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A REPORT ON THE 2012 ARCHAEOLOGICAL INVESTIGATION OF THE SHORELINE ADJACENT TO THE NORTH STORR'S LAKE ARCHAEOLOGICAL SITE (SS-4)

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In December 2012 Youngstown State University archaeologists traveled to San Salvador Island, Bahamas to continue excavations at the Wood Star site (SS-4) at the north end of Storr's Lake. The site was once occupied by the Lucyan people. The excavations took place from December 15th through December 20th. In addition to the excavations performed at the main site, an exploratory effort was initiated to identify cultural material that might be found in shoreline areas adjacent to the lake as well as submerged areas at the lake boundary. The project was led by Ron Madeline and was a continuation of an effort begun the previous research season (December 2011). The purpose of the project was to determine if adjacent submerged areas might have once been a part of the Wood Star Site. The project was directed by Ron Madeline with assistance from Youngstown State University archaeology students Steven Campbell, Chris Nichols, and Michael Flowers. Other students also assisted in the excavation and analysis.

The project employed a grid system to allow for a systematic excavation of materials along the shoreline and adjacent submerged areas. Core samples of sediments were taken from the bottom of the lake and down the shoreline. The survey area was south of the datum 5 degrees north and 0 degrees east. Expanding off the work done in 2011, stakes were placed along a transect at 10 meter intervals to determine the location of a sample. A total of 26 core samples were taken and analyzed. A 0.8" wire screen was used to isolated artifacts having cultural significance. Artifacts were found during the analysis of core samples but findings were ultimately inclusive. A subaqueous cultural boundary for the Wood Star Site was not able to be determined.

DO OPEN POPULATIONS OF RED MANGROVES (*RHIZOPHORA MANGLE*) HAVE MORE VARIATION THAN CLOSED POPULATIONS ON SAN SALVADOR?

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Mangroves on San Salvador occur in both closed and open populations. Closed populations occur around inland marine lakes with restricted opportunity for gene flow due to topographic barriers and separation from the coastline that prevents propagule influx. The open population borders Pigeon Creek and has greater potential for gene flow due to the coastal location. Preliminary data for one microsatellite locus suggested that the closed population around Mermaid Pond had less genetic variation than the open population at Pigeon Creek. To extend the study we are examining not only additional loci but also additional closed populations across the island. We hope to determine whether additional closed populations also exhibit reduced genetic variation and if different alleles are fixed in these populations.

DEVELOPMENT OF A NONDESTRUCTIVE TISSUE SAMPLING TECHNIQUE FOR DECAPOD CRUSTACEANS: A CASE STUDY WITH THE PINK SHRIMP *FARFANTEPENAEUS DUORARUM*

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Traditional systematics based on morphology may be inadequate when species exhibit high

levels of intraspecific phenotypic variation. In these cases, molecular systematics has become an essential tool in analyzing phenotypic variation, specifically its role in species interactions, ecosystem dynamics and the interplay between ecology and evolution. However, to obtain the necessary tissue to perform molecular analysis typically requires sacrificing the organisms which is not appropriate for small or threatened populations. The common pink shrimp, *Farfantepenaeus duorarum* was chosen as a model organism to study nondestructive sampling techniques involving decapods. Decapods are a well-known and diverse group of crustaceans and many of its members are currently the focus of conservation efforts to preserve biodiversity. We examined post treatment survival, as well as, the quality and quantity of DNA recovered from six regenerative tissues. None of the treatments resulted in significant mortality rates (at $\alpha = 0.05$, df = 6, $x2 = 2.142 < P = 12.53$) and suitable DNA was recovered from all tissues sampled (1.73 µg - 26.62 µg). This nondestructive technique may prove to be invaluable in future molecular studies for conservation or commercial efforts by reducing impacts on populations under examination.

PLANT USE BY THE LEAF-CUTTER BEE *MEGACHILE ALLENI* MITCHELL (HYMENOPTERA: MEGACHILIDAE) ON SAN SALVADOR ISLAND, THE BAHAMAS

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Megachile alleni Mitchell is a common ground-nesting solitary bee found throughout the Bahamas. In the field we have observed that females visit 27 species in 14 different plant families for several purposes. Besides using nectar for nourishment, females collect pollen to provision nest cells for the developing larvae. The ventral surface of the female's abdomen is covered by a mat of stiff hairs (scopae) which, when rubbed over the plant's anthers, pick up pollen to be stored in nest cells. As the common name of the genus implies, female leaf-cutter bees also visit selected plant species and cut leaf pieces to use in constructing nest cells, each of which contains all the resources needed for a single developing larva. To date we have observed leaves of five species used for nest cell construction.

