Alice McCosh Trust Award Report (2025), Z. Bowden

Characterizing the Microbiome of Red Campion (*Silene dioica*)

Using 16s-rRNA

I was awarded a small grant from the Alice McCosh Trust to support the research for my MSc by Research at the University of Exeter last year. This grant was invaluable; without it I would not have been able to finish (or nearly finish!) my postgraduate studies, as a result of which I have begun my PhD this year. I am immensely grateful.

Project Background and Summary:

Silene dioica (Caryophyllaceae) is a wildflower with a wide distribution across Europe. It's a common sight in many gardens, wildflower mixes and hedgerows. The genus *Silene* is a well-studied genus in the fields of ecology and evolutionary biology. One reason for this is the fact that within the genus many different mating systems are found and this is has been investigated from a number of different angles, from pollination ecology to genetics. The term mating systems refers to the way plants are pollinated and reproduce. We often think of plants as hermaphrodites with male (stamens, composed of anthers and filaments) and female (carpels, made of stigma, style and ovaries) reproductive organs and this is broadly true for most of the angiosperms (flowering plants). However, in many species different plants are male or female, a condition botanists refer to as dioecy. Red campion one such species, hence the name *Silene dioica* (Fig 1.).

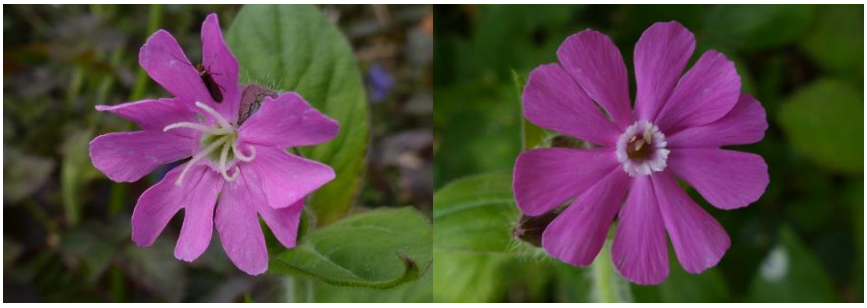

Figure 1. Male and female red campions. The individual on the left is female, the white structures in the middle are the carpels. The individual on the right is male; one can see the stamen within the opening.

Why plants, like red campion, should be dioecious has long intrigued naturalists. In fact, in his 1877 book *The Different Forms of Flowers on Plants of the Same Species*, Darwin stated “there is much difficulty in understanding why hermaphrodite plants should ever have been rendered dioecious”.

While, we have made a lot of headway into why some species are dioecious and others aren’t there is still a lot to learn. For this project we turned our attention to some of the consequences of this phenomenon.

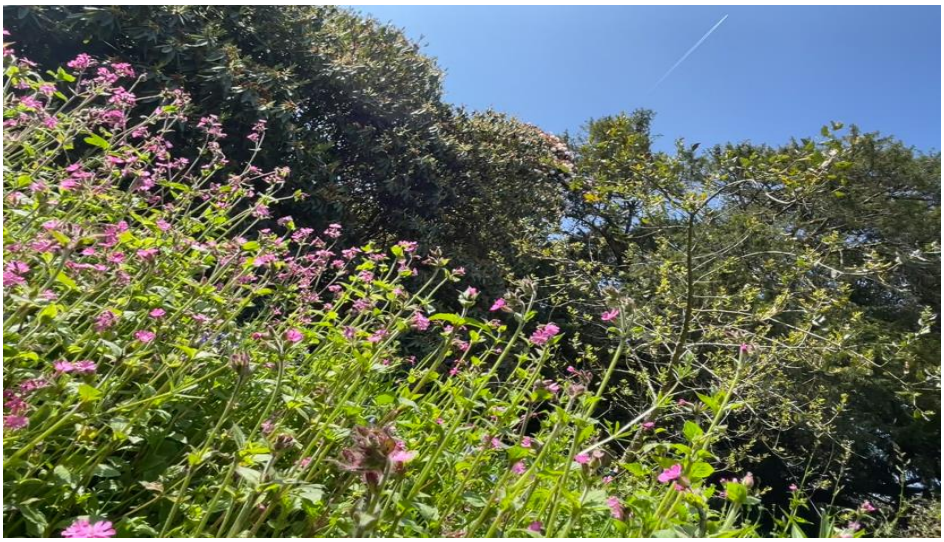

Figure 2. A patch of red campion in Cornwall, containing males and females. Astute readers may note that sampling was conducted in the summer, as I am somewhat of a fair-weather biologist.

It is becoming increasingly common knowledge that plants have complex interactions with many microbes in the soil. These microbes are crucial for making essential nutrients such as nitrogen and phosphorous available to plants. Plants can often control which microbes they associate with via their root exudates. As pollen and seeds are very different in makeup, we set out to investigate whether male and female plants have different rhizobacterial communities associated with them.

To do this we had to turn to molecular techniques. It is one of the major fallacies of early microbiology that everything can be grown in culture. Unfortunately, like plants, many microbes are hard to grow. Thanks to

modern sequencing technology we can infer the presence of many species using genetic markers. The genetic marker we use for bacterial communities is called 16s-rRNA. This is an ideal marker as it is found in all bacteria and varies significantly between species. To see whether male and female plants have more diverse and/or different rhizobacterial communities we took samples from the roots of 10 male and 14 female plants. We also took bulk soil samples in order to check whether it was the plant's sex and not background differences in community composition we were detecting. RNA was then extracted, purified and sent off for sequencing. We await the results!

Future work:

Another interesting aspect of this study system is a fungal pathogen called *Microbotryum*, an anther smut (Figure 3.). *Microbotryum*, is transmitted from plant to plant via pollinators, such as bumblebees and causes the plants to produce spores instead of pollen. In female plants infection also effectively masculinizes the flowers so the fungus can spread its spores. This whole process also sterilizes the plant. We believe it would be interesting to see whether *Microbotryum* also affects the plant's interaction with the rhizosphere and whether this varies between males and females.

Figure 3. Red campion infected with Microbotryum, *an anther smut. Infection with this pathogen sterilizes the plant as plant gamete production is replaced with spore production. Interestingly, this can be considered a venereal disease in plants!*