Rare fossil embryos show early Ecdysozoa development in Cambrian era

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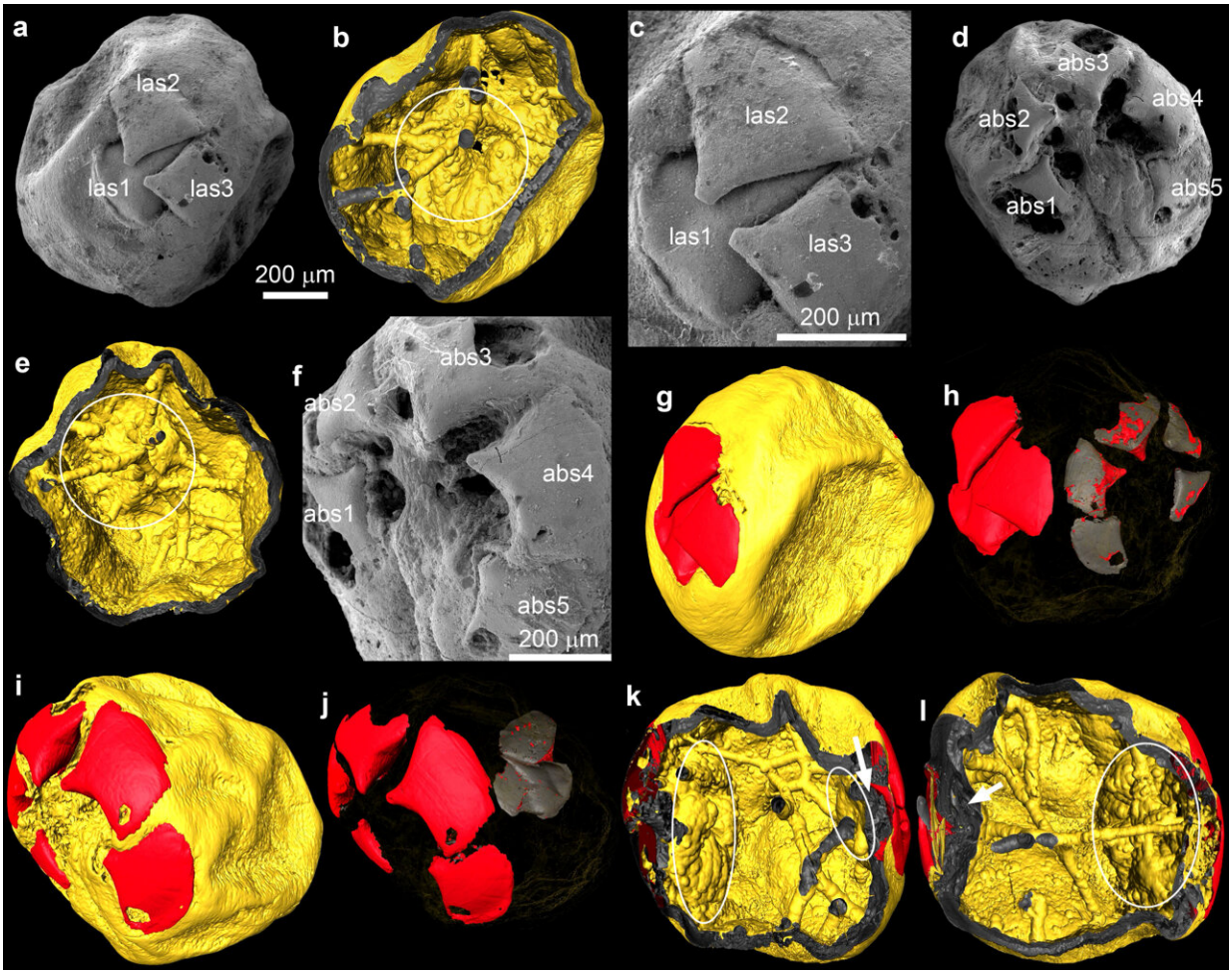

Fig. 1: Saccus xixiangensis gen. et sp. nov. Credit: *Palaeogeography, Palaeoclimatology, Palaeoecology* (2024). DOI: 10.1016/j.palaeo.2024.112635

An international research team has made a notable discovery of fossil embryos belonging to Ecdysozoa, a diverse group of animals including roundworms, velvet worms, insects, and crabs. These fossils, dated to approximately 535 million years ago, were found in the early Cambrian Kuanchuanpu biota in southern Shaanxi Province, China.

