

Cover Story

The Hardy Citrus of Texas

as reported by C.T. Kennedy from the notes of
John R. Brown, M.D.

Part I

Editor's note: Cold-hardy citrus is a tantalizing mirage, so close and yet ever so far away! The genetic material to produce hardy citrus exists in trifoliolate orange, and near-hardy citrus species abound. For many years, the promise of new and hardy citrus has motivated a circle of horticulturists—notably William Chapman, John Brown, Stewart Nagle and Major C. Collins—in east Texas and Georgia, to produce many hundreds of experimental crosses in search of a dessert fruit that can be left to grow in the open ground, far to the north of commercial citrus regions. During the 1980s, the Indoor Citrus & Rare Fruit Society conducted a round-robin newsletter among the hardy-citrus enthusiasts. Since the demise of that society, results of hardy-citrus breeding in Texas has had no proper journal for the record. C. T. Kennedy of CRFG has transcribed the recollections of Dr. John Brown, formerly of Houston and now of Franklin, from notes, correspondence and conversations of past years' accomplishments.

To start at the beginning ... the year was 1941-42 and I was set in motion to grow hardy citrus. My earlier experience with citrus consisted of planting orange seeds and watching the seedlings in high school at Franklin and New Baden. Botany class with Dr. S.R. Warner at Sam Houston State Teachers College, 1938, was my first formal exposure to *Poncirus trifoliata*, the hardiest of the citrus relatives that will freely hybridize with commercial citrus types.

I learned the principles of hybridization the next year in Dr. F.A. McCray's genetics course, and I read on my own initiative and spare time, all eight volumes of Luther Burbank's Autobiography. I transferred to Texas A&M for my fourth year, and took a course in horticulture under Drs. Adriance and Brison. Soon I was working at the horticulture and agronomy divisions of the Experiment Station under Drs. J.O. Beasley, Sidney Yarnell and Walter Florey where I became acquainted with the problem posed by polyembryony in citrus breeding. Then, in an Aggie Mess Hall discussion with Homer Blackhurst, I received the first suggestion that Temple tanger and King "tangerine" could be prospective monoembryonic parents of dessert-quality hardy citrus.

The polyembryony problem was this. Conventional citrus tend to produce

nucellar seed, that is, generated directly from parent tissue without sexual conjugation. The seed is genetically identical to the plant that produced the fruit. These seeds are almost always polyembryonic, being able to produce more than one plant from each seed, and usually all will be identical. Many of the embryos are abortive, however. These nucellar seeds are produced even when the parent flower receives pollen from a genetically differing source. Every so often, however, a highly polyembryonic strain will give a hybrid plant, recognizable only by its differences from the rest of the progeny—a difference in cotyledon color, in the leaves that are opposite not alternate or trifoliolate not unifoliolate, or in some other characteristic. More hybrid citrus seedlings are obtained by starting with 100% monoembryonic ("zygotic" or "gametic") females.

The trifoliolate orange, *Poncirus trifoliata*, may be perfectly hardy as far north as St. Louis, but it is deciduous and produces small, dry fruits with a repellent, resinous flavor within the fruit. Its supreme hardiness makes it the ultimate standard of hardiness in hardy-citrus breeding, and it figures in the parentage of nearly all the hybrids I mention below. We wish we could impose the hardiness of *P. trifoliata* on dessert-quality fruit. *P. trifoliata* is strongly polyembryonic, and so its hybrids are few are far between, except by using its pollen on 100% monoembryonic (i.e. gametic) females. I have never obtained a hybrid from the reciprocal, though William B. Chapman

of League City has presented some obvious open-pollinated hybrids out of 'Flying Dragon' and 'Davis B' clones of *P. trifoliata*. Palatability, however, is the trade-off for greater hardiness; as for the off-flavor, it seems to last for generations.

