



UNIVERSITY OF GUAM
COLLEGE OF NATURAL
& APPLIED SCIENCES



Deep Dive Into
CNAS

“ All the GREAT things you
are looking for, start within
yourself.

- Anonymous

Lee S. Yudin
University of Guam Dean/Director
College of Natural & Applied Sciences



Buenas yan Hafa Adai!

Over the many years that I have been the dean and director of the College of Natural and Applied Sciences, at the University of Guam, we have put a great amount of emphasis in highlighting impact reports that center around faculty research and community outreach projects. It has been a goal of mine to showcase how faculty-student relationships not only demonstrate a better understanding of science but how important it is to enrich the lives of our students when working with their faculty mentors. This year we have finally put out such a report that highlights these interactions and it's entitled "Deep Dive into CNAS." I want to thank each of the students and faculty members who help create this report and to the wonderful media team for their creative production. I am hoping that this becomes an annual report as we highlight these great relationships.

We are a very unique college and we all take pride in our primary stakeholders our STEM students. As you read through our report, you will see that our students have presented many of these research studies at national conferences. Naomi Borg, presented her research at the 2018 SACNAS national diversity STEM conference. Jaried Calaor, presented his work at the 18th International Bat conference in Phuket, Thailand. Lauren Duenas, talks about her work with Guam rails and Ahmyia Cacapit had the opportunity to study in Costa Rica, under the

NSF REU/NAPIRE program. Francisco Villagomez, of our MS in Biology, used otoliths to help fill the gaps in the literature around the crimson snapper. Undergraduate, Bea Daria, a LSAMP intern, studied native tree snails on Guam. Brandon Datuin, a student scholar in the BUILD EXITO research mentorship program, is already in a doctorate program in chemistry in the U.S. One of the most recent ROTC graduates, Lucand Camacho, majoring in our computer science program, talks about using his degree in the US Army. Both, Jianna Soriano and Anthony Noni Cruz, have been inspired in the tropical agriculture program in CNAS. As a native CHamoru, Leilani Sablan, wants to have a better understanding of Guam's marine ecology. Remedios Perez, is exploring community gardens to help build a healthier lifestyle on Guam. The graduate students from Asia, working at our Guam Aquaculture Development and Training Center, are a great example of our college's connection with our Asian neighbors. Finally, the University of Guam's youth scholar research experience in mathematics (YSREM) and NRUEP, are prime examples of faculty grants that are benefiting a large number of our current math majors.

We are proud, we are CNAS and please enjoy learning more about these dedicated students and their faculty mentors.

Buenas yan Hafa Adai!

Our College of Natural & Applied Sciences (CNAS) is unique for many reasons. Two of those reasons are highlighted in this Impact Report—"A Deep Dive Into CNAS." First, although the land-grant mission was solely based in agriculture—our college embraces a diverse suite of undergraduate programs in Agriculture, Biology, Chemistry, Computer Science, and Mathematics, as well as Military Science (ROTC) as a minor. This framework is much broader than many of our sister universities on the US mainland. Second, although our MS programs in Biology, Environmental Science, and Sustainable Agriculture, Food, & Natural Resources are growing—historically our greatest educational focus has been on our undergraduate programs. Over the last few years, these undergraduate programs have shifted their emphasis from older models of classroom instruction to increased

experiential learning. An increasing number of our students are actively engaged in original, publishable research with their UOG faculty. In addition, our students successfully compete for and complete research in labs and programs away from the island of Guam. While only a few of our students are highlighted here, there are many more with equally interesting research stories. I might suggest that readers take note of these students—not only for what they are currently achieving, but also for what these students will continue to contribute to the communities in which they live. They have discovered the thrill (and hard work) of scientific research, the importance of continuing to learn, and the value of preparing for the future through contribution to their communities.



**“ Education is our passport
to the future, for tomorrow
belongs to the people who
prepare for it today.**

- Malcolm X

Kate Moots

University of Guam Associate Dean
College of Natural & Applied Sciences

WHO ARE WE?

The College of Natural & Applied Sciences (CNAS) was founded in 2003 by consolidating the former College of Agriculture and Life Sciences with the Mathematical Sciences, Natural Sciences, and Pre-professional programs of the former College of Arts and Sciences. CNAS offers courses in agriculture, natural, applied, consumer, and military sciences as part of our federal land-grant mandate.

OUR MISSION

Our mission is to discover and share science-based knowledge that improves quality of life and learning in Guam and the Western Pacific.







“ Before becoming a CNAS major I had no idea what I wanted to do with my life. Now, however, after graduating through the CNAS Biology program, I have so many opportunities to choose from. The amazing faculty and staff at CNAS have helped to prepare me for a future in science through their hard work and dedication.

