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Progression Magazine, 2019 Fall/Winter

Coastal Carolina University

COASTAL CAROLINA UNIVERSITY

progression MAGAZINE

Fall / Winter 2019

KEEPING UP WITH THE EDUCATIONAL MOMENTUM OF THE GUPTA COLLEGE OF SCIENCE

MEASURING THE HISTORY OF EXTREME FLOODS

WHAT DO HUMANS AND PLANTS HAVE IN COMMON?

GUPTA COLLEGE OF SCIENCE

BRAIN MECHANISMS FOR NAVIGATION

INTELLIGENT TRANSPORTATION SECURITY

progression

A message from the dean

This issue of ***Progression*** (our 12th overall) marks the first one produced under our new college name: the Gupta College of Science. We are extremely thankful for the generosity of Mr. Sunny Gupta and his family, for the faith they have shown in us by making this substantial gift. Future generations of Coastal Carolina University students will be supported in their educational pursuits, and we in the college are proud to carry this name forward.

The new name is not the only interesting thing going on at the University. If you have not visited our campus recently, we in the college and in the University extend an invitation. Our science programs and science facilities are second to none and provide opportunities for more than 4,000 students who are enrolled in one of our 12 major disciplines to learn alongside our exemplary faculty. Our approach toward education is engaged and hands-on, providing the skills needed for 21st century careers.

Should you have any questions concerning our programs in science, or want more information on any of the articles within, please do not hesitate to contact me or the specific authors. My phone number and email are listed below; you can also follow me on Twitter at @CCUScienceDean. Finally, if you wish to support the work that we do, please feel free to contact Bryan Steros, interim vice president for philanthropy, at bsteros@coastal.edu.

Regards,

Michael H. Roberts, Ph.D.
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Vice President for Emerging Initiatives
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coastal.edu/academics/colleges/science

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DEPARTMENT OF BIOLOGY

John Hutchens, Ph.D.
Department Chair

The Department of Biology is home to about 500 undergraduate biology majors, 10 graduate students, 15 full-time faculty, and 10 lecturers. Undergraduate students in our department earn a Bachelor of Science in biology. We also offer other programs of study that prepare students for entry into various health professions. Our department participates in the Master of Science in Coastal Marine and Wetland Studies and offers courses for graduate students in education.

Students in our department have access to professors with expertise ranging from molecules to ecosystems. Faculty in the Department of Biology provide excellent opportunities for learning inside the classroom and out. Our faculty have varied research interests, and undergraduates can participate in that research.

Visit coastal.edu/biology. John Hutchens can be reached at jjhutche@coastal.edu or 843.349.2169.

DEPARTMENT OF KINESIOLOGY

Gregory F. Martel, Ph.D.
Department Chair

The Department of Kinesiology at CCU is a dynamic unit of faculty, staff, and students who study and promote human movement (kinesiology) as applied to a variety of physical activity, sport, and therapeutic settings. The department houses a major in exercise and sport science (EXSS), minors in EXSS and sport coaching, the Physically Active Living Skills (PALS) classes, and the Community Fitness Testing program. Nationally, regionally and locally, there has been an increase in demand for kinesiology-related services and programs; this is reflected in the rapid growth of the EXSS major since beginning at Coastal Carolina University in January 2008. The EXSS major is now the third largest on campus. Our role is to provide students with the knowledge, skills, abilities, and attitudes for effective leadership in the field of kinesiology. We excel not only by teaching well, but by engaging students in hands-on research, community service projects, and field-based learning and leadership opportunities.

Visit coastal.edu/knes. Greg Martel can be reached at gmartel@coastal.edu or 843.349.2957.

DEPARTMENT OF CHEMISTRY

David Evans, Ph.D.
Department Chair

Our department is home to two disciplines within the physical sciences: chemistry and biochemistry. Bachelor of Science degrees are offered in chemistry and biochemistry. Whether you are here for a course in science as part of the Core Curriculum or you are interested in becoming a chemistry or biochemistry major, please contact us with any questions you may have.

Visit coastal.edu/chem. David Evans can be reached at devans@coastal.edu or 843.349.2209.

DEPARTMENT OF HEALTH SCIENCES

Fredanna M'Cormack McGough, Ph.D.
Department Chair

The Department of Health Sciences is home to programs that incorporate evidence-based best practices for disease prevention, health assessment, health management, quality care, and patient safety. Through community collaborations and diverse faculty research interests, students can participate in research activities that connect theory to practice. The department offers Bachelor of Science degrees in public health, health administration (completion program), and nursing (2+2 program nursing residential program and RN-to-BSN completion program). The 2+2 Nursing Residential program is a collaborative between Coastal Carolina University and Horry Georgetown Technical College (HGTC) and is for first-time freshmen only.

The nursing completion program is committed to advancing the education of registered nurses to meet the local and global growing health care needs. The health administration completion program builds on foundation courses in associate degree and other four-year degree programs. The public health program focuses on the art and science of promoting healthy communities and healthy behaviors.

Visit coastal.edu/healthsciences. Fredanna M'Cormack McGough can be reached at fmcorma@coastal.edu or 843.349.2991.

DEPARTMENT OF COMPUTING SCIENCES

Jean French, Ph.D.
Department Chair

The Department of Computing Sciences offers three undergraduate degrees, serving roughly 400 actively enrolled majors in computer science, information systems, and information technology. The department offers minors in web application development, scientific computing, and computer science. Both the computer science and information systems major programs are accredited by the Accreditation Board for Engineering and Technology Inc. The department also offers a completely online Master of Science in information systems technology, which has a dual concentration in both security and data analytics. The department supports the University core and other majors and minors of study with course offerings in web development, programming, and business applications.

Visit coastal.edu/computing. Jean French can be reached at jennis@coastal.edu or 843.234.3430.

DEPARTMENT OF SOCIOLOGY

Robert Jenkot, Ph.D.
Department Chair

This is an exciting time to explore the Department of Sociology. Sociology has a strong history of being student-centered in teaching and research. We offer our students a wide variety of educational opportunities to explore the social world and to take part in changing that world. In order to maintain our student-centered approach to education, all of our professors are active researchers. We bring our experience with various topics into the classroom so that our students get to see what sociology is, how it works, and what it can be used for in the world around them. Importantly, our students are invited to work with our professors on research projects that might interest them. Our students have access to professors who teach courses in: sexuality and gender; race and ethnic relations; social inequality; crime and deviance; religion; popular culture; social justice; health and medicine; sports; HIV/AIDS; juvenile delinquency; and the social relations of the South.

Visit coastal.edu/sociology. Robert Jenkot can be reached at rjenkot@coastal.edu or 843.349.2274.

DEPARTMENT OF MARINE SCIENCE

Craig Gilman, Ph.D.
Department Chair

The Department of Marine Science is one of the largest undergraduate marine science programs on the East Coast. In addition to undergraduate studies, the department interacts with CCU's Coastal Marine and Wetland Studies master's program and the doctoral program in marine science: coastal and marine systems science. Lecture, laboratory, and field experiences are integrated to provide an outstanding and well-rounded academic program. With our ideal location near the coast and collection of research-active faculty committed to undergraduate and graduate education, our strength is in providing individual attention and hands-on opportunities for students.

Visit coastal.edu/marine. Craig Gilman can be reached at gilman@coastal.edu or 843.349.2228 .

DEPARTMENT OF PHYSICS AND ENGINEERING SCIENCE

Brian Bunton, Ph.D.
Department Chair

The Department of Physics and Engineering Science is a group of faculty and staff seeking to promote an atmosphere of scholarly endeavors that emphasizes the application of the scientific method in the generation of knowledge across its major and non-major curricula in a liberal arts context. The faculty are committed to developing strong student competencies in physical and engineering science and its applications in a technology-rich, interactive, student-centered learning environment and to preparing students to successfully compete for employment or to succeed in graduate school. We take pride in our high-quality teaching using current pedagogic techniques, our proactive mentoring and advising, and our outreach to the local community. We strive to be a focal point for disciplinary scholarship and expertise within the college, and to collaborate with our colleagues in the college to actively contribute to the advancement of science. The faculty supports the goals of the University's Core Curriculum through general education courses in physics and astronomy.

