TAMUS AGEP Mini-Grant Awards

Award Year: 2015

Student Name: Danielle Carter de Macedo
University: Texas A&M University – College Station

Degree Program: Master's

Faculty Co-Mentors:
Dr. Luis Hurtado (TAMUCS)
Dr. Lee Smee (TAMUCC)

Research Project Title: Population genomics of the blue crab, *Callinectes sapidus*, in the Gulf of Mexico

Abstract: The goal of this proposal is to examine temporal and geographical genetic variation and differentiation of the blue crab, *C. sapidus*, in the Gulf of Mexico using high-throughput DNA sequencing genomic methods.

The blue crab, Callinectes sapidus, is a keystone species in estuarine habitats, serving as both predator and prey to other species. It plays a pivotal ecological and economic role in the Gulf of Mexico and the mid-Atlantic region. It is one of the most important fisheries in the Gulf of Mexico, producing $192 million in 2013. In recent years, however, it has been suffering a population decline. According to NOAA, the Gulf region has seen a decrease of nearly 13% in hard blue crab landings, with the mid-Atlantic region suffering an even greater decrease of 36%. Bottlenecks like these can have severe economic and ecological repercussions. In addition to loss of genetic diversity, a continued population decline of the blue crab will negatively impact critically endangered organisms that depend on the blue crab, like the Kemp's Ridley sea turtle and the whooping crane, as well as commercially important fish species.
Despite being a keystone species, little is known about its genetic population structure. Previous research provides conflicting evidence of genetic variation in the blue crab across its range. Some studies have identified significant population structure in blue crabs in the Gulf of Mexico, attributed to seasonality, catastrophic events, and post-larval selection, while others have found genetic homogeneity in the Texas coast, possibly due to gene flow by larval dispersal. These studies are further limited by the number and types of genetic markers used. Nonetheless, the results from previous studies are being used to implement management strategies, despite their limitations.

High-throughput DNA sequencing genomic tools, such as restriction site associated DNA markers (RAD seq) and anchored hybrid enrichment, as well as microsatellites, will be used to better understand the spatial and temporal genetic architecture of the blue crab. This will provide more robust results over traditional genetic markers and clarify past results. Single nucleotide polymorphisms (SNPs) will be used to assess sequence variation, using principal component analysis and fixation indices. SNPs have several advantages over traditional markers, particularly their abundance throughout coding and non-coding regions and their simple mutation models. Blue crabs will be sampled throughout the Gulf. Previously collected samples will be analyzed to further understand the role seasonality plays on gene flow. A thorough examination of the blue crab's genetic structure will aid management plans, prevent further population decline, and maintain biodiversity by mitigating damages due to overfishing, pollution, and other anthropogenic activities. The goal of this proposal is to examine temporal and geographical genetic variation and differentiation of the blue crab, *C. sapidus*, in the Gulf of Mexico using high-throughput DNA sequencing genomic methods. The project will benefit from Dr. Hurtado's (TAMU) expertise in conservation genomics and Dr. Smee's (TAMU-CC) expertise on ecological aspects of the blue crab. Our results will advance conservation and our understanding on the ecology of this important species.

Student Name: Lewis Haynes
University: Texas A&M University – Kingsville

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Lee Clapp (TAMUK)
Dr. Phillipe Tossot (TAMUCC)

Research Project Title: *Geochemical Modeling to Support a Groundwater Restoration Study at an In-Situ Recovery (ISR) Uranium Mining Site*

Abstract: Background. The Kingsville Dome In-Situ Recovery (ISR) uranium mine, located eight miles from TAMUK, is currently undergoing restoration. In December 2014, the Environmental Protection Agency proposed new regulations that would impose significantly stricter groundwater restoration standards at these ISR uranium mining facilities.1 Anticipating stricter standards, the mining company recently funded a short-term pilot groundwater restoration study that was performed by TAMUK doctoral student Lewis Haynes. The pilot study specifically evaluated the effectiveness of stimulating *in-situ* microbial reduction and immobilization of residual uranium by delivering dissolved hydrogen to the groundwater using a down-well membrane infusion system (Figure 1). Bromide was simultaneously added as a conservative tracer. Mr. Haynes will complete the experimental part of the study this spring; initial results indicate that uranium concentrations near the injection well decreased by over 85%.2 Research Objective. Although the experimental results of the pilot study appear promising, the experimental data alone neither elucidate the efficiency with which the supplied hydrogen was channeled into reducing uranium (as opposed to competing constituents like ferric iron and sulfate) nor reveal the effective radius of influence around the hydrogen injection well. Therefore, the *research objective* of the proposed project is to use the experimental data obtained during the pilot study to calibrate a geochemical fate and transport model that will allow both the hydrogen utilization efficiency and the effective radius of influence to be accurately estimated (this modeling effort will not be funded by the mining company).

