When you've doubled your genes, what's 1 chromosome more or less?

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An individual with Down syndrome and a male calico cat have one thing in common -- each has an extra chromosome. For animals, most instances of an extra chromosome result in birth defects or even death, but plants are another matter entirely. Many plants are able to survive the presence of an extra copy of their entire genome (known as polyploidy) and are often even more vigorous as a result. For plants, the process of polyploidy often results in a new species, making it an important mechanism in evolution. In fact, over 80% of plants may be a product of polyploidy.

However, this extra set of chromosomes can sometimes cause confusion during meiosis, the process by which sets of chromosomes are divided up to produce egg and sperm cells, with half the number of chromosomes present in a mature plant. Many recent studies have examined the effects of polyploidy on meiosis. A recent study by Drs. Andreas Madlung, Kirsten Wright, and J. Chris Pires, published in the September issue of the American Journal of Botany, examines the effects of polyploidy on a more common type of cell division, mitosis--the process of cell division that results in daughter cells that are identical to the parent cell--which allows the plant to grow and develop.

"We had been working on genomic responses to allopolyploidy for many years in newly formed allopolyploids and had noticed some instabilities during meiosis and gamete formation in newly formed allopolyploids," Madlung said. "The commonly held belief is that in established allopolyploids, incompatibilities of the two parental genomes somehow

are reconciled during the evolution of the allopolyploid species but there is only relatively little data in the literature that supports this notion.

"Our work shows that even established polyploids can harbor considerable genomic instabilities, but interestingly this is not always the case either, as the different responses in different sibling lines show."

Madlung and colleagues studied whether mitosis proceeds normally in newly formed polyploids and whether there are differences between mitosis in newly formed polyploids and polyploids that were established long ago. They examined a species of rock cress, *Arabidopsis suecica*, a polyploid with 26 chromosomes that is both found in nature and can also be resynthesized in the laboratory. *Arabidopsis suecica* was formed from the hybridization of a tetraploid accession of *Arabidopsis thaliana*, a species with 20 chromosomes, and the tetraploid Arabidopsis arenosa, a species with 32 chromosomes.

Madlung and colleagues found that a small number of cells in both natural and in one of two newly formed *A. suecica* had either extra chromosomes or were missing chromosomes. Interestingly, in examinations of the progenitor species of *A. suecica*, Madlung and colleagues found many cells with differing numbers of chromosomes in *A. arenosa*; however, most cells in individuals of both diploid and tetraploid A. thaliana had the expected 10 or 20 chromosomes, respectively. In individuals with unexpected chromosome numbers, the numbers varied between cells like in a mosaic, suggesting that these changes are not stable.

"Maybe the most interesting result to me is the fact that plant cells can sustain a large amount of aneuploidy in their tissue without detrimental phenotypic consequences," Madlung said. "We were also surprised to notice that the tissue we looked at consisted of a mosaic of different types of aneuploid and euploid cells. The fact that the plants were quite

fertile indicates that possibly the euploid cells contribute the majority of cells to what later becomes the gametes."

These results suggest that slight changes in chromosome number in an individual's non-sex cells are tolerated but are not fixed, providing new insights into how polyploidy and genomic change can lead to evolutionary change and possibly ultimately affect plants' fitness and vigor.

More information: www.amjbot.org/cgi/content/full/96/9/1656

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