Ghost worms mostly unchanged since the age of dinosaurs

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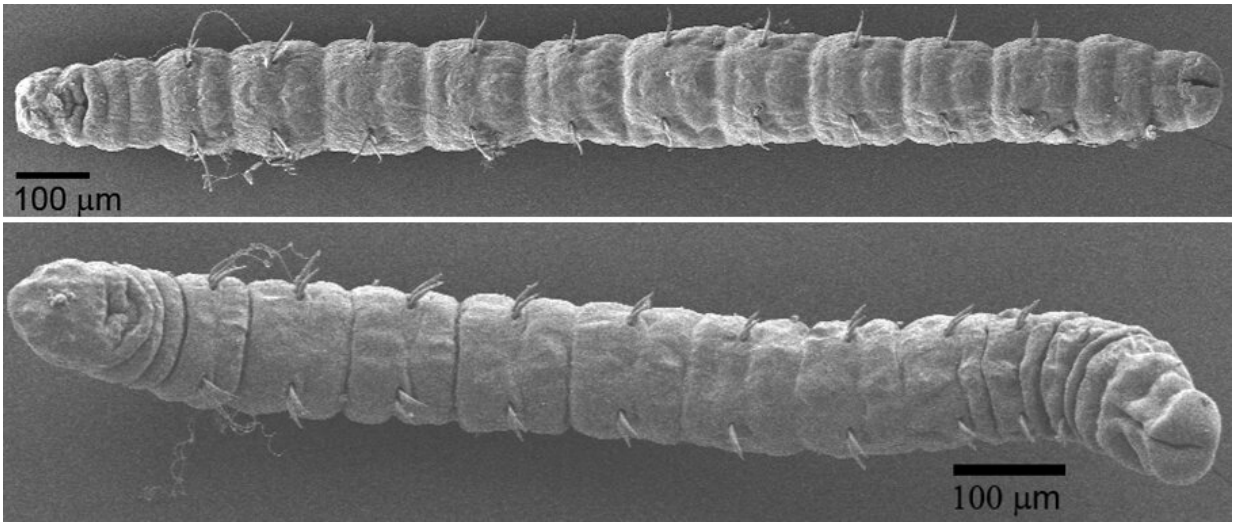

Upper specimen: *Stygocapitella josemariobrancoi* from a beach close to Plymouth, UK: Lower specimen: *Stygocapitella furcata* from the 4th of July beach on San Juan island, WA, USA Credit: José Cerca, Christian Meyer, Günter Purschke, Torsten H. Struck

It is well known that the size, shape and structure of organisms can evolve at different speeds, ranging from fast-evolving adaptive radiations to living fossils such as cichlids or coelacanths, respectively.

A team led by biologists at the Natural History Museum (University of Oslo) has uncovered a group of species in which change in appearance

seems to have been brought to a complete halt. The tiny annelid worms belonging to the genus Stygocapitella live in sandy beaches around the world. In their 275-million-year history, the worms have evolved 10 distinct species.

But what makes the group stand out is the presence of only four morphotypes. Such absence of morphological change has lately proven to be a common feature of many so-called cryptic species complexes, for example, in mammals, snails, crustaceans and jellyfish.

"Cryptic species are species which have already been distinct species for a substantial amount of time, but have accumulated very little or no morphological differences. Such species can help us understand how evolution proceeds in the absence of morphological evolution, and which factors might be important in these cases," explains Professor Torsten Struck at the Natural History Museum (University of Oslo)

Meiofauna field collection in Sommaøya (Tromsø), Northern Norway Credit: José Cerca

Two of the Stygocapitella species that were investigated split apart at the time when stegosaurus and brachiosaurus lived. But despite 140 million years of evolution, these ghost worms today look almost exactly the same. However, looks may be deceiving. Molecular investigations reveal that they are highly genetically distinct, and considered reproductively isolated species.

In comparison to other cryptic species complexes separated by a maximum of a couple million years, the time span in this complex is 10 times longer, which makes the lack of change in ghost worms extreme.

"These species can also be studied to understand how species respond to extreme ecological changes in the long run. Some of these morphotypes have experienced the much warmer conditions of the Cretaceous as well as the changing intervals of the ice ages," says Struck.

What makes the case of Stygocapitella particularly puzzling is that closely related taxa seem to be evolving morphotypes significantly faster. The findings therefore highlight that evolutionary change in appearance should be viewed as a continuum, ranging from accelerated to decelerated, and where the investigated worms stand out as one of the more extreme cases of the latter. The study also points out that species formation is not necessarily accompanied by morphological changes.

The researchers suggest that lack of morphological change may be linked to the worms having adapted to an environment that has changed

little over time.

"Beaches have always been around and had the same composition then as now. We suspect these worms have remained in the same environment for millions and millions of years and they are well adapted. We suspect they have become good in moving around, but not having changed much," explains first author of the study Ph.D. Fellow José Cerca. "Alternatively, it has been suggested that populations regularly crash to only a few surviving individuals, and newly evolved characters get eliminated in the course of these events. Finally, besides or instead of the environment, their development may constrain their evolution."

However, the reasons for the slow rate of morphological change are still inconclusive in the current study, and remain to be explored by the group in the future.

More information: José Cerca et al, Deceleration of morphological evolution in a cryptic species complex and its link to paleontological stasis, *Evolution* (2019). DOI: 10.1111/evo.13884

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