Digital Dissection: CT scans reveal new muscles in horseshoe crabs

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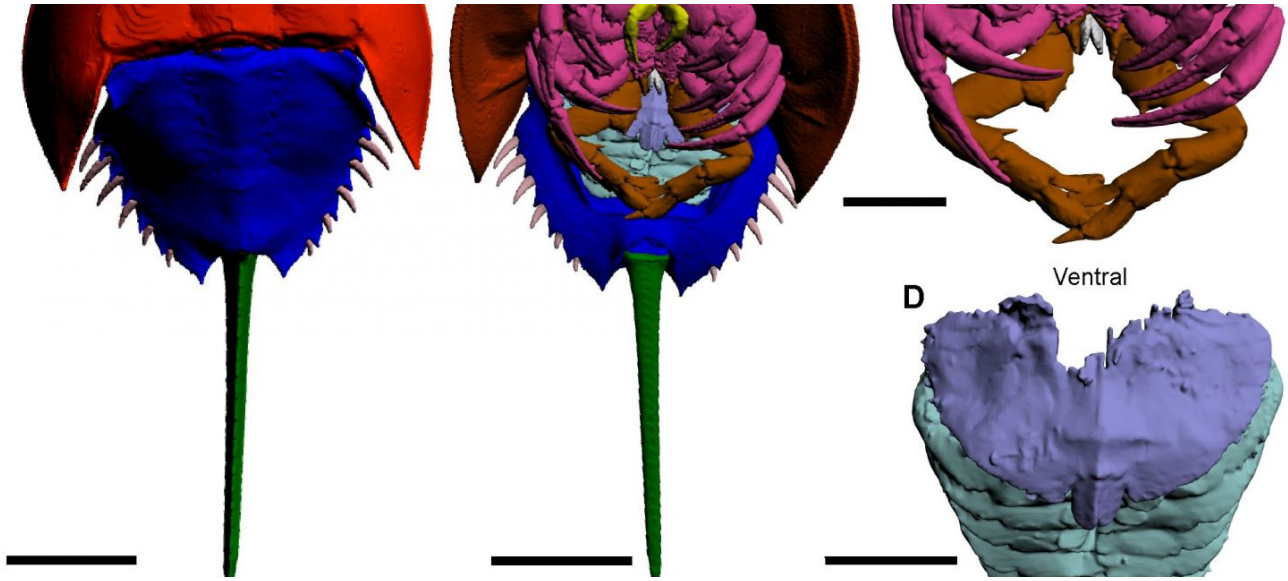

The horseshoe crab, *Limulus polyphemus*, has unique anatomical features and an ancient lineage, which is why it's sometimes referred to as a "living fossil." Most images captured of *Limulus* and other invertebrates are two dimensional, so Russell Bicknell from the University of New England (UNE) in Australia was curious to see what three dimensions might reveal. He and a team of colleagues conducted CT scans of a dried horseshoe crab carcass from the University of New England Natural History Museum as well as of fresh appendages, and then used the scans to create a 3-D model of its muscular system. The 3-D image revealed some new muscular structures in the horseshoe crab appendages. I spoke with Bicknell further about this finding, which was recently published in PLOS ONE.

What drew you to studying horseshoe crabs?

RB: Well to begin with, the project was assigned to me as part of my Ph.D. Having come from New Zealand, I had hardly ever seen a horseshoe crab before, let alone studied one at length! However, I really enjoyed studying them, so *Limulus* became a central focus of my research. I even went to the States last year to research and study live specimens.

Why is the horseshoe crab considered a living fossil?

RB: Horseshoe crabs are considered a living fossil because they have such a long fossil record and there are fossil species related to *Limulus* as far back as the Jurassic that look pretty much the same as *Limulus* today.

What do CT scans reveal that 2-D images do not?

RB: We are able to show the 3-D shape of the muscles with CT scans, as opposed to just documenting outlines of them. Furthermore, by segmenting the scans and making 3-D PDFs, we can present interactive 3-D reconstructions.

Was there anything that surprised you in this study?

RB: We were surprised to find muscle groups that looked completely different from anything else documented thus far. It took a while to process, but we realized we had found muscle groups that had previously not been described.

What are the next steps for your research?

RB: The next stages of my research will use *Limulus* to model the feeding mechanics for fossil groups that are thought to have fed the same way. I am also working with colleagues to document examples of injuries in live and fossil horseshoe crabs. Finally, the research team at UNE will be exploring further uses of iodine staining and CT scanning to document more organisms in 3-D.

Reference: Bicknell RDC, Klinkhamer AJ, Flavel RJ, Wroe S, Paterson JR (2018) A 3D anatomical atlas of appendage musculature in the chelicerate arthropod Limulus polyphemus. PLoS ONE 13(2): e0191400. https://doi.org/10.1371/journal.pone.0191400