Besting Johnny Appleseed

With a few tricks, and a lot of patience, fruit geneticists are undoing the work of an American legend

KEARNEYSVILLE, WEST VIRGINIA—Ask how many fruit trees he's responsible for, and Michael Glenn just laughs. "I have no idea," he says.

Glenn oversees some 120 hectares as director of the Appalachian Fruit Research Station here, and seemingly every road leads to a new orchard. Glenn tramps through one rolling 6-hectare plot on a bright day in March, pruning season. Half the branches of some trees lie discarded. After thinking for a moment, Glenn guesses that 315,000 trees live on the station's acreage in the eastern handlebar of West Virginia. To fit them in, the station plants row after row of ash-brown trees, two meters tall and about as far apart, in military formations. The regularity is deceptive.

Even though all these trees are the same species, *Malus x domestica*, the apple, there's no end to the variety of shapes and postures they assume. Glenn, trim, white-haired, points out that some trees grow vertically like elms, while some droop like willows. Some have branches with elbows and right angles, still others lack a central trunk and sprout stalks like bamboo. And that's only part of the variety he'll see when their fruit arrives in late April. Cross two adult fruit trees—a wild variety resistant to disease, say, and a domesticated one with sweet fruit—and there's almost no telling what you'll get.

As slower-breeding plants, apples are not far removed from their wild ancestors, so they have had fewer chances to shed unwanted genes. And apple trees cannot reproduce with close relatives because special proteins recognize their own or similar pollen and choke off reproduction. Growers get consistent varieties only through clonal propagation, and today 11 cloned varieties make up 90% of the apples sold in the United States. This leaves apples vulnerable to diseases and environmental stress. To "update" a popular variety to withstand those traumas, a breeder must cross it with apples with quite different genes, which can dilute or scatter its good qualities.

This genetic roulette makes for interesting walks through orchards but frustrates scientists who want to develop consistent but hearty apples, plums, and pears. "Stringent, ugly, bitter, tiny fruit, squishy, doesn't store well—anything you can think of that will be bad in a fruit—it happens," says Cameron Peace, an apple and cherry geneticist at Washington State University, Pullman.

Traditional breeding, part of what Glenn calls "cultural practices," requires crossing two lines of apples, each with one or a few good traits. The result: anonymous brown pips. Once, the only way to sort the duds from sweet and hearty varieties was to plant them all, an expensive and laborious job. And because first crosses rarely meet supermarket standards, breeders improve them by recrossing the best fruit of each generation with other varieties, up to five times.

A faster approach would be tweaking apple DNA directly with the tools of molecular genetics. But until recently, geneticists, their skills honed on *Arabidopsis* and other quick-breeding flora, avoided fruit-tree research like a blight. Of the 11,000 U.S. field tests on plants with transgenic genes between 1987 and 2004, just 1% focused on fruit trees. That's partly because of the slow pace. Whereas vegetables like corn might produce two harvests each summer, apple trees need eons—around 5 years—to produce their first fruit, most of which will be disregarded as ugly, bitter, or squishy. Given the odds, 315,000 trees can look tiny.

But everything in apple breeding is about to change. An Italian team plans to publish the decoded apple genome this summer, and scientists at places like Kearneysville, which is run by the U.S. Department of Agriculture (USDA), are starting to single out complex genetic markers for taste and heartiness. In some cases the scientists even plan, by inserting genes from other species, to eliminate the barren juvenile

Mr. Appleseed. In New York, USDA's Philip Forsline studies *M. sieversii* (*top*) from wild fruit collected in Kazakhstan.

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