Chromosome Biology 2023

6th Edition



Brachypodium distachyon POACEAE



► Brachypodium distachyon interphase nucleus without and with a micronucleus induced by X-radiation. Chromosome-specific (green, purple and yellow) and telomere-specific (red) FISH signals are visible.

 \blacktriangleleft *B. distachyon* (2n=10) is a small-genome annual grass originated from the Mediterranean region. It has been used to study various aspects of the plant genome organisation for more than twenty years. It is also a model organism for economically important temperate zone cereals and forage grasses.



Jolanta Kwasniewska, Arita Kus and Robert Hasterok (University of Silesia in Katowice, Poland)

JANUARY

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Lathyrus sativus FABACEAE

▼ The grass pea, *L. sativus*, is a legume with a large genome (6.52 Gbp/C) and low chromosome number (2n = 14). The chromosomes possess extended primary constrictions (meta-polycentric chromosomes) with multiple domains of centromeric chromatin.



► A single satDNA family labels the extended primary constrictions of all chromosomes. Painting probes designed for the *Pisum sativum* centromere 6 (PS6-C/PS6-A) label orthologous centromere in *L. sativus*, revealing its expansion compared to *P. sativum*. Part of this centromeric extension is due to the accumulation of the satDNA family FabTR-54.

Laura Ávila Robledillo and Jiří Macas (Biology Centre, CAS, Czech Republic)

FabTR-2 FabTR-54 PS6-C PS6-A

FEBRUARY

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► FISH with 5S (red) and 45S (green) rDNA probes (left image) followed by hybridization with GAA_n (green) and pTa-713 (red) satellite sequences (right image) allowed the precise identification of all seven chromosome pairs. Chromosomes are designated according to genetic nomenclature.

Aegilops comosa POACEAE

Ae. comosa (2n = 2x = 14, MM), a mediterranian species with a main distribution area in coastal and inland Greece, but also occurring in Albania, former Yugoslavia and Turkey. Recently it was also found in Northern Cyprus. The photo was taken on the roadside near Troodos (h-1800 m), Cyprus by Mr. Roland Tsandekidis.



Ekaterina D. Badaeva (Vavilov Institute of General Genetics, RAS, Moscow, Russia)

MARCH

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Chromosome 2 Chromosome 9 Nucleolus ROOT LEAF 2 µm

Oryza sativa POACEAE

▼ Rice is one of the most important cereal crops worldwide. Its 389 Mb genome is one of the smallest of monocots which makes rice an important experimental system for genome research.



◄ Positioning of chromosomes 2 and 9, and nucleoli in interphase nuclei of rice. In the root meristem, both chromosomes were preferentially associated (in 90% of the nuclei) compared to leaf nuclei (only in 35% of the nuclei). Chromosome 2 and chromosome 9 containing NOR region were visualized using oligopainting FISH. Nucleoli were visualized by anti-fibrillarin using immunolabeling. 3D-models were created using the software Imaris.

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Rye (Secale cereale) POACEAE

► Rye is a self-incompatible, windpollinating species belonging to the Poaceae (Monocotyledons). Rye was domesticated from weeds outside its region of origin, the Fertile Crescent, which was first hypothesized by Nikolai Ivanovič Vavilov (1887–1943).

▼ Meiotic pachytene chromosomes of a feral rye accession collected in Afghanistan (*Secale cereale* subsp. *afghanicum*). Pachytene chromosomes were immuno-labeled for ZYP1 (green) and stained with DAPI (blue). The total length of all pachytene chromosomes was measured using SingleNeuriteTracer (approx. length = $793.27 \mu m$).





Yixuan Gao, Natalie Koch and Steven Dreissig (Martin-Luther-University Halle-Wittenberg, Germany)

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Lemna japonica LEMNACEAE

▼ Le. japonica (2n = 42, 453 Mbp/1C) is an interspecific hybrid between Le. minor and Le. turionifera according to tubulin gene polymorphism fingerprinting (Braglia et al., 2021) and GISH.



◄ GISH with genomic probes of *Le. minor* (red) and *Le. turionifera* (green) of mitotic chromosome of *Le. japonica* (clone 8434) confirms that this clone is a dihaploid hybrid between *Le. minor and Le. turionifera.*

Phuong TN Hoang[,] Veit Schubert, Jörg Fuchs, Tram NB Tran and Ingo Schubert (Dalat University, Vietnam and Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) Gatersleben), Germany)

JUNE

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Agropyron cristatum POACEAE





Crested wheatgrass (Agropyron cristatum L. Gaertn.) a wild relative of possesses many genes that are potentially useful in wheat improvement. The tetraploid form is the most widely used crossing partner in introgression breeding programs.

► GISH of mitotic metaphase chromosomes of wheat-*A. cristatum* lines using labeled genomic DNA from tetraploid *A. cristatum* (green). Chromosome 4P (top) and 6P (bottom) disomic addition.

