Preliminary Report on the Archaeobotany, Paleoclimatology, and Archaeoentomology of the Barbuda Historical Ecology Project 2010 Season

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1. Introduction

Since 2006, archaeologists and students from Brooklyn College (City University of New York) have studied Barbuda in order to better understand past human activity on the island as well as the island's climate and environmental history. Barbuda has a rich cultural heritage, and few sites have been extensively studied (Look 2009; Perdikaris *et al*. 2008; 2009). A collaborative multidisciplinary approach was developed through collaboration with Université Laval (Bain, Faucher), Virginia Tech (Kennedy) and the University of the West Indies in Jamaica (Burn) along with a forthcoming collaboration with the Universities of Missouri (Deborah Pearsall) and Nottingham (Sarah Metcalfe). After an initial reconnaissance survey to identify potential sampling locations in January of 2010, we recovered sediment cores from multiple locations, along with botanical remains, and specimens of the flora of Barbuda to develop a modern botanical and pollen reference collection. Insect traps set up at Highland House also collected a small sample of the present insect fauna on Barbuda. This report presents preliminary results of the 2010 field season as well as recommendations for subsequent research.

2. Objectives

Our primary goal for 2010 is to assess archaeological samples for the presence of preserved fossil remains (charcoal, plant macrofossils, insects), and to identify sediment coring locations (lagoons, ponds, wetlands) with high potential for reconstruction of Late Holocene environmental change through analysis of sedimentary proxy data (sediment stratigraphy, pollen and spores, microscopic charcoal, ostracods, molluscs, charophytes, diatoms) from lake sediment records. We will then answer specific questions about the environmental history of the island, and to eventually integrate the resulting data into the wider research framework of the Barbuda Historic Ecology Project (BHEP).

The themes and questions to be addressed are as follows:

> 1. Reconstruction of the long-term history and relationships between vegetation, fire, and human activities. What was the vegetation composition upon initial occupation on the island and how it changed through time given the successive waves of settlement and with differing land use? When did the first introduced species arrive and which peoples brought them? Have fire patterns changed through time, and if so, how do those patterns relate to human activities and climatic oscillations (such as droughts)?
>
> 2. Reconstruction of long-term climate history. How have climate patterns changed through time based on the analysis of sedimentary proxy data? Can drought periods or changes in precipitation/evaporation be identified? Do coastal sediments in Barbuda record hurricanes through overwash related to storm surge? If so, can we reconstruct past hurricane activity throughout the late Holocene period?

3. Field Survey and Sample collection

We conducted a survey of the ponds and coastal lagoons of Barbuda in order to assess their potential for palaeoenvironmental reconstruction (Figure 1). Barbuda's climate exhibits strong seasonality associated with the latitudinal migration of the Intertropical Convergence Zone (ITCZ) with precipitation occurring predominantly during the summer wet season (May–October). Closed lake basins tend to respond to seasonal changes in precipitation by exhibiting increased lake levels during the summer months and decreased lake levels during the winter months, where rates of evaporation exceed those of precipitation. Sites were therefore visited during the peak of the dry season (January) to distinguish between permanent and ephemeral water bodies. Permanent water bodies are more likely to maintain anoxic conditions along the water-sediment interface, and thus have greater potential for the preservation of microfossil remains. The following section describes sample collection for sediment cores, archaeobotanical samples and modern pollen and insect surveys, while the GPS coordinates for all sampling locations can be found in the annex.

