

Maple Scholars Projects for Summer 2019

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#1

Music, the Brain, and Social Change

Maple Scholars Proposal for Summer 2018

Music and the Brain, Gathering the Data

Jose Rocha | Music Department

Description

Music education is extremely important, and for many years, educators have been relying on phrases like “music students are better learners” “music students score better in standardized tests” or “music students are smarter” when looking for validation for music study. Music has been linked to the development of skills such as discipline, organizational skills, the ability to keep engagement for longer periods of time, music is a social development tool, music is fun, and many other qualities. Often times, though, these statements lack proof or solid evidence of the validity of these claims, and we are forced to concede to the possibility that these skills could be learned doing sports or other organized type of activities.

Fortunately, neuroeducation and other emerging fields studying how the brain works have offered new evidence of specific benefits of music study--and more importantly, scientific data that supports the theory that the study of music has unique healing effects on the brain; benefits that reach far beyond good test scores and the development of positive self esteem. These new studies have found a very close connection between sound and brain health, and in the center of this research, scientists have found specific qualities unique to music that are replicable and that have an immensely positive impact not only on brain health, but in the realignment or healing of the brain and brain waves.

The most important find in these studies is the scientific recognition and scientific evidence that the formal study of music for a period longer than two years offsets and heals many of the effects of poverty in the brain of a child

I am proposing a Maple Scholar project where a student and myself would explore the current research and results of studies related to the effects of music in the brain with the long-term goal to create and organize a class that serves the Music for Social Change minor, and additionally could function as a stand-alone perspectives course.

The student will spend approximately the first half of the project gathering data and studying current research. The second half will be dedicated to organize the data and create a catalog that could be used to guide planning for the class. Additional issues may include exploring activities and studies that can be done in a class setting.

Background Expected This project is suitable for current sophomore, junior, or senior students interested in exploring music for social change topics.

Anticipated Results

The student will be collecting data from current research, selecting the most relevant studies to be shared with Goshen College students and the music for social change classe. Information will be shared during the weekly colloquia meetings. Once research and studies have been selected, a catalog will be created . Progress will also be shared at the weekly colloquia meetings. The completed catalog and proposed curriculum of study will be shared at the program finale activities.

#2

Artificial Lipid Bilayer

Maple Scholars Proposal for Summer 2019

Establishment and Optimization of a Protocol for the Artificial Expression and Electrophysiological Characterization of Ion Channels

Neil Detweiler, Biological Sciences

Description:

Ion channels are present in all types of living organisms from humans to bacteria. Ion channels open and close to control the passage of various ions such as sodium, potassium, calcium, or chloride. Ions flowing across the cell membrane can alter the electrical potential across the cell membrane, and can act as intracellular second messengers leading to activation of a variety of cellular functions such as muscle fiber contraction. One of the great things about ion channels is that their activity is relatively convenient to assess because it can be measured electrically!

Being able to generate ion channels artificially using a cell culture-based expression system and then study the electrophysiological properties of these channels at Goshen College would enable a broad range of student projects that would potentially be of interest not just to biology majors, but chemistry, physics, and pre-engineering majors as well. In the past, the lipid bilayer system at Goshen College was used to study amphotericin channels, which are purchased in powder form before being incorporated into the artificial membrane. To my knowledge, ion channels first raised in a cell culture system and then incorporated into the bilayer has not been done with this system, though it is done commonly by researchers at other institutions. This capability would allow for the expression of any ion channel (or transporter) for which the gene sequence is known, and therefore could be transfected into easily-cultured cells such as Chinese hamster ovary cells. Additionally, genetic mutants of ion channels of channels could be made in order to study the importance of particular parts of the channels.

The work required for this project would include culturing cells using the cell culture system in the biology department. These cells would be forced to express an ion channel of interest using a technique called transfection where the gene for an ion channel is incorporated in the cells so that the protein product of the gene is produced. Next, these channels would be transferred into the membrane of the artificial lipid bilayer system so that electrical activity of the channels could be measured. The ion channel of interest could be an ion channel that is important to pulmonary artery smooth muscle cells, which would tie this project to the yak pulmonary physiology project, or the student could propose to use another ion channel that they are interested in. Ideally, the channel would be a voltage-gated channel which would

make it easier to confirm that the currents being measured are really a really a results of the channel of interest.

Background expected:

This project would be best suited for a student who has a strong interest in physics and perhaps engineering as well as biology, but may have only completed one year of college. This could lead to additional future projects such as setting up a patch-clamp system which would favor a student who enjoys working with electronics.

