Plants that move: How New Zealand species disperses seeds in high alpine, wet environment

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High in an alpine meadow, Gesine Pufal, from the University of Wellington, New Zealand, crouched low to the ground and splashed some water from her water bottle on a low green plant cushion, then sat back waiting to see if something would move. Sound crazy? Many hikers passing by her may have thought so, but Pufal was trying to find potential plant species that possess a type of plant movement called hygrochasy.

Although the ability to move is typically thought to be a characteristic unique to the animal kingdom, plants are also capable of movement, from the sudden quick snap of a Venus flytrap to the more subtle creeping of the growing tips of a morning glory vine.

Pufal and her colleagues were interested in another type of plant movement—one used for dispersing seeds, called hygrochasy. While most plants rely on outside sources such as animals or wind to move their seeds to new locations, some plants have specialized, self-sufficient mechanisms. Hygrochasy combines the movement of a plant organ with dispersal of seeds—in response to moisture, such as rain drops, water fills specific cells or cell walls, changing their size, which in turn pops open a capsule expelling the seeds found within.

"Hygrochasy is a dehiscence mechanism that was previously thought to be very specific to plants from very dry environments with only sporadic rainfall," Pufal notes. "When the closed fruits of some desert plants are wetted by rainfall, they open and the seeds get dispersed, thus taking immediate advantage of the recently moistened soils and ensuring successful seed germination."

Although hygrochasy has been found primarily in plants in xeric, or dry, environments, Pufal's interest was piqued by reports that hygrochastic capsules had been found in plants from wetter environments, including some alpine cushion-forming species of Veronica in New Zealand.

Pufal's search for hygrochasy in New Zealand's high alps was successful—she investigated capsules of 17 species of Veronica, which she used to examine the function and anatomy of this dehiscence behavior. She and her colleagues published their findings in the September issue of the *American Journal of Botany*.

To determine which of the *Veronica* species were hygrochastic, Pufal and her co-authors submerged entire dry fruit capsules under water and exposed frozen tissue slices on slides to drops of water. Based on their results, they classified 10 of the 17 species as hygrochastic, meaning their capsules opened up under water and closed upon drying, or their cells absorbed water. Upon closer examination, they found that when the capsule of a hygrochastic species was exposed to water, the cell walls of a single layer of cells located between the two halves, or septum, of the fruit capsule filled up with water. These distinctly elongated cylindrical cells swell, increasing in diameter and extending the height and length of the capsule septum, but not its thickness. At the same time, cells lining the outer edge of the capsule were found to be thicker walled and to contain lignin—these cells do not swell with water and thus provide a resistant outer edge to the capsule. As the inner tissue swells and the outer tissue stiffly resists, the capsule halves pull away from each other, and a valve on the outer edge splits open. As the splits widen, a splash cup is formed.

This movement is reversible—when the capsule dries, the swelling recedes, and the cells contract to their original position.

In contrast, the cells in the septum of the remaining 7 species of *Veronica* were found to have thick cell walls, and all the cell walls in the fruit capsule were completely lignified. The authors classified these species as ripening dehiscent as they opened with ripening and remained open in all weather conditions.

"The most important point from our research," Pufal emphasizes, "is that we described the function and anatomy of this very specific dehiscence mechanism in some New Zealand *Veronica* and these occur in the New Zealand alps, where the environment shows just the opposite of desert conditions—it is very wet most of the year."

So why do these plants exhibit this intriguing dehiscence behavior?

"We have already published some results, stating that hygrochasy in alpine Veronica might serve as a safe site strategy for seeds in patchy environments, by restricting dispersal to suitable patches," Pufal notes. "However, it would be interesting to investigate hypotheses for hygrochasy in plants of very different habitats, such as prairies or wetlands and compare those with the 'typical' hygrochastic species of deserts in southern and northern Africa and our own results of the work in New Zealand. What happens in other extreme environments such as the sub-Antarctic islands or tundras around the Arctic circle?"

"We also think there is the possibility for future studies on the evolution of hygrochasy in alpine members of the large *Veronica* clade in New Zealand (100+ species)," Pufal concludes. "Does hygrochasy follow phylogeny or did it evolve independently?"

More information: Pufal, Gesine, Ken G. Ryan, and Phil Garnock-

Jones (2010). Hygrochastic capsule dehiscence in New Zealand alpine Veronica (Plantaginaceae). American Journal of Botany 97(10): 1413-1423. DOI:10.3732/ajb.1000066

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