Ninth Annual

Spring Research Symposium

March 12, 2011
St. Croix Campus
College of Science & Mathematics
University of the Virgin Islands

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Sponsors:

- National Institutes of Health, Minority Access to Research Careers (MARC) Program
- National Institutes of Health, Minority Biomedical Research Support Research Initiative for Scientific Enhancement (MBRS RISE) Program
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- The Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR)
- LANA VENTO FUND Scholarships
- NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)

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Emerging Caribbean Scientists Programs

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A cell culture approach to studying fatty acid modulation of porcine lung macrophage-like cell function

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Dr. Kevin Fritsche (mentor)
University of Missouri, Columbia

Omega-3 (n-3) fatty acids improve cardiovascular health and may have beneficial effects on the immune system. In these experiments we sought to investigate the anti-inflammatory actions of these fatty acids using a porcine lung macrophages cell line, 3D4/31. First, we characterized how we could modify the fatty acid profile of these cells by adding different combinations and concentrations of different fatty acids to the cell culture medium. Following this we determined how such changes in cellular fatty acid composition affected the production of the pro-inflammatory cytokine, tumor necrosis factor-alpha (TNF-a). Our results show that under normal culture conditions this cell line displayed a fatty acid profile unlike that of lung macrophages isolated directly from pig lungs. We were able to normalize the fatty acid profiles by co-culturing the 3D4/31 cells with linoleic acid (LA) and arachidonic acids (AA) for 24 hr. When a mixture of n-3 fatty acids, EPA and DHA (3:2 @ 50 uM), were added to the culture medium along with LA and AA, the overall fatty acid profile in the 3D4/31 cells was similar to lung macrophages isolated from pigs fed a diet containing fish oil. Culturing the 3D4/31 cells with LA and AA reduced their ability to produce TNF-a. Enriching these cells with EPA and DHA diminished TNF-a production even further. We also investigated the impact of EPA and DHA treatments separately. Our data suggest that both of these n-3 fatty acids reduced porcine macrophage TNF-a production to a similar extent and in a dose-dependent manner. Additional studies are needed to determine the specificity of this effect as well as the underlying mechanism(s) for n-3 fatty acids on immune cell function. In conclusion, the porcine macrophage cell line 3D4/31 appears to be a useful in vitro system to study the immune modulating effects of omega-3 fatty acids.

This project was sponsored by NIH MARC Grant # 5T34GM008422 and by the Miller summer program in animal sciences, University of Missouri, Columbia.

Diversity of bacteria associated with *Montastraea* spp. across sea water quality gradient in the United States Virgin Islands

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University of the Virgin Islands, St Thomas, VI

Rapid coastal inhabitation has lead to drastic changes in water quality in part contributing to increased incidence of coral diseases and overall worldwide declines in coral cover,. The microbial community found in coral mucus forms the primary line of defense against pathogenic invasion and it has been suggested that changes in the physical and chemical properties of sea water can cause changes in their populations, potentially making corals more susceptible to diseases.

The present study is aimed at quantifying the microbial community composition associated with the *Montastraea annularis* species complex, which are the major framework building species (50-80% of total coral cover) of corals in the USVI region. Coral reefs in the region are greatly impacted by various kinds of anthropogenic stress and there is a trend of decreasing coral cover and health across a nearshore to offshore stress gradient. To analyze the microbial community mucus samples were collected from different reef habitats including nearshore, shallow (<30 m) and highly impacted reefs as well as offshore, shallow and relatively pristine reefs. Samples were analyzed using 16S rDNA technique for patterns of change in microbial composition across the above mentioned gradient.

Results from the study will help in understanding whether the microbial community composition changes as one moves across this proposed water quality gradient and whether this change is associated with coral health.

This research supported by the Lana Vento Charitable Trust.

Fireworm Size and Copepod Parasitic Load are Positively Correlated

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University of the Virgin Islands, St Thomas Campus

The fireworm (*Hermodice carunculata*) is a polychaete well known for its fuzzy, stinging chaeta on either side of their long slender lengths. Fireworms are scavengers and predators to corals and sea anemones. Fireworms are parasitized in their gills that run along their entire length by copepods, *Pseudoanthessius tortuosus* that belong to the family *Pseudoanthessiidae*, a family that mainly parasitizes echinoderms. This species of copepod was only recently described as parasitizing fireworms in the Caribbean in 2009. We investigated if there is a correlation between the size of fireworms and the copepod parasitic load, as well as if there were differences in parasitic load at different sites. Eleven fireworms were captured in baited traps constructed from PVC fittings. Another 11 fireworms were caught by hand along the airport runway. We were unsuccessful at capturing fireworms in a nearby coral reef. The fireworms were then placed in anaesthetic solution (Magnesium Chloride) and left for one to two hours. Under a dissecting microscope, copepods were removed, counted, and preserved in separate vials for future references. We found a significant, positive correlation between the parasitic load and the sizes of fireworms found under the dock ($p< 0.001$, $R^2=0.8$). The fireworms collected along the airport runway averaged approximately half the size of the fireworms found under the UVI dock. Despite the size differences, the fireworms at the airport runway still fall within the general trend with the parasitic load with the fireworms found under the UVI dock. It remains to be seen whether the parasitic load affects predatory and scavenging ability of the fireworms.

This research was funded by NIH MBRS-RISE grant number GM061325.

Developing Unique ISSR fingerprint for *Musa acuminate*

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In the Caribbean, *Musa acuminata*, also commonly known as banana, is a widely grown crop. It is one of the most exported crops that bring in foreign exchange into Caribbean islands. There is just one species of banana, but approximately 500 varieties (Daniel, 1995), some of which are difficult to identify. The fruit has many health benefits. Bananas reduce depression and high blood pressure, and help to maintain a healthy kidney and healthy bones. It also provides a good amount of iron and helps to maintain healthy eyesight (Anderson et al. 1994). To identify unknown varieties, it can be helpful to develop a DNA fingerprint by studying the genetic diversity of banana through developing a molecular analysis technique.

The purpose of this experiment was to create a unique DNA fingerprint to identify unknown banana varieties. Banana samples were collected from different trees and their DNA was extracted and amplified through polymerase chain reactions (PCRs) using 18 primers. I found out that the different varieties of banana, despite being cloned from one another, have different DNA fingerprints. So far, six primers worked really well with *Musa acuminata*. Some varieties have the same alleles, but some differ. Future research would include getting these same primers to work with different individuals in the same varieties already tested. It would be interesting to compare those genotypes with the ones already obtained. Another step would be to test different varieties and compare their genotypes.

This project was sponsored by NIH MBRS-RISE Grant Award No. GM061325

Triunitary Perfect Numbers

Leonardo José Bardomero
Mentor: Dr. D. Iannucci

Given positive integers n and d, we write $d \,||\, n$ if d divides n but the greatest common divisor of d and n/d is 1. We may write instead $d \,|_1\, n$. In this case we call d a **unitary divisor** of n. Then we write $d \,|_2\, n$ if $d \mid n$ and the greatest common unitary divisor of d and n/d is 1. In this case we say d is a **biunitary divisor** of n, and we write $d \,|_2\, n$ in this case. We may extend this inductively: we say d is a **k-ary divisor of** n, and we write $d \,|_k\, n$, if d divides n, and the greatest common (k-1)-ary divisor of d and n/d is 1. We refer to 3-ary divisors as **triunitary divisors,** and to 4-ary divisors as **tetraunitary divisors,** and so on.

