea level (lake level) on the western boundary of the site to ca. 20 m above sea level at the peak of the dune. The site appears to be a large multicomponent prehistoric Lucayan site, with radiocarbon dates from ca. A.D. 932-1552 (Blick and Murphy 2005, Blick, Creighton and Murphy 2006, Blick n.d., Shaklee, Fry and Delvaux 2007). Details on previous long-term work at the site by a team from Youngstown State University have been published elsewhere (Shaklee, Fry and Delvaux 2007). Perry Gnivecki and John Winter have also been involved in recent work at SS-4. This report will concentrate on the 2x4 m stratigraphic excavation conducted by Blick and students in May 2006 (Blick, Creighton and Murphy 2006).

Figure 1. Aerial photograph showing the location of the North Storr's Lake site (SS-4) (GoogleEarth 2006).

THE MAY 2006 EXCAVATION AT SS-4

23,675 prehistoric artifacts and ecofacts were recovered in the May 2006 excavations of two adjacent 2x2 m units, 85E51N and 87E51N, falling into about 19 categories, listed as follows: animal bones and otoliths (reptile [sea turtle], fish, mammal, etc.), shell beads, *Cerion* shells and shell fragments (*Cerion watlingensis*), charcoal (charred wood) fragments, chiton (*Chiton tuberculatus* [West Indian chiton] or *Acanthopleura granulata* [fuzzy chiton]), clam shell fragments (*Codakia orbicularis*), conch shell fragments (*Strombus gigas*), coral fragments (*Acropora cervicornis*, etc.), crab fragments (*Cardisoma guanhumi* and *Gecarcinus ruricola*), music volutes (*Voluta musica*), nerites (*Nerita* sp.), pottery, pumice, rock and possible fire-cracked rock (FCR), a shark's tooth (Carcharhinidae), a piece of worked and engraved shell believed to be a piece of inlay for a wooden duho or zemi's mouth), turban shells (Turbinidae), variable Cepolis (*Hemitrochus varians*), West Indian top shell (*Cittarium pica*), a variety of unidentified shell and shell fragments, and a number of as yet unidentified gastropods. No historical artifacts were found in the May 2006 excavations. All artifacts were identified, sorted, counted, and weighed according to previously established laboratory analysis procedures. Blick performed additional analyses on some of the items (e.g., animal bones, shell beads) as necessary for this article and other projects.

Stratigraphy at the May 2006 excavation locale (Unit 1, 85E51N, and Unit 2, 87E51N) was similar to that encountered in the May 2005 2x2 excavation at coordinates 81E17N ca. 34 m to the south of Unit 1 (Blick and Murphy 2005). The excavation was carried out in approximate 10 cm arbitrary levels (numbered Levels 1-6 from most superficial to most profound) within natural stratigraphy (numbered Strata I-III from uppermost to lowermost). Natural Stratum I (ca. 0-11 cm below surface) is classified as an A_1 horizon or humus layer, light gray-gray (10YR6/1) to light brownish gray (10YR6/2) in color. Stratum I consists of a medium sand with fine, poorly sorted subangular grains. Stratum II (ca. 11-34 cm below surface) is characterized as an A_2 horizon or leached zone, light gray-gray (10YR6/1) to light brownish gray (10YR6/2) in color, with very pale brown (10YR8/3) or white (10YR8/2) mottling which increases as one approaches Stratum III. Stratum II is composed of medium sand with fine, poorly sorted angular/subangular grains. Stratum III (ca. 34-69 cm below surface) is classified as a

B horizon, very pale brown (10YR8/3) to white (10YR8/2) in color, and appears to represent the ancient beach or sand dune surface upon which the Lucayan occupation eventually settled. Stratum III consists of fine/medium sand with fine, poorly sorted rounded to subangular grains. Soil horizon descriptions generally conform to Sealey (1990:4, Fig. 1.4, 1994:86, Fig. 8.1). A deep test in the center bottom of excavation Unit 1 (85E51N) was performed to an additional depth of 50 cm (total depth below surface of ca. 1.2 m) and revealed no further cultural deposits and only sterile sand. The sterile sand was very fine, almost powdery, and white (10YR8/2). Some 5.43 m^3 of earth were excavated in the two units (2.785 m^3 in Unit 1, 85E51N; and 2.645 m^3 in Unit 2, 87E51N). Additional details on the excavation may be found in Blick, Creighton and Murphy (2006).