Anticipated Results:

Establishing and refining the procedure for expression of an ion channel and subsequent incorporation into the lipid bilayer system is the primary goal. Results would include determination of what cell culture and transfection conditions result in the best expression of the ion channel as assessed by visualization of a co-expressed fluorescent reporter protein. In addition, if the channel is successfully incorporated in the lipid bilayer, ion currents through the channel would be measured electrically. Results from this project will hopefully be combined with other future results to produce a peer-reviewed scientific publication for the students who contributed.

Bovine Lung Physiology

Maple Scholars Proposal for Summer 2019

Comparative Physiology and Relative Susceptibility of Yak and Cattle Lungs to the Pathophysiological Effects of Low Oxygen Exposure**Neil Detweiler, Biological Sciences****Description:**

Yaks are a species of cattle in the same genus (*Bos*) as common domesticated cattle but evolved in the high altitudes of the Himalayas and the Tibetan plateau. While yaks readily tolerate the low-oxygen environment of high altitude, common cattle develop severe pulmonary (lung) hypertension. There has been little research into the molecular physiology of yak lungs. In humans and model organisms such as mice and rats, pulmonary arteries actively constrict when exposed to low oxygen, a phenomenon known as hypoxic pulmonary vasoconstriction. This is an important mechanism by which blood flow in the lungs is directed to regions that can most effectively provide oxygen. However, upon exposure to high altitude, which lowers the oxygen levels of the entirety of both lungs, this can lead to pathologically elevated pulmonary blood pressure.

Voltage-gated potassium (K_v) channels were the first of several types of ion channels to be discovered to play a role in hypoxic pulmonary vasoconstriction. These channels are expressed on the plasma membrane of pulmonary artery smooth muscle cells, where they normally exhibit a high degree of activity that contributes to the maintenance of the normally inside-negative electrical membrane potential of the cell. Exposure to low oxygen inhibits of these channels, leading to depolarization of the cell, and constriction of pulmonary arteries. More recently, several additional ion channels have been implicated in this response. Although pulmonary arteries from yaks have been shown to largely lack hypoxic pulmonary vasoconstriction, the types of ion channels expressed in yak pulmonary artery smooth muscle cells is not known.

The goal of this maple scholars project is to examine the mRNA and/or protein expression of 2-3 ion channels that have previously been implicated in hypoxic pulmonary vasoconstriction. Lung samples from yaks and cattle will be obtained from local butcher shops. Cattle make a convenient control for yaks; although they are dramatically more susceptible to pathological effects of low oxygen exposure, common cattle are from the same genus as yaks and share many other traits. Pulmonary arteries will be dissected from these lungs and cDNA and/or protein lysates will be prepared according to standard protocols. This will allow us to examine which ion channel genes are being expressed using polymerase chain reaction (PCR) or western blot.

This project is new and will require troubleshooting from the initial processing of lung tissue to the optimization of the experimental protocol for assessing gene expression, though some of the groundwork will be performed during the 2019 spring semester.

Background expected:

This project is best suited for a student who has completed their sophomore or junior years, and has a strong background in biology and chemistry. It is hoped that the project will provide experience that will strengthen the student's application to graduate schools in the biological sciences or health-related professional schools.

Anticipated Results:

The hypothesis is that the expression of ion channels known to play a role in hypoxic pulmonary vasoconstriction will be lower in pulmonary arteries from yak compared to those of cattle. Alternatively, it may be that yaks' express genetic variants of these channels that are not sensitive to hypoxia. Future studies may include closer examination of the properties of relevant ion channels using electrophysiological techniques such as patch-clamp or an artificial lipid bilayer system such as the one that already exists in the physics department. The intention is that this maple scholars project will lead to results that, when combined with other future results, will culminate in a peer-reviewed scientific publication authored by the students involved.

