

The Hardy Citrus of Texas

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

Progress in breeding a hardy citrus for cultivation outside conventional growing regions of commercial citrus has been slow. The greatest impediment has not been a shortage of suitable hardy relatives of citrus—which are many—but the polyembryony, and thus unreceptivity, of the hardy female parent. The most important parent of hardy citrus, *Poncirus trifoliata*, tends to produce no hybrid seed at all. In Texas, Dr. John Brown of Houston has devoted a lifetime to producing palatable, hardy citrus hybrids from germplasm of *Poncirus* and other citrus relatives.

Dr. Brown's work using *Poncirus* as parent was described in the February issue of FRUIT GARDENER. Here he recounts his efforts in using other, less common species of *Citrus* and *Fortunella*, and the resulting unusual hybrids.

—C.T.K.

Kumquat Hybrids

The kumquat is the hardiest of popular citrus, but not much hardier than oranges—maybe ten degrees at most—while the fruits are uniformly small and sour. They are another ingredient capable of mixing into the hardy citrus recipe. My first crosses of kumquat were undertaken not for the purpose of creating hardy seedlings, but to test the longevity of pollen in storage. I made crosses on one small Nagami plant in a tub: a third to old and a third to new *P. trifoliata* pollen, and a third to Meiwa. No takes from six-week-old pollen, six from new, and twelve from Meiwa. Of this last cross, I grew out the seedlings, which were called NaMeiwa. One of these was seedless, but with sterile pollen, and seeds appeared no more often than once in ten fruit. Its progeny in turn seemed to show no variation, and must be a stable nucellar type uninfluenced by any of several different pollens.

Another of the progeny produced one long rose-colored but wooden fruit, high flower and fruit production, a potentially good ornamental but the least cold-hardy kumquat ever seen, and gone fifteen or more years ago. Four others were intermediate in characteristics between Nagami and Meiwa, and one came to be called Nameiwa #1, being quite seedy like Meiwa, with a more peppery peel



John R. Brown, M.D., with Changsha trees at Texas A&M in October 1970. (Photo by Bill Chapman)

than either parent, but producing a fair number of hybrids as a female. One of the more memorable of these was by Glen citrangedin, itself a citrange x calamondin hybrid. The Nameiwa #1 x Glen hybrid showed enough trifoliolate leaves at an early stage to identify it as progeny of Glen pollen. It produced calamondin-like fruits; the tree was hardier and fruit prettier and larger than calamondin, but less hardy than Glen. It came to be called Clusterquat because of its heavy fruiting in clusters. Bill Chapman, who has survivors growing in the Rio Grande Valley, calls it Clustermondin. Mine went in December 1989.

The obvious first choice of work with kumquat is the cross with *P. trifoliata*. Six seedlings were obtained, and all died out the first year or so, except one grafted on *Severinia* which merely hung on for possibly six or seven years. I don't recall

why it never got onto a *P. trifoliata* rootstock. One graft on Meiwa kumquat grew like a storm one summer, but was killed back by the first cold of winter. One 'Ruby Red' grapefruit grafted high up in the Yuzu tree did the same thing one time, and from the two experiences, I still can't isolate the cause—weather, scion or stock.

Dr. Olson showed me a trifoliolate Hong Kong kumquat (*Fortunella hindsii*), which I was unsuccessful at establishing by grafting here. We did produce one plant of Nagami x *F. hindsii*, which grew beautiful dark green leaves, and was quite prolific of Nagami-sized fruit, with flavor dominated by *F. hindsii*. The F2 seedlings were quite similar, but variable in vigor, and no F2 ever fruited. At the same time I became reacquainted with the Meyerquat, a hybrid between the fruit known as Meyer lemon in California, and a kumquat. The Meyer lemon itself is a probable kumquat x lemon, so this makes the Meyerquat an F2 kumquat backcross. The Meyerquat is a juice fruit for blending, a sweet-sour blend of its own, with a sweet albedo (the white underpeel) like the other kumquats and Yuzu. Like its kumquat parent, the Meyerquat is relatively seedy and extremely polyembryonic. When backcrossed again, either to Nameiwa or Nagami, the resulting NameiMQ and NagamiMQ give bushes yielding seedless fruits, when not pollinated by other citrus. If the fruits are the result of selfing, they are somewhat sweet; the NameiMQ will produce seedy, woody fruits if pollinated by *P. trifoliata*. Such seeds will all be nucellar.

