What if your crop abundantly produces EDVs by itself

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UPOV Seminar on interaction between PVP and the use of plant breeding technologies

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EDVs of Edible mushrooms;
Button mushrooms as a case study

A.F. van Peer, J.J.P. Baars, A.M. Sonnenberg, 03 2023

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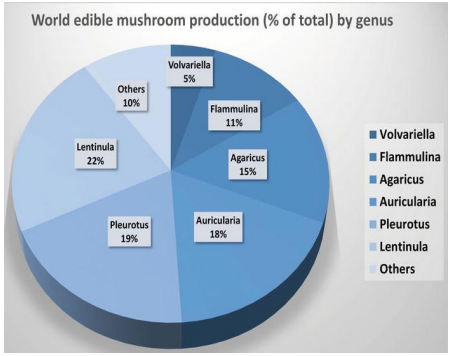
Breeding of mushrooms

- **5 dominant cultivated mushrooms world-wide**
  - Button mushroom is dominant mushroom in Europe / USA / Canada / Australia / India

- **Market share 'exotic' mushrooms keeps growing**
  - Breeding incentive increasing (e.g. SPOPPO)
  - Varieties from Asia on the European market

- **Expected: demand for new strains due to changes in production systems**
  - Limitations on fungicides/pesticides
  - Changing substrate/casing (peat, straw)
  - Automatization, different cropping regimes

- **Growing: interest in specialty button mushrooms**
  - Health (nutrition/protein)
  - Health (immune stimulation)
  - High end market (special taste/colour/texture)



Sakawhat ea 2021, DOI: 10.5772/intechopen.102694

Mushrooms and EDVs

- Mushrooms are genetically special organisms
- No clear rules exist on EDVs for edible mushrooms
- No known case laws
- Obstacles DUS testing

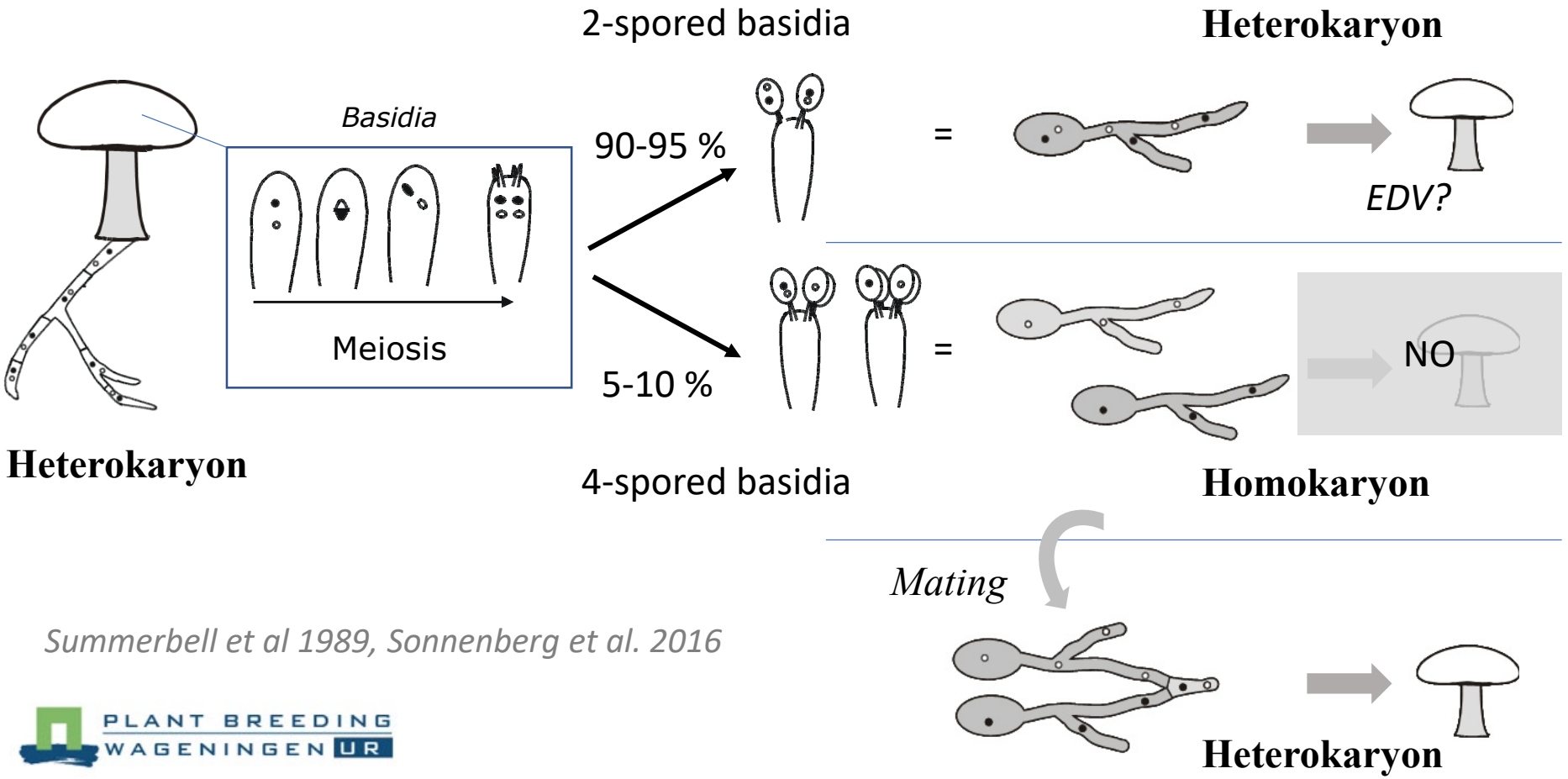
- Only one example of consensus for EDV:

