

Ninth Annual

Summer Research Symposium



July 29, 2011
St. Thomas Campus
College of Science & Mathematics
University of the Virgin Islands

Ninth Annual Summer Research Symposium

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St. Thomas, U.S. Virgin Islands

Emerging Caribbean Scientists Programs Featured

Emerging Caribbean Scientists Programs increase research training and promote excellence for STEM (science, technology, engineering, and mathematics), psychology, & nursing students at the University of the Virgin Islands.

- Mathematics Behind the Science summer bridge program – The Math Behind the Science summer bridge program is designed to enhance the mathematics preparedness of college-bound STEM students by preparing them to enter the introductory calculus course and provide a foundation for success in calculus and beyond.
- Summer Sophomore Research Institute (SSRI) – SSRI fellows work with faculty on a research project and participate in workshops to learn basic research methods and techniques.
- Summer Undergraduate Research Experience (SURE) - SURE fellows work closely with faculty on challenging scientific programs.

The University of the Virgin Islands' Emerging Caribbean Scientists Programs are sponsored by local and national grants from National Institute of Health, National Science Foundation, J. Raymond Jones Foundation, Google, and other donors.

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**Threats to Our Reef
Lionfish-The Eating Machine**

Denniqua Benjamin

Bernard Castillo II, PhD (mentor) & Kynoch Reale-Munroe (mentor)
Summer Undergraduate Research Experience
University of the Virgin Islands

The invasion of the Atlantic by the Indo-Pacific Lionfish (*Pterois Volitans/Miles Complex*) began in the early 1990s off the coast of Florida. By 2008 the invasion made its way to the United States Virgin Islands. On November 25, 2008 the first Indo-Pacific Lionfish was removed from Frederiksted Pier on St. Croix. Because there are no predators to the lionfish in the Caribbean the invasion continues. This project aims to identify the prey of the invasive lionfish recovered off the westend of St. Croix as a means to possibly predict what aquatic species will face extinction as the invasion continues. The fish removed were characterized by sex, length, and weight. Through dissection the stomach contents were analyzed and when possible the species were identified. The male to female ratio of the lionfish was also observed. Our stomach content analysis showed the juvenile yellowhead wrasse, shrimp and the bicolor damselfish were the most frequent prey. Trends in the weight, length, and male to female ratio of the lionfish were also observed. Female lionfish were generally larger and bigger than male lionfish.

This research was funded by NSF HBCU-UP Grant # 0506096. Travel for the presenter and her mentor was sponsored by NSF Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR) Grant #0814417.

**Machine Learning to Classify *E. coli* Promoters into Functional Categories
Is More Accurate When using Tetranucleotide Frequencies
Rather than Di- or Trinucleotide Frequencies**

Emanuel Camacho

Shenelle Dore & Stuart Ketcham, PhD (mentor)
Summer Undergraduate Research Experience
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A promoter is a DNA segment that serves as the initiation site for expression or transcription of a gene. A DNA segment consists of a series of chemical subunits that are represented by a linear sequence of letters. Transcription is the copying of information from a gene by an RNA polymerase enzyme. In *E. coli* and other bacteria, the part of the RNA polymerase that recognizes a promoter is a subunit called sigma (σ). There are different versions of σ that are active under different environmental conditions and recognize different sets of promoters. So the σ 's play a key role in regulating bacterial gene expression. Machine learning may be a relatively inexpensive way to identify candidates of different types of promoters compared to molecular biology experiments. The purpose of our research is to discover whether or not machine learning algorithms can accurately classify promoters into classes recognized by different σ 's and which features are most useful for classification. We compared classifications using the 3 following alternative types of features: the frequencies of each of the 16 possible dinucleotides in the DNA segment; the frequencies of the 64 possible trinucleotides, and the frequencies of the 256 possible tetranucleotides. We used the programming language PERL to develop scripts to calculate these frequencies in promoters known to be specifically recognized by each of the 6 types of σ 's: σ_{70} , σ_{54} , σ_{38} , σ_{32} , σ_{28} , and σ_{24} . With these frequencies, we used the J.48 tree and Naive Bayes algorithms in the machine learning package WEKA to classify promoters into one of two σ classes (for example: σ_{70} vs. σ_{54}). Applying these methods, we rejected the null hypotheses of no difference between the distribution of correct and incorrect sequence instances classified between classifications using dinucleotide features vs. those using trinucleotides (p value = $<.0001$) and trinucleotides vs. tetranucleotides (p value = 0.0024). The % correctly classified increased from 65% to 78% to 83% for the classifications using di-, tri- and tetranucleotides, respectively. The J.48 tree classifications used only a subset of the initial features to construct the trees. In general, reclassification using only those features resulted in higher classification accuracies. These results suggest that machine learning may be useful in identifying important features of different types of promoters and recognizing previously unknown promoters.