The most successful, and most widely propagated hardy hybrid of kumquat is the citrangequat. While the direct hybrids of kumquat and *P. trifoliata* were not viable, those using the *P. trifoliata* derivative citrange have been worth making over and over. Thomasville citrangequat was another early hardy hybrid of Dr. Swingle's from Florida, and has stood the test of time. It is the workhorse, as hardy as any here, and we grow it still for its own sake, and as a parent. It is one, if not the only, quarter-progeny of *P. trifoliata* which can be

John R. Brown, M.D., is a retired family practitioner in Franklin, Tex. He has been an enthusiast of Texan citrus since youth, and has hybridized citrus fruits for over four decades at his home in Houston and at farms in east Texas. C.T. Kennedy is a frequent contributor to FRUIT GARDENER.

eaten, peel and all. Even this is an acquired taste, however, and Thomasville is still by no means a dessert fruit, and any kumquat has a thicker, softer and sweeter albedo. If frost should knock it out of early spring flowering, it will usually rebloom a little later, and those fruits will ripen in their normal season.

We used Thomasville citrangequat as pollen parent with Clementine tangerine. The few seedbox survivors were planted at William Chapman's in League City about 1970, and fruited some time in the early 1980s. The flavor was worse than Thomasville, and though it made some early indications of being hardier, it was erased from the list by the December 1989 freeze. We also used it for pollen onto Nagami kumquat, in a backcross. Three plants were produced, and one, grafted onto *P. trifoliata* root in a favorable location, shot straight up eight to ten feet, and produced kumquat-like leaves and very Nagami-like fruit. Our original plans were to backcross again to Thomasville for analytical purposes, but that did not happen before a frost in December 1983 cut the experiment short; we could have expected some seedless progeny of crosses to Meiwa or Meyerquat. Two siblings left in a less favorable corner lasted until December 1989. This freeze was our century's worst, in east Texas, and spread temperatures from zero in Franklin to five above in Houston. It did, understandably, prove a watershed in the history of my hardy citrus hybridizing.

Chinotto Hybrids

The chinotto is a peculiar citrus, long believed to be a form of the sour orange, *C. aurantium* but more likely a hybrid. The chinotto is better known in Italy than in the U.S., but it may fairly be described as a small, flattened, sour orange midway in size between calamondin and tangerine. The flavor is sweet but the peel is decidedly bitter, and it is used in various tonics in the Old World. It has two advantages: chinotto is the hardiest of oranges, and the tree is naturally dwarfed. The leaves are crowded together, with very short internodes. It is not however so hardy as to be able to stand on its own

Ujukitsu was pollinated with limequat by John Panzarella of Lake Jackson, Tex. to produce F-1 hybrid seeds. (Photo by J. Panzarella)



here at Franklin, or even at Westfield or League City, so we may conclude that it confers slight hardiness, if any.

Chinotto produces some hybrids as a female. The Citradia, also called CiChinotto or Chinottotri, is a hybrid with *P. trifoliata*. It is fully hardy and produces flowers prodigiously and in flurries. One such event Chapman and I caught at the old place on Shady Nook in mid-July 1990, and we pollinated it to NameiYuzquat and Murami kumquat. It is of great hardiness and productivity, and very bad flavor. This survivor, which we call 'Large-leaf' (sometimes 'Purple-flower') Citradia, bears annual crops of undesirable fruit and becomes ever less promising as a female parent, especially as we examine the most recent season's progeny. The other CiChinotto was a dwarf with small trifoliolate leaves crowded on short internodes kept for a while on a *P. trifoliata* rootstock, and there was no improvement in vigor after grafting onto sour orange stock. Eventually this dwarf disappeared from sight.

Changsha Hybrids

The Changsha is a hardy citrus, from the middle latitudes of China. Since its introduction to the U.S., it has been identified as a form of mandarin. It seems considerably hardier than either the conventional mandarins or Satsuma, so it must have an admixture of hardy exotic somewhere. Its origins are lost in oriental antiquity, but is certainly older yet than Yuzu.