Use of single or multi spore cultures of an initial variety of button mushrooms

Button mushrooms life cycle

Button mushroom (*Agaricus bisporus*), represented mainly by 2 subspecies

- *A. bisporus* var. *bisporus* → all commercial varieties
- *A. bisporus* var. *burnettii*



Summerbell et al 1989, Sonnenberg et al. 2016

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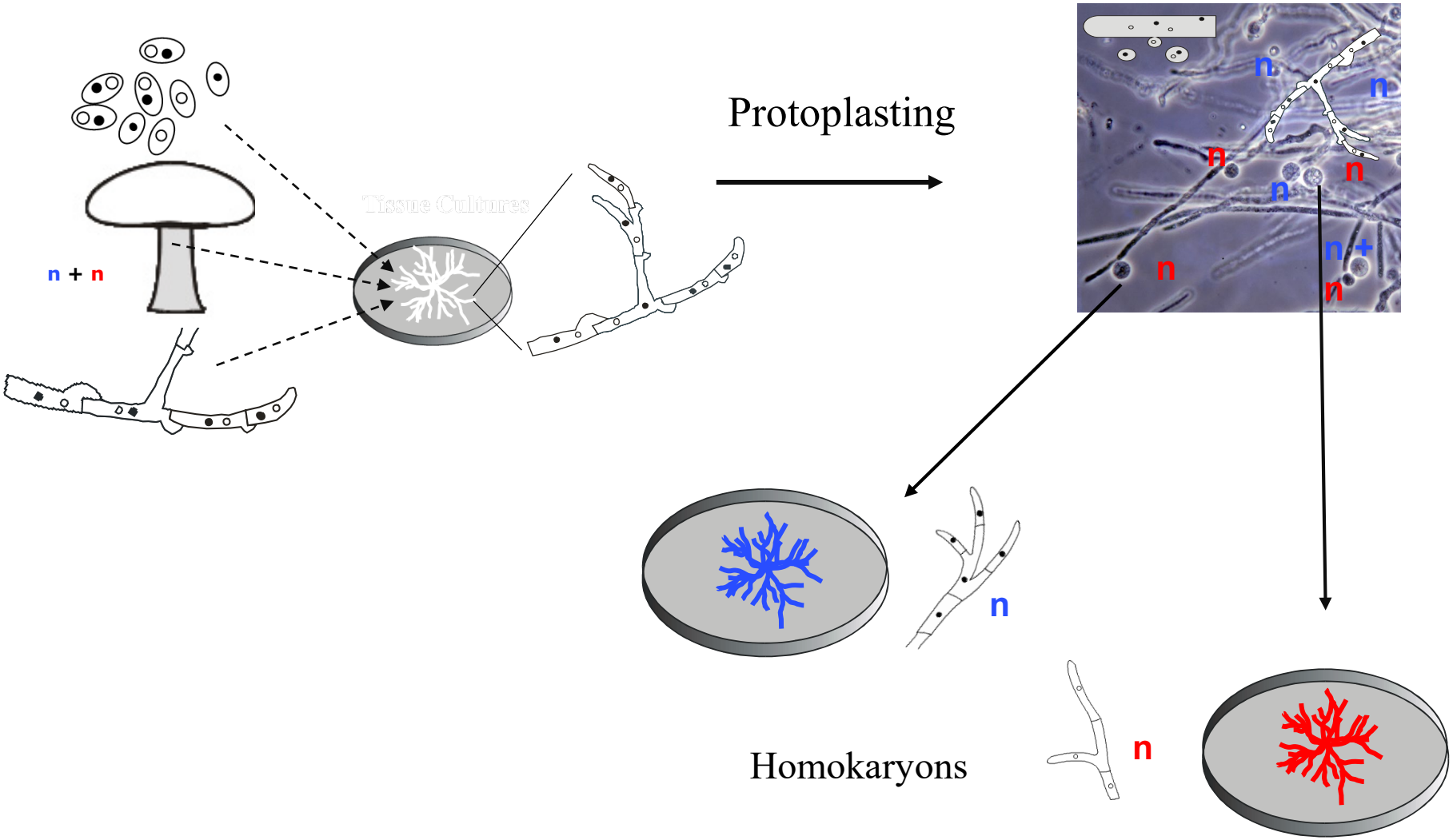
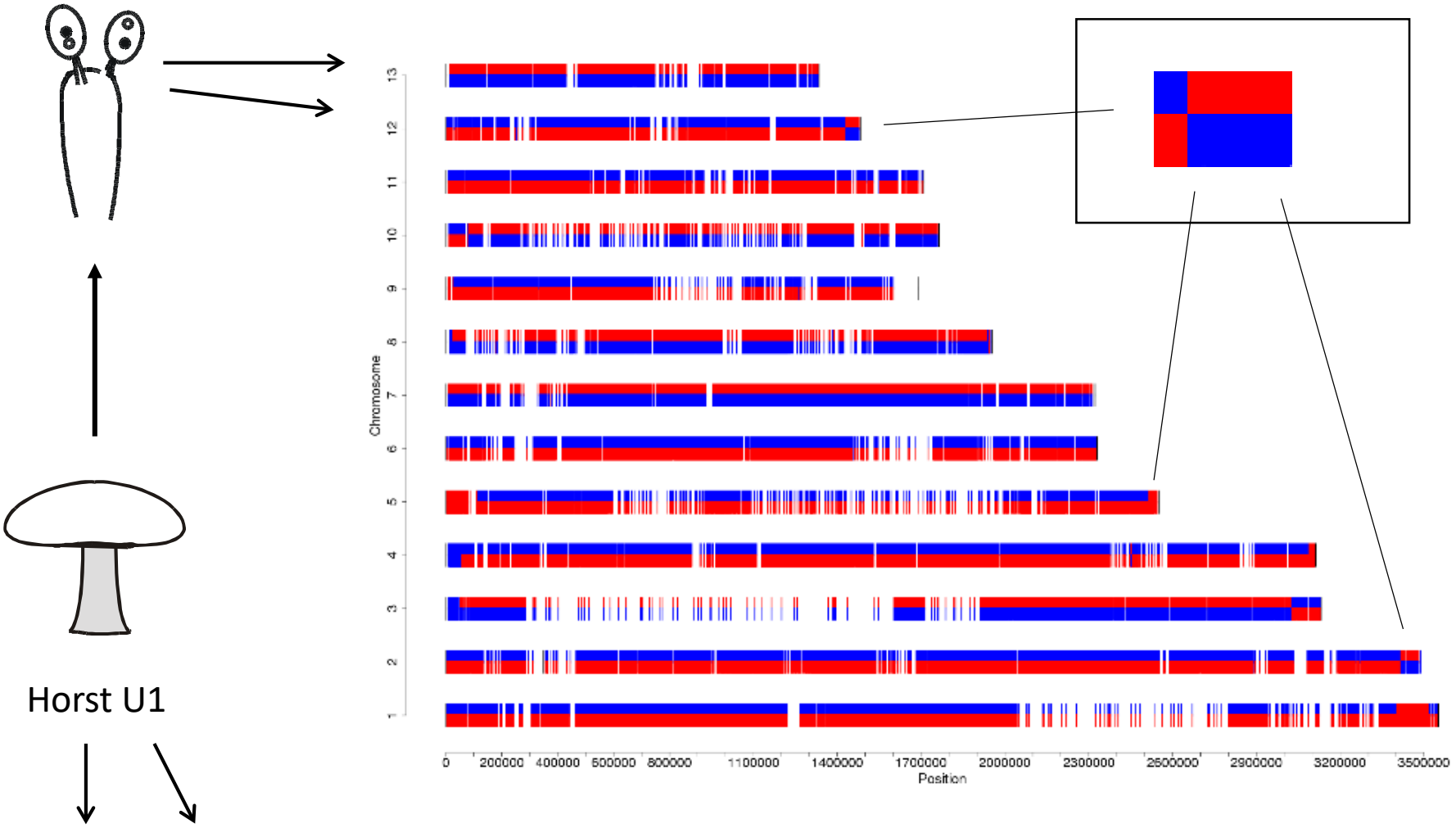
Recovering constituent nuclei: haplotyping