This research was supported by NSF HBCU-UP grant number HRD – 0506096. The promoters used in this research were retrieved from the RegulonDB Database (<http://regulondb.ccg.unam.mx/>).

Temperature and feeding affect Caribbean corkscrew sea anemones' stinging temperament

Jacob M. Case

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Sea anemones are known to use mechanical and chemical stimuli to determine when to fire their cnidocytes, cells on their tentacles that fire a type of toxic filled harpoon for defense or for prey capture, but other factors may influence the degree of the firing of these cells. The common corkscrew Caribbean sea anemone, *Bartholomea annulata*, is usually quite aggressive yet sometimes seems to be very docile in our holding tanks. We explored several factors which may lead to changes in sea anemones' stinging temperament including temperature and feeding habits. We measured anemone temperament for stinging with a gloved finger poke on a scale of 0-3. We conducted field experiments to explore the effect of feeding on anemone stinging temperament, by comparing temperament before feeding, during feeding and post-feeding (~45min after feeding). *B. annulata* was more aggressive during feeding than before or after feeding. To explore the role of temperature, we compared the temperament of anemones in warm (34°C), or cold water (20°C) to their temperament in normal seawater (28°C). We found that anemones in cold water were more aggressive than those in normal or warm water. The changes in anemone aggressiveness may have implications for the cleaner shrimp that inhabit these anemones, such that the shrimp may have to alter their behavior during cooler times and when anemones are feeding. The increase in anemone aggressiveness in colder water may be due to increased oxygen supply in colder water, though we have not tested this directly yet. Furthermore, a large die off was noted during these experiments which coincided with an increase in the acidity of the holding tanks' seawater, suggesting we should further investigate the role of seawater pH in relation to the health and aggressiveness of the corkscrew anemone.

Funding for this program was provided by means of a grant from the National Science Foundation's (HBCU-UP program).

Preliminary Results: Measurement of Sediment Production and Particulate Organic Material in Small Subtropical Watersheds on the East End of St. Croix, USVI

Jewel Cumberbatch

Bernard Castillo II, PhD (mentor) & Kynoch Reale-Munroe (mentor)
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Ongoing research in the US Virgin Islands is being conducted in an effort to better understand the relationship between increased terrestrial sediment inputs and the degradation of receiving marine ecosystems. Degradation of near-shore coastal habitats, resulting from sediment laden runoff, continues to be one of the main nonpoint sources of pollution contaminating surrounding waters in US Virgin Islands. Land use changes that decrease vegetation cover, increase the potential for soil erosion and therefore, sedimentation into coastal marine environments. Increased development, unpaved roads and a lack of effective erosion control practices have massively contributed to increased sediment loading rates in the territory. Increased erosion rates effectively decrease organic content in surficial soils by simple soil loss. Particulate organic material is critical for nutrient and moisture holding capacities in soils and for productive plant growth. Productive plant growth stabilizes soil structure and reduces erosion. This study was designed to quantify and compare sediment production rates from natural and anthropogenic sources of sediment within the subtropical environment of the East End and Boiler Bay watersheds. Sediment production rates are being measured from undisturbed, vegetated hillslopes, and disturbed areas, represented by old unpaved roads that are currently used as foot trails. The main objectives of this project are: 1) to compare erosion rates between the two types of surfaces (i.e., trail vs hillslope); and 2) to quantify the particulate organic material composition of the collected sediment samples from both source types. Monitoring sites have been established throughout the watersheds by the installation of 21 sediment traps that collect material from trail, hillslope and cliff surfaces. Material collected from each of the sediment traps during the 2010 study period were analyzed and correlated with rainfall data, slope and vegetation cover. Subsamples taken from the material collected from the sediment traps were analyzed for organic content, using the Loss on Ignition (LOI) method. Preliminary results are indicating that erosion rates on trail surfaces are higher than undisturbed hillslopes. In addition, the ranges of particulate organic material present in the soil samples are showing that samples taken from trail surfaces are generally lower than those taken from undisturbed hillslopes.