Natasha Haggans
BS Biology
University of Guam 2019 Valedictorian

UNDERGRADUATE PROGRAMS

Agriculture and Life Sciences

- Agriculture and Natural Resource Science
- Tropical Agriculture Production
- Human Nutrition and Food Sciences
- Child and Family Life Sciences

Biology

- Integrative Biology
- Bio-Med
- Applied Biology

Chemistry

- Chemistry
- Chemistry Pre-Pharmacy
- Chemistry-Biology Dual Degree
- Chemistry Teaching

Computer Science

Mathematics

GRADUATE PROGRAMS

Biology

Environmental Science

Sustainable Agriculture, Food, and Natural Resources

MINORS

Biology

Chemistry

Computer Science

Crop and Environmental Protection Science

Farm and Natural Resources Management

Food Science

Mathematics

Military Science and Leadership

Nutrition

Tropical Horticulture

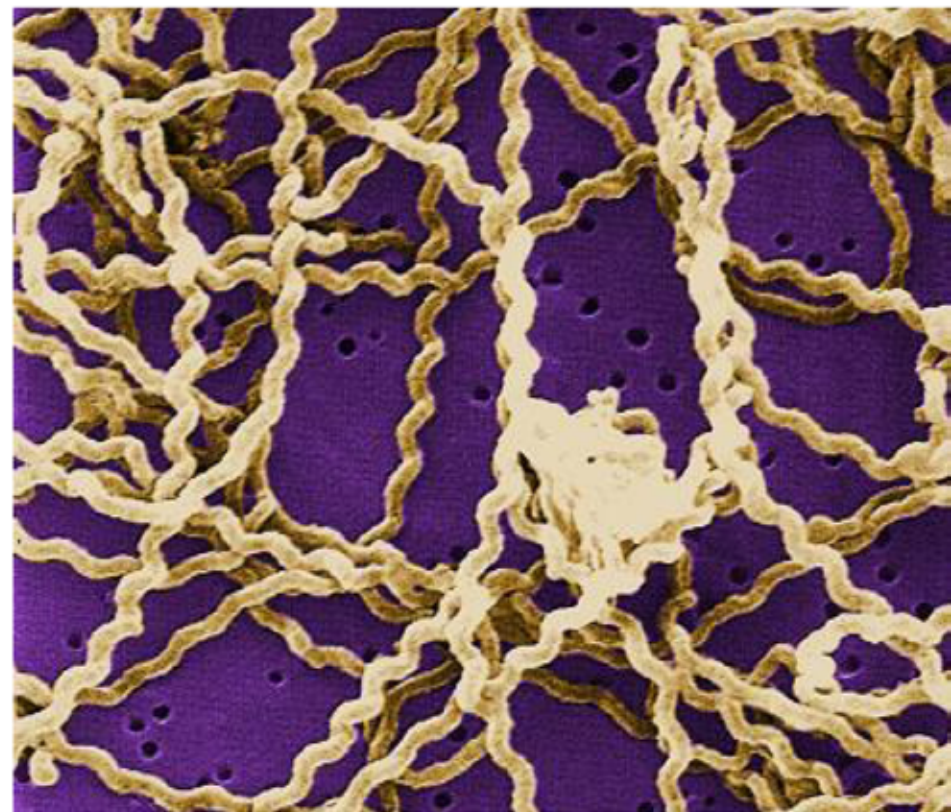
NATURAL SCIENCES GO WILD

The faculty team of the Division of Natural Sciences has been making changes to accommodate student needs and it is paying off in student successes.

“We are a very committed teaching team and have rearranged courses to fit in more strategically for students. It has resulted in an increase in student collaboration,” said Division Chair Dan Lindstrom.