Haplotypes remain largely conserved in offspring

Recombinations at chromosome ends



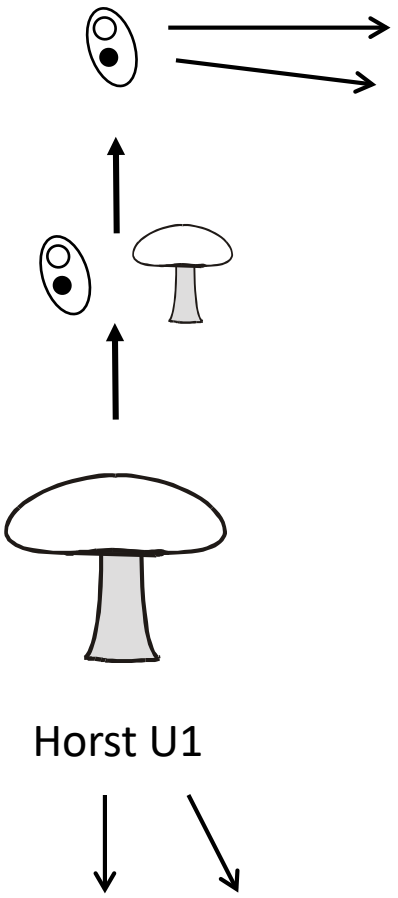
Horst U1

Parental type 1

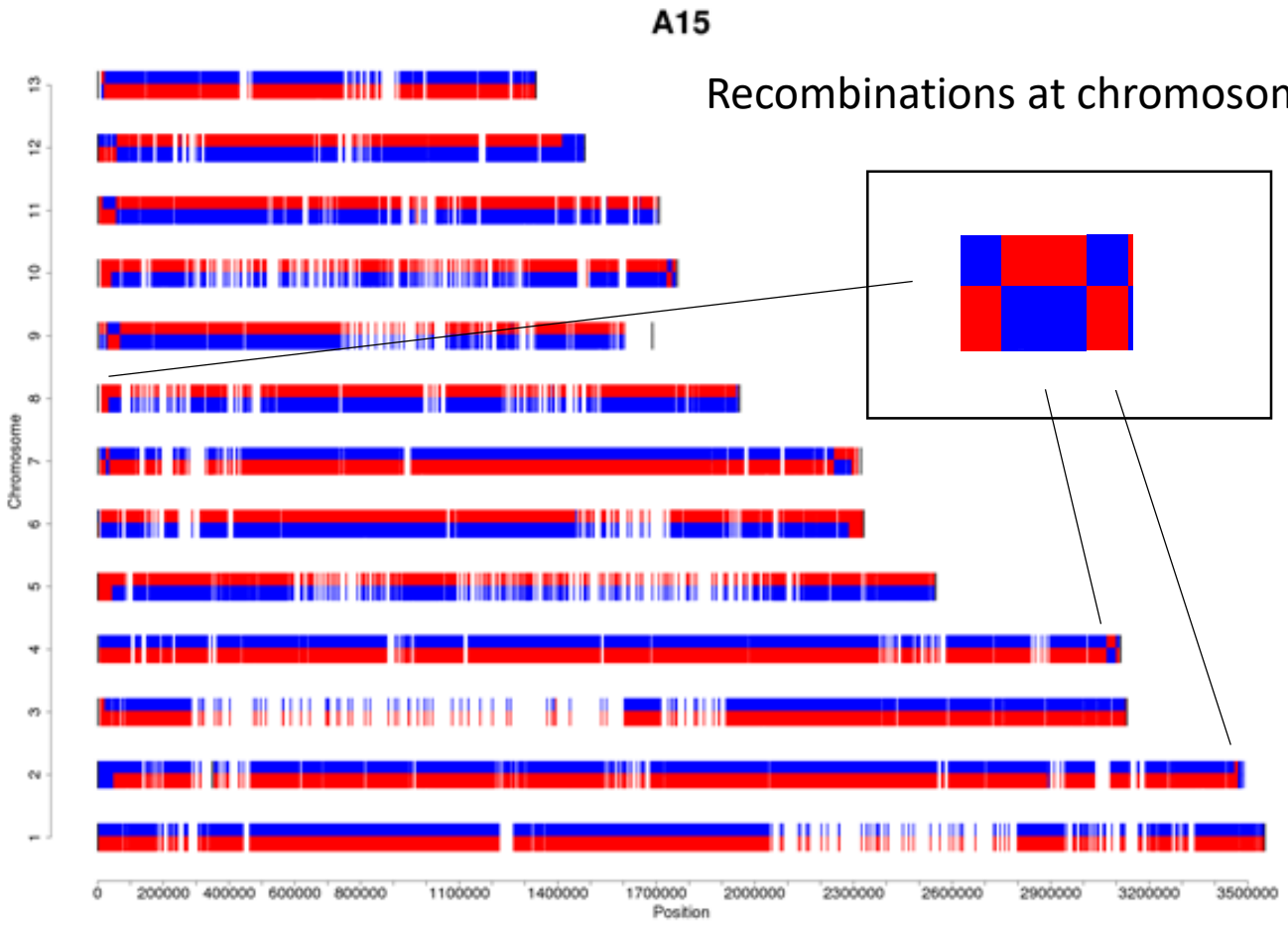
Parental type 2

Sonnenberg et al., 2016

Genotype of nuclei in Sylvan A15



Horst U1



Recombinations at chromosome ends

Parental type 1

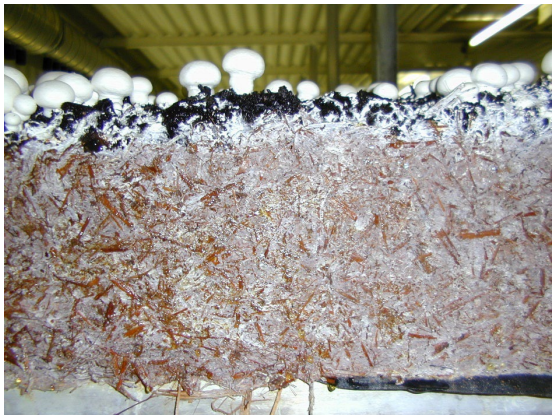
Parental type 2

Obstacles in DUS testing edible mushrooms

- Low number of phenotypic traits compared to plant varieties
  - To be improved or expanded?

- Phenotype variation by environment or small genetic variation
  - Substrate quality
  - Climate (and growers skills)
  - EDVs button mushroom

- DUS tests for mushrooms are expensive (compared to plant DUS tests)
  - Special inoculum preparation (spawn)
  - Special substrate preparation
  - Strict climate and hygiene
  - No test facility at this moment for button mushroom varieties



Using a genetic distance threshold to detect EDV

- Genetic distance threshold as indication for putative EDV
  Sequencing is easy and affordable for mushroom genomes

- If sample shows value above threshold:
  Reverse burden of proof
  Breeder of ‘new variety’ must open its books