Tangor Hybrids

After the war and school, and settling into medical practice in Arp, I returned to my earlier speculations about 'King' mandarin and 'Temple' tangor as parents for hardy citrus. Baker-Potts Nursery in Harlingen supplied me with a tree of each, which were then common varieties in the Rio Grande valley. After a year's growth, with weather at or near zero for three or four days, both froze to the ground in spite of a cell-o-glass frame and kerosene lantern heat source. Temple came back, but only sour-orange rootstock showed for the King. A few Temple fruit were produced the second year after, and a bushel the next.

*We'd like the hardiness
of P. trifoliata in a
dessert-quality fruit.*

By pollinating to *P. trifoliata*, a yield of 400 seeds and hybrid seedlings in the seedbed resulted in a hedge of some 30 trees, planted at my sister's place in Franklin in 1955. They were fruiting by the time of Hurricane Carla, 1960. It may seem impossible, but true nonetheless, that early fruiting of these was accomplished by attempts at girdling by wire, and girdling by bark inversion, done on alternate trees during the third year, when the trees looked of a size to fruit. I recall no differences in effectiveness, but I believe more limbs died after a year or two on those trees that were wire-girdled. These hybrids have been called Citemple, and among them I found one which had edible fruit, with no *P. trifoliata* flavor, and about the same as 'Morton' citrange: rather sour for those who use sugar on their grapefruit. It had good pollen and it later was crossed to a more recent citemple cultivar, 'Edible' (see below); their sole progeny was a tree with unifoliolate leaves of willow-like appear-

C.T. Kennedy, former CRFG Board member, is a frequent contributor to the Fruit Gardener. Last year, he moved his trees from Atherton, Calif. to a farm 100 miles south of San Francisco.

...e, and hardy, at least until the ice siege beginning New Year's Eve 1978.

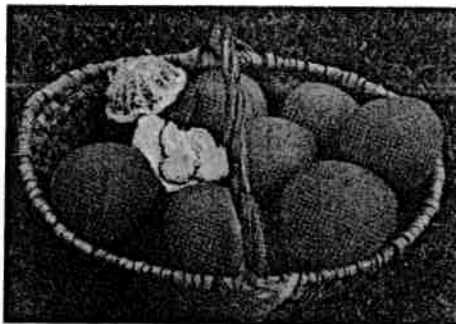
The other edible-fruited hybrid of Temple tangor by *P. trifoliata* was produced at Dr. William Bragg's home in Houston during the 1960 season. I had grafted Temple onto *P. trifoliata* rootstock and had planted it there, and when it came into bloom, I used *P. trifoliata* pollen that had been exposed to 1200 roentgens of x-radiation. The time was certified to my memory, since I collected this lone fruit sometime during the January 1961 freeze—frozen through, there at the southwest corner of his house, and yet 12 to 15 of a probable 30 survived. They were planted on their own roots, on Severinia rootstock, and on *P. trifoliata* in groups of three. All but one were obvious *P. trifoliata* types.

The single unifoliate plant could very well have been a haploid Temple, but between its low vigor and getting broken off with the hose a time or two, it didn't make it, so we'll never know for sure. It probably wouldn't have survived a good cold spell anyway. Citemple is largely monoembryonic, as in CiClementine. One Citemple tree which came to be known as Citemple 'Edible' produced poor or no pollen in the spring flowering but did on summer flowers, the so-called "June blooms." 'Edible' appeared to be fully hardy until killed to the ground in December 1983.

Bill Chapman uses the name 'Citimesweet' for a sibling clone still growing under a pecan tree at the home of my sister, Mrs. Vernon Anderson, here at Franklin, because its fruits have a tinge of sweet with its tinge of resin, plus the usual sour. This plant survived 0°F in December 1989. Notwithstanding the cold, it produced perhaps three fruits in the summer of '89 and nine fruits this year. So far it has (for various reasons) eluded my efforts at controlled pollination, though it shows ten fruits as of this writing, three of them open pollinated or crossed to 'Morton' citrange, another to a ClemYuzu 2-2 perhaps, and six perhaps to 'Anderson' grapefruit. Another cross of Citemple 'Edible' x Bloomsweet was grown at Westfield. Its identity was lost for a while, but the plant was remarkably

like Bloomsweet in its large, unifoliate leaves. It flowered but never fruited at least two of the three years it spent beside a thriving, blooming 'Siam' pummelo x Ichang Lemon. Both were wiped out by five degree temperatures in December 1989.