This research was funded by the USGS through WRRRI at UVI. Project number: 2010VI170B

Successfully Classifying Promoter Regions of *Escherichia coli* into Different Functional Types Using Machine Learning

Shenelle Dore

Emanuel Camacho & Stuart Ketcham, PhD (mentor)
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Promoters are regions of DNA found at the beginning of DNA segments called genes. Promoters are essential in cells because they are the binding sites for the protein RNA polymerase. Once bound to the promoter, given the right conditions, RNA polymerase will initiate the transcription of that gene, creating messenger RNA that is later translated to make a protein encoded by that gene. In our research project we studied different types of *E. coli* promoters. Each promoter is specifically recognized in the cell by one of six different sigma (σ) subunits of RNA polymerase, σ_{70} , σ_{54} , σ_{38} , σ_{32} , σ_{28} , and σ_{24} . Different σ 's are active under different environmental conditions and are critical in regulating gene expression in *E. coli*. There is structural similarity shared by σ_{70} , σ_{38} , σ_{32} , σ_{28} , and σ_{24} , so these proteins are called the σ_{70} family. Sigma 54 is outside of the σ_{70} family. The purpose of this project is to see how accurately machine learning algorithms can classify previously identified promoter sequences into different functional categories using tetra-nucleotide frequencies as distinguishing features. We wrote a PERL script to create a program that would calculate the frequencies of tetra-nucleotides in each sequence. Those frequencies were then used as input for classification algorithms in the WEKA data mining platform. We used two algorithms, the C4.5 tree algorithm and the Naïve Bayes algorithm, to classify promoter regions into different classes, for example σ_{70} vs. σ_{54} . Our first null hypothesis is that there is no difference between the distribution of correct and incorrect sequence instances classified using the C4.5 algorithm and the expected for random guessing, 50% correct. In fact, the accuracy for the C4.5 classification is 68%, and using the χ^2 (Chi-squared) test, we reject this null hypothesis (p-value <0.0001). Our second null hypothesis is that there will not be a significant difference in the accuracy of classification of promoters between classifications into one class that is recognized by a σ_{70} family member and another class recognized by σ_{54} . Using the C4.5 tree algorithm, pairs of classes that included σ_{54} had an average correct classification of 73%, whilst pairs of classes that only included members of the σ_{70} family had an average correct classification of 62%. Using a χ^2 test, we reject this second null hypothesis (p-value \approx 0.0002). The result is that there is a significantly greater accuracy of classifications of promoters when one of the promoters is outside the σ_{70} family than when both are in the σ_{70} family. In addition, we will present results using the Naïve Bayes algorithm and discuss efforts to increase the accuracy of classification and identify those features that are most useful in these classifications.

This research was supported by NSF HBCU-UP # HRD-0506096.
The promoters used in this research were retrieved from the RegulonDB Database.
<http://regulondb.ccg.unam.mx/>

**A Pilot Study for the use of the "HUSI"
for establishing a record of herbal use in the US Virgin Islands**

Althea Duke & Holly Young

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University of the U. S. Virgin Islands

In the United States Virgin Islands, a melting pot of many cultures from around the world, many locals have a preference for the use of natural, herbal remedies or "bush remedies/treatments" to help treat many disease states such as diabetes and skin infections. In the United States Virgin Island of St. Thomas, nine people were screened using the "Herbal Use Screening Instrument (HUSI)" questionnaire in order to explore the different kinds of alternative medicines used by locals to treat diseases such as diabetes and skin conditions, and to establish a detailed record of trends in the territory. Of the nine persons screened in the pilot study, 44.44% use herbal remedies to prevent/treat diabetes, 33.33% make an herbal remedy used to prevent/treat their diabetes, and 11.11% use herbal remedy for a skin condition. Additionally, 22.22% of the participants also use prescribed medications, and 22.22% inform their physician of their herbal use even if they are not asked. After analyzing the data collected, it was found that 11.11% of the population uses herbs routinely because it is part of their culture. Data from this pilot study will help to direct the development of future survey tools, follow-up surveys, and phytochemical investigations.

