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Seeing the inner workings of centrioles in early land plants

How centrioles assemble and function in animal cells has long grabbed the attention of scientists. New work in mosses delves into the 3D architecture of these structures and shows that they are more diverse than previously thought.

Oeiras, 24 August 2021 - A new study published in **Current Biology** unravels how centrioles form in the moss *Physcomitrium patens*, revealing unique details of their architecture. According to the results, despite being made with the same molecular blocks as the ones found in animal cells, they mature in a very different way. “It’s the first time we see how centrioles form without a template in nature with such a high level of detail. From conserved building blocks, mosses generate centrioles with very unique features in their sperm cells. It shows us how plastic evolution can be”, explains **Mónica Bettencourt-Dias**, IGC principal investigator, who co-led the study.

Most knowledge on centrioles has been built by studying dividing animal cells in a narrow group of species, like flies or humans. “Recent technological advances in several fronts allow us to study other species with high economic and environmental relevance”, says **Mónica**. And plants have their own story to tell. “Most literature states that plants don’t have centrioles and that’s the end of it. But centrioles are created totally without a template in the sperm cells of some plant species. The organism has never had these structures and it just makes them, in the right number and place. It almost looks like magic”, reveals **Sónia Gomes Pereira**, former IGC PhD student and first author of the study.

Mosses, contrary to flowering plants, have motile sperm that depends on water to move, much like in humans. Motility is given by their flagella, which contain centrioles. According to Sónia, “the two centrioles that exist at the base of the flagella assemble connected, but then split and elongate very differently. This not what happens in animals, where centrioles are very similar within each cell. In this moss, two similar structures are born at the same time and remain very close to each other, yet somehow the cell can regulate which one elongates or not. There is a unique symmetry break.”

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"We initially thought these unique features could be technical artifacts, something that was never seen before, and we thought could not happen. That is when we used 3D electron tomography, and what we saw made total sense", Sónia describes. It all starts with a sample that is frozen at very low temperatures (cryopreservation) that then is sectioned and put in a transmission electron microscope. There, a beam of electrons is transmitted through the sample and, as it interacts with the sample, an image is formed. Physically tilting each section and taking pictures of it at each degree allows then for mathematical reconstruction of the full 3D structure. "This type of technology gave us the three main steps of centriole development in 3D, in a level of detail that is unprecedented."

Studying a wide variety of organisms, such as *Physcomitrium patens*, provides an understanding of what are the commonalities of the process of centriole formation across the tree of life. In animals, the manipulation of the molecular blocks that make the centriole is constrained—animals without centrioles are unhealthy. "This moss has them only in its sperm cells, which is a huge advantage. Since potential defects only appear there, we can grow it and study it as usual. What we learn by pushing genetics and molecular biology in this context, not only microscopy, can open new paths to start understanding how diversity is generated", Mónica highlights.

"This kind of studies also help us understand how evolution works, especially in very early land plants. And this is the first species where we describe this process", says **Jörg Becker**, former IGC principal investigator now at ITQB and member of GREEN-IT, who co-led the study. Mosses are crucial for ecosystems, especially newly formed ones: they stabilize the soil surface, reducing erosion, and keep moisture in the ground, reducing water evaporation, while allowing other plants to grow. "It is crucial to understand how they reproduce and live, and from that knowledge, build the basis for future interventions, if it gets necessary", adds the researcher.

This study was developed at Instituto Gulbenkian de Ciência and supported by FCT (Fundação para a Ciência e Tecnologia), Calouste Gulbenkian Foundation, ERC (European Research Council) and FCT ERA-CAPS project EVOREPRO, together with a Christian Boulin fellowship from EMBL awarded to Sónia Gomes Pereira.

Paper - Sónia Gomes Pereira, Ana Laura Sousa, Catarina Nabais, Tiago Paixão, Alexander J. Holmes, Martin Schorb, Gohta Goshima, Erin M. Tranfield, Jörg D. Becker, Mónica Bettencourt-

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Dias (2021). **The 3D architecture and molecular foundations of de novo centriole assembly via bicentrioles.** Current Biology. **DOI:** https://doi.org/10.1016/j.cub.2021.07.063

More information

Ana Morais
Head of Institutional Communication
@: anamorais@igc.gulbenkian.pt
Contact: +351 965 249 488