In midsummer 1990 a single tree in an outer hedgerow flowered for its first time since it was planted in 1967. This tree was a lone survivor from among an initial 20 to 30 open-pollinated seedlings of



'Bloomsweet' grapefruit peels like a tangerine. Photo by John Panzarella.

Citemple 'Beautiful,' usually called Citbeau for short, which was a Citemple 'Edible' sibling. The tree was three feet away from two other trees, named SanCitChang #2 and #3, in the backmost row next the fence, in a clump that included a *P. trifoliata* rootstock that once bore grafts of the small-leaved *P. trifoliata* x Chinotto. One fruit was produced and was gathered late last December 1990. It was two inches in diameter at the equator, with a rough, harshly odorous peel, perhaps predicting a bad flavor within. Surprise: when the tan-colored vesicles, firm like a pummelo or 'Bloomsweet' grapefruit, proved edible, almost up to Morton level, I was startled in a mild sort of way. This fruit with a tough rind and the worst *P. trifoliata* odor had an interior more tolerable to taste than I could have imagined. It makes one think. I shall not dare again to judge such hybrids by the peel flavors. From this experience, we just don't know how bad, bad can be, or how less bad it is than we imagine. (This is certainly upstream to Calvinist theology, but I am talking about flavor, not the sinfulness of humanity.) And so there were four seeds within, and progeny. Three grew but did not survive this summer.

Citrange Hybrids

The citrange, hybrids between *P. trifoliata* and sweet orange, are the most obvious and oldest of the hardy citrus hybrids. These had first been produced in Florida through the works of Drs. Swingle and Webber, as far back as the 1890s. Later generations of citranges were being produced, or earlier generations were being tested, mostly for rootstocks not for hardy dessert fruits, as late as the 1940s. In 1950 or thereabouts, I purchased Volumes I and II of *The Citrus Industry*, which event was the turning point in my citrus hybridizing. There I discovered that the citranges Phelps and Sanford were the only two of Dr. Swingle's hybrids that were monoembryonic.

While still at Arp, I obtained from Orlando open-pollinated seeds of Sanford and Phelps. These seedlings produced two important progeny. The first, an extra-vigorous tree with dark-green, larger leaves came to be called 'Sanford F2' citrummelo. Both were very monoembryonic as parents in later breeding experiments. The citrummelo was assumed to be a hybrid with grapefruit or pummelo, hence the name, and produced beautiful yellow fruit, of smooth skin, fair size and delicious odor externally, but terrible flavor, as bad as the worst of the F2 citranges, such as Sanford itself.

Citrange was assumed to be a Sanford backcrossed to *P. trifoliata*, and was typical of its majority parentage, its fruits fuzzy, smaller and no worse in flavor, perhaps a bit better. To tell the truth, it is almost forgotten by now, being among the first to die off. Before it went, I did cross it with Clementine tangerine, but the progeny were of low vigor and poor longevity, and neither particularly impressive in fruitfulness or quality, as judged from plants grown around a house under trees and among shrubs. There survived, for another 25 years, one of a pair of Citrange progeny from a cross with the grapefruit 'Bloomsweet.' This is a Texas Gulf Coast name for an import from Japan, whose handle in its home country is something quite else, 'Kinkohji'; I have given up tracking the Bloomsweet etymology after learning of

Two successive changes of a Japanese name. Bloomsweet is doubtless a pummelo derivative, sweeter than grapefruit but dryer, with tougher vesicle tissue and no peel bitterness. Like its Bloomsweet pollen parent, the hybrid had the dark green leaves of grapefruit and pummelo hybrids, grew vigorously under a Post Oak tree, or at least rather near to one at the front door in Houston. It never produced flowers or fruit, and has been eliminated as of this writing. Its sibling died in its third or fourth year, across the entry way from the longer survivor.