We hypothesized which flowers were visited for nectar and which for pollen based on observations of floral structure and insect behavior. To test these hypotheses, we isolated and identified pollen occurring in cocoons from nest cells collected in June, 2012. Twenty-six species of pollen (several as yet unidentified), were found in the cocoons. More than half the cocoons contained pollen from four species (*Corchorus hirsutus, Jacquemontia cayensis, Lantana involucrata*, and *Croton* sp,), and 11 cocoons contained pollen traces that may have adhered to females as they fed on nectar.

MORE ON *COPULA SIVICKISI* (CNIDARIA; CUBOZOA) FROM SAN SALVADOR ISLAND, BAHAMAS: THE MYSTERY CONTINUES

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Copula sivickisi is a small cubozoan known for its sexual dimorphism and unusual courtship behavior that culminates in copulation via spermatophore transfer from male to female. In 2010, two individuals were collected from Grahams Harbor on San Salvador Island with additional observations and collections made in 2011 and 2012. This species had previously been

recorded only from the Indo West-Pacific tropical region and its unusual presence suggests a recent anthropogenic introduction, a circumtropical distribution, or an isolated cryptogenic species. We provide an update of our ongoing study of this species to better understand this enigmatic occurrence in Bahamian waters. To date we have only collected male *C. sivickisi* individuals in the Atlantic locality which is quite perplexing given the equal representation of both sexes in well-sampled Pacific localities. Clonal populations of sexually reproducing freshwater hydromedusae have been reported but this study represents a first for cubomedusae. The life cycle of *C. sivickisi* has not been completely documented but reports on its early development are consistent with typical cubozoan metamorphosis. Microscopic examination of excised testes revealed active sperm; therefore, the hypothetical presence of females would suggest a sexually reproducing population. However, females were not witnessed despite three consecutive years of sampling, and their whereabouts in this population needs to be further investigated. Morphological differences are not readily apparent between individuals from each of the widespread geographic populations so molecular analysis was used to examine genetic differences between populations. Comparison of mitochondrial cytochrome c oxidase (COI) and 18s rRNA genes for Bahamian samples (n=2) showed a range difference of less than 0.2% and 0.3% respectively. However, differences between Bahamian and Indo-West Pacific populations (n=2) were between 20.1% and 22.5% for COI and 14.3% and 25.7% for 18s rRNA. Additional molecular analysis of Bahamian specimens is ongoing to better ascertain genetic differences between these widespread populations. Although sample sizes examined to date are very small, the genetic differences noted suggest that the Bahamian population may represent a cryptic species that requires a name and formal description.

BEYOND RHIZOLITHS: MULTIPLE EXAMPLES FOR PLANT-SEDIMENT INTERACTIONS IN TERRESTRIAL AND SHALLOW MARINE PALEOENVIRONMENTS OF THE BAHAMAS

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Rhizoliths are fossilized organosedimentary structures that represent various modes of preservation of plant roots and are the most common evidence of ancient plant-sediment interactions throughout the Bahamas. There are many other examples, however, of significant sediment substrate modification by terrestrial and marine plants. Some of these examples are well known, such as the important role of modern red mangrove (*Rhizopora mangle*) root systems in trapping sediment and preventing coastal erosion. Although not as well documented, other examples of plant-sediment interactions represent important evidence of past vegetation and can be used as paleoclimate indicators of ancient temperature and precipitation regimes. Modification of sediment deposits by plants can also produce significant amounts of post-lithification porosity and permeability, which can increase reservoir quality (i.e., storage potential for water and petroleum) of the host sedimentary rocks.

