

Mutualism Between Birds And Pines

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The bird and pine are in a co-dependent relationship sculpted by evolution. Limber pine, *Pinus edulis*, relies on the bird to harvest, disperse, and plant its seeds. Clark's nutcracker, *Nucifraga columbiana*, relies on limber pine seeds to get through the winter. Both the bird and the pine have evolved morphological traits (a sublingual pouch, wingless seeds) to better serve and exploit their partner. The behavior of the bird explains the curious distribution of populations of limber pine.

The cones of pines with wind-dispersed seeds dangle from branches, so that the seeds fall out when they dry.

In contrast, the cones of limber pine have evolved to be more appealing and accessible to the Clark's nutcracker. The cones are held level, so that they serve as landing platforms for the birds. Furthermore, the seeds are retained in drying cones, so the birds have an accessible, abundant and nutritious resource. Mutations erode unused characters, and consequently the seed wing that catches the wind in other pines has disappeared in limber pine.



In late summer and throughout the fall, Clark's nutcrackers harvest seeds from limber pines and cache them in the ground for consumption during the winter and early spring. The birds perch on a cone, chiseling the cone scales with their powerful beaks, deftly extracting the large seeds. Pale and hollow seeds, which are neither viable nor

nutritious, are discarded. Dark, filled seeds, 3/8 inch long, are tucked into a large pouch beneath the tongue. A bird can carry approximately 30 limber pine seeds, or more than 50 seeds from whitebark pine, a close relative of limber pine.

When its pouch is full, the bird flies to a propitious site for caching and harvesting seed. The flight distances are highly variable, ranging from a few yards in most cases to record flights exceeding 10 miles. Each bird harvests and caches approximately 30,000 seeds, and recovers them in winter, when it relies solely on the seeds it has cached. However, each bird recovers only about half of its hidden seeds. This is their evolutionary contract: limber pines feed the nutcrackers in exchange for having them harvest, disperse, and plant their seeds.



The nutcracker digs a hole by jabbing its stout beak into the ground. Then, it places 2 to 15 seeds in each cache or hole. The seeds are not recovered in winter will germinate in the spring. When several of the seedlings in a cache survive, they grow as a tight cluster that appears to be a multitrunk tree. A cluster of unrelated trees grows tightly appressed, but each retains its individuality. However, if the trees are half sibs (seeds from the same tree), the bark fuses, enclosing multiple genotypes within a single cylinder of bark.

Because the birds collect seed for winter food, they must cache seeds at a site that is accessible in winter. In the mountains of Colorado, the birds must use sites that are swept clean of snow. As a result, the distribution of limber pine is often restricted to windy ridges or hillsides blasted by winter winds. The flexibility of limber pine is an adaptation to wind; limber pine can occupy windy sites that cannot support other tree species.

This mutualism flourishes on high elevation ridges and scree slopes. These rocky sites are safe havens from fires, and the high elevations exclude the insects that kill trees at lower elevations. Consequently, many limber pines at high elevations are more than 1,000 years old. On these rocky sites, the solitary trees are conspicuous and therefore easy to find, and they are surrounded by terrain ideal for hiding and retrieving seeds.