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Naturally occurring flower mutation in offspring of a large fruited raspberry chance seedling

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Background

A key trait in any raspberry (*Rubus idaeus L.*) breeding program is fruit size.

Raspberry fruits consist of numerous individual drupelets. Thus, fruit size is affected by the number and size of drupelets.

We detected individuals with abnormal flower morphology in offspring of a large fruited chance seedling.

Those flowers are characterized by an increased number of sepals and carpels. In apple, a similar flower phenotype is caused by loss-of-function of the floral meristem identity gene *PISTILLATA*.

Key question

Is the abnormal raspberry flower phenotype caused by a mutation of *PISTILLATA*?

Results

1. Phenotyping

- The three phenotypes were collected and photographed as whole flowers (**Fig. 2.**) and as flowers cut apart to their floral organs (**Fig. 3.**).

Fig. 2. Flower phenotypes found in one raspberry population. (A) Type 1 with five sepals and petals, stamens and carpels present. (B) Type 2 with six sepals and petals, stamens and carpels present. (C) Type 3 with sepals and carpels, no petals and stamens.

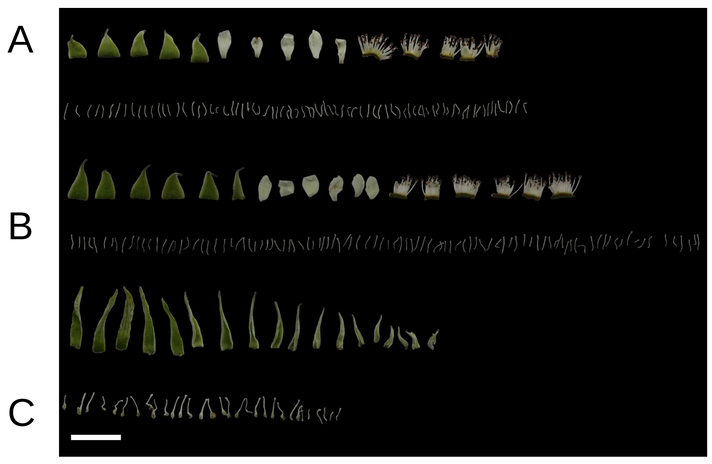

Fig. 3. Three flower phenotypes cut apart to their floral parts found in one raspberry population. (A) Type 1 with five sepals and petals, stamens and carpels present. (B) Type 2 with six sepals and petals, stamens and carpels present. (C) Type 3 with sepals and carpels, no petals and stamens. Bar = 10 mm.

- Type 2 has more carpels than both types 1 and 3.

- Fruit of the three phenotypes were measured and their individual drupelets counted (**Fig. 4.**). Type 2 has on average significantly heavier and larger fruit with more drupelets than types 1 and 3.

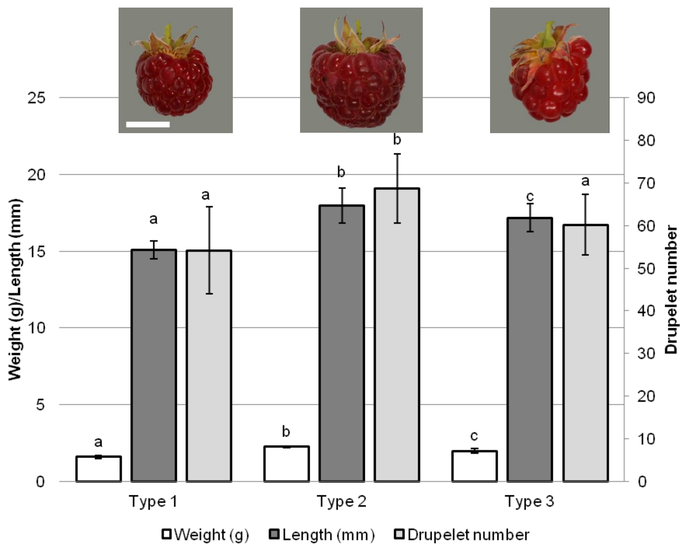

Fig. 4. Fruit of the three phenotypes evaluated for weight, length and drupelet number. Pictures above columns show a typical fruit for the plant phenotype, n = 838 for weight and length, n = 482 for drupelet number, t-test with $p < 0.05$.