Following the freeze of January 1961, we made some crosses of Changsha. This

was at the Boyle orchard at Friendswood. His Clementine tree was about the only thing available to receive pollen, so we dosed it with the Changsha from College Station. A single tree came out of it, one of which was a worthwhile upgrade of Changsha for fruit quality, and of comparable Changsha hardiness.

The two ChangshaYuzu are hardy progeny of Changsha. They were identifiable, at embryonic stage, as two white cotyledons among green (nucellar) polyembryos. Both were hardy enough to survive the Decembers of 1989 and 1990. ChangshaYuzu #1 is vigorous and productive in alternate years, but quite sour, with many rather dry fruit, and no fruit at all after the last two years of freeze. Its counterpart ChangshaYuzu #2 is a much less vigorous, willow-leaved tree, but produced sour juicy fruit instead, and made one fruit after the severe freeze of December 1989. ChangshaGlen was Changsha x Glen Citrangedin, and its progeny was of reasonable vigor and hardiness and was as sharply sour as any Calamondin descendant; its size was half that of Changsha. A Changsha x grapefruit was also produced about the same time, which lived from 1964-84 in the Boyle orchard at Friendswood, but never a sign of flower or fruit. Changsha x Thomasville citrangequat survived with me for some twenty years to Boone Prairie and back to Westfield, in reasonable vigor, but never once flowered or fruited. It was wiped out to a finality in December 1989 on both the *P. trifoliata* and Namei-Meyerquat rootstocks.

We also hybridized Sanford Citrummelo by Changsha, analogous to those made with Bloomsweet pollen, mentioned under citrange. Twelve of 60 seedlings reached maturity in the backyard hedgerow at Houston, and 10 of them fruited. The resulting SanCitChang fruits were paradoxically larger than SanCitBloomsweets, all orange to bright orange in color, except one of the progeny which was yellow. This one had the tightest, thinnest, smoothest and brightest peel also; it was the earliest to come to fruit and the most prolific, but it was tinged unmistakably with *P. trifoliata*

flavor. All were sour, even the one I could eat in the manner of a grapefruit. This one was quite large, but short of grapefruit size because of the thickness of its peel: it was most prone to winter damage. It did withstand 5 degrees in 1989, surviving to within three feet of the ground. Another, SanCitChang #1, the largest and prettiest, but also most seedy and least productive, did not survive that freeze. A third sibling, SanCitChang #9, one of the best for size, color and flavor but inferior for excessive seeds and segmentation, had large round leaves, quite unlike the others out of this cross. The specimen growing at Westfield with SanCitBloomsweet #9 and Siam pummelo x Ichanglemon were intercrossed in all directions in the spring of 1988. The seeds of these were planted rather late that fall, and because of cold weather, only one possible hybrid looking like 'Round Leaf' has survived to date, regrowing from the ground each year with three obvious Yuzus.

Citrus ichangensis Hybrids

The mystery species *C. ichangensis* is likewise an ancient Chinese fruit, and is known only in cultivation—or at least trees found in the Szechuan countryside cannot be proven not to be abandoned dooryard trees from 'way back. The species has been spread during centuries past to the northern limits of citrus culture, and is a common courtyard plant in China, usually grown in containers. It is the supposed parent of Yuzu, and source of the Yuzu hardiness. A single plant grew in Franklin on its own roots without fruiting or flowering since the early 1960s, until struck down by the freeze of December 1989. A graft of it on *P. trifoliata* in the 1960s grew like a storm, and flowered and fruited within four years of grafting. After two seasons, it had to be removed from the tree to give other grafts a chance to grow. *C. ichangensis*, like Yuzu, does not flower or fruit for us on its own roots—only on *P. trifoliata*, in my experience. Seed for *C. ichangensis*, Yuzu and Ichanglemon were supplied to us about 1960 by Lynn Lowry from his old home place in Sulphur, La.