Student Name: Nebechi Osia
University: Texas A&M University - Kingsville

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Lee Clapp (TAMUK)
Dr. Dorina Murgulet (TAMUCC)

Research Project Title: Evaluation of Alternative Inorganic Reductants for Reducing Uranium in Groundwater

Abstract: The *research objective* of the proposed project is to evaluate the effectiveness of alternative inorganic reductants that can reduce soluble hexavalent uranium (U^{6+}) without reacting with sulfate. **Background.** South Texas is a leading region in the U.S. for supplying uranium to the nuclear power industry. In 2014, three of the seven active in-situ recovery (ISR) uranium mines in the U.S. were located in South Texas, and three additional South Texas ISR mines were undergoing restoration;1 in addition, there were ten active uranium exploration permits in South Texas.2 All these sites are within an 80-mile radius of both TAMUK and TAMUCC. In December, 2014, the Environmental Protection Agency proposed new regulations that would impose significantly stricter groundwater restoration standards at these ISR uranium mining facilities.3 **Inter-Institution Collaboration.** The proposed project will be a follow-up to a recent DOE-funded pilot-scale study supervised in which 100,000 standard cubic feet (scf) of hydrogen were injected into groundwater at an ISR mining site near Kingsville that was undergoing post-mining groundwater restoration.4 The goal of the completed study was to restore groundwater in a post-leached aquifer by chemically reducing soluble hexavalent uranium (U^{6+}) to insoluble tetravalent uranium (U^{4+}). The study results demonstrated that H_2 injection decreased soluble uranium concentrations by 99%. However, the results also indicated that the "zone of influence" was limited because H_2 reacted with sulfate in the groundwater. The ***research objective*** of the proposed project is to evaluate the effectiveness of alternative inorganic reductants that can reduce U^{6+} without reacting with sulfate. It is hypothesized that this will more efficiently channel reducing equivalents into uranium reduction, ultimately resulting in a larger zone of influence and thus a more cost-effective restoration approach.

Student Name: Seaborn B. Carter
University: Texas A&M University – College Station

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Sergio Capareda (TAMUCS)
Dr. Ruby Stevens-Morgan (PVAMU)

Research Project Title: Creation of a Laboratory for Simulation and Modeling of Integrated Biorefineries.

Abstract: In response to a nationwide agenda to develop independence from foreign fuel, some funding agencies have recently increased support for research focused on the design and operation of commercial biorefineries. As a result, development of integrated technologies to produce advanced fuels and other consumer materials that contribute to the nation's biobased economic profile is at an all-time high. With the assistance of simulation and process modelling tools, data generated from bench scale experiments can be transformed into advantageous knowledge for developing full-scale economically viable biorefineries. Additionally, these tools allow for resource saving and rapid assessment of multiple simulated operation scenarios including consideration of improving compliance with environmental quality regulations. The Laboratory for Simulation & Modelling of Integrated Biorefineries (SMIB) is established to assist research focused on the scale up of feedstocks conversion and upgrading to value-added biobased products at the industrial scale through the development of multiple alternative processes integrated into a single biorefinery modelled platform. Biomass conversion from agricultural-based feedstocks like algae and renewable forestry materials are ideal for exploration through the SMIB laboratory to model production of biodiesel processes. The SMIB lab will be instrumental in establishing linkages to other industries affiliated with the biorefinery industry such as biotechnology, water purification, air pollution control, and nutraceuticals production. The dissertation research of Seaborn Carter addresses the optimization of unit operations associated with biorefineries. The SMIB lab will assist Mr. Carter in testing his hypothesized theories for efficient production of potential transportation fuels, therapeutic proteins, and crop soil enhancers through an integrated biorefinery utilizing algae-based feedstocks. Researchers and educators from multiple disciplinary backgrounds will also benefit from the opportunity to accelerate their experimental investigations with the advantage of current modelling and simulation tools. Collaborative learning communities will be fostered for both novice and advanced users who choose to employ unit operations and techno-enviro-economic analysis for the research designs. The SMIB lab will also support the development of related course material for university faculty and K-12 educators to utilize in their classroom environment. Training videos, guest lectures, and workshop resources for a Renewable Energy Conversion course will be available to K-16 educators and students for free. Industry and research personnel interested in SMIB resources will be charged a fee to defray cost of maintaining daily operation and future upgrades for the SMIB Lab. The appropriateness of K-12 renewable course materials will be evaluated by Faculty Co-mentor, Dr. Ruby Stevens-Morgan, who is an expert in curriculum and instruction in secondary schools and teaching and learning across K-16 classrooms. Dr. Stevens-Morgan will also support training and development of K-12 educators to

implement Renewable Energy Conversion concepts into their courses. The SMIB Lab tools will consist of the following software: Comsol, SuperProDesigner, and Labview. The software installation requirements can be met with computers using a minimum CPU speed of 2.1 GHZ. The SMIB lab will be comprised of one laptop for data collection mobility and three desktop computers placed in a dedicated workspace area inside the research laboratory of Faculty Co-mentor Dr. Sergio Capareda.