Mahmoud Said, Alejandro Copete Parada, Eszter Gaál, István Molnár, Adoración Cabrera, Jaroslav Doležel and Jan Vrána (UEB, Olomouc, Czech Republic; MTA, Martonvásár, Hungary and UCO, Córdoba, Spain)





JULY

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Sorghum purpureoesriceum POACEAE

▼ Wild sorghum (*S. purpureosericeum*) is a tropical, often crosspollinating species with loose and open panicles. Its genome (2n=2x=10) occasionally carries supernumerary B chromosomes.



◄ B chromosome distribution in a sorghum embryo. Cross section of a mature embryo after FISH with a B chromosome-specific probe (red). The B chromosome is absent in proto-root cells and leaf primordia. Only in very few groups of cells predetermined to form meristems and reproductive organs the B chromosome exists.

Miroslava Karafiátová, Alzbeta Doležalová, Tereza Bojdová and Jan Bartoš (Institute of Experimental Botany of the Czech Academy of Sciences, Olomouc, Czech Republic)

AUGUST

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Phaseolus lunatus FABACEAE

▼ *Phaseolus* L. beans are one of the most important legume crops. *Phaseolus lunatus* (2n =22), also known as Lima bean, was domesticated twice, in Mesoamerica and in the Andes. It is worldwide consumed for its high level of fibers and proteins.

► Oligo-FISH painting probes for *P. vulgaris* chromosomes 2 (green) and 3 (red) were hybridized to *P. lunatus* chromosomes, evidencing a conserved synteny of these two chromosome pairs. Chromomycin A3 (yellow) marks pericentromeric heterochromatin. Chromosome 6 carries 35S rDNA repeats (purple). 5 µm

Thiago Nascimento and Andrea Pedrosa-Harand (Federal University of Pernambuco, Recife, Brazil)

September

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Cycas revoluta CYCADACEAE

◀ "Cycads are to the vegetable kingdom what Dinosaurs are to the animal, each representing the culmination in Mesozoic times of the ruling Dynasties in the life of their age." Lester Ward, 1900. The members of the *Cycadaceae* family exhibit several interesting genomic features: stable chromosome number x=11; there are only diploid species, their karyotypes are asymmetrical and they contain abundant telomeric repeat variants in both telomeres and centromeres.

▼ Immunostaining of *C. revoluta* (2n=2x=22) mitotic chromosomes with antibodies recognizing phosphorylated histone H3 at threonine 3 (green) and phosphorylated histone H3 at serine 28 (red). Histone H3 phosphorylation is enriched in pericentromeric regions (green arrows). Diffuse anti-H3T3p signals are also observed along the chromosome axis between the chromatids and some chromosome ends (green arrowhead).



Radka Vozárová and Aleš Kovařík (Institute of Biophysics CAS, Brno, Czech Republic)

OCTOBER

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Festuca pratensis POACEAE

▼ Festuca species have a diverse distribution and are considered important components of grass ecosystems of the temperate zones. In *F. pratensis i*n addition to the essential A chromosomes, one to five supernumerary B chromosomes have been reported.



► FISH of an intact pollen grain of *F. pratensis* using the B-specific probe Fp_Sat 253. Only sperm nuclei display B-specific signals indicating that the drive of Bs occurs in the first pollen mitosis.



Rahman Ebrahimzadegan, Jianyong Chen, Andreas Houben and Ghader Mirzaghaderi (University of Kurdistan, Iran and IPK Gatersleben, Germany)

NOVEMBER

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Arabidopsis thaliana BRASSICACEAE

▼ *A. thaliana* (2n = 10) serves as one of the model systems to understand the 3D organising principles of the genome, in eukaryotes.



◄ 3D imaging using Stimulated Emission Depletion (STED) of Arabidopsis nuclei allows to gain insight into the 3D genome organization at nanoscale resolution. Here, isolated leaf nuclei were immunostained for RNA Pol II ser2P (green) and counterstained for DNA using Live 560 (Abberior. magenta). The image was segmented to produce a digital representation of the nucleus, heterochromatin (chromocenters and nanochromocenters) and transcription clusters. This step enables a quantitative analysis, in 3D, of the distribution of transcriptional clusters.

Ricardo Randall and Célia Baroux (University of Zürich, Switzerland)

DECEMBER

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Cephalaria syriaca (Pelemir) DIPSACACEAE

▼ *C. syriaca* (2n=2x=10) is a member of the Dipsacaceae family, which is generally distributed in Europe, West and Central Asia, Northern and Southern Africa, and Mediterranean regions. The genus Cephalaria is extremely rich in macromolecules and chemical compounds, and has a significant biological and morphological diversity in Turkey.





▲ FISH revealed the centromere-specificity of the Cs150 satellite repeat on chromosomes of *C. syriaca*.

Sevim D. Kara Öztürk, Yi-Tzu Kuo, Andreas Houben, Ahmet L. Tek (Niğde Ömer Halisdemir University, IPK)

2024

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(Polygonaceae) anther. fissue section of a Fagopyrum tataricum Immunodetection of histone H4 acetylation (green) in a Cover picture

Betekhtin (University of Silesia in Katowice, Poland) Agnieszka Brąszewska, Artur Piński and Alexander

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