Understanding How Flowering Plants Respond to Climate Change

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A welcome sign of a change in seasons, the year's first flowers usher in the start of spring. Yet, as the climate warms, some flowers are blooming earlier. Since plants respond to environmental cues, such as temperature, shifts in their annual development has long been considered an effect of climate change. However, significant warming does not always lead to earlier flowering.

Dr Christa Mulder from the University of Alaska, Fairbanks recognised that plant flowering may not be directly related with spring temperature. Rather, she hypothesised that temperature shifts that occurred in previous years may influence the effects of rising temperatures in the flowering year.

Dr Mulder and her colleagues began by analysing subarctic plant communities in Canada. An analysis of decades of data for 39 plant species yielded surprising results: despite significant warming over time, there was no evidence that species were flowering earlier, suggesting that there must be counteracting effects on rising temperatures.

Diving deeper, the scientists focused on the early summer temperature in the year before flowering – a time when the buds start to develop. Their results suggested that warmer temperatures during the budding year could delay flowering time in the next year. Though the causes are still uncertain, the team hypothesised that warmer temperatures may cause the buds to induce early dormancy.

Next, Dr Mulder focused on understanding the development of the bud itself. In a collaboration with Dr Pamela Diggle and Eileen Schaub, she investigated how variation in temperature affected the flower development of the shrub lingonberry – also known as low-bush cranberry. The researchers headed into the field to collect flowering shoots at different stages of development from warm and cool sites in the boreal forest, and conducted an anatomical assessment of the buds.

In sites where it was warm in spring and the ground thawed early, buds started to develop early. However, because the buds all stopped developing at the same stage, there were no differences between buds at warm and cold sites by the end of the summer. This suggests that, at a certain point, flower development is controlled by internal processes within the plant.

Next, Dr Mulder and her colleagues looked at what happened in six plant species when temperatures are higher than normal. They created artificial open-topped chambers to warm the plots and split them into four treatments: plots warmed in the budding year; plots warmed in the flowering year; plots warmed in both years; and a control group.

For most species, plants that had been warmed only in the flowering year flowered earlier. However, for lingonberry and two other species, when the plants were warmed only in the budding year, flowering was delayed. Effects of warming in both years were additive, cancelling each other out and potentially explaining why some species in the wild show no change in flowering times.

Timing mismatches between plants and animals – especially pollinators – can throw an entire ecosystem out of sync. When plants and insects respond to different cues, flowering may not overlap with the activity of the pollinating insects that the plant depends on to reproduce. As a result, it may not bear fruit later in the year, causing starvation amongst the animals that depend on its fruit.

This can also have serious implications for arctic communities that pick berries as an alternative to expensive, imported produce. As such, Dr Mulder's work is a crucial step towards understanding how particular species of plants are responding to increased temperatures.

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