Do bears disperse *Darlingtonia*?

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Sodden fields of silent green serpent heads complete with dark red tongues stretch out before me as I explore the Northern California habitat of *Darlingtonia californica* – the Cobra Lily. Closer examination of their domed heads reveals the clear patches or fenestrations which trick insects into following the light down into the pitchers. As I marvel at these fascinating plants, I ask myself rhetorically, "How could they be any more interesting?" Well, what if their seeds were distributed by bears?

This isn't exactly a new idea, but it hasn't been widely accepted as fact either. Peter D'Amato has long suspected this to be true. He even mentioned it in the first edition of his book, "The Savage Garden". Peter notes, "the small seeds are bristly, no doubt to encourage dispersal by animals."

Indeed, the little club-shaped seeds are covered in tiny bristles that immediately make you think of animal dispersal. Bears are an obvious suspect because of their long, shaggy fur and love of water.

In 2003 Harry Tryon took Peter and me to a *Darlingtonia* site that he calls "bear wallows" in Del Norte County, California. His red pickup truck jostled us down narrow timber "roads" composed of loose rock, a crumbling uphill slope to the right, and a sheer drop of at least 50 meters to the left. Peter leaned in from the back seat and asked, "If we fell how long do you think it would take to find our bodies?"

Figure 1: Harry Tryon leads the way to "Bear Wallows", with a *Darlingtonia*-lined wallow beyond him; and an American black bear (*Ursus americanus*). Left photo by Damon Collingsworth; right photo by U.S. Fish and Wildlife Service.

Shortly after the uneasy laughter died down, the truck thankfully came to a stop. As we got out, Harry pointed out bear tracks and warned us. He said that he never visits this spot by himself. We followed him quietly down a trail to the wallows. I noticed bear hair stuck on the low branches and bark of the tree trunks as I walked. The trail led us downhill a ways and ended in front of a bear-sized pool bordered by Cobra plants. Our path literally dumped into the wallow and then climbed out on the other side before dropping into another cool pool. As I recall, the path led through at least three more of these small pools, each surrounded by *Darlingtonia*. Thankfully the wallows were not in use at the time, but their purpose was clear. Bears must surely take this path to cool down. It was an amazing site where, probably due to the relatively low light, the *Darlingtonia* grow pitchers that are about waist high. While this evidence is admittedly largely circumstantial it does lend some credence to the idea that the seed were hitchhiking on the bears to find areas to germinate where the water can cool the plants' roots on hot summer days.

Years later, after a *Darlingtonia* talk I gave at the 2012 ICPS conference, Dr. Adam Cross approached me. He was quite intrigued by the bear idea in particular and offered to do a SEM image of *Darlingtonia* seed. He has done quite a bit of research on seed dispersal in Australia and so his insights have been invaluable. When I received the initial SEM images of the seed (Fig. 2), I was a little disheartened. The bristles lacked barbs or hooks that might more firmly suggest animal dispersal. In personal communication with Adam, he pointed out that the dispersal objective of *Darlingtonia* is very unique, which might account for the somewhat tame look of the bristles. It has been pointed out by others that the bristles would also add surface area to the seed allowing them to float better on the surface of water. This might suggest that the bristles are purely for water dispersal, but given the vast expanses of hot and dry landscapes that *Darlingtonia* seeds have traveled to find the cool streams and fens where they grow, it seems that water dispersal certainly cannot be the whole story.

Adam and I would point out here that the ideal dispersal model for *Darlingtonia* would be for the seeds to be bristled just enough to hang in the shaggy hair of a wandering bear, but not so hooked as to get stuck permanently in their fur. Bears are wallowers, so *Darlingtonia* seeds deposited in their fur would have a good chance of finding their way into some water. Once in the water, however, the seeds will need to release from the hair into the water and float to some suitable location for germination. We believe it is this two-step distribution that explains why the seed don't look more aggressive when compared to other more typically animal-distributed seeds.

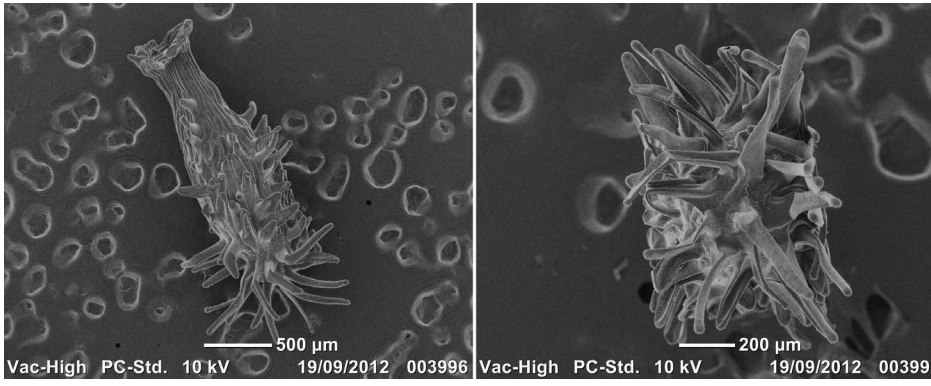


Figure 2: A close look at the seed coat projections which enable the seeds to entangle in the hair of animals. Photo by Adam Cross.

Figure 3: The full progression of *Darlingtonia* flowers, starting with the freshly opened flower in the left background. In the foreground from bottom to top, each flower shows how the flowers turn up after pollination; and on the right, a nearly ripened seed pod fully upturned.