#4

Philipp Gollner, Department of History, Politics and Society

Maple Scholars Proposal, Summer 2019

Bonnets y la Biblia: A Religious-Ethnic Atlas of Elkhart County

Description:

The electric sign in front of the small but tidy one-story building of the Iglesia Sinai Pentecostes, on a state road connecting the city of Goshen to the area of Elkhart County to the city's East, advertises a Wednesday night prayer meeting in Spanish with blinking, neon letters. A row of three or four horse-drawn buggies rolls by this late Saturday afternoon – members of the nation's third largest Amish settlement on their way home from shopping. It's a brief meeting of two distinct immigrant religious worlds, a snapshot of Elkhart County's religious and ethnic diversity that seems startling only in theory: on factory floors, farmers markets and fairgrounds, Old Order Amish and Latinx Protestants work and live side by side. The two groups have more in common, however: against the backdrop of their religious cousins, mainline Mennonites and Latinx Catholics, they are hard to define. Where, for example, does Iglesia Sinai Pentecostes fit on the American denominational map? Are these Pentecostals? Are they affiliated with similar communities in the U.S., or elsewhere? And how do Elkhart County's supposedly "liberal" Old Order Amish fit within the myriad of other Anabaptist-derived groups in the county, from the messianic Jewish Christians with surnames like Troyer and Yoder at Mount Moriah Church west of town to the LGBTQ affirming Mennonites in the city of Goshen?

To begin mapping the religious and ethnic groups of Elkhart county - particularly its lesser known ones - and attempt to define and catalogue their origins, beliefs and affiliations is the goal of this project. It holds interest for Goshen College for at least two reasons: for one, quite simply, because all this diversity happens here, in our backyard, an area from which many of our students hail. And what is written and researched on the religious history of Elkhart County so far remains denominational history, largely Mennonite, with little connection to the county's wider religious landscape and its newer and more recent immigrant storylines. In addition, such a project is relevant because it places Goshen, and the county we live in, in the context of a broader conversation on ethnicity, race and religion in America. Colleagues in the field are regularly intrigued when I describe to them a county at once home to one of the highest percentages of Latinx inhabitants in the Midwest as well as to a large and diverse Anabaptist population. Throw in the mix of Ukrainian, Russian, Irish or German immigrants, and Elkhart County appears peculiarly relevant to various vibrant currents in American scholarship on religion and migration. It was studies of European immigrant religious groups in the Midwest that began the "ethnoreligious turn" in American history six decades ago when the University of Minnesota's Oscar Handlin famously quipped that "once I thought to write a history of the immigrants in America. Then I discovered that the immigrants *were* American history." In recent years, the eyes of immigration scholars have turned again to the

American heartland, spurred most recently by the country's political realignments and the stunning growth of the Midwest's Latinx population and religious diversity.

It is far from myopic to assume that Elkhart County, with its historic and present diversity, holds at least a few case studies that relate to newer interdisciplinary scholarship such as the pathbreaking *Latino/a Midwest Reader* recently edited by scholars at the University of New Mexico, or an ongoing project to outline Latinx Catholic diversity in the Midwest at the University of Iowa. I hope that such a conversation might begin from the interviews and research I propose for this Maple Scholars project, and benefit students at Goshen College as well as scholars in other institutions.

Background expected:

The student should be a major in History or Religion. Ideally, he/she would already have had significant intercultural experience through their time at Goshen College. Ability to read Spanish is a definite plus. More than anything, the student should have a warm personality that will facilitate good contacts with various religious groups not used to scholarly attention, be conscientious, self-disciplined, detail-oriented and curious. Eventually, I aim for the information collected to be accessible on an easy-to use digital platform – if Maple Scholars is in the position to offer an additional student skilled in programming such a platform, I would be grateful. In any case, this might be an internship for a Computer Science major in the nearer future.

Anticipated Results:

I hope to outline roughly 50 religious groups or congregations by the way of research in primary source materials available and/or oral interviews. This information would be compiled in a standardized format (i.e., year and context of founding, affiliation, immigration history or history of schisms). Ideally, we would be able to suggest a few lines of further research or storylines to pursue in the format of student papers or conference papers for researchers.

Game Theory

Maple Scholars Proposal for Summer 2019

Game Theoretic Models of Power, Cooperation, and Resource Allocation **David Housman, Mathematics**

Description:

The first veto by a United States President was against a bill apportioning congressional representatives to states. The United Nations Security Council passes measures by simple majority but five permanent members can veto any measure. Some European parliaments have representatives assigned based on votes for a political party. Some New York State county councils have members with weighted votes because they represent different numbers of constituents. How can voting power be defined and distributed fairly in these types of situations? After each decennial census, states must create districts of roughly equal population sizes for each representative. How can states avoid political gerrymandering of district boundaries?

Under what circumstances will self-interested individuals cooperate with other self-interested individuals? This is a central question underlying attempts by scholars to understand how cooperative behavior has evolved in humans and other organisms. One model that has been extensively studied has been repeated play of the two-player Prisoners' Dilemma game. How can this work be extended to other situations and more players?

