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ECR SPOTLIGHT

ECR Spotlight – Nikolaos Papachatzis

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. Nikolaos Papachatzis is an author on 'Does foot anthropometry relate to plantar flexor fascicle mechanics and metabolic energy cost across various walking speeds?', published in JEB. Nikolaos conducted the research described in this article while a doctoral graduate research assistant in Kota Z. Takahashi's lab at the University of Nebraska at Omaha, USA. Nikolaos is now a postdoctoral research associate in the lab of Madhusudhan Venkadesan at Yale University, USA, investigating locomotor mechanics and energetics.

Nikolaos Papachatzis

Describe your scientific journey and your current research focus

Following a couple of troubled years and shifting from mechanical engineering to exercise science, I decided, in 2009, that my only option was dropping out of my undergraduate studies. But after a phenomenal biomechanics lecture by Professor Iraklis A. Kollias at the Aristotle University of Thessaloniki, Greece, followed by an enlightening discussion, I decided to stay and volunteer in his lab. During the following years, I fell in love with biology and mechanics, published my first article, got the scientific bug, and my journey had just begun!

In 2015, I received a graduate scholarship to join Professor Kota Z. Takahashi's research team at the University of Nebraska at Omaha in the Department of Biomechanics. I completed my MSc and PhD under Kota's mentorship, where I investigated how the structures of the ankle and foot produce mechanical energy and how this energy gets converted or utilized by the body – including how mechanical energy is converted to metabolic or thermal energy (i.e. heat dissipation). Kota was an exceptional mentor who encouraged and fed my curiosity about how different animals, from worms to dinosaurs, achieve locomotion. Inevitably, I developed a vast interest in comparative approaches and evolutionary biology and how I can incorporate scientific perspectives from different fields to understand why animal bodies move and look the way they do.

In 2022, I started my postdoc at Yale University's Department of Mechanical Engineering and Material Science, mentored by Professor Madhusudhan Venkadesan. Currently, I am developing mathematical and comparative experimental approaches to understand how mechanical forces have shaped the morphology of primates' lower and upper extremities and how morphology affects energetics.

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

We must apply forces with our feet to the ground to move forward, and our calf muscles are crucial for producing such forces. The calf muscles are attached to the heel bone of our feet, and the heel length functions like a skeletal lever. Prior studies have indicated that natural variations in foot anthropometry (e.g. heel length) between humans can directly affect the force production of calf muscles. However, its effect on how much energy a person uses (i.e. metabolic energy) to produce a given force during locomotion has been inconclusive. Therefore, our study aimed to determine whether person-to-person variations in foot anthropometry directly affect calf muscles' contraction behavior and whole-body energy consumption across a series of walking speeds. Surprisingly, we found that individuals with longer heels spend less metabolic energy, but only at speeds above the typical comfortable speed – allowing them to push against the ground with less muscle activation to walk faster.

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

Our study, among others, aims to gain an understanding of the interplay between foot anatomy and muscle–leg energetics. By doing so, we aspire to design and develop the next generation of wearable devices (e.g. footwear) to assist, restore or even surpass human muscle capability.

Are there any important historical papers from your field that have been published in JEB?

To keep my answer short, I set two rules. First, the paper should be at least a half-century old, and second, it should be related to anatomy and energetics. The first papers that came to my mind were H. C. Bennet-Clark and E. C. A. Lucey's 1967 paper, 'The jump of the flea: a study of the energetics and a model of the mechanism' (doi:10.1242/jeb.47.1.59) and H. C. Bennet-Clark's 1975 paper 'The energetics of the jump of the locust *Schistocerca gregaria*' (doi:10.1242/jeb.63.1.53) – even if the second violates the first rule by 2 years. These papers showed that the anatomy of insects, like that of fleas and locusts, provides catapult mechanisms that power-amplify their jumps. Since then, power amplification mechanisms have been found in various animals and have paved the road for bioinspired technological applications.

