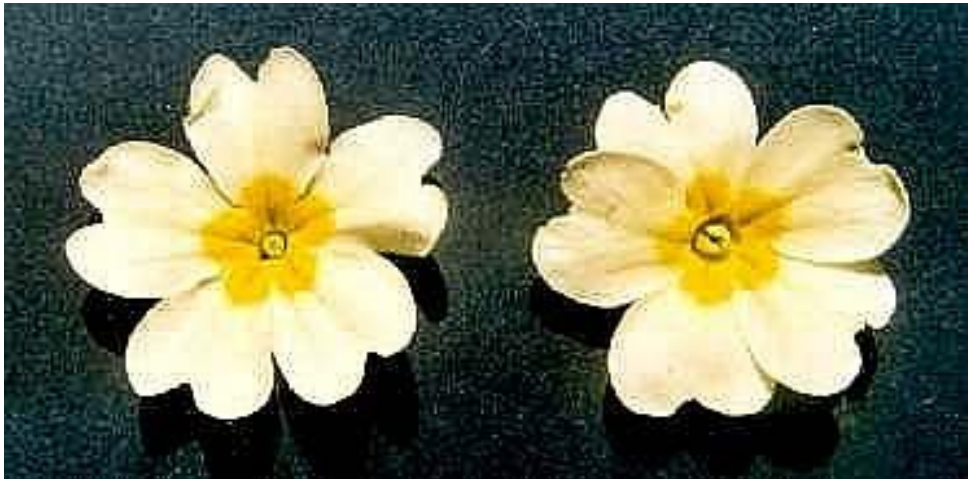
THE PRIMULA *S* LOCUS,

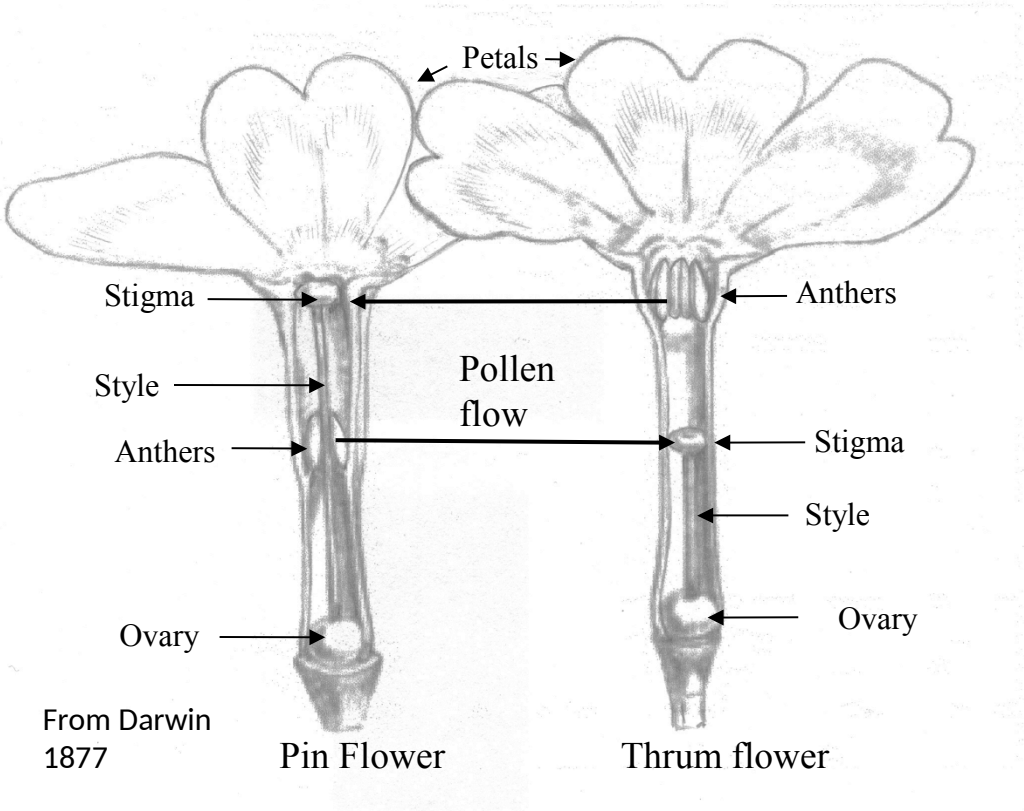
thrums, pins, and homostyles

PRIMULA BREEDING SYSTEM

Wild *Primula vulgaris* comes in two forms pin and thrum. Pin flowers have long styles, small pollen, and the stigma at the mouth of the corolla tube. Thrum flowers have short styles, large pollen, and the stigma approximately half way down the corolla tube. Pin flowers have anthers approximately half way down the corolla tube. Thrum flowers have anthers at the mouth of the corolla tube.