There were a number of *C. ichangensis* hybrids, beside Citemple, described

earlier. *C. ichangensis* pollen produces sweeter hybrids from Changsha than does Yuzu, though only two of each have grown so far. Changsha x *C. ichangensis* survived until December 1989, after having been killed to the ground in 1983. One selection produced leaves resembling the *C. ichangensis* parent, and was very productive in alternate years of small, thin-peeled, orange-colored fruit, bright orange inside with 2-4 very large seeds, juicy and sweet but with a slight off-flavor of Yuzu. Another selection, with leaves like Yuzu, fruited for its first time in summer 1989, with fruits a bit larger, sweet, thus prompting thoughts of further work with it—but it froze out that December.

There were hybrids between *C. ichangensis* and 'Bloomsweet.' I had grafted a *P. trifoliata* rootstock to *C. ichangensis* at Houston, and it was in flower three years later. I wet one flower with saliva, blew it dry and applied Bloomsweet pollen. Eight young trees were produced of this cross. They grew at Westfield, froze to the ground in 1983 but regrew, and two produced fruit in 1988. The fruit were small but sweet with russet spots on their thin peel, that hot, dry August and September. The fruits will be remembered fondly by a number of tasters who had spent too many long years sampling *P. trifoliata* hybrids. One Clementine tangerine x *C. ichangensis* produced perfect flowers during the years from the mid-1970s, until it froze to the ground in December 1989. But the tree never set a single fruit. One switch of regrowth has appeared from the ground this year.

In 1987, I moved from Houston to Franklin. Many or most trees had been moved or repropagated in advance, either to my sister's place in Franklin, or to the old Mitchell place on Boone Prairie ten miles north; some few others were restarted after the move at the Luther Cole orchard a mile south of Franklin. (His children had grown up eating Changsha mandarins planted in a protected space by his house, until about 1979.) Some trees too large to move, or just coming into fruiting, were left behind

in the Houston area. The move north had the incidental result of making my hardiness trials rather more rigorous. But the cold in December 1989 (to zero at Franklin, five above at Houston) resulted in about the same losses, at both locations. It has reminded me what a fool I am.

Yuzu Hybrids

The Yuzu is an age-old hybrid of *C. ichangensis* x mandarin, one which has been popular in Japan since before the arrival of Commodore Perry, so we may never know how far back it goes. It is grown on most of the islands of Japan, and is famous for its ability to burst into bloom at the moment of snowmelt. The Japanese count it as an edible citrus, but probably for culinary purposes, not for eating out of hand. It is encountered more frequently now in the U.S., at the northern limits of citrus culture.

My first Yuzu hybrids were produced at the College Farm at Texas A&M, College Station. The big freeze of January 1961, of three days around the eleventh, I believe, dropped temperatures at College Station to the twenties, and nights to ten or twelve. The experiment station lost one of two Changsha mandarins, their only Satsuma and only grapefruit, but merely defoliated the adjacent rows of Yuzu and one other which I recalled as Savage citrange but which Bill Chapman much later decided was a Sacaton citrummelo. While working the Yuzu in the following spring, I ran out of the pollen I had been using, and seeing the flowers on the neighboring citrange, I reached for one and used it. Out of the fruit formed of that Yuzu flower came the seed that produced two hybrid seedlings displaying *P. trifoliata* characteristics, doubtless from the Savage pollen. In fact, the more vigorous of the two was unmistakably trifoliolate all the way, and upon fruiting gave the impression that Yuzu can cancel the bad flavor of *P. trifoliata*. The other seedling, much the less vigorous, soon turned unifoliolate (these things happen), and the one or two fruit we ever had from it are remembered as up to tangerine standards—but I no longer have it. The YuSavage could instead be YuSacaton

if Yuzu was pollinated by Sacaton citrummelo instead of Savange. The YuSavange has withstood one degree above zero at Franklin, being more than "twig-bit." The original tree fruited at Friendswood before 1967, was eliminated at Tomball by cold in 1989; we await fruits at Franklin.