Student Name: Natividad Robert Fuentes
University: Texas A&M University – College Station

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Robert Chapkin (TAMUCS)
Dr. Yi Li (TAMUK)

Research Project Title: Plasma membrane as a potential target for developing therapeutics.

Abstract: Rates of obesity and type 2 diabetes are at an epidemic level in this country. The National Institute of Health estimates more than 2 out of 3 adults are considered overweight or obese1. Furthermore, the Center for Disease Control, estimates that approximately 29 million, or 9.3% of the population Americans have diabetes2. Specifically South Texas, the location of Texas A&M –Kingsville, is directly impacted by diabetes and obesity, where diabetes affects approximately 16% of the population3. Indeed, recently a new pilot program from the Healthy Texas Initiative called "Healthy South Texas" has been formed to address some of these issues. There is strong evidence to suggest a link between obesity and diabetes4. Type 2 diabetes is characterized by insulin resistance, however the molecular basis for how obesity contributes to reduced insulin sensitivity has not been fully elucidated. Plasma membrane spanning insulin receptors and glucose transporters are directly involved in maintaining cellular glucose homeostasis5. From a functional perspective, the phospholipid composition of cellular membranes is known to influence the ability of many plasma membrane receptors to function properly. Interestingly, obesity is known to modify the phospholipid composition of many cell types including adipose (fat) and erythrocyte (blood) cells6,7. Therefore, by altering phospholipid composition, obesity may alter the biophysical properties of plasma membranes and thereby promote insulin resistance. In order to study plasma membrane biophysical properties, we will utilize isolated plasma membrane blebbs termed giant plasma membrane vesicles (GPMV), which maintain the lipid and protein diversity of the plasma membrane8. One critical observation that can be elucidated with this model is the temperature at which the GPMVs transition from homogenous to heterogeneous separated domains (Fig. 1), termed phase transition temperature. Recent findings provide evidence that the phase temperature influences cell signaling and even drug resistance9. Our primary goal is to determine if obesity alters the phase transition temperature of isolated blood cells. We hypothesize that obesity will reduce the phase transition temperature of isolated blood cell plasma membranes. To test this hypothesis we will utilize an in vivo high fat diet-induced obese mouse model. This model has been used to study obesity-induced hyperglycemia and treatments to improve insulin resistance10–12. Isolated erythrocytes and T cells will be utilized for GPMV phase transition as well and plasma membrane lipid composition experiments. The proposed work will help elucidate the mechanistic underpinnings as to how obesity modulates insulin sensitivity, and may provide rationale for membrane target based therapies for insulin resistance. Furthermore, isolation of GPMVs from primary human blood cells may be utilized as a biomarker for insulin sensitivity, and help clinicians recommend specific therapeutic recourse. Collaboration Statement: By utilizing Dr. Robert Chapkin's extensive background in nutrition and lipid biochemistry, combined with Dr. Yi Li's, expertise in nutritional genomics focused on obesity and type 2 diabetes, and Mr. Robert Fuentes' expertise in GPMV isolation and imaging, we hope to generate pilot (proof of concept) data that can be utilized for a collaborative grant submission.

Student Name: Gerardo J. Pinzon
University – Texas A&M University - Kingsville

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Jianhong Jennifer Ren (TAMUK) and Dr. David Ramirez (TAMUK)
Dr. Guillermo Dominguez (TAMIU) and Dr. Juan Hinojosa (TAMIU)

Research Project Title: "Improving the Impact Analysis of Shale Oil and Natural Gas Production on Regional Rural Communities Using Industrial and Environmental Engineering Techniques"

Abstract: This proposal is to develop a model that will help improve the impact analysis by the Eagle Ford Shale (EFS) on rural communities. The EFS is a formation located in South Texas that was traditionally considered to be economically unfeasible as a potential natural gas and oil producing formation. Since the onset of hydraulic fracturing of the non-porous rock, the Shale has rapidly become one of the highest producing areas of natural gas and oil, with a positive economic impact on the communities located over it. This rapid growth placed a heavy burden on the EFS communities because of not only the lack of infrastructure and facilities but also on governments not having the proper manpower and expertise to deal with such a demand. Many studies have been undertaken with most highlighting the economic boost and others interested in the social and environmental impacts but none have taken a holistic approach.