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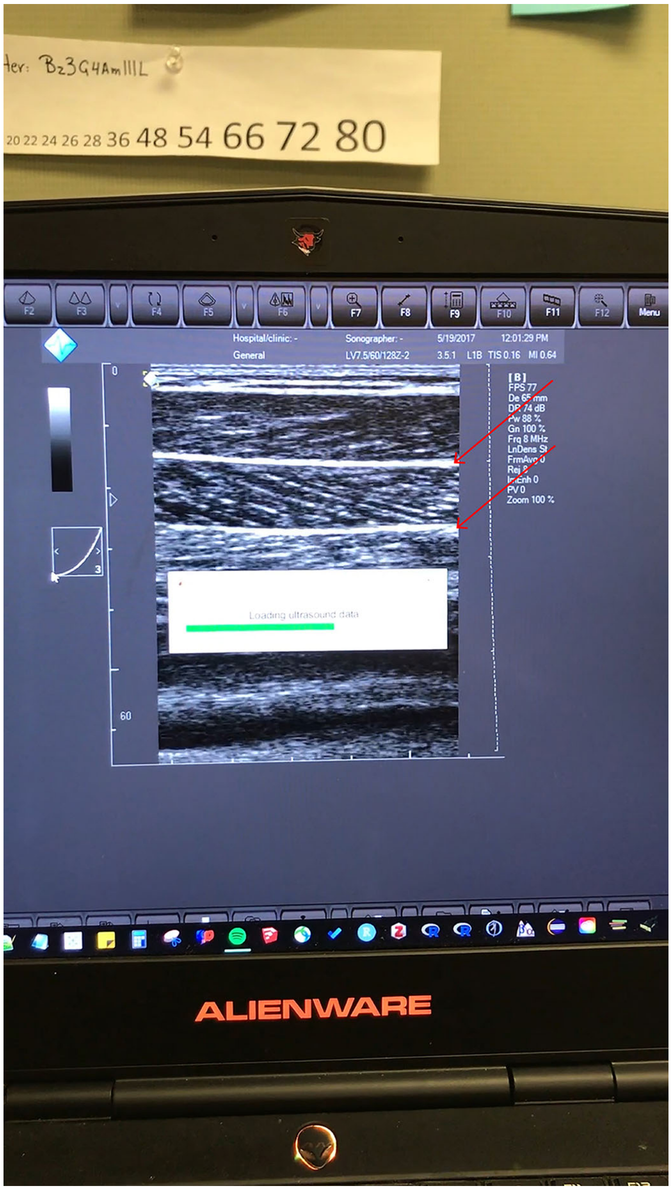

An ultrasound image during the very early stages of practising. The red arrows indicate the muscle fascia, while the diagonal lines between them are muscle fascicles.

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

One way I see experimental biology is as an effort to improve our understanding of the past, present and future of biological organisms. So, naturally, I want to see protein engineering technologies like DNA shuffling becoming readily available and used in comparative studies along with phylogenetic trees. Such methods of artificial evolution combinations could provide insights into how recombination or the creation of novel mutations can generate proteins and even organisms with altered functions.

What changes do you think could improve the lives of early-career researchers, and what would make you want to continue in a research career?

To improve the lives of early-career researchers in academia or industry, we must start by changing how undergraduate and graduate students are trained as future researchers. For instance, it would be beneficial during the early-career research life if you received career guidance alongside your academic training as a student. As an undergraduate, such guidance could help you explore various research employment opportunities and choose the right field for your PhD. Likewise, as a graduate, you should be encouraged to develop a portfolio of ideas independent of your thesis that could be used during the first years of your research career.

What's next for you?

I recently started my postdoc in an environment that bridges all the research topics (biology, evolution, mathematics) that excite me, so I plan to enjoy it for as long as possible. After that, I would like to find a research environment where ideas and perspectives from the fields of evolutionary biology and mechanics coexist in harmony, along with cultural diversity and mutual respect.

Reference

Papachatzis, N., Ray, S. F. and Takahashi, K. Z. (2023). Does foot anthropometry relate to plantar flexor fascicle mechanics and metabolic energy cost across various walking speeds? *J. Exp. Biol.* **226**, jeb245113. doi:10.1242/jeb.245113