Visit coastal.edu/phys. Brian Bunton can be reached at bbunton@coastal.edu or 843.349.2066.

DEPARTMENT OF PSYCHOLOGY

Terry F. Pettijohn II, Ph.D.
Department Chair

The Department of Psychology enrolls more than 500 undergraduates. We offer a bachelor of science degree and emphasize the scientific nature of psychology and experimental research methods. Our 13 full-time faculty have expertise in a wide variety of areas, including experimental, social, developmental, cognitive, biological, school, and clinical psychology. Our faculty are excellent teachers and active researchers in the field, presenting at conferences, contributing articles and books to the research literature, and sharing their findings and expertise with the media. Through our research methods sequence, students gain extensive knowledge and experience by designing and conducting research. Motivated majors may find additional opportunities to join faculty research labs as research assistants.

Visit coastal.edu/psych. Terry F. Pettijohn II can be reached at pettijohn@coastal.edu or 843.349.6447.

DEPARTMENT OF COASTAL AND MARINE SYSTEMS SCIENCE

Rich Viso, Ph.D.
Department Chair

The Department of Coastal and Marine Systems Science houses Coastal Carolina University's marine and wetland graduate programs: a Ph.D. in marine science: coastal and marine systems science, and an M.S. in coastal marine and wetland studies. Students in these programs focus on the complex and interconnected environments and processes found in the coastal zone. With the expanding coastal population and the increase in economies dependent on the world's coastal resources, there is a growing need to advance the understanding of these interconnected environments and processes to help society best manage coastal resources and economy. Our graduate programs focus on training students to advance understanding of complex systems and to work across disciplines to develop predictive capabilities for sound resource management.

Visit coastal.edu/cmss. Rich Viso can be reached at rviso@coastal.edu or 843.349.4022.

DEPARTMENT OF RECREATION AND SPORT MANAGEMENT

Colleen McGlone, Ph.D.
Department Chair

The Department of Recreation and Sport Management currently enrolls more than 300 students as well as houses a graduate program in sport management. Recreation and sport management professionals create, plan, market, implement, and evaluate leisure and recreational activities in both the private and public sectors, as well as in both nonprofit and for-profit industries. In other words, our work is your play. The program works with Coastal Carolina University Athletics in several capacities and events, training students in specialized ticketing technology and sales techniques.

The faculty have a wide range of experience in the field which they bring to the classroom to enhance students' abilities to connect theory and practices. In addition, faculty maintain very active research agendas in which students frequently assist.

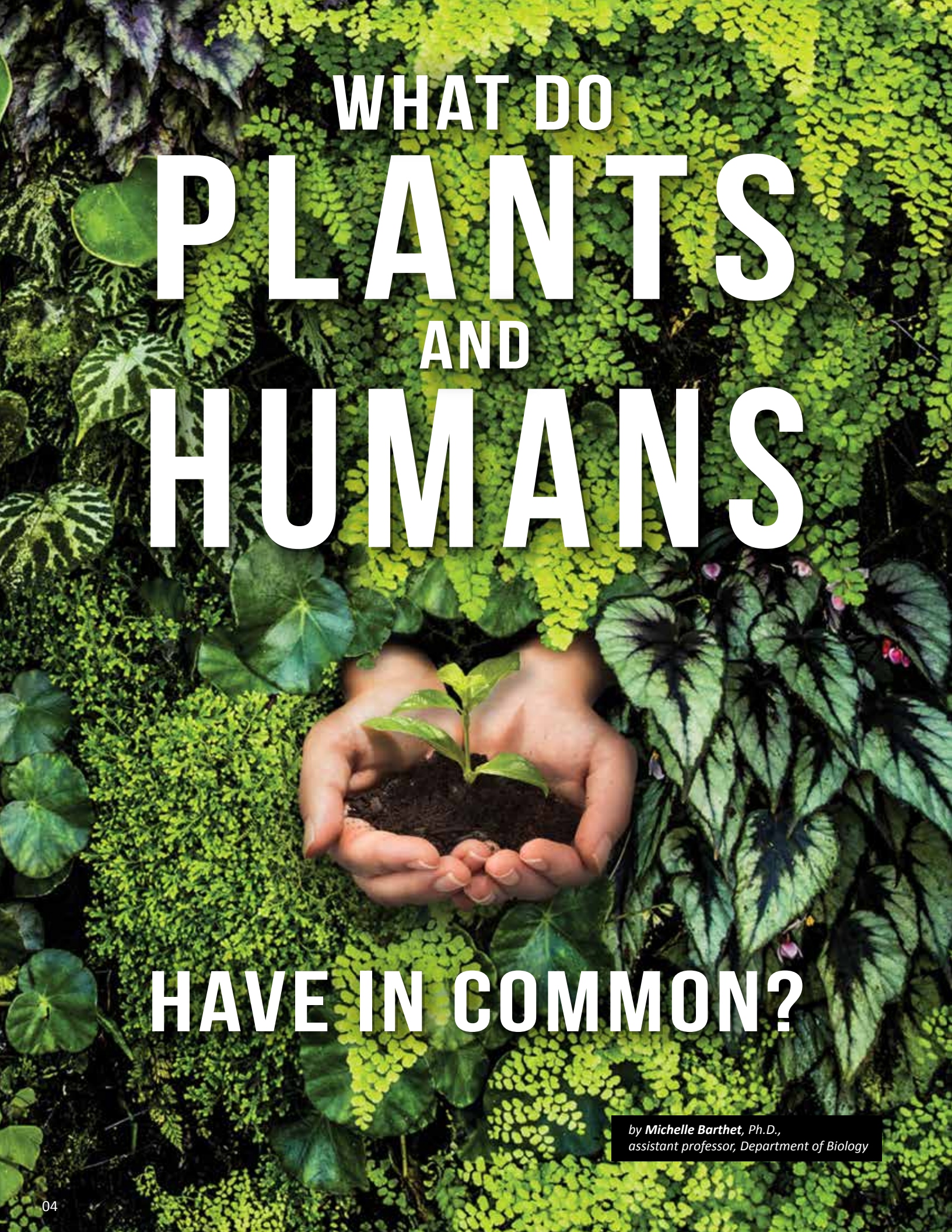
Visit coastal.edu/rsm. Colleen McGlone can be reached at cmcglone@coastal.edu or 843.349.2989.

DEPARTMENT OF MATHEMATICS AND STATISTICS

Thomas Hoffman, Ph.D.
Department Chair

The goal of the Department of Mathematics and Statistics at Coastal Carolina University is to improve students' mathematical understanding and competence. However, we also strive to illustrate the importance of mathematics, both as an interesting and challenging subject on its own, and as a tool that can be applied to other disciplines. Our degree program in applied mathematics is designed to develop a high degree of mathematical proficiency, as well as extensive reasoning and problem-solving skills. We recognize the interdisciplinary nature of the modern mathematical world. Therefore, students may choose to concentrate their studies in analysis, applied mathematics, discrete mathematics, mathematics for secondary education, or statistics while still obtaining a solid mathematical background.

Visit coastal.edu/math. Tom Hoffman can can be reached at thoffman@coastal.edu or at 843.349.2249.



WHAT DO PLANTS AND HUMANS HAVE IN COMMON?

by ***Michelle Barthet****, Ph.D.,*
assistant professor, Department of Biology

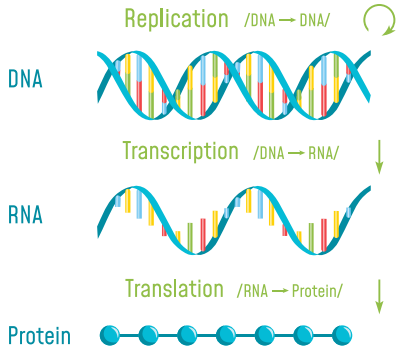
PLANTS AND HUMANS HAVE A LOT IN COMMON, AT LEAST ON THE CELLULAR LEVEL.

