University of the Virgin Islands Division of Science and Mathematics

6th Annual Spring Research Symposium

St. Croix Campus

March 15, 2008

Student Research Projects

ABSTRACTS

6 th Annual UVI Undergraduate Research Symposium

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Contact Information:
Emerging Caribbean Scientists Programs
Division of Science and Mathematics
University of the Virgin Islands
#2 John Brewer's Bay
St. Thomas, VI 00802
Phone: (340) 693-1232
Fax: (340) 693-1245
Email: ECS@UVI.EDU

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Study of the Ant-based algorithm approach to the vehicle routing problem

Trevil Baker
Dr. Marc Boumedine, Mentor
Division of Science and Mathematics, University of the Virgin Islands,
St. Thomas Campus

This work compares the ants-based and classical search based algorithm for solving optimization problems. Ant algorithm is a multi-agent approaches to difficult combinatorial travelling salesman problem (TSP). Ant-based algorithms have been applied to many different discrete optimization problems such vehicle routing, sequential ordering, graph colouring and routing in communications networks.

The algorithm was inspired by the observation of real ant colonies. The basic idea of the Ant algorithm was developed from their food searching behaviour. When ants are on their way to search for food, they start from their nest and walk among random pathways towards the food source dropping pheromone on their trail. The pheromone marks the route taken. The scent of the pheromone will allow other ants taking the path to find the food source and get back to the nest.

An important and interesting behaviour of ant colonies is their foraging behaviour, and, in particular, how ants can find shortest path between food sources and their nest. This research compares the Ant vs. the breadth-first algorithms, a classical search algorithm that searches each adjacent node. Both algorithms are described and discussed on the TSP example. Then the Ant algorithm is used to solve the vehicle routing problem and results are discussed.

Pederson Cleaner Shrimp Affect Ectoparasite Size distribution on a Reef Fish Host

Kavita Balkaran, Dr. Donna Nemeth
Dr. Donna Nemeth, Mentor
Coral World Ocean Park, St Thomas US Virgin Islands

Cleaning associations are considered to be one of the most intriguing evolutionary behaviors amongst organisms. This involves a cleaner organism removing ectoparasites or detritus from the surface of its client. Previous research has shown that cleaning stations do make a difference on the parasitic load of a fish. Reducing parasitic load can improve the health of the clients. We investigated if the cleaning shrimp Periclimenes pedersoni had a size preference for monogenean Neobenedenia parasite found on Blue tang Acanthurus coeruleus. The hypothesis tested was P. pedersoni cleaner shrimps prefer larger parasites verses smaller parasites. The purpose of this study is to observe the relationship between the size of the parasite and the preference of the cleaner shrimp. A study was conducted at the Coral World Ocean Park above a 300000 l exhibit. The trough was divided into four sections two of which served as treatments and two were buffer zones. One treatment held the cleaning shrimp and the other served as the control with no shrimp. Corkscrew anemones Bartholomea annulata were placed in both treatments to prevent them from acting as variable since the cleaner shrimp live within their tentacles. Twenty-eight A. coerulus were caught from Brewer's Bay and Coki Point and fresh water dipped to remove all parasites. A 1-mm grid was placed on the platform of the microscope for scale and 69 monogeneans were selected randomly from each treatment and photographed using a microscope camera. Monogenean's lengths were measured from the digital images using NIH Image J. A t-Test was used to determine if the parasites' length differed significantly between treatments. There was a statistically significant difference between the average lengths of the monogeneans from the control treatment and from the treatment containing the cleaner shrimp (p 0.001). The hypothesis, size of monogenean Neobenedenia parasites will decrease on fish cleaned by P. pedersoni, was supported. Thus, the results could suggest that Periclimenes pedersoni cleaner shrimp prefer larger parasites rather than smaller parasites. The cleaner shrimp were probably able to see the larger monogeneans first and therefore ate those. Also eating the bigger monogeneans mean getting a greater reward per food item. This means that they would not have to look for smaller monogenean to satisfy their appetite.

Identifying Relationships between Scleractinian Coral Families Using the Nuclear 18S ribosomal RNA gene

Cherissre Boateng, Dr. Sandra Romano, Joel Stake
Dr. Sandra Romano, Mentor
University of the Virgin Islands, MacLean Marine Science Center,
Sandra L. Romano PhD Lab

Coral reefs are underwater gardens found in clear, warm tropical seas. Coral reefs are very important because they provide shelter and food to many marine organisms and protect our shorelines from erosion. The health of coral reefs is drastically declining because of coral diseases, coral bleaching and human activity. A third of the world's coral reefs have already disappeared and many more remain threatened. For coral conservation we need to be able to distinguish relationships between scleractinian coral families. Results from molecular and morphological data support different hypotheses about the relationships within the Scleractinia. Morphological analyses divide the scleractinian corals into seven suborders. In contrast, molecular phylogenetic analyses divide the order into two large subgroups but so far are unable to resolve the relationships within each of these subgroups. Our analysis will use the nuclear 18S gene which is the small subunit of ribosomal RNA (rRNA). Previous studies have used partial sequences from 18S rRNA, but we will be using complete sequences. We hypothesize that phylogenetic analysis of complete nuclear 18S rRNA gene sequences will be able to determine relationships within the two subgroups of scleractinian coral families. To date, we have collected eight species of scleractinian corals representing six of 24 scleractinian families. Whole genomic DNA was extracted using a CTAB protocol and the 18S gene region was amplified by the polymerase chain reaction (PCR) using previously published primers. Genomic DNA and PCR products were visualized by gel electrophoresis. PCR samples were purified using a Quantum Prep Kit and DNA sequencing was performed using an automatic sequencer. The complete 18S gene consists of an approximately 1600 bp region. A search demonstrated that my 18S partial sequences match those in GenBank from other scleractinians. Initial analyses of partial 18S sequences support the hypothesis that the order is divided into two large subgroups, but do not differentiate relationships within the subgroups. Further analyses based on complete 18S sequences from at least 25 taxa species representing currently recognized scleractinian coral families will be used to determine relationships within the two subgroups of scleractinian coral families.

