

Research on the Pawpaw (*Asimina triloba*) at the University of Maryland

R. NEAL PETERSON

USDA-FHRS

PO Box 23432

Washington, DC 20026

When I moved here I didn't know anything about Dr. Allard, who used to own this property, or about his trees. I am a native New Yorker. I couldn't tell you a pawpaw tree from a mamma tree. The first year I was here, it was a mess; these big green fruits started falling out of the trees onto the grass. I didn't know what to think. I thought they were poisonous. New Yorkers just don't pick things up off the ground and put them in their mouths. But they smelled good! So the next year, though I still didn't know what they were, I decided to try one. It was wonderful! I didn't know if anyone else in the world had a tree like this. I didn't know that scientists were interested in them. I know I love them. I have at least one a day, for breakfast or late afternoon snack.

from a conversation with Tana Ross about Dr. Allard's pawpaw, 1982.

Introduction

Dr. Harry Swartz and I are cooperators in a long-term breeding project whose aim is to domesticate *Asimina triloba*, the North American pawpaw. It is an obvious candidate for domestication, being delicious, nutritious, and North America's largest edible native fruit. The idea is not original with us. The possibilities have been discussed since before 1916 when David Fairchild and Charles Deering (a founder of the NNGA) conceived of a national contest for "The Best Pawpaws" (Am. Genetics Assoc. 1917; Fairchild 1939). James A. Little talked about it in his 1905 pamphlet called *The Pawpaw*. Probably it was talked about earlier but never written down. The majority of the effort devoted toward pawpaw domestication has been chronicled in these pages (see NNGA vols. 29, 49, 53, 56, 60, 61, 65, 66, 73) and more recently in NAFEX Pomona.

On the basis of the work that other scholars have done in selecting superior clones from the wild, and in accumulating experience and observation about *Asimina*, Harry and I felt justified and inspired in 1982 to undertake a concerted research effort. We noted how most previous research was conducted outside of institutional settings, and had suffered from a lack of continuity, coordination, and sufficient resources. We reasoned that we could overcome those problems at the University of Maryland and could make a significant contribution towards domestication.

The first priority in our research has been the assemblage of germplasm. This is fundamental, as no serious, systematic, scientific breeding can be done until that is accomplished. The majority of the work we report here concerns germplasm researches, which consists of three different projects: investigating old collections, expanding our nursery, and collecting related species of *Asimina*. We can also briefly report on some hybridization of *Asimina* and its attendant problems.

Investigating Pawpaw Collections of Historic Significance

In the first half of the 20th century, according to the literature, 22 different clones of pawpaw were selected and named and sometimes disseminated to other growers (Am. Genetics Assoc. 1917; Zimmerman 1941). Since World War II another 18 clones have been selected, named and sometimes disseminated (Page 1965; Davis 1969; Davis 1975; Hickman 1980; and personal communications). In addition, it is clear from the literature that Buckman, Zimmerman, Hershey, and the Blandy Experimental Farm assembled large collections of pawpaw that included many named varieties of their time and also many unnamed selections (Flory 1958; Thomson 1974). Allard's collection, mentioned only once in the literature, was small but interesting (Allard 1955). Locating, salvaging, and evaluating these collections has been our first and major task.

Finding these sites required a great deal of sleuthing: rummaging through old library records (such as 1890 Platt Books), correlating the old maps with recent ones, inquiring with county agents and local residents as to the properties' whereabouts, and talking with present owners of the land. Invariably, I have encountered interest and cooperation in the search.

The Buckman collection of Farmingdale, IL, is the earliest "surviving" collection, dating to the turn of the century (Am. Genetics Assoc. 1917). Buckman was a nurseryman, primarily a breeder of apples and pears (incidentally the originator of the Farmingdale pear, still in use today for rootstock), but interested in all manner of fruit and nut trees. A catalog of his fruit and nut trees lists 1,743 varieties of 20 different species, and contains 12 varieties of pawpaw (David Robson, Sangamon County (IL) extension advisor, personal communication). None of these pawpaws are now found in cultivation, unfortunately.

I have known about Buckman since 1977, but was unable to travel there and collect fruit until 1984. Exploration of the property revealed that little of the original plantings remain, only some trees (hickory, walnut, pear, apple, etc.) on a ten acre tract around the house. Pawpaws are found growing in the woods near the house in three different patches. Are any of these original trees, or suckers thereof? It is impossible to say. There is no evidence of rows or other nursery practice. In the absence of Buckman's records we can only presume that these are descendants of some of his original pawpaws. The best trees were found in patch "No. 2," eight of which I labelled, BB-2a through BB-2h. Their fruit tended to be large (up to 12 oz.), relatively less seedy, as little as 8% seed by weight (14% is the species average), and above average in flavor. We collected fruit for seed, and may later collect scionwood.