Gene Machinery of Plants

We all know that plants are wonderful green things that enable us to breathe, eat, and sustain life, but what else goes on beneath the surface? Plant biology is a large field encompassing everything from agriculture to medicine. In fact, plant biotechnology is everywhere in our society. Plants are used for generating new biofuels, cleaning up our environment from pollutants, and developing new ways to administer human vaccines and other medical treatments. Even our fundamental understanding of disease inheritance was founded by studying plant breeding. So what else can we learn from plants?

Everyone nowadays has heard the acronym GMOs, which stands for genetically modified organisms. Although GMOs can be any genetically modified organism, we tend to think of this mainly for plants, and for good reason. Plants have been genetically altered to satisfy a variety of human needs, including better crops for clothing production, food, oils, and even medicine. To generate such crops and make new plant-based technologies that improve our environment and health, we have to gain a much more comprehensive understanding of how plants work at the cellular level.

Plants and humans have a lot in common, at least on the cellular level. Plants, like animals, are eukaryotes, meaning that they contain membrane-bound organelles such as the nucleus. Inside the nucleus, two very important processes occur: DNA replication and gene expression. Although DNA replication is important for making new DNA for new cells, it is gene expression that keeps cells alive. Gene expression is the process of converting the genetic code into the ribonucleic acids (RNA) and proteins that make the cell a cell.

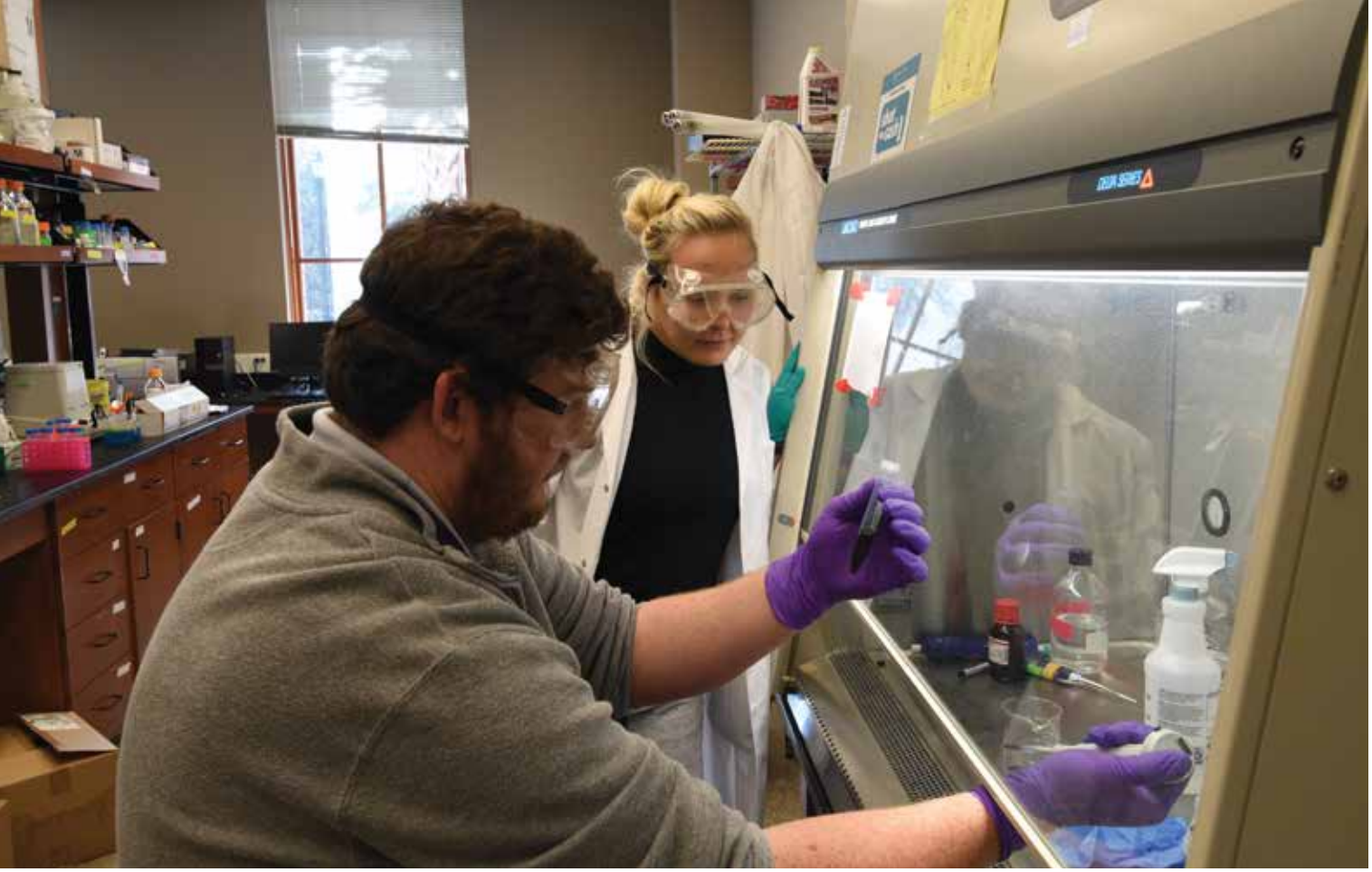


Genes comprised of DNA are transcribed into messenger RNA which in turn provides the information template for protein synthesis. Introns are parts of genes that are transcribed but subsequently edited from the messenger RNA during maturation.

When investigating plants to generate new medicines, improve agriculture, increase conservation of landscapes, and develop new biotechnologies, we have to first see how genes that already exist in the plant are expressed and what factors can alter this expression.

Gene expression consists of two steps: transcription, in which a region of the DNA code called a gene, is rewritten as RNA; and translation, the process of converting RNAs, specifically mRNAs, into proteins. Think of this process like building a house. The blueprint gives the builder the design that needs to be implemented, but it's up to the builder to interpret the design correctly to make the right house. If anything happens with the builder or if the builder misreads the blueprint, the wrong structure will be made and the whole house will lack structural integrity. In this analogy, the DNA is the blueprint, while the RNA is the builder interpreting the blueprint to finally make the house (the protein product).

One critical component of gene expression is a type of editing where the removal of something called introns occurs in order to make the RNA transcript ready for translation.



CCU students Dyshali Lammey (left) *and Isabella Becker* (right) *extract DNA from rice.*

Introns are extraneous sequences in the DNA code that need to be removed from the premature RNA to make that RNA "mature" and ready to go through translation. If anything goes wrong in this process and the introns are left in the premature transcript, the wrong mature RNAs and protein products can result leading to devastating consequences for the plant.

Introns can be removed in one of three ways: self-excision, meaning the introns remove themselves from the premature RNA; by maturase excision; or by the nuclear spliceosome.

The nuclear spliceosome is a large complex of protein and RNAs that is found in the nucleus (the same part of a cell that holds the DNA) of all eukaryotic cells, including plants, fungi, and animals alike.

The nuclear spliceosome is responsible for removing introns from all of the premature RNAs. Malfunctioning of the nuclear spliceosome has been linked to human diseases, including cancer.

So what does this have to do with plants, other than plants also have a nuclear spliceosome? Plants have chloroplasts, the organelle that uses sunlight to make sugars. Chloroplasts have their own DNA and also have their own gene expression, separate from that of the nucleus. Introns in the chloroplast are not removed by the nuclear spliceosome but by various protein factors. One of these protein factors is Maturase K, or MatK for short. Maturases are protein enzymes related to the evolution of the nuclear spliceosome but often found in bacteria. The chloroplast was once, billions of years ago, a free-living bacterium that a eukaryote "ate" and then retained for the benefit of photosynthesis to the plant cell. Due to the bacterial origin of the chloroplast, the chloroplast may use maturases for some intron excision. MatK is the only maturase known to be expressed in the chloroplast of plant cells. Bacterial maturases only remove one intron for each maturase, but MatK is thought to excise at least seven different introns.