Pak1 expression in cardiomyocytes

Tryphena Cuffy, Dr. Nicole Glaser, Dr. Rui-Ping Xiao, Dr. John Solaro
Dr. Rui-Ping Xiao, Dr. Nicole Glaser, Mentor
National Institute on Aging Laboratory of Cardiovascular Science, Baltimore MD

Pak1, the best characterized member of the p21-activated kinase (Pak) family, is an important downstream effector of the small GTPases, cdc42 and Rac1. Pak1 plays a crucial role in various vital cellular activities, including cell motility, cell survival and proliferation. However, it remains elusive as to Pak1's activation under certain pathological and physiological conditions and the role it plays in cardiac cell survival. Here we demonstrate that Pak 1 is activated under classic physiological beta-adrenergic stimulation and that active Pak 1 protects cardiomyoctyes against cell death. The is supported by the evidence that beta-adrenergic stimulatioby isoproterenol (ISO) leads to a significant increase in Pak 1 phosphorylation (active form) in a time- and dose-dependent manner. We also observed that enhanced Pak 1 mutant, protects cardiomyocytes against death-inducing-stimuli mediated death by over 40 percent. Additionally, in myocardium infarctions (MI) induced cell death, Pak 1 activity was induced after 4 hrs of MI treatment when compared to sham groups. We also did genotyping of four separate conditional and inducible Pak 1 overexpressing transgenic mice models were done in order to bettter define Pak 1's role in cardiac remodeling. Altogether, these results provide compelling evidence for the importance of Pak 1 activation in the heart and our understanding of the benefits of Pak 1 as a possible therapeutic agent in cardiomyocyte death.

Additive Properties of Euler's Totient Fuction

Andre Douglas, Dr. Douglas Iannucci
Dr. Douglas Iannucci, Mentor
University of the Virgin Islands (STT)

Let $\varphi(n)$ denote Euler's Totient Function. This function counts the residues relatively prime to n. We observe $\varphi(n)$ is multiplicative, i.e. $\varphi(mn)=\varphi(m)\varphi(n)$ if $(m,n)=1$. We are interested in finding all integers m, n such that $\varphi(m+n)=\varphi(m)+\varphi(n)$. We investigate special cases (such as m+n= prime and m+n= square of a prime), and search for ways to generate (possibly) infinitely many outcomes.

Effects of muscarinic agonists on central control of rhythmic bursting of a small, peripheral motor circuit in the spiny lobster, Panulirus argus.

Maisha Frederick and Dr. Richard Hall
Dr. Richard Hall, Mentor
Marine Science Center Lab, University of the Virgin Islands, St Thomas Campus

The pyloric central pattern generator (CPG) is a small motor circuit in the stomatogastric nervous system (STNS) of lobsters. The pyloric CPG produces rhythmic bursts of action potentials that control the activity of muscles involved in food sorting in the foregut. Extracellular recordings of the pyloric CPG allow easy identification of five motor neuron types: two pyloric dilators (PD), one ventricular dilator (VD), a lateral pyloric (LP), an infracardiac (IC), and eight pyloric constrictors (PY). While pyloric bursting stimulates muscle activity, all chemical synapses between pyloric neurons are inhibitory. Consequently phasing of bursting activity is maintained in large measure by graded synaptic transmission and electric synapses, neither of which can be recorded extracellularly. We hypothesize that as cycle frequencies increase, phasing of cell bursting should advance so as to insure coordinated motor activity within shorter burst intervals. To test this hypothesis we superfused central neurons known to stimulate pyloric frequency with a cholinergic mimetic, oxotremorine and measured phasing of two pyloric cells, the LP and VD which have reciprocal, inhibitory synapses.

The Effect of Monetary Rewards and Punishments on
Stimulus-Response Learning

Afiya Fredericks1, Karin Cox2, 1University of the Virgin Islands, 2University of Pittsburgh
Dr. Nasseer Indrisi, Mentor
University of Pittsburgh

The caudate nucleus is located within the basal ganglia in the brain. We know the caudate (whose activity appears to be modulated by both valence and magnitude of monetary outcomes) is involved in learning stimulus-response relationships. This project stemmed from questions concerning monetary rewards and punishments and their effect on learning. Ultimately, we wanted to see if different kinds of monetary outcomes influenced how well people learned. The stimulus-response program was created where subjects had to learn which response was correct based on the stimuli that were presented. This program was comprised of round 1, round 2 and round 3 sequences which were repeated three times for each of the three sets. Each set presented 24 different stimuli (flags) to the subject. Round 1 was where the subject received feedback. This feedback included whether or not the response was correct or incorrect and simultaneously, small or large monetary rewards and punishments. Both Rounds 2 and 3 were different from Round 1 in that no feedback was solicited. Learning was measured based on the findings that report both the valence and magnitude effects of subject's performance on round 2, in terms of the kind of outcome they received on round 1. We found that reward feedback was associated with better learning and that lower-valued rewards and punishments were also linked to an increase in learning.