I've spent quite a bit of time walking amidst the Cobra plants now and I have noticed another trait that further supports this theory of bear-dispersal. Like *Sarracenia*, *Darlingtonia* flowers are born on tall scapes and they hang like little green and purple lanterns. Once the flower is pollinated, the scape straightens out turning the fruit upside down before it dehisces. By autumn, the fruit cracks open slightly longitudinally, but because the fruit is upturned like a cup, nearly all of the seeds are stuck inside. This would be a pretty big evolutionary flaw for a plant family which is so specialized and evolved. The common sense of nature dictates that there must be some evolutionary advantage to this. *Sarracenia flava* and *S. leucophylla* flowers often turn up after pollination, but this helps the seeds to fall away from the umbeli-

Figure 4: A fully opened seed pod from above showing the seeds still trapped inside. Photo by Jason Ksepka.

form pistil. In *Sarracenia*, the upturned pistil can also shade the developing fruit from the scorching southern sun after the flower has inverted.

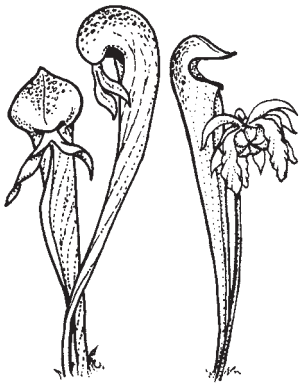
So, why do *Darlingtonia* flowers then seem to stupidly invert and trap their seeds in their own fruit? It would take less energy to leave the flower the way it is and just drop the seed in the water below if water dispersal was your sole goal.

After thinking about this long and hard, I propose that the seeds are not stuck, but waiting for a ride. A very few seeds often do immediately fall from the openings in the side of the dried fruit and might very well disperse a short distance in the water below. Almost all of the other seeds are still stuck in the open fruit even a year after they've opened. You often see last year's pods still full of old seed. I have noticed that as I troop through the Cobra plants, I brush past the tall, stiff scapes. They would be pushed down slightly, then spring back to attention, flinging the seeds everywhere. No doubt, as bears lumber through the water-logged plants the seed would be flung into their fur in the same way. Obviously, seeds that have fallen on the ground are much less likely to casually make their way into the fur of an animal, making the type of long distance dispersal necessary for finding new habitat unlikely at best. Strangely then, falling immediately out of the fruit becomes evolutionarily limiting if not truly disadvantageous.

Although, water is an obvious part of *Darlingtonia*'s seed dispersal strategy, particularly within suitable habitat once colonized, animal dispersal is almost certainly key to colonizing new suitable habitat. Miles and miles of dry rocky hills often separate *Darlingtonia* sites. How else would their seeds traverse all of this unsuitable land to find their very specific and often isolated habitat?

In comparison, the most likely mechanism for *Sarracenia* colonization of new habitat is almost certainly wind, despite their seeds' rather rotund appearance. The southeastern United States is infamous for both hurricanes and tornadoes, but they can occur along the entire eastern seaboard of the U.S. The Atlantic hurricane season starts in July and ends in November. *Sarracenia* seeds usually mature by late August and pods are fully dehisced by late September to early October. A Category 1 hurricane has wind speeds of 119-153 km/h and a Category 5 has winds >252 km/h. Tornadoes often occur within the hurricanes. A very weak tornado starts at 105 km/h and the biggest have winds exceeding 320 km/h. With severe weather like this, it is not hard to imagine how little round *Sarracenia* seeds, seed pods, or indeed entire plants might be scattered to every wet corner of the southeast. Especially when you combine that with what used to be a more contiguously wet region than California. Thankfully for us, the cold waters of the Pacific Ocean prevents strong hurricanes from hitting Northern California. Strong winds can occur, but these major wind events are very rare with the worst wind usually at high elevation. *Darlingtonia* are more commonly found in wet areas between the hills and mountains where they would be mostly protected from strong winds. The few higher elevation populations would almost always be buried by snow before or during these storms, as California only has strong storms in the winter. This all makes significant wind dispersal of *Darlingtonia* seed improbable at best.

Due to the lack of credible fossil record of the family Sarraceniaceae, it is unclear where they initially evolved or even when *Darlingtonia* branched off. Regardless of the details, I think that a long-distance dispersal event via animals could be responsible for *Darlingtonia*'s far-flung range relative to *Sarracenia*. Indeed, it could have been that slight difference in the seed coat that carried the family to California where *Darlingtonia* diverged due to the extreme and long geographical isolation. Granted this is conjecture, but it is fun to think about.



CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society
www.carnivorousplants.org

Volume 44, Number 2
June 2015

Front Cover: *Pinguicula megaspilaea* growing on serpentine rock in Muğla province, Turkey. Photo by Andreas Fleischmann. Article on page 48.

Back Cover: Dry landscape stretches for kilometers around this *Darlingtonia* site in southern Oregon. This is the challenge which *Darlingtonia* must overcome to colonize new habitat. Photo by Damon Collingsworth. Article on page 44.

Inside Back Cover: A dense population of *Darlingtonia* on a rainy day in southern Oregon. Photo by Damon Collingsworth. Article on page 44.

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Date of effective publication of the March 2015 issue of Carnivorous Plant Newsletter: 23 February 2015.

The ICPS is the International Cultivar Registration Authority (ICRA) for the names of cultivated carnivorous plants according to the International Code of Nomenclature for Cultivated Plants. Send relevant correspondence to the ICPS, Inc.

Carnivorous Plant Newsletter is published quarterly in March, June, September, and December by the ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Periodicals postage paid at Walnut Creek, CA and additional mailing offices. Postmaster: Send address changes to ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Printed by Allen Press, Inc., 810 E. 10th Street, Lawrence, KS 66044. Logo and masthead art: Paul Milauskas.
 ISSN #0190-9215