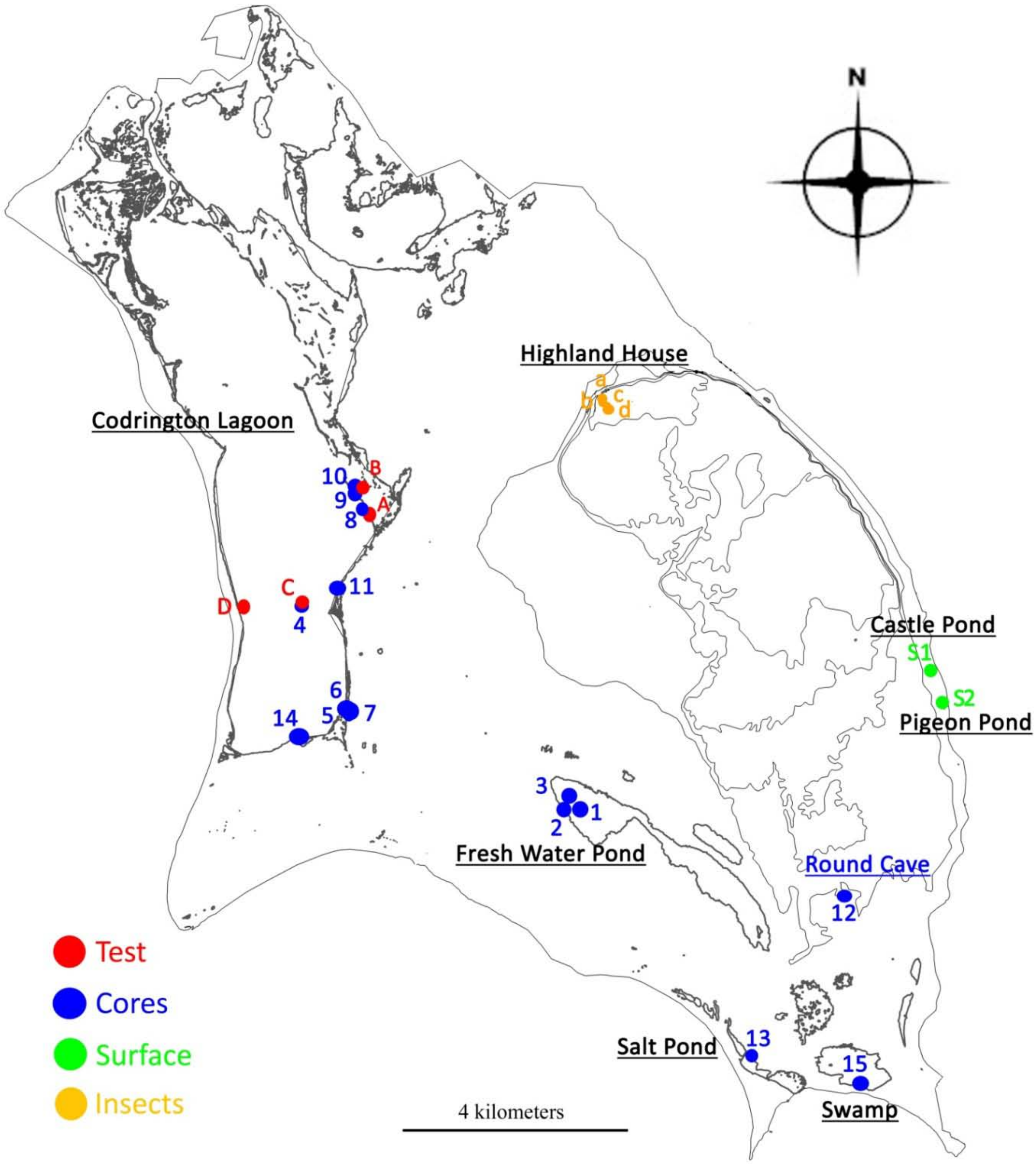

Figure 1. Map of Barbuda indicating the location of surface, sediment core and insect trap samples.

3.1 Collection of surface sediment samples

Castle Pond

We visited two fresh water ponds on the eastern side of the island (Figure 1, S1, S2). Castle Pond (S1) is surrounded by an historical stone wall and dense mangrove vegetation (Figure 2). This lake is less than 30 m in diameter and has a combined water and sediment depth of approximately 50 cm. A surface sample (S1) of the pond sediment was recovered for pollen analysis in order to assess the composition of modern pollen and its qualitative relationship to the surrounding vegetation. The shallow depth of the sediments and potential for sediment disturbance as a result of continued use as a local water source for animals indicate low potential for sediment analysis.

Figure 2. Castle Pond

Pigeon Pond

Pigeon Pond[1] (Figure 3) is a small linear coastal lagoon with water depth of about 35 cm (peak dry season) and lined by mangroves along the seaward margin. The barrier between the lagoon and the Atlantic Ocean is less than 100 m wide. The proximity of Pigeon Pond to the ocean as well as the presence of sandy sediments within the recovered sample suggests this site may contain evidence of past overwash sediments associated with hurricane or tsunami-induced overwash events. A surface sample (Figure 1, S2) was recovered to assess the composition of modern pollen rain.

Figure 3. Pigeon Pond

3.2 Core Sampling

[1]This pond's local name is Fresh Water Pond. To avoid confusion with another pond using the same name, it has been renamed Pigeon Pond after a nearby cliff.

Sediment cores were taken from five different locations (Figure 1) across Barbuda using a *Geocore* Colinvaux-Vohnout drop-hammer piston corer (Colinvaux et al. 1999).

We recovered a single core from Swamp Pond (Figure 4), a large saline pond on the southern end of Barbuda (Figure 1, location 15). A 50 cm sediment core from the edge of the lake primarily comprised fine lake muds grading into black and grey clays toward the base. Much of the lake bed was exposed at the time of sampling (January) suggesting low lake levels during the dry season and potential therefore exists for the lake to record changes in precipitation/evaporation over time. Further to the southwest, we recovered a core from Salt Pond (Figure 5, Figure 1, location 13). The water was about 30cm deep and the ponds sediments were composed of black and brown-grey organic material and clay, resulting in a sediment core of about 30cm.

Figure 4. Swamp Pond

Figure 5. Salt Pond

Figure 6. Round Cave

Mr. Calvin Gore, a lifelong resident and guide, led the team to Round Cave (Figure 6, Figure 1, location 12), a large sink hole filled with dense vegetation and standing water of an unknown depth. A dense mat of floating vegetation on the surface of the lake prohibited recovery of lake sediments from this location at the time; however a sample of the mat was obtained for pollen analysis. A full coring expedition to this site is envisaged during the next field season (January 2011).