Visiting insects facilitate pollen flow between the two forms of flower.





LONG HOMOSTYLE

HOMOSTYLES

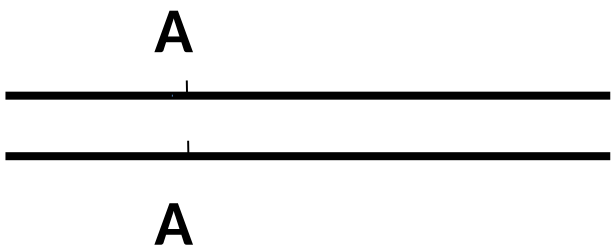
There also exist rare self fertile forms of primrose where the anthers and stigma are at the same level. If both are at the mouth of the corolla they are known as long homostyles, if half way down the corolla tube they are short homostyles. Short homostyles have never produced populations in the wild but they do occur occasionally in commercial crops of *Primula*. In contrast long homostyle populations have been found in the wild; e.g. in the Chilterns, but the greatest concentration of long homostyle populations has always been in Somerset and north Dorset.

SHORT HOMOSTYLE

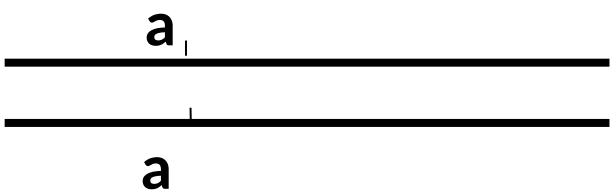
When long homostyle populations were first discovered in 1940 it was thought that being self fertile that they might take over from the pin/thrum populations, but this does not appear to be happening.

The long homostyle as a newly discovered form of *Primula vulgaris*, became the subject of much study. The pin/thrum breeding system of *Primula* had already been of interest and study since Darwins time and continues to be researched today.

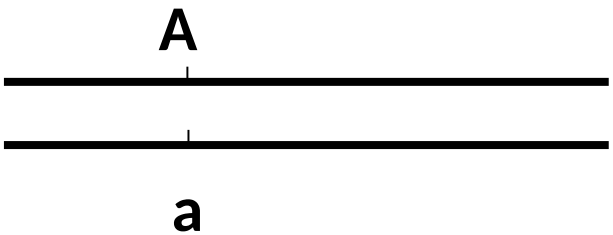
Primula vulgaris **is a diploid plant; that is it has 2 sets of homologous chromosomes i.e. the genes on the matching pairs of chromosomes are similar but not identical so that one allele may be dominant to the matching gene or allele on the other chromosome. For example:-**



A pair of homologous chromosomes homozygous for the dominant allele A



A pair of homologous chromosomes homozygous for the recessive allele a



A pair of homologous chromosomes heterozygous for the alleles A and a

In *Primula* the thrum phenotype is heterozygous dominant to the pin phenotype. Whether a primrose plant is thrum or pin is determined by a suite of genes known as the *S* locus. Originally it was thought that homostyly arose from recombination between the *S* locus genes but molecular analysis has recently proved this to be incorrect.