The next collection in time belonged to Dr. G. A. Zimmerman, a member of the NNGA, who collected pawpaws from 1917 to his death in 1941. Much of his material derived from Buckman and from the contest of 1916. In all, his collection numbered sixty or seventy varieties. The present-day property contains many pawpaw trees, some quite old, some in rows, and some scattered about. The fruit quality is not especially good, but that may be due to the poor rocky soil and dense shade. Forty-six trees of fruiting size have been labelled GAZ-1 through GAZ-46.

Harry and I have collected from the old Zimmerman property numerous times since my first visit in 1980. On our trip to Zimmerman's in September 1984, we discovered that a tract had been completely cleared, destroying a row of 15

labelled trees. This emphasizes the fragility of these old collections, and reminds us of our need to complete our investigations soon. (NOTE: Several of the bulked trees were earlier propagated in Corwin Davis's collection for evaluation, and hence are not really lost, should they prove of any value).

The Blandy Experimental Farm was the first collection I ever investigated, back in 1979. It was the easiest of all to find, it never having changed hands and being well known around Winchester, VA. The Blandy pawpaw accessions date to the period 1926-1955, from seed that various individuals sent in from around the country, and from Zimmerman, the bulk of whose collection was donated to Blandy by his widow (Flory 1958). Around 60 trees, which I judge to be original, remain growing in two rows in the backwoods, and four more growing near the Quarters. All of these have been labelled. Some of the most interesting material we have discovered is at Blandy. An instance is BEF-53, which has large fruit (up to 14 oz.), very few seeds (4%), and an inferior flavor (unfortunately). We have been collecting seed from Blandy for several years.

The Hershey collection of Dowington, PA, dates from roughly 1925 to 1980. John Hershey was a fruit and nut grower, a commercial nurseryman, and a friend of Zimmerman's through the Pennsylvania Nut Growers Association. He acquired his stock from Zimmerman (Thomson 1974). At present, fewer than two dozen trees remained on the property. All are judged to be chance seedlings, except the old tree near the main house. We labelled the three best trees. Tree JH-2, which grows in a clump of ten near the "packing house," especially pleased us. Its fruit tastes exceptionally fine -- very "cool," not too rich or cloying, and well balanced in flavor. We collected seed in 1984, and will later propagate it.

A fifth collection we have gathered from, in 1982 and 1983, belonged to Dr. H. A. Allard, of Arlington, VA, a scientist with the Department of Agriculture. Allard's pawpaws are of interest because he bred them for several generations, and hence because they do not derive from the Buckman-Zimmerman lines, and hence broaden our genetic base. They descend from some trees of superior flavor which Allard found on a camping trip in the Blue Ridge Mountains in the '20s or '30s. When Allard's land was subdivided and built upon in the 1970s, most of his trees were destroyed. However, one lot owner, Mrs. Ross, liked and kept her trees, which is quite fortunate because in that grove of pawpaws is a stem with one of the finest flavors I have ever tasted, equal or better than JH-2. I have labelled it HAA-1, and have collected seed of it. However, HAA-1 itself has not been propagated; the property has been sold, and it is uncertain if we will be allowed access.

Expansion of the Nursery

Our nursery now contains almost 2,000 young pawpaws. Most of the seed comes from those five historic collections. The remainder came from trees along the C & O Canal near Washington, DC, where pawpaws grow extensively, from a couple of trees belonging to Schlaanstones of West Chester, PA, (beautiful vigorous trees, heavy fruited, seedlings from John Hershey), and from seed that other pawpaw growers have sent us of named varieties, namely Overleese, Sunflower, Mitchell, Davis, Taytwo, etc. Over 700 of the trees are in their 3rd or 4th leaf, and are growing in a permanent nursery at the Wye Research and Education Center of the University of Maryland, on the Eastern Shore of Maryland. These may flower

in 1989. Another 700 are in their 2nd and 3rd leaf, and were just planted in March to a permanent nursery site at the Sharpshurg Research and Education Center in western Maryland. We do not expect these to flower before 1992. The remaining 450 are at the University greenhouses, where 150 are in their 2nd and 3rd leaf, and 300 just germinated this July. These are being grown in coarse well-drained medium in 2' X 2' X 12" cardboard tube-containers that are arranged 6 by 6 square in heavy duty plastic milk crates. The tubes are open at the bottom and the crates raised 2" off the ground to promote air root-pruning. The seedlings make good growth in these containers, and if germinated in the greenhouse in mid-March can make two years' growth in one year. (NOTE: Seeds sown in mid-February will germinate in mid-March at soil temperatures near 75°F. If germinated much earlier, when the day length is shorter, the seedlings will often set a terminal bud, thus halting growth). We like to set the seedlings in the nursery when they are about 12" high, which generally equals two years growth in containers. More than two years in these containers tends to stunt them.

Growth in the field has been quite good. In only a few progeny lines have we noticed stress from being grown in full sunlight. We are seeing considerable variation in growth rates both within and between different progeny lines. Those from the C & O Canal are noticeably the most uniformly vigorous (possibly because they were not selected for superior fruiting quality). Irrigation is provided as needed. Weeds are controlled with Surflan herbicide and hand cultivation. Nitrogen is applied annually at the rate of 50 lb/acre. Of the roughly 800 plants set out in the spring of 1984, only a couple dozen plants have been lost.