Fresh Water Pond (Figure 1, locations 1-3) is an inland lake surrounded by mangrove forest and the does not appear to have been subjected recent disturbance. This lake, like others on the island apparently exhibits considerable seasonal water-level changes (personal communication with Mr. Gore). Indeed the lake appears to treble in size during the summer wet season. This site was sampled on two different visits by the team and three sediment cores were taken. The first core (Core 1A, Figure 1, location 2) was taken around 2.5 m from the shoreline (Figure 7) and yielded around 25cm of lake muds containing an abundant mollusc fauna. Two more sediment cores were taken (Figure 1, locations 1 and 3) on a second visit. Fresh Water Pond Core 2 from location 3 (See Table 1) measured 87 cm in length and is considered to be the most promising record for both palaeoclimatic and palaeoenvironmental analysis. Results of initial laboratory investigations for this core are provided in Section 6.1.

Figure 7. Fresh Water Pond, Core 1A

With assistance from Mr. Kelly Burton and his team from the Codrington Lagoon National Park, we built a coring platform for use with the *Geocore* Colinvaux-Vohnout piston corer. The team explored the lagoon with a park ranger and boat captain, Mr. De Souza, (Figure 8), to identify appropriate sites for the extraction of sediment cores. The first coring attempt was at Mangrove-A (Figure 1, location A). An evaluation of the sediment depth suggested that there was not enough sediment for coring at this location. Figure 1 also indicates test locations B, C, and D, which produced only short cores due to lack of sediment or the interference of strong currents during coring.

Figure 8. Codrington Lagoon, Mangrove-A

We took a core in an area referred to as the “Sink Hole” (Figure 1, location 11) by locals. This effort produced a 98 cm core, composed of coarse grey clayey material within the top 25 cm and shells within an organic matrix towards the base (Figure 9).

Figure 9. Codrington Lagoon, Sink Hole-1

Figure 10. Codrington Lagoon, Center-1

Another core site (Figure 1, location 4) produced <40 cm of sediment with small shells (possibly including ostracods) present. This core was composed mainly of grey-white clay with some organic material towards the surface (Figure 10).

Two subsequent trips onto the lagoon were undertaken with a team from the Hunter College and Manhattanville College field schools. Three cores were recovered from the central eastern edge of the lagoon near Codrington Village (Figure 1, locations 8-10). This area (named “Mangrove” by us) is partially separated from the main lagoon by a sand bank, and colonies of mangrove stands grow in less than 1m of water. Three sediment cores were collected from different core sites in this area: Mangrove 1 (Figure 11) is composed of organic material grading into clay towards the base, while Mangrove 2 comprises mainly organic and Mangrove 3 mainly clay sediments.

Figure 11. Mangrove 1

The final day of coring took place in the southern end of the lagoon (Figure 1, locations 5-7, Figure 12). The two first cores (Figure 1, locations 5 & 6) were taken without using the platform at low tide. The recovered sediment comprised mainly organic material with evidence of mangrove roots.

Figure 12 : Mangrove Palm (left), Sandy pond (right)

We took a third core (Figure 1, location 7), in a small sub-basin located on the southeastern edge of Codrington Lagoon. It was separated from the main basin by a sand bank and was surrounded by mangrove forest (Figure 13).

Figure 13: Codrington Lagoon, Mangrove Palm-3

The final core was recovered from a small body of water located at the southern end of the lagoon and separated from Codrington lagoon by a sand bank (Figure 1, location 14). The lowermost 35 cm of this core comprise soft lake muds and the uppermost 35 cm consist of course sandy sediments. The location and lithostratigraphy of this record close to the Caribbean Sea, suggests it may potentially record the influx of sandy overwash deposits.

4. Insect Collecting- Highland House

Insects, along with seeds, pollen and sedimentary records, can provide important environmental, cultural and climatic data for the Quaternary Period. As literature about the present entomological fauna on Barbuda is limited, four insect traps were set in January 2010 by Allison Bain and Anne-Marie Faucher to begin collecting a sample of the present insect fauna. Knowledge of the present island fauna may facilitate the identification of insect remains if they are recovered in future sediment samples. A survey around the island was necessary to determine the best areas suitable for this work, as the traps were to be in areas that were easily accessible, and outside of town in a *natural* setting.

Four insect traps were set up near Highland House (Figure 1, locations a-d), for an 8 day period. A flight interceptor trap, which recovers flying insects, was set up over a pan containing a solution of water, vinegar and dish soap (Figure 15). Ideally, insects fly into the net and drop down into the solution. The dish soap break the surface tension ensuring they stay in the liquid, while the vinegar keeps the insect bodies soft. The trap was set up in a cleared area along the edge of the Highland House property. The other three traps were pit fall traps (Figure 15), which are essentially a small bowl dug into the ground containing the same liquid mixture described above. They are designed to trap insects, especially ground beetles (Carabidae) running along the ground. The traps were located in three different types of vegetation to recover the maximum number of species. One was placed in a cleared area adjacent to Highland House; a second trap was located along a pathway in the bush, while the third trap was located in denser scrubby bush. The traps were emptied regularly and the results are presented in section 6.3.

