Monkeying with dogwood evolution

The soft, sweet flesh of an Asian dogwood's red fruit poses a puzzle in evolution. Among a group of closely related dogwoods, all the Asian species have a compound fruit that looks like a fat strawberry, while all the species native to the Western Hemisphere have bunches of smaller, olive-type fruits. What could have caused the evolution of the different fruits? Richard H. Eyde of the Smithsonian Institution in Washington, D.C., now suggests the distinguishing force was the appetite of Old World monkeys.

The bean-sized simple fruits, common to the majority of dogwoods, appear to be the ancestral type. Eyde is studying a subgroup of dogwoods that includes the common North American flowering dogwood, which bears the simple fruits, and the Asian dogwoods, which bear the sweet compound fruits. While trees in this subgroup, called big-bracted dogwoods, appear to have a large showy flower, it is actually four large white, pink or yellow petal-like structures, called bracts, beneath a tight cluster of small, true flowers.

Fossils of simple- and compound-dogwood fruits, collected at European sites, can be distinguished by their shape: The stone of the simple fruit is ovoid whereas the stone of a compound fruit is asymmetrical and tapered. The simple-fruit fossils are found at sites dated earlier than those of the complex fruits.

Alice Tangerini, courtesy Eyde/Smithsonian Inst.

American flowering dogwood (Cornus florida) *has clusters of individual fruits (top), but the Asian dogwood called kousa* (C. kousa) *has a compound fruit (bottom). Both these trees have large white bracts that look like petals.*

The change from a simple to a compound fruit must be linked to the dispersal of the seeds, Eyde says. "Why are dogwoods with such fruits found only in the Old World?" he asks. Because both the simple and compound fruits of big-bracted dogwoods have red seeds, Eyde believes they are dispersed primarily by animals with good color vision. The simple fruits, which are bitter or tart, are known to be dispersed by robins and other migratory birds. These birds also peck at the compound fruits, but do not seem to prefer them. Eyde has considered which animals might be preferentially attracted to a compound fruit.

Among the mammals, monkeys are the most likely candidates. Eyde says that macaques, an Old World species, can distinguish colors. These monkeys eat dogwood fruits and spit or void the seeds. The larger fruit is both more conspicuous and more manageable to a monkey. "They get more goodies per grab," Eyde says. When he mapped their natural habitats, he found that macaques once ranged almost everywhere where compound-fruited dogwoods grow. In addition, one fossil site has been found to contain both compound dogwood fruit and the bones of a macaque.

"Big-bracted dogwoods formerly extended round the Northern Hemisphere, and all had ordinary fruits until monkeys came in contact with them about 5 million years ago," Eyde proposes in ARNOLDIA, the magazine of the Arnold Arboretum (Vol. 45, No. 4). "Selection for a better monkey meal meant better scattering of seeds; so compound fruits replaced the simple ones, but only in Eurasia. America retains the older kind because the New World monkeys, blind to red and tied to warmer regions, never took up foraging on dogwoods." —*J.A. Miller*

Waspish son-killers and sex-switchers

Birds do it and bees do it. But bees do it differently, as do wasps and other members of the order Hymenoptera. In general, while females of these species develop from the union of sperm and egg, males — in the process called parthenogenesis — develop from unfertilized eggs. Now researchers report in the Feb. 28 SCIENCE that a bacterium newly discovered in a parasitic wasp may eventually help explain this mechanism.

The wasp, *Nasonia vitripennis,* lays her eggs — fertilized and unfertilized — on the pupa of a fly. If the mother wasp is infected with the yet-unnamed bacterium, development of most of the unfertilized eggs will be prevented. The fertilized eggs hatch unharmed, resulting in a mostly female brood. The researchers, at the University of Maryland in College Park, the University of Wisconsin in Madison and the West German Institute for Biological Pest Control in Darmstadt, speculate that the bacterium produces a chemical in the female that can distinguish fertilized from unfertilized eggs, killing the male eggs.

"People gave up on [trying to find the mechanism for parthenogenesis] a long time ago," says John Werren of the University at Maryland. "The bacterium interferes with something that plays a key role in the development of unfertilized eggs. It gives you a tool."

Every female of this wasp species can determine the sex of her offspring, since she stores sperm in a sac in her reproductive tract. By relaxing or contracting a muscle to release the sperm, she controls the proportion of fertilized eggs and hence the proportion of daughters. But about 35 percent of the females also carry one of three factors that will distort the sex ratio of offspring; of the three factors, the son-killing bacterium is perhaps the least bizarre.

The "maternal sex ratio" factor — perhaps another microorganism — induces females to contract the sperm-releasing muscle more frequently, boosting the proportion of daughters.

And the strangest of the sex-ratio distorters is a "paternal sex ratio" factor that causes the wasp to produce only sons, the researchers say. "It shows paternal inheritance, meaning it's transmitted through the male line," says Sam Skinner of the University of Wisconsin. "That's a fairly extraordinary phenomenon because there is no male line [since males are produced from unfertilized eggs]." Since the factor is transmitted with sperm into an egg during fertilization, it affects only eggs that would normally become female. "It comes in with the sperm and then seems to turn around and destroy the male-derived chromosome," he says. "The egg would have been diploid and female; it's now haploid and male. But it's a male that has inherited this [paternal sex ratio] trait."

The maternal and paternal factors allow the females to make gender adjustments in offspring to maximize the number of grandchildren. The son-killing bacterium is different: The death of male eggs leaves more food for female offspring, which grow bigger and have more female, infected offspring. But the loss of eggs also means the wasp pays a price in absolute numbers of offspring and in opportunities to transmit her genes. In the end, only the bacterium collects the benefit. —*L. Davis*