Now let $\sigma^{(k)}(n)$ denote the sum of k-ary divisor of n. We say that n is **k-ary perfect** if $\sigma^{(k)}(n) = 2n$. In this talk we will give all our results to date regarding the existence of triunitary perfect numbers.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

The Correlation between Recruitment and Retention and Computational Thinking Skills

Laurie Barnwell
Mentor: Dr. Steven Case

This research evaluates the impact of computational thinking skills on overall recruitment and retention of students in computer science. The current retention rate of undergraduate students in lower level computer science courses is very low. Other research has identified reasons why students switch from computer science and suggests that a lack of computational thinking skills is a major characteristic of students that are not retained in computer science. This research investigates if those same trends apply at the University of the Virgin Islands (UVI). This research hypothesizes that UVI students who have adequate computational thinking skills are more likely to both choose computer science as an undergraduate college major and more likely to be retained in the computer science major. This research assesses incoming UVI undergraduate students to assess their computational thinking skills and their selected undergraduate major to validate the correlation between these two. The research monitors those students who have selected computer science as a major to evaluate retention rates and compare the retention rates for those students identified as having adequate computational thinking skills and those without. Finally, the research develops a preliminary set of tools to help improve computational thinking skills amongst freshman computer science majors and evaluate the impact such improvement in computational thinking has on overall retention rates.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

Parasitic burden of the American eel, *Anguilla rostrata* by *Anguillicoloides crassus* in two estuaries of South Carolina

Jan-Alexis Barry
University of the Virgin Islands
Mentors: Steve Arnott & Bill Roumillat

In Winyah Bay, and the Cooper River, SC, the American eel *Anguilla rostrata,* was collected by way of electrofishing to determine the age, length, weight, health assays, and sex ratio of these eels as well as determine the prevalence of the invasive parasitic swimbladder nematode *Anguillicoloides crassus.* This study's objective was to determine if the aforementioned factors may be statistically significantly altered when comparing the estuaries in the months of June and July. The invasive parasite *A. crassus* occurs in both Winyah Bay and Cooper River and could possibly cause deleterious effects on the populations of these two estuaries. Prevalence was slightly higher in Cooper than Winyah, but only in June. The length frequency of eels compared within the two estuaries was significantly different, showing larger eels in Winyah Bay. Parasitic prevalence declined from June to July in both estuaries. Only small/young eels were more likely to be infected than large/old eels, but only found during the month of June. Infected eels had enlarged spleens, and were slightly heavier than uninfected eels. Liver weight was not affected by infection, but declined from June to July. Eel total mass was also heavier in infected eels vs. uninfected eels.

Funding was contributed by South Carolina's Minorities in Marine and Environmental Science (MIMES) and the National Science Foundation. This work was also supported by NSF HBCU-UP grant number HRD – 0506096

Influence of Sucrose Concentration on Long-term Sweet Potato Cultures

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Virus-free sweet potato plants are being grown in culture to supply clean plantlets to local growers and require frequent transfers due to the rapid rate of growth. However, between requests for plant material a system was needed to control growth and increase the intervals between transfers. Long-term in vitro maintenance, on MS medium containing 0-12% sucrose, was used to evaluate shoot growth over time on four sweet potato cultivars. Sucrose levels from 2-12% had no influence on controlling in vitro growth and development over time. Having no sucrose in the medium resulted in minimal growth but was lethal to 50% or more of the cultures. The rate of root growth and leaf development was greatly reduced on sucrose levels from 0.1-0.3%. These low sucrose levels controlled the rate of growth and extended the interval between transfers from monthly to nine months. Low sucrose concentrations can be used to control growth of sweet potato and extend the intervals between transfers in vitro.

This research was funded through the VI Dept. of Agriculture Specialty Crops Block Grant and USDA. This work was also supported by NSF HBCU-UP grant number HRD – 0506096

Overgrowth Interaction of *Dictyota pinnatifida* algae with Live and Dead *Porites porites* and *Porites asteroides* corals at the US Virgin Islands

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The interaction of multiple stressors, such as increase in seawater temperature, alterations in water quality including increase in acidity and sediment/nutrient loads, and overfishing, has led to a regime shift from coral reefs to algal reefs throughout the Caribbean. The replacement of corals by algae on reefs has been pointing to a probable loss of resiliency in coral reef ecosystems, since sessile corals possess largely effective mechanisms that prohibit overgrowth by other organisms, such as mucus excretion and mesenterial filaments extrusion. If this proposition is valid, then algae are expected to overgrow not only available space provided by dead corals but also non-available space provided by live corals. We analyzed data from the 2008-2010 Territorial Coral Reef Monitoring Program of the US Virgin Islands to identify algal "winners" and coral "losers" on USVI coral reefs. *Dictyota* spp. was the most abundant algae on these reefs (15.1% of benthic cover) while *Porites porites* (60% of corals) and *Porites asteroides* (74% of corals) were among the corals exhibiting the highest frequency of interaction with *Dictyota* spp. Subsequently, we set up a randomized, controlled field experiment to test whether the ubiquitous algae *Dictyota pinnatifida* overgrows live or dead *P. porites* and *P. asteroides*. For this purpose, nubbins of live and dead *P. porites* and *P. asteroides* were securely attached next to *D. pinnatifida* on a wire frame and monitored for overgrowth. We expect that the defense mechanisms of live *P. asteroides* will be effective at preventing algal overgrowth by *D. pinnatifida* and that *D. pinnatifida* will readily overgrow dead corals due to the absence of these same defense mechanisms. The results of this study will be of particular use to the Department of Planning and Natural Resources because replacement of corals by algae on reefs is associated with alterations in primary ecosystem processes as well as goods and services generated by coral reefs in the USVI Territory.

