

There is a close connection between finite projective planes and systems of mutually orthogonal Latin squares. (A set of Latin squares is "mutually orthogonal" if each pair of squares in the set is orthogonal.) For each projective plane of order n there is a system of $n - 1$ mutually orthogonal Latin squares of order n , and vice versa. The correspondence is elementary, though not completely obvious. Essentially, each Latin square corresponds to a set of n parallel lines in the affine geometry associated with the projective plane. It is fairly easy to prove that a system of mutually orthogonal Latin squares cannot have more than $n - 1$ members. This maximum size occurs only when n is the

order of a projective plane.

Euler's problem amounted to asking for a pair of orthogonal Latin squares of order 6. It turns out to be relatively easy to prove that such pairs exist when the order of the squares is odd or evenly divisible by 4. Euler conjectured that no such pairs exist in the remaining case, when n is even but not divisible by 4.

The case $n = 2$ is trivial. Euler's conjecture for $n = 6$ was confirmed in 1900: there is no solution to the 36-soldier problem. However, the rest of the conjecture was demolished in 1959, when E. T. Parker, R. C. Bose, and S. S. Shrikhande showed that there is at least a pair of orthogonal Latin squares for each

order other than 2 and 6.

Except for prime-power orders (corresponding to the known projective planes), it remains unknown how many mutually orthogonal Latin squares there can be of a given order. The Concordia group's result implies that there can be at most eight mutually orthogonal Latin squares of order 10, but so far no one has found even three. Lam thinks it is a hard problem. "I suspect that trying to find three Latin squares [of order 10] is even more work than what we have done," he says. ■ **BARRY A. CIPRA**

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Extinction Imminent for Native Plants

Some 253 native American plants are so imperiled that they are likely to become extinct within 5 years, and another 427 will probably vanish by the end of the century, according to a new study released last week. Nearly 8% of these 680 critically endangered plants are already thought to be extinct in the wild and are preserved only in arboreta and botanical gardens.

But compared with cute and cuddly endangered animals, plants have received relatively little attention and few conservation funds. This survey, conducted by the Center for Plant Conservation, a consortium of 19 botanical gardens and arboreta, was designed to help target conservation efforts to those species that are most in need.

Previous surveys have revealed that more than 10% of the nation's 25,000 species, subspecies, and varieties of native plants are at risk of extinction, mostly from habitat loss

to agriculture or urbanization. What this survey did, for the first time, was to estimate the imminence of extinction—in other words, how much time is left for various species.

"We must know how fast the clock is ticking," said Donald Falk, executive director of the Center for Plant Conservation at a press conference at the Smithsonian Institution where the survey was released. "The survey tells us where we have to go first and how quickly we must work to save species before they become extinct."

Nearly three-fourths of the nation's critically endangered plants exist in just five states and territories: Hawaii, California, Texas, Florida, and Puerto Rico. As soon as the survey was completed, the center launched an emergency conservation program focusing on those five regions. Falk said a program to rescue all the plants at risk

of extinction in this century would cost \$10 to \$15 million.

In conducting the survey, the center asked 89 botanists and horticulturists around the country to rank some 800 threatened and endangered plants according to whether they are likely to go extinct within 5 years, 10 years, or to survive beyond 10 years. The list was drawn from data from The Nature Conservancy and the U.S. Fish and Wildlife Service. The experts also added to the list any additional plants they considered at high risk.

Of the 680 plants likely to go extinct by the end of the century, only 91 are now maintained in cultivation or seed storage. Over the next 3 years the center plans to bring specimens of the other plants into the National Collection of Endangered Plants, a living collection of rare plants housed in 19 botanic gardens and arboreta around the country. The specimens can then be used for research and for propagation to enhance wild populations. For some plants, arboreta may be the only place they survive.

Some of the plants at highest risk include:

■ A pretty Hawaiian shrub, *Hedyotis parvula*, which has shiny leaves and clusters of waxy white and pink flowers. It is known in the wild from just one specimen that has been found growing at the base of a cliff on the island of Oahu.

■ The large-flowered amsinckia, or *Amsinckia grandiflora*, is known from just one population growing on Army property in California. It has brilliant yellow-orange flowers.

■ A bizarre prickly pear cactus with bright red flowers, *Opuntia spinosissima*, survives on private land on one small island in the Florida Keys. Only six plants remain.

■ Peter's Mountain mallow, or *Iliamna corei*, a shrub with stunning pink flowers, is found at only four sites in Virginia.

■ **LESLIE ROBERTS**



Lesquerella pallida, a bladderpod plant with delicate white flowers, had not been seen for 100 years until small populations were found at four sites in Texas.