How some plants spread their seeds: Ready, set, catapult

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A cluster of ripening siliquae is pictured. Credit: Dr. David J. Ellerby, Wellesley College, Wellesley, Massachusetts.

Catapults are often associated with a medieval means of destruction, but for some plants, they are an effective way to launch new life. Dispersing seeds greater distances by catapulting can provide selective advantages, including the establishment of populations in new environments and escape from certain threats.

In new work published in the recent October issue of American Journal of Botany, Dr. Ellerby, students, and postdoctoral researcher Shannon Gerry at Wellesley College measured the mechanics involved in catapulting seeds for the ballistic disperser *Cardamine parviflora*.

"While plants are generally thought of as immobile organisms, many of them are capable of spectacularly rapid movements," stated Ellerby. For *C. parviflora*, the valves of the silique rapidly coil outward catapulting the seeds away from the parent plant. The entire coiling and launching process is completed in around 5 msec—faster than the blink of an eye.

Analysis of the launch showed that the catapulting mechanism is not very reliable in *C. parviflora*, with the majority of the seeds simply falling to the ground. For the seeds that were launched, however, the transference of stored energy to kinetic energy was ~20% efficient. An impressive number when compared to the 0.5% efficiency observed for a ballistic diplochore (*Impatiens capensis*) in a previous study of Ellerby and colleagues.

This incredible speed and high energy storage present a challenge for the researchers. "These seed pod catapults are on a hair trigger," said Ellerby. "Successfully positioning them in front of our high-speed camera without them exploding prematurely requires an incredibly steady hand."

Seed launching has evolved in a number of groups. Comparing the mechanics of seed dispersal and the morphology of fruits and seeds between plants utilizing ballistic methods and closely related plants that do not, can provide a deeper understanding of the evolution of ballistic mechanisms and the properties required for energy storage and transference.

Seed dispersal has been studied extensively in the model plant *Arabidopsis thaliana*, a close relation to *Cardamine*. Like most other members of the Brassicacae, *A. thaliana* does not disperse its seeds via catapulting. Instead, the seeds are dropped to the ground as the silique dehisces and splits. Despite these differences in seed dispersal mechanisms, the siliques of *C. parviflora* and *A. thaliana* are

morphologically similar. One difference is the persistence of second layer on the inner surface of the valve in *C. parviflora* that degenerates in *A. thaliana* during maturation. This additional layer likely plays a role in valve coiling.

"Ultimately it will be important to analyze the spring-structures at a tissue and cellular level to determine precisely how they store such impressive amounts of energy," Ellerby said. "This could inform the design of human-engineered structures for absorbing or storing elastic energy."

More information: Marika Hayashi, Shannon P. Gerry, and David J. Ellerby (2010). The seed dispersal catapult of Cardamine parviflora (Brassicaceae) is efficient but unreliable. *American Journal of Botany* 97(10): 1595-1601. DOI:10.3732/ajb.1000173