Azimina Species Collection

Another part of our collection consists of the southern species of *Azimina*, the dwarf pawpaws: *parviflora*, *incarna* (sometimes called *spectiosa*), *reticulata*, *obovata*, *longifolia*, and *pygmaea*. We have several specimens of each, and are only missing *tetramera*, a rare and endangered species. All of our specimens were raised from seed collected in north central Florida, and are doubtfully hardy here in Maryland, even on the more temperate Eastern Shore. As an experiment, in the summer of 1984 we planted 63 plants of our six southern species at Wye, and kept another 36 at the University. Of the 63, only 31 made it through the winter of '85 (which was not abnormally cold) whereas 35 of the 36 survived that were overwintered in the walk-in refrigerators. Moreover, with the exception of *A. parviflora*, which is known to be hardier, the survivors at Wye were all topkilled. We conclude that the southern species, with the exception of *A. parviflora*, are not hardy here and require winter protection.

Raising the southern species in the artificial environment of pots and greenhouses is proving to be a major problem, and a painful learning experience. Container culture of dwarf pawpaws has never been tried before, so we are the first to make mistakes. And we have not been as attentive to the problems of culture as we might have. Every summer we lose some potted plants, and every winter in the refrigerators we lose some more. The major cause of death appears to be root rot, which reflects improper soil conditions, namely inadequate drainage, and possibly inappropriate pH and nutrient levels. The losses can be costly, as for example this summer, 98% of 200 2-year old *obovata* seedlings were killed by overwatering, because some greenhouse staff moved the crates, and placed them directly on the

ground, thus preventing bottom ventilation, and impeding drainage. Our soil mix, though adequate when the crates are elevated, is too heavy, with too much water holding capacity, when the crates are placed directly on the ground. The loss of these 1977 plants is particularly severe because the plants were a breeding experiment. They were the offspring of the 10 best clones out of 30, that were selected as being superior on the basis of statistical analysis of their fruiting characteristics of yield, size, flavor, and fleshiness. They were to be raised to fruiting (4 years for *obovata*) and then evaluated on those same characteristics before a final selection of parental material for hybridization with *triloba*. The lessons learned from these failures are the importance of perfect drainage, the need to better understand the soil and climate requirements of the southern species, and of maintaining close personal supervision of experiments.

Hybridization

The purpose of the species collection is, of course, hybridization. The southern *Asimina* hybridize freely in the wild, and have a number of desirable traits we wish to incorporate into domesticated pawpaw varieties, namely thick skins (for improved handling), small seeds, precocious flowering, shorter stature, adaptability to dry and exposed sites, and greater pollination success (meaning improved yields) (Kral 1960). They also have a number of undesirable traits which we do not want, such as inferior flavor, small fruit size, high seed-to-fruit ratio, and lack of hardiness. To achieve these breeding goals will require repeated back-crossing.

We began hybridization in the spring of 1985 when 11 specimens of *parviflora*, *pygmaea*, *longifolia*, and *obovata* flowered. Approximately 40 cross-pollinations were made using those four species as the female and *triloba* as the male. Although initially many of the pollinations took, the young fruits soon aborted at a length of 5-10 mm. One *pygmaea* fruit did not abort, however, reached maturity, and produced five seeds. The hybrid seed was treated with standard methods of stratification and germination we use with the southern *Asimina* species. The seed was sown in May and should have germinated in July. However, as of September they have not germinated. And although *Asimina* are slow and irregular to germinate, this appears to be failure. The seed coats have split but no radicle has emerged. It may be a failure of the embryo to develop normally; the dissection of one seed failed to reveal an embryo.

Future Work

Our immediate needs are to complete the germplasm collection. Foremost is our need to acquire the named varieties, such as Silver Creek, Sunflower, Taytwo, etc. We began chip budding this summer with moderate success. We will continue grafting and budding and perhaps the purchase of grafted varieties. We wish to replicate the named varieties at both nursery locations in eastern and western Maryland.

We also need to replenish our stocks of southern *Asimina* which have been depleted. This may justify a trip to Florida next year when they are fruiting, to examine them in the wild, collect fruit for seed selectively, and to learn firsthand their natural growing conditions. Possibly, we need to consider a Florida site for maintaining these tender species, instead of relying on potted culture in Maryland.

Lastly, we need to expand our *triloba* germplasm beyond what we have gathered from existing collections and named selections. The great majority of the present germplasm originates in the Midwest. We need to sample the genetic diversity across the geographic range of *triloba*. Exploration of disjunct populations in the south, west, and north may reveal special adaptation to extremes of heat, cold, and drought. Exploration that draws on the knowledge of specially interested individuals represented by such organizations as NNGA and NAFEX, may bring to light new clones of pawpaw with superior fruiting characteristics.

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