5. Archaeobotanical Sampling

Sediment samples, varying from 1.2 to 20 litres in volume, were taken in 2008 and 2009 from the Indian Town Trail (BA-01) and Seaview (BA-16) archaeological sites to assess their potential for future archaeobotanical studies. Nine soil samples were taken on the Indian town Trail site, while 18 were taken from the Seaview site. Sediments were screened using 1,7mm and 500µm sieve sizes and preliminary results confirm the presence of both charcoal and carbonized seeds in the archaeological assemblages. Samples of 50g of sediment were also saved from each context and will be the subject of future study for preserved pollen, phytolith, and starch remains. With this initial data, a sampling strategy was prepared by Allison Bain and Anne-Marie Faucher in collaboration with Dr. Deborah Pearsall of the University of Missouri, for the 2010 field season.

Given that the main mean of preservation of both charcoal and seeds on Barbuda's archaeological sites is carbonization, large volume of sediments (20 litres) were collected in 2010 with the goal of recovering adequate amounts of archaeologically preserved charcoal and seeds and other plant macrofossils (Pearsall 2000). Therefore, 20 litres of soil in each archaeological *in situ* context was taken, whenever possible, from The Castle Site (BAH-07) and the Cave 2 site (BAA-22). Two 50g sediment samples were also collected from each context for future phytolith and starch analyses.

Two 20 litre samples were also collected from the Seaview site (BA-16, Area A1, Figure 16), given the charcoal remains noted in the 2008 and 2009 samples. Small samples for phytolith and starch analysis were also taken.

The inside surface of many pre-Columbian pottery shards excavated over the past few seasons on Barbuda have an crust considered to be charred organic residue from cooking. In coordination with Norie Manigault, a small sample of this residue was also collected for future analysis.

Anne-Marie Faucher also began a modern wood and seed reference collection to aid in future archaeobotanical identifications. Dr. Nancy Todd (Manhattanville College) is creating a plant key for the island which will be used as a guide when taking modern plant and wood samples. The wood samples will be carbonized in order create a charcoal reference collection which will be housed at Université Laval.

6. Results

6.1 Sediment cores

We collected a total of 15 sediment cores (Table 1) during the January 2010 field season and are presently evaluating their potential for pollen analysis. The sediment cores are being stored under refrigeration at both Virginia Tech and the University of West Indies.

Cores	Length (cm)
1. Fresh Water Pond-1	52
2. Fresh Water Pond-1A	25
3. Fresh Water Pond-2	87
4. Lagoon Center-1	38
5. Lagoon Mangrove Palm-1	36
6. Lagoon Mangrove Palm-2	70
7. Lagoon Mangrove Palm-3	40
8. Lagoon Mangrove-1	63
9. Lagoon Mangrove-2	95
10. Lagoon Mangrove-3	88
11. Lagoon Sink Hole-1	98
12. Round Cave-1	30
13. Salt Pond-1	26.50
14. Sandy Pond-1	70
15. Swamp Pond-1	50

Table 1: List of sediment cores from 2010

We have begun analysis of one promising sediment core recovered from Fresh Water Pond (Core 3, Fresh Water Pond 2) Table 2 presents the results of the initial core description and descriptions of organic samples identified for radiocarbon dating. To provide an initial chronology, three samples will be analysed for radiocarbon at the radiocarbon facility at NOSAMS, Massachusetts.

Sediment samples were extruded from the tube at 1 cm intervals for analysis of ostracods and charophytes at the University of the West Indies (Michael Burn), of pollen, spores, and microscopic charcoal at Virginia Tech (Lisa Kennedy and Anne-Marie Faucher) and of diatoms at the University of Nottingham (Sarah Metcalfe). Preliminary analyses of surface samples suggest the presence of an extremely abundant albeit less diverse freshwater ostracod fauna comprising genera of the Cypridacea Superfamily including *Ilyocypris* and *Cypretta*. The abundance of ostracods also provides the potential for the analysis of oxygen isotopes from ostracod calcite in order to reconstruct past changes in lake level and consequently precipitation/evaporation in the region (see for example Hodell et al. 1991; Hodell et al. 1995). Charophyte (aquatic algae) oospores and incrustations are also abundant in the surface samples and may provide significant corroboratory evidence of lake level change. Indeed, Hallett et al. (2003) used the accumulation rate of *Chara* oospores in Southeastern British Columbia, Canada, and initial work on stable oxygen isotope measurements of *Chara* incrustations has demonstrated a positive correlation between charophyte carbonate and groundwater $\delta^{18}O$ (Coletta et al. 2001). Decisions on the applicability of stable isotope analyses will be made once the results of ostracod counts and radiocarbon dating are complete.