THE SEA TURTLE BARNACLE, *CHELONIBIA TESTUDINARIA*

Charles Darwin (1854) was one of the first to systematically describe, albeit briefly, the sea turtle barnacle, *Chelonibia testudinaria*, in his classic work, *A Monograph on the Sub-Class Cirripedia* (Stott 2003). In the present year (2009) marking the 200th anniversary of Charles Darwin's birth and the 150th anniversary of the publication of his *On The Origin of Species*, it is indeed an honor to pursue a topic that so fascinated one of the fathers of modern biology.

Chelonibia testudinaria is an obligate, commensal species that spends its entire life cycle attached to the highly mobile host, the sea turtle (Darwin 1854, Moriarty, Sachs and Jones 2008, Rawson et al. 2003). Biologists define "obligate" as capable of functioning or surviving only in a particular condition or by assuming a particular behavior; a commensal species is one that lives on or within another organism, but that does not cause injury or harm to the host (as opposed to a parasite). Sometimes these sea turtle barnacles, and other externally attached creatures, are referred to as *epibionts*, organisms that live on the exterior body portions of their hosts (ERC 2007).

Chelonibia testudinaria seems to prefer certain locations on the sea turtle: "This sessile barnacle preferentially settles on the carapace ... and plastron, but is also known to occur on the head, flippers, and skin" (Frick and Ross 2001). Common settlement locations also include the posterior one-third of the turtle's carapace and beneath overlapping vertebral scutes in the nuchal region (Frick et al. 2003). *Chelonibia testudinaria* attaches itself to the turtle via a membranous basis and essentially "glues" itself to the host with a cementing substance similar to that used by other barnacles (Kamino 2008, Moriarty, Sachs and Jones 2008). A familiar tenacious creature, the chiton (Mollusca: Polyplacophora), on the contrary, attaches itself to a substratum via a muscular, suction cup-like foot. The barnacle builds its calcite (CaO_3) shell from dissolved inorganic carbon in ocean water, and the calcite is typically a good indicator of habitat and diet (and therefore species) (Biasatti 2004).

While considered relatively immobile once settled, surprisingly *C. testudinaria* is "capable of substantial post-settlement locomotion" on the sea turtle carapace, and it moves "generally from areas of low to higher current flow" (Moriarty, Sachs and Jones 2008) as an aid in filter feeding on plankton (Zardus and Balazs 2007). Typically considered to be commensals of the sea turtle, the "Approximately one dozen species of barnacles ... [that] live exclusively attached to sea turtles are largely considered benign .... [although] occasional wounding and negative effects of hydrodynamic drag have been documented" for some species (Zardus, Zarate and Beaumont 2008:34).

Archaeological sea turtle remains are notoriously difficult to identify to genus and species since typically 85-90% of archaeological fragments found are plastron or carapace (Frazier 2003, 2005). In fact, most zooarchaeologists identify sea turtle remains only to the family level, Cheloniidae. It was hoped that the turtle barnacles discovered at SS-4 would act as a species-specific indicator for the turtle, but *C. testudinaria* is a widespread, cosmopolitan species reported from all species of sea turtles in all of the world's oceans (Zardus and Hadfield 2004). In fact, *C.*

testudinaria is the most often reported sea turtle barnacle in the world (Frick and Ross 2001). However, *C. testudinaria* is often confused with another turtle-inhabiting barnacle, *Chelonibia caretta*, which occurs in its highest densities upon hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean (Frick et al. 2003).