This research was funded by a 2010 VI-EPSCoR Incubator Grant # 203053, NSF HBCU-UP grant # HRD–0506096, and VI-EPSCoR grant # 0814417

Extensive DNA Damage Not Responsible for Decreased Tumor Size and Incidence in Mice with a Partial Defect in the Hus1 DNA Damage Checkpoint Protein

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Effective genome maintenance is essential in all organisms and acts to prevent diseases such as cancer. Natural sources of DNA damage occur continuously, from endogenous factors, such as oxidative free radicals and replication errors, as well as from exogenous factors, such as UV light and environmental carcinogens. To maintain the integrity of the genome, there exist two main highly conserved DNA damage checkpoint pathways, the Atr and Atm pathways, which serve to protect against accumulation of mutations. In the presence of DNA damage, these pathways are activated and halt the cell cycle, initiate DNA repair, and induce senescence or apoptosis. However, if these checkpoints become altered and are unable to repair damaged DNA, cells acquire mutations that may lead to tumorigenesis. Additionally, if cells acquire excessive mutations, the resulting genomic instability may lead to cell death. This information is especially pertinent to the field of tumorigenesis, as the hyper-replication and increased genomic stress observed in cancer cells may make them more dependent on genomic maintenance mechanisms to prevent cell death. In a previously conducted experiment, a two-step skin carcinogenesis model was created using mice with impaired Atr pathway function. It was observed that mice with decreased Atr pathway function developed significantly smaller and fewer tumors. We hypothesized that the decreased tumor size and incidence observed is due to DNA damage induced cell death as a result of the cells' inability to repair damage caused by excessive replicative stress. To test this hypothesis, I utilized immunohistochemical techniques, using γ-H2AX staining as a marker for DNA damage, on tumor sections to determine if mice with an impaired Atr pathway showed significantly more DNA damage than wt mice. The results show that the decreased tumor size and incidence observed in mice with impaired Atr pathway function does not correlate with increased DNA damage, suggesting other factors may be involved. An alternative hypothesis for differences in tumor size and incidence is that cells of mice with an impaired Atr pathway may have senesced in response to oncogenic stress and therefore do not acquire significant DNA damage. To test this hypothesis, p19 immunohistochemical staining, as a marker for cell senescence, will be used. Together these experiments will provide valuable information on the mechanics of the Atr pathway and its role in tumorigenesis.

This research is supported by MARC 5T34GM008422.

Chemical Resolution of 1,10-Phenanthroline Derivatives with (*R*)-Mandelic Acid

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The resolution of 5,6-dihydro-6-((R)-α-methylbenzylamino)-1,10-phenanthroline-5-ol with (R)-mandelic acid was studied using various solvents to get the best separation of stereoisomers. Mandelic acid protonated the amino group attached to the B-ring to form two salts with different properties. The properties of the two diasteromers were observed and the results compared to those obtained previously with (S)-mandelic acid. The best result was obtained when the salts were crystallized from a chloroform/ethyl acetate mixture (1:1) to give a 30.9% diastereomeric excess. The dehydration reaction of the aminoalcohol led to an advanced intermediate, which can be used for further studies.

This project was sponsored by NIH MARC Grant # 5T34GM008422

Understanding the Function of HIV-1 Rev through C and N-Terminal Truncations

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Regulator of Expression of Virion Protein or REV is an RNA-binding protein that plays a major role in the export of the HIV-1 virus from the nucleus of the cell to the cytoplasm. The main function of REV is to move HIV-1 RNA strands into the cytoplasm before they can be properly spliced. This occurs because REV essentially "pulls out" 9 kb and 4 kb RNA strands before they can be properly spliced to 2 kb strands. The goal of this research is to understand how the different regions of REV affect the export of HIV-1 RNA from the nucleus to the cytoplasm. We hypothesized that mutant constructs that had more parts of their n and c termini removed would have grater export activity that those that had more intact. To determine how this occurs, truncations of REV were constructed using Phusion PCR. A Western Blot was then performed to test whether the constructs expressed any proteins. Those constructs that expressed protein well were used to perform a GAG/POL reporter assay to determine export activity. The results from the GAG/POL reporter assay were inconclusive due to high levels of unspecific binding on the gel. A repeat of the reporter assay must be repeated at a later time in order to determine if the binding is indeed unspecific or if there is export activity.

This project was sponsored by NIH MARC Grant # 5T34GM008422

PRELIMINARY RESULTS: MEASUREMENT OF SEDIMENT PRODUCTION AND PARTICULATE ORGANIC MATERIAL IN SMALL SUBTROPICAL WATERSHEDS ON THE EAST END OF ST. CROIX, USVI

Jewel Cumberbatch and **Anthonio Forbes**
Bernard Castillo II, Ph.D. and Kynoch Reale-Munroe

Ongoing research in the U.S. 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 U.S. 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 WRRI at UVI. Project number: 2010VI170B. This work was also supported by NSF HBCU-UP grant number HRD – 0506096

Influence of Extraction Solvent on Anthocyanin Concentration in Sorrel

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Sorrel is important to the culture of the Virgin Islands for its use in making a healthy red holiday beverage. The calyx of sorrel varies in the intensity of redness between cultivars. The purpose of this research was to determine the concentration of the red anthocyanin pigment in the calyxes from 12 sorrel cultivars. Sorrel calyxes were ground 1/1 (w/v) in either ethanol or water. Following centrifugation, the solute was read in a spectrophotometer at 535 nm. Ethanol was found to be better for extracting the anthocyanin pigment. Paper chromatography, utilizing multiple solvents, was used to try and separate the pigmented compounds. Ethanol is the most efficient solvent for both extracting the red anthocyanin pigment and resolving the compound with paper chromatography. This research was funded through the VI Dept. of Agriculture Specialty Crops Block Grant and USDA.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

Fungipod Formation in Immature Dendritic Cells Depends on Particle Ligand Size

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Fungal infections are prominent in immunocompromised individuals; however these infectious diseases can also attack the innate immune system of healthy humans. Dendritic cells (DC) are critical antigen-presenting cells responsible for capturing microbial antigens. Assisting DC's regulatory efforts are C-type lectins (CLR), pattern recognition receptors expressed in human immature dendritic cells. Dendritic cells use these CLRs to recognize fungal pathogens invading the body and present them to T cells for initiation of immune responses. Expressed on immature dendritic cells is CD206 (Mannose Receptor), a CLR that is activated by a specific carbohydrate, mannan, found in the yeast cell wall, thereby forming a novel CLR-driven cellular protrusive structure termed the fungipod. We are interested in investigating how physical properties of a fungipod stimulating particle influence the DC's fungipod response. We used beads, varying in size and coated with mannoprotein, to understand the possible contact areas required between DC and yeast for fungipod response. We hypothesized that larger contact areas would have a significantly greater fungipod response. Differential interference contrast (DIC) analysis revealed a gradual decrease in fungipod formation as the bead sizes decreased. Interestingly, the 0.5 μm beads were unable to induce fungipod formation in comparison to the larger 4.5 μm beads, which stimulated funigod response. Thus, fungipod formation depends on bead size. Confocal microscopy suggested that the size of the CD206 contact site is correlated to the size of the stimulating particle/bead. The bigger size beads were able to monopolize enough CD206, which resulted in a greater number of fungipods formed. Ongoing experiments using cubes varying in stiffness are examining if DC can utilize the stiffness of the yeast cell wall for recognition of fungal pathogens. Future work entails further use of live imaging of contact site fungipod formation to investigate efficiency of CD206 recruitment in contact site for different bead size and whether a particular threshold is required for fungipod stimulation.