Sediment in the Bahamas is composed of the carbonate minerals calcite and aragonite (CaCO3). These minerals are highly susceptible to chemical weathering by dissolution under acidic conditions. Carbonate sediments are also subjected to physical and biological modifications, such as erosion by storms and bioturbation, respectively. Since carbonate sediments lithify relatively rapidly, carbonate rocks have a relatively high potential of preserving the record of these modifications. The following examples of past plant interactions with carbonate sediment from coastal and shallow subtidal settings in the Bahamas demonstrate their highly variable nature and products:

1) Impressions of silver thatch palm fronds (*Coccothrinax argentata*) in eolian (i.e., wind-blown dune) deposits; 2) impressions of terrestrial plant roots (sea grape = *Cocoloba uvifera*), prostrate stems (bay geranium = *Ambrosia hispida*), and runners (railroad vine = *Ipomoea pes-caprae*) buried in eolian and back-beach sediments; 3) the common presence of vertical pipes in eolian deposits that may represent buried palm tree trunks and/or clusters of large roots, although roots can also exploit pre-existing pathways created by dissolution and possibly other mechanisms; 4) highly porous "spongiform" texture of eolian deposits, which likely forms by sand trapping and lithification around dense roots, stems and organic litter of grass and shrub vegetation, including their various microbial, fungal and insect communities, as well as accumulation and burial of marine algae (e.g., *Sargassum*) and seagrasses in beach sediment; and 5) extensive seagrass (*Thalassia testudium*) root systems, that can trap sediment in shallow marine subtidal settings, and may have potential to leave traces in the geological record, but have not commonly been documented from ancient strata. Similarly and somewhat surprisingly, large and extensive palm tree roots do not seem to be easily preserved and recognized in the geological record, but they may be partially responsible for producing the commonly observed spongiform texture of Holocene non-marine carbonate deposits in the Bahamas.

BIODIVERSITY OF AMPHIBIANS, REPTILES, AND BIRDS IN THE BAHAMAS: HOTSPOTS, PRIORITIZATION, AND PROTECTION

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As a part of the Caribbean biodiversity hotspot, The Bahamas hosts substantial species richness and endemism. However, like archipelagos elsewhere, and largely because of anthropogenic impacts, many of these species and the habitats they require are threatened. Islands, sadly, are at the forefront of the biodiversity crisis. Biodiversity hotspots have become prominent in conservation biology, but their delineation, prioritization, and protection can be elusive. To address these issues in The Bahamas, I identified biodiversity hotspots for terrestrial amphibians and reptiles (collectively) and, separately, for birds based on three indices (species richness, endemism, and threat) and two taxonomic levels (species and subspecies). Diversity lists were constructed from the literature for each of 19 islands or island groups. Within each of the six categories (three indices x two taxonomic levels), the two most diverse islands (10%) were deemed hotspots. For native terrestrial amphibians and reptiles (sea turtles were excluded due to inadequate information), there was poor congruence among the three indices and, for endemism, between taxonomic ranks. Habitat protection in the form of National Parks exists for the amphibian and reptile hotspots, but the only threatened species recognized (iguanas) and the vast majority of endemics lack protected habitat. For breeding birds, there was also poor congruence among indices and, for endemism, between taxonomic ranks (species and subspecies richness hotspots were not assessed due to inadequate information). Existing habitat protection is weak for seabirds, several critically endangered taxa, and many endemics. This approach, which can be applied to other taxonomic groups, provides an objective basis for hotspot prioritization and for decisions regarding management and protection of biodiversity. It also underscores two urgent needs: 1) to address species limits using modern systematics methods and concepts, and 2) to assess the current population status of many taxa. These needs are especially important for the 37 species and 87 subspecies of native terrestrial amphibians and reptiles. Current taxonomies of this neglected group are based on decades-old assessments (during the "lumping" era), and population status remains unknown for all but a few taxa.