C. TESTUDINARIA AND ITS LONG-TIME ASSOCIATION WITH SEA TURTLES

As noted above, *Chelonibia testudinaria* is not species-specific, as it occurs on all seven of the Cheloniidae in the world's oceans today (Zardus and Hadfield 2004), although some turtle barnacles appear to be species-specific (as *Platylepas coriacea* is to the leatherback sea turtle, *Dermochelys coriacea*) (Zardus and Balazs 2007). The association between barnacles and sea turtles is apparently ancient: "Fossil evidence suggests that the association between *C. testudinaria* and *Caretta caretta* extends back to as early as the Miocene epoch [22-5 MYA]" (Rawson et al. 2003:2698, Ross 1963). In fitting with the stable isotope analysis (SIA) results on sea turtle bone from North Storr's Lake, which indicate a carnivorous diet (→ *Caretta caretta*) for at least one of the individuals represented (Mark Todd Clementz, personal communication), "Loggerhead turtles (*C. caretta*) host *Chelonibia testudinaria* more frequently and in higher densities than any other species" (Rawson et al. 2003:2697). Not only are the barnacles common and widespread, but a single turtle may host "as many as several dozen barnacle species at any time" (Rawson et al. 2003:2697). A study by Frick and Ross (2001) recorded an average of 6.2 barnacles per turtle (155 barnacles on 25 loggerheads). The barnacles also appear not to be seasonally restricted, at least in temperate and tropical waters: *C. testudinaria* occurs yearlong on loggerheads in Georgia and NE Florida, the closest and largest nesting area in proximity to the Bahamas today (Rawson et al. 2003). In one North American study of Georgia and Florida turtles (Frick, Williams and Robinson 1998), *C. testudinaria* was found on 100% of all *Caretta caretta* investigated (n=65); a similar study from coastal Brazil reported *C. testudinaria* on 30.8% of *Chelonia mydas* (n=13) and none on *Caretta caretta* (Bugoni et al. 2001). In Brazil, *C. testudinaria* is reported as one of the most frequent barnacles associated with *Chelonia mydas* (Bugoni et al. 2001). The association of *C. testudinaria* with loggerhead and green turtle populations throughout the world is therefore well documented (Bugoni et al. 2001, Rawson et al. 2003, Zardus and Hadfield 2004).

MORPHOLOGY OF *C. TESTUDINARIA*

The morphology of *C. testudinaria* is unique, and is an aid in its identification: "Barnacles of the genus *Chelonibia* differ from all other barnacles that settle on sea turtles by having eight wall plates" (Frick and Ross 2001), also referred to as "shell compartments" (Darwin 1854, Zardus and Hadfield 2004). The eight wall plates, according to Frick, are as follows: 1) carina; 2) right carino-lateral-1; 3) right carino-lateral-2; 4) right rostro-lateral; 5) rostrum; 6) left rostro-lateral; 7) left carino-lateral-2; 8) left carino-lateral-1. Several hours post-settlement, the juvenile barnacle secretes eight shell compartments; two days post-settlement, suture lines between the plates are distinct, but the rostro-laterals … coalesce with the rostrum giving the impression of a six-plated shell (Frick's correction to Zardus and Hadfield 2004:417, Fig. 5). In fact, in the archaeological record, we find six plates, rather than eight, with shell compartments 4, 5 and 6 forming a single unit around the rostrum (Figure 2).

