A NEEDLING PARADOX
Why Do Some Conifers Shed Their Leaves?
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When you visit the Arnold Arboretum, most of the conifers you encounter are evergreen, holding their leaves through all seasons. Extant conifers throughout the world are overwhelmingly evergreen and dominate high-latitude boreal and alpine forests, where longer leaf lifespans are favored. Although a small number of deciduous conifers exist and are represented in the Arboretum collection—including species of *Larix* (larch), *Metasequoia* (dawn redwood), *Pseudolarix* (golden larch) and *Taxodium* (bald cypresses)—these plants usually are confined in the wild to wet environments. Researchers surmise that the relatively low capacity for water transport in conifer xylem has limited their ability to exploit a deciduous habit in all but moisture-rich environments. Therefore, the ability of some conifers to shed their leaves annually may carry with it the penalty of increased sensitivity to dry conditions, limiting their diversity across the world.

Untangling the biology underlying this paradox ideally begins with studies that compare deciduous conifers and their close evergreen relatives growing in a common garden. The rich and well-documented collection of conifers at the Arnold Arboretum and its advanced laboratories offer the right tools for this work, and the Putnam Fellowship Program gave me the opportunity to conduct studies here to advance our understanding of these plants. Trained in plant physiology and ecology, I am interested in revealing how the functions of plants are shaped by environmental conditions. Specifically, my research has focused on long-distance water transport in vascular plants and the role it plays in determining how they respond to challenges like drought and the stresses incurred by low temperatures.

Over the course of my Putnam Fellowship, I am studying the Arboretum’s deciduous and evergreen conifer species to identify any major differences in their hydraulic capacity or their response to drought or cold stresses. Primary results suggest that when compared with their close evergreen relatives, deciduous conifers demonstrate significantly higher efficiency in water transport, but suffer the cost of higher susceptibility to hydraulic failure in dry conditions. As my research continues in coming months, I will be measuring the susceptibility of conifer xylem to freezing stresses and testing the biomechanical traits that enable their stems to handle the challenges that commonly occur in their habitats, such as heavy snow loads and strong winds. My study has benefited by interacting closely with other Arboretum scientists, including collaborating with Sargent Fellow Sarah Mathews to analyze the evolution of plant functional traits. My research as a Putnam Research Fellow is supervised by Harvard Professor N. Michele Holbrook, whose own work in this field has been inspiring.

Investigating xylem functions in conifers will improve our understanding of how these plants have adapted to some of Earth’s most forbidding environments, and perhaps shed light on their competition with flowering seed plants—the angiosperms. Another factor in the paradox of conifer habit is that deciduous species may be more susceptible to human disturbances and the effects of climate change. In addition to its own scientific merit, this study may contribute to the conservation of deciduous conifers as a beautiful and eminently fascinating element of biodiversity.