ORIGINAL MODEL

Thrum

$$\frac{GPA}{gpa}$$

Pin

$$\frac{gpa}{gpa}$$

Below, hypothetical recombinants

$$\frac{g \quad PA}{g \quad pa}$$

Long homostyle

$$\frac{g \quad pa}{G \quad pa}$$

Short homostyle

Where:-

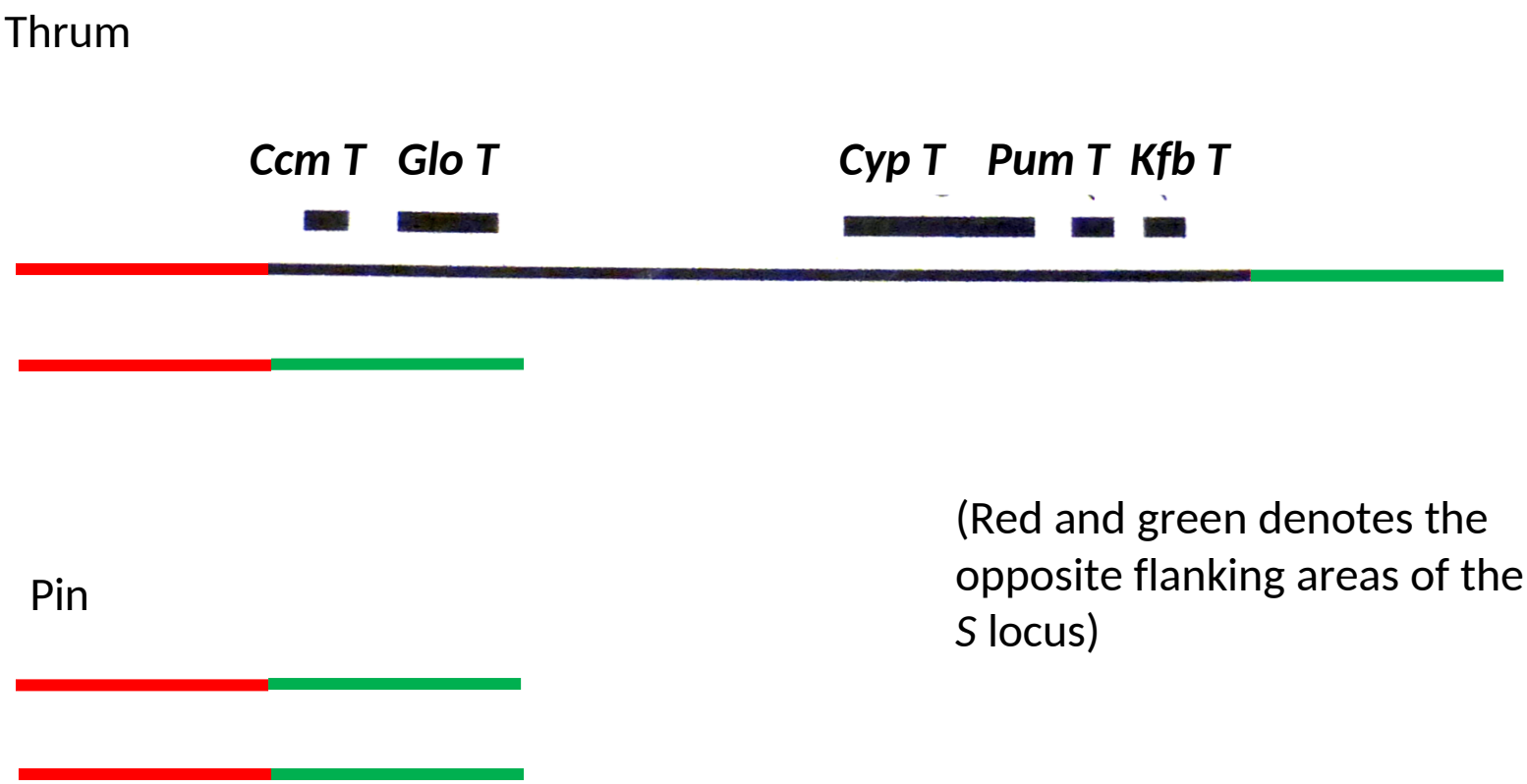
G **controls the Gyneocium (stigma + style length)**

P **controls pollen size**

A **controls anther position**

It was believed that at least 3 genes were involved *G*, *P* and *A*, but some authors considered that there were as many as seven. It was only molecular analysis that could accurately discover the *S* locus genes.

NEW MODEL



(Red and green denotes the opposite flanking areas of the *S* locus)

Recent molecular analysis showed that there are 5 genes present in thrums that are not present in pins. Consequently no recombination could take place and homostyles must have another origin.

Further molecular analysis showed that long homostyles have the 5 thrum genes but with a mutation in the *Cyp T* gene. Similarly the short homostyles also have the 5 thrum genes but with a mutation in the *Glo T* gene.

One of these *S* locus genes, *Glo T* proved to be a close relative of the *Globosa* gene. *Globosa* is/was an already known B function gene required for petal formation, that has been identified in a number of other plant species.

HOSE IN HOSE PRIMROSE (PETALOID CALYCES)

OAK LEAF PRIMROSE
(LEAVES LOBED LIKE OAK LEAVES)

My PhD work found that both of the above heterozygous dominant forms were linked to the *S* locus, one at either side. Later, molecular analysis found that the retrotransposon responsible for *Hose in Hose* was in the *Globosa* gene. This knowledge helped in mapping the *Primula S* locus.

Gene duplication and divergence is one way in which evolution occurs. *Glo T* responsible for the thrum phenotype, is an example, and it was possible to date the duplication and divergence of *Glo T* from *Globosa* to 51.7 million years ago!

These findings are very recent, published in "Genetic architecture and evolution of the *S* locus supergene in *Primula vulgaris*", Li et. al., Nature Plants 2nd Dec. 2016.

Links to the web page and the University press release can be found at:-

http://www.nature.com/articles/nplants2016188

https://www.uea.ac.uk/about/-/biologists-unlock-51-7-million-year-old-genetic-secret-to-landmark-darwin-theory