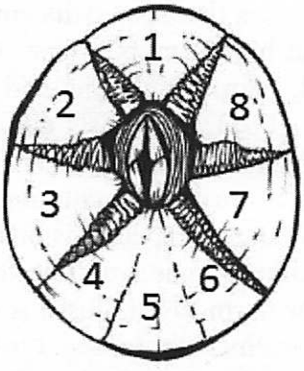

Figure 2. Chelonibia testudinaria *and its eight wall plates (adapted from ERC 2007:34, Fig. 4A).*

ARCHAEOLOGICAL REMAINS OF SEA TURTLES AND BARNACLES AT SS-4

A total of 1286 fragments of sea turtle bone (Cheloniidae) occur in six archaeologically excavated levels in association with 13 wall plates of the sea turtle barnacle, *C. testudinaria*, in the May 2006 excavation at North Storr's Lake (SS-4). Barnacle plates (n=3) first appear in Level 3 (ca. 22-34 cm below surface) in correlation with the peak in sea turtle bone frequency. Barnacle wall plates also occur in Level 1 (0-11 cm below surface; n=5) and Level 2 (11-22 cm bs; n=5) (Blick, Creighton and Murphy, this volume). There is stratigraphic association of both *Caretta caretta* (loggerhead) and *Chelonia mydas* (green turtle) with the barnacles. Young turtles coming in from the open ocean generally lack barnacles, and the specimens recovered in this work are from barnacles that are at least several months to a year old given their size (Zardus, unpublished data). It is therefore apparent that the Lucayans were harvesting adult and/or subadult sea turtles at North Storr's Lake.

The identification of at least two species of sea turtle at SS-4 has been confirmed independently by two different laboratories using two different techniques: Mark Todd Clementz at the University of Wyoming using SIA and Kathy Moore of NOAA-NOS, Charleston using DNA. In addition, Clementz has identified a third individual based upon different dietary signatures revealed via SIA (1 carnivore, 1 sea grass eater, and 1 marine algae eater; or 1 loggerhead, 1 green turtle, and a second green turtle, perhaps a juvenile, whose diet included marine algae) (Mark Todd Clementz, personal communication). Kathy Moore's DNA analysis reveals the presence of at least two species, *Chelonia mydas* and *Caretta caretta*, although the DNA appears to be somewhat degraded (Kathy Moore, personal communication). Additional testing on sea turtle bone using techniques specifically to detect degraded DNA will be attempted in the future (Kathy Moore, personal communication).

As indicated in the previous paragraph, the number of identified specimens (NISP) for *C. testudinaria* is 13. This count is essentially a count count of the individual fragments or specimens, and provides a maximum number of individuals represented in the deposit. The minimum number of individuals (MNI) refers to the smallest number of individuals that is necessary to account for all of the skeletal elements or specimens of a particular species found at an archaeological site or in a fossil assemblage (Reitz and Wing 1999, White 1953). The principal of MNI accounts for each possible individual animal as an individual unit in the most parsimonious way, meaning to count the least number of individuals in an archaeological site; it also considers sex, measurements, size, bilateral symmetry, redundancy of body parts, etc. (Reitz and Wing 1999). The MNI of *C. testudinaria* at SS-4 is four, a number that closely approximates (given the sampling vagaries involved) the average number of barnacles per turtle (6.2) as reported by Frick and Ross (2001). The measurements of the 13 barnacle fragments recovered from SS-4 are provided in Table 1. Figure 3 illustrates one of the archaeological *C. testudinaria* wall plates recovered in the May 2006 excavation by Blick and students Megan O'Neill, Kristi Brantley Smith, and lab analyst Betsy Murphy.

Specimen Number	Compartment or Wall Plate	Width (mm)	Height (mm)
SS-4/06-1-a	L lateral	10.54	11.56
SS-4/06-1-b	R rostro-lateral	5.82	12.73
SS-4/06-1-c	L rostro-lateral	6.38	10.49
SS-4/06-2-a	L carino-lateral	14.87	12.17
SS-4/06-2-b	R carino-lateral	12.31	11.14
SS-4/06-11-a	R rostro-lateral	14.76	16.85
SS-4/06-11-b	Rostrum	7.3	13.17
SS-4/06-12-a	Rostrum plus L rostro-lateral	16.55	16.56
SS-4/06-12-b	L carino-lateral	12.39	11.95
SS-4/06-12-c	R carino-lateral	10.57	11.07
SS-4/06-13a-a	R carino-lateral	10.83	11.73
SS-4/06-13b-b	R carino-lateral	21.77	21.5
SS-4/06-13b-c	L lateral	11.55	9.42

Table 1. Barnacle wall plate identifications and measurements from SS-4 (by John Zardus); L=left, R=right.