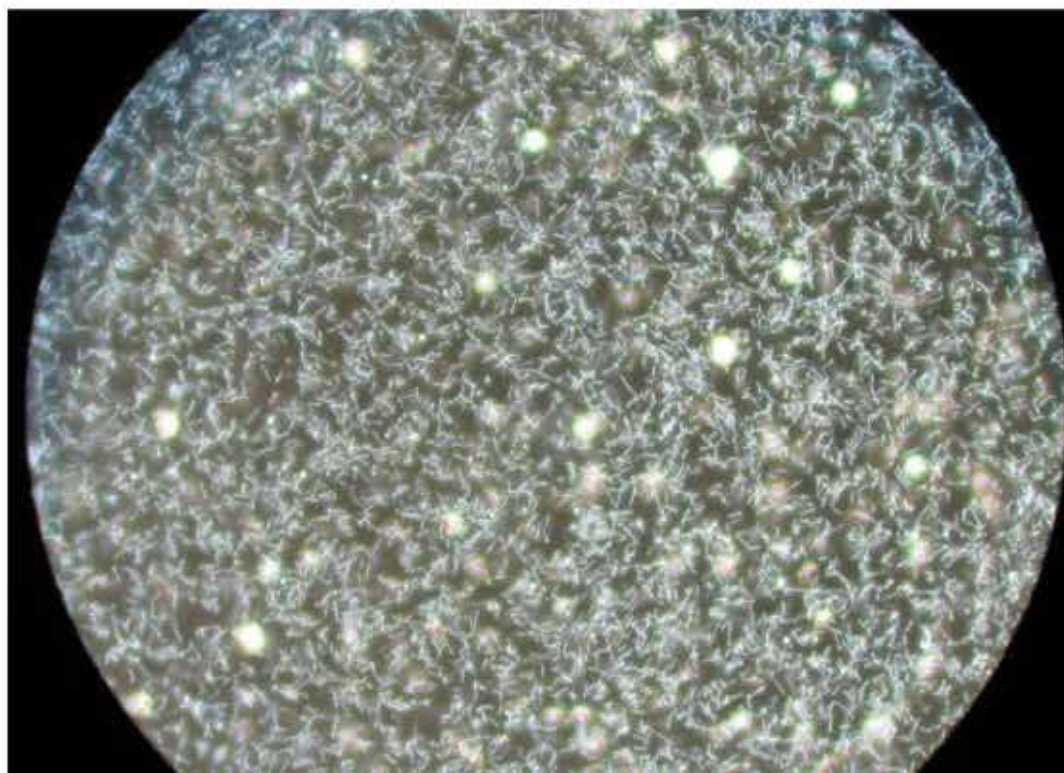
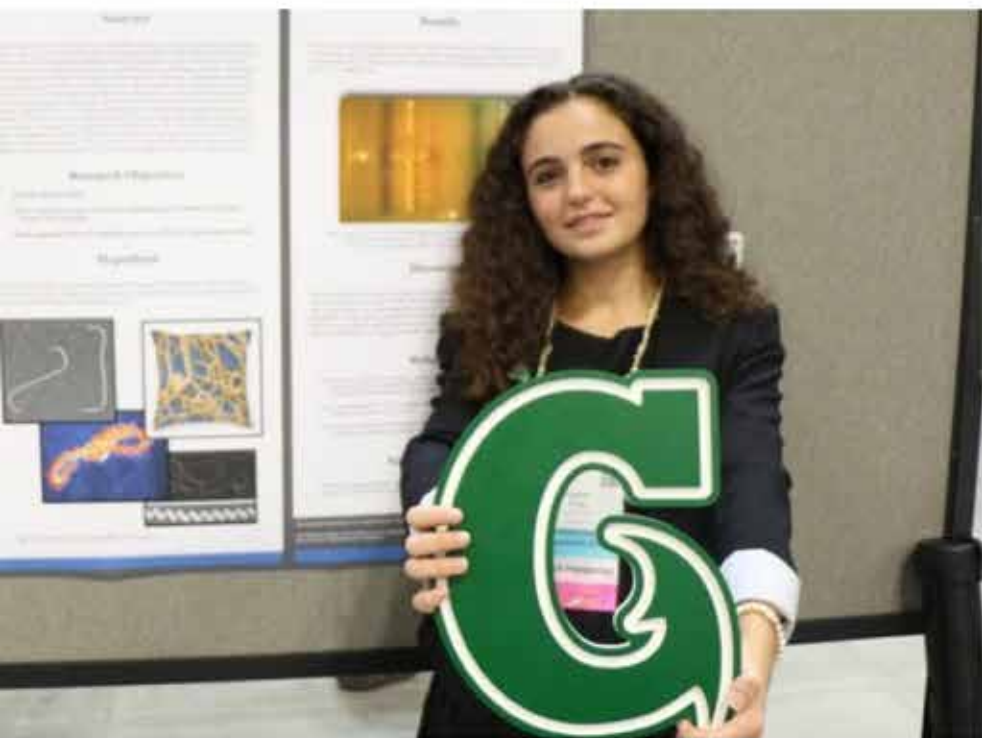
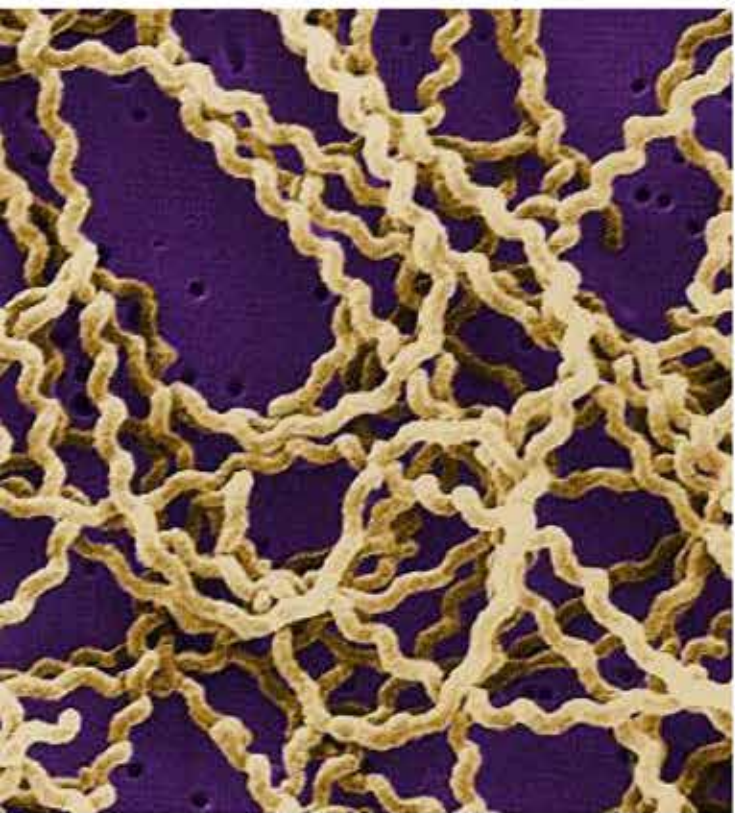
He would know, as his office is just off the entrance lobby to the Science Building where students meet to study together and talk about what is happening in their lives.