The purpose of this project is to prepare a System Dynamics (SD) model to understand the effect of social, economic and environmental impacts to rural communities caused by the effects of the oil production in the EFS area. The SD model will essentially help us organize what we know, understand its cause and effect and finally being able to see the interaction between each impact. There are four objectives for this project:

- The first objective is to understand how the SD Software could be used for modeling in this study. A software review will be prepared to compare the various software packages available and select the one that better suits the need for this study. The software selected are: Ithink, Goldsim, Vensim, STELLA and Dynamo.
- The second objective is to re-evaluate the overall impacts of the EFS development in consideration of a set of extended components, in addition to the production, drilling, and related activities that have traditionally been considered. A baseline benchmark for each impact will be provided based on previous studies, research and information provided by experts in the field. These will be then used to create the SD model. The third objective will be to apply the model to a specific community. For instance, the City of Cotulla has been proposed as a target of this study because of its location and greater impact due to the oil production. The model will simulate how each of the variables affects and impact each other. The outcome of the model will provide a better management tool for the future.
- The final objective is to prepare the model so that any rural community could apply this SD model as a tool that can assist in the planning and development of its infrastructure. Community leaders and managers could adjust the model appropriately based on their current needs. In the future, this model could be replicated for any community that has been or could be impacted by any industry that caused an unexpected growth.

Student Name: Nebechi Osia
University: Texas A&M University – Kingsville

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Lee Clapp (TAMUK)
Dr. Dorina Murgulet (TAMUCC)

Research Project Title: *Evaluation of Alternative Inorganic Reductants for Reducing Uranium in Groundwater – Part II: Elemental Characterization of Mining Sediments*

Abstract: Background. South Texas is a leading region in the U.S. for supplying uranium to the nuclear power industry. In 2015, three of the seven active in-situ recovery (ISR) uranium mines in the U.S. were located in South Texas, and three additional South Texas ISR mines were undergoing restoration;1 in addition, there were ten active uranium exploration permits in South Texas.2 All these sites are within an 80-mile radius of both TAMUK and TAMUCC. In December, 2014, the Environmental Protection Agency proposed new regulations that would impose significantly stricter groundwater restoration standards at these ISR uranium mining facilities.3 TAMUK doctoral student Nebechi Osia is currently performing AGEP-funded research (June 2014-May 2015) to compare the effectiveness of different inorganic reductants (Na2S2O4 and CaS5) for stimulating microbial reduction and immobilization of uranium in aquifer sediments obtained from a nearby ISR mine (Figure 1). To date, these studies have focused only on changes in aqueous chemistry and have not characterized the solid phase chemistry. Research Objective. The objective of the proposed study is to build on the ongoing research by performing analyses to characterize the solid-phase chemistry of the sediments. Characterizing the solid phase geochemistry will provide needed data for future planned geochemical modeling.

Student Name: Michelle J. Zamarron
University: Texas A&M University – College Station

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Carlos Fernandez (TAMUCS)
Dr. Eliezer Louzada (TAMUK)

Research Project Title: Development of a Genetically Improved Line of Microalgae to be Utilized for Renewable Energy Applications.

Abstract: Microalgae can be utilized as sources of renewable energy, however limitations of current strains to withstand changing environmental conditions has been one of the obstacles encountered by algae farmers across the United States. Within South Texas, development of outdoor commercial algae ponds for biofuel production is of an economic interest in areas of Matagorda Bay (Corpus Christi). The localities proposed for these algae ponds has limited use for other types of commercial purposes so interest is great for biofuel production as a means of developing renewable energy. However, some of the limiting factors in using microalgae (for biofuel) in the Matagorda bay area is the ability of the algae to maintain production of high lipids as well as a consistent increase in biomass while surviving seasonal environmental factors such as salinity (increasing in summer), higher water temps (during summer), as well as low light (during winter) while keeping costs of the ponds low. The Chlamydomonas RIL algae lines obtained (from USDA-ARS) would be used in order to apply traditional breeding techniques to move the lines from growth in freshwater environment (or TAP media) to those conditions found in the natural bay environment.

Goal 1 of project: Screen the existing USDA-ARS 276 viable lines for growth in various amounts of salinity using artificial sea water, bay water, as well as TAP media. Screening will include cell sorting through flow cytometry completed at A&M Vet School; College Station, Texas

Goal 2 of project: Screen the existing 276 viable lines for high lipid producers
development for identification of high lipid producers.

Goal 3 of project: Use the phenotypes collected above with a minimum 200 available genetic markers to map quantitative trait loci (QTL) for these traits with preparation work completed in collaboration with Dr. Louzada TAMUK Citrus Center; Weslaco, Texas

Goal 4: Make crosses between the most salinity tolerant, and the highest lipid producer, and develop a new population. Selected a new generation of lines from this population and evaluate the success of selection by screening for the traits in Goals 1 & 2. Validate markers identified in Goal 3.