Figure 2. Photographs of archaeologically recovered Chelonibia testudinaria *left lateral wall plate, superior (top) and inferior (bottom); excavated from Level 1, 0-11 cm bs, at North Storr's Lake. Width is 10.54 mm. Specimen number SS-4/06-1-a (see Table 1). Photos by John Zardus.*

ACCELERATOR MASS SPECTROMETER (AMS) DATES FROM SS-4

There are now some 22 new, reliable, AMS dates from the 2006 excavations at North Storr's Lake (Blick n.d.; see also Table 2). Material submitted consisted of wood charcoal, and sea turtle barnacle and animal bone ($CaCO_3$). The material was cleaned of residual soil by sonicating in high purity water. The material was then treated with a series of mild mineral acid and base (1M HCl / 0.5 M NaOH / 1 M HCl) to remove contaminating carbonate salts and humic acids from the burial environment. The cleaned material was combusted at 900°C in evacuated and sealed ampoules in the presence of CuO. The resulting carbon dioxide was cryogenically purified from the other reaction products and catalytically converted to graphite using the method of Vogel et al. (1984:289-293). Graphite $^{14}C/^{13}C$ ratios were measured using the University of Georgia CAIS 0.5 MeV accelerator mass spectrometer. The sample ratios were compared to the ratio measured from the Oxalic Acid I (NBS SRM 4990). The sample $^{13}C/^{12}C$ ratios were measured separately using a stable isotope ratio mass spectrometer and expressed as $\delta^{13}C$ with respect to PDB, with an error of less than 0.1‰. The quoted dates are given in Table 2 in radiocarbon years before 1950 (Libby Age), using the ^{14}C half-life of 5568 years. The error (± factor) is quoted as one standard deviation and reflects both statistical and experimental errors. Corrections for isotopic fractionation are included for reference ($\delta^{13}C$ Corrected Libby Age), and they assume the original material had a $\delta^{13}C$ composition of -25‰. AMS dating was performed at the University of Georgia Center for Applied Isotope Studies (CAIS) in Athens, Georgia facilitated by D. Dvoracek.

The AMS dates, which are $\delta^{13}C$ corrected Libby ages with 1-sigma error ranges have been calibrated using the CALIB 5.0 radiocarbon dating program (Stuiver, Reimer and Reimer 2009) using the probability method, and converted into years in the Christian calendar (for easier comprehension). The dates range in age from A.D. 932-1552. Dates on oceanic species have been corrected using the Marine Reservoir Correction Database (nearest marine sample location: Golding Cay, Andros Island; $\Delta R = 146$, ΔR error $= 66$) (Stuiver, Reimer and Reimer 2009). Materials dated included nine fragments of charcoal (carbonized wood), seven fragments of bone (six sea turtle and one parrotfish), and four sea turtle barnacles. The dates are from all six levels of the archaeological excavation (Levels 1-6, ca. 0-69 cm below surface). Dispersion of the dates throughout the stratigraphy indicates the deposits are mixed with early dates occurring near the surface in Level 2 and later dates occurring in deeper levels, such as Level 6. Dates on the barnacles, which occur in the three uppermost levels (Levels 1-3), range in age from A.D. 1145-1322. These latter dates suggest that barnacles were being brought ashore on the backs of sea turtles some 350-170 years before the arrival of Columbus. The mixing of the dates throughout the stratigraphy complicates the interpretation of these deposits. When placed in chronological order, the radiocarbon ages sort according to type of material dated: charcoal is generally older (ca. A.D. 932-1268), barnacles are of intermediate age (ca. A.D. 1145-1322), and bone is late (ca. A.D. 1288-1552). This suggests differential carbon uptake by different classes of organisms (e.g., Pan and Wang 2004) and/or organisms living in different habitats (land plants as opposed to ocean animals, and even barnacles as opposed to sea turtles). There is significant overlap in these ages using the 2-sigma error range, indicating that, despite these differences, there are no statistical outliers in this group of dates. The radiometric dates support a long-term utilization of the locality from ca. A.D. 932-1552. Table 2, at the end of this article, presents the recent radiometric dates from SS-4 in radiocarbon years B.P., their 1-sigma error ranges, and corrected, and calibrated dates A.D.