This research was supported by The Center for the Study of Complementary and Alternative Medicine via the University of the Virgin Islands Foundation.

High Performance Liquid Chromatography (HPLC) Method Development for the Qualitative Analyses of Lemongrass and Soursop Decoctions

Emilio Edwards, Debra Garvey, & Tobias Ortega-Knight

LaVerne Brown, PhD (mentor)

Center for the Study of Complementary and Alternative Medicine
University of the U. S. Virgin Islands

Complementary and alternative medicines in the form of herbal remedies or “bush teas” are culturally accepted alternatives to pharmaceutical drugs in the US Virgin Islands. These herbal remedies are composed of a complex array of phytochemicals that are potentially linked to efficacy claims. However, variations in the preparation and/or storage of herbal remedies may alter the phytochemical composition and thereby result in significant changes in efficacy or even toxicity values. To investigate the effects that preparation and storage have on the phytochemical composition of decoctions of Lemongrass and Soursop leaves, our group developed a HPLC (high performance liquid chromatography) method to obtain fingerprints of the diverse phytochemical matrices. For both decoctions, 3 μ L samples were injected at a flow rate of 0.5mL per minute using a gradient mobile phase of 80:20 water: acetonitrile to 40:60 water: acetonitrile. The resulting chromatograms showed complete elution after 20 minutes with adequate separation of phytochemical components; and thereby provided “fingerprints” of the complex mixtures suitable for quality assessment studies. Our preliminary data showed a clear distinction in phytochemical composition for both the lemongrass and soursop decoctions that were prepared and refrigerated vs. decoctions that were prepared and stored at room temperature. The link that the observed changes in the phytochemical composition may have with respect to anti-microbial or anti-cancer efficacy is currently being investigated in our lab.

This research was supported by The Center for the Study of Complementary and Alternative Medicine via the University of the Virgin Islands Foundation.

**Investigation of the synergistic relationship between mixtures
of components in Soursop decoctions**

Debra Garvey & Delreese Giff

Jennilee Robinson, PhD (mentor) & LaVerne Brown, PhD (mentor)
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University of the U. S. Virgin Islands

Annona muricata (soursop) is a tree indigenous to the Virgin Islands and it is often used for the treatment of certain ailments such as diabetes. The purpose of this study is to explore whether soursop tea and any of its components has antimicrobial, anti-proliferative and/or toxicity properties. In addition, it is expected that through the separation of these components the properties of the original tea would be altered which eludes synergy. The experiment was conducted by using disc diffusion assay for the antimicrobial study and brine shrimp toxicity (BST) assay for the anti-proliferative and toxicity study. The BST assay revealed that certain components of soursop have anti-proliferative properties which may be useful for cancer research. Furthermore, synergy was confirmed by the fact that the original soursop decoction did not have a very high level of toxicity whereas a number of the fractionated components' levels of toxicity were significant.

This research was supported by The Center for the Study of Complementary and Alternative Medicine via the University of the Virgin Islands Foundation.

Is there a social preference of the rock boring sea urchin, *Echinometra lucunter*?