Graduate students and undergrads are conducting interesting and pertinent research in and outside the classroom. In her lab class with Lindstrom, Naomi Borg pitched the idea of studying the prevalence of the bacterial disease, leptospirosis, found in streams around the island. Lindstrom and Borg developed a highly sensitive genetic assay for leptospirosis; then took samples of Guam’s rivers and ocean outfall areas after major rain events. Using Lindstrom’s PCR machine they were able to get a picture of lepto-dynamics on the island. Borg presented this research at the 2018 SACNAS National Diversity in STEM Conference.



Clockwise from top: Magnified images of leptospirosis bacteria. Jeried Calaor at CNAS hooding ceremony with Dean Lee Yudin and Associate Dean Kate Moots. Naomi Borg presents research on the bacterial disease leptospirosis.







Jeried Calaor, one of Lindstrom's graduate students, presented his research on local fruit bats and their role in seed dispersal in native forests of Guam at the 18th International Bat Conference held in Phuket, Thailand. Calaor studied how well the fruit bats, known locally as fanihi, dispersed the seeds from a native fig tree *Ficus prolixa*.

Calaor fed four bats living at the Guam Zoo fruit from the trees and then collected seeds that either passed through their digestive systems or were ejected from their mouths after chewing them. He then planted each to compare germination success rates. After a month, he found that "ejecta" seeds had greater germination rates than those found in the bat droppings. Ejecta seeds are typically left behind near the parent tree, while seeds from the bat's droppings end up further away – which is more beneficial since it helps ensure growth elsewhere. "Despite the lower germination rates, the study suggests there is still dispersal occurring across longer distances, which reaffirms the bats important role and supports the need to restore and better protect them and their habitats," enthused Calaor.



Photo of a Mariana fruit bat
courtesy of the Guam National
Wildlife Refuge.



Photo of Guam rail (ko'ko' bird) at the Guam Department of Agriculture.

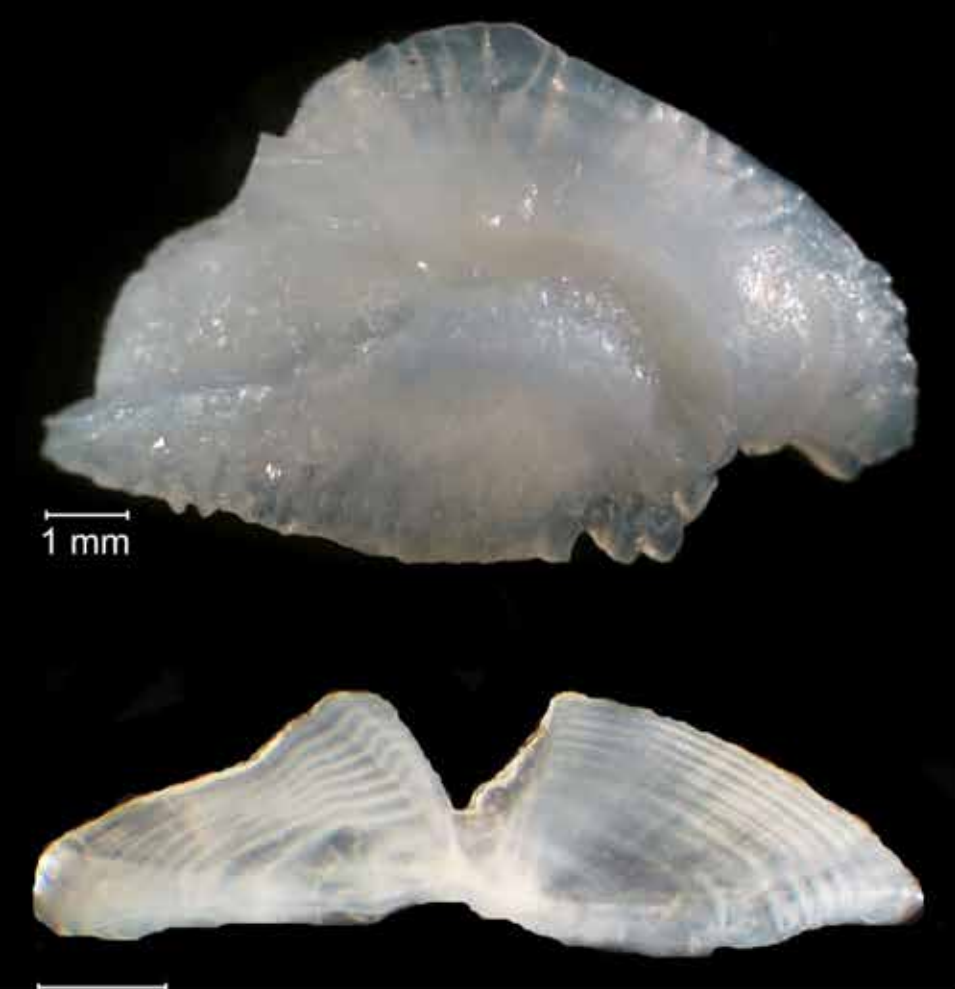
The once ubiquitous Guam Rail (Ko'ko' bird) caught the attention of Lauren Duenas, another of Lindstrom's graduate students. In order to look at population genetics of these critically endangered birds, she took blood samples from individual birds captive on Guam and in zoos and was also able to obtain samples from all individuals of this species for the last 20 years. Once completed, her research will inform breeding practices as scientists attempt to propagate and reintroduce this species in Guam. "It is vitally important to maintain diversity among individuals in captive breeding programs," said Duenas. This genetic diversity will hopefully pull the species back from potential extinction.