By collaborating, several cities can save money on upgrading their water treatment facilities. What is a fair way of allocating the savings? Several people have inherited an estate, but they differ in their opinions about the worth of each item in the estate. What is a fair way of allocating the estate? Different sportswriters have different rankings for college football teams. What is a fair way of melding these different opinions into a single ranking? In these situations, do the agents involved have incentives for stating their true costs, valuations, or rankings?

Game theory is the mathematical study of situations of conflict and/or cooperation. In this research, students develop a mathematical model of a situation, define fairness properties or rules of engagement, suggest solution concepts, determine solutions for their specific situation, and/or provide appropriate interpretations. Students may extend, modify, or rely on previous work done by students or results found in the mathematics, economics, biology, and political science literature, or students may begin with a totally new situation, model, properties, rules, or methods.

Background Expected:

A student participant should have the ability to read, critique, and write mathematical proofs. For some research areas, the student participant should have the ability to write computer

programs to explore possibilities. Knowledge of an application area of interest would be beneficial.

My expectations for students: Mathematics involves a mixture of divergent and convergent thinking. Some of the most important ideas occur while taking a shower or hiking through the woods. So, I am fairly flexible about when and where students work; however, I do expect full-time effort: 40-plus hours per week and no major time commitments to other activities. If possible, I expect students to participate in one or more professional meetings where they can present their results.

Anticipated Results:

The primary goal is the development of the student's ability to undertake mathematical research and communicate their results to others. Students are expected to write a project report, offered opportunities to present their work at conferences, and offered the opportunity to turn their project report into a paper that could be submitted for publication.

Additional Information:

I have mentored over seventy undergraduate students in summer and/or academic year research (see list at http://www2.goshen.edu/~dhousman/ugresearch/ugresearch_complete.htm). Gina Richard, a Maple Scholar in 2008, won an award at Math Fest, the national summer meeting of the Mathematical Association of America, for a presentation of her research. Seth Unruh, a Maple Scholar in 2009, published "Envy-Free Divisions" in the *Rose-Hulman Undergraduate Math Journal*, Vol. 10, Issue 2, 2009, which can be accessed at <http://www.rose-hulman.edu/mathjournal/>. Several of my students have been selected by their peers to be the public presenters during the Maple Scholars Celebration.

The summer of 2017 was an ideal version of what can happen during the Maple Scholars program. Christian Bechler and Kenan Bitikofer found a draft paper written in 2016 which claimed to have solved a long-standing problem in "cake cutting." Aziz and Mackenzie claimed to have devised an algorithm that used a bounded number of steps to ensure that any number of people share a cake in an envy free manner. Christian and Kenan implemented and tested parts of the Aziz and Mackenzie algorithm. What appeared at first to be bugs in their code turned out to be a flaw in the algorithm and proof provided by Aziz and Mackenzie. Christian and Kenan finished the summer by constructing a five person example in which the Aziz and Mackenzie algorithm would stop before completion. Upon receipt of the Bechler and Bitikofer paper, Aziz and Mackenzie responded with a revised paper they claim addresses the difficulty.

In the summer of 2018, Nick Schrock considered ways to measure voting power when the ideological positions of the voters are known, and he applied his work to the United States Senate. If ideological positions are not considered, then each Senator has exactly the same voting power, but if ideological positions are taken into account, then the Senators in a central ideological position have the most power to change an outcome. Nick defined ways of quantifying this voting power and how to place voters in ideological positions based upon their previous voting records.

The Impact of Anabaptist Teacher Preparation on Beginning Teachers' Practice

Suzanne Ehst, Education Department

Description: In the United States, nationally accredited Teacher Education departments are now required to track the impact of their program beyond their students' graduation, measuring the success of program completers in their first few years of teaching. The metrics preferred by our accrediting body prioritize quantitative data, specifically the standardized test scores of our graduates' students. We see this use of test scores as an incomplete measure of the quality of any teacher education program and plan to complement this data with a qualitative study that will be carried out within the Maple Scholars structure.

This study will seek to first define what is distinctive about Anabaptist teacher education in a liberal arts context. My student researcher and I will conduct a literature review that helps us identify traits of Goshen College's program that are distinctive and that describe the value of a liberal arts education. We will then create an interview protocol to be carried out with six teachers in their first through third year of teaching, three elementary and three secondary educators. We will transcribe each of these six interviews and will code them for both predetermined and emergent themes. After analyzing the qualitative data, we will write a report that will become part of the education department's accreditation data, and we may also write an article for the AILACTE Journal (Association of Independent Liberal Arts Colleges of Teacher Education).