57Fe Exchange in Hemoglobins Starting with 57Fe2O3 by Heme Exchange

Charnise Goodings, Faizah Syed-Ali
Dr. Bill Anderson, Mentor
University of the Virgin Islands

Hemoglobin is a compound made of iron and protein. When oxygen enters the blood stream the oxygen attaches to the iron ion of hemoglobin and it is then transported to the tissue. With hemoglobin S, when the oxygen is released the red blood cells then become distorted into a "sickle", a crescent shape. This then makes it difficult for the red blood cell to pass through the blood stream. Nitric oxide (NO) plays a role in treating vascular ailments and resembles O2 in structure. Is it possible for the Fe in the hemoglobin to pick up the NO molecule like it picks up the O2? Mossbauer spectroscopy can observe an interaction between NO and the Fe ion in hemoglobin via, but the iron must be enriched in 57Fe. Iron oxide was dissolved in 6 M HCL and then reduced from Fe (III) to Fe (II) with several reducing agents. Protoporphyrin IX was added to the Fe (II) solution, producing a heme. UV-Visible spectrometry was used to analyze the absorbance data for these solutions, at different wavelengths. Commercial hemoglobin was purified using a tris buffer with a pH of 8.0 and exclusion chromatography. Hemoglobin was unfolded and its heme removed using dialysis and high concentrations of urea. Again spectrometer was used to find out if heme was released into urea solution from the hemoglobin. The newly synthesized heme was then inserted into the hemoglobin and the protein refolded by lowering the urea concentration.

Changes in Mound Size of the Lugworm Arenicola cristata Over Time in the United States Virgin Islands

Jacinthia Greaux
Dr. Stephen Ratchford, Mentor
UVI St. Thomas Campus

The lugworm, Arenicola cristata, builds dense assemblages of sandy mounds covering thousands of square meters in Brewer's Bay, St. Thomas, United States Virgin Islands. These mounds have the potential to bury other organisms, particularly sessile, benthic invertebrates such as sea anemones, corals and sponges. This study investigated the dynamics of mound building by lugworms near an area that is part of a long term study of the sea anemone, Bartholomea annulata (corkscrew anemone). We believe that lugworm mounds are responsible for the disappearance of some sea anemones. A field study was conducted on SCUBA in approximately 6 m of water. We performed six 20 m x 4 m transects around the reef to count the number of lugworm mounds in relation to distance from the reef. We also constructed three quadrats off the reef, each 16m2, and measured the area and volume of each mound within the quadrats every 2-3 days. From the 6 transects, we determined the density of lugworm mounds to be about 0.5/m2. From the 3 quadrats, we found that very few mounds less than 100cm3 persisted for 2-3 days. Mounds 200-1000cm3 grew 50-200cm3 per day. Mounds over 1000cm3 grew 200-400cm3 per day. Maximum size seems to be 4000-7000cm3. We believe that there is a connection between the growth of these mounds and the health of coral reefs. Corkscrew anemones, which serve as cleaning stations for fish and home to various symbiotic shrimp, may be buried by the mounds. These data will be useful in parameterizing a model of mound growth and persistence, as well as the potential impact on the sessile benthic community.

The Caribbean Coral Reef Keystone Species Diadema antillarum (long-spined black urchin) have a preference to the red alga Acanthophora spicifera over other algal species

Fitzherbert Harry
Dr. Teresa Turner, Mentor
UVI's Marine Science Center, St. Thomas Campus

During the early 1980's, an unknown pathogen swept through the Caribbean and waters killing over 95% of the long spined sea urchin, D. antillarum. Reefs underwent a phase shift from coral dominance to algal dominance. Though the D. antillarum has shown signs of recovery, does this mean that our reefs will return to being coral dominated if the D. antillarum population returns to pre-die off numbers? That is the question this research will attempt to answer. Knowing the feeding preference of urchins can help us to determine if indeed urchins are the keystone species for reefs to return to coral dominance. Experiments were conducted in the Marine lab at University of the Virgin Islands from May-July 2007. Urchins were collected and placed in 14 separate buckets in seawater tables. Urchins were starved for 48 hr. Two species of algae were collected, weighed, and fed to the urchins after the starvation period. Urchins were given 14 hr to graze on algae, afterwards the algae were weighed to find out the percent eaten. The urchins were then placed back into their natural habitat and new urchins were collected for future trials. In total four different algae used were: the red alga, Acanthophora spicifera, the brown alga, Dictyota menstrualis, and the green algae, Caulerpa sertularioides, and Halimeda opuntia. Urchins preferred A. spicifera over other algal species used. In the future more algal species should be used and more tests should be done to see which algal species urchins ultimately prefer. These results may explain the dominance of Dictyota, Caulerpa, and Halimeda on the reefs in St. Thomas.

An Entropy Based Approach for Signal Classification

Artisha Hector
Dr. Marc Boumedine, Mentor
UVI, St. Thomas Campus

The main goal of this project is to use pattern classification to differentiate between abnormal and normal signals such as heartbeat, seismic, and electric signals.   This is the merging of pattern classification and signal processing. To be able to accomplish this task, techniques in pattern classification were extensively explored. The process of pattern classification entails preprocessing, feature extraction, and lastly classification. Decision trees are commonly used in the classification process. These decision trees are constructed in a specific way to maximize efficiency. To determine the root node of the tree, the entropy of the dataset is first calculated. Entropy is the measure of disorder and therefore, the ultimate goal is to achieve an entropy of 0. The fractions that represent the occurrence of each instance are used in calculating the dataset's entropy. Once that is determined the information gain of each attribute (reduction in entropy) is calculated. The attribute with the greater information gain would be considered the root node. The branches from that node would represent subsets of the different values associated with it or different categories that the data can be sorted by. This process is accurately carried out once all subsets achieve zero entropy (purity). This same process is used in the classification of signals using attributes such as wavelengths and frequency. Results are discussed.