FUNDED BY: NIH R01GM041402 (K.J.), NIH GM064346 (K.J.), F32AI71900 (A.N) and MBRS-RISE

Volume Rendering: Creating 2D Images From 3D Datasets

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University of the Virgin Islands

Have you ever imagined being able to see a person's skull simply by examining a photograph of the head? Volume rendering has become an increasingly popular field for its usefulness in medicine, engineering, and even astrophysics; it is a technique used to project 2D images from 3D datasets. A 3D dataset is a set of cross sectional scans of an object scanned in an MRI or other acquisition devices. Usually, an MRI scan is taken for every millimeter of the object to complete a dataset. When the dataset is rendered, we have the ability to visualize the internal structures along with the external structures in a single projection. During the process of volume rendering, an initial image of a dataset is projected on a grid though the use of voxels. These 3D pixels are each assigned a value from 0 to 255 based on their intensity level. Now a person would manipulate a transfer function, a "linear piece-wise function", to determine which voxels are to be rendered transparent and which are to be rendered opaque and to determine the color of these voxels. This is what creates the 2D image from the 3D dataset. The current volume rendering programs are slow, inefficient, and subject to research. Using the program "vuVolume", we created transfer functions to generate 2D images from 3D datasets that will be used for benchmarks for examination of algorithms that promise to be a faster, more reliable program. The transfer functions, developed over the summer, have yielded lovely results for future research. More transfer functions will be needed to test the upcoming program which, after completion will be distributed for academic purposes.

Funding Sources: NSF SEAGEP Program = UF05034 & NSF HBCU-UP grant number HRD – 0506096.

Mathematical modeling of disease in *Montastraea faveolata*

Akima George
Dr. Marilyn Brandt

Montastraea faveolata, the Mountainous Star coral, is one of the major reef-building coral species in the Caribbean. This experiment investigated how disease will affect the number of corals in different reef ecosystems. Discovering this information will provide insight to the severity of the problem that *M. faveolata* faces from disease so steps can be taken towards preservation before it is too late to save this species in Caribbean habitats.

The questions we sought to answer were: "How quickly are the reefs dying compared to how quickly they are recovering," and "Does disease differently affect this species in the mesophotic reef zone versus the shallow reef zone?" The hypotheses I tested were: 1.) There is no significant impact of disease on the demographic structure of *M. faveolata* in the near shore and mesophotic reef habitats of the USVI and 2.) There is no difference in the demographic trajectories of *M. faveolata* between near shore and mesophotic reef habitats in the USVI. The data that were used were collected by the U.S. Virgin Islands Territorial Coral Reef Monitoring Program. This data was used to develop and analyze stage-based demographic matrix models of *M. faveolata* in the two habitats with the R statistical program package "popbio."

Results from 100 year projections showed that disease had a significant impact on the demographic structure of *M. faveolata* in both reef habitats. Analysis of transition matrices showed that near shore reef habitats are in greater danger of experiencing extreme losses of this important reef building species. Projections also showed that disease had a greater impact when set to target small and medium sized corals than when targeting large and medium-large sized corals.

This work demonstrates that disease acts differently among variable habitats therefore finding a way to help corals stem the impact of disease needs to address the diverse situations of each habitat.

This project was sponsored by NIH MBRS-RISE Grant Award No. GM061325

Generalized Ratio Tests

Jemica Gumbs
Mentor: Joseph Gaskin

One of the most intriguing problems in mathematics is to determine whether an infinite series converges or diverges. The most well known and perhaps the favorite of all students to resolve the problem of convergence/divergence is the Ratio Test. Unfortunately, the Ratio Test fails if $\lim_{n\to\infty} \frac{a_{n+1}}{a_n}$.

Our research focuses on generalized Ratio Tests. In particular, we prove that if $\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = 1$ and if $\lim_{n\to\infty} \frac{2a_{2n}}{a_n} = \rho$, then;

$\sum_{1}^{\infty} a_n$ converges if $\rho < 1$ *and*

$\sum_{1}^{\infty} a_n$ **diverges if** $\rho > 1$.

We also demonstrate how our results can be applied with a few examples. Finally, we show how our results can be extended in some cases.

This research project was made possible through NSF HBCU-UP Research Fellowship, funded through a grant from the National Science Foundation (NSF) grant number HRD – 0506096

The relative importance of nutrients and herbivory on benthic community structure: Nearshore vs. offshore reefs

Leslie Henderson
Major Advisor: Dr Angela Dikou
Additional Committee Members: Dr. Tyler Smith, Dr. Marilyn Brandt

The relative importance of bottom-up (nutrients) and top-down (herbivory) factors in controlling the shift of desirable, coral-dominated reef systems into the alternate stable state of undesirable, macroalgal-dominated reef systems is heavily debated in the literature. One major source of conflict is the fact that it is hard to determine which factors are causing a shift when multiple stressors are all occurring at once. Regardless, a trend toward macroalgal dominance has been demonstrated on reefs around the world. Reefs that are suffering from a higher number and intensity of stressors are the forerunners of this unfortunate trend. Nearshore reefs are known to be particularly vulnerable due to their close proximity to human activities while offshore reefs have a buffer between themselves and the detrimental effects of development. This project is manipulating two common reef stressors, herbivory intensity and nutrient levels, on nearshore and offshore reefs found in the United States Virgin Islands. From this, the relative importance of top-down and bottom-up controls can be evaluated for each location and then compared between the two for evidence of differences in reef resilience.

This research supported by the Lana Vento Charitable Trust

DNA Extraction and Amplification of Rhizophora mangle and Laguncularia racemosa

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Jeffrey Renchen, and Dr. Alice Stanford

Although mangroves have significant ecological importance to our marine ecosystems, they have been diminishing rapidly over the last 30 years. Alarmingly, 20% of mangroves found around the world have been depleted and 67% of the mangroves found in the U.S. Virgin Islands have been destroyed. In an effort to find appropriate ways to conserve these mangroves, we seek to find out more about the population genetics of *Rhizophora mangle* (red mangrove) and *Laguncularia racemosa* (white mangrove). This information will allow us to distinguish which populations merit special protection due to the genetic variation of each mangrove community. In this project, we sought to find the best DNA extraction/isolation kit that will have yielded the most DNA with the least contaminants between two kits; the Ultra Clean Plant DNA Isolation Kit and MasterPure Plant Leaf DNA Purification Kit. We first used a UV spectrophotometer to determine the DNA quantification concentrations of our samples. After visualizing the DNA on a 0.7% high melting agarose gel, our results indicated that there were no visible differences between the two kits. However, we amplified our extracts using a thermo cycler with primers that have been tested and proven to amplify different loci on each species and found that the EPICCENTRE Biotechnologies kit yielded the most and purest DNA. We will also be testing different PCR protocols for DNA amplification. All of our samples will be amplified and dehydrated before being sent to the Genetic Ecology Laboratory at Harbor Branch (Florida Atlantic University) to be separated using an automated sequencer. This crucial information will enable us to preserve and protect these mangroves from further damage, and monitor the loss of genetic variation in the future.

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

Site fidelity, residency time and movement of juvenile Blacktip sharks (*Carcharhinus limbatus*) and juvenile Lemon sharks (*Negaprion brevirostris*) within nursery areas of St John, USVI.

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Loss of sharks from marine ecosystems due to fishing and habitat degradation yields negative trends in the health and stability of marine communities because of shark's role as apex predators. Juvenile lemon sharks (*Negaprion brevirostris)* and blacktip sharks (*Carcharhinus limbatus*) utilize nearshore seagrass and mangrove forest as nursery areas for protection. This study aims to understand the movement of juvenile lemon sharks and blacktip sharks within the nursery areas of Fish Bay and Coral Bay St. John, U.S. Virgin Islands.