The research, led by Professor Zhang Huaqiao from the Nanjing Institute of Geology and Paleontology of the Chinese Academy of Sciences, was published in the journal *Palaeogeography, Palaeoclimatology, Palaeoecology*.

Fossilized invertebrate embryos are rare, but when preserved, they offer key insights into the evolutionary developmental biology of extinct animals. While such embryos have been reported from the early Cambrian to the Early Ordovician periods, most examples are limited to cnidarians and the scalidophoran taxon Markuelia. The early Cambrian Kuanchuanpu biota is rich in diverse cnidarian embryos and their hatched stages, but fossilized embryos of Ecdysozoa have not been identified in this biota.

In this study, the researchers discovered well-preserved fossil embryos from the early Fortunian (early Cambrian) Kuanchuanpu Formation, specifically from the Zhangjiagou section in Xixiang County, Hanzhong City, Shaanxi Province, China. Seven specimens were identified, all three-dimensionally phosphatized.

Micro-CT analysis indicated that the embryos were internally hollow, resulting in the absence of preserved internal soft anatomy. Based on variations in the number and arrangement of sclerites at their anterior and posterior ends, these embryos have been classified into two new taxa: Saccus xixiangensis gen. et sp. nov. (Fig. 1) and Saccus necopinus gen. et sp. nov. (Fig. 2).