Separation of Lanthanide Ions with Kläui Ligand Resin

Victoria Henry, Trinity Granger, Dr. Stanley L. Latesky
Dr. Gregg J. Lummetta, Mentor
Pacific Northwest National Laboratory, Richland WA

Separation and pre-concentration of a desired analyte is often a critical step in radioanalytical methods. Current procedures for separating and concentrating analytes for detection are complex, and can be both expensive and time consuming. Therefore, the purpose of this research is to attempt an alternative method of separating lanthanide ions through the use of an extraction chromatography resin containing a Kläui ligand salt. This research is a continuation of a concerted effort to develop new methods of detecting small concentrations of radionuclides and lanthanides using Kläui ligands. The Klaüi ligand, $C_5Me_5Co(OP(OR)_2)_3-$ (R=Me, Et, i-Pr, n-Pr) (LOR-), has a unique affinity for lanthanide and actinide ions in the presence of competing metal ions. The use of 1 wt% NaLOR (R=Et or n-Pr) adsorbed onto resin support has been shown to selectively extract lanthanide ions from aqueous nitric acid solutions of different concentrations. In order to further evaluate the utility of these materials in radiochemical separation, the selectivity of the resins in separating lanthanide ions were examined by measuring the distribution coefficients (Kd) values for a series of lanthanides over a range of solution conditions. Based on prior research with actinide ions, it is hypothesized that the lanthanide ions would bond strongly with the Kläui ligand. The success of this research is important, because it will assist in expanding and improving current automated radiochemical methods, which will decrease the cost of developing and implementing radiochemical methods. Thus far, this project has dealt with the determination of Kd values for Eu^{+3}, Nd^{+3} and Pr^{+3} under varying nitric acid (HNO_3) concentration. Future work will involve the determination of the Kd values for the remainder of the lanthanide series.

Conservation of Genetic Variation in Zanthoxylum thomasianum

Dr. Alice Stanford, Sayvi George, Duvane' Hodge
Dr. Alice Stanford, Mentor
UVI, St. Thomas Campus

One of our local flora, Zanthoxylum thomasianum, has become endangered due to deforestation and habitat destruction for the building of roads and other properties. In order to properly design a conservation project for this species, we will be continuing research started by Charnise Goodings and Prof. Stanford by studying a conjugate species, Zanthoxylum monophyllumi for comparative purposes. Leaf samples of this plant were collected from St. Thomas and St. John and subjected to various techniques in order to develop population genetics information on the species. DNA was extracted using CTAB procedures, then quantified and amplified through a series of different experiments. Of the numerous extractions that we performed, few produced pure DNA. There was no significant difference in the primers that were used but all primers appeared to work better at higher temperatures. For future studies a different extraction procedure may need to be used or different procedures for cleaning the samples should be considered. We may also need to use different annealing temperatures and primers, taking into consideration that different primers work better with different temperatures.

The Use of Aerial Photography to Determine the Rate of Wetland Loss in the B.V.I.

Isha Hodge[1], Argel Horton[2], Nadya George[2], Nikeema Bachus[2]

Dr. Lianna Jarecki, Mentor[2]

1. University of the Virgin Islands, #2 John Brewers Bay, St. Thomas V.I. 00802

2. Hamilton Lavity Stoutt Community College, Paraquita Bay, Tortola, British Virgin Islands.

The value of mangroves to human communities has been well documented in the past 30 years of scientific research. It is now widely accepted that mangrove ecosystems provide various critical ecological services in their ability to absorb inland nutrients and trap sediments in runoff waters, provide nursery habitat for commercial fish species, and protect coastal land from erosion and destruction during storms. Yet, declining wetlands continue to be a problematic issue for governmental agencies involved with environmental monitoring, protection and conservation. The BVI government, through the Town and Country Planning Department, is currently designing a Wetlands Management Plan to guide the future conservation and use of wetlands. The implementation of good management practices for wetlands has many difficulties such as; the paucity of data defining the past and current extent of mangrove habitat in the BVI, the rate of habitat loss, and the causes of this loss. This study sought to define the historical extent of mangrove wetlands as recorded on aerial survey photographs from the 1950's and provides a baseline from which trends in mangrove wetland coverage over the past half century can be evaluated. Aerial survey photographs from 1953 and 1959 were studied to determine the historical location and extent of each mangrove wetland existing in the BVI. The perimeter of each identified wetland was traced over the photographs. The geometric areas of the resulting shapes were determined by overlaying the tracings onto 1mm or 0.1 inch grid graph paper (depending on the size). These areas were then arithmetically converted to the corresponding ground area using the airplane altitude and camera focal length data printed on the corresponding aerial photograph. To account for subjective determination of the extent of individual wetlands, measurements of 7 sites of varying sizes were repeated by different investigators. The mean difference in repeated measurements was 1.4 with a confidence interval of 1.4 ± 1.8 acres, at alpha = 0.05. We concluded that the rate of wetland loss in the B.V.I. over the last 50 years (1950-2000) was 57% and was largely due to coastal development.

