Findings reveal eurypterids evolved giant size independently at least nine times

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A giant specimen of the pterygotid eurypterid A. macrophthalmus about 1.25 m long from the Fiddlers Green Formation at Passage Gulf in upper New York State. This specimen (Yale Peabody Museum IP 208195) is one of the largest known complete examples of a eurypterid, if not the largest. The length of eurypterids over 2 m long is based on extrapolation from the dimensions of isolated elements of the exoskeleton. Credit: *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2024.1184

Sea scorpions, ancient predators that patrolled Earth's marine and freshwater habitats hundreds of millions of years ago, are the focus of a sizable scientific mystery.

Also known as eurypterids, these long-extinct relatives of modern-day horseshoe crabs, spiders, and scorpions sometimes grew to be more than two meters long and were, at their zenith about 430 million years ago, among the planet's top predators. But paleontologists have debated over the cause of eurypterids' gigantism—speculating that it had to do with everything from water temperature to changes in habitat.

A Yale study in the journal *Proceedings of the Royal Society B* suggests that researchers exploring the factors behind these animals' unusual size may need to go back to the drawing board.

"We do not find any correlation between the evolution of giant size in eurypterids and changes in habitat oxygen levels, temperature, latitude, or local diversity, all of which have been proposed as explanations for the evolution of giant size," said Alex Ruebenstahl, a Ph.D. student in Earth & planetary sciences and the study's co-first author with former Yale graduate student Nicolás Mongiardino Koch, who is now a postdoctoral researcher at the Scripps Institution of Oceanography in California.

For the study, the researchers analyzed 138 eurypterid species and assembled a dataset of sea surface temperature, levels of dissolved oxygen, and other data relating to ancient habitat.

They found that the evolution of giant size in eurypterids was rapid, and in some instances giant species evolved among much smaller relatives. They also found that eurypterids evolved giant size at least nine times independently in different groups.

The eurypterids' gigantism was not necessarily a response to environmental factors, the researchers said, noting that features of eurypterids themselves—such as their reproductive strategy or the size of their genome—may have allowed them to evolve giant size rapidly.

"Gigantism is an important feature of these remarkable fossil arthropods and ours is the first comprehensive analysis of the phenomenon in a phylogenetic context, i.e., considering their relationships and evolutionary history," said Derek Briggs, the G. Evelyn Hutchinson Professor of Earth & Planetary Sciences in Yale's Faculty of Arts and Sciences and senior author of the study.

The study was inspired, in part, by the Ciurca Collection in the Peabody's Division of Invertebrate Paleontology—an extensive collection of sea scorpions donated by the late Samuel J. Ciurca Jr., a former curatorial affiliate of the Peabody.

The study was also co-authored by former Yale postdoc James Lamsdell, who is now an associate professor of geology at West Virginia University.

More information: Alexander Ruebenstahl et al, Convergent evolution of giant size in eurypterids, *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2024.1184

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