A HYPOTHETICAL PREHISTORIC VILLAGE SCENE AT SS-4

The North Storr's Lake (SS-4) site is strategically located on the Atlantic side of San Salvador, atop a 6 m+ dune ridge, with a commanding view of some 4 km from East Beach to Greene Harbour, an area that was historically known as a major sea turtling location by the modern inhabitants of the island (interview with elderly local informant). The North Storr's Lake site appears to have been about the second largest settlement on the island, second in size only to the large Pigeon Creek site (ca. 8-10 ha) located on the southeast coast of the island near the head of Pigeon Creek. Archaeological evidence (Blick and Murphy 2005, Blick, Creighton and Murphy 2006, Shaklee, Fry and Delvaux 2007) indicates that the North Storr's Lake site stretches some ca. 300 m north-south and ca. 150 m east-west and perhaps contained numerous pre-Columbian households (Blick and Murphy 2005) dating to the period ca. A.D. 900-1550. A community of palm-thatched houses likely lined the dune ridge, taking advantage of the incoming ocean breeze and the panoramic vista of the ocean and beach from the site.

Situated at a haulover location (a narrow neck of land between two bodies of water, in this case the Atlantic Ocean and Storr's Lake) over which the site's pre-Columbian inhabitants could portage a canoe, this site was located in a prime position for its inhabitants to remain on the lookout for the arrivals of sea turtles along a virtually uninterrupted span of beach (Nietschmann 1973). During the egg-laying season, from approximately May-September (Spotila 2004), literally hundreds of sea turtles, including loggerheads and greens, may have utilized this location as their laying grounds, providing eggs, meat, and other turtle products to the Lucayans of the east coast of San Salvador in abundance. Sea turtles may have been captured on the beach, netted, harpooned, grappled by hand at sea, or otherwise roped and hauled in from the offshore reefs into the relatively shallow waters off the coast of North Storr's Lake (Blick 2008). Once ashore, the turtles could have been butchered and/or roasted virtually *in situ*, or perhaps hauled up to the village on the fixed dune to be divvied up by the canoers and hunters, or the big man or chief of the village (Thomson 1934). If Pacific cultures are a valid comparison, a high status individual, such as a chief, would have had control over the distribution of turtle meat and turtle products to the various families or clans living in the village (Luna 2003). At North Storr's Lake, we find evidence of butchering (cut marks and diagonal scoring that cut across the matrix of the bone) and cooking (scorch and burn marks), mostly on the underside of the plastron of the turtles (Blick, Creighton and Murphy 2006). Modern Yapese islanders place the turtle on its back and construct a fire over the belly of the turtle, essentially cooking the turtle in its own shell. This is the scenario proposed for the turtle butchery and processing locale at the North Storr's Lake site.

DISCUSSION

North Storr's Lake (SS-4) is one of the few sites where sea turtle barnacle, *Chelonibia testudinaria*, has been found in association with archaeological remains of sea turtle on San Salvador, or virtually anywhere else for that matter. This association is generally rarely, if ever, reported in the archaeological literature. This is probably because sea turtle barnacle is commonly misidentified as either shell or bone during zooarchaeological identification and cataloging. At SS-4, *C. testudinaria* is stratigraphically associated with the remains of both loggerhead (*C. caretta*) and green turtle (*Chelonia mydas*) as identified by SIA and DNA analyses (M.T. Clementz, personal communication and K. Moore, personal communication).