Figure 14. Codrington Lagoon, Sandy Pond-1

Sediment Description for Freshwater Pond 2 (84cm):		
Depth (cm)	**Sediment Colour (Munsell Colour)**	**Description**
0 - 32	10 YR 5/3 Brown	Calcareous lake muds containing abundant ostracods, chara oospores and chara incrustations
33 - 44	10 YR 5/3 Brown	lake marl sediment in a very fine sandy matrix. Abundant ostracods and mollusca.
45 - 50	10YR 4/2 Dark greyish brown	lake marl sediment in a very fine sandy matrix. Abundant ostracods and mollusca.
51 - 70	GLEY 2 6/10 BG greenish gray clay	Clay sediment with red/brown mottles; presence of woody (mangrove) material and coarse gravel (coral fragments)
71 - 84	GLEY 2 6/10 BG greenish gray clay	Predominantly clay sediment with coarse gravel fragments Woody (mangrove) material present
Possible depth of samples for ^{14}C dates		
51 - 52 cm	woody fragment	No woody material found above this level indicates fragment and sediment age are probably the same
65 - 66 cm	twig	distinct twig - not part of root system (age of sediment and twig probably the same)
83 - 84 cm	woody fragment	Possible mangrove root - ^{14}C age could be younger than surrounding sediment

Table 2. Sediment description of Freshwater Pond, Core 2

6.1 Pollen, Spores, Microscopic Charcoal

The sediment cores were recently transported to Virginia Tech, where Kennedy and students, and Faucher (U. Laval) will conduct analysis of pollen, spores and microscopic charcoal, loss on ignition (LOI: analysis of water, organic, and carbonate fractions), and sediment stratigraphy on selected cores. Our plan for summer and fall 2010 is to conduct LOI at regular intervals and along visible stratigraphic boundaries in one or more cores from each of the study areas, and process test samples from each core using standard paleoecological procedures to investigate pollen preservation and the surface samples from several cores to learn the pollen flora. Loss on ignition analysis will help us to identify changes in climate and other conditions, possible hurricane overwash layers, and cores/core sections with high potential for acceptable pollen preservation.

 

Figure 15. Flight interceptor trap (left); pit fall trap (right)

We will isolate pollen and spores by treatment with acids and bases to dissolve other organic fragments and rock, and then makes slides of the residue. Pollen grains and spores will be identified using published keys and Kennedy's reference material.

6.3 Insects

The insect remains collected using the flight interceptor trap, three pitfall traps and general capture are presented in Table 3. The traps were emptied at regular intervals and contained a diverse (ants, flies, spiders, true bugs, beetles, moths and butterflies, etc.) but very modest fauna which results from rather limited collecting during the dry season over a relatively short period of time. The general capture category of insects contains beetles and a true bug (Hempitera) that were collected around Codrington.

On the islands of the Lesser Antilles, the number of insect species varies greatly between islands which are likely the result of numerous factors including the number of biotopes, as well as the collecting records themselves. For example, the island of Grenada is just over 350 km^2 with over 2000 species of insects and 507 species of beetles (Woodruff et al. 1998, Peck 2009), while Dominica is 751 km^2 in area, with 347 species of beetles (Peck 2006, 2009). The present insect fauna on Barbuda is likely the result of a perhaps small endemic fauna, species introduced intentionally or accidentally during the historic period and the indigenous fauna which populated the island having arrived via over-water dispersal processes (see Peck 2009 for discussion).

Figure 16. Archaeobotanical sample collection at the Seaview Site

Trap		Species & MNI
Highland House	**Chelcerata**	
	Araneida	2 species
	Insecta	
	Orthoptera	3 species
	Isotoptera	1 species
	Lepidoptera	1 species (MNI 4)
	Hemiptera	1 species
	Coleoptera	
	cf. Derodontidae	1 species
	Diptera	14 species (MNI 116)
	Hymenoptera	1 species
	Formicidae	4 species
Pitfall 1	**Insecta**	
	Coleombola	2 species
	Diptera	2 species
Pitfall 2	**Insecta**	
	Coleoptera	
	Tenebrionidae	1 species
	Diptera	3 species (MNI 6)
	Hymenoptera	
	Formicidae	1 species

Trap		Species & MNI
Pitfall 3	**Chelicerata**	
	Araneida	2 species
	Insecta	
	Lepidoptera	2 species
	Trichoptera	1 species
	Coleoptera	
	Carabidae	
	Clivina sp.	1 species (MNI 10)
	Diptera	4 species (MNI 14)
	Hymenoptera	
	cf. Ichneumonoidea	1 species
	Formicidae	1 species
General Capture	**Insecta**	
	Hemiptera	2 species
	Coleoptera	
	Cicindelidae	
	Cicindela sp.	1 species
	Carabidae	1 species
	Scarabaeidae	
	Onthophagus sp.	1 species
	Aphodius sp.?	1 species
	Chrysomelidae	1 species
	Hydrophilidae	
	cf. *Hydrochara*	1 species (MNI 6)

Table 3. Results of 2010 insect collecting on Barbuda

6.4 Charcoal and Plant macro remainsThis section presents preliminary results from the 2009 and 2010 assemblages of charcoal and plant macro remains. No identification to genus/species is yet available as the analyses are still in their preliminary phase. Samples were sorted using a 4mm mesh size for charcoal recovery, while 1mm and 500µm screens were used to recover seeds and other plant macro remains. All charcoal fragments have been weighed and tabulated, while seeds presented according to their presence or absence.