Ultimate Goal:
Development of a genetically improved line of Chlamydomonas reinhardtii (derived from the USDA-ARS Chlamydomonas RIL supplied lines) which has the characteristics (salinity tolerance as well as high lipid production) that can be further utilized for outdoor algae biofuel production in the environment of the Matagorda Bay areas of Corpus Christi. Most of the initial work would be completed in collaboration with Dr. Louzada TAMUK citrus center, with additional work completed in Dr. Fernandez's growth chambers at Agrilife-CC, and will include the use of lab space of other scientists at Agrilife-Weslaco.
I do not have any funding for my dissertations research. The NSF-AGEP mini grant would allow me to purchase the chemicals, materials, and pay for processing of cells which would enable the completion of goals #1 and #2, and complete preparation work required for goal #3.

Award Year: 2016

Student Name: Isabella Aguirre
University: Texas A&M University - Kingsville

Degree Program: Master's

Faculty Co-Mentors:
Dr. Jianhong Jennifer Ren (TAMUK)
Dr. Jeremy Landon Conkle (TAMUCC)

Research Project Title: Development of effective experimental procedures for studying surface-subsurface exchange of synthetic microfibers in aquatic systems

Abstract: While much attention has been paid to microplastics in personal care products, recent research has demonstrated that microfibers, mostly from synthetic fabrics, vastly outnumber the former. Microfibers are released when clothes are washed, which then travel to municipal wastewater treatment systems where some proportion is released into surface waters (Dris et al. 2016). It has been found that toxins such as DDT and PCBs bind with microfibers, which serves as a transport mechanism. Due to their small size, microfibers, are often ingested by fish and other aquatic organisms, which can lead to bioaccumulation and potential human exposure to the compounds sorbed on the plastics (Cole et al. 2013). Despite the potential for adverse environmental and health impacts, the transport and fate of these microfibers in aquatic environments are poorly understood.

In surface waters, water is constantly exchanged between saturated shallow sediments and the surface water column. Exchanges often carry fine particles/contaminants into sediment beds, where they may accumulate. As a result, the bed sediments and pore water can become a significant reservoir for pollutants in surface waters or a significant source of contamination long after the original pollutant input ceases (Fuller and Harvey, 2000; Areepitak and Ren, 2011). Thus, when studying the fate and transport of microfibers in surface waters, it is important to examine their behavior during surface-subsurface exchange to better understand their distribution and potential role in toxin transport across various aquatic systems compartments.

To date, some studies have examined the distribution and characterization of microfibers in natural environment, but studies on fate and transport of these microfibers in aquatic environment are lacking. As an emerging contaminant, innovative solutions must be developed to study microfiber fate and transport. Thus, the goal of this proposed M.S. thesis research is to develop effective experimental procedures for studying surface-subsurface exchange of synthetic microfibers in aquatic systems. A laboratory-recirculating flume located at TAMU-K will be used to simulate a representative surface water system ranging from fresh water streams to estuarine rivers. The specific objectives of the project are to:

1) Examine various methods for preparing microfibers that will mimic what is found in the natural environment,
2) Develop effective experimental procedures such as dye application for better visual observation and demonstration of the transport behavior, transport pattern capturing methodologies, and sediment type, size and preparation methodologies to be used for running flume experiments, and
3) Conduct a few flume experiments following these new protocols to obtain preliminary results that demonstrate microfiber transport and the effectiveness of the developed experimental protocols.

The proposed work will be co-advised by Dr. Jianhong Ren, Professor of Environmental Engineering of TAMU-K, an expert on surface-subsurface exchange processes and Dr. Jeremy Conkle, Assistant Professor of Environmental Sciences of TAMU-CC, an expert on aquatic plastic debris. It is expected that the project will provide valuable preliminary findings that can be used to develop a competitive proposal for state and federal funding opportunities that may include the Texas General Land Office Coastal Management Program or the NOAA Marine Debris Program.

Student Name: Kassandra Gonzalez
University: Texas A&M University - Kingsville

Degree Program: Master's

Faculty Co-Mentors:
Dr. Ambrose Anoruo (TAMUK)
Dr. Nithya Rajan (TAMUCS)

Research Project Title: Seedling regeneration, growth, and development on abandoned farmland.

Abstract: I am conducting a randomized complete block design experiment on an abandoned 56 ha farmland which has grown into upland woodland. The area is surrounded by farms, thus it is prone to over grazing and trampling by wildlife. For this reason, I am studying species diversity, and their growth and development to decipher the impact of wildlife foraging in the area. The experiment is replicated four times with a 10 X 10 meter fencing to exclude grazing animals. The same dimensions are measured adjacent to each fenced area as the control. Initial Spring 2016 results obtained from measurements of the following species Southern Zexmenia, Drummond Phlox, Descurainia pinnata, Rudbeckia triloba, Dracopis amplexicaulis,Verbesina Enceliodes, Monarda punctata, Gaillardia pulchella, Onopordum acanthium L. indidate that species diversity is higher in fenced area than the control areas. Also height growth of species is higher in the fenced plots than the control plots. I will begin the second year of the research in the Spring of 2017 in the hope of finishing my final analysis for May 2017 graduation. My plan is to begin my doctoral work in the fall of 2017.