Sea turtle barnacle (*C. testudinaria*) wall plates occur simultaneously in the same strata in which sea turtle bone peaks in abundance (both by count and by weight) in Levels 1-3 at SS-4, therefore the association of the barnacle with two species of sea turtle is clear. Despite the fact that direct AMS radiometric ages on sea turtle barnacles (A.D. 1145-1322) generally date earlier than the radiometric ages on sea turtle bone itself (A.D. 1288-1552), the overlap in ages between ca. A.D. 1195-1288 (using the 1-sigma error range) suggests pre-Columbian exploitation of at least two different species and at least three different individual sea turtles ca. 200-300 years prior to the arrival of Columbus on San Salvador.

According to radiometric dates on charcoal in the strata excavated at SS-4 by Blick and students in May 2006, and if SIA and DNA results remain as they currently are, site stratigraphy and dating suggest that green turtle may have been harvested earlier and/or over a longer time span (ca. A.D. 1100-1500) than loggerhead turtle (ca. A.D. 1311-1354).

The sea turtle butchery locale uncovered at SS-4 by Blick and students in May 2006 appears to be a location at which multiple individuals of sea turtle were repeatedly butchered over a relatively lengthy span of time (ca. A.D. 1145-1322), a roughly 200-300 year period prior to the advent of European incursion in the Greater Caribbean. Various lines of evidence indicate that the sea turtle butchery locality at SS-4 was a traditional sea turtle butchery site affiliated with the middle-to-late occupation of the Lucayan village at North Storr's Lake previously identified and tested by Winter (1981, 1982), and excavated by Fry and Delvaux (Shaklee, Fry and Delvaux 2007).

It should be noted that a search through bags of literally tens of thousands of artifacts from the May 2004 excavation of the Minnis-Ward site (SS-3) has revealed the presence of *C. testudinaria* at SS-3 in Level 3 (ca. 30 cm below surface). In addition, excavations at Minnis-Ward in May 2009 also recovered remains of *C. testudinaria* in Level 6 (ca. 60 cm below surface) (Blick et al. 2009), suggesting that sea turtle barnacles may be more common in archaeological deposits on San Salvador (and elsewhere) than previously thought, if one is aware of the possibility of finding them and if one knows what to look for.

CONCLUSION

In conclusion, it is quite clear that "the relationship between marine turtles and their epibionts remains a poorly studied aspect of sea turtle natural history" (Frick, Williams and Robinson 1998). In our own search through the archaeological and scientific literature, it was discovered that "the literature focusing on carapace epibionts is scattered in taxon specific articles that are largely hidden from turtle biologists" (Bugoni et al. 2001), not to mention hidden or virtually obscured from the view of archaeologists who might happen upon the remains of sea turtle barnacles in the course of their own field investigations and subsequent research. In fact, a recent compilation of the entire literature on sea turtle barnacles yielded only some 170 articles and other works (Zardus n.d.), a clear indicator of the rarity of the sea turtle barnacle in the scientific literature, not to mention in the zooarchaeological literature. It is hoped that this article on *C. testudinaria*, associated with prehistoric sea turtle remains from the North Storr's Lake site (SS-4) on San Salvador, Bahamas, will contribute to the study of sea turtle natural history and will make evident the need for such studies involving commensal fauna associated (but not often considered) with archaeological remains in the Bahamas, the Greater Caribbean, and elsewhere.

