Research team classifies key gene for cell division for the first time

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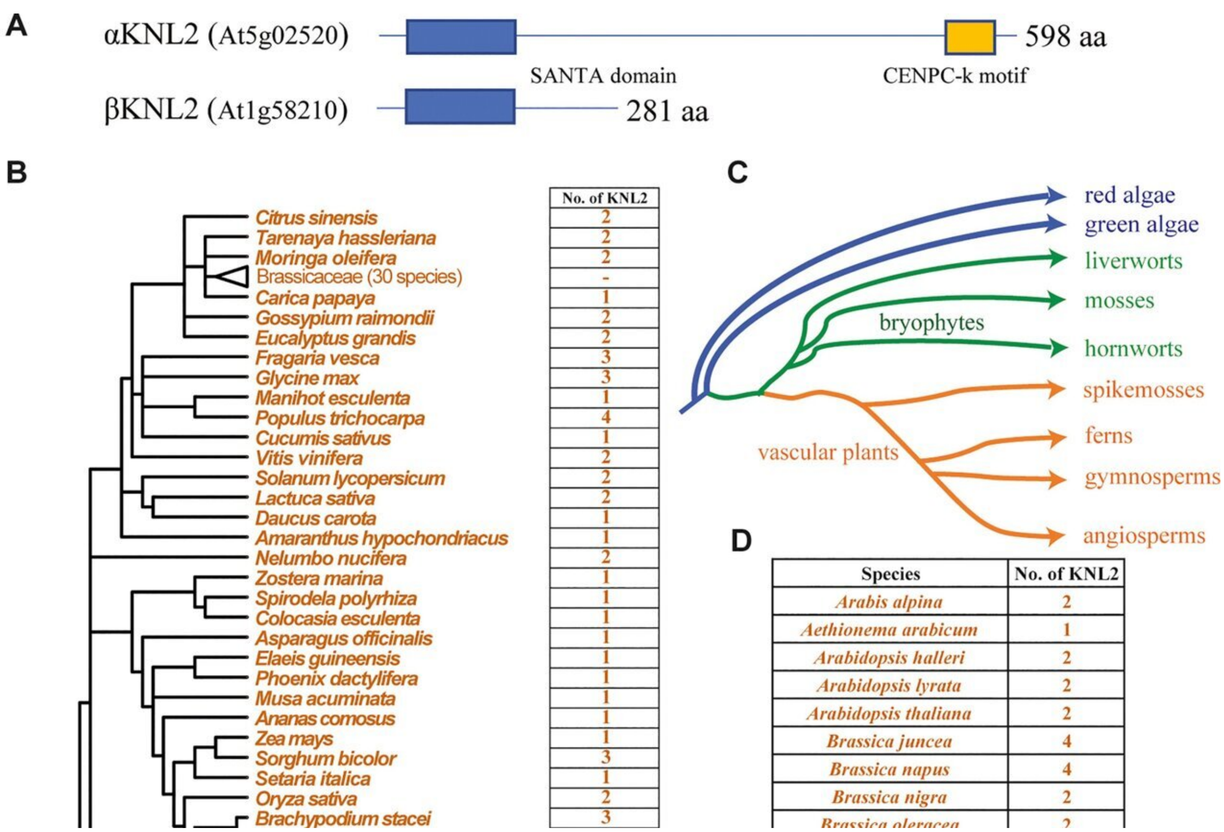

Identification of the KNL2 gene homologs across major plant lineages. (A) Protein structure of KNL2 in Arabidopsis. SANTA domain and CENPC-k motif are indicated by differently colored boxes. (B) The number of KNL2 homologs in 90 representative plant species. The phylogenetic tree is adopted from the NCBI common tree. The blue-, green-, and orange-colored species names indicate alga, bryophytes, and vascular plants, respectively. The red filled boxes mean that we could not retrieved KNL2 from these species. (C) Phylogenetic relationships of the analyzed species were adapted from Banks et al. (2011). (D)

The number of KNL2 homologs identified in analyzed crucifer (Brassicaceae) genomes. Credit: *Molecular Biology and Evolution* (2022). DOI: 10.1093/molbev/msac123

The gene KINETOCHORE NULL2 (KNL2) plays a major role in the incorporation of the histone CenH3 into the centromere of chromosomes and is thus important for cell division. This same gene is also important for the production of double haploids, with which the generation of homozygous lines for plant breeding can be accelerated quite considerably. An international research team led by the IPK Leibniz Institute has reconstructed the evolutionary history of the gene and classified it for the first time. The results have now been published in *Molecular Biology and Evolution*.

In living organisms, cells divide and reproduce in two ways, mitosis and meiosis. Mitosis results in two identical daughter cells, whereas meiosis results in four sex cells.

During mitotic and meiotic cell divisions, the spindle fibers bind chromosomes via a special region called the centromere to pull sister chromatids apart. The centromere consists of centromeric DNA and a multi-protein complex, the kinetochore.

The kinetochore ensures the correct segregation (distribution) of the chromosomes between the two daughter cells and hence maintains genome stability in eukaryotic organisms.

In plants, defects in centromere (kinetochore) function often result in the formation of cells with an abnormal number of chromosomes (poly- and/or aneuploidy) leading to abnormal plant development. In animals and human, defects in centromere (kinetochore) function result either in apoptosis and cell death or in initiation and progression of cancer as well as in various genetic disorders.

The histone CenH3 is essential for the formation and function of the kinetochore. It is incorporated into the centromere in a multi-step process which is largely determined by a specific protein, called KINETOCHORE NULL2 (KNL2), in addition to several other factors.

By manipulating KNL2, it has already been possible to produce double haploids in the model plant Arabidopsis thaliana. This is very important because it makes it possible to generate homozygous lines in only one generation instead of five or more, as has usually been the case in conventional breeding.

To gain insight into the origin and diversification of the KNL2 gene, an international team of scientists led by the IPK Leibniz Institute reconstructed its evolutionary history in the plant kingdom.

"Our results indicate that the KNL2 gene in plants has undergone three independent ancient duplications in ferns, grasses and eudicotyledons," said Dr. Inna Lermontova, head of the Kinetochore Biology research group at IPK. "In addition, we were able to show that previously unclassified KNL2 genes can be divided into two groups: αKNL2 and βKNL2 in eudicotyledons, and γKNL2 and δKNL2 in grasses."

"We also confirmed that the recently identified βKNL2 variant of Arabidopsis plays a role in centromeric localization of CenH3 and in control of cell division as it has been shown for the αKNL2 variant. We therefore consider a βKNL2 as a new candidate for use in haploid induction approaches."

Overall, the study provides a new understanding of the evolutionary diversification of the KNL2 gene and suggests that plant-specific duplicated KNL2 genes have a significant impact on the centromere and kinetochore and are thus also involved in the maintenance of genome stability.

More information: Sheng Zuo et al, Recurrent Plant-Specific Duplications of KNL2 and its Conserved Function as a Kinetochore Assembly Factor, *Molecular Biology and Evolution* (2022). DOI: 10.1093/molbev/msac123

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