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ECR SPOTLIGHT

ECR Spotlight – Claudia Silva Rubio

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. Claudia Silva Rubio is an author on 'Physiological responses to hypoxia are constrained by environmental temperature in heterothermic tenrecs', published in JEB. Claudia is a research technician in the lab of Frank van Breukelen at the University of Nevada, Las Vegas, investigating mechanisms underlying mammalian torpor.

Claudia Silva Rubio

Describe your scientific journey and your current research focus

I recently received my master's degree at the University of Nevada, Las Vegas, working on *Tenrec ecaudatus*, or the common tenrec. These peculiar mammals are responsible for wholly directing my focus to research as a career. I had first joined Dr Frank van Breukelen's tenrec laboratory as an undergraduate and became fascinated with the unique physiological responses these tenrecs partake in and how these responses are not only variable but also heavily influenced by their environmental temperature. Such responses are unique in the mammalian world and are currently under investigation in our lab. My research focus is currently planning the right projects in an attempt to answer the neuronal interactions that occur in torpid tenrecs for my PhD.

How would you explain the main finding of your paper to a member of the public?

The scientific literature on tenrecs has been relatively sparse compared with other mammals but existing accounts have repeatedly stated tenrecs only hibernate by themselves in burrows. Recent hunting videos from the island of Reunion have shown these previous observations to not be completely true, since as many as 13 hibernating tenrecs are seen being removed by hunters from the same enclosed burrow. An environment that is sealed for many months and with many tenrecs will likely begin to have less environmental O_2 and more environmental CO_2, supporting the notion that tenrecs may be highly tolerant to those stressors. We therefore set out to measure the metabolism, ventilation and body temperature of active tenrecs as we continually decreased O_2 or increased CO_2 to determine their tolerance and compare such results with their torpid state and with other mammals.

Active tenrecs already do a lot of bizarre things without changing their O_2 and CO_2 environments: they not only fluctuate in resting metabolism individually and within a group, but they also occasionally have unexpected disconnects between their metabolism and body temperature, i.e. an increase in metabolism is followed by a decrease in body temperature. To further complicate their physiology, their variability in resting metabolism and body temperature is also temperature dependent, with colder temperatures resulting in more variability with both variables.

Our main finding shows that tenrecs have temperature-dependent responses to these conditions. When O_2 is decreased, they lower and become less variable in resting metabolism when their environment is colder, this constrained response in metabolism of tenrecs has only been observed in warm environments, where O_2 is unchanged. Surprisingly, their body temperatures remain relatively the same in cold and decreased O_2 conditions, a complete contrast to other mammals, even those that are heterothermic! Ventilation of tenrecs only increased with the highest CO_2 and lowest O_2 in warm conditions.

What are the potential implications of this finding for your field of research?

An environment lacking in O_2 (hypoxia) is a highly detrimental stressor and has driven many adaptive responses across all phyla that use aerobic metabolism. Comparatively, mammals have the least tolerance to hypoxia (and anoxia), possibly due to the larger energetic demands required for thermoregulation. Tenrecs are a very

Claudia Silva Rubio's contact details: School for Life Sciences, University of Nevada, Las Vegas, 4505 S Maryland Pkwy, Las Vegas, NV 89154, USA.
E-mail: Claudia.silvarubio@unlv.edu

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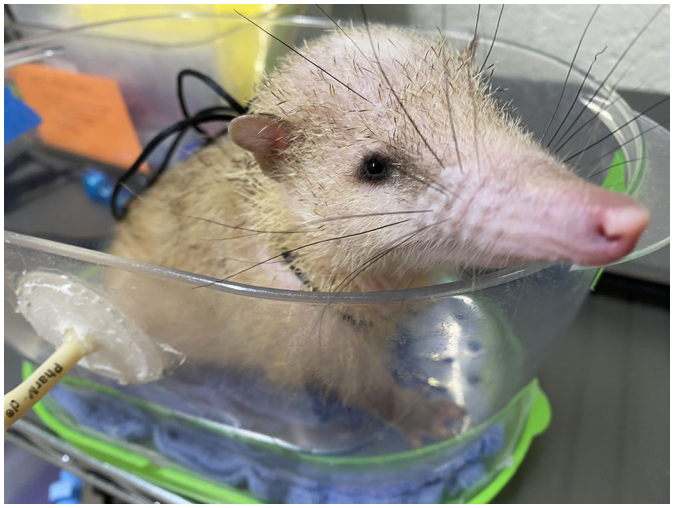

