Youngstown State University
BIOLOGICAL SCIENCES
News

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Research Herbarium of YSU

In 1965, Nicholas Sturm and Inga S Worley founded a teaching herbarium at Youngstown University. The herbarium had 200 speciments when I joined the faculty in 1967, the same year Youngstown University became part of the state system of higher education. Over the next decades, the herbarium was transformed from a teaching tool to a research treasure trove of over 100,000 cataloged specimens of plants from all over the world, a landmark reached in 2008.

Professors Sturm and Worley had both died by this time, but Nicholas Sturm had seen the beginning of the growth and was always encouraging the acquisition of specimens from far away so we would have an international makeup. There are just over 1,000 from New Zealand and Australia; over 300 each from Japan and Thailand; more than 600 from Europe, but only 290 from Latin America.

Today, thanks to two NSF grants—the first was for $35,000 and the second was awarded in conjunction with Ohio University, YSU receiving $97,000—all 107,500 specimens are housed in modern herbarium cases. Those specimens come from all seven continents; we even have a moss from Antarctica. The more than 58,000 specimens from North America come from all 50 states and all 10 Canadian provinces. This past July, Bonnie Isaac of the Carnegie Museum of Natural History and I traveled to Newfoundland and Labrador to collect more than 350 specimens in less than a week. Of course as you would guess, Ohio, Pennsylvania, and West Virginia are the largest holdings.

The vascular specimens are almost totally databased using BRAHMS, and the imaging process has started. All of the work is done by undergraduates who earn money and learn about plants at the same time. The nonvascular plants (bryophyta, fungi, lichens, algae) have not yet been databased.

This is my 45th year at YSU, and I hope that by the spring of 2015 (the 50th anniversary of the herbarium) there will be over 130,000 specimens in the herbarium, making it the 3rd largest in Ohio. In August I collected a grass, *Schizachyrium scoparium*, which bears my 50,000 collection number. This points out that more than half of the

(continued on back page)

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What Turtles Can Tell You

Turtles are often used for neurological research involving hearing and vision. But would you ever imagine that turtles would be important for teaching us about how muscles and bones interact during locomotion? At this point you are having fanciful visions of turtles exercising on a treadmill with wires hooked up to their muscles and bones. As improbable as this sounds, this is exactly what Assistant Professor Dr. Michael Butcher and his graduate student, Brett Aiello, are up to in the Department of Biological Sciences at YSU.

Butcher and Aiello are interested in understanding how muscle contractions directly influence the stresses and strains that bones experience during locomotion, and more generally, how limb-bone biomechanics have evolved from early sprawling tetrapods like turtles, to upright runners like horses. To do this, they are working with a specific species of turtle known as the river cooter (*Pseudemys concinna*), or simply "cooter" to folks in the South. In collaboration with Dr. Rick Blob at Clemson University, the cooters are trapped (see photo) in spillways of Lake Hartwell that surround the Clemson campus and brought to YSU where they are housed in Butcher's laboratory.

Despite being primarily aquatic animals, it turns out that river cooters (like other turtles) make a great model for locomotor studies because they are restricted to using a walking gait over ground due to the massive shell they carry around to protect them against predators. Cooters also have simple muscle architecture, displaying long muscle fibers in a parallel arrangement. This muscle design is good for muscle contractions that generate high power during swimming, and allows for easy implantation of special crystals to measure the length change of muscle contractions, which is related to the work of terrestrial walking. The crystals transmit and receive sonar impulses at the speed of sound and allow the researchers to determine how much strain a muscle undergoes during contractions.

Certain muscles in the cooter hindlimb are outfitted with these sonometric crystals in addition to electromyography (EMG) electrodes for recording when the muscles are turned on and off, and thus when muscle contractions are active and passive, respectively. To account for bone stresses and strains, a small strain sensor is also attached to the cooter's femur in alignment with the muscle sensors. Each instrument is custom made by Aiello, and all are surgically implanted into the right hindlimb to permit live biomechanical recordings from both muscles and the femur during treadmill walking. This approach is technologically challenging and is the first time such an

endeavor has been reported in biomechanical research.

River cooters are a particularly tractable species of turtle to use for these experiments, and relatively little effort is needed to train them to walk on a treadmill. The captive cooters are trained to perform on the treadmill several weeks to familiarize them with the rigors of the experiment. A typical experiment involves numerous trials of the cooters walking at their maximum speed while making direct recordings of live muscle contractions and bone strains. Each experiment is also documented with a high-speed video camera so the walking gait of the cooters can be matched in real time to the recorded patterns of muscle and bone strains. All recorded data are synchronized by a special software program that allows simultaneous visualization of the strains in the muscles and femur, and how they change with the movement of the hindlimb during walking. This allows the researchers to take measurements to better understand how muscle contractile function and bone biomechanics may be correlated.

Studying a single turtle comes at the expense of two full months of work. However, all the hard work is paying off. With the animals studied thus far, the research team has observed a close relationship between muscle contractile patterns and bending of the cooter femur during walking. These novel data are allowing us to further understand the mechanisms of how limb bones bend and twist during routine locomotion, and they provide insight into how limb bones may have evolved their shape and strength as animals diversified for terrestrial locomotor activities. Data from this study may also prove to be important for biomedical engineers

to design new materials for prosthetics or develop uses of other materials for limb-bone repair and reinforcement.

