How spring-loaded filaree seeds self launch

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When filaree seeds ripen and burst, they are launched with an inbuilt spring. Scientists based at the University of California, Berkeley, and Harvard University have discovered that the inbuilt spring stores energy as the seed head dries and can flick the seed as far as 0.5m before drilling it into the soil by repeatedly unwinding and rewinding as the humidity rises and falls.

Even by invading plants' standards, the filaree, or common stork's bill, has been remarkably successful. Introduced into North America in the eighteenth century, it is now endemic in south-western states such as California, and the plant's intriguing seed dispersal mechanism seems to lie at the root of their success. Having launched as far as possible from the mother plant, the seed drills itself into the ground by repeatedly curling and unwinding a strap-like structure, known as an awn, to give it the best chance to germinate. But how do they self-drill? Having watched the seeds bore themselves into the ground in California, research associate Scott Hotton took them back to Jacques Dumais' Harvard laboratory to take a closer look and when Dumais set his introduction to botany class the challenge of making a time-lapse movie, Dennis Evangelista jumped at the opportunity to film the seed's drilling action. Evangelista, Hotton and Dumais publish their discovery that filaree seeds are launched with a spring mechanism that also drills the seeds into the ground in The Journal of Experimental Biology.

Setting up a camera in his kitchen, Evangelista wet the dry seeds and filmed them as they uncurled and then rewound when they dried. Evangelista explains that when humidity is low the awn dries, curls and drills the seed into the soil. When the humidity rises the awn uncurls, but backward facing hairs on the awn force the seed to move in one direction so that it continues drilling into the ground even when it uncurls. Plotting the tip's trajectory as it wound round, Evangelista realised that the awn behaved like a beam bending into a stretched logarithmic spiral. He could use engineering physics to calculate the amount of energy stored in the awn as it ripened and dried within the fruit and use it to explain how the seeds launch themselves. 'By knowing how much energy is in the dry awn when it is held straight in the seed head I can estimate the range that it goes,' says Evangelista; but first he needed to find out just how far the seeds could fly.

Setting up a high speed camera in Mimi Koehl's Berkeley laboratory and filming seed heads – formed from clusters of five awns – Evangelista captured the instant when an awn finally tore loose and the speed as it catapulted free, launching the seed up to 0.5m from the plant. But how well would Evangelista's energy storage model hold up when he used it to calculate how far the seed could be launched?

Calculating the amount of energy that was released as the dry awn curled and broke free of the seed head, Evangelista then subtracted the amount of energy required to tear the awn away and the energy lost to wind resistance as the seed tumbled through the air, before calculating the distance that the seed could be flung. His calculations matched the distance that the filmed seed had flown. So filaree seeds disperse by using energy stored in the dry awns, which act as springs to fling the seeds by up to 0.5m.

Having discovered how filaree seeds are so successful at propagating, Evangelista and Dumais are now keen to find out how other members of the geranium family disperse their seeds. Evangelista explains that all geraniums are thought to use variations of the awn catapult mechanism for seed dispersal and propagation and he is keen to find out how changes in the awn's material properties affect seed dispersal in other members of the geranium family.

More information: Evangelista, D., Hotton, S. and Dumais, J. (2011). The mechanics of explosive dispersal and self-burial in the seeds of the filaree, Erodium cicutarium (Geraniaceae). J. Exp. Biol. 214, 521-529. http://jeb.biologists.org/cgi/content/abstract/214/4/521

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