Background expected: Students applying for this project should be elementary or secondary education majors. They should have completed at least one class that requires a schools-based field placement, and preference will be given to those who have completed student teaching. No background is necessary in qualitative research methods, but the applicant should demonstrate strong writing and analysis skills, as well as the ability to work both independently and collaboratively.

Anticipated Results: As noted above, the research will result in a report that is an essential part of the Goshen College Education department's accreditation process. Depending on the results of the study, we may also submit an article to the peer-reviewed AILACTE Journal for consideration.

Agreement with Mentor Responsibilities I agree with the mentor responsibilities. There is one week in June when I will be gone for a pre-planned family vacation. However, I will continue to connect with my Maple Scholar through emails and Facetime through that week, and there will likely be several tasks that s/he can complete independently during the week that I'm away.

The last time I did a Maple Scholars project, I employed a “gradual release of responsibility” model in my mentoring. Toward the beginning of the project, I was fairly directive and instructional, telling my student what to read and explaining some of the key facets of qualitative research design. I also controlled the concept of the project as we began. As we moved through the eight weeks, I gradually put more responsibility on the student not only for doing work but for doing analysis and owning the project conceptually. By the end of the summer, my student was able to articulate all components of the project--our literature review, methodology, and findings--with a sense of authority. Because this is also a qualitative research project that utilizes a case study method with interviews, I imagine a similar approach to mentorship again this year.

With regard to hours and expectations, I would expect a student to work full time on this project, but with that fluctuating some each week depending on where we are in the research process. The student would help me co-construct the interview protocol, transcribe interviews, code interviews, and write and edit the results.

International Students and SST

Maple Scholars Proposal for Summer 2018

International Students and SST**Jan Bender Shetler, Department of History****Description:**

The 50th Anniversary of SST gives the Goshen College community the opportunity to both celebrate the program as well as to evaluate and look toward the future. Last year I worked with Jose Ortiz and Landon Weldy on a very successful Maple Scholars project to interview Latino students about their SST experience. Jose and Landon have produced an important paper and presented at Homecoming this year. I would like to do a similar project this coming summer with International Students. In the past International Students were not required to do SST because they are already in a cross cultural learning situation. But some years ago that changed and now most of them do SST-Alt. I would like to explore with them what kind of alternatives might be useful for them and how they benefit from the current program, whether they do SST or SST-Alt. Clearly the SST program, as well as the on-campus alternative, has to better meet the particular needs of International students. But we do not know what that is yet. The first step in that evaluation process is to interview to a variety of current and recent International students and alums about their experience with the program and their thoughts about what would be useful to them. Why did they choose to go or not, what was their SST or SST-Alt experience like, how was it different from US students, how has it benefited or affected them after? Student and faculty together will design the interview questions, identify students and carry out the interviews. They will be able to draw on the model created by Jose and Landon last year. Interviews will be transcribed and coded for qualitative analysis. From these interviews we hope to build a set of observations and perhaps recommendations for the GC community.

Background expected:

The student should have some background in the Social Sciences and/or Humanities (History, PJCS, BRP, Sociology, Psychology, English) and preferably in qualitative research methods, but this can be taught. Ideally the student would be an International Student and with experience on SST. But more than anything the student should have a warm personality that will facilitate good interviews, be conscientious, self-disciplined, detail-oriented and curious.

Anticipated Results:

I hope to complete at least 25 interviews, as well as have most of the them transcribed and coded by the end of the session. We would be able to produce at least some preliminary observations and recommendations, if not a full paper as did the pair last summer.

Maple Scholars Proposal for Summer 2019**A Popular History of the Indonesian Mennonite Churches****John D. Roth / History Department**

Description: In collaboration with an Indonesian partner, Paulus Widjaja, I am planning to write a relatively short (ca. 120 page), illustrated, popular history of the Indonesian Mennonite Churches (three conferences – *Gereja Injili di Tanah Jawa / Persatuan Gereja-Gereja Kristen Muria Indonesia / Jemaat Kristen Indonesia*), that will serve the interests of North American Mennonites who plan to attend the 17th Mennonite World Conference assembly in Samarang, Indonesia in the summer of 2021. For many outsiders, the three synods that make up the Mennonite church in Indonesia—GITJ, GKMI and JKI—seem like an intimidating welter of acronyms. But their history, individually and collectively, is a beautiful microcosm of the global Anabaptist church. The MWC Assembly in 2021 will offer participants a fascinating window into the various ways that Anabaptism has taken root in Indonesia. The Maple Scholar will assist in the research, outlines, and possibly even the initial draft of the volume. The Maple Scholar will create timelines, help to organize photographs, and, depending on skills and interest, possibly help to envision layout and design.

