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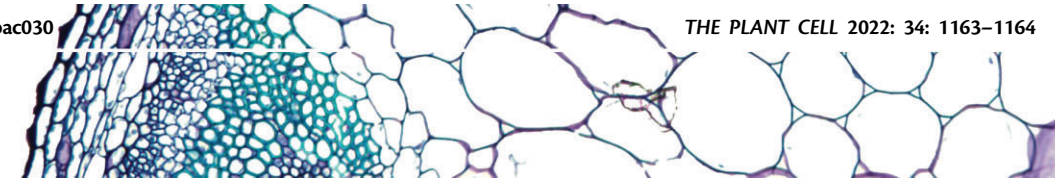

Illuminating the early embryonic cell divisions in *Volvox carteri*

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In Brief

Cell division is the basis of differentiation and growth. The overall process is the same everywhere—one cell that generates two cells—but there are differences in the mechanism across the tree of life. Some features such as the nature of microtubule involvement, the formation of the spindle, or the rupture of the nuclear envelope vary across taxa (Buschmann and Zachgo, 2016). Green algae, including *Chlamydomonas* and *Volvox*, are used as a model system for the study of mitosis (Birchem and Kochert, 1979) also because they possess both key animal and plant functions. In general, the simple multicellular alga *Volvox* is a suitable model organism for investigating cell division, cell differentiation, and morphogenesis (Matt and Umen, 2016). Additionally, the size of the reproductive cells in *Volvox* is an advantage for studying subcellular structures.

In this issue of *The Plant Cell*, work by **Eva Laura von der Heyde and Armin Hallmann** (**von der Heyde and Hallmann, 2022**) provides a comprehensive analysis of embryonic cell divisions in the green alga *Volvox carteri*. They selected mitosis- and cytokinesis-associated genes to generate yellow fluorescent protein (YFP)-tagged proteins to study cell division in *Volvox* using live-cell imaging. The selection of six proteins allowed the study of different aspects of mitosis in vivo, including nuclear envelope fate, chromatin motion, microtubule dynamics, and membrane remodeling (see Figure).

First, YFP carrying a nuclear localization signal allowed the analysis of dynamics of cell nuclei and the nuclear envelope during early embryonic cell divisions, while YFP without a targeting signal (pts-free YFP) was used to track cytosolic and nucleoplasmic processes. Histone H2B was used to monitor chromatin dynamics as the degree of condensation of the chromatin is another marker of phase transitions during cell division. Next, with β-tubulin (TubB2), the authors tracked the formation of microtubular structures, including the complete development of the mitotic spindle, and monitored how these structures are positioned. Additionally, the YFP:TubB2 signal was helpful to analyze the formation of the phycoplast (a microtubule array, function-related to the phragmoplast in plants). The authors also studied membrane remodeling using the dynamin-related protein 1 and Ran GTPase activating protein 1. Finally, the authors provide a detailed description of the overall process and a model for mitosis in *V. carteri*.

The cell division in *V. carteri* has five crucial features: the high degree of interchange between cytosol and nucleoplasm, the persistence of the nuclear envelope until telophase, the organization of the spindle by cytoplasmic centrosomes, the involvement of the phycoplast in cytokinesis, and when viewed as a whole, the enormous dynamics of cytoskeletal and membranous structures. These observations were possible with the use of live-cell imaging, providing time-lapse data of the complete cell division process at high optical resolution.

This work sheds light on the understanding of the assembly and dynamics of key structures that participate in cell division. Additionally, it provides a reference for comparative studies not only to understand the evolution of cell division in the large group of algae but also to get hints regarding the evolutionary history of cell division in plants and animals.

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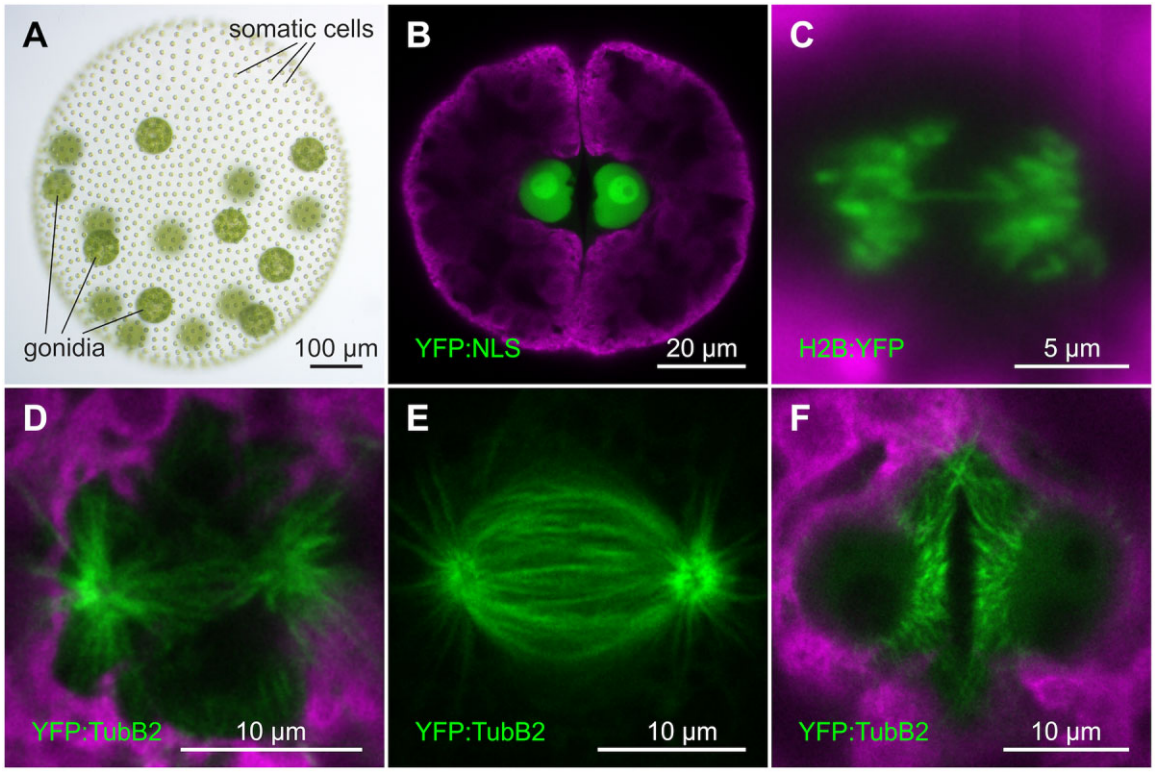

Figure The first embryonic mitosis in *V. carteri*. A, A female *V. carteri* spheroid with gonidia cells before the first embryonic cell division. B, Two-celled embryo with flattened interphase nuclei. C, Separating sets of chromatids. D, Microtubular structures during centrosome separation. E, Microtubule asters and spindle apparatus at metaphase. F, Advanced stage of cytokinesis showing the microtubular network of the phycoplast. Adapted from von der Heyde and Hallmann (2022), Figures 1, 2, 5–7, and 9.

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