2. Genotyping

- The *PISTILLATA* fragment of type 1 and 3 gDNA and cDNA were cloned and sequenced. Two alleles PI.1 and PI.2 were found in both type 1 and 3 plants (**Fig. 5**.). The allele PI.2 has two larger deletions in the last exon compared to PI.1.

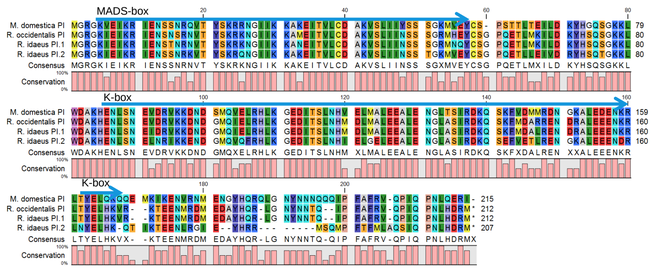

Fig. 5. Protein alignment of the PISTILLATA sequence of *Malus domestica, Rubus occidentalis* and the two alleles found in one *Rubus idaeus* population. Arrows span the functional domains MADS-box and K-box.

- A sequence similarity tree was created with *R. occidentalis* floral homeotic genes and the two alleles PI.1 and PI.2 found in our population (**Fig. 6.**).

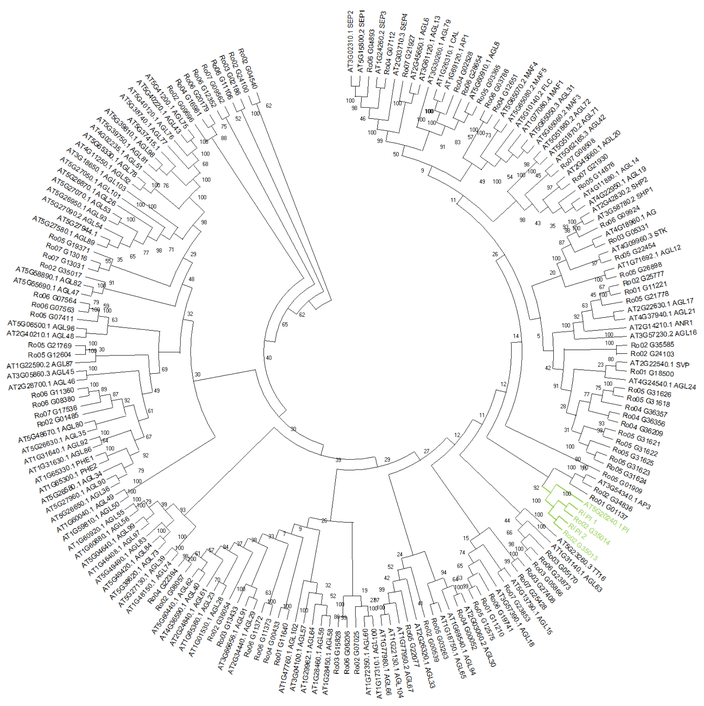

Fig. 6. Protein sequence similarity tree created of *Arabidopsis thaliana* floral homeotic proteins, *Rubus occidentalis* floral homeotic proteins and predicted proteins, and the two alleles found in our *Rubus idaeus* population PI.1 and PI.2.

Summary

Type 2 has more carpels and a larger fruit size.

There are two *PISTILLATA*-like alleles in the population, one of them with two large deletions.

Type 1 and 3 have both alleles, the difference in phenotype is probably caused by the regulation of the gene.

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