Student Name: Nebechi Osia
University: Texas A&M University - Kingsville

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Lee Clapp (TAMUK)
Dr. Dorina Murgulet (TAMUCC)

Research Project Title: Evaluation of Alternative Inorganic Reductants for Reducing Uranium in Groundwater – Part III: Continuous Flow-Through Column Studies

Abstract: **Background.** Uranium is a naturally occurring groundwater contaminant, with concentrations dependent on the aquifers geochemical composition. At one point, South Texas had more in-situ recovery (ISR) uranium mines than any other state in the U.S. In South Texas, at least two mines are located within a short drive of Texas A&M University-Kingsville (TAMUK). The production of uranium mining has great contribution to not only the energy sector, but for military purposes as well. However, the public has concerns about the possible health hazards associated with uranium mining. Upon completion of ISR mining, the law requires mining companies to restore the aquifer back to baseline conditions. In the South Texas region, restoration processes such as groundwater sweep, reverse osmosis, and pump-and-treat are implemented to restore pre-mining aquifer concentrations. The aforementioned methods are only effective to a certain degree, as they do not restore the aquifer to its original reduced conditions. **Research Objective.** In this study, sodium dithionite and calcium polysulfide (CPS) will be compared as electron donors for stimulating microbial reduction and immobilization of U(VI). It is hypothesized that dithionite, being a weaker reductant, will stimulate U(VI) reduction and immobilization while avoiding sulfate reduction, whereas CPS will stimulate U(VI) and sulfate reduction. A geochemical model will also be developed to simulate bench-scale experiments. **Research Methods.** The above hypothesis will be tested by supplying groundwater amended with with sodium dithionite and calcium polysulfide (CPS) to continuous-flow sediment-columns (Figure 1). A third column will be supplied with groundwater only as a control. Groundwater will be supplied to the sediment columns from adjacent reservoir columns. N_2 gas will be supplied at a constant pressure of 125 psig to the headspace in the reservoir columns as a means of delivering the GWF solution to the sediment columns. Groundwater collected from a nearby uranium ISR mining site will be used as the influent. The effluent from each column will be analyzed using both inductively coupled plasma mass spectrometry (ICP-MS) and ion chromatography (IC).

Inter-Institutional Collaboration. Dr. Lee Clapp (TAMUK) has been supervising research related to restoring groundwater at uranium mining sites for 13 years. His research team uses inductively coupled plasma-mass spectrometry (ICP-MS) and ion chromatography (IC) for measuring uranium and other constituents in groundwater. Similarly, Dr. Dorina Murgulet (TAMUCC) has been studying various aspects of groundwater contamination for over 10 years. Her research includes use of energy spectral analyses (using a Durridge RAD7 detector) to measure radium and radon, which are decay products of uranium. Doctoral student Nebechi Osia (TAMUK) has dual Master's degrees in Environmental Engineering and Environmental Chemistry and also has experience with ICP-MS. The ***inter-institutional collaborative objective*** of this project is to evaluate advanced analytical methods for characterizing the solid-phase geochemistry of mining sediments.

Figure 1. *Photo of the sediment column set-up.*

Student Name: Trent Pinion
University: Texas A&M University - Kingsville

Degree Program: Master’s

Faculty Co-Mentors:
Dr. Lucy Mar Camacho (TAMUK)
Dr. Mahmoud El-Halwagi, (TAMUCS)

Research Project Title: Optimizing Polysulfone Mixed Matrix Membranes for High Permeate flux in Membrane Distillation

Abstract: Membrane Distillation (MD) is a relatively new membrane technology for water desalination. In the MD process, two aqueous solutions at different temperatures are separated by a membrane barrier. The membrane is made with non-wetted pores and thus allowing only vapor to pass across. The water vapor flows from the hot saline water to permeate driven by the difference in vapor pressure caused by a temperature difference across the membrane. MD can increase permeate recovery and reduce brine disposal. MD can also use alternative energy sources, such as waste heat or solar energy, which reduces the cost of the process. The development of membranes specific to MD remains a major challenge to the progression of the technology towards commercialization. This is because the desirable properties and morphology for an ideal MD membrane are fundamentally different from most commercially available membranes. MD membrane should be hydrophobic and highly porous. Polysulfone is a well-known hydrophobic and thermally resistant polymer, which makes it a good polymer candidate to produce laboratory fabricated membranes. In this research study, Polysulfone/Graphene Oxide membranes will be produced using the phase inversion method and tested for permeate flux and salt rejection on MD. Morphological studies of fabricated membranes will be done using SEM. The effects of membrane properties and graphene-type additive on the permeate flux and salt rejection will be quantified. Results will be used to prepare a proposal to request NSF or DOE research funding.