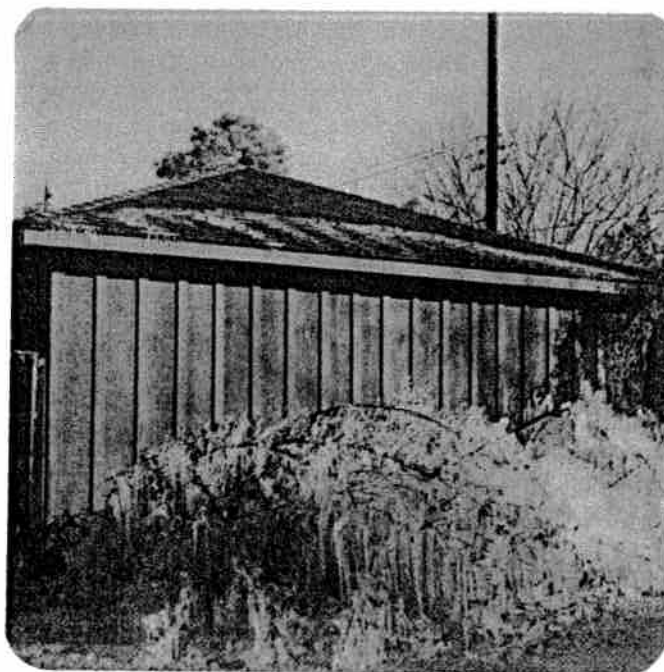
I also pollinated the Sanford citrange with Yuzu (which itself is now believed to be *C. ichangensis* x mandarin), the one fruit of which had been pulled off, bitten into and thrown down by marauding neighborhood kids, or so it appeared when the fruit was found. The seeds were salvaged and of perhaps four survivors, one was especially vigorous and was perpetuated as YuSanfordtrange, a hardiness champ until December 1983.

Dr. Olson at Weslaco had discovered a variant 'Satsuma' mandarin we called Satsuma monoembryonic, because it produced 100% zygotic seed and seedlings. One or two hybrids out of every fruit containing 20 or so seeds appeared to be the rule for YuSanfordtrange used as a female. I applied pollen from Satsuma monoembryonic to YuSanfordtrange and of the progeny, I remember one that was repropagated onto a limb of a *P. trifoliata* tree at Wilbur Boyle's orchard in Friendswood. It produced fruit that was a thin-peeled, tight-skinned orange of good quality, named Valencia by Chapman.

We also made the reciprocal cross—Satsuma monoembryonic x YuSanfordtrange—which for short we called SMYSf. These were planted at Westfield, among many other hybrids, each planted in a pair with its graft on *P. trifoliata*. Three seedlings reached mature size, but had frozen to the ground on their own roots in a week of weather in the twenties, down even to 8-12°F during the last week of 1983, while grafts three feet up on *P. trifoliata* stock had limbs killed half-way back at a level of 4-6 feet. Seedling number two of SMYSf produced fruit in

fair numbers in 1986, and number one also began fruiting by 1988. Both were rather sour upon the first year's taste, but conceded to be near grapefruit in flavor the year following. They're not up to the size of grapefruit, though I eat them in that style anyway. They're just sour, with neither rag nor peel bitterness of grapefruit. Seedling number one had ruby-red stippling and was slightly smaller than number two.

There were other hybrid progeny of *P. trifoliata* worthy of note. The citradia is a hybrid of *P. trifoliata* with sour orange



(l. to r.) Citemple Edible, Phelps F2 open pollinated, and Cichangsha survived a cold night under lawn sprinkler. Photo by J.R. Brown.