Passive acoustic telemetry is the best choice to analyze long term movement of marine species. From August 2006 through June 2010, 25 lemon sharks and 48 blacktip sharks were surgically implanted for passive acoustic telemetry with coded transmitters creating unique identification pulses to be recorded by a fixed receiver array.

Blacktip sharks reside within Fish bay for 1-524 days ($\overline{X}$ = 7.52, σ=23.98) and Coral bay from1-429 days ($\overline{X}$ = 90.4, σ=21.29). Lemon sharks reside within Fish bay for 1-222 days ($\overline{X}$ = 51.45, σ=20.85) and Coral bay from 1-221 days ($\overline{X}$ = 37.33, σ=15.34). Site attachment ranging from 0.11 to 0.92 ($\overline{X}$ = 0.49, CI=0.002) in blacktip sharks and 0.12 to 0.83 ($\overline{X}$ = 0.40, CI=0.003) in lemon sharks (strong site attachment=1.00). 35.4% of blacktip and 61.5% of lemon sharks were tracked outside of their primary nursery. Travel between nursery areas was limited to 7.7% of blacktip. Strong site fidelity to primary nursery areas and limited connectivity between areas indicates that protecting each nursery area is required as each supports a distinct juvenile population.

Funding sources:
University of Puerto Rico Sea grant, Lana Vento Charitable Trust.

The interactions of depth, grazing and addition of nutrients on the abundance and distribution of *Gambierdiscus* spp.

Christopher Richard Loeffler
Faculty mentor: Dr. Tyler B. Smith Research Assistant Professor UVI, Dr. Mindy Richlen WHOI

Gambierdiscus spp. are marine dinoflagellates that produce a suit of toxins responsible for ciguatera fish poisoning (CFP). CFP is the most commonly reported non-bacterial seafood related illness associated with the consumption of seafood. *Gambierdiscus* cells passively produce toxins which concentrate in the tissue of the consumer, these toxins are then bio-transformed and bioaccumulate in the tissues of higher order predators. *Gambierdiscus* cells are abundant on coral reefs of the US Virgin Islands, commonly adhering to macroalge. Herbivores inadvertently ingest the cells when grazing macroalgae and dead coral surfaces, thus initiating the chain of toxin bioaccumulation. The USVI's are classified as hyperendemic areas for Ciguatera Fish Poisoning, affecting 1 in every 50-100 Virgin Islanders annually.
This project seeks to understand how grazing, excess nutrients and depth influence the abundance and distribution of *Gambierdiscus* spp.

To illuminate the influence of the factors tested a standard area tile was used at 6 sites as a substrate for *Gambierdiscus* to adhere. After an initial month, control tiles were collected for an initial population estimate, with the remaining tiles receiving various treatments. Fish surveys, clod cards, water samples and nutrient samples were taken to account for variability in water motion, nutrients and grazer biomass. Tiles were processed and preserved for observation under a light microscope for *Gambierdiscus* spp. cell enumeration.
Analyzed samples from the initial tile cell counts were positive for the presence of *Gambierdiscus* spp. Thus the tiles are a suitable substrate for *Gambierdiscus* spp. and the administration of treatments to these tiles should influence the present populations.
This project is funded by the Vento Foundation with contributions from Dr. Tyler Smith and Dr. Mindy Richlen.

This research supported by the Lana Vento Charitable Trust

Influence of Spacing on Production for Two Sorrel (*Hibiscus sabdariffa*) Varieties

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Hibiscus sabdariffa, also known as sorrel in the Virgin Islands, is an annual plant that is grown mainly for its colorful fleshy calyces during the Christmas Season. Sorrel is used to make a healthy drink that is high in vitamin C and anthocyanins which is claimed to be better than cranberry juice. Sorrel is normally planted at 60 cm during July and August. The objective of this study was to compare sorrel growth and production of a Caribbean day-neutral variety and a Zambian short-day variety planted in September with in-row plant spacing of 20 cm, 40 cm and 60 cm and 150 cm between rows. Data was collected weekly on plant height, branching and fruit set. The results indicated that the day-neutral variety can be grown at 20-60 cm with no effect on branching or production. However, day-neutral plants are shorter at 60 cm spacing than either 20 or 40 cm while spacing was not an influence on plant height for the short-day variety at 20-60 cm. Short-day sorrel has greater branching and fruit set as the plant spacing increases from 20 to 60 cm. Planting sorrel in September at 40 cm can increase production per length of row.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

Investigation of the advantages or disadvantages of Botanical Therapies used in the USVI.

Ascertain the life-span expectancy of normal, diabetic, and aged C. elegans models for each of the selected botanical preparations..

Melisa Matthias, Chinaemere Igwebuike, LaVerne L. Brown, Ph.D.

The Virgin Islands is a place where ethno-medical preparations of botanical or herbal sources are used to relieve some common illnesses. It is believed that these sources contain a mixture of several "active" ingredients. This is unlike most Pharmaceutical treatments which are based on a FDA approved single, purified "active" ingredient. Virgin Islanders believe that the ethno-medical preparations enhance therapeutic value, reduce side-effects and give an inexpensive alternative to conventional medicine. Our goal is to investigate the effects of select botanical remedies on the island of St. Thomas USVI with respect to the life span expectancy of normal, diabetic, and aged Caenorhabditis elegans animal models. We hypothesize that alternative botanical medicines used in the U.S. Virgin Islands contain a mixture of "active" ingredients that interact synergistically to yield enhanced therapeutic efficacies and reduce toxicities. Thus, our aim is to develop a process for growing, transferring and observing the lifespan of C. elegans that will best facilitate our ability to ascertain the effects that each botanical preparation has on the life-span expectancy of normal, diabetic, and aged C. *elegans* models. To date we have explored several techniques for seeding, culturing and transferring the nematodes; and we have identified and developed protocols that are most applicable for our study.

This project was sponsored by NIH MBRS-RISE Grant Award No. GM061325 & NSF HBCU-UP grant number HRD – 0506096

High larval settlement of the long-spined black sea urchin, *Diadema antillarum* in the United States Virgin Islands

Stephen McCauley
Advisor: Teresa Turner, University of the Virgin Islands, St. Thomas, USVI

Larval abundance is suggested to be a limiting factor for populations of the long black spiny sea urchin *Diadema antillarum* recovering from the 1983-84 Caribbean-wide die-off, yet such data are scarce. Coral reef recovery may well depend on this keystone herbivore as well. Using methods comparable to similar previous studies in the Caribbean, this study is the first to quantify larval settlement rates on shallow water (<7 m) coral reefs within the U.S. Virgin Islands. In January 2010, larval traps were deployed in areas of low (0.32 m^{-2} ± 0.22 SE) and high (8.80 m^{-2} ± 4.20 SE) densities of adults (Wilcoxon, $p<0.05$) in Brewer's Bay, St. Thomas, and settlement was quantified monthly for a period of 12 months (January-December 2010). We predicted that if these two areas, which differ dramatically in adult density, do not differ in larval supply, this would suggest that small-scale differences in post-settlement mortality determine the extent of adult recovery at these locations. Monthly settlement rates of juvenile *Diadema* to date are high (max. ~17 m^{-2}) compared to previous studies of settlement in nearshore reefs in Puerto Rico (max. ~0.3 m^{-2}) and the Florida Keys (max. 1.9 m^{-2}). Larval settlement appears to be seasonal, with peaks of juvenile settlement occurring between April-July 2010. Settlement between sites was statistically similar (Wilcoxon, $p>0.05$), suggesting that post-settlement mortality, not larval supply, is the limiting factor responsible for the observed differences in adult densities. Quantifying larval settlement patterns allows managers to better understand factors affecting coral reef recovery.