Photo courtesy of Las Cruces Research Station, Costa Rica

As a UOG biology major, Ahmyia Cacapit applied for and received the opportunity to study in Costa Rica under the NSF REU/NAPIRE program, which promotes excellence in scientific research for minorities that are typically underrepresented in research communities. Her research project while there was on fish in mountain streams which she presented at the 2019 SACNAS conference. "The NAPIRE program professors and staff really enjoy the UOG students who take part in their summer program. It is such a great experience on many levels for our students," said Lindstrom.

CNAS students, mentored by attentive professors, continue to make a difference for people, plants and animals of the islands with the depth of their research studies.



AN OLD FISH STORY

Yes, we do have rocks in our heads, or our ears to be exact. So do the rest of the vertebrates including fish. In both humans and fish these calcifications, called otoliths “ear stones”, help with balance and in fish they can be used to determine age. This is not unlike counting the rings of a tree.

Francisco Villagomez, a recent graduate of the Master of Science in Biology program used otoliths to help fill in the gaps of knowledge regarding *Pristipomoides filamentosus*, the crimson snapper or opakapaka. These deep-water fish are a prized catch, but in order to effectively manage fish populations there is a need to know more about their life history, such as life span and at what age they can begin to reproduce. The fish used in the study came from throughout the Mariana Islands. Specimens were weighed, measured, and catalogued.

Villagomez worked with Professor Frank Camacho in removing otoliths from the brain cavities of these fish. In Camacho’s lab the tiny otoliths were then delicately cut into sections to reveal the rings of calcium carbonate that are built up daily as long as the



From top to bottom: Photo of otoliths courtesy of the Burke Museum. Otoliths being removed from crimson snapper courtesy of NOAA.



fish is alive. Using a microscope to count the rings, Villagomez documented the age of each fish that had been catalogued.

For a confidence factor they used a time series of carbon-14 (radiocarbon) of a coral core drilled from a reef along the west coast of Guam. Since coral have pronounced patterns of growth, this core shows the annual variation of growth and with that, years can be assigned. By sampling the C14 from the oldest part of the otoliths and matching it with the coral core record, they were able to determine the birthdate of the fish. The oldest opakapaka they recorded was 30 years old.

The next step was to determine gender. They sectioned and stained gonads and then were able to assign gender to each of the specimens in the study. This gave them age, length, weight, and gender. Their findings indicated that males mature faster than females. Furthermore, fish from the waters of sparsely populated areas of the northern Marianas had slightly faster growth rates early in their development than fish from the more human-inhabited southern Marianas, such as Guam and Saipan. Finally, opakapaka from the Marianas had a lower growth rate and maximum length compared to more northerly stocks from Hawaii.

Under the direction of Professor Camacho, through his research, Villagomez has made an important contribution to the scientific literature on the natural history of the crimson snapper.

This research is valuable for making informed decisions in management plans for deep-water species, perhaps resulting an individual management plan for opakapaka, rather than the current assessment methods of including all deep-water species in one category.

NATIVE SNAIL SPOTTER

Undergraduate biology major, Bea Daria, is finding out just how much she enjoys biology through her lab research under Professor Curt Fiedler. As a Louis Stokes Alliance for Minority Participation in the Sciences (LSAMP) intern, she has been spending time in the field looking for native tree snails. Daria began her internship by investigating mark and recapture techniques using physical methods such as sharpies, nail polish, and paint pens. Since the native snails are listed as endangered, she used non-native lined tree snails to test these traditional marking methods.

After a series of difficulties, they shifted to other techniques and came upon HotSpotter, a visual marker program that uses an algorithm to identify individual animals from color patterns and creates a database that matches key features. They have identified three sites on island that they monitor and take photographs of individual snails. Once the photos are processed, Bea inputs them into the program and searches for matches. There have been successful matches

from the populations they are monitoring. This will allow them to estimate the population sizes of tree snails at these locations.

Using HotSpotter makes the research less complicated since they are working with an endangered species and do not have to directly handle or touch snails. Unlike physical marking, photographing snails doesn't require a special permit from the US Fish & Wildlife Service. "This is an example of good proof of concept that can be used for other more in depth applications," said Fiedler.

Daria is gaining valuable field experience while increasing knowledge about Guam's endangered snails. She will write up a report and present the research at a UOG conference and elsewhere. Her work is an excellent example of student research within the framework of laboratory studies with a professor passionate about teaching, learning, and conservation of native invertebrates.