BEHAVIORAL ECOLOGY AND CONSERVATION OF THE ENDANGERED ROCK IGUANA *CYCLURA RILEYI*

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Three subspecies of the rock iguana *Cyclura rileyi* are currently recognized, including the San Salvador Iguana (*C. r. rileyi*), the Acklins Bight Iguana (*C. r. nuchalis*), and the Sandy = White Cay Iguana (*C. r. cristata* of the southern Exumas). Population and threat assessments indicate that all three taxa remain vulnerable to extinction. Threats identified include habitat degradation (from catastrophic storms and an introduced cactus-eating moth), feral mammals (particularly rats, but also a raccoon), disease, population fragmentation, ecotourism and smuggling, and habitat inundation by rising sea levels. Discriminant analyses of meristic data (head scales and femoral pores) confirm significant divergence among the three subspecies. Dietary diversity of these near-exclusive vegetarians appears to be highly constrained on some cays. Home range size seems similar for males and females but varies somewhat between populations. Females attain sexual maturity at approximately 20 cm SVL and 300 g. Mating takes place from late May to mid-June. Both males and females seek multiple copulations, suggesting a polygamous mating system. Males often utilize forced copulation and mate-guarding. Egg laying in relatively short nest burrows occurs mainly during July, with clutch size corresponding to female body size (both being relatively small in this species). Nest defense by females varies with nesting density. Hatching occurs from late-September to mid-October. Adults occasionally cannibalize young. Habitat restoration (invasive mammal and *Casuarina* eradication, nest substrate replenishment) on several cays offers mixed results, with a dramatic iguana population recovery on Sandy Cay but no measureable response on Low Cay of San Salvador Island. Translocation proved effective in establishing a new population of *C. r. nuchalis* in the Exumas in the 1970s, but two recent projects for *C. r. rileyi* on San Salvador failed, in one case most likely because of rats (*Rattus rattus*). With support from Seacology, a captive headstarting facility was established in 2012 at the Gerace Research Centre of San Salvador Island. In addition to its role in reintroducing iguanas to select areas on the main island, the facility will offer educational value and promote habitat protection within a proposed national park.

JAMES BOND AND THE MYSTERIES OF BIRD TAXONOMY: NEWLY RECOGNIZED BIRD SPECIES IN THE BAHAMAS AND CONSERVATION IMPLICATIONS

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Unbeknownst to many, the namesake for James Bond–the spy character invented by novelist Ian Fleming–was a prominent Academy of Natural Sciences of Philadelphia ornithologist (and a one-woman man) of the mid-20th century who specialized in West Indies birds. His prolific studies of the region's avifauna established the taxonomic status of many bird species recognized to this day. His work embraced the mindset of the "lumping" era, during which many geographically distinct populations (subspecies) were collapsed under a single species. Thus, for many decades following his work, only three endemic bird species—found nowhere else in the world—were recognized in the Bahamas. However, new species concepts and new methods for delineating species boundaries have sparked reassessment. Indeed, recent studies examining morphological, plumage, vocal, and molecular variation have identified previously unrecognized avian diversity. Newly recognized species which were formerly considered geographical variants or subspecies include the Bahama Oriole (*Icterus northropi*), formerly lumped with three other West Indian

species as the Greater Antillean Oriole, and the Bahama Warbler (*Setophaga flavescens*), split from the Yellow-throated Warbler (*S. dominica*) of the North American continent. Evidence also suggests that the two recently named Bahama subspecies of the Cuban Parrot (Abaco Parrot, *Amazona leucocephala abacoensis*, and Inagua Parrot, *A. l. inaguaensis*) are distinct species, and that the Bahama Nuthatch (*Sitta pusilla insularis*) could be split from the Brown-headed Nuthatch of the North American continent. Several additional species consist of differentiated populations that might also warrant elevation to full species, including several Bahama subspecies of the West Indian Woodpecker (*Melanerpes superciliaris*). In each of these cases, elevation of the taxon to full species also elevates its conservation status, especially since the new and candidate species are island endemics with small, highly vulnerable populations. The Bahama Oriole, Bahama Nuthatch, and San Salvador Woodpecker, for example, are all critically endangered, with estimates suggesting fewer than 300 individuals remain. Thus, our emerging view of avian biodiversity in the Bahamas invites reassessment of conservation priorities for the nation.

LEARNING INQUIRY AND NATURE OF SCIENCE THROUGH AN OPEN INVESTIGATION IN A FIELD-BIOLOGY COURSE.

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We investigated students' learning of inquiry skills, the nature of scientific knowledge (NOS) and nature of scientific inquiry (NOSI) through participation in a field-based Biology course with a strong field laboratory component involving a short-duration independent research project. Our research questions were: 1) what inquiry skills did students employ in their research projects compared to their prior undergraduate education; 2) what understandings about NOS and NOSI did students develop in the course; and 3) what discernible differences in outcomes were there for Biology majors and non-science majors in the course? We found that both majors and non-majors gained in practicing a variety of inquiry skills, including higher–order skills such as posing testable questions, designing methods and developing explanations. Many students also developed more sophisticated understandings of some aspects of NOS/NOSI, in particular the validity of observational science, the creative NOS, the roles of anomalies and questions in NOSI, and the distinction between data and evidence. These gains were often linked to personal experiences grappling with the indeterminate nature of conducting open inquiry in the field. Several themes highlighting the differences between the experiences of majors and non-majors and implications for future course development are also discussed. We also compared these outcomes with those of students participating in a more intensive, long-term summer research experience and conclude that students benefit from participating a range of authentic inquiry experiences, including those that are low-tech, short duration investigations of their own design.