Example; genetic distance of Horst U1 and its parentals

75 SNP markers:

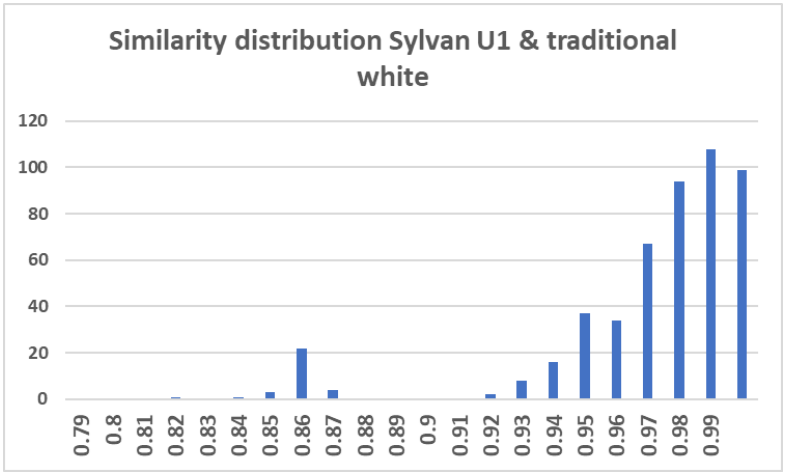
Traditional white

Meiotic spore of Somycel 53

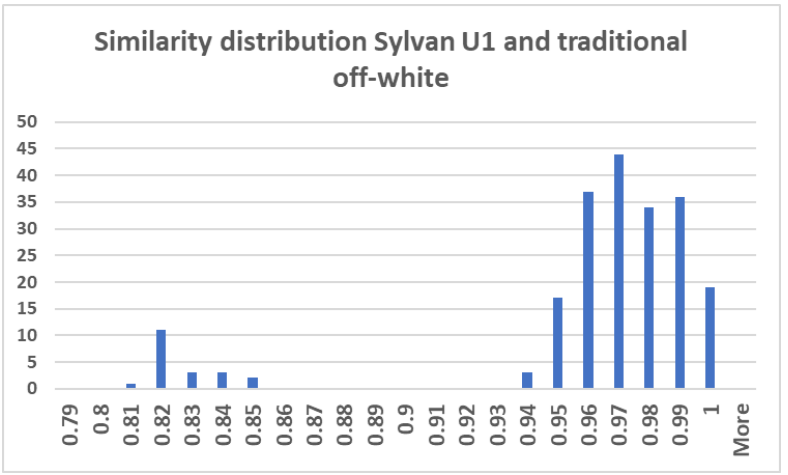
Traditional off-white

Meiotic spore of Somycel 9.2

Horst U1



Horst U1 Traditional white



Horst U1 Traditional off-white

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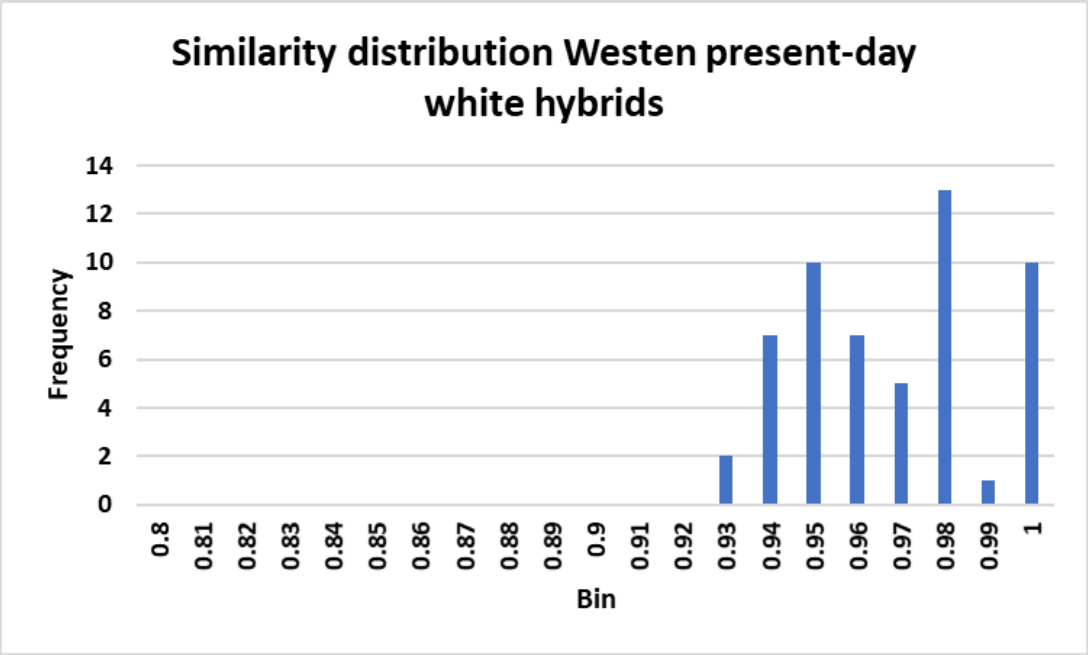
Example; genetic similarities with the present-day hybrids

75 SNP markers:



- Fertile single spore cultures of *A. bisporus* var. *bisporus* generates genetic variation in a range from ~ 0.92 to 1.0.

EDV definitions for Mushrooms

Consensus:

Use of single or multi spore cultures of an initial variety of button mushrooms = EDV

No definition or consensus: Needed to make breeding worthwhile

- **Recovering haplotypes** of a protected variety by protoplasting and:

Restoring the original variety by mating the recovered haplotypes

Restoring [...] but with a different mitochondrial type

Using an intact parental type in breeding

- **Introgression breeding**:

Repeated backcrossing to high similarity with a protected variety

What is the genetic threshold above which a variety is considered as an EDV?

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