(*C. aurantium*), and while I never produced any myself, this one came from the experiment station at Weslaco, in the Rio Grande valley. Dr. Olson considered this citradia to be the only edible *P. trifoliata* derivative, being like a grapefruit but more sour, dryer, and firmer in texture. I used the citradia to pollinate a Citbeau x Bloomsweet, and the progeny were reaching bearing age when they were destroyed on the grounds where they were growing, after I had moved to Franklin. There was even a sibling Citemple x citron 'Buddha's Hand,' and then a citrange Sanford F2 sibling x citron

'Buddha's Hand'; both revealed the characteristic fingering of the citron, but neither these nor any of the lesser Sanford progeny were ever very productive, and died out during the first ten years in the hedge at Franklin.

CEI #1 is our name for one of about 20 seedlings from a fruit of Citemple 'Edible' which arose from a flower pollinated by *C. ichangensis*. This seedling was the outstanding one of that lot for vigor and hardiness and for early fruiting, as it produced fruits on its own roots at age five years. CEI #1 is unifoli-

ate and very productive of orange-colored fruits of small to moderate size. The fruit, while neither particularly good nor bad, is sour.

As a parent, CEI #1 produces 100% zygotic (non-nucellar, monoembryonic) seed. It appeared fully hardy until the last week of December 1983, with maxima in the 20s, minima 8-12°F, which killed all its branches back 3-4 feet. However, it put out new shoots from uninjured wood and fruited a substantial crop that same year.

Because of the unusual trait of producing functional flowers in the tips of rather long shoots of new growth from below the freeze damage, and its 100% production of zygotic seedlings, I used it heavily for crosses with pollen from ClemYuzu 2-2, NamieYuz, Clementine, Ujikitsu, ClemIchangensis, Morton and CEMorton. Fourteen progeny of the CEMorton are growing as five-year old trees on *P. trifoliata* and I have four such of CEI #1 x ClemIchangensis, two of CEI #1 x FRWL ("From Russia With Love," identification uncertain), two of CEI #1 x Morton, as well as several x Ujikitsu and x Clementine. I also have CEI #1 x TriYuz, CEI #1 x Chekwashstri, and a hybrid with the so-called "Thorn," a

Citrange or Citrandarin of lost identification.

The smaller trees on their own roots were approaching fruiting size and a few grafts large enough to anticipate flowers and fruit (by use of wire girdling) were wiped clean away by 0°F in December 1989, except for two grafts of CEI #1 x 'Thomasville' Citrangequat open pollinated and three grafts of SanCitChang #5 open pollinated. Both of these Thomasville progeny were of a single season's growth, yet survived.

CEI #1 itself was killed to the ground at 5°F in Westfield at the same time, but regrew from the roots. It was killed again last winter but has regrown since July.

After one hundred years, Morton citrange from Dr. Swingle is still our nearest to edible citrus of any real hardiness, though still quite a distance away from *P. trifoliata* in this regard. At the latitude of Franklin, halfway from Houston to Dallas, I believe one may be more assured of satisfaction by growing Morton Citrange, which has a better flavor to one well-acquainted with it, better than CEI #1, or what would seem to be a too-early harvested grapefruit. It seems quite sour to those requiring sugar on grapefruit, but scoops out clean with little rag or peel bitterness. Morton does produce good pollen, which is often both deficient and defective in conventional citrus, especially Navel orange and seedless kumquat. Morton however is a very unpromising female, totally polyembryonic to all my experience. For that matter, the same may be said of Meiwa kumquat, but Stewart Nagle has two hybrids of Meiwa by Morton pollen. My own experience with Meiwa, when crossed by *P. trifoliata*, tells me that any such thing with Meiwa as seed parent is impossible, or at least miraculous. I anxiously await the fruiting of either of Dr. Nagle's seedlings, but am braced for the sting of just another citrangequat, though one just as good as Thomasville should not be sniffed at.

Citrummelo Hybrids

Another point of departure was the use of the citrummelo, a hybrid of *P. trifoliata* with either grapefruit or pummelo, since the botanists do not distinguish. As types of breakfast or snack citrus, both

grapefruit and pummelo could stand an improvement in hardiness, as could even the 'Bloomsweet,' the hardiest of the type.