Funding for this research was provided by an incubator grant from VI-EPSCoR & S-STEM

Energy and the Environment

David Mohammed
Faculty Mentor: W. E. Archibald, PhD
Affiliations: Energy and Resources Group| UC Berkeley

Inevitably, in going about our daily lives — traveling, harboring our families, eating — each of us contributes to the greenhouse gas emissions that are causing climate change(s). Nevertheless, **there are many things we can do to decrease our carbon emissions.** However, we must completely understand our current standing point before change(s) can be strategically implemented into the society. To effectively assess our climate impact(s) in the U.S Virgin Islands, information concerning electricity and water production, public transportation, annual imports & exports and air/boat travel between islands are needed to properly model our emissions factor using a **Carbon Footprint Calculator.** This research project is essentially about trying to understand the carbon dioxide output of the U.S Virgin Islands as one entire entity. We must first break down each section and carefully examine their contribution towards carbon emissions independently. In this section and with respect to the common population, we aim to understand the frequency of use, modes of preference, costs and related fuel usage of the public transportation systems in the territory. The project procedures are as follows: Administer a questionnaire to taxi drivers/owners then enter the data into a pre-developed Excel spread sheet and, lastly, analyze the data. The quantitative information regarding the taxi industry will then be inputted into the Virgin Islands first Carbon Footprint Calculator which will be used to calculate the emission impacts of public transportation systems in the U.S. Virgin Islands.

Funding Source: NSF HBCU-UP Research Fellowship grant number HRD – 0506096.

Sustainable Housing Renovation & Prototype at USVI

Mohammad Mustafa
Dr. Wayne Archibald, University of the Virgin Islands

The Caribbean Green Technology Center at the University of the Virgin Islands (UVI) has joined the "VIenergize" effort in making the US Virgin Islands sixty percent fossil fuel free by the year 2025. In a joint collaboration, University of the Virgin Islands, University of California- Berkeley, and Harvard University have been progressively conducting research on sustainable housing renovation, alternative forms of transportation, and biomass.

The project 'Sustainable Housing Renovation and Prototype at United States Virgin Islands' focuses on generating a model of a Net-Zero Neighborhood in the United States Virgin Islands, which is also known as an N-ZEN model . The Net-Zero Neighborhood strategy is to formulate a plan to create innovative sustainable communities in the USVI to extensively reduce water, carbon, and energy consumption. Additionally, these actions concurrently reduce pollution and greenhouse gas emissions, which will increase the quality of life in the communities of the United States Virgin Islands. The main focus of the research is to analyze and design a strategy that will be used to assist USVI neighborhood planners in attaining net-zero communities. Through a sequence of chronological energy evaluations and procedures, N-ZEN neighborhoods will lower energy consumption levels. The sequence of analysis steps in this energy strategy includes reducing energy usage loads, climate optimization, increase the build-up of energy free buildings and infrastructures, encourage the use of highly efficient and passive electric technology, educate and progress toward having carbon neutral energy integrated communities. In order to develop an N-ZEN neighborhood in the US Virgin Islands, a pilot design project needs to be created. This includes selecting a resourceful site. After the site selection has been made, performing existing site analysis, evaluation, and resident surveying must take place within that chosen neighborhood. Then, the buildings, infrastructures, and services within that neighborhood must be thoroughly and meticulously examined. This process involves the initiation of early LEED evaluations and procedures to pilot the N-ZEN Neighborhood project. Finally, the ultimate design will include the estimated LEED ratings for the LEED neighborhood development, homes, and building design. Using a survey that was designed by Seth Holmes (Harvard) and Rebekah Shirley (UC-Berkley, preliminary surveying was done within a selected neighborhood. In general, the results displayed that the homes in the Virgin Islands lack efficient energy standards. For example, only one home out of eight had a solar power water heater. No homes received electricity by sources such as wind energy, or solar energy. Based on observations made, there is room around the houses to assemble setups dealing with wind or solar energy. On the other hand, the building structures of the homes were presentably designed in an energy efficient manner. This observation is made because of the structure of the roofs of the homes and how they were painted. Also, the interior of all of the homes that were surveyed were insulated and painted in light colors. In the near future, the results of the official survey will be obtained to gather accurate information which will be helpful in piloting the Net-Zero Neighborhood project. The United States Virgin Islands can be an energy efficient territory because our Islands have all the necessary resources (Wind, Water, Land)!

Funding Sources: NSF HBCU-UP Grant# HRD-0506096

Determination of the Equilibrium Constant of the Bis-(2-ethylexyl) Phosphoric Acid (HDEHP) with Octyl (phenyl)-n, n-diisobutyl Carbamoylmethyl-phosphine Oxide (CMPO) System

Marisha Perkins
[1]Gregg J. Lumetta, Phd; [2]Stanley Latesky, PhD; [2]Stella C. Jarvis; [1]Pacific Northwest National Laboratory; [2]University of the Virgin Islands

Nuclear processes as a basis for the production of energy has been used for decades and is receiving increased interest in recent years. The renewed interest in nuclear power is mainly because of its fuel availability for decades to come, and the fact that it produces very little greenhouse gas emissions. One obstacle to the expansion of nuclear power is the long term management and disposition of the nuclear waste arising from this technology. If fission-based nuclear power is to be produced as a widespread form of energy in the coming decades, isolation of the waste from the environment and reduction of the long-term risk will be essential. To irradicate this issue scientists theorized that the transuranic elements found in nuclear waste can be extracted and reused, thus limiting the amount of high risk radioisotopes requiring disposal. Towards this end, the scientists in Radiochemical Processing Laboratory (RPL) at the Pacific Northwest National Laboratory (PNNL) have been investigating new ways to reprocess and reuse nuclear fuels as a means to turn nuclear energy into a renewable energy source. One system being investigated uses a combination of bis-(2-ethylhexyl) phosphoric acid (HDEHP) and octyl (phenyl)-N,N-diisobutyl carbamoylmethyl-phosphine oxide (CMPO) to extract and separate the transuranic elements from other components of irradiated fuel. In this work, various samples were prepared for Nuclear Magnetic Resonance (NMR) Spectroscopy to determine the equilibrium constant of the adduct(s) that form between HDEHP and CMPO. Understanding this equilibrium is necessary to the understanding and development of the process for separating the transuranic elements. Numerous experiments were carried out in order to measure the adduct formation constant and the HDEHP dimerization under a variety of conditions. Measurements were done using varying concentrations of HDEHP with 0.1 M of CMPO in dodecane contacted with deionized water. An attempt to measure the dimerization constant for HDEHP by NMR spectroscopy led to results inconsistent with literature. This suggested that the NMR technique is perhaps not suitable for determining the HDEHP dimerization constant, conceivably because a suitable concentration range could not be accessed with the instrument used. The equilibrium constant for the formation of the CMPO-HDEHP adduct was calculated using the chemical shifts recorded by the NMR data generated and HypNMR modeling.