6.4.1 Indian Town Trail (BAA-01)

Analyses indicate the presence of either charcoal and carbonized seeds or both in all contexts from the 2009 samples (Table 4). Seed remains were generally not well preserved, following the preservation criteria of Hubbard and Al Azm (1990). At the moment, this suggests that identification to genus and species will be limited.

6.4.2 Seaview (BAA-16)

The study of the 2009 assemblage indicates the presence of modern seeds (M) in 3 samples from Seaview. Carbonized seeds are also present in two other contexts while charcoal fragments are present in almost all samples (Table 4). The presence of modern seeds is likely due to the combination of the sampling strategy of some of the contexts as well as the nature of the soil. Sand, small shells and coral fragments are the main components of the soil which indicates a well drained site where modern seed movement is likely. The presence of abundant recent material such as roots and chitinous fragments(insects?) also confirms this.

Site	Contexts	Volume (L)	Seeds	Charcoal	Weight (g)
BAA-01	2003	2	X	-	-
	2004	2	X	X	0,152
	2005	2	X	X	0,029
	2006	1,5	X	-	-
	2007	2	X	X	0,074
	2008	1,5	X	X	0,291
	2009	2	X	-	-
	2010	2	X	X	0,048
	2011	3	X	X	0,064
BAA-016	701	12	M	-	-
	702	11	M	X	0,436
	803	20	-	X	4,556
	804	5	-	X	4,520
	853	3	X	-	-
	856	5	-	-	-
	857	4	X	X	0,019
	858	5	-	X	0,029
	860	5	-	X	0,232
	861	6	-	X	0,129
	863	5	-	X	1,600
	866	3	-	X	0,303
	867	3	-	X	0,009
	1002	?		X	365,531
	1003	6	M?	X	13,709

Table 4 : Presence of seeds and charcoal, 2009 samples

Samples taken during the 2010 season (Table 5) indicate abundant charcoal, especially towards the middle section of the midden. As indicated in Perdikaris et al. (2008), this context is probably associated with the main activity layer of the site. A few carbonized seeds were also recovered, and all came from the lower layer of the midden, suggesting that water moving through these contexts may have moved the seeds to lower midden levels. Moreover, from an archaeological perspective, seed and cereal remains are often found in food processing areas such as hearths and other domestic contexts rather than in middens which may explain the low volumes of seed remains recovered.

6.4.3 The Castle (BAH-07)

The analysis of the archaeobotanical assemblages from this colonial site indicates at least one major burning event. Large amounts of charcoal fragments were recovered from contexts 26 and 31 with smaller amounts in the upper contexts – 18 and 23 (Table 5). Carbonized leaves and few seeds were also recovered in almost all contexts.

Site	Contexts	Volume (L)	Seeds	Charcoal	Weight (g)
BAA-16	Top	18	-	X	0,178
	Middle	19	-	X	15,149
	Bottom	19	X	X	5,023
BAH-07	18	20	X	X	2,582
	23	20	X	X	7,244
	26	17,5	X	X	10,562
	31	15	X	X	14,600
	33	20	X	-	0,537
BAA-22	5	20	M	X	0,208
	6	20	M	X	0,609

Table 5 : Presence of seeds and charcoal, 2010 samples

The majority of the charcoal fragments appear to be timber, suggesting that this carbonized event is probably associated with the burning of large pieces of wood, most likely a building.

Timber is not the main type of wood that is found nowadays in Barbuda. Only few remaining large trees could be classified as "timber" trees. These results need further examination as they may provide evidence for large scale deforestation of the island after the arrival of Europeans as well as trade networks for wood products within the Caribbean and perhaps beyond.

6.4.4 Cave 2 (BAA-22)

Only two contexts were sampled from this Archaic Age site. They both contain similar assemblages with few charcoal fragments and abundant modern seeds as well as insects (fire ants), clearly indicating both samples are contaminated by the modern flora and fauna. The presence of charcoal fragments is therefore difficult to interpret. Is the charcoal associated with the Archaic Age occupation of the site or are they also a modern contaminant? Radiocarbon dating and future sampling could certainly shed light on this problem.

Recommendations

We plan to continue the study of our 2010 set of sediment cores including analyses of pollen and spores, microscopic charcoal, sediment stratigraphy, loss on ignition, ostracods, diatoms, and other biotic remains. We will also continue analysis of archaeological samples (insects, pollen, seeds, charcoal, starch and phytoliths). This multiproxy approach will allow us to answer key questions on environmental history, and in particular, of the history of human-environment interactions.

During the remainder of 2010 our team will continue to analyze our test cores with the goal of identifying cores with good potential for palaeoenvironmental analysis and sites for additional coring in 2011. In addition, we will select the best cores through test samples for expanded analyses, such as radiocarbon chronology, high resolution analysis of pollen, and stable isotope analysis. We expect that several of the sediment cores we have already collected will provide publishable data and important insights on the environmental history of Barbuda. We also plan to investigate sites on neighbouring island, Antigua, that will help us to reconstruct not only local-scale environmental changes, but also extra-local/regional signals, and the differences between the islands.