Lehmer Numbers

Zina Dore, Mary Mootoo, Dexter Hypolite, Glenfield Jarvis
Dr. Douglas Iaanucci, Mentor
University of the Virgin Islands

A Lehmer number is a natural number with a quotient K. It follows two basic properties:The first property states that the natural number n is equal to a 1a2a3…am, where n is a Lehmer number and the a's are the factors of n. Property two states that the number n -1 is equal to the product of K times each of the factors minus 1. To find Lehmer numbers, we used five methods which are trial and error, random selection, Fermat numbers and quadratic equations; however, we found the most efficient method to be a computer program, which was designed by our mentor. Our goal was to find all Lehmer numbers with six factors and by using the computer program there were 23 Lehmer numbers

Will Comprehensive Molecular Data Accurately Identify Relationships Among Scleractinian Coral Families?

Elisha Jno-Baptiste
Dr. Sandra L. Romano, Mentor
University of the Virgin Islands, MacLean Marine Science Center Sandra L. Romano PhD Lab

Coral reefs are intricate ecosystems that serve as habitats for a diverse array of organisms. In addition to this role, they provide economic benefits, construction materials, pharmaceutical compounds for medicine, beaches and islands, protection from the sea, and regulation of carbon dioxide levels. To small island nations such as the Virgin Islands, coral reef preservation is vital. Before we can accomplish this task, we must understand and know what corals are. Scleractinian corals, or "hard" corals, are the foundation of coral reefs. Previous taxonomic classifications of scleractinians based on their morphological traits divide the order into seven distinct suborders. Morphological characters, due to their high variability, make species classification a difficult task, obscuring the determination of relationships among families. Phylogenetic analyses based on molecular data do not support traditional taxonomy based on morphological data. Molecular analyses divide the order into only two distinctive groups. However, the relations within these two large groups are still very unclear due to the highly conservative nature of the mitochondrial markers and to the relatively few characters obtained from these markers. We hypothesize that using more taxa and complete gene regions will accurately establish higher level relationships within the two large groups of scleractinian corals supported by all molecular analyses. We are examining sequences from the complete nuclear 28S ribosomal RNA gene region, which is approximately 2,400 base pairs long. Thus far, we have collected eight species of scleractinian corals (representing 5 families) from St. Thomas, USVI. We extracted the coral DNA using a CTAB protocol, and our gene regions were amplified using the polymerase chain reaction (PCR) with previously published 28S primers. Gel electrophoresis provided visual evidence of our extracted genomic DNA and PCR products. DNA sequences of PCR products were determined by automatic sequencing. A BLAST search of our DNA aligned our sequences to other scleractinian 28S sequences in GenBank. These sequences represent 5 scleractinian families, but include only 200 -700 bp of the entire 28S gene region. Due to the limited length of these sequences, a thorough analysis of our data is not yet possible. New primers are being used that will provide sequences for the complete 28S gene. Our results will be used to construct a phylogenetic tree of scleractinian coral genera to establish robust hypotheses for relationships among families.

Antihypertensive Metabolites from Atrocarpus altilis (Breadfruit)

Ali Kareem, Keisha R. Christian, Andrita Griffin, Dr. Omar E. Christian, Ph D
Dr. Omar E. Christian, Mentor
UVI Organic Chemistry Lab, St. Thomas

Artocarpus altilis belongs to the mulberry family Moraceae, and is a large tree which grows in subtropical regions of the Pacific and the Caribbean, where it is known as the breadfruit tree. It is indigenous to the Tahiti islands and southeastern pacific. The Artocarpus altilis fruit is eaten as a food by many people in the Caribbean islands. The leaves of the breadfruit tree are used to brew tea, a Caribbean medicinal folklore remedy to alleviate asthma symptoms, relieve chronic body aches and pain, and most importantly to reduce high blood pressure. Recent studies have confirmed this folklore as This study is aimed at investigating the antihypertensive and other bioactive compounds isolated from Artocarpus altilis. Green and yellow breadfruit leaves were extracted sequentially with hexane, ethylacetate and methanol. Preliminary thin layer chromatography (TLC) carried out on the methanol extract suggested the presence of several UV and non-UV active components.In an effort to identify the antihypertensive metabolites in the consumed tea, yellow and green leaves were brewed and the ethylacetate extract or the tea mixture analyzed by LCMS and NMR.The analytical and spectroscopic data of the organic extracts as well as the aqueous extract of the yellow and green leaves of the breadfruit plant will be discussed.

Cleaner shrimp Periclemines pedersoni reduces parasite loads on Blue Tang Acanthurus coeruleus

Mutahammis Kareem, Richard Morgan, Kavita Balkaran, Dr. Donna Nemeth
Dr. Donna Nemeth, Mentor
UVI Marine Science Center and Coral World, St Thomas

On tropical coral reefs fish can be seen going to "cleaning stations" where a "cleaner" such as striped cleaner wrasse eats the parasites off of the "customer" fish such as banner wrasse. In this experiment we tested to see what affect cleaner shrimp actually had on the external parasite loads of fish. We hypothesized that Periclemines pedersoni (Pederson cleaning shrimp) would reduce parasite loads on Acanthurus coeruleus (Blue Tang) compared to fish without access to cleaners. Twenty-eight A. coerulus were evenly divided into an experimental treatment along with eight Batholomea annulata (anemones) and 30 P. pedersoni (cleaners) and a control treatment with eight B. annulata and had no access to P. pedersoni. A. coeruleus with access to P. pedersoni had - significantly ($p < 0.01$) fewer monogeneans (mean=23 per fish) than the control (mean=79.5 per fish)after 14 days. This experiment shows support for the hypothesis that cleaner shrimp P. pedersoni can significantly reduce parasite loads on A. coerulus. This experiment is the fourth in a series of experiments all following the same trend of fish with access to cleaners having fewer parasites than those without. (Nemeth personal communication, Nov. 2007). This research could have implications for reducing parasite loads on fish in aquaculture facilities where parasite loads are often very high due to overcrowding and stress.   These findings also suggest that conserving biodiversity, including cleaner organisms, can impact the health of fish populations.