Tricia Greaux

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University of the Virgin Islands

The rock boring sea urchin, *Echinometra lucunter*, is a very interesting species that has not been extensively studied and little is known about its social preferences. This intertidal herbivore consumes algae, which harm corals, creating a better environment for the survival of coral reefs. Using transects, a density analysis was conducted in the field to determine the natural occurrence of the *Echinometra lucunter*. The transect data revealed that there is an abundance of juveniles and the high standard deviation means aggregation is present. I observed these sea urchins push each other as a form of intraspecific competition. An experimental study was designed to determine the social preference by using a Y-maze choice experiment conducted at the William P. MacLean Marine Center, St. Thomas campus, University of the Virgin Islands. In the choice experiment, there was a group of juveniles in one arm of the Y-maze with a single adult in the other arm (n=22). This was done to determine if, like other species of sea urchins, the juveniles *Echinometra lucunter* aggregate with other juveniles. The other possibility is that adults protect the juveniles under their spine canopy, therefore the juvenile would travel towards the adult. A chi-squared test revealed there was no strong difference in the choice between both arms ($p=0.088$). This means the juveniles sea urchins did not respond strongly to the cues of groups of juveniles or single adults. Next steps include testing the response of juveniles in the field or in the presence of predators.

This research was supported by the ECS Honors program and NSF HBCU-UP grant # HRD-0506096.

Elimination of Cruzan Rum's Vinasse Effluent Discharge Into the Caribbean Sea

Nathan Gubser

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For each gallon of rum manufactured, between ten and twelve gallons of waste product, called vinasse effluent, is generated. Cruzan VIRIL Ltd. operates a rum distillery on St. Croix, U.S.V.I. Until recently, Cruzan VIRIL has been permitted to discharge this undesirable waste product into the Caribbean Sea. However, a change in what will be legally allowable has driven Cruzan Rum to stop this practice, and implement an alternate approach to the processing and disposal of their vinasse effluent stream.

After a review of available alternative technologies, Cruzan Rum has selected an evaporative treatment method, and is currently constructing an evaporative process facility. This facility will concentrate the waste stream into a condensed molasses solids product, which will then be shipped off island to be reused as animal feed additive. Furthermore, the water recovered from this evaporation process will be purified, utilizing reverse osmosis technology and recycled for re-use in the fermentation process. This development is an engineering solution to an environmental problem. Structural, civil, electrical, chemical, and mechanical engineering design elements are all integral components in the application of this solution. While this experience cannot be considered classical research; through it, I gained immersive exposure to varied engineering applications and plant technology. This was facilitated by the guidance that I received from chemical and mechanical engineers as well as the project's construction manager. The result is a dynamic exposure to and understanding of, multi-disciplinary engineering collaboration and project management, during the construction of this industrial facility.

This research was supported by an NSF grant "Interdisciplinary Innovations", UVI NSF HBCU-UP Award No. 0506096.

An efficient Algorithm for Solving the Berth Assignment Problem

Tyriq Isles & Kyle Williams

Marc Boumedine, PhD (mentor)

Summer Sophomore Research Institute (SSRI)

University of the Virgin Islands

Vessels or ships that arrive at the terminal (port) need to be assigned to berths in order to unload/load containers or passengers effectively. Therefore vessels/ ships compete over the available berths and various parameters affect the berth assignment. The berth scheduling problem (BSP) is typically formulated as a combinatorial optimization problem. The BSP is an NP-hard problem and heuristics or meta-heuristic algorithms are necessary to produce computationally acceptable solutions given the constraints and available resources. NP-hard problems in computational complexity theory, places these problems as one of the hardest problems to solve. These problems require great detail of information to work on regardless of algorithms, in our case constraints and allocating resources.

Also vast variety mathematical models are used to make alternate possibilities, in which heuristics are used to figure which solutions work by trial and error, but meta-heuristics is used to find the best estimated solution. We are given n ships and n berths; each ship-berth pairing has an associated cost, C_{ij} , corresponding to the cost that the i th ship associates with the j th berth. The goal is to assign exactly one ship to each berth so that the resulting one-to-one correspondence minimizes the total cost. Many algorithms use iterative methods for finding the optimal assignment from the set of $n!$ possible assignments. The *Hungarian* or *the Kuhn–Munkres* algorithm, which is one of the best known algorithm for solving the assignment, has been implemented. As expected, the algorithm find the best solution in polynomial time since its complexity is $O(n^3)$. A basic graphical user interface allows the visualization of the solution. This algorithm is currently been adapted to consider additional constraints specific to U.S. Virgin Islands ports.

We would like to thank Mr. Mark Sabino, WICO for his helpful conversations. This research was supported by NSF HBCU-UP grant number HRD-0506096.