Stable oxygen isotope work will be part of our ongoing analyses of appropriate cores. We propose to conduct preliminary investigation of for potential for the reconstruction of long-term (predating historical records) hurricane landfalls (a subfield referred to as "paleotempestology"; Liu 2004, 2007; Nott 2004). This future work would involve taking multiple cores in transects near to and perpendicular to the sand barriers between coastal lagoons and the sea and conducting analyses that include LOI, particle size, geochemical, and others. Sites on Barbuda with potential for paleotempestological analysis include Pigeon Pond (Figure 3) and Sandy Pond-1 (Figure 14), along with other coastal lagoons not yet sampled on the north-eastern and southeast coasts of Barbuda, and sites in Antigua. Kennedy is involved with paleotempestological study of coastal lagoons in the Dominican Republic (funded by NSF) and can help to lead this effort.

Based on our initial coring survey, Codrington Lagoon has yielded short cores consisting primarily of clay material from which the extraction of microfossils including pollen and ostracods is often difficult. However, cores from near-shore environments such as mangroves, often contain organic matter that usually preserves pollen. Even without pollen, stratigraphic changes in cores from Codrington Lagoon can be studied to assist with reconstruction of climate and environmental changes. For example, microscopic charcoal from a large basin such as this may help us to reconstruct a record of island-scale burning. The short lengths of the Codrington cores do not preclude them from representing long time periods. Lakes in low relief areas such Barbuda often accumulate sediments very slowly.

At least one or two radiocarbon dates on all cores to be studied for this project are critical for the appropriate interpretation of data generated by our analyses and it is recommended that future resources be dedicated dating as a means to fully exploit the potential of the 2010 and future cores.

Initial results also confirm the potential the recovery of charcoal and carbonized seeds and other plant macro remains from archaeological contexts. Charcoal was recovered from several contexts and further sampling is necessary in subsequent years. Carbonized seed remains are present but in a lower proportions, which simply may be reflection of the sampling context rather than their research potential on Barbuda, as it important to note that carbonized seeds are often concentrated on archaeological sites in activity areas dedicated to food processing and consumption where they can be exposed to fire (hearths and fire places) or in storage rooms. The material is also best preserved when it is left *in situ* after carbonization (Wilkinson and Stevens 2008). Extensive sampling of specific areas such as buildings and hearths would encourage better seed and charcoal recovery. Charcoal fragments from fireplaces and hearths may also indicate understanding fuel and forest management practices over time.

The results of insect collecting suggest a diverse but modest fauna, which may reflect the collecting season (dry season) and collecting methodology. During 2010, we will continue to gather available entomological literature on the fauna of the region and seek out collecting data on Barbuda that was noted in preparing the 2010 samples. If a modern insect survey aligns with the goals of the Barbuda Historical Ecology Project, then future resources would need to be devoted to this project. The sediment samples examined for archaeobotanical remains do not indicate the presence of preserved insect remains within archaeological contexts on Barbuda, but further investigation is required.

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Bibliography

Coletta, P., Pentecost, A. & Spiro, B. 2001. Stable isotopes in charophyte incrustations: relationships with climate and water chemistry. *Palaeogeography, Palaeoclimatology, Palaeoecology* 173: 9-19.

Colinvaux, P.A., De Oliveira, P.E., & Moreno, P.J.E. 1999. *Amazon Pollen Manual and Atlas*. Harwood Academic Publishers: Amsterdam.

Hallett, D.J., Mathewes, R.W. & Walker, R.C. 2003. A 1000-year record of forest, drought and lake-level change in southeastern British Columbia, Canada. *The Holocene* 13: 751-761.

Hodell, D.A., Curtis, J.H., Jones, G.A., Higuera-Gundy, A., Brenner, M., Binnford, M.W. & Dorsey, K.T. 1991. Reconstruction of Caribbean Climate Change over the past 10,500 years. *Nature* 352: 790-793.

Hodell, D.A., Curtis, J.H. & Brenner, M. 1995. Possible role of climate in the collapse of Classic Maya Civilisation. *Nature* 375: 391-394.

Hubbard, R. N. L. B. & Al Azm, A. 1990. Quantifying Preservation and Distortion in Carbonized Seeds; and Investigating the History of *Friké* Production. *Journal of Archaeological Science*, 17: 103-106.

Liu, Kam-biu. 2004. Paleotempestology: Principles, Methods, and Examples from Gulf Coast Lake Sediments". Murnane, R. J.; Liu, Kam-biu (eds.). *Hurricanes and Typhoons: Past, Present, and Future*. New York: Columbia University Press. pp. 13–57.

Liu, Kam-biu. 2007. Paleotempestology. Elias, Scott A. (ed.). *Encyclopedia of Quaternary Science* 3. Amsterdam: Elsevier. pp. 1978–1986.

Look, C. 2009. Assessment for Qualitative Field Analysis of Phosphates on Barbuda. *Barbuda Historical Ecology Project 2009.* Brooklyn, Brooklyn College and CUNY Graduate Center.