A COMPARATIVE ANALYSIS OF TRAVEL ATTITUDES OF STUDENTS VISITING THE GERACE RESEARCH CENTRE WITH THOSE OF A GENERAL STUDENT POPULATION

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When Dr. Donald Gerace founded the CCFL Bahamian Field Station (later renamed the Gerace Research Centre), he conducted questionnaire research to assess physical, emotional, and intellectual attributes of students who visited the field station. Dr. Gerace was convinced that students who sought educational opportunities in field research had a more robust outlook on life than did their counterparts in the general student population. As a follow-up to that line of inquiry,

we recently compared attitudes and attributes of contemporary visitors to the Gerace Research Centre to attitudes and attributes of a general student population. We were interested in determining if Youngstown State University students traveling to the Gerace Research Centre had a greater inclination for field research and international travel than did their counterparts in the general student population. We developed a 38 item survey instrument that assessed the travel attitudes and inclinations of students taking the travel class and the general student population.

We examined several aspects of travel motivations including physical health, stamina, previous travel experience, attitudes towards activities that present physical and mental challenges, class status, gender, and age. We report the results of these analyses and evaluate the potential for using this type of instrument to recruit future students to engage in learning and research in classes conducted in field settings away from a student's home campus.

CONCERTED EVOLUTION OF RDNA GENES IN THE MILLEPORES

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Current approaches to understanding evolutionary relationships increasingly rely on molecular analyses. The acquisition of DNA sequence information has caused us to rethink the taxonomic relationship of many coral groups that were previously classified based on morphology. The inherent uncertainty, due to phenotypic plasticity, in using morphological characters to determine coral evolutionary relationships has led to the use of ribosomal DNA (rDNA) and more specifically, the internal transcribed spacer (ITS) regions of rDNA to obtain a more accurate evolutionary history.

Although phylogenetic analyses based on rDNA have helped untangle evolutionary relationships, the use of rDNA has been shown to be problematic because rDNA genes are repeated hundreds to thousands of times in several chromosomes within an individual's genome and repeats may show variability in their DNA sequence. However, concerted evolution, a process that leads to homogenization of all rDNA gene sequences through gene conversion and unequal crossing over, is believed to occur within a few generations. Homogenization of repeated arrays allows these DNA sequences to be considered as single-copy genes for phylogenetic purposes. If sequences are not homogenized and remain variable, using rDNA to determine evolutionary relationships leads to false polyphyletic species lineages.

The Caribbean millepores (fire coral) represent a phenotypically plastic group displaying a wide range of growth forms that do not fit neatly into either of the two current morphologically-based species groups (*Millepora complanata* and *Millepora alcicornis).* Our previous research, using rDNA sequence analysis, suggests the existence of two phenotypically plastic cryptic clades that are independent of morphology. We have conducted a molecular analysis to determine the level of intragenomic variation present in millepore rDNA repeats in order to ascertain whether these sequences have been homogenized. Using average pair-wise sequence divergence (percent divergence), genetic distance, unrooted phylogenetic trees and denaturing gradient gel electrophoresis (DGGE), we have shown that millepore rDNA sequences are homogenized and that using rDNA for phylogenetic constructions in this diverse, phenotypically plastic group of corals is a valuable tool.

ADDITIONAL HISTORIC FINDS FROM SAN SALVADOR, THE BAHAMAS

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San Salvador Island continues to reveal evidence of its historic past. In March 2013, our group was able to examine the remains of what appears to be the Harbour Estates Plantation. This plantation lies near Jake Jones' road. The compound contains a dug well that was made into a step-down well, work buildings that were framed in wood and then covered in plaster and stone, and a leveled main house. Several of the stone walls around the compound had evidence that there were wooden gate entrances.

A field house was located about 430 yards and 240 degrees from the 2-story building at Kerr Mount. This building differs from the previous field houses on the island in that there are windows.