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*Table 2. Radiometric (AMS) assays from the May 2006 excavation at the North Storr's Lake site (SS-4). Radiometric assays were performed at the University of Georgia Center for Applied Isotope Studies. SS-4=site number; 06=year of excavation; levels are indicated by numbers 1-6 or 11-16 (Levels 1-6); a lower case letter (a, b, c, etc.) indicates more than one sample from a particular level; ch=charcoal; lpga =lower pharyngeal grinding apparatus of parrotfish (*S. viride*); ba=barnacle; stb=sea turtle bone.*

Sample ID	UGA Lab #	Material	δ^{13}C	% Modern Carbon	±	1 σ	Libby Age	±	1 σ	δ^{13}C Corrected Libby Age	±	1 σ	Calibrated Date A.D. (1σ)
SS-4/06-13a/ch	4323	charcoal	-24.68	87.802	±	0.269	1045	±	24	1048	±	29	981-1020
SS-4/06-3b/ch	4324	charcoal	-23.85	154.208	±	0.524	-3479	±	31	-3470	±	31	invalid age
SS-4/06-6a/ch	4325	charcoal	-24.20	88.599	±	0.293	972	±	26	979	±	30	1018-1046
SS-4/06-14a/ch	4326	charcoal	-22.06	88.916	±	0.272	944	±	24	967	±	24	1092-1121
SS-4/06-12a/ch	4327	charcoal	-9.97	88.333	±	0.278	997	±	25	1118	±	24	932-970
SS-4/06-13b/ch	4328	charcoal	-24.88	87.948	±	0.272	1032	±	24	1033	±	23	993-1019
SS-4/06-16a/ch	4329	charcoal	-24.37	88.683	±	0.272	965	±	24	970	±	30	1089-1122
SS-4/06-5a/ch	4330	charcoal	-24.77	90.771	±	0.279	778	±	24	780	±	34	1225-1268
SS-4/06-3a/ch	4331	charcoal	-23.93	89.713	±	0.279	872	±	25	881	±	28	1154-1212
SS-4/06-16b/lpga	4332c	parrotfish grinding plate collagen	-18.59	93.699	±	0.471	523	±	40	574	±	40	1351-1464
SS-4/06-16b/lpga	4332a	parrotfish grinding plate bioapatite	0.83	89.819	±	0.276	863	±	24	1073	±	24	1351-1464
SS-4/06-11/ba1	4333	barnacle	4.59	87.286	±	0.263	1092	±	24	1334	±	30	1151-1291
SS-4/06-12/ba2	4334	barnacle	4.27	87.861	±	0.272	1040	±	24	1278	±	27	1195-1322
SS-4/06-13a/ba3	4335	barnacle	3.81	87.157	±	0.266	1104	±	24	1339	±	30	1145-1287
SS-4/06-13b/ba4	4336	barnacle	3.69	87.674	±	0.264	1057	±	24	1291	±	29	1185-1313
SS-4/06-15a/stb	4340	sea turtle bone collagen	-12.08	89.704	±	0.276	873	±	24	977	±	26	1428-1552
SS-4/06-14b/stb	4341a	sea turtle bone bioapatite	1.20	90.521	±	0.291	800	±	25	1013	±	25	1408-1523
"	4341c	sea turtle bone collagen	-5.63	89.231	±	0.289	915	±	26	1072	±	26	1351-1465
SS-4/06-13a/stb	4342a	sea turtle bone bioapatite	2.29	89.737	±	0.282	870	±	25	1092	±	25	1342-1450
"	4342c	sea turtle bone collagen	-11.64	94.757	±	0.291	433	±	24	541	±	24	unreliable (1850-1952)
SS-4/06-3c/stb	4343a	sea turtle bone bioapatite	0.39	89.545	±	0.326	887	±	29	1094	±	29	1340-1449
"	4343c	sea turtle bone collagen	-12.64	93.084	±	0.280	576	±	24	676	±	24	unreliable (1697-1870)
SS-4/06-12b/stb	4344a	sea turtle bone bioapatite	0.01	89.579	±	0.287	884	±	25	1087	±	25	1344-1453
"	4344c	sea turtle bone collagen	-8.42	90.581	±	0.281	795	±	24	929	±	24	1465-1594
SS-4/06-1a/stb	4345a	sea turtle bone bioapatite	-7.11	87.803	±	0.283	1045	±	25	1190	±	25	1288-1400
"	4345c	sea turtle bone collagen	-12.07	104	±		-315.1			-210.515			lab error/ modern