Background expected: Some familiarity with basic Anabaptist-Mennonite history, and with the global Anabaptist-Mennonite church. A demonstrated ability to conduct research, to work somewhat independently, and to write clearly. Ideally, the student would be Indonesian, though this is not an absolutely firm requirement.

Anticipated Results: A book (ca. 120 pages) that communicates clearly the history and contemporary identity of the various Indonesian Mennonite Churches for a popular readership. The timeline for the project is as follows:

Summer, 2019: Work with Maple Scholar on basic research; 8-day research / photography trip to Indonesia focusing on the GKMI church; 5-day research trip to California focusing on JKI church; draft outline

December, 2019: draft Introduction, GKMI chapter; gather photographs/captions

Summer, 2020: Work with Maple Scholar on book design/layout; 8 day research / photography trip to Indonesia focusing on the GITJ and JKI church; draft chapters on GITJ and JKI churches

Fall, 2020: basic draft of the book completed and sent out to readers

March, 2021: publication deadline

Spring, 2021: marketing and distribution in time for the MWC Assembly 17 (Samarang, Indonesia)

#9

enACTing Support

Maple Scholars Proposal for Summer 2018

Using Immersive Theatrical Methods to Train Sexual Misconduct Response Team Members

Anna Kurtz Kuk and Phil Weaver-Stoesz - Theater Department

Description

This project will develop a 20-minute immersive theatrical piece that will help contextualize sexual violence for members of Goshen College's Sexual Misconduct Support Team as well as provide experiential training in providing support for students disclosing experiences of sexual misconduct. The content for the show will be gathered through interviews and group conversations with people who work to support and prevent sexual misconduct, as well as those who have experienced it.

The student working on this project will act as a collaborative creator, facilitator, and producer of the theatrical work. This is a new project that is in partnership with sexual violence prevention faculty.

Tasks will include:

- Interviewing pertinent campus and public sources, including Sexual Misconduct Response Team members, student advocates, professionals in the field of Health and Wellness and survivors of sexual violence who consent to share their story.
- Writing and developing monologues, dialogues, and theatrical scenes from the interviews gathered - in collaboration with faculty members in theatre and sexual violence prevention.
- Collaborating with performers and designers to create an interactive theatre piece.
- Rehearsing, testing interactions, and actively receiving feedback on our work.

Background expected

Students who apply should have experience in theatrical and creative contexts, which may include writing, performing, interviewing, facilitating, directing, and designing. If the student doesn't have experience with one or more aspects of the process - they should be ready to get excited about doing things for the first time.

Anticipated Results

We anticipate to, by the end of the process, have a 20-minute script, which we will rehearse, test, and present a "first-draft" performance to the public and members of Goshen College Faculty. Ideally, this creative work will be used annually to both contextualize and teach incoming faculty and students about realities of sexual misconduct, strategies for support, and tools for ensuring safety, health, and joy in the relational and sexual context of Goshen College.

#10

Maple Scholars Faculty Proposal (Summer 2019)

Short title: **Mosquito Genetics/Queen Bee Genomics**

Full title: **Investigation of Mosquito Population Dynamics and Genetics in Northern Indiana/Honey Bee Queen Rearing and Genomic Analysis**

Dr. Andrew Ammons, Department of Biological Sciences

The following two projects are both open for new students for summer research in 2019. Upon approval, one student may be chosen for each project. **In the event there is only available funding for one student, the applicant will choose which project to engage in:**

Mosquito Genetics Description:

The spread of human illnesses, particularly those caused by viruses, by mosquito species vectors has been a bane of human society for thousands of years. The study of mosquitoes, virus transmission, and how mosquitoes detect their human hosts can help alleviate this suffering (Spielman and D'Antonio, 2001). This mosquito project will continue work done over the last two years by previous GC students in Elkhart and Noble Counties to understand local mosquito population dynamics and mosquito genetics.