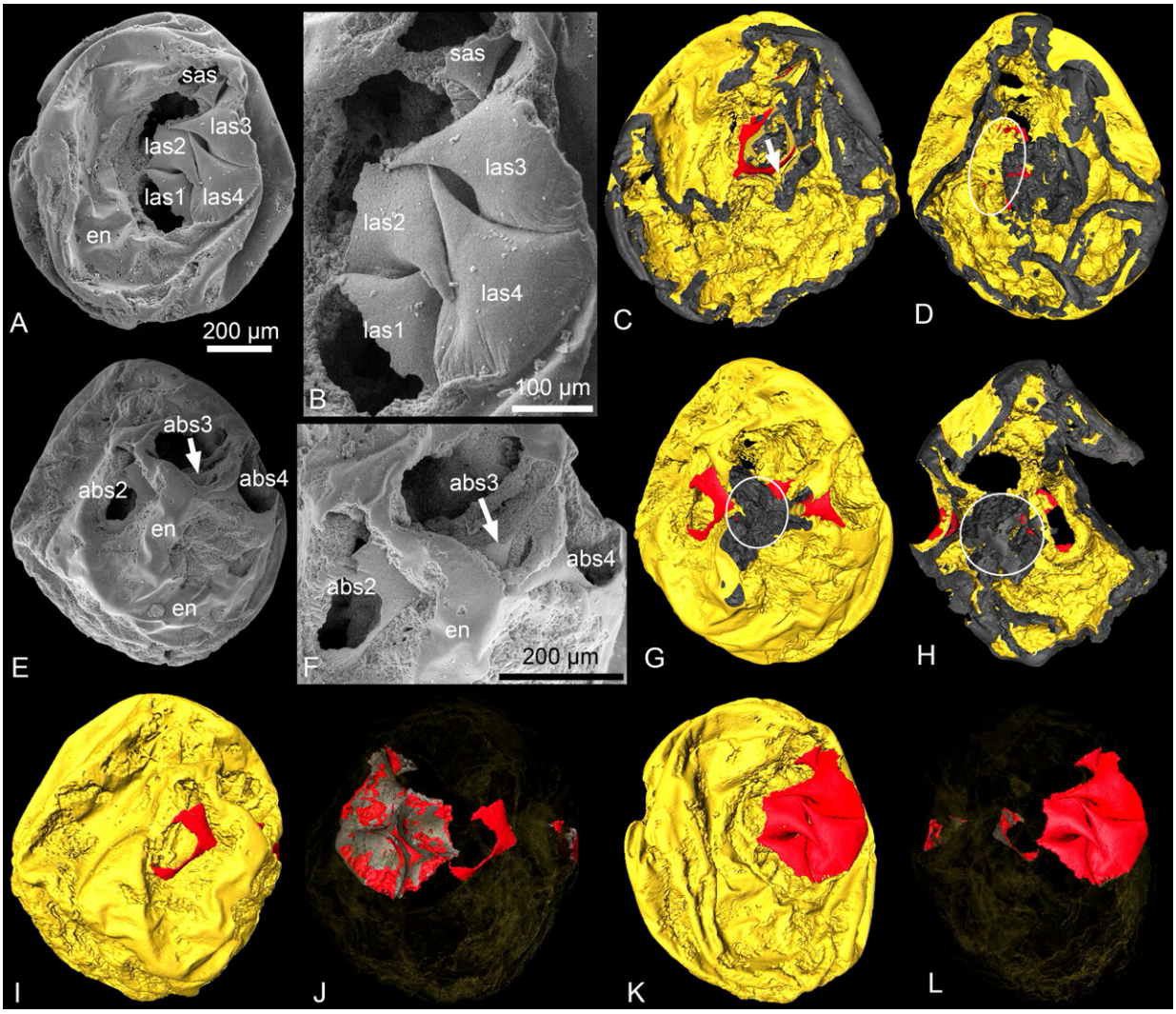

Fig. 2: Saccus necopinus gen. et sp. nov. Credit: *Palaeogeography, Palaeoclimatology, Palaeoecology* (2024). DOI: 10.1016/j.palaeo.2024.112635

The study reveals that the embryos are enclosed within a thin, smooth envelope, with diameters ranging from 730 µm to 1 mm. Their relatively large size indicates a yolk-rich composition, providing sufficient energy for development (lecithotrophy). The embryos exhibit a bag-shaped body without introverted or paired limbs.

High-resolution scanning electron microscope images show that the integument is non-ciliated. The anterior sclerites are arranged radially, while those at the posterior end are bilaterally arranged. The integument shows soft deformation, but the sclerites remain largely undeformed, suggesting they are stiffer and likely cuticularized. Notably, the embryos lack orifices, representing a developmental stage before the formation of a mouth or anus.

The bilaterally arranged sclerites at the posterior end suggest bilateral symmetry, categorizing these new embryos as bilaterians. Additionally, the absence of cilia or sites for cilium insertion, along with the presence of cuticularized sclerites, points to an ecdysozoan relationship. The presence of cuticles implies that these embryos are in the later stages of embryonic development, possibly nearing hatching.

Due to the absence of hatched specimens, the exact developmental mode of Saccus is not yet determined. It is inferred that these embryos likely underwent indirect development, hatching as lecithotrophic (yolk-feeding) larvae. This suggests that the juvenile and adult forms may vary due to metamorphosis during later growth. Alternatively, they could undergo direct development, hatching as lecithotrophic juveniles.

These juveniles might exhibit a similar bag-shaped body without introverted or paired limbs, akin to Saccorhytus. In either scenario, the embryos rely solely on yolk for energy until they develop a functional mouth and begin feeding.

The direct development hypothesis has implications for the evolution of body shape in early ecdysozoans. If Saccus and Saccorhytus belong to total- or stem-group ecdysozoans, it suggests a bag-shaped body is likely primitive for ecdysozoans, while a vermiform body, characteristic of crown-group ecdysozoans, evolved later.

More information: Mingjin Liu et al, New ecdysozoan fossil embryos from the basal Cambrian of China, *Palaeogeography, Palaeoclimatology, Palaeoecology* (2024). DOI: 10.1016/j.palaeo.2024.112635

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