

[A-Z Index](#) | [Search](#) | [Directories](#) | [Maps](#)



A Metropolitan Research University of Distinction



Researchers find unusual type of hybrid origin in a rare plant

By **Cindy Salo**



Christ's Paintbrush
Photo by Danielle Clay

A colorful wildflower called Christ's paintbrush is found only one place in the world—atop a southern Idaho mountain in an area only slightly larger than the Boise State University campus. The plant, whose scientific name is *Castilleja christii*, is not only rare, it also

has a remarkable origin. Boise State University graduate student Danielle Clay has found that the species developed from an unusual type of hybrid cross between two common species of paintbrush.

Christ's paintbrush (Christ's rhymes with mists) has been named a candidate for listing under the Endangered Species Act. The Boise State project has received funding support from the U.S. Fish and Wildlife Service, the agency responsible for managing threatened and endangered plants. Clay, who is completing an M.S. in biology, is working under the direction of biology professor Jim Smith, who procured the USFWS award.

"It's been really rewarding to work on this project, which has combined both field work in the mountains and laboratory studies here at Boise State," said Clay. "My hope is that this research will help scientists and land managers better identify and understand the threats to the plant's survival and how to mitigate them."

Two other species of paintbrush share the subalpine meadows and sagebrush stands near the top of 9,000 foot Mount Harrison, located south of Burley. The yellow-orange flower heads of Christ's paintbrush contrast with the reds of the more common paintbrushes, *Castilleja miniata* and *Castilleja linariifolia*. The presence of other paintbrushes, which did not seem to belong to any of the three species, caught Smith's eye. The plants appeared to be intermediate among the species, with flower heads ranging from yellow through red. He suspected that these plants might be hybrids, as paintbrush species often cross with each other.

"Hybridization is a concern with rare plants because it can dilute their unique genomes to the point of extinction," Smith said, an expert in plant molecular systematics who has several current grants from the National Science Foundation for his research. "Initially, we were concerned that Christ's paintbrush may be crossing with the other species to produce the more variable plants. But in the end we found something far more interesting."

To determine the relationship among the plants, Clay examined their physical characteristics (morphology), conducted genetic studies on specimens she collected at the remote mountain site, and looked for ecological differences among the paintbrushes. Her morphological study involved measuring the structure of each specimen, such as the length and width of the leaves and flower parts, and then analyzing the overall mathematical differences among the species. This quantified how similar or different the paintbrush species were in terms of their physical appearance.



Danielle Clay at Work
Photo by Cindy Salo

Previous researchers found that the “waxy” gene, which is involved in the production of starch in plants, can be used to distinguish among species of paintbrush. Clay located portions of this gene that contained unique molecular sequences in each of the three species. This let her identify any individual to species, including samples from all three paintbrush species and the suspected hybrids.

Clay was surprised to find that individuals identified in the field as Christ's paintbrush and those suspected of being hybrids all contained genes from both of the two more common paintbrush species, *C. miniata* and *C. linariifolia*. This indicated that the suspected hybrids, with their wide range of colors, are actually Christ's paintbrush and that this species originated as a hybrid between the two common paintbrushes. No one had suspected that Christ's paintbrush itself may be the result of hybridization because its physical appearance is so different from the other two species.

In addition to displaying more variable colors than the parental species, the flowers on Christ's paintbrush are shaped differently than are other paintbrush species. Clay also found that these plants have a unique type of hair on their stems and leaves that is not present in *C. miniata* or *C. linariifolia*.

Clay's ecological study provided further insight into this rare species. For example, Christ's paintbrush grows in different plant communities than the parental species on

Mount Harrison. This indicates that Christ's paintbrush may be adapted to different soils and growing conditions, Clay explained.

Clay and Smith's work highlights the complex role of hybridization in biodiversity. While it can reduce biodiversity by overwhelming the genomes of rare plants, it can also increase biodiversity through the creation of new species. This process is seen in some insects and numerous plants. For example, many of the different types of sagebrush found in Idaho are the result of hybridization between related species or subspecies. The unique genomes that result provide the raw material for the development of plants that are uniquely adapted to local conditions.

In order for a hybrid to move down the path toward speciation, it must be reproductively isolated from both parental species. Hybrid plants usually combine the chromosomes from both parents. The resulting offspring have more chromosomes than either parent, which makes it impossible for them to interbreed. Christ's paintbrush is unusual because it has the same number of chromosomes as both its parents. This is an example of homoploid hybrid speciation, which occurs only rarely in plants. It is rare because the plants must remain reproductively isolated through other mechanisms.

"With Christ's paintbrush, we're seeing both morphological traits and ecological differences that may be preventing it from crossing with its parents," said Clay. "Its different floral coloration and structure may attract different pollinators and the fact that it grows in different plant communities on the mountain may physically isolate the plants."

Although Clay and Smith now understand the unusual origin of Christ's paintbrush, they are still uncertain about its future. Threats to the species include competition from weedy plants and disturbance from road building and recreation on Mount Harrison. Global climate change poses additional threats to Christ's paintbrush, whose only home is the highest north-facing slopes of the mountain. This constrained area prevents it from migrating upslope to cooler areas as temperatures warm.

Clay is completing her M.S. degree this fall, after spending her summer monitoring rare plants for the state of Idaho. "This was a unique opportunity to study a rare plant growing in a limited geographical area and with an unusual origin," Clay said of her research on Christ's paintbrush. "I hope that this work will help scientists understand genetics and speciation in other rare plants."