“ Dr. Wu was the one who instilled in me a love for organic chemistry and the attitude needed to succeed.

Brandon Datuin
BS Chemistry
University of Guam 2020 Graduate



REACHING NEW HEIGHTS

Brandon Datuin will soon finish the last chapter of a thick textbook. The chapters covered his experience the past four years as an undergraduate chemistry major, as a student scholar in the rigorous BUILD EXITO research mentorship program, and as an assistant for two years with an anticancer research project. And the next book he's about to open is even more ambitious. Following his graduation from the University of Guam with a Bachelor of Science in Chemistry May 2020, Datuin will move to Minneapolis, where he will pursue a doctorate in chemistry at the University of Minnesota - Twin Cities. His acceptance into the program came with a full scholarship and a teaching assistant position that will help pay for the cost of living. He will also take on a departmental fellowship for first-year students, which his acceptance letter states is for students with a strong record of achievement.

Datuin said most of the doctoral programs he looked into expected applicants to have experience or aptitude in conducting research. His involvement in the BUILD EXITO program gave him that strength. Over the course of three years, the National Institute of Health-funded program trains

undergraduates, in particular those from diverse backgrounds, to become scientific researchers.

Datuin started in the program his sophomore year and was paired with Dr. Bulan Wu, assistant professor of chemistry at the University of Guam, his junior year to assist with her research project evaluating cannabidiol, or CBD, analogues for potential anticancer properties.

He said Wu's mentorship played a large part in his motivation. "Dr. Wu was the one who instilled in me a love for organic chemistry and the attitude needed to succeed," he said. Likewise, Wu said that Datuin's enthusiasm and motivation for his work in chemistry have prepared him for great success as a Ph.D. student.

He aspires to potentially work in an advisory role for a company that requires chemistry knowledge and experience, but he said his career plans are flexible at this point. Regardless, he said he feels well prepared to open the next textbook, or more likely, set of textbooks, and see what the chapters hold.



CYBER WARRIOR

Lucand Camacho is majoring in computer science through the College of Natural and Applied Sciences, and he is also a leader in the University of Guam's Army Reserve Officer Training Corps (ROTC) program. In the ROTC program, Lucand serves as the Operations Officer, where he has developed and guided over twenty separate training events for over 100 Cadets in the ROTC program in 2019. These included training in land navigation, physical fitness, rifle marksmanship, and small unit tactics, as well as a 3-day Field Training Exercise with 25 Cadets visiting from the Philippines. Throughout the past year, Lucand has gained real-world leadership experience, and was recognized nationally as one of the nation's few Distinguished Military Cadets. In the summer of 2019, Lucand was selected for an internship at the Army Cyber Institute in West Point, NY, where he utilized his computer science education and applied his skills in a project designed to detect and defeat the hacking of civilian software and online applications. Based on his outstanding performance at UOG and in the ROTC program, Lucand was selected to serve as an Active Duty Army Officer upon graduation from UOG in May of 2020. Lucand Camacho and the members of ROTC are proud to use their educational attainments in service to their country.

 Photo of Lucand Camacho.



“ Being a female millennial in the field of agriculture is a challenge in itself, however the Tropical Agriculture program has inspired me to lead my generation onward to become more sustainable and influential within the island’s agricultural sectors. I appreciate the diversity within the program’s curriculum, faculty and student body as it truly reflects the diverse cultures of Guam. Personal goals of mine are to continuously expand my knowledge and provide my services to improve the island’s sustainable agricultural production and local food security.

Gianna Soriano
BS Agriculture and Life Sciences
University of Guam 2019 Graduate

“ As a native CHamoru interested in local marine science, I knew I wanted to pursue my degree at our local university in order to better understand the marine environment that surrounds us. UOG’s biology program constitutes a plethora of diverse knowledge from experienced researchers and professors that has allowed me to immerse myself in the science encompassing Guam’s ocean and its inhabitants. By attending UOG’s biology program as a local resident, I have given back to the community and environment that raised me while growing as a native scientist in the progress.

Leilani Sablan
BS Biology
University of Guam 2018 Graduate



BUILDING A HEALTHY COMMUNITY

Community gardens are known to provide space to grow fresh healthy food close to home. However, they bring more than just fresh produce to the table. Community gardens create the opportunity to learn, practice cultural traditions, restore and build health, practice teamwork, and empower individuals to organize and advocate for themselves and their communities. The University of Guam's Cooperative Extension and Outreach has a strong forefront when it comes to community gardens. All core areas in Extension have taken their skills and expertise in community gardening to the people of Guam. As these experts influence our community so are undergraduate and graduate UOG students when they complete Capstone projects. Our student highlight for this article is Remedios (Remy) Perez, a graduate student in the Sustainable Agriculture, Food and Natural Resources (SAFNR) program. Overseeing her project is Dr. Tanisha Aflague, RDN, an Extension Agent IV and Associate Professor.