Nott, J. 2004. Palaeotempestology: the study of prehistoric tropical cyclones—a review and implications for hazard assessment. *Environment International* 30 (3): 433–447.

Pearsall, D. M. 2000. *Palaeoethnobotany: A Handbook of Procedures,* San Diego, Academic Press.

Peck, S. B. 2006. The beetle fauna of Dominica, Lesser Antilles (Insecta: Coleoptera): diversity and distribution. *Insecta Mundi* 20: 165-209.

Peck, S. B. 2009. The Beetles of Barbados, West Indies (Insecta: Coleoptera): Diversity, Distribution and Faunal Structure. *Insecta Mundi* 73: 1-51.

Perdikaris, S., McGovern, T., Brown, M., Look, C., McGovern, D., Pálsdóttir, A. & Smiarowski, K. 2008. Field Report, Barbuda Historical Ecology Project. 2008. Antigua & Barbuda National Parks Dept., City University of New York.

Perdikaris, S., McGovern, T., Hambrecht, G., Look, C. &Manigault, N. 2009. Field Report, Barbuda Historical Ecology Project 2009. Antigua & Barbuda National Parks Dept., City University of New York.

Wilkinson, K. & C. Stevens. 2008. *Environmental Archaeology: approaches, techniques & applications*. Tempus Publishing, Stroud, England.

Woodruff, R. E., B. M. Beck, P. E. Skelley, C. Y. L. Schotman, & M. C. Thomas. 1998. Checklist and bibliography of the insects of Grenada and the Grenadines. *Memoirs of the Center for Systematic Entomology* 2. 286 p.

Annex: GPS coordinate of all sampling locations

Sample	UTM	Longitudes/Latitudes
Insects		
a. Flight Interceptor Trap	20 Q 0628339 E / 1953672 N	61 47'24.05 W 17 39'58.48 N
b. Pit Fall Trap 1	20 Q 0628330 E / 1953609 N	61 47'24.37 W 17 39'56.43 N
c. Pit Fall Trap 2	20 Q 0628389 E / 1953566 N	61 47'22.37 W 17 39'55.02 N
d. Pit Fall Trap 3	20 Q 0628431 E / 1953479 N	61 47'20.97 W 17 39'52.18 N
Surface Pollen Samples		
S1. Castle Pond	20 Q 0633939 E / 1948842 N	61 44'15.11 W 17 37'20.15 N
S2. Pigeon Pond	20 Q 0634077 E / 1948260 N	61 44'10.56 W 17 37'1.19 N
Tests		
A. Lagoon Mangrove A	20 Q 0624254 E / 1951576 N	61 49'43.12 W 17 38'51.13 N
B. Lagoon Mangrove-4	20 Q 0624130 E / 1952250 N	61 49'47.18 W 17 39'13.08 N
C. Lagoon Center-A	20 Q 0623193 E / 1950032 N	61 50'19.44 W 17 38'1.11 N
D. Lagoon West-1	20 Q 0622146 E / 1949903 N	61 50'54.99 W 17 37'57.12 N
Cores		
1. Fresh Water Pond-1	20 Q 0627847 E / 1946265 N	61 47'42.35 W 17 35'57.61 N
2. Fresh Water Pond-1A	20 Q 0627792 E / 1946267 N	61 47'44.21 W 17 35'57.69 N
3. Fresh Water Pond-2	20 Q 0627775 E / 1946477 N	61 47'44.74 W 17 36'4.52 N
4. Lagoon Center-1	20 Q 0623187 E / 1950042 N	61 50'19.64 W 17 38'1.43 N
5. Lagoon Mangrove Palm-1	20 Q 0623881 E / 1948030 N	61 49'56.52 W 17 36'55.84 N
6. Lagoon Mangrove Palm-2	20 Q 0623885 E / 1948042 N	61 49'56.38 W 17 36'56.23 N
7. Lagoon Mangrove Palm-3	20 Q 0623909 E / 1948026 N	61 49'55.57 W 17 36'55.70 N
8. Lagoon Mangrove-1	20 Q 0624155 E / 1951723 N	61 49'46.45 W 17 38'55.93 N
9. Lagoon Mangrove-2	20 Q 0624010 E / 1952095 N	61 49'51.29 W 17 39'8.06 N
10. Lagoon Mangrove-3	20 Q 0624031 E / 1952157 N	61 49'50.56 W 17 39'10.07 N
11. Lagoon Sink Hole-1	20 Q 0623725 E / 1950269 N	61 50'1.34 W 17 38'8.71 N
12. Round Cave-1	20 Q 0632657 E / 1944785 N	61 44'59.51 W 17 35'8.45 N
13. Salt Pond-1	20 Q 0630988 E / 1941808 N	61 45'56.78 W 17 33'31.95 N
14. Sandy Pond-1	20 Q 0623075 E / 1947536 N	61 50'23.96 W 17 36'39.93 N
15. Swamp Pond-1	20 Q 0633015 E / 1941382 N	61 44'48.13 W 17 33'17.66 N