CORNELL AND USDA PROSPECT FOR 'GREEN GOLD' IN THE MOUNTAINS OF TURKEY

November 24, 1999

Linda McCandless, llm3@cornell.edu, 315-787-2417

by Linda McCandless

GENEVA, NY: Phil Forsline and Herb Aldwinckle work like Johnny Appleseed, collecting and sowing apple seeds for future generations. In the last decade, they have traveled thousands of miles by bus, jeep, helicopter, and foot to bring back apple seeds for breeding and species preservation from wild apple forests in Central Asia and China.

Suggested captions: (from right to left) Phil Forsline, Dr. Hikmet Saygili, Hayri Saglam (interpreter), Herb Aldwinckle, Dr. Ali Unal, and two provincial assistants (names unknown) hold bags of apples collected at one of the Turkish sites.

Download 300 DPI tiff or jpg photo

"Prospecting for apple DNA is like prospecting for green gold," says Forsline. "The gold mine we brought back from our most recent trip to Turkey weighed less than a pound, took centuries to form, and over 3,500 miles to collect." In the space of a small sack, they collected over 30,000 wild apple seeds from 62 different wild specimens, containing DNA with enough genetic potential to improve the commercial apple for centuries to come.

"Wild germplasm is critical in maintaining diversity in the gene pool," explains Forsline, who is the curator of the apple collection at the USDA-ARS Plant Genetics Resources Unit (PGRU) in Geneva. If a new strain of disease or insect comes along that decimates current commercial varieties like McIntosh or Gala, for instance, germplasm that has evolved desirable traits through natural selection might provide

genes for resistance that could be bred into future varieties.

"We don't know what the threats from diseases, insect pests and other biological or physical hazard will be in the future, but having as broad an array as possible of different apple genes to draw on is an excellent way of forearming us," says Aldwinckle,a Cornell University plant pathologist and apple rootstock breeder who works at the New York State Agricultural Experiment Station in Geneva.The party of two Americans and five Turkish scientists took part in a three-week expedition through Turkey in September to expand the apple collection at Geneva. In particular they were looking for *Malus orientalis*. Present cultivars of the commercial apple (*Malus x domestica*) have a narrow genetic base, according to Forsline, and are more closely related to *Malus sieversii* which the group collected in Kazakstan and China.

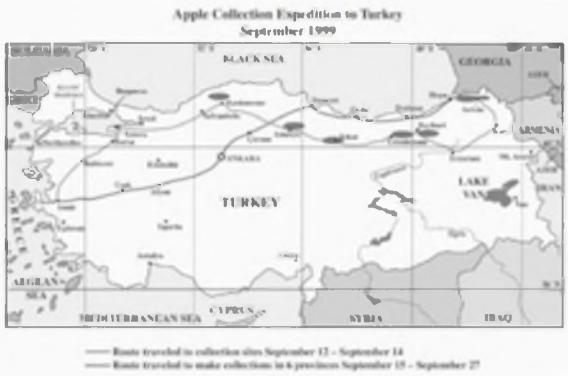
In general, the quality of *M. orientalis* is not as good for eating as *M. sieversii*. The apples tend to be smaller-roughly one inch in diameter compared to *sieversii* which are an inch to three inches in diameter- and very sour to astringent in taste. But, some of the apples looked "very clean," says Forsline, "and may be a source of new disease or pest resistance." The scientists had not expected the diversity they found.

The group spent from two and one-half to three days in each of six provinces in northeast Turkey over a period of three weeks. The germplasm prospecting trek took them through primitive villages and wild forests in the mountains, at 3,000 to 7,000 feet above sea level, within 50 miles of the Black Sea. They traveled on the fringe of the area devasted in August's earthquake, and right through the area hit in November.

The trek roughly followed the Silk Route that linked China and Central Asia with the Middle East and Western Europe. Scientists believe

Agriculture in the mountain villages of Turkey is conducted by hand and on foot, with labor supplied by animals and strong human backs.

Download 300 DPI tiff or jpg photo



Map: The six apple collecting sites in Turkey were in Kastamonu, Amasya, Tokat, Gümüshane, Bayburt and Artvin.

Download 300 DPI tiff or jpg photo

SIDEBAR

UPDATE ON SILK ROAD APPLE RESEARCH

by Linda McCandless

GENEVA, NY: Until 1989, when Herb Aldwinckle made his first trip to the Asian center of origin for apples to collect seeds, *Malus sieversii* germplasm collected directly from wild trees were not available for study or evaluation in the West. Subsequent collecting expeditions were undertaken in 1989, 1993, 1995 and 1996. These expeditions successfully introduced large quantities of seeds of *M. sieversii* and precipitated an international evaluation effort.

To date, over 130,000 seeds were collected from 892 trees. Through 1998, the PGRU has distributed over 1300 seed populations-that is, 28,300 seeds-*of M. sieversii* to 24 cooperators worldwide for evaluation. In addition, over 2000 seedlings resistant to apple scab in

apples originated in Central Asia, were brought to Europe by nomads, and spice and silk traders, and adopted by local farmers along the way. Various specimens then co-evolved over the ensuring centuries in response to local environmental stresses. By collecting samples from these remote regions, the researchers hope to expand the collection of wild genes-genes that may contain important new traits such as pest or disease resistance

"Some of the trees we saw were 100 to 300 years old, three and one-half feet in diameter, and 40 feet tall," says Forsline.

