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ECR SPOTLIGHT

ECR Spotlight – William Bugg

ECR Spotlight is a series of interviews with early-career authors from a selection of papers published in Journal of Experimental Biology and aims to promote not only the diversity of early-career researchers (ECRs) working in experimental biology during our centenary year but also the huge variety of animals and physiological systems that are essential for the 'comparative' approach. William Bugg is an author on 'Elevated temperatures dampen the innate immune capacity of developing lake sturgeon (*Acipenser fulvescens*)', published in JEB. William conducted the research described in this article while a PhD Student in the lab of Dr Gary Anderson and Dr Ken Jeffries at University of Manitoba, Canada. He is now a postdoc in the lab of Dr Kristi Miller and Dr Andrew Bateman at the Pacific Salmon Foundation, Canada, and the University of British Columbia, Canada, investigating the physiological impacts of compounding environmental stressors in fishes of conservation concern.

William Bugg

Describe your scientific journey and your current research focus

My scientific journey has been a curvy road. My first real lab experience was in 2014 at the North Carolina Museum of Natural Sciences as an intern working under Dr Arthur (Art) Bogan, helping to manage the museum's collection of freshwater mussels to aid researchers interested in their conservation. This experience helped me develop a love for the underappreciated, threatened species that inhabit our freshwater systems, and I still hold a soft spot for freshwater mussels in my heart to this day.

Following my undergraduate graduation from North Carolina State University in 2015, I received a Graduate Student Fellowship from Auburn University to work in their Catfish Molecular Genetics laboratory. Here, I got my first dive into the combination of genetics and physiology as we worked with a variety of catfish species to improve performance traits for aquaculture, through either transgenerational selection or applied transgenesis and gene editing.

While I enjoyed my time and research at Auburn (which ended in 2017), I wanted to get back to the conservation side of research. Thus, when I was offered an opportunity to study the physiology and transcriptional responses of threatened lake sturgeon populations at the University of Manitoba, I was overjoyed. I had no idea where Winnipeg was, but when I googled Manitoba it said there were wolves and polar bears, so I was somewhat intimidated by the move from the deep south to the great white north.

Moving to Manitoba turned out to be one of the best decisions I've made in my life; I met my partner there, made friends that I will have throughout the rest of my life, and was able to conduct a great deal of experiments with the goal of conserving lake sturgeon. I was able to work with industry hatcheries through Manitoba Hydro, advising both rearing and release practices for sturgeon to reduce stress and improve survival. Further, lab-based acclimatory studies revealed population-specific gradients along the latitudinal range of lake sturgeon throughout the province and highlighted the vulnerability of northern populations to a warming environment. Finally, I was able to conduct the research for this paper and show that increasing temperatures may have profound impacts for developing lake sturgeon; both in hatcheries and in wild environments, as stress mounts, their energetic stores are reduced, and their innate immune responses become dampened.

What are the potential implications of this finding for your field of research, and is there anything that you learned during this study that you wish you had known sooner?

I think these findings are important to lake sturgeon specifically as they can help inform hatchery rearing practices (higher temperatures to increase growth may not necessarily be good for immunity), but also speak to the vulnerability of developing fishes to compounding stressors. There are extensive bodies of research examining the impacts of singular stressors, but the natural environment doesn't come at these organisms one challenge at a time. This research highlights the need to do these multistressor studies when attempting to evaluate the impacts of stressors in the wild, and I hope it helps to highlight just how vulnerable freshwater fishes may be in early development.

Which part of this research project was the most rewarding/challenging?

Definitely the COVID part. This research was originally planned to be conducted in the summer of 2020 and because of COVID travel

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Capture of wild spawning, adult lake sturgeon, for gamete collection, at Pointe du Bois on the Winnipeg River, MB, Canada.

restrictions and facility limitations, it had to be rescheduled for 2021. Even in 2021, it was difficult to conduct with the restrictions that were in place. At the time, I was living with my partner in Vancouver, BC, so I made the 23 h drive to Winnipeg, quarantined in an Airbnb for 14 days as government regulations required, and then immediately traveled to Pointe Du Bois the next day to catch the sturgeon spawn, which was already occurring. Luckily, I had an excellent team of folks already out at the sampling location with sturgeon caught and we were successful in our gamete collection (and one of them even let me live with them for 3 months to complete this work: big shoutout to Ian Bouyoucos for that one). Then, we had to manage the rearing of these tens of thousands of developing sturgeon, working in shifts at the University of Manitoba, to make sure we could provide the fish with the best care possible given the circumstances.

I am extremely grateful to my lab mates and co-authors who made this study possible, working the long hours under the circumstances we were in. This type of work is not something anyone can, or should, attempt to do alone, and without them this project would have been completely impossible to complete as it stands.

Why did you choose JEB to publish your paper?

I felt that this research was mechanistic and hypothesis driven enough to make it into the journal. I also feel like overall there is a lack of sturgeon work that gets featured in JEB. There's a lot of great research out there being conducted on some of the most endangered organisms on the planet and it deserves to be highlighted by such a well-renowned and well-read journal as JEB. I'm glad they agreed. Hopefully this will ultimately encourage other folks to study these species, to aid in their conservation.

Are there any modern-day JEB papers that you think will be the classic papers of 2123?

I think that Patricia Schulte's 2015 paper, 'The effects of temperature on aerobic metabolism: towards a mechanistic understanding of the responses of ectotherms to a changing environment' (doi:10.1242/jeb.118851) is an excellent example of a paper that summarizes the findings concerning a complex fundamental mechanism that is critical to a variety of species as environmental temperatures intensify. It delves into the mechanistic impacts of temperature on aerobic performance, applies that in an organismal context through thermal performance curves, and addresses the impacts of temperature on complex multi-step organismal processes that are enacted across levels of biological organization. It paves the way for future research by establishing a multi-level framework to investigate these impacts as temperatures increase. I believe this paper will stand the test of time and be viewed as a classic paper in 2123.

If you had unlimited funding, what question in your research field would you most like to address?

The goal, to me, is to figure out how best to conserve our biodiversity as environments shift and how best to implement management practices that preserve the species that we still have. If that is a question that is answerable with unlimited funding, that's the question I want to answer. We are in a time of immense change as species go extinct at an unprecedented rate across the tree of life. I think biologically, and as a conservationist, that is the most important question that we can possibly answer: how do we preserve the remaining life on Earth when so many pressures are applied to snuff them out?

What's next for you?

I have submitted and successfully funded a Mitacs proposal to work with the University of British Columbia and the Pacific Salmon Foundation to develop gill biomarkers for food deprivation in juvenile Chinook salmon for non-lethal application to wild salmonids. This research continues my passion for conservation, but also my scientific curiosity surrounding the interplay of compounding stressors, energetic deficiencies, and how they may impact the survival of fish in the wild. I am very thankful to have this avenue of funding to continue my research journey.

Reference

Bugg, W. S., Yoon, G. R., Schoen, A. N., Weinrauch, A. M., Jeffries, K. M. and Anderson, W. G. (2023). Elevated temperatures dampen the innate immune capacity of developing lake sturgeon (*Acipenser fulvescens*). *J. Exp. Biol.* **226**, jeb245335. doi:10.1242/jeb.245335