Further, MatK may bind to other proteins to form a chloroplast spliceosome. If so, evolution of MatK and its associated protein factors may help us understand how the nuclear spliceosome of plants, and animals, evolved and also may help us to determine how problems with the nuclear spliceosome lead to cancer. Also, understanding how introns are removed in the chloroplast allows researchers to better understand chloroplast function, which is vital to plant growth and life, and can have significant impact on making beneficial GMOs.

ALTHOUGH WE ARE NOT MAKING NEW HYBRID DINOSAURS, SUCH AS THOSE FEATURED IN "JURASSIC WORLD," A VERY SIMILAR FORM OF BIO-TECHNOLOGY IS EMPLOYED.

Into the Cold

Undergraduate students at Coastal Carolina University have been working on unraveling how MatK works in the chloroplast of rice plants, and determining if this maturase works with other protein factors to form a chloroplast spliceosome. Students learn a vast array of molecular techniques to express MatK in a bacterial system and then use this MatK protein to test how MatK works to excise introns from premature RNA molecules. Although we are not making new hybrid dinosaurs, such as those featured in "Jurassic World," a very similar form of biotechnology is employed. Regions of DNA are stuck together from different sources and then put into bacteria for making the protein product, in this case, MatK.

In order to determine what proteins may work with MatK to aid intron excision in the chloroplast, proteins are isolated from plants in a way that keeps the proteins that already interact with each other together so that interactions between proteins can be identified. To accomplish this, the proteins are extracted in the cold. Much of this work takes place in a cold room that keeps a constant temperature of about 10 C°, the same temperature as your refrigerator. After isolating proteins that may work with MatK, we send them off to get identified using equipment at the Mass Spectrometry Center at the University of South Carolina. By using molecular techniques and working in the cold, our lab group is working on determining which proteins MatK works with and how these proteins may have led to the evolution of the nuclear spliceosome. This research is supported by funds from the SC INBRE Bioinformatics Pilot Project grant and a professional enhancement grant from Coastal Carolina University.

CCU undergraduate student James Hatton in the cold room while isolating proteins that form a complex with MatK. Hatton uses small magnetized beads to separate bound protein complexes from background contaminants.

(left to right) *CCU students Emilie-Katherine Tavernier, C. Logan Pierpont, and Alexandra Margets getting ready to present their posters on their MatK research projects at the regional Southern Section of the American Society of Plant Biologists conference in Orlando, Fla.*

Major donation from CCU alumnus leads to the naming of the

GUPTA COLLEGE OF SCIENCE

*by **Jerry Rashid**, director of communications and marketing, Office for Philanthropy*

Sunny Gupta, a leading software entrepreneur and 1992 graduate of Coastal Carolina University, has made a major donation to the University's College of Science. In recognition of his generosity, CCU announced the college has been renamed the Gupta College of Science.

Sunny Gupta '92 (second from left) *with his family and friends at the newly installed Gupta College of Science sign that was unveiled during the dedication ceremony on July 30, 2019. He is joined by* (from left) *his son, Zubin; wife, Prerna; mother, Rama; daughter, Zoe; Tripta Malhotra; father, JD; and Jeevak Malhotra '98.*

Sunny Gupta '92 is the co-founder and CEO of Apptio, one of the nation's fastest growing software as a service companies.

The gift, one of the largest ever received by the University, will provide financial resources and student scholarship support for the college, which boasts more than 4,300 students and has the largest enrollment of CCU's six academic colleges.

The gift supports the University's I'M IN endowment campaign, which to date has secured more than $30 million for CCU's endowment. Visit coastal.edu/endowment to learn more about the campaign.

"Coastal Carolina has been in awe of Sunny Gupta's career trajectory," said Coastal Carolina University President David A. DeCenzo. "He continues to be an innovative and highly successful software entrepreneur. We are grateful for Sunny's gift and the impact it will have on our students for years to come. His generosity speaks volumes to the commitment and loyalty he has for his alma mater."

Gupta, a native of Chandigarh, India, earned a bachelor's degree in computer science and a minor in mathematics in three years from Coastal. As a student, he served as an intern in the Chancellor's Office, a resident adviser, and as president of the International Club. He also worked in the computer science lab.

His professional career spans more than 20 years in enterprise software, with roles including general management, strategic marketing, product management, and business development at large companies as well as successful startups.

Prerna and Sunny Gupta '92 at the Gupta College of Science dedication ceremony.

"Sunny's generous gift will be transformational for both the University and our students," said Bryan Steros, Coastal Carolina University's interim vice president for philanthropy. "Alumni support is the backbone of our past, present, and future success. We are delighted that Sunny Gupta will forever be associated with CCU via the naming of the Gupta College of Science."

Gupta is the co-founder and CEO of Apptio, one of the nation's fastest-growing software as a service (SaaS) companies. It builds advanced data and analytics applications that help technology leaders analyze and plan their technology spending so they can invest in products that increase the speed of business and deliver innovation. Founded in 2007, Apptio is headquartered in Bellevue, Wash., with an additional 15 offices around the world.

"Coastal Carolina gave me the opportunity to learn computer science and go on to start three companies and eventually start Apptio," Gupta said. "I also received an academic scholarship – without this scholarship, I would have never been able to complete my education. Without the education, faculty, and the support from Coastal, I would have never gotten to where I am in my life today. I am so grateful, and I wanted to create an opportunity for future students who don't have the financial means to pay for their education. Hopefully, they will get the opportunity to earn an education and become successful in their personal and professional lives."

Gupta led Apptio to an initial public offering in September 2016 then its acquisition by Vista Equity Partners in January 2019 for $1.94 billion. He won the 2011 Ernst & Young Entrepreneur of the Year award in the Pacific Northwest.

"On behalf of the entire community that makes up the College of Science, now the Gupta College of Science – and especially on behalf of our students – I want to thank Mr. Sunny Gupta and his family for this generous gift," said Michael Roberts, dean of the Gupta College of Science. "By supporting students as they prepare for high-tech careers, this gift will have a major impact well beyond this college and University. The college is grateful for this support, and we are pleased that with the naming, we have a tangible legacy that will last well into the future."

> Alumni support is the backbone of our past, present, and future success. We are delighted that Sunny Gupta will forever be associated with Coastal Carolina University via the naming of the Gupta College of Science."

– Bryan Steros,
CCU's interim vice president for philanthropy

Prior to founding Apptio, Gupta was executive vice president of products at Opsware, responsible for all product businesses, until Opsware's acquisition by HP in 2007. He was also the cofounder and CEO of iConclude, which pioneered the IT runbook automation market through its acquisition by Opsware. He previously held senior leadership roles in products, business development, and engineering at Mercury Interactive, Rational Software, and IBM.

He and his wife, Prerna, have two children, Zubin and Zoe, and live in Kirkland, Wash. Gupta was named the College of Science's 2008 Outstanding Alumnus of the Year. The couple previously established the Sunny and Prerna Gupta Jamboree Alumni Scholarship at CCU.

The Gupta College of Science offers undergraduate students degree programs in 17 areas of study ranging from biochemistry to sociology, as well as 22 minors and three certificate programs. For graduate students, there are three master's degree programs and one doctoral program.

Visit coastal.edu/science for more information.

Sunny Gupta '92 is flanked by Bryan Steros (left)*, interim vice president for philanthropy, and President David A. DeCenzo.*

MEASURING THE HISTORY OF EXTREME FLOODS

*by **Zhixiong Shen**, Ph.D., assistant professor, Department of Marine Science*

Flooding is among the most devastating and deadly natural hazards in the world. People living close to rivers and in lowland coastal areas are particularly vulnerable to flood hazards. Extreme flooding in the southeastern United States is often driven by prolonged heavy precipitation in winter and extreme precipitation and storm surge due to tropical storms in summer and fall.

South Carolinians witnessed many extreme floods during the past century. Recently, floods associated with hurricanes Joaquin (2015), Matthew (2016), and Florence (2018) created new historical flood records in many local rivers.