Award Year: 2017

Student Name: Patricia Cockett
University: Texas A&M University – Corpus Christi

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Ruby Mehrubeoglu (TAMUCC)
Dr. Lifford McLauchlan (TAMUK)

Research Project Title: Quantification of variation in phenotypic plasticity of shell characters: *Rangia spp.*

Abstract: Molluscs are excellent model species for monitoring ecosystem quality. *Rangia spp.* are broadcast spawning bivalves that occupy estuaries along the gulf coast of Texas and are commonly used to make inferences on salinity as they only reproduce in low salinity environments. Phenotypic plasticity can increase the fitness of an organism in response to changing environments or the colonization of a new environment. In the case of aquatic invertebrates with a pelagic larval stage, environmental factors can induce the formation of specific morphological traits that help the organism acclimate to their environment.

Adaptations such as phenotypic plasticity, are the result of the selective pressures a population experiences. While it might be advantageous for a population to specialize within a particular habitat, gene flow among habitats can resist this specialization. Thus, gene flow connects populations across varied landscapes and can reduce the fitness of specialists**.** The goal of this research is to use *Rangia spp.* as a model organism to investigate the effect of selection on adaptations and plasticity on a spatial scale within and among Texas bay populations. The information gained from this research will aid in the identification of populations under strong selection using phenotypic plasticity as a proxy for selective pressures such as salinity and pollution.

We will collect 50 *R. cuneata* from each of three Texas bays with varying levels of salinity and population densities: (1) Hynes Bay, (2) Upper San Antonio Bay, and (3) Guadalupe Bay (N=150). The volume and thickness of a bivalve shell may change in response to the presence of predators. Consequently, as shells increase in thickness, the more difficult it becomes for predators to exploit. Furthermore, food availability can be a limiting factor for *Rangia spp.* and may inhibit shell growth. We will measure shell volume using a high-precision 3D scanner to determine morphological patterns among sites. The proposed 3D scanner will capture accurate 3D internal and external shell volume, providing information about volume and thickness. Current methods utilize a hand-held caliper to measure shell height, length, and width. This method assumes perfect cone shape and is therefore not accurate, thus potentially removing small differences among shells due to inaccuracies. The 3D scanner will also capture shell color, expedite and automate the data collection process, and provide visual archiving of data for further analysis, as opposed to limited data points from manual measurements. This project will classify shells with respect to morphometrics which can then be related to phenotypic plasticity based on the suite of selective pressures at each site, ultimately providing a significant contribution to the field of evolutionary biology and estuarine ecology. Application of the proposed 3D scanning technology offers a novel application in this research, and will have additional implications in the long-term goals of the project.

Student Name: Michael Jochum
University: Texas A&M University – College Station

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Young-Ki Jo (TAMUMC)
Dr. Jinhua Jung (TAMUCC)

Research Project Title: Host Mediated Microbiome Engineering for Increased Drought Resistance

Abstract: Water is the main limiting resource in global agriculture, restricting yields in approximately 70% of arable farmlands. According to recent literature publications, it is possible to drive a microbiome to deliver a particular phenotype by subjecting it to the same environment and subsampling from the treatment that yield the most preferable phenotype (Mueller and Sachs 2015; Panke-Buisse et al. 2014; Bresson et al. 2013). Therefore, in an effort to engineer the microbiome to become more drought tolerant, five soil cores from the previously identified drought tolerant field bermudagrass were homogenized and diluted 10:1 with sterile growing medium cultivated with *Triticum aestivum* cultivar TAM111 wheat seeds that was subsequently germinated, subjected to a drought condition and compared for drought tolerance. The roots and soils from top 10% of the most drought tolerant pots were used as an inoculum to repeat the process for eight rounds. In this method, all viable microorganisms (viruses, bacteria, fungi, etc) living in the root microbiome were propagated from one parental community to the next, while maintaining the same unevolving host line through the use of seed. Results showed that host mediated microbiome engineered soils contributed greater alleviation of host drought phenotype based on survivability, root and shoot biomass, and relative water content when compared to the untreated control. The next step in this process will be to identify changes in the community composition using next generation metagenomic sequencing. Funding for this project would allow us to conduct metagenomics, and understand how the community of microorganisms changed from one round to the next. Funding this research would also allow us to know what selective media to use when trying to isolate keystone plant growth promoting microorganisms (PGPM) for downstream commercial application. This and other future discoveries from this project can potentially be used to isolate PGPM on a community level that can act in a synergistic manner as a probiotic treatment for plants in drought seasons and help to increase our understanding of influencing the phytobiome for improved host resistance to abiotic stress.