A common tenrec (*Tenrec ecaudatus*) inside a metabolic chamber prior to a respirometry experiment.

unique model – they are placentals that do not strictly partake in the standard interactions between metabolism and temperature seen in other mammals. These findings imply that hypoxic cooling may not be necessary for tenrec survival, which may be closer to a reptilian response than a mammalian one.

Additionally, it seems environmental temperature continues to influence tenrecs more than hypoxia, further amplifying the need to research the mechanisms underlying these temperature-dependent changes. Our tenrecs also bring into question what exactly defines a hypoxic metabolic response in mammals, is it just a metabolically induced depression? Must it be a concerted interplay between metabolism and core body temperature? I am excited to see how future work alleviates this conundrum.

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

The respirometry setup used to collect metabolic data gave us a minor headache during the first few days of data collection because pushing gas mixtures throughout an entire system requires absolutely no leaks to be successful. We were finally able to maintain a stable inflow by using some really refined reagents: diluted dish soap to find any leaks and either mounting putty or petroleum jelly to seal those leaks. Once this major problem was resolved, it felt especially rewarding to get past that hurdle and finally begin our experimental protocols.

Why did you choose JEB to publish your paper?

JEB is at the forefront of publishing impactful research, especially in comparative biology; publishing our paper with JEB guarantees a wide readership across all disciplines. Additionally, our very first paper on tenrec physiology was published in JEB and we saw it fitting to publish other physiological effects of tenrecs within this journal.

Are there any important historical papers from your field that have been published in JEB? If so, which paper, and how did it pave the way for later research?

Previous work from our lab on tenrecs by Treat et al. (2018) ['Extreme physiological plasticity in a hibernating basoendothermic mammal, *Tenrec ecaudatus*' (doi:10.1242/jeb.185900)] provided a great foundation for understanding tenrec physiology compared with other tenrec articles and I sincerely believe that if this publication were absent, it would not only be especially difficult to interpret our results when they were exposed to decreasing O_2 or increasing CO_2, but it would also be challenging to relay those results effectively to others, regardless of science background.

What do you think experimental biology will look like 50 years from now?

In 50 years, I believe the number of projects published or submitted to journals will likely double or triple due to how quickly technology is expanding; right now, the hot commodity is AI that can write essays and I foresee it being used by researchers to write manuscripts on the fly, which will in turn allow researchers to formulate and enact even more projects. I think, like with many other advances in science, AI will help greatly but will also largely change how academic publishing is structured. I also hope that in 50 years we finally have effective (and cheap) temperature logging devices that can be used without surgery/non-invasively and can give accurate temperature readings in real-time.

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

If money (and realistically time) was no issue, I would definitely contribute to the ongoing work of figuring out which neurons are responsible for torpor in a mammal, specifically the orchestrated synapses that begin the massive physiological events of metabolic depression and lowering of core body temperature. It would be especially interesting to see if similar synapses are involved when a mammal is entering and exiting torpor.

What's next for you?

There are many things to do! I am currently awaiting revisions on a separate manuscript that we submitted to JEB in February where we compared tenrec responses with those of the golden-mantled ground squirrel, *Spermophilus lateralis*, in a 7% O_2 environment. I'm also analyzing data on torpid tenrecs when they were also exposed to decreased O_2 or increased CO_2 conditions. Finally, I am about to pursue a PhD! I'm excited to start my doctoral journey this fall, where I can further sharpen my critical thinking skills and extend my research toolkit as I attempt to answer those physiological/mechanistic questions that keep me up at night.

Reference

Devereaux, M. E. M., Silva Rubio, C., van Breukelen, F. and Pamenter, M. E. (2023). Physiological responses to hypoxia are constrained by environmental temperature in heterothermic tenrecs. *J. Exp. Biol.* **226**, jeb245324. doi:10.1242/jeb.245324