The magnitude of a flood is further conditioned by ground and river conditions. For example, urbanization reducing percolation of rainwater and flood-control levees constraining flows to narrow waterways tend to enlarge floods. South Carolinians witnessed many extreme floods during the past century. Recently, floods associated with Hurricane Joaquin (2015), Hurricane Matthew (2016), and Hurricane Florence (2018) hit South Carolina's coastal plain particularly hard and created new historical flood records in many local rivers. One of the most important questions for flood control and mitigation is how often an extreme flood happens. Answering this question is not straightforward. Typically, flooding of a river is monitored for a few decades, and we can count all floods with a magnitude above a certain threshold during this period to calculate the probability of flooding at this threshold for each year: the so-called annual exceedance probability. A plot of annual exceedance probability against threshold flood magnitude is then created for flood prediction. However, this method has several pitfalls.

First, the most extreme floods rarely occur during the relatively short monitoring period and their annual exceedance probability can hardly be reliably calculated. Second, the climatic background related to extreme floods changes. As a result, extreme floods during a short monitoring period may not capture the full spectrum of its variability and are not representative of what may happen in the future. Climate shows patterns of periodical change over thousands of years. It is well known that the climate patterns in both the Atlantic and the Pacific oceans, such as the El Niño-Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Atlantic Multidecadal Oscillation (AMO), and Pacific Decadal Oscillation (PDO), can have profound impacts on precipitation and tracks of tropical storms striking the United States. Warming of the atmosphere is expected to increase its capacity to hold moisture by about 7 percent per one degree (Celsius), resulting in heavier precipitation. And third, land-use changes and river engineering may have modified the probability of riverine flooding.

A core of newly deposited riverine sediments collected after Hurricane Florence.

Overwash sediments deposited on a beach ridge in St. Vincent Island, Fla., during 2018 Hurricane Michael.

To overcome these pitfalls, we need records of flooding encompassing the most extreme events, and we need to understand the climatic and anthropogenic drivers of extreme floods. One of the characteristics of extreme flooding is fast and powerful flow capable of transporting large sediment particles. Therefore, the particle composition of deposited sediments can be used to indicate the occurrence of extreme floods and even flood magnitude. This has been demonstrated in a paper I recently co-authored in the journal Nature.

At Coastal Carolina University, the major focus of paleo flood study in my research group is to expand the record of extreme flood using sediment data. We are interested in both riverine floods and floods due to storm surges in the lowland coastal zone, because this area is often densely populated and highly vulnerable to flood hazards. Specifically, we have ongoing projects involving undergraduate and graduate students at CCU, and in collaboration with colleagues outside CCU, to investigate flooding in the Great Pee Dee River and Waccamaw River; in the state of South Carolina as a whole; and storm surge flooding by major hurricanes in Florida.

In order to trace extreme flood in sediment records, it is essential to know the characteristics of sediment related to extreme floods. Hurricane Florence and Hurricane Michael (2018) caused record-breaking flooding in South Carolina and Florida, respectively, and offered an exceptionally rare opportunity to learn this. With support from the National Science Foundation, we collected freshly deposited sediments along the Great Pee Dee River, the Waccamaw River, and in Winyah Bay immediately after the Hurricane Florence flood receded.

In Florida, we collected fresh overwash deposits preserved in marshes and ponds behind beach ridges in St. Vincent Island at Apalachicola. This island was almost completely inundated by storm surge during Hurricane Michael. The sediments will be analyzed for particle composition using a laser diffraction particle size analyzer (LDPSA) recently acquired in the Department of Marine Science. In addition, the abundance of a short-lived isotope, 7Be, that is used specifically to trace fresh deposits, will be measured for the Hurricane Florence sediments. Foraminifera tests will be done for the Hurricane Michael overwash deposits to help identify their marine source.

Expanding the record of extreme flooding demands long sedimentary records, and we took sediment cores for this purpose. We used piston coring, vibracoring, and push coring in floodplain lakes that are abundant and known to preserve relatively long sedimentary records in South Carolina, and in coastal ponds and marshes behind beach ridges in Florida. The cores were split and subsampled for different measurements to identify extreme paleo floods. The basic measurement is particle composition. In addition, we may in the future employ isotopic analysis to help identify flooding by

Professor Zhixiong Shen (right) *with students Kaylea Carter and Morgan Sopar analyzing particle composition of sediment samples.*

heavy precipitation due to tropical storms in South Carolina, and foraminifera analysis to help confirm overwash events in Florida. The LDPSA data can be further analyzed to estimate the magnitude of paleo flood when monitoring data are available to calibrate the LDPSA data.

After identifying extreme flood events in sedimentary records, we plan to build a flood history to assess the climatic and anthropogenic drivers of extreme flooding. This is often done by measuring sediment ages using a multiple-dating-method approach. For sediments younger than about 100 years, ages can be obtained by measuring the abundance of isotope 210Pb. In addition, a peak abundance of isotope 137Cs in sediments is linked to the climax of atmospheric nuclear weapon tests in the 1960s. Age of much older sediments can be measured by radiocarbon dating of macrofossil organics, such as charcoals, leaves, and seeds that are preserved in the sediments. In addition, optically stimulated luminescence dating, which measures the last time when the sediments were exposed to sunlight prior to burial, is a good complement to radiocarbon dating.

Our preliminary data are starting to reveal some interesting patterns about extreme flooding in northeastern South Carolina. Frequency of extreme flooding in the Great Pee Dee River shows distinct multidecadal variations, and we speculate that may be correlated with multidecadal patterns of climate change in both the Atlantic (AMO) and the Pacific (ENSO and PDO). The most severe floods in this region are strongly correlated with landfall hurricanes; the Waccamaw River experienced extreme floods around 4,000 years ago with magnitudes similar to those associated with Hurricane Matthew and Hurricane Florence.

These findings, if verified by additional data analyses and further research, suggest that the historical flooding record for the past few decades does not cover the full spectrum of flood frequency in our region. Our sedimentary records, when completely interpreted, will cast a more comprehensive picture of extreme riverine flooding. In addition, we may expect floods in the future that are larger than any in the historical record because global warming can change strong hurricanes so that they dump more heavy rains when making landfall (e.g., the Texas landfall of Hurricane Harvey in 2017).

by **Julie Harvey**, M.S., and **Sathish Kumar**, Ph.D.,
associate professor, Department of Computing Science

Intelligent Transportation Systems Security:
ISSUES AND SOLUTIONS

Incorporation of intelligence is becoming an increasingly important part of the transportation system. Attacks on the transportation infrastructure have been limited, but as more vehicles become connected, the threat for cyberattacks increases.

Now more than ever, there is a need for secure Intelligent Transportation Systems (ITS) in individual vehicles and public transportation. Security of these systems is crucial for safe and efficient transportation. The purpose of this article is to present a survey of ITS security problems followed by potential solutions.

ITS security is critical due to the advancement and emergence of new technologies in transportation. Different modes of transportation and traffic management use ITS's innovative services for smarter transportation networks. ITS are also an important part of vehicle safety and luxury. ITS incorporate a wide range of applications and continue to increase in importance for individual and public transportation systems. These applications process and share information to make improvements for traffic flow, traffic management, and environmental impacts from transportation systems. Technology is also used in individual vehicles to connect vehicle information to other vehicles and remote infrastructure. Clearly, ITS are crucial to creating smart cities, and attacks to these systems could cause serious transportation disruptions and inconvenience to the public.

TYPES OF THREATS

Research in the field of ITS is very active, but most of it focuses on the applications of ITS rather than on cyber-

Criminal gangs, hacktivists, cyber-terrorists, insiders, unscrupulous operators, and natural disasters are all described as potential attackers to ITS.

security. There are limited studies addressing the security of ITS and attacks on the systems.