PCR (polymerase chain reaction) is an effective and vital molecular genetic tool for identifying and manipulating DNA and RNA. Through the use of sequence-specific oligonucleotide primers, we can accomplish precise targeting and amplification of genomic regions. These techniques can aid in the identification of viruses, bacteria, filarial worms, and protozoan parasites carried by mosquito vectors. In fact, recent RT-PCR experiments have successfully isolated and identified the emerging infectious flavivirus, Zika, in wild, field-caught mosquito samples collected from around the world (Faye *et al.*, 2013)

For this project, the student will be expected to participate in the laboratory elements of mosquito research – setting up mosquito traps and collecting samples, rearing mosquitoes in the lab, extracting and manipulating DNA/RNA from frozen samples, and performing PCR and electrophoresis. In addition, the Maple Scholar will learn primer design and how to access and utilize online genomic databases. Other skills to be practiced might include sampling mosquito blood meals, extracting and analyzing proteins, quantification of DNA and RNA (using NanoDrop technology), microsurgery of mosquito organs (salivary glands, etc.), compound and dissecting microscopy, and dichotomous key identification of mosquito samples to species.

Queen Bee Rearing and Genomics Description:

The management of honey bee hives is an agricultural practice that has its origins in the very beginnings of human civilization – the ancient Egyptian, Assyrian, Olmec, and Incan civilizations were the first humans to practice apiculture (beekeeping) thousands of years ago. Now, honey bee management in the US involves the annual production of hundreds of thousands of honey bee queens (for some queens – artificial insemination to control genetic lines), and for others, natural mating and sale in the package bee industry (Buchmann and Nabhan, 1996).

The sale of “packaged” bees with a queen every spring is vital to honey bee management in this country, and often the foundation for the profitable success of honey producers and commercial beekeepers. In fact, package bee sales to hobbyist beekeepers now accounts for higher profits among most commercial beekeepers than sales of honey and beeswax.

As part of continued honey bee queen rearing workshops attended at Purdue University over the last summer (2018), this project would involve developing a small, queen-rearing set up (with associated equipment) here at Goshen College. The Maple Scholar would assist in the attempt to successfully rear honey bee queens in our apiary using various methods, and then use genomic tools such as DNA extraction, PCR, and electrophoresis to analyze and compare gene expression between sister queens reared in our apiary. This project would help us to characterize the background genetics of hives in our apiary, and understand the population dynamics of these colonies. The relatedness of our queens to each other (and approximate levels of inbreeding or hybrid vigor) can be determined and used in annual honey bee management.

For this project, the student will be expected to participate in the laboratory elements of genomics research, as well as become adept at honey bee hive inspection, management, and queen rearing in the apiary. In addition, the Maple Scholar will learn primer design and how to access and utilize online genomic databases. Other skills to be practiced might include sampling DNA from queen bees and drones, quantification of DNA and RNA (using NanoDrop technology), larval grafting and queen rearing, compound and dissecting microscopy, and assisting with trips to Purdue University to practice queen rearing techniques and transporting live queens.

Student and Investigator Expectations:

Student enthusiasm, self-motivation, independence as a researcher, and commitment to the project are a major factor in selecting Maple Scholar finalists.

The principal investigator’s hopes and goals for the summer would be to have a student engage in active research, design their own experiments with guidance, and learn how to present research in a professional format.

Student applicants would be aided by some biology or science background (appropriate for first or second year Biology majors), but this is not necessary for applying. Attendance at informal journal clubs will be necessary for the student to train in the interpretation of scientific publications.

The anticipated results from summer research for the participant would be the completion of an independent research project. This project would be suitable for presentation at local or national scientific conferences. All scholars are also asked to write a research paper using the guidelines of the National Conference on Undergraduate Research. Student research may also contribute to eventual scientific publication, in which case the student would be listed as a co-author.

The principal investigator agrees to all mentor responsibilities as listed in the faculty guidelines. Appropriate supervision, support, and encouragement for the student will nurture a one-on-one mentoring relationship. Any students will be treated as colleagues in the discovery of knowledge. The advisor will be available to guide, discuss issues, and train in the use of techniques, but will also try to allow the student to develop as an independent researcher designing their own project. Expectations for student scholars

include working full 8-hour days (and some weekends) for the duration of the project, being receptive to guidance offered by the advisor, and being passionate about doing science.

References

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#11

Air Quality

Maple Scholars Proposal for Summer 2019

TRAQR Traveling Air Quality Recorder

John Buschert, Physics Department

Description:

Air quality in Elkhart County has been of some concern due to the presence of major industries and pollution sources upwind and also many smaller local manufacturing facilities. The EPA measures air quality fixed sites all over the country but in Elkhart County there are just two.