Remy's ongoing project developed from an in-class assignment for AL539 Public Health Nutrition into a funded project by the Pay-Less Foundation Mini-Grant and she was awarded \$4,600.00 to plan and establish a student-maintained campus community garden at the University of Guam's Residence Halls. The Pay-Less Foundation Mini-Grants are awarded to selected applicants who aim to improve the quality of life on Guam and address significant gaps in the areas of

health, education, social services, and the environment. Part of Remy's assignment was to identify a community need, and being a graduate student, she put her interests in addressing the needs of the UOG community. In response to a Triton's Call article about dorm residents wanting variety in dorm meals and opportunities to cook island foods, Remy applied her knowledge of nutrition and worked alongside her mentor to shape the campus community garden project.

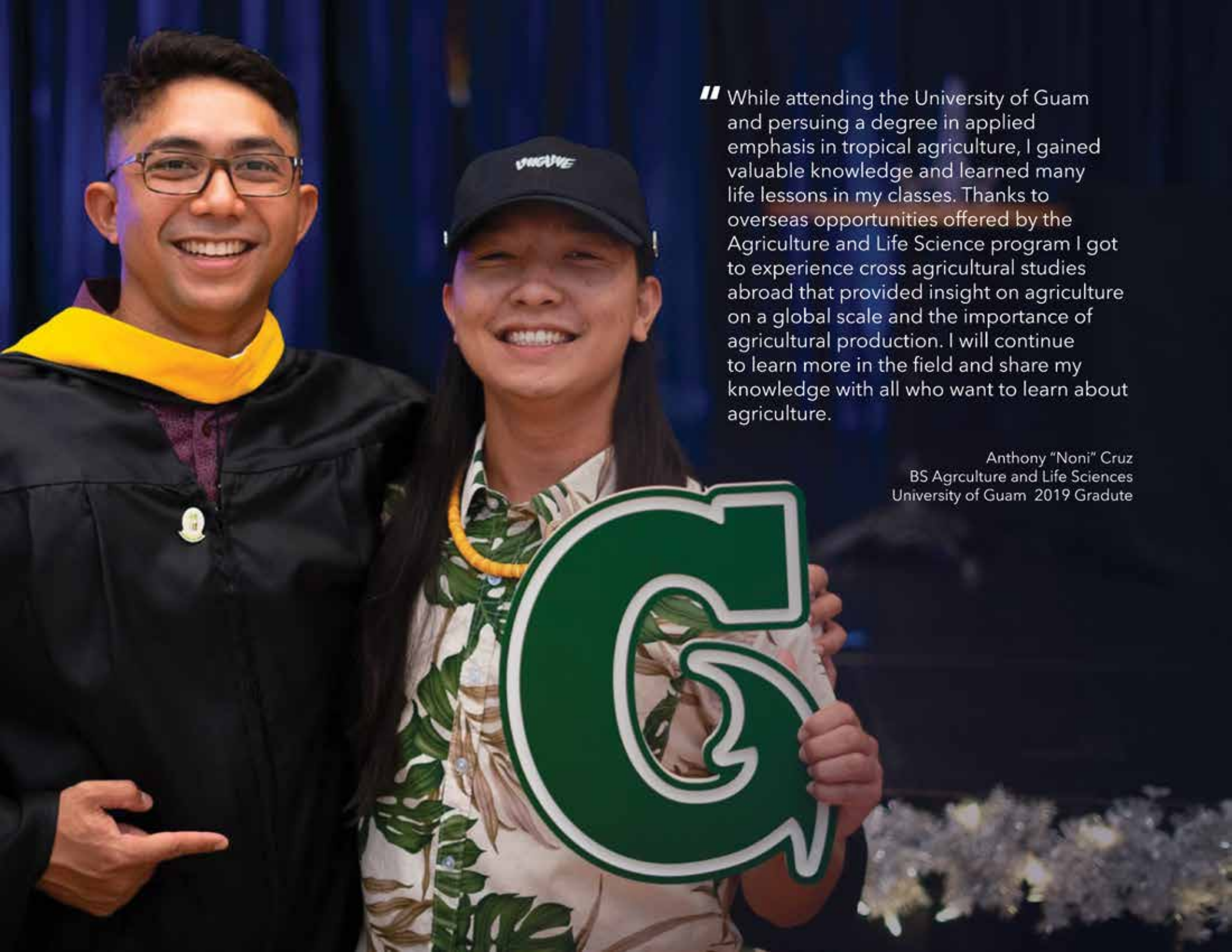
The campus community garden project will provide familiar local fruits and vegetables on dorm grounds for residents to add to their catered or cooked meals, as well as, demonstrate Remy's academic training to create a sustainable food system. Remy's project extends beyond the course and the semester. In addition to executing the mini-grant activities, she plans to assist dorm residence and staff with developing a micro-market for garden produce not consumed. What was once an assignment has turned into more than just a garden to feed people, but a potential business for dorm residents to make money for future events or activities. All the while, fostering a sense of home and ownership among dorm residents that aligns with cultural practices from their home islands and contributes to their quality of life. The saying is "it takes a village" to establish a successful community garden and is no different for Remy's campus community garden project. Assisting Remy, alongside Dr. Aflague, with this project are

Cooperative Extension & Outreach professionals Joe Tuquero, Mark Acosta, Roland Quitugua, and Dr. Bob Barber and the Residence Hall office staff and Director, Mark Mendiola. Together, this project's village, will work collaboratively to train and support students and staff to plan, establish, and maintain the campus community garden over the next year (2020-2021).