Criminal gangs, hacktivists, cyberterrorists, insiders, unscrupulous operators, and natural disasters are all described as potential attackers to ITS. Intelligent transportation systems are unique in that they are highly visible and result in large impacts when the systems are attacked. This visibility can be a strong draw. Motives may be ransom, data theft, information warfare, system gaming, theft, revenge, and terrorism. The information can be acquired by physical, wireless, or network attacks, and attacks can occur through single or multiple vectors.

Information warfare includes denial-of-service attack on the ITS infrastructure, thus leading to system crash. It can also be used to post messages of political positions, protests, or pranks. Traffic chaos can be created if a fake vehicle-to-vehicle (V2V) message is transmitted. Map hacking can also be used to compromise location transmitters and GPS receivers.

System gaming and theft involves stealing goods from inside vehicles or stealing the entire vehicle. ITS are also exploited to avoid paying fees and service charges. Autonomous vehicles can be hacked and rerouted to remote locations or used for delivery of contraband anonymously. Autonomous vehicles can be hacked and instructed to a remote location where a theft of valuables, vehicle parts, the whole vehicle, or abduction is possible. A competitor's car may be hacked to subvert competition and make the vehicles unavailable. Fake orders for ride-sharing services can be placed to charge unsuspecting customers.

Revenge and terrorism is another model used for attacks on ITS, and is one of the most serious. Driving functions can be compromised and vehicles can be turned into weapons. Predicting and defending against these types of attacks is very difficult. Traffic flow control mechanisms can be disrupted, ITS safety systems disabled, roadside emergency alert systems triggered, and sensitive data compromised.

Physical attacks are easily conducted because the ITS infrastructure is exposed on the roadways. A device can be accessed using brute force or guessing credentials. Topology can be discovered by scanning a secured or closed network. An ITS device can be compromised by deleting files, or firmware can be installed to recover credentials and configurations. Man-in-the-middle attacks intercept data using exposed wiring or cables and can send false data to the back-end servers. Corporate networks can be accessed by pivoting an ITS device as an entry point to be trusted.

Wireless attacks pose a major security threat to ITS infrastructure. Spoofing messages can be broadcast; sniffing wireless transmissions can be done; malicious firmware can be remotely transmitted and installed; wireless transmissions and vehicle safety systems can be electronically jammed; and man-in-the-middle attacks can be conducted to intercept and modify data.

Network attacks are a risk because intelligent transportation systems are exposed to the internet and discoverable on Internet of Things (IoT) search engines, making them vulnerable. Device misconfigurations are identified and abused while vulnerabilities in software and hardware are exploited. The system can be discovered remotely and abused through the installation of malware and/or spyware.

ITS ecosystems are constantly evolving, and threats to these systems are evolving as well.

Vehicular Ad hoc Networks (VANETs) are vulnerable to attacks that can affect roadway safety. Sybil attacks are the most dangerous and can be very difficult to detect. They involve a vehicle appearing to have more than a single identity. Data received from this vehicle cannot be determined if it is coming from one vehicle or multiple. Attackers use this to shape the network according to their goals. A distributed denial of service (DDoS) attack occurs by more requests being sent to a system than it can handle, leading to overwhelming and crashing the system.

MINIMIZING THREATS

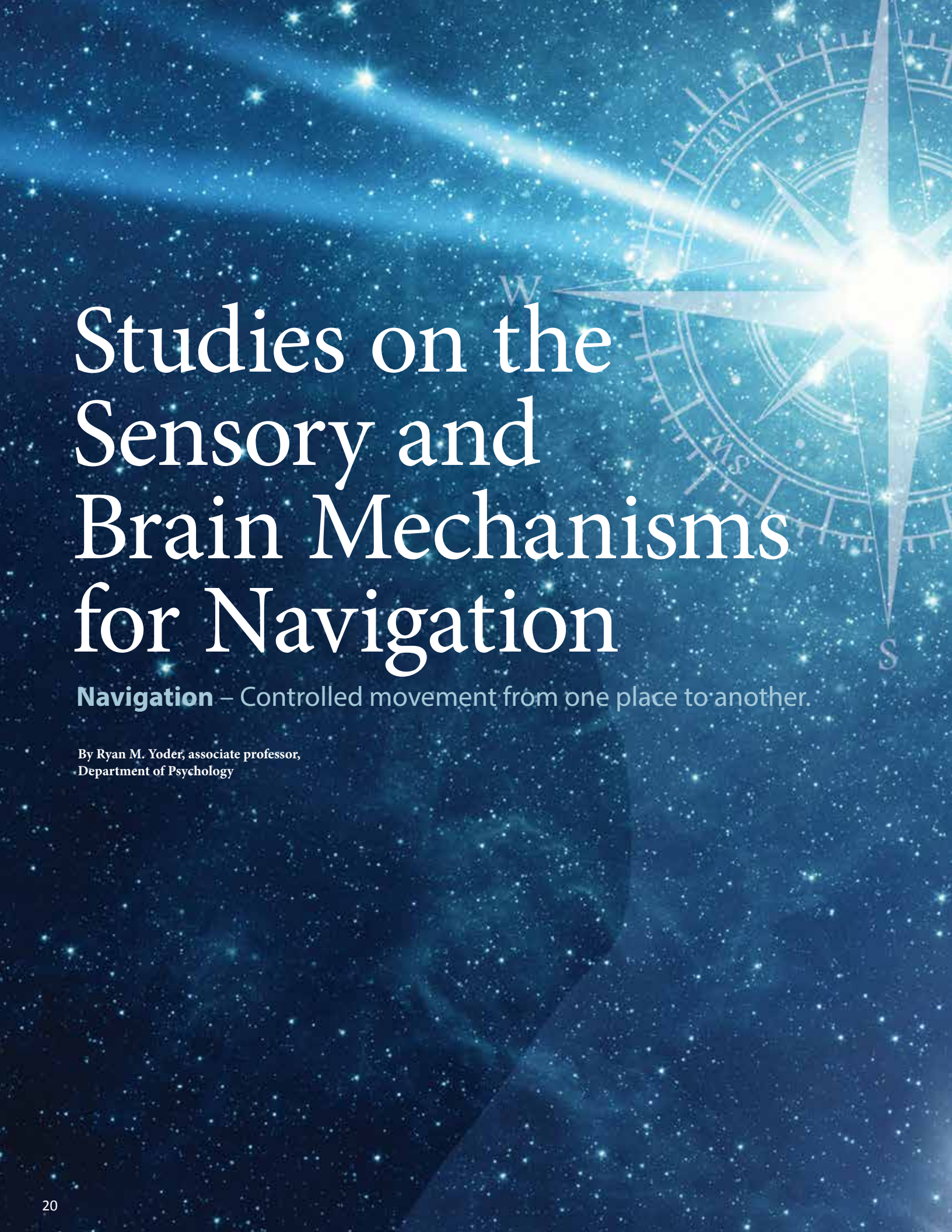
Cyberattacks and breaches are inevitable, but prevention and recovery strategies should be an integral component of the daily business operations for ITS operators. Security breaches need to be identified quickly and responded to continually. Security breaches need to be contained and the loss of sensitive data stopped. Attacks need to be prevented by securing all vulnerabilities. Defenses need to be strengthened and repeat incidents prevented following an attack on the ITS ecosystem.