The prefix SanCit, to which is annexed an acronym of a pollen parent, is the name given to hybrids of Sanford Citrummelo seedlings. One of the most provocative of these SanCit hybrids was by Bloomsweet grapefruit. Called SanCitBloomsweet, this hybrid started with some 60 seeds from one fruit of Sanford Citrummelo by Bloomsweet pollen, which translated to ten or twelve mature trees in the row; four actually produced fruit that we could sample. Three of these produced yellow fruit, strongly tainted with *P. trifoliata* flavor, but the first in the row, SanCitBloomsweet #9 by name, was the last to fruit and had a better flavor. In fact, we never left it untasted on the tree long enough to find out what color it would reach upon full maturity for fear of losing the hybrid seeds within, so my memory of it is as a green rind, orange-fleshed fruit. It was heavily injured, but survived zero degrees in December 1990, six or more weeks after its removal from Westfield to Will Flemming's nursery at Tomball. It has (so far) survived a repeat insult a year later and has made good regrowth the past year.

Tangerine Hybrids

The common tangerine is the hardiest of the dessert citrus, and was a possible source of genetic material. The first attempt was Clementine x *P. trifoliata*, and these survived, at least in Franklin at 0°F and in Houston at 5°F to fruit following the freeze of 1989. They seem to be hardy to five degrees above zero. Several siblings, 'Dimicelli,' 'Backyard' and 'Hardy Fruitful '90,' have received the dignity of names. The third is growing here in Franklin and acquired its title by surviving zero temperatures in December 1989, and because of its heaviest fruiting in both the spring and in September of the same year. A few early and even more mid-summer and late summer flowers set in 1991. It is at present among the hardiest of our hybrids here, and also the worst tasting, not excluding *P. trifoliata* itself. No attempts were made to pollinate

Ciclem Hardy Fruitful '90 this past spring. It makes ten staminate flowers for every perfect flower in the spring, and is too tall for a 70-year-old man on a ladder.

The Ciclemsweet is growing on the Kenton Harris property, part of the Wilbur Boyle planting (circa 1967) in Friendswood. It should not be confused with Citemsweet described earlier, though they resembled each other. Neither should be confused with Citembusweet, Bill Chapman's name for Citbeau sibling x Bloomsweet, which was lost in the cold of December 1983. For two years, it produced a crop of orange-colored fruit Bloomsweet-like inside; Bill Chapman hopes he has it still, propagated from cuttings, but not yet fruiting. I have a number of CiMineolas of two years' growth that I wonder what I'm doing with. This cross is *P. trifoliata* x tangelo. Bill Chapman got the seed from Donna Hudson and relayed it to me for disposition.

A hybrid known as Taitri, of seed acquired by Bill Chapman from Dr. Soost, then at U.C. Riverside, is known to be *C. taiwanica* x *P. trifoliata*, and quite hardy. My seven in Franklin survived with only minor damage at one degree above zero, likewise one at Houston at five degrees above. Bill Chapman agrees the juice of this hybrid is sweeter with less of the objectionable flavor than any other 50% *P. trifoliata* hybrid. A recent re-test comparing Taitri #1 with Citemsweet (both were admittedly frost-damaged to 23°F and only Taitri #1 had fully colored) found them quite close, indistinguishable to my taste. No positive or negative comments arose in a taste test in Houston on November 30, 1991.

Variants have been grown from its F2 seeds, but none to maturity and none survive at present. It has produced a curious progeny; Citemsweet x Taitri #1 was one of five or six seedlings produced in the fall of 1989. It survived through the following summer, was cut down to the ground December last and appeared to be recovering, but, runt that it was, has since died. ■

Editor's note: In Part II, the story of the search for cold-hardy citrus will continue with Kumquat, Chinotto, Changsha, *Citrus ichangensis* and Yuzu hybrids.