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University: Texas A&M University – College Station

Degree Program: Doctoral

Faculty Co-Mentors:
Dr. Katie Shamberger (TAMUMC)
Dr. Hussain Abdulla (TAMUCC)

Research Project Title: The influence of oceanic particulate organic matter uptake on coral reef calcification: Implications for ocean acidification

Abstract: Coral reefs are one of the most productive and biologically diverse ecosystems on Earth, provide coastal communities protection from storms, contribute to global food supplies, and hold significant cultural importance. Anthropogenic carbon dioxide (CO_2) emissions are changing Earth's climate as well as warming and acidifying the surface ocean. These processes interfere with coral reef growth and endanger these vital ecosystems. Ocean acidification (OA) may be one of the greatest threats to coral reefs globally. OA refers to the oceanic absorption of anthropogenic CO_2 and the consequent decline in ocean pH. This increase in ocean acidity slows the production of calcium carbonate (i.e., calcification) by corals and other coral reef calcifiers. In order to predict coral reef response to OA, we must first understand the natural biogeochemical processes that contribute to ecosystem function.

A key component to coral reef health that has not been adequately explored is the ability for corals to utilize oceanic particulate organic matter (POM) as an energy source to support calcification. Net reef uptake of POM, particulate organic carbon (POC) and particulate organic nitrogen (PON) can be measured through changes in concentrations between the source water (i.e., open ocean) and downstream community. However, since we are interested in the uptake of allochthonous POM as an external energy source to the reef, and both consumption and production of POM occurs simultaneously on the reef, we cannot simply measure bulk POM/POC/PON. In order to distinguish between oceanic-sourced POM and reef-derived POM, will use Chlorophyll *a* (Chl *a*) concentrations as a tracer for oceanic phytoplankton, or a proxy for oceanic POM. By determining Chl *a* and POC/PON in multiple samples at the source site, we will use a linear regression to determine the Chl *a*:POC/PON ratio. Combining this ratio with the total Chl *a* concentration at each site gives the contribution of phytoplankton to total POC/PON. Thus, by measuring Chl *a*, we can track the uptake of phytoplankton carbon/nitrogen (POCp/PONp) as water crosses the reef.

We are proposing to utilize high performance liquid chromatography (HPLC) to determine Chl *a*, as HPLC provides highly reliable Chl *a* concentrations without interference by other pigments. Another benefit of using HPLC is to quantify other photosynthetic pigments (such as other chlorophylls *b* and *c,* and carotenoids). These pigments serve as diagnostic markers for different types of phytoplankton in the community, thereby providing us with a snapshot of the phytoplankton community composition that are contributing to total POC.

During January 2017, samples for POM, carbonate chemistry and photosynthetic pigments using the HPLC were collected as water traversed across a barrier reef in Kaneohe Bay, Oahu, Hawaii. We will be collaborating with Dr. Hussain Abdulla, Assistant Professor of Chemistry at TAMU Corpus Christi, for HPLC analysis. Dr. Abdulla utilizes a ThermoFisher UltiMate 3000 x2 Dual Ultra Performance Liquid Chromatography coupled with a diode array and fluorescence detectors, and will be assisting us by running the approximate 100 samples we have collected. We will be using algal culture extracts as standards and following a well-established protocol.

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Dr. Naruki Hiranuma (WTAMU)

Research Project Title: Heterogeneous Chemistry between Organic Acids and Amines Relevant to Atmospheric Aerosols

Abstract: Aerosols influence the Earth's energy balance directly by scattering and absorbing solar radiation and indirectly by modifying cloud formation and altering the lifetime and albedo of clouds. Major gaps in the understanding of the aerosol direct and indirect forcing represent some of the largest uncertainties in climate predictions. While most aerosols scatter solar radiation back to space, cooling the Earth-atmosphere system, certain aerosol types also absorb light, and the net effect between absorption and scattering depends on the aerosol complex refractive index.

Heterogeneous reactions of amines have been implicated in the formation and transformation of atmospheric aerosols, especially in the nucleation and growth of new atmospheric aerosols and as precursors of chemicals that can contain chromophores that will contribute to atmospheric absorbance, and hence heating. The acid-base neutralization of particle phase dicarboxylic acids by low molecular weight aliphatic amines results in the formation of stable low volatility alkylaminium carboxylate salts altering the atmospheric aerosols properties.

The goal of the proposed research is to measure the kinetics of the heterogeneous reactions between organic acids and amines to assess their role in atmospheric aerosol formation and transformation. Specifically we proposed to (1) measure uptake coefficients of amines on various of organic acid surfaces using a fast-flow reaction in conjunction with ion drift – chemical ionization mass spectrometry detection and (2) to characterize the properties of surface of the organic acids and the organic-amine reactions using AFM, Raman, FTIR, and NMR spectroscopy.