Specific actions used to protect the security of ITS include:

- Network segmentation that splits a network into subnetworks reducing congestion, improving security, and limiting failures.
- Firewalls implemented to control the outgoing and incoming traffic. This control is based on a rule set that is applied to the monitor.
- Next-generation firewalls and gateways that bring multiple systems and services together in a single engine or appliance.
- Anti-malware software used to scan files. Malware can be detected, blocked, and removed.
- Anti-phishing solutions that scan email for incoming spam and phishing emails and block them. Malicious attachments pose a potential risk and can be screened using message sandboxes as part of anti-phishing solutions.
- Breach detection systems (BDS) that detect and analyze targeted attacks threatening to harvest information from the system.
- Intrusion Prevention Systems (IPS) and Intrusion Detection Systems (IDS) scan the entire network, looking for traffic deemed suspicious.
- Digital signature algorithms (e.g., encryption) used to overcome attacks on ITS applications and systems.
- Physical and virtual patch management and scanning for software update endpoints, servers, and remote computers.
- Shodan scanning used for internet-connected devices and identifying unpatched vulnerabilities and exposed cyber assets.
- Data fusion software on a vehicle that can identify the true state of the vehicle. It can also give information about the vehicle's surroundings. These data fusion systems can potentially assist in the identification of anomalous inputs from cyberattacks.
- Biometrics is an authentication technique that measures physiological and individual characteristics and can make a decision whether or not to authorize the user. The security of the whole IT system is increased with the use of biometrics, and the risk of impersonation is reduced.
- Policy recommendations can help provide security protection for ITS. Countries sharing land borders should coordinate so their ITS frameworks can work together instead of trying to integrate incompatible ITS frameworks. Greater collaboration, exchange of information and knowledge of cybersecurity across borders will help to develop and implement awareness for educating end users of the potential risks in the ITS environments. Information and countermeasures can be shared regarding cyber threats and attacks.

CONCLUSION

ITS ecosystems are constantly evolving, and threats to these systems are evolving as well. There is a large range of improvements that should be directed toward prevention and resolution of attacks. However, a more holistic evaluation of ITS is needed to analyze early stage threats. Research needs to be approached from a variety of perspectives, with the goal of balancing the security, convenience, and functionality of security vectors.



Studies on the Sensory and Brain Mechanisms for Navigation

Navigation – Controlled movement from one place to another.

By Ryan M. Yoder, associate professor,
Department of Psychology

Vestibular system – Sensory system in the inner ear that coordinates movement and balance.

Efficient navigation is a necessary part of our daily lives. From walking around the house in the middle of the night, to efficiently taking a detour around a closed street, to finding our car in a crowded parking lot, we would essentially be lost if we were unable to learn how to navigate accurately. The importance of navigation is even more apparent in a debilitating disorder such as Alzheimer's or dementia, where memories for locations and routes are lost. While the neural mechanisms facilitating navigation have been heavily studied for many years, we are only just beginning to understand each sensory system's role in this process.

Otolith organs – Component of the vestibular system that detects linear acceleration and gravity.

(Above) *Biology major Rob Tracey* (left) *and psychology major Mckenzie Nichol* (right) *prepare a leopard gecko for a behavioral experiment.*

(Opposite page) *Behavior studies on leopard geckos are conducted where the spatial field and light levels can be controlled.*

Mechanics of Navigation

Each sensory system provides unique information that can be used to guide navigation. For example, humans often navigate by relying predominantly on vision, but are also able to navigate relatively accurately in darkness. At least some of this non-visual information originates in the vestibular system – the inner ear mechanism that detects head movements and regulates balance. Research at Coastal Carolina University focuses primarily on the vestibular contribution to brain development as it relates to navigation.

Most of our understanding of the navigation-related brain mechanisms – henceforth referred to as spatial functions – comes from animal research. The use of animal models has several benefits, including the option to selectively remove or alter sensory signals prior to testing. Using this approach, our previous studies revealed that navigational performance depends on signals from the otolith organs – the specific part of the vestibular system that represents head position relative to gravity. These studies tested genetically modified mice that were born with dysfunctional (faulty) otolith organs. Across several different tasks, otolith-deficient mice were impaired at choosing which direction offered the most efficient path to a goal, but were not impaired in the ability to recognize a goal once the animal arrived at that location. These findings led to our current studies of altered brain development in mice lacking functional otolith organs. Our recent results suggest that otolith dysfunction impacts several brain regions involved in navigation, as well as in general learning functions. Unraveling the degree to which vestibular signals and memory processes overlap will provide both important insight into the cognitive deficits associated with vestibular dysfunction and a foundation for effective treatments.

Research Approaches

A full understanding of the brain processes underlying navigation also requires a comparative approach. Our lab has recently been working with Scott Parker, Ph.D., of the Department of Biology to evaluate the navigation abilities of leopard geckos (*Eublepharis macularius*), a reptile species whose ancestors diverged from mammalian predecessors several hundred million years ago. By determining how geckos organize their exploratory movements, as well as how they respond to visual and non-visual stimuli, we are seeking to understand how the reptilian brain performs spatial functions. Knowledge of which aspects of navigation are shared among mammals and reptiles is particularly helpful for our understanding of the fundamental properties of navigation.

FACULTY RESEARCH PROJECTS

Drew Budner, Ph.D., of the Department of Biochemistry and Chemistry, received a $2,000 grant from SC-EPSCOR. His project, titled "MADE in SC Research Experience for Teachers (RET)," seeks to involve local teachers in an authentic Coastal Carolina University research program.

Derek Crane, Ph.D., of the Department of Biology, received a $5,000 grant from the Belle-Baruch Foundation. His project, titled "Validation of Back-Calculation Methods for Juvenile Tarpon (*Megalops atlanticus*), and Assessment of Larval Recruitment to South Carolina Estuaries," seeks to develop new methods of accurately aging juvenile tarpon in South Carolina estuaries.

Erin Hackett, Ph.D., of the Department of Coastal and Marine Systems Science, received a $273,187 grant from the Office of Naval Research. Her project, titled "Influence of Horizontal Inhomogeneity of Refractivity Vertical Profiles on Electromagnetic Measurements in Application to Refractivity Inversions," seeks to understand the relative importance of refractivity horizontal variations on EM propagation in marine environments.

Fang Ju-Lin, Ph.D., of the Department of Biology, received a $2,000 grant from SC-EPSCOR. Her project, titled "MADE in SC Research Experience for Teachers (RET)," seeks to involve local teachers in an authentic CCU research program.

Richard Peterson, Ph.D., and **Rich Viso**, Ph.D., of the Department of Coastal Marine and Systems Science, received a $158,286 sub-award from the University of Georgia Long-Term Ecological Research Site. Their project seeks to understand groundwater movement to Sapelo Sound. The two professors also received an $111,638 grant from the University of Rhode Island for a part of their project that focused on groundwater and nutrient budgets in Narragansett Bay.

Rich Viso, Ph.D., and **Angelos Hannides**, Ph.D., of the Department of Marine Science, received grants of $132,785 from Briarcliffe Acres, Horry County, and North Myrtle Beach. Their project, titled "Water Level and Water Quality Monitoring," will determine the impacts of changes in channel trajectory across the beach face of the Whitepoint Swash, a tidal creek in North Myrtle Beach, S.C., linking the ocean and an estuary surrounded by commercial and residential development.

Bryan Wakefield, Ph.D., of the Department of Biochemistry and Chemistry, received a $63,804 grant from SC INBRE-NIH. His project, titled "DRP: Synthesis and Biological Evaluation of Phidianidine Analogues," seeks to identify novel methods for synthesizing variants of phidianidines, a group of molecules that protect cells from oxidative damage.

STUDENT RESEARCH PROJECTS

Danielle Capella (Coastal Marine and Wetland Studies graduate student) received a $1,500 grant from the MK Pentecost Fund. Her project, titled "Tracking Gravid Female Movements of Diamondback Terrapins in North Inlet, S.C.," seeks to measure the movements of diamondback terrapins in their natural habitat.

Madison Fink (Coastal Marine and Wetland Studies graduate student) received a $1,000 grant from the MK Pentecost Fund. Her project, titled "Sea Level Changes over Historic and Geologic Timescales in Winyah Bay, S.C.," seeks to understand the complex sea level history of Winyah Bay.

Garrett Herigan (Coastal Marine and Wetland Studies graduate student) received a $2,000 grant from the MK Pentecost Fund. His project, titled "Assessment of Habitat and Land Use Factors Influencing Presence and Absence of Sandhill Chub (*Semotilus lumbee*)," seeks to understand environmental effects on Sandhill chub populations.

Colleen Naeger (Coastal Marine and Wetland Studies graduate student) received a $1,000 grant from the MK Pentecost Fund. Her project, titled "Conservation of Diamondback Terrapin Nesting Sites in North Inlet, S.C.," seeks to improve diamondback terrapin nesting success.