Constraing Ocean Acdification in the Greater Caribbean Region.

Vanessa Malone, Dwight Gledhill, Tyler Christensen, Mark Eakin, Gang Lui & Al Strong
Dr. Mark Eakin, Dr. Dwight Gledhill, Mentor
Coral Reef Watch, NOAA, National Environmental Satellite, Data and Information
Service (NESDIS) Silver Spring, MD 20910-3226

Ocean acidification is an increasing problem facing marine ecosystems, largely attributed to rising atmospheric CO2 over the last century. With effects that range from coral degradation to the breakdown of marine ecosystems -due to changes of the oceanic chemistry of the region- ocean acidification has become a prime focus of subtropical regions, namely the Greater Caribbean Region (also known as the GCR; 17º to 26º N to 63º to 83º W.) Due to such recent attention, the National Oceanic and Atmospheric Association (NOAA) has made several studies (via the Atlantic Oceanographic and Metrological Laboratories Explorer of the Seas cruise line) to observe and assess such fluctuations in oceanic chemistry. The analytical procedures used to assess those observations have become the focus of this project. In attempt to derive an effective basis of climatic information for the GCR, this experiment focused on analyzing and improving techniques of data analysis overall yielding important information such as: salinity data collected from the AOML cruise line and data predicted from past climatology reports were 95% synonymous; and the major lack of alkalinity data pertaining to the GCR. These results will be used by NOAA to improve current models of ocean acidification in the GCR. Overall, the effort proved successful in displaying not only the immediacy of ocean acidification but also the several steps currently being used to analyze and properly assess it.

Cleaning symbioses and Parasite Loads: Identifying a potential correlation between Monogenean flatworm (Neobenedina sp.) populations and cleaning station densities

Stephen McCauley
Dr. Donna Nemeth, Mentor
Coki Pt., Brewer's Bay, Flat Cay, STT

Cleaning stations are an integral part of any healthy coral reef. Cleaning interactions among fish involve the removal of dead skin, mucus and scales, as well as the removal of ectoparasites from the surface of client fish. The symbiotic relationship between cleaning organisms and their clients affects the delicate balance of the reef. Little is known about the factors that contribute to the density of ectoparasites on a given reef. A potential relationship between fish and parasite populations, such as isopods, copepods and monogenean flatworms has been suggested. A study by Dr. Donna Nemeth and colleagues indicated that densities of the Monogenean flatworm, Neobenedenia melleni on the blue tang, Acanthurus coeruleus can shift dramatically in a relatively short time period as well as vary among sites. Simultaneous quantification of cleaning station density on the reefs along with a survey of fish parasite loads could allow one to look for possible causal relationships between the two. In general, we hypothesize that the density of cleaning stations on a reef is correlated with the populations of external parasites on client fish.H1: Cleaning station density influences the attraction of fish ectoparasites to a reef due to a higher amount of hosting, client fish present.OR H2: The varying density of fish parasites on a reef is responsible for a shift in cleaning station density. We predict that if cleaning station density is important for reducing parasite loads, then we expect to find low external parasite loads where cleaning station densities are high. In contrast, areas of high fish ectoparasite density should correlate to low cleaning station density in that area. This scenario, which presents questions which can only be answered by long-term temporal studies, for which it is first necessary to quantify the potential relationship between cleaning fish or shrimp density and total ectoparasite load. Insight to this correlation can be determined by quantification of cleaning station density by surveying reefs using transects to be completed by divers using SCUBA. This will be compared to total ectoparasite load which is determined by the mean number of parasites per fish. Previous studies show that cleaning fish do in fact remove a significant number of ectoparasites (Grutter 1999) and suggest that obligate cleaner distribution correlates with parasite availability, although more information on the long-term effects of cleaners on parasite populations is needed. For example, higher densities of coral-dwelling cleaning gobies tended to coincide with lower gnathiid loads on their clients, despite the premise that cleaner fish are known to prefer inspecting clients with higher ectoparasite loads (Cheney; Cote 2003). Understanding this potential correlation is significant because cleaning station density and parasite load are important bioindicators of the condition of our coral reefs. Field studies involving cleaning station density and the mean parasite loads of blue tangs can reveal important influential dynamics of this potential cause and effect relationship, which will better our understanding of coral reef health.

Effects of Muscarinic Agonists on Central Control of a Peripheral Neural Circuit

Hiba Mustafa, Rifa Abdullah, Dr. Richard Hall
Dr. Richard Hall, Mentor
UVI's Neuroscience Lab, St. Thomas Campus

