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Climate change threatens early-flowering plants due to lack of snow

Among the ecological effects of climate change are changes to the timing of natural events, such as flowering. To understand why these phenological changes affect reproduction, this study manipulated conditions in a spring herb to prompt premature flowering. This exposed the flowers to frost, and resulting damage caused dramatic reductions in plant reproduction, suggesting that climate change may threaten plant survival.

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Source: Gezon, Z., Inouye, D. & Irwin, R. (2016). Phenological change in a spring ephemeral: implications for pollination and plant reproduction. *Global Change Biology*, 22(5): 1779–1793. DOI: 10.1111/gcb.13209

Contact:
zak.gezon@disney.com

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Known as nature's calendar, phenology describes the timing of critical events, such as when flowers bloom, birds migrate or trees shed their leaves. These processes are closely linked to environmental conditions, such as temperature.

As the climate warms, therefore, the timing of life history events of plants and animals are changing, which may have implications for reproduction. In particular, changes to when plants flower can have dramatic effects on their survival and seed production and, therefore, fitness, with implications for survival of the population and perhaps even the species. It is important to investigate this process in order to understand how plant species across the world will respond to a changing climate.

Changes to phenology can affect reproduction in various ways. First, changes to the timing of flowering influence the conditions the plant will experience. For example, early flowering may increase the risk of frost damage in some plant species, which has a knock-on effect on seed production. Changes in phenology can also lead to 'mismatches' between plants and pollinators (as a plant may no longer flower at the same time that bees are flying, for example), with potentially drastic effects on reproduction.

This study investigated both possibilities. The researchers experimentally altered the timing of flowering and observed the effects on plant–pollinator interactions and reproductive success. As a case study, they used the wildflower *Claytonia lanceolata*, which is found in Canada and the US. It thrives in the rocky soil of alpine climates and flowers early in the spring. The timing of its flowering is closely linked to when the snow melts.

The researchers manipulated flowering in two ways. Both experiments were conducted in subalpine meadows in Colorado, USA. First, they removed snow from the area where the plants grow to induce earlier flowering (flowering occurred around 10 days earlier). These plants were more likely to experience frost damage, which led to low reproduction rates. Even when supplemental pollen was provided, the frost-damaged plants could not recover their reproductive output.

Some plants did not experience frost damage, however. Surprisingly, these plants were more often visited by pollinators and had higher rates of reproduction than the controls. The researchers say this may be because of an increase in water availability due to snow melt.

To eliminate differences in water availability, in the second experiment the researchers induced flowering in a greenhouse before placing the plants in outdoor arrays with constant resources. They created three stages of flowering (early, control and late) by placing plants in the greenhouse at eight-day intervals. Although late flowering is not an expected consequence of climate change, this treatment was used to simulate a feasible scenario in which bees emerge earlier due to climate change.

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Even though earlier-flowering plants sometimes received more visits from pollinators, the benefits of this were negated by the adverse impacts of frost damage, which had severe effects on flower production and plant reproduction. Delayed flowering (equivalent to the earlier emergence of pollinators) also resulted in losses in reproduction, due to reduced pollination.

This study points to some of the possible consequences of climate change for plant reproduction. The findings show that changes in environmental conditions have an effect on reproduction equivalent to, and in some cases more severe than, changes in plant–pollinator interactions. In particular, earlier flowering increased the risk of frost damage, which had severe consequences for plant reproduction.

Although this study was conducted in the US, the findings are relevant across Europe, where a lack of snow in spring is already occurring. Although there is a general climate-warming trend, there is also high natural variability in temperatures in Northern and Atlantic Europe, which means that flowering plants will face various reproduction-related challenges under the changing climate.[1]

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1. IPCC, 2014: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspect,* Chapter 23: 1276: http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap23_FINAL.pdf