**DNA Extractions of White Mangroves:
The enzymes RNase & Proteinase K produced the purest DNA**

Gemel Joseph & Laida Brooks

Alice Stanford, PhD (mentor)
Summer Sophomore Research Institute (SSRI)
University of the Virgin Islands

Mangroves are known for their high salt tolerance and ability to provide shelter to many aquatic and non-aquatic organisms. They protect coastal lands from erosion by trapping sediment runoff from flowing into oceans and other bodies of water. Molecular data are currently not available for the white mangrove species, *Laguncularia racemosa*, which is one of four species of mangroves found in the Virgin Islands. This is because the DNA extracted in the past by scientists of the VI often was not clean enough to allow for further examination of its genetic variation. In this study, we investigated the question “What method of DNA extraction produces the highest quality DNA sample for *L. racemosa* for use in genetic testing?” There were four DNA extraction methods: the CTAB protocol, the double chloroform (CTAB) protocol and two DNA extraction kits, Epicentre and Ultraclean. After extracting the DNA, we measured the purity and quantity of the sample using UV spectrometry. We cleaned the least pure samples using 3 enzymes: proteinase K, phosphatase and RNase. After which we amplified the DNA samples and analyzed the DNA bands (under UV light) after they were separated in an agarose gel. The use of enzymes proteinase K and RNase produced the best samples with $AAA_{260}: A_{280}$ ratios of 1.85 and 1.86 respectively. The outcome from amplifying and analyzing the DNA bands is inconclusive. The results indicate that we are well on our way to finding the ideal extraction method which produces high quality DNA for further genetic testing.

This research was funded by NSF HBCU-UP grant # HRD – 0506096 and NSF VI EP-SCoR.

An examination on the synergistic effects of phytochemical compounds found in traditional Virgin Island's preparations of Lemongrass (*Cymbopogon citratus*)

Danny Lynch, Tobias Ortega-Knight, & Thalia Lake

LaVerne Brown, PhD (mentor)

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University of the Virgin Islands

Modern Western medicine almost exclusively uses manufactured pharmaceuticals to treat most patients with synthesized drugs. The rigorous efficacy testing done on these drugs most commonly focuses on one isolated active ingredient, instead of concentrating on synergistically designed drugs. Natural treatments, such as herbal medicines, are commonly used in St. Thomas as cheaper alternatives to pharmaceuticals. The purpose of this study is to determine if there are any advantages or disadvantages when consuming lemongrass tea, as it is traditionally used by Virgin Islanders due to synergistic effects, rather than common pharmaceutical therapies. Lemongrass (800g) was collected on the campus of UVI and from various locations on St. Thomas, traditional decoctions were prepared, and dilutions (100%, 75%, 25%, and 12.5%) were used for analyses. Methods included fractionation by liquid-liquid extraction, evaporation, Brine Shrimp Toxicity (BST) Assays, High Performance Liquid Chromatography (HPLC), and bactericidal Disc Diffusion Assays on lawns of *E. coli*. Our data showed that lemongrass elicited strong cytotoxicity in the BST assays but showed no significant anti-microbial effects with respect to the controls in the bactericidal tests. With the current data, synergistic effects can neither be claimed nor denied. For future studies, additional assays will be used to confirm synergy.

This research was funded by NSF HBCU UP grant # HRD-0506096 and by The Center for the Study of Complementary and Alternative Medicine, University of the Virgin Islands Foundation.

Studying the Interactions between Coral Reefs and Participants of Marine Conservation Activities

Kyvonn A. Morton & Antonio Farchette

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University of the Virgin Islands