The stomatogastric nervous system (STNS) controls all motor activity of the lobster foregut and is comprised of four ganglia. The paired commissural ganglia (COG) are located within connectives of the central nervous system and send axonal projections to two peripheral ganglia: the esophageal ganglion (EOG) and through a single nerve to the most distal stomatogastric ganglion (STG). The pyloric central pattern generator (CPG) in the STG produces rhythmic bursts of action potentials even in isolated STNS preparations. Central nervous system input is necessary for the pyloric CPG and cutting all connections from the COG or EOG to the STG stopped bursting activity. While two neurons in the COG are known to influence the pyloric rhythm, the pharmacology of these influences is not clear. Lobsters, like most animals, employ relatively few types of neural transmitters in motor circuits. We hypothesized that control of higher motor centers will involve neurotransmitters also used in peripheral centers: acetylcholine is an important inhibitory neurotransmitter in the pyloric CPG and acts through muscarinic type receptors. To test this hypothesis we superfused both COGs with a cholinergic mimetic, oxotremorine, for one minute followed by repeated washes with lobster saline. We observed a dose dependent increase in the bursting frequency of the pyloric CPG. The superfusion with 10-4 M oxotremorine had a significant effect, and increased burst frequency by 23% (from 1.10 - 0.09 Hz, P 0.01) for up to an hour. The treatment with 10-2 M oxotremorine also caused an increase burst frequency by 50% (from 0.99 ± 0.03 Hz to 1.52 ± 0.15 Hz, P 0.01) for at least 5 minutes. Thus, at least one neurotransmitter common to the STG also influences activity of higher centers known to control the pyloric CPG.

Species of branching Porites in St. Thomas, USVI do not form distinct morphological groups

Semoya Phillips
Dr. Sandra Romano, Mentor
University of the Virgin Islands, Division of Science and Mathematics, St. Thomas campus

Corals in the family Poritidae are among the most abundant reef building corals in the Caribbean. There are three recognized species of branching Porites in the Caribbean, P. furcata, P. divaricata and P. porites. Overlapping morphological variation within and among Porites species make their taxonomy most difficult among the scleractinian corals. While all forms are branching, P. porites usually has larger branch diameters than P. furcata, and P. divaricata has the smallest branch diameter of all the branching forms. However, many authors argue that, because they live sympatrically and are not easily distinguished, that there are not three species of Porites but just one species with three different sizes. I hypothesize that the three morphs found around St. Thomas, USVI are three distinct species that can be distinguished using predetermined morphological standards. If morphology is useful for distinguishing these species, characters identified as diagnostic in other studies will differentiate the three morphs. The methods for my study were based on a study done by Weil in 1992. I used Vernier calipers to measure and record the branching cycle length and diameter of the coral colonies. There were five samples of Porites divaricata, six samples of Porites furacata, and four samples of Porites porites. Differences for means of each character were tested using ANOVA to determine if there is a significant difference among the means for those characters of the morphs found around the Virgin Islands that would categorize them into three distinct groups. Comparisons between my samples and published data were done using t-tests. I found no significant differences in the character measurements for each species. The characters were not distinct enough from each other to be placed in three separate groups. However, we did find that most of my measurements were not significantly different from the published data. This seems to point to the species being a continuum of one morph. I failed to reject my hypothesis that there are three distinct species because of the results of the ANOVA. Some unexpected variables may have occurred because of different colony morphologies that make determining the appropriate place to measure the length or diameter difficult. In continuation of this study I intend to use the additional character of corralite diameter to see whether that character would differentiate the three species.

A Summary of the Classical and the Fast Black Algorithms for Rotating Monochromatic Images

Marlon Richardson
Dr. Marc Boumedine, Mentor

Most algorithms rotating monochromatic images produces white holes in black areas, making edges uneven and disconnecting neighboring elements. These white holes affect the quality of images. This paper summarizes results of Chien and Baek's study on the comparison of two algorithms, the Classical and the Fast Black Run algorithms in an effort to better understand the white hole problem during the rotation of monochromatic images and its impact of image quality.

Diadema antillarum, the long-spine black sea urchin, shows recovery at airport runway, Brewers Bay St. Thomas US Virgin Islands, with high overall density and high recruitment

Gabriel J. Rivera, Dr. Teresa Turner
Dr. Teresa Turner, Mentor
University of the Virgin Islands, St. Thomas Campus USVI

Diadema antillarum plays an important role in the coral reef community as a keystone grazer. As such they eat algae which compete with coral for space. This maintains algal density to a low level where corals are able to flourish. Moreover, their grazing habits clear the rocky surface for potential coral recruits. In the early 1980's there was a great die-off or urchin densities killing 99% of the population around the Caribbean. This even created the opportunity for algal cover of reefs to increase to the corals' detriment. To quantify the recovery on St. Thomas, we surveyed the densities of this long-spine black sea urchin from 1-3 m depth along the Brewers Bay airport runway (18˚ 20.4' N, 64˚ 59.0' W), which is adjacent to the University of the Virgin Islands St. Thomas campus. Both areas along the base and the length of the runway were surveyed. The average density of the urchins was 4.0/m2. This is relatively high in comparison to many other places in the Caribbean. The base area of the runway showed higher densities with a significant amount of urchins 3cm. Thus, this is an area of urchin recruitment. We hypothesize that there were such high densities because of the lack of water movement. Also, there might be high density because of urchin recruits or there may be urchin recruits because of a high density. Young urchins can find protection among the spines of their larger group mates. The location of the runway acts as a barrier from the waves and currents that would otherwise sweep away the urchins. Also, the lack of algal cover that could otherwise brush off the urchins from the rock enables them to have free range—increasing their numbers. It is thought that the grouping of the urchins allows smaller urchins to have a protective cover, a canopy of spines, which increased the number of juveniles. Low water movement, larger urchin protection and even high rugosity can allow the high number of recruits to settle and survive. Areas such as this may be important in understanding reef recovery because it shows the significance of factors such as low water movement and high urchin densities working together to create a more suitable habitat for a coral reef system.