Funding Sources: This Research was funded by HBCU-UP grant # HRD0506096, The National Science Foundation, and NIH grant # GM061325. Other funding and accommodations were provided by the Pacific Northwest National Laboratory (PNNL), The Department of Energy (DOE), and Battelle.

A Parish Nurse Intervention Model: The Wilkinsburg Community Health Initiative to Reduce a Behavioral Health Disparity in Wilkinsburg

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Ms. Ann Greider***, Co-Principal Investigator Dr. Betty Braxter**, Co-Investigator
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Within the context of healthcare disparities, the African American community appears to be among the highest minority group to suffer from behavioral health risks (BHR). In a small urban northeastern city in Pennsylvania the mental health risk of depression, anxiety and stress has become a prominent concern for African American (AA) women who head single family households, especially those of lower incomes. In this community it is very common to notice AA women between the ages of 21-70 in low paying jobs struggling with three or more young children to provide adequate food, clothing, shelter and utility payments for their families. Additionally, many are stressed from being overweight, behind in bill payments, absent fathers or conflictual relationships with their significant other, and juggling the entire burden of raising a family. Growing evidence over the past 20 years indicates that there is a positive relationship between spirituality and health. The church is noted as the most trusted institution in black communities to provide refuge from stressful circumstances, especially for black women. However, the church is not being utilized as a major component to deliver health care. Parish Nursing has recently developed to enhance the physical and spiritual health of parishioners. The purpose of the Parish Nurse Intervention Model (PNIM) is to test a new model to decrease depressive symptoms, anxiety and stress in at-risk African American women who are single mothers. This pilot study is to test the feasibility of a Parish Nurse Intervention (PNI) to reduce the following Health Disparities, (anxiety, stress, and depressive symptoms) by providing initial and follow-up PN assessments and referral services to specific Health Services among African American single mothers of 8-12 year old children. This study will examine the three identified behavioral risk using intervention model components (traditional, non-traditional, faith-based) in a protestant denominational church site in a targeted neighborhood. The preliminary analysis would consist of detailed descriptive analysis (e.g., means, standard deviation, percentiles, and ranges) and graphical techniques (e.g., histograms, scatter plots). A non-parametric comparison would be conducted to address the specific aims. A pre and post repeated measures design and linear contrasts are planned. The ultimate goal of this study is to provide specific strategies to promote the collaboration between research scientists and community residents to improve African American health.

Research was supported by the University of Pittsburgh Center for Translational Science Inquiry at the School of Medicine & NIH MBRS-RISE Grant Award No. GM061325.

Genetic structure and connectivity of two mangrove species (*Rhizophora mangle* and *Laguncularia racemosa*) throughout the Caribbean

Jeff Renchen
Co-Authors: Dr. Alice Stanford (University of the Virgin Islands), Dr. Donna Devlin (Florida Atlantic University), and Dr. Simon Pittman (NOAA)

Mangrove forests are an important part of coastal ecosystems, and have been linked to such benefits as improved coral reef and fisheries health. Not only do mangrove forests improve the biodiversity of an area, but they also help to protect coastal communities from hurricanes and tropical storms. Mangroves are found throughout the Caribbean, but the migration pathways used by mangroves to spread throughout the Caribbean is relatively unknown. This study will look at the genetic structure and connectivity of two mangrove species (*Rhizophora mangle* and *Laguncularia racemosa*) in the US Virgin Islands, Jamaica, and Florida using existing microsatellite markers. The genetic information generated from this study will fill knowledge gaps about the genetic structure of mangroves, which the USVI is currently lacking. This study has implemented various methods for DNA extraction and PCRs in order to determine the best technique for gathering "clean" DNA samples for genetic analysis. Preliminary results indicate that the technique used for *R. mangle* is working great, while the techniques used for *L. racemosa* still need some tweaking.

Thanks to funding from:
S-STEM Grant, VI-EPSCoR & the Lana Vento Charitable Trust

Assessing the ecological and economic impact of derelict fish traps in the U.S. Virgin Islands

Gabrielle Renchen
Faculty Mentor(s): Simon Pittman[1,2], Angela Dikou[2] and Marilyn Brandt[2]
Affiliations: [1]NOAA Biogeography Branch, [2]University of the Virgin Islands

Fish traps are a widely used multi-species fishing gear in the Caribbean and around the world. When traps are lost or discarded they are considered derelict and are often considered a threat due to "ghostfishing" and habitat damage leading to marine debris removal programs. In the Caribbean, very little is known about the distribution of derelict traps and whether they pose a threat to fisheries and marine habitats. This study uses underwater controlled experiments to quantify the mortality associated with derelict traps. Twelve unbaited traps (6 actively fishing and 6 with door open) were monitored for 3 days a week for 6 months and fish sizes, condition and behavior were recorded. In addition, the number of days fish spent in the traps before escaping or expiring was determined. The economic value of mortality was estimated based on local market values. The vast majority of fish appeared able to enter and leave the traps, but some species-specific vulnerability was evident. This study will for the first time objectively and quantitatively determine the impact of derelict fish traps and will provide useful information for both fishing communities and managers.

Funding Sources: NOAA's Marine Debris Program & the Lana Vento Charitable Trust

Bio-Resource Characterization Study

Mpho Sello and Kerez Phipps
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Affiliations: Energy and Resources Group| UC Berkeley

The Bio- resource characterization study describes renewable biological resources such as plant biomass from which renewable energy can be obtained. Biofuel such as biodesiel, ethanol, and methanol is among a range of sustainable energy options that would decrease and perhaps eliminate the use of fossil fuels and does not contribute to the carbon dioxide (CO_2) burden of today's world. The overall objective of this study is to understand the nature of food waste generation, collection, treatment and disposal in the USVI. This information can help in determining the potential for redirection of such waste to a useful and economic energy production stream, and later, to explore the types of biomass resources that may be applicable to the United State Virgin Islands.

The project was split into two categories; the FOG Study and the Literature Review. The FOG study focused on ways in which Fats, Oils and Grease (F.O.G's) can be converted into sustainable energy. To gain information, a sequenced process was followed where VIWMA, waste water haulers, Tropical shipping and restaurateurs were targeted in order for accurate and necessary information to be obtained. The literature review portion of this study was to determine the standing of bio-fuel production and usage in island nations of the Caribbean. In this study, research was conducted to learn the yields or limits of various species in tropical agro-forestry in terms of effectiveness, and sustainability.