He and Aldwinckle believe the gene pool in Turkey has diminished to one to two percent of the population that it was 50 years ago. Like many scientists, they believe the diversity of the world's gene pool is being lost to encroaching development andagriculture-"a depleted resource," says Forsline-and apple genes are no exception.

As is true in the other collecting sites in the former Soviet Union and China, villagers have intensified their land use for grazing and crops and have cut down much woodland for agricultural purposes or firewood. In Turkey, for instance, apple wood is a favorite among the native farmers who use it to make plows. The few trees that have been left were probably particularly prolific or good tasting fruit trees, said Forsline.

"We visited lots of little villages, where the populations ranged from 200 to 2000," says Forsline. Except for the satellite dishes outside their houses, the people lived a very primitive agricultural lifestyle. There were some tractors, but horses were still used to thresh beans and plow fields.

COLLECTING WILD SEEDS

The scientists' methods of collection are based on past experience and capitalize on

screening at Geneva have been sent to five cooperators across the U.S.

Most trees are not yet fruiting, so evaluation to date has focussed on disease resistance or vegetative traits. HortResearch in New Zealand and the PGRU are the sites with the largest numbers of fruiting trees. Evaluators are concentrating on standard fruit traits such as size, color, texture, aroma and flavor, as well as vegetative traits such as growth habit and vigor. Most evaluators are also targeting disease and pest resistances and other traits related to adaptation in their region. This includes apple scab, fire blight, cedar apple rust, late flowering, storage ability, powdery mildew, woolly apple aphid, leafroller, burr knots, tree habit and vigor, Phytophthora, and drought tolerance.

"We have done a lot of work in the greenhouse as well as the field to test large samples of the material we collected in Tajikistan, Uzbekistan and Kazakstan for resistance to fire blight," said Aldwinckle. "It is encouraging that some trees grown from the seeds have shown a high level of resistance. In some cases, their fruits are quite good quality, and should be useful for breeding resistant, high quality varieties in the future for apple growers in New York and other states. Some trees are resistant to other diseases besides fire blight, like scab and rust,"

In a paper to be published in the journal *HortScience* in 2000, researchers conclude the germplasm will ultimately offer useful genetic diversity for several reasons. The species collected showed a diverse ecological tolerance, from lush, humid temperate forests to sparse, dry,

accumulated knowledge. They also rely on input from native researchers and guides. Tim Momol, a former research associate of Aldwinckle's who is from Turkey, helped arrange the trip. The main guide was Dr. Hikmet Saygili, a bacteriologist from the Aegean University in Izmit.

Acquiring a critical mass of germplasm is deliberate and painstaking work. When the party found a likely prospect, they collected 200 fruit from the particular tree. Each night after dinner, they sat around a table with their pocket knives, carefully sliced open the apples theyhad collected that day, removed the 1 to 15 seeds contained in each fruit, and dried the seeds on a piece of newspaper overnight. They transported the seeds in carefully marked paper envelopes where they continued to 'breathe', and opened them to the air for the next several evenings until they were dry. In the Turkish climate, drying took only two to three days. In addition, cuttings or scions of local varieties were collected.

cold northern forests, and near-desert habitats. Also, *M. sieversii* in its native Asian habitat has co-evolved with pathogenic organisms, including apple scab and codling moth. In addition, some positive and critical horticultural traits have been observed.

The success of utilization of the *M. sieversii* germplasm will not be known for many years, but the preliminary data from many of the sites participating in the evaluation are promising.

"The biggest mistake most collectors make is keeping seeds and scions too moist," says Forsline. It is not a good idea to store scions in a damp paper towel, for instance.

The group had permits from the Turkish government and the USDA to bring seeds and scions back to the U.S. As part of the agreement with their hosts, the Turkish scientists took one-quarter of all the seeds for their own research purposes.

EVALUATION

In addition to holding seeds in long-term cold storage at PGRU and Fort Collins, CO (at the National Seed Storage Laboratory), the seeds will be carefully germinated and then evaluated for disease and pest resistance, and vegetative traits such as growth habit and vigor. When the trees fruit, the apples will be evaluated for size, color, texture, aroma and flavor. Over 50 scientists and technicians in sites all over the world are involved in the project, as they have been with the seeds from the earlier collecting trips.

In Geneva, Aldwinckle will spearhead the effort to evaluate the seedlings for apple scab, cedar apple rust, fire blight, Phytophthora, and powdery mildew. Cornell entomologist Harvey Reissig will conduct studies to compare the seedlings for resistance to apple maggot and codling moth. In addition, cooperators will look at cold hardiness, tolerance to mild chilling for production areas with warm winters, late bloom, tolerance to drought, and sunburn resistance. Preliminary results should be available in about six years.

Through molecular tests, researchers are also now able to characterize the entire gene map of each apple to determine their particular genetic makeup and ensure that only "new" apples are selected for study, testing and eventual preservation.

The trip was paid for by the USDA Plant Exploration Fund, which funds about 12 germplasm collecting trips each year. This was the seventh germplasm expedition for apples."We have one of the most active collection programs in the system, along with that for potatoes," says Forsline.

Aldwinckle took the first trip to Central Asia in 1989. Forsline has been on the six subsequent trips; the most recent was the trip he and Aldwinckle took to China in 1997.

Forsline expects to return to other sites in China in 2001 or 2002. "We want to look for additional species near Sichuan," he says.