“ The goal of expanding the community garden is to contribute to building an overall healthy environment within our university community. The intent is to build upon the existing efforts to produce a community garden at the University of Guam, one that has the capacity to produce local fruits and local vegetables for the Iyo-hami and Guma-ta residence halls. This community garden will provide access to fresh, local produce and nutritionally rich foods to dorm residents who otherwise may not have had financial or direct access to areas where nutritious food is more available.

Remedios Perez
SAFNR Graduate Degree Program
University of Guam 2021 Graduate





“ While attending the University of Guam and pursuing a degree in applied emphasis in tropical agriculture, I gained valuable knowledge and learned many life lessons in my classes. Thanks to overseas opportunities offered by the Agriculture and Life Science program I got to experience cross agricultural studies abroad that provided insight on agriculture on a global scale and the importance of agricultural production. I will continue to learn more in the field and share my knowledge with all who want to learn about agriculture.

Anthony “Noni” Cruz
BS Agriculture and Life Sciences
University of Guam 2019 Graduate

SUMMER RESEARCH PROGRAM IN MATH

The University of Guam's Young Scholar Research Experience in Mathematics (YSREM), and the National Research Experience for Undergraduates Program (NREUP) were two math research programs hosted in the summer. Both funded by the Mathematical Association of America with YSREM being a grant from the Tensor-SUMMA Program and NREUP under the NSF Grant DMS-1652506.

The programs were introduced in 2018, led by Dr. Hyunju Oh with co-faculty mentors Drs. Leslie Aquino, JaeYong Choi, and Hideo Nagahashi and continued their second year in 2019. These programs serve both undergraduate students at the university, as well as high school students on Guam. Both grants assisting these students include the Tensor-SUMMA (Young Scholars Research) grant, which is geared toward high school students and the NREUP funded by the Mathematical Association of America (MAA), which is awarded to university students. The goal for these summer programs is to inspire students to take math to a different level to insure a brighter future. Mentors hope to see their students continuously applying for summer opportunities and internships followed by pursuing higher education after graduation for high school students. Additional goals for the programs include mentoring more high school

students in order to increase the number of applicants applying for college in STEM fields. This leads to building confidence to create higher goals for themselves and communities.

This research programs started off by dividing 12 students into four teams consisting of at least one undergraduate student and one high school student. Two of these teams worked on a coding theory while the other two teams worked on the Vaccination game theory that models diseases and looks at control strategies. The programs proved to be beneficial to students experiencing first-time exploration of mathematics and its application to real life. Mentors also saw a vast improvement in students' ability to apply skills and strengths in teamwork, communication, and confidence building. In addition to the projects mentioned above students had the opportunity to explore various areas in mathematics such as differential equations, linear algebra, coding theory, and game theory and provide opportunities for students to learn technical skills in MatLab, SageMath, and LaTeX. Students mentoring students, a win-win solution for everyone!


AQUACULTURE FROM ABROAD

The Guam Aquaculture Development and Training Center (GADTC), more commonly known as the Fadian Hatchery, has been conducting extensive research for years. This aquaculture center serves as a platform of applied research to accomplish the University of Guam's mission as the lead agency for aquaculture development in Micronesia. The Fadian Hatchery moves forward in their research and development through the assistance of research scholar/graduate students from the J-1 exchange visitor program. Most visiting researchers received funding support from their home agriculture universities/institutions abroad to participate in aquaculture research on Guam. Within the last decade, the Fadian Hatchery has involved visiting scholars/graduate students with J-1 student visas in conducting various experiments. These hands-on experience and efforts in the field allow visiting researchers to expand their skills and knowledge in breeding and help to further the aquaculture research for Guam. Graduate students are conducting research focused on the family-based selective breeding of shrimp under various environmental conditions.

GADTC has created learning opportunities for these graduate students to utilize their skills to run these intricate experiments.

"The graduate students are eager to extend their knowledge and expertise to further their studies and run the experiments we have set in place at the hatchery. For example, the students would conduct experiments to generate multiple shrimp families, evaluate their performance in a specific developmental stage, and investigate any genetic, environmental, or nutritional effects on their performance. The variables of study include, but not limited to, water salinity, temperature, pH, dissolved oxygen, photoperiod, light intensity, stocking density, water exchange rate, type of feeds (live feed, artificial feed), and different feeding regimes administered. The goal is to understand and optimize the culture condition so that the domesticated aquatic animal stock would be healthier and perform better," explained Dr. Hui Gong Jiang, associate professor of aquaculture.

"Overall, the Fadian Hatchery is excited to be a part of the collaboration to promote aquaculture research on Guam via the scholar/graduate student exchange program. Hopefully, the program can be expanded, and the prospective students from Guam can travel to and learn at the partner schools in Asia," said Dr. Jiang.

 J-1 Exchange Student Meng Li monitors shrimp eggs at the Guam Aquaculture Development and Training Center (GADTC).



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