Funding Source: NSF HBCU-UP grant number HRD – 0506096

Tim-3 Protein is Involved in Regulating T-cell Receptor Signaling

Johnasha Stuart
Judong Lee, Lawrence P. Kane. Immunology, SURP University of Pittsburgh

T-cell immunoglobulin and mucin domain 3 protein (Tim-3) is a type I transmembrane protein that regulates T-helper type I cell responses and is expressed on a variety of cells such as, CD 8^+ Tc1 (cytotoxic) and dendritic cells. Expression of Tim-3 on T-cells is known to regulate autoimmune diseases and is involved in chronic viral infections like HIV, HCV, and HSV. We have observed that transfection of Jurkat T-cells with wild type Tim-3 enhanced NFAT-AP1-luciferase activity induced by TCR signaling. The cytosolic domain of Tim-3 has two conserved tyrosine residues (Y256 and Y263), which are predicted to be phosphorylated by Src family kinases, and three distal tyrosine residues (Y271, Y272 and Y274). We hypothesized that the cytosolic region of Tim-3 containing the conserved two tyrosine residues (Y256 and Y263) are responsible for Tim-3 functioning. We generated a series of three Tim-3 deletion constructs that consist of the deletion of the cytoplasmic region that included three distal tyrosine residues from the C-terminus (269-282), deletion of the cytoplasmic region that included the distal and conserved tyrosine residues (256-282) and deletion of the entire cytoplasmic region (223-282). We confirmed the expression of the Tim-3 constructs in Jurkat T cells, and performed NFAT-AP1-luciferase reporter assay. Results from this experiment showed that the two conserved tyrosine residues (Y256 and Y263) are involved in the regulation of signal transduction initiated by TCR activation and the three distal tyrosine residues (Y271, Y272 and Y274) may be involved in some inhibitory function of Tim-3.

Funded by NIH MARC Grant # 5T34GM008422

Generative Models using Cellular Automata [Preliminary Study]

Odari C. G. Thomas & Stella Jarvis
Mentor: Dr. Robert Stolz, College of Science & Mathematics, University of the Virgin Islands

This project aims to build a generative model of a protein image using cellular automata. Applying this method to the study of proteins is a novel idea, with little research done on the topic. Cellular automata are a collection of cells whose discrete values change over time based on given local rules. These mathematical models can mimic real life situations, which make them useful for modeling infectious diseases, forest fires, and many other applications that grow or change over time.

Using MATLAB, we first assign a set of probabilistic rules for the automata to follow. The rules that we select will determine whether we get back to a realistic protein image. We will apply different rules and observe the results in order to choose the best rules for mimicking the protein. Initially, visual inspection will be used to determine whether or not the rules are successful. Good rules converge to a realistic image in a timely manner.

The ultimate aim is to use these preliminary results to build an accurate model of a cell. These generative models will also provide additional information for understanding protein structure.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

Effects of Physical Activity on Cognitive Function in Multiple Sclerosis Patients

Indira Turney
MENTOR: Dr. Ruchika Prakash
INSTITUTION: The University of the Virgin Islands, The Ohio State University

Multiple Sclerosis (MS) is an inflammatory, demyelinating disease of the central nervous system (CNS). Previous research has shown that 45-65% of MS patients experience some form and degree of cognitive dysfunction. Working memory and retrieval memory functions in short-term and long-term memory appear to be the most common cognitive deficits in MS. Based on prior research, physical activity increases hippocampal activity, which is an area often affected in MS patients. Despite this, cognitive functioning in MS patients has received little to no attention from health care professionals. The purpose of this research is to develop awareness and to help maximize the quality of life of MS patients through non-pharmacological methods. This study investigated how physical activity impacts brain plasticity and cognitive functioning in MS patients. We hypothesized that individuals who have a higher score for physical activity will have greater brain plasticity, which will result in better cognitive functioning. Participants wore an accelerometer for 7 days, which measured their physical activity before the resting MRI session of the study. The MRI lasted approximately 30 minutes. The relationship of physical activity and brain plasticity was examined through the MRI. High-resolution T1 images measured hippocampal volume in MS patients. Sub-cortical segmentation is performed using FMRIB Software Library (FSL). Regression and correlation analyses determined the relationship among physical activity, hippocampal volume, and performance on an item-relation memory task (face-scene recognition). The multiple linear regression that predicted relational accuracy based on average hippocampal volume was even significant (F (1,28) = 7.30, p = .012, with an R^2 of .207. A non-significant regression was found (F (2,27) = 2.69, p = .166, with an R^2 of .166. Thus 16.6% of the variation in left hippocampal volume can be explained by differences in activity and relational activity scores. Taken together, these results suggest that hippocampal volume exerts a prophylactic control of MS patients' cognitive functioning performance on tasks such as relational accuracy.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

An Efficient Tabu Search-based Algorithm for Solving the Airport Gate Assignment Problem

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From the year 2000 through the year 2008, there has been an approximate 10.2% growth in the number of passengers flying around the world (733,850,823 in 2000 and 808,536,596 in 2008). As a result, airport administrators are continually searching for faster and more efficient ways to assign gates to incoming aircraft using solutions from various algorithms and mathematical models. This research explores a solution based on the popular Tabu Search Algorithm. It has been implemented in both C++ and Java using the Cyril E. King Airport, U.S. Virgin Islands, as a model with three specific constraints. Each flight must be assigned to: 1) its general boarding gate, 2) the first available gate or, if none are available, the gate with the least waiting time, and 3) a gate large enough to accommodate it. Presently, ten experiments have been conducted using summer and fall 2010 and spring 2011 scheduled flight data. The flight data includes 135 scenarios (the number of hours of commercially-scheduled aircraft activity at the airport) and 404 flights (arriving and departing). Also, only 380 scheduled-commercial flights and 24 random, unscheduled flights were used in these experiments. Cargo flights, on the other hand, were not included because they are assigned to gates at the airport's terminal; however, "cargo" gates are being added to accommodate these flights in the future. In each experiment, an average of 18 milliseconds to assign the optimal gate to each flight with minimal to no delay on an Intel Atom N280 (1.66GHz) CPU. The results show that with the increase of the number of flights, there will also be an increase in the program's running time by n, or linearly; however, the program's running time also depends on the amount of constraints and gates included and each constraint's growth rate. The algorithm's complexity will be analyzed with the big O notation for each constraint. Also, calculating the growth rate will assist me in determining the amount of time it will take to assign s aircraft to k gates, with c constraints.

This work was supported by NSF HBCU-UP grant number HRD – 0506096

**The College of Science and Mathematics thanks,
Mr. Winston Charles of the Duplicating & Printing Services, the
Eastern Caribbean Center, Chef's Catering, the St. Thomas
Purchasing Department, Mr. Kwame Garcia,
Mr. Marthious Clavier, Mrs. Hedda Finch-Simpson,
Mrs. Washington, Dr. Rosalie Dance, Dr. Thomas Zimmerman,
all the students, mentors, judges and the public for your support.**

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Dr. Teresa Turner, Ms. Moneca Pinkett and Ms. Amanda Wright

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