In 2017 we worked on developing a device based on a Raspberry Pi that can measure air quality and record it. Outfitted with sensors for various pollutants, temperature and humidity, in addition to a clock and GPS, it is designed to log data about the air quality anywhere it is taken. Then it connects via Wi-Fi to upload its data to a website. The plan is to make this into a more robust device and produce many of them. Mounted on people's cars we will collect data and start to map the air quality of the county.

This year's project will include:

1. Device. We will complete the design testing and construction of several devices. The prototype has demonstrated nearly all of the basic features. Some more work is still needed so that it properly responds to the car turning on and off by entering a kind of sleep mode. The prototype is on a temporary breadboard and needs to be built in more rugged fashion on a circuit board. Further improvements could include some type of live indicator to the driver of the current air quality such as tones or lights.
2. Web page. The web page for displaying the data in map form is working but could be improved in several ways.
3. Calibrating. The sensors will need to be calibrated in some fashion by exposing them to known concentrations of pollutants.
4. Testing. We will make several TRAQR devices and try them out in various vehicles in all kinds of weather and with different Wi-Fi systems.
5. Data collection. Once we have useable devices we will give them to people who live in various parts of the county and drive regularly. We'll need to keep them all in working order and watch the data as it comes in to see what patterns emerge.
6. Connections. We will try to identify others interested in our data and those with expertise to help us understand and interpret the data. As a start we will contact local, state and federal government agencies with responsibilities for air quality and monitoring.
7. Confronting. If we identify local sources of unhealthy levels of emissions, we may contact them to share what we have found and try to help them find ways to reduce the emissions.

Students will participate in all aspects of planning, designing, building, testing, collecting data, managing the system, modeling, as well as searching for others' data and contacting other parties about our data.

Background expected:

Students with a variety of backgrounds will be considered but applicants should have taken General Physics and have some computer programming experience. Electronics experience would be very helpful and chemistry might be of some use.

Anticipated Results:

The aim is to build several such devices and test them by the end of the Maple Scholars program. The student(s) will be fully involved in the design construction and testing of the devices as well as all the other areas outlined above.

#12

Maple Scholars Proposal for Summer 2019

Precipitation fluctuations and crop impacts

Paul Meyer Reimer, Physics Department

Description:

A host of satellites are observing Earth in ever increasing detail at the same time as humanity's impacts on our home planet are reaching unprecedented levels.

My research group has been mapping groundwater using NASA – GRACE satellites, and more recently collaborating on a research project into the effects of mycotoxins on infant stunting, with colleagues in Tanzania and the U.S. Students at Goshen College have accumulated expertise in acquiring, processing, and analyzing GRACE and other satellite data over more than three years.

Mycotoxins are produced by a variety of fungi naturally present in the soil. Proven risk factors for high levels of mycotoxins include crop stress and excessive moisture in stored grain and groundnut. Crops can become stressed by a lack of water at key times in plant development. Moisture at harvest time can be carried on into the stored crop.

The Tropical Rainfall Measurement Mission (TRMM) comprised a set of satellites using radar to measure real time precipitation events for 17 years, starting in 1997. Shortly before TRMM came to an end, NASA launched the Global Precipitation Measurement (GPM) mission to follow up on TRMM's success and improve the technology. Both missions have and will provide public access to near real-time precipitation data.

Research goals and anticipated results:

The focus of the project this summer (2019) will be to use the TRMM and GPM data to study the relationship between precipitation and crop stress. We hope to look beyond average rainfall, to consider fluctuations in rainfall and interaction with other factors such as soil type, elevation, and aspect (tilt). Through our collaboration on the mycotoxin project, we hope to have access to spatial information on mycotoxin prevalence in the Kongwa district of Tanzania over the course of several years, and collaborators on the ground in Kongwa. This will hopefully allow us to analyze the relationship between spatial and temporal rainfall fluctuations and mycotoxin risk.

The student researcher will use GIS (Geographical Information System) software, and scripts that he/she writes to acquire and analyze rainfall data. Working with others, we hope to correlate this with visual indications of crop health (a variety of satellite spectroscopic “vegetative indices”) and the mycotoxin data that we will have access to.

Background expected:

The student will be expected to do a good deal of programming. Any experience in programming would be helpful, though a programming class is not required.