The reefs provide an aquatic habitat that promotes enhanced species biodiversity, protection to our coastal shorelines, and promotion of sustainable marine and natural resource-based livelihoods. Coral reefs are being diminished daily due to anthropogenic and natural threats. In this process the role of information and education of the society regarding coral reef health and conservation is critical to prevent coral loss. In order to determine how people's general knowledge affects how they perceive and interact with coral reefs and how participants interact with each other and the environment during marine conservation activities, we administered a pre-survey to determine their attitudes, beliefs, and behaviors about the coral reefs. The participants undertook a boat trip to three different spatial locations, varying in their characteristics (e.g., difference between inshore and offshore reefs). We interviewed focus groups and used their responses in a content analysis of key perceptions and cognitive characteristics in three key temporal stages: (a) before the trip, (b) during, and (c) after the boat trip. The participant behavior in the water was observed in order to study their interests and the complexity of their interactions, and their encounter patterns with the natural system. The data was used to study the relationship between human interactions and the reefs. The participants realized how their actions affect the coral reefs and they noted the differences between inshore and offshore spatial locations. The study experience enhanced their understanding of how human interactions degrade the reef ecosystem and cause detrimental effects. Our study shows that the participants found the research to be vital, educational and have important impacts to the community perceptions regarding coral reef conservation. Finally, our results present a new approach to studying how social learning from experience can benefit and improve perceptions, beliefs, and attitudes toward environmental conservation.

The participation of the authors in the research study was funded from the UVI's SSRI 2011 program (HBCU-UP grand no: HRD-0506096). The research project activities and fieldwork was funded by NSF/VI-EPSCoR research project entitled "Experiential Social Learning for Coral Reef Resilience" (ESLCRR incubator project no: 203058). The fieldwork coordination was conducted by Ms. Elena Kobrinski, a UVI-MMES graduate research assistant for the ESLCRR project. Special thanks to Dr. Teresa Turner for her participation in the educational part of the experiment, Mr. Steven Prosterman, who served as the CMES boat captain, Ms. Serah James for her assistance during the experimental boat trip, and Dr. Kimarie Engerman for her contribution to the pre-survey instrument construction. Finally we would like to acknowledge the invaluable contribution of all the study participants without whom this research would have not materialized.

The never-ending pairs of (m, n) where

$$\sigma(m+n) = \sigma(m) + \sigma(n)$$

Dwayne C. Richardson

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 University of the Virgin Islands

Let \mathbf{N} be the set of natural numbers. We define the arithmetic function $\sigma: \mathbf{N} \rightarrow \mathbf{N}$ by

$\sigma(n) = \sum_{d|n} d$, where $\sum_{d|n} d$ is the summation of all the *positive divisors* d , of n . This operation is known as the *sum - of - divisors* function.

Suppose m is another element in \mathbf{N} . Given the case $\sigma(mn)$ where $(m, n) = 1$ (which is to say that m , and n are **relatively prime**), it is clear that σ is a **multiplicative function**, i.e.,

$$\sigma(mn) = \sigma(m)\sigma(n)$$

We ask ourselves: are there infinitely many solutions (m, n) for which

$$\sigma(m+n) = \sigma(m) + \sigma(n) ?$$

(1)

In exploring this aspect of σ , we hope to develop a greater understanding on how numbers work, which may lead to other discoveries within mathematic and scientific disciplines. Some specific cases have been found, where (1) holds for infinitely many pairs (m, n) . However, the question above still remains unanswered in general.

This is why we seek only for **primitive solutions** (m, n) . A solution is known as **primitive**, if the greatest common unitary divisor of m , n , and $m+n$ is 1.

Upon investigating pairs (m, n) that solve (1), it was found that each m , n and $m+n$ would be multiples of primes. Using odd primes p , q , and r , along with natural numbers a , b , and c , where $p \nmid a$, $q \nmid b$, and $r \nmid c$, a system of linear equations was developed, as seen here.

$$ap + bq = cr$$

$$\sigma(ap) + \sigma(bq) = \sigma(cr)$$

Through applying Linear Algebra and Number Theory, an algorithm was developed which provided some solutions (m, n) .

