Tiny jumping roundworm undergoes unusual sexual development

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A newly hatched Steinernema carpocapsae juvenile (shown here, scale bar 50 µm) is only about 0.25 mm (less than 1/100 of an inch) long with a gonad only 0.013 mm in length. During development, the worm will increase over 10 times in length (in comparison, the average human only increases about 4 fold in height from birth to adulthood) and its gonad increases almost 500 times in length. Credit: Nathan Schroeder, University of Illinois

Nematodes may be among the simplest animals, but scientists can't get enough of the microscopic roundworms. They have mapped the entire genome ofC. elegans, the "lab rat" of nematodes, and have characterized nearly every aspect of its biology, with a particular focus on neurons. For years, it was assumed other nematodes' neurons were similar to those ofC. elegans, until researchers at the University of Illinois demonstrated the vast diversity in neuronal anatomy present across species.

Now Nathan Schroeder, assistant professor in the Department of Crop Sciences at U of I and leader of the previous study, has shown that gonad development also varies in other nematodes relative toC. elegans. Specifically, he and graduate student Hung Xuan Bui focused onSteinernema carpocapsae, a nematode used in insect biocontrol applications in lawns and gardens.

The gonads in all nematodes develop within a structure called the gonad arm, a tube through which multiple reproductive organs migrate into place throughout the animal's postembryonic development. This happens in a highly predictable manner in C. elegans, with very low variability among individuals. Not so withSteinernema.

Schroeder says finding and understanding examples of variability within and among species can help scientists understand how diversity arises, an open question with relevance to evolution and genetic processes.

But it also has practical applications, especially in this species.

"One of the issues in terms of commercialization of Steinernema biocontrol products is being able to produce a lot of them," he says. "Can we somehow increase the overall reproductive output of these animals? Understanding more about the gonad development, where babies are actually being made, might move us in that direction."

Aside from showing that Steinernema development differs from C. elegans, the study also represents an advancement in terms of studying organisms whose development occurs almost entirely inside another organism.

These tiny roundworms, less than a millimeter long, stand upright on their tails and jump up to 10 times their body length with the goal of landing on and infecting an insect. Once they find a bug, Steinernema expels symbiotic bacteria from its gut, which is what kills the insect.

That's when the nematode starts feeding on the insect and the bacteria that, by this point, has spread throughout the insect's body. Being exposed to this external bacterial stew is what triggers the nematode to begin its postembryonic sexual development and then to reproduce with other nematodes nestled inside the same insect. As one can imagine, it could be rather difficult to replicate that environment in the lab.

"Bui was able to trick them. He put them in a high density of this bacteria, and essentially tricked them into coming out of this juvenile stage to undergo normal reproductive development without being inside the insect," Schroeder says.

The technique should allow further study of the anatomy and behavior of this and other so-called entomopathogenic, or bug-eating, nematodes.

The article, "Postembryonic ventral nerve cord development and gonad migration in Stinernema carpocapsae," is published in the *Journal of Nematology*.

More information: Postembryonic Ventral Nerve Cord Development and Gonad Migration in Steinernema carpocapsae. *Journal of Nematology*, DOI: 10.21307/jofnem-2018-005