Meiotic cell division 'the other way round'

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Rhynchospora pubera. Some species have developed their own strategy to ensure genetic diversity in their offspring with a variation of the "standard procedure", as Ph.D. student Gabriela Cabral and group leader Peter Schlögelhofer at the Max F. Perutz Laboratories (MFPL) now show. The researchers examined meiosis in *Rhynchospora pubera* and *R. tenuis* -- plants that are widely distributed in Gabriela Cabral's home country Brazil. Credit: Gabriela Cabral

Meiosis is not like another: Gabriela Cabral and Peter Schlögelhofer at the Max F. Perutz Laboratories (MFPL) of the University of Vienna and the Medical University of Vienna dived into the process of meiosis in specific plant species and revealed that these plants display an inversion of the standard meiotic phases. The researchers describe the detailed mechanisms in the scientific journal *Nature Communications*.

Meiosis is the two-step series of cell divisions that make sexual reproduction and genetic diversity possible.The coordination of the two meiotic chromosomal divisions (the reductional followed by the equational division) gives meiosis its distinctive characteristics: a reduction in the number of chromosomes by half, accompanied by mixing of parental chromosomes, and swapping of regions between homologous chromosomes (crossing over).

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"I started studying meiosis in these species already in the lab in Brazil and 'imported' the project to Austria in 2009 as part of my master project", says first author Gabriela Cabral. In the meantime, she switched to the Dammermann group at MFPL and works now as a PhD student on the model organism *C. elegans*, a nematode worm.

And we've come full circle *C. elegans* displays a chromosome type that is also present in the two plant species: During somatic cell divisions, their holocentric chromosomes have the unusual property of attaching to spindle microtubules along their entire length in contrast to the well-studied monocentric chromosomes in e.g. humans with a clearly

localized attachment site (kinetochore) for spindle microtubules. Spindle microtubules are responsible for segregating chromosomes during cell division.

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"Holocentric chromosomes create unique problems during meiosis that organisms with monocentric chromosomes do not face: They have to find another way to distribute the chromosomes correctly", explains Peter Schlögelhofer. "The plant species in our study have a special strategy on how to solve the problem: They show an inversion of the canonical meiotic sequence, with the equational division preceding the reductional."

Segregating sister chromatids during the first meiotic division represents an atypical process when compared to regular meiosis, but the real challenge is to orderly distribute homologous non-sister chromatids during the second, subsequent meiotic division.

Together with their colleagues at the Federal University of Pernambuco in Brazil and the Leibniz Institute of Plant Genetics and Crop Plant Research in Germany, the researchers at MFPL show that in the investigated plant species the homologous non-sister chromatids are associated with thin chromatin threads prior to the second meiotic division. These connections seem to provide sufficient force to allow proper orientation and disjunction during the second division.

In conclusion, Gabriela Cabral and Peter Schlögelhofer, in collaboration with the researchers from Germany and Brazil, not only present robust evidence for inverted meiosis in plant species, but they also provide the first in-depth analysis on their meiotic behavior.

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