This method shows that it is simple, but not trivial to provide several pairs (m, n) which satisfy (1). This strengthens the conjecture that there are infinitely many **primitive** solutions satisfying

$$\sigma(m+n) = \sigma(m) + \sigma(n)$$

**Center for the Study of Complementary and Alternative Medicine
Restoration of the UVI-CES Herbarium**

Agene' Rogers & Sean Richardson

Toni Thomas (mentor)

Cooperative Extension Service

University of the Virgin Islands

Herbarium resources are systematically arranged collections of dried plant specimens used for botanical reference and research that serve to support scientific and community activities. As part of its pilot project goal, the University of the Virgin Islands (UVI) Center for the Study of the Alternative and Complimentary Medicine (CCAM) is investigating the challenges associated with using alternative and complementary medicine. In 1982, CES established a herbarium on St. Thomas as part of a resource management project conducted by several institutions such as the V.I. National Park, the U.S. Geological Survey and Smithsonian Institution. However, the herbarium lacked a curator to maintain the valuable collections. Our participation in the CCAM project has provided the opportunity to determine the current integrity of the collections. Based on our inventory, the herbarium contains over 1800 specimens in 14 separate collections, from 1969 to 2001. Approximately 10% damage was caused by dermestid beetles. We have assessed and improved the preservation of the collections, updated the hard-copy catalog, conducted a search for a suitable database format that included contacts with the Fairchild Tropical Botanical Garden, the Virtual Herbaria Project and local experts, and are in the process of designing a relational database. The final goal of this project is to develop a user-friendly online database for the UVI and local community to help preserve a valuable part of our local Caribbean heritage for future generations.

This study was supported and funded by the Center for the Study of Complementary and Alternative Medicine via the University of the Virgin Islands Foundation.

Larval settlement of the long-spined sea urchin, *Diadema antillarum*, corroborates seasonality and importance of post-settlement processes in the US Virgin Islands

Jamie Spray

Teresa Turner, PhD (mentor)

Summer Undergraduate Research Experience (SURE)

University of the Virgin Islands

Rapid phase shifts from coral reefs to algal-dominated reefs have occurred throughout much of the Caribbean following a mass mortality event claiming 95-99% of long-spined sea urchins. Such a strong correlation with this event suggests the herbivorous *Diadema* fulfill an important niche in maintaining coral-dominated reefs. Hence, their reestablishment could enable coral reef recovery. Yet, recovery has been variable and patchy across and within the region. Possible reasons for this could be a difference in larval supply between localities, preferential settlement, and post-settlement processes acting strongly on certain populations. In continuation of a study instituted in Brewer's Bay, St. Thomas, USVI, we are deploying settlement collectors monthly to test the larval supply between two sites with contrasting adult population densities. Data from 2010 show a possibility of a late spring/early summer seasonal peak in settlement. Thus, we predicted a similar peak this 2011 season: May-July. Data show a seasonal peak, with one month's difference between years. The observed annual variation could be due to oceanographic conditions or nutrient flux. Additionally, we predicted that if larval supply accounts for the differences in adult populations, the locality with higher adult density (Runway) would show significantly higher *Diadema* settlement. The results were that Black Point, the site with low adult density, had the higher amount of settlement, whereas Runway had low settlement for the peak month. Because the site with higher adult density had the lower number of settlers, the larval supply hypothesis is falsified. A t-test performed over the entire study period showed no significant difference in the larval supply. Therefore, post-settlement processes must affect juvenile recruitment, and further study on the behavior and nursery requirements of recently-settled juveniles could lend insight into survival mechanisms to ensure healthy adult populations.

This research is funded by the NSF VI-EPSCoR grant # 0814417 and NSF HBCU-UP grant # HRD-0506096.

Sponsors

- National Science Foundation, Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) Grant # HRD-0506096
 - Summer Undergraduate Research Experiences (SURE)
 - Summer Sophomore Research Institute (SSRI)
 - Mathematics Behind the Science summer bridge program
- National Institutes of Health, Minority Access to Research Careers (MARC) Curriculum - Vertical Integration of Quantitative & Biological Sciences Grant #GM078003A
- J. Raymond Jones Foundation
- ECS Honors Fund
- Google, Inc. Employee Matching Program
- Center for the Study of Complementary and Alternative Medicine
- National Science Foundation, Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR) Grant #0814417

Thank You!

Tanisha Mills
Winston Charles
Stevie Henry

Save The Date!

Fall 2011 Research Symposium
1 to 3pm, Sunday September 25, 2011
ACC Building, St. Thomas Campus

For more information, visit <http://ecs.uvi.edu>

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