By Dr. Michael Butcher

Stephanie McCann MS Student

Stephanie McCann graduated from YSU with a BS in chemistry in December 2007. From there she got a job with L'Oreal in Solon, OH, in the company's quality control lab. But she missed the research environment and returned to YSU to join the laboratory of Dr. Gary Walker in our department as a Master of Science (MS) graduate student in August 2009, working on the molecular biology of muscle stem cells.

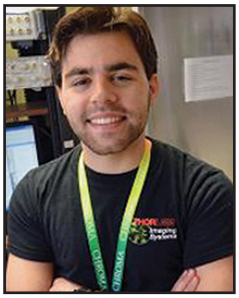
Stephanie McCann

Her interest in molecular biology started when, as a chemistry undergraduate, she conducted DNA sequencing experiments in Dr. Walker's lab. The laboratory was working on cloning and studying muscle proteins involved in autoimmune rippling muscle disease. Stephanie displayed the skills that make a great molecular biologist. She successfully sequenced a portion of the titin gene, which resulted in her co-authoring a journal article and a GenBank submission. As a graduate student she has subcloned the portion of titin gene into a green fluorescent protein fusion gene and has expressed this protein in mouse muscle stem cells.

She will finish her degree this fall. Her future plans are to pursue a research career in molecular biology in the biotech industry.

By Gary R. Walker, Ph.D.

Zane Kalik BS Student



Zane Kalik

Zane Kalik is a very busy senior undergraduate student. He is double majoring in biology and chemistry, is in the YSU Honors program, and serves in the YSU marching band. In addition, he has been actively involved in scientific research throughout his time at YSU, starting his freshman year when he worked with Dr. Carl Johnston studying brown-field decontamination using microorganisms. However, for the past three years, he has been actively investigating how cardiac muscle cells regulate their contractile activity.

Zane began his research project as a sophomore, working under the guidance of the late Dr. Carl Sims in the Department of Biological Sciences, who taught Zane how to isolate cardiac cells and record calcium currents. When Dr. Sims submitted an abstract for presentation at the 2010 international Biophysical Society meeting in San Francisco, Zane was included as an author and accompanied Dr. Sims to the meeting.

In 2010, Zane was chosen for the YSU MBUR (Math and Biology Undergraduate Research) program, a National Science Foundation (NSF) funded program that provides summer research fellowships for undergraduate students. However, tragedy struck that summer with the untimely death of Dr. Sims. Despite this setback, Zane completed his ongoing cardiac experiments. Working with Dr. Mark Womble of Biology and Dr. Jozsi Jalics of Mathematics as MBUR research advisors, Zane modified the cardiac cell model and ran simulations to test their hypothesis. These biological and mathematical findings then became the basis for several poster presentations. The MBUR students presented their research at national and regional scientific conferences. In addition, Zane was first author on an abstract submitted for the 2011 Biophysical Society meeting in Baltimore, which Zane attended with travel funds provided by YSU. In 2011, Zane was awarded a highly competitive University of Pittsburgh Research and Investigation Summer Experience fellowship that allowed him to work full time in a cardiac research laboratory at theUniversity of Pittsburgh Medical School where he extended and expanded his cardiac muscle research. A manuscript that incorporates all of the biological and mathematical work is currently in preparation for submission to a major peer-reviewed scientific journal.

Zane views his research efforts with pride. His advice for new students: "Get started with research as early as possible and be passionate about what you are studying. This leads to both research and academic success." After graduation, Zane hopes to enter the M.D./Ph.D. program at the University of Pittsburgh, where he plans to continue in his cardiac research.

By Dr. Mark Womble

Research Herbarium of YSU

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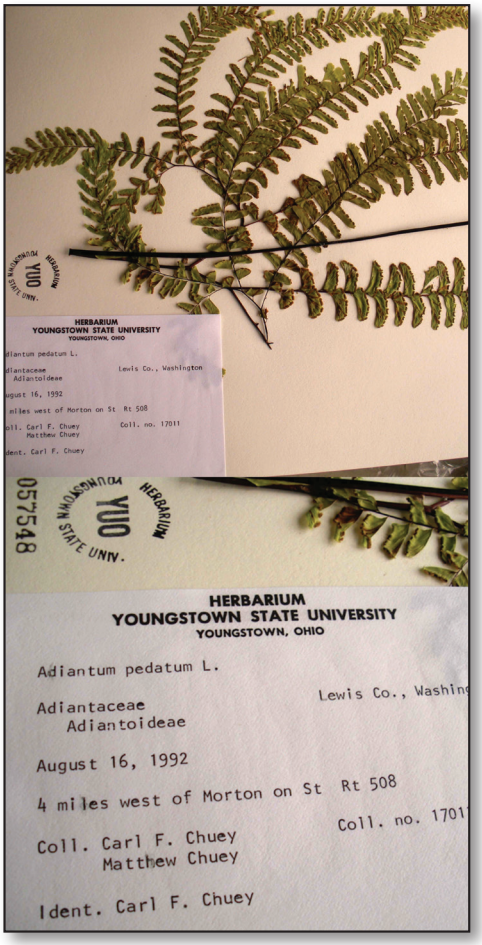
collection has been collected by you, my former students.

I invite all of you to stop by for a visit, to see the herbarium you helped make by all your collections, and to



make a generous donation to the herbarium endowment. This will ensure that there will always be a herbarium at the urban research university—YSU.

By Carl Chuey