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Recommended Citation
University Communications, Illinois Wesleyan University, "Students' New Research Technique May Shed Light on Avian Evolutionary History" (2015). *News and Events*. 2697.
https://digitalcommons.iwu.edu/news/2697

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Students' New Research Technique May Shed Light on Avian Evolutionary History

Jan. 29, 2015

Undergraduate Research: Biology major Jason Murphy compares eggshell structure of different bird species

Two recent graduates of Illinois Wesleyan University have developed a method to create polyurethane casts of the internal airspaces in bird eggshells, providing ornithologists with a new way to look at pore structure for a better understanding of avian evolutionary biology.

Biology majors Jason Murphy ’14 and Mark Swanson ’14 are lead authors on a paper highlighting this research that has been published in *The Auk: Ornithological Advances*, one of the top ornithological journals in the world. Murphy and Swanson were co-advised by Will Jaeckle, associate professor of biology, and R. Given Harper, George C. and Ella Beach Lewis Endowed Chair of Biology, who are also co-authors of the paper.

All eggshells have pores that facilitate the movement of gases and water vapor between the embryo and the surrounding environment. For this reason, many ornithologists are interested in the frequency and distribution of eggshell pores because the rates of gas movements can affect rate of development of embryos, the authors said.

Until recently, few techniques existed to visualize the three-dimensional shape of these internal air spaces, making it difficult to predict gas and water vapor movement across the eggshell. “Our understanding how eggshells influence gas fluxes has been largely dictated by our abilities to count and measure the outer diameter of the pores,” said Jaeckle. To examine the shapes of the pore spaces Murphy and Swanson filled the pores of eggshells of the domestic chicken, the house sparrow and the ostrich with a polyurethane resin.

“After the pore spaces of the shell were filled, we were able to dissolve away the eggshell around the hardened resin with acid,” explained Murphy. “We then viewed our casts using a scanning electron microscope (SEM).”

It was a process filled with failures as well as successes. “It took about two weeks to produce a round of casts, and initially they did not turn out too well,” said Swanson. “But it was exhilarating, too, because we never knew what we would see (with the SEM). Every time we examined a new cast, it was like exploring a foreign world.”

Mark Swanson '14

The authors said the simplicity of the technique along with the stability and resilience of the resulting casts allow researchers to evaluate the morphology of eggshell pores among birds of different taxonomic groups. The paper’s publication is the culmination of a two-year project conducted when Murphy and Swanson were IWU students.

Predicting gas flux across eggshells may help to answer questions about evolutionary biology, according to Harper. “Using this technique to look at pore structure and then comparing among eggshells of different species will, perhaps, shed light on their evolutionary histories,” said Harper.

The publication of the paper illustrates the possibilities for students to make substantive contributions in a particular field, if they are willing to devote the time, energy and patience to original research, Jaeckle added.

Murphy said the project was rewarding because he learned about the process of conducting research and the effort necessary to complete a project and publish one’s work in a peer-reviewed journal. “It gives me a great sense of pride knowing that my research will be read by professional scientists,” said Murphy, who is a University of Chicago lab technician working on a project using nanoparticle-based therapeutics for the treatment of glioblastoma.

Currently a Ph.D. student at the Louisiana State University Museum of Natural Science, Swanson credited Jaeckle and

Harper for their guidance in facilitating his development as a scientist. “They were able to find the perfect balance between allowing Jason and me the freedom to explore our own ideas and reining us in when we needed more help,” he said.