CCU FACULTY AND STUDENT PUBLICATIONS

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–CCU authors in **bold**.
–CCU student [1].

PRESIDENT'S HONOR LIST SPRING 2019

APPLIED MATHEMATICS

Alexander O. Foster
Adam D. Goga
Michael J. McFarlane
Cannon R. McIntosh

BIOCHEMISTRY

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Amber L. Fultz
James D. Heldmann
Klea Hoxha
Conner M. Rapp
Mya E. Roblee
Korinne M. Swanson

BIOLOGY

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Abbey S. Montoya
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Madison L. Redick
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Alicja Z. Zduniak
Sayer Zimmerman

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Chrystal J. Spivey

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Jade V. Salis
Jacob Simone
Abigail K. Solarz
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Elizabeth Tautges
Jacob D. Vannoy
Ryan P. Ware
Brittany M. Whitcher
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NURSING

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Ryan Williams

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Meg E. Blake
Jazmine T. Bolden
LaDaysha K. Bonaparte
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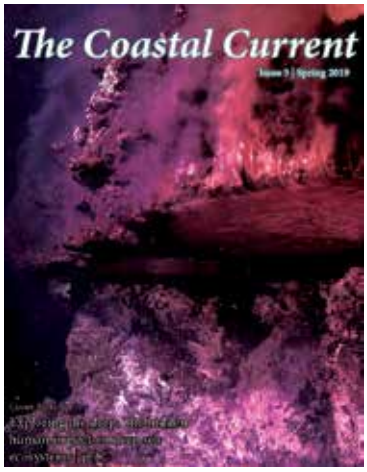
the COASTAL CURRENT

Graduate students edit new magazine, "The Coastal Current"



"The Coastal Current," a magazine edited and produced by graduate students in the Coastal Marine and Wetland Studies program, is now in its third issue. The current editors, Charlotte Kollman and Kaitlin Dick, hope the publication will inform the larger Coastal Carolina University community about people and events within the School of the Coastal Environment. We asked Kollman about her experience as the magazine's editor.

Q&A WITH

CHARLOTTE KOLLMAN

Q. How did this magazine come into existence?

A. The publication was started in 2017 under the advisement of Richard Viso Ph.D., and then-graduate coordinator Karen Fuss. The job of publication is offered as a graduate assistantship to support CMWS and CMSS students. The first co-editors were Todd Rhodes (CMSS) and Claire Nolan (CMWS).

Q. What is the most difficult part of producing an issue?

A. The most difficult part of producing an issue for me is the editing process. We have pretty strict word counts in order to have a graphically polished issue, but I hate to cut out parts of interviews or stories because I find it all fascinating.

Q. What have you learned so far in your role as editor?

A. I came on to this publication in the sophomore issue, working with Claire Nolan. The biggest thing I learned working on "The Coastal Current" is that there are so many diverse and interesting things happening within the School of the Coastal Environment. It was nice to step outside of my own lab and learn about the other cool things my peers and the faculty are working on.

Q. What has been the response from readers?

A. It is still such a young publication, but the response from readers gets better with each issue as we learn and adapt. I look forward to seeing how Kaitlin and the new student who will help her next year continue to improve the newsletter.

Charlotte Kollman is a student in the CMWS program. She studies isotopic geochemistry in the Groundwater Discharge Measurement Facility, under the advisement of Rick Peterson, Ph.D. She grew up all over the Southeast, but has lived in South Carolina for the last 14 years.

THE COASTAL CURRENT

EDITORS:
Charlotte Kollman, Kaitlin Dick

GRAPHIC DESIGN/LAYOUT:
Charlotte Kollman

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SWAIN SCHOLARS PROGRAM
ANNOUNCES NEW SWAIN SCHOLARS

by **SHARON H. THOMPSON, PH.D.,** *professor, Department of Health Sciences*

Swain Scholars are selected among the top undergraduate students in Coastal Carolina University's sociology, public health, biochemistry, biology, exercise and sport science, and chemistry programs. For Fall 2019, three Coastal Carolina University students received this distinction: Jonah Nordeen, Caroline Durham, and Armani Sumpter. Nordeen and Sumpter were named Kenneth E. Swain Scholars and Durham is a Jewel Clemmons Swain Scholar. As Swain Scholars, these students will plan and implement community outreach and research projects designed to improve the quality of life of Horry County residents.

JONAH NORDEEN

Jonah Nordeen, a Kenneth E. Swain Scholar, is a double major in biochemistry and psychology with a behavioral neuroscience concentration. He is currently a University Housing resident adviser, a chemistry laboratory assistant, and a chemistry tutor. He is a member of the National Society of Leadership and Success, a member of the CCU Honors program, and is a President's Scholar Award recipient. Nordeen has particular interest in understanding the biological mechanisms of neurodegenerative disorders, such as Parkinson's disease and Alzheimer's disease. He plans to attend medical school and become involved in research for these disorders. He spent his summer working with faculty members in the Department of Chemistry on a project focusing on synthesizing a molecule that works to alleviate the effects of oxidative damage in the brain.

"It was really a fun and interesting experience and I'll be continuing that work this coming fall," Nordeen said. "To be named a Swain Scholar is an incredible honor, and I'm excited to be a part of a program that simultaneously provides me with priceless experience and assistance to those in need in the surrounding communities."

CAROLINE DURHAM

Caroline Durham, the Jewel Clemmons Swain Scholar, is a public health major and psychology minor from Myrtle Beach, S.C. She currently works as an emergency room scribe at Tidelands Waccamaw Community Hospital. She is the president of Eta Sigma Gamma, the public health national honor society on campus; the assistant to the president of the Cannabis Business Organization; and a mentor of the Dalton and Linda Floyd Family Mentoring program. Durham has a passion for international public health issues and recently traveled to East Africa to provide service.

This summer, she traveled to Cartagena, Colombia, South America, where she worked with a foundation for children with cancer. She is preparing for a future public health internship in Quito, Ecuador. Durham plans to join the Peace Corps for two years after graduating, and then obtain a master's degree in public health to work in preventative health care in underdeveloped countries.

"I am so grateful to have the opportunity to bring awareness and change to the community where I was born and raised," said Durham. "I hope to better the lives of residents of Horry County through research with other students who share common interests with me."

ARMANI SUMPTER

Armani Sumpter, a Kenneth E. Swain Scholar, from Hemingway, S.C., is a public health major with a double minor in statistics and Spanish. She recently completed an internship at Smith Medical Clinic in Georgetown, S.C., where she shadowed physicians and educated patients on the importance of disease prevention. Sumpter is a CCU SHORE peer educator, a member of Eta Sigma Gamma, and a member of Doctors of Coastal. She has volunteered in numerous agencies such as the American Red Cross and Pee Dee Community Teen Improvement Project. Sumpter aspires to earn a master's degree in public health and work in the public health realm. She is interested in many areas, including holistic health, disease prevention, language, culture, and travel.

"Being a Swain Scholar means an opportunity to contribute to the local community through educating and creating awareness about health concerns specific to this area," Sumpter said.

The Swain Scholars program was founded in 2009 by Kenneth E. Swain, a Coastal Carolina University benefactor and retired Myrtle Beach pharmacist. The students receive scholarships up to $5,000 per year for a total of four semesters.

Previous Swain Scholars presented their research at a vast array of national conferences, including Posters on the Hill, Society of Public Health Conference, American College Health Association, and the Food and Nutrition Conference and Expo. Swain Scholars also have either won or been finalists in the CCU Undergraduate Research Competition six of the past eight years.

Senior-level Swain Scholars (Hailey Wimmenauer, Kassidy Smith, and Jeremy Evans) studied the effects of screen time on depression and suicide during their junior year and will expand this research in 2019-20. They have submitted a research abstract, "Breaking Suicide and Depression (SAD) Initiative: Examining the Correlations between Screen Time and Mental Health," to be considered as a presentation at the upcoming Society of Public Health (SOPHE) Conference in Atlanta, Ga., during Spring 2020.

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