Application of Optimization Problem

Aimee Sanchez, Dr. Joseph Gaskin
Dr. Joseph Gaskin, Mentor
University of the Virgin Islands, St. Thomas Campus

A standard problem often used to introduce the topic optimization in most calculus texts is to find the rectangle of maximal area that can be inscribed under a parabola. To solve optimization problems, some knowledge of calculus techniques is required. To be more specific, optimization problems are an application of the derivative. To begin with, we chose to analyze the quadratic formula $f(x) = ax^2 + bx + c$, which is also a general equation to represent a parabola, under the special conditions where $a < 0$ and $b^2 - 4ac > 0$. Then we obtained an equation for the area of any inscribed rectangle, given by $A(x) = (ax^2 + bx + c)(-(2xa + b)/a)$. We will prove that the critical points at which such rectangles are maximized bear an amazing resemblance to the quadratic formula. Further mathematical analysis revealed that the ratio of the area under the curve to the area of the rectangle with maximum area is simply the square root of three. Additionally, we looked at yet another, more general function given by the formula $f(x) = x^r$. We will show that the ratio of the area under the curve $f(x) = x^r$, which is found by an integral, to the area of the maximal inscribed rectangle approaches the number e as r approaches 0.

Antimicrotubule Metabolites from Ircinia strobilina and other Virgin Islands Sponges

Ophelia Wadsworth,a Susan Mooberry,b John Reed,c Omar E. Christian*a Division of Science and Mathematics, University of the Virgin Islands, St Thomasb Department of Physiology and Medicine, Southwest Biomedical Foundation, Texasc Division of Biomedical Research, Harbor Branch Oceanographic Institution, Florida
Dr. Omar Christian, Mentor
Division of Science and Mathematics, University of the Virgin Islands, St Thomas, Department of Physiology and Medicine, Southwest Biomedical Foundation, Texas, Division of Biomedical Research, Harbor Branch Oceanographic Institution, Florida

Cancer is one of the most researched diseases of the 21st century. Despite this fact it remains one of the leading causes of death in the world. The race for a cure has led to the isolation of anticancer components from a wide variety of organisms, especially marine sponges, which are a rich source of biologically active metabolites. Recent examples include the microtubule stabilizing agent discodermolide isolated from the Caribbean sponge Discodermia dissoluta. Antimicrotubule metabolites have been successful in treating various cancers, of this group taxol the most potent. Herein we describe the fractionation and biological evaluation of the ethyl acetate extract of Ircinia strobilina resulting in several potential anticancer leads. The sephadex fractionation of this Virgin Islands' sponge yielded six semi-pure fractions, four of these fractions displayed microtubule depolymerization activity in vitro at concentrations of 10 μg/mL and 25 μg/mL. Furthermore, several other crude fractions from Mycale laxissima, Agelas conifera and Agelas wiedenmyeri also displayed microtubule depolymerization activity at these concentrations. The microtubule assays were conducted in A-10 rat aortic smooth muscle cells. The cells were exposed to the extracts for eighteen (18 hrs) hours then stained and visualized microscopically. Samples are currently being assayed for general cytotoxicity against a panel of human and murine cancer cell lines. The cell proliferation and microtubule inhibitory activity, in addition to the chromatographic separation and elucidation of compounds from Ircinia strobilina will be discussed.

Cytotoxic metabolites from Pseudocerintina crassa

Digna M. Washington1, Omar E. Christian, PhD1, John Reed2, Susan Mooberry, PhD3
Dr. Omar Christian, Mentor
Division of Science and Mathematics, University of the Virgin Islands, St Thomas, USVI,
Harbor Branch Oceanographic Institution, Fort Pierce, FL, University of Texas Health
Science Center at San Antonio, San Antonio, TX

In 2004, it was estimated that over 1.3 million Americans were diagnosed with various forms of cancer and of this number; in excess of 560,000 have died from the disease. Natural products, natural product derived drugs or natural products inspired drugs account for the vast majority of chemotherapeutic agent currently in clinical use. In recent years marine sponges have been established as a sustained source of biologically active and biosynthetically diverse natural products. Sponges of the order Verongida are known to produce interesting and biologically active bromotyrosine derivatives. Recent examples include psammaplins isolated from Verongida, which exhibit potent HDAC (Histone Deacetylase) and DNMT (DNA Methyltransferase) activity. As a result, several synthetic psammaplin-inspired compounds are currently in phase I clinical trials against hematologic malignancies. As a part of our on-going search for novel anticancer drugs from Virgin Island sponges, extracts of Pseudoceratina crassa are currently under investigation for antimicrotubule activity. The hexane and the ethyl acetate extracts displayed classic microtubule inhibitory activity at 25 µg/mL and 10 µg/ml. The bioactivity observed at the crude extract level is not surprising as Pseudoceratina is a prolific producer of the extremely cytotoxic psammaplins. The microtubule assays were conducted in A-10 rat arotic smooth muscle cells. The cells were exposed to the extracts for eighteen (18 hrs) hours then stained and visualized microscopically. Chromatography of the extracts of P. crassa has yielded two pure fractions. Samples are currently being assayed for general cytotoxicity against a panel of human and murine cancer cell lines. The cell proliferation and microtubule inhibitory activity will be discussed. The identity of the elucidated metabolites will be determined based on 1D and 2D NMR data.

The University of the Virgin Islands is a learner-centered institution dedicated to the success of its students and committed to enhancing the lives of the people of the U.S. Virgin Islands and the wider Caribbean through excellent teaching, innovative research and responsive community service.

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Emerging Caribbean Scientists Programs
Division of Science and Mathematics
University of the Virgin Islands
#2 John Brewer's Bay
St. Thomas, VI 00802
Phone: (340) 693-1232
Fax: (340) 693-1245
Email: ECS@UVI.EDU