Meanwhile at the Bales orchard in Friendswood, the January 1961 freeze eliminated five of 30 Satsumas; five were essentially uninjured and later bloomed but set no fruit, and the remainder were intermediate in degree of damage. The one Temple tangor and both Ponkan mandarins were killed, the Bloomsweet grapefruit and Nagami kumquats injured, and I believe the various oranges also, as well as the single Clementine tangerine in the neighboring Boyle orchard. It took a year for the Clementine to return to blooming condition, and when it did, it was pollinated to Yuzu. There must have been a lot of seed produced, as I soon had two tubs of Clementine x Yuzu seedlings, later to be called ClemYuzu. One selection, the ClemYuzu 2-2, survives in fair condition as a mature tree in Houston, though its seedlings freeze to the ground repeatedly up here, and only 10% resprout from the ground. If it were only more consistent in producing its best every time, it would be our sweetest, best hardy hybrid citrus. However, it's bad about producing dried-out, juiceless fruit, overloading one year and a blank the next, in alternate bearing. Another promising seedling of that group, ClemYuzu 1-5, did not survive the cold of December 1989. A third sibling, ClemYuzu 3-3, is in the possession of Stewart Nagle. The same clone or one much like it has received from us the self-explanatory name of 'Tingletongue,' a reference to the tingletongue or toothache tree, the "Hercules Club" of East Texas.

A selection of these ClemYuzu siblings were grafted onto a mother tree rootstock of *P. trifoliata*: ClemYuzu 1-1 through 1-6, along with ClemYuzu 2-1 and 2-2, and a limb of Satsuma monoembryonic for good measure, not to mention all five or six surviving Nagami x Meiwa kumquats, the YuSavanges,

ClemYuzu 3-3, and Tingle tongue on a neighboring multiple-grafted *P. trifoliata* in the Bales orchard. The various branches bloomed and set fruit, and the resulting seeds from these were therefore open pollinated. Some of those from ClemYuzu were saved and grown by Dr. Bricker, a friend of Bill Chapman. The progeny produced fruits that varied from typical tangerines, to the "Kat" type of tangerine like Tim Kat and Chou Chow Tien Kat, and the trees were hardy to about Satsuma level. These tend to be polyembryonic, and hopeless as female parents. ClemYuzu 2-2 has produced large, sweet fruits with a minimal detergent taint of Yuzu, and survived perhaps five degrees above zero, with only slight damage, but no crop for the following year.

The basic hybrid of *P. trifoliata* x Yuzu, known as TriYuz, produced fruit that was a bland piece of wood, and though they were presumed perfectly hardy, December 1989 proved them otherwise, at least for older trees in Houston. Here in Franklin, seedling trees were only "twig bit" at the edges, and flowered and fruited their first this year.

Other Yuzu hybrids have already been described under Sanford citrange. We also had, until December 1983, Yuzuquat, from Nagami x Yuzu. Another, called Nameiyuz, is Yuzu x Nameiwa #1, and produced a large smooth pretty lemon on



Six Orlando tangelo fruits were hand-pollinated by Taitri #1 (three fruits), Meyerquat (two) and Clementine (one)—all to no avail. (Photo by J. Brown)

one of our most vigorous and hardy trees. It is known as 'J-Lemon' elsewhere. It was a good juicer, though quite seedy, with a sourness to the lime level and some Yuzu off-flavor when fully ripe, with the soft non-bitter albedo of both parents. It was quite productive, with intermittent flowering year-round, like kumquats. Professor Randall at University of Houston had a trifoliate seedling from one of these Nameiyuz, which has always appeared structurally monoembryonic for most of its nearly twenty years of fruiting, but has never produced a verified hybrid. Attempts at Yuzu x Bloomsweet grapefruit have not been brought to fruition.

Yuzu x Thomasville citrangequat was a promising hybrid, with which we may conclude. Among some 20 seeds to come out of the Yuzu fruit in this cross, there were only three variant seedlings, two of them rather less than vigorous and less deep-green of foliage, but otherwise typical of Yuzu; the third bore trifoliate leaves and of reasonable vigor. The latter was distinctly less hardy than the Yuzu look-alikes—this suggests that hardiness and trifoliate-ness are not inseparably linked.

We still cannot conclude anything about linkage of quality factors to either trifoliate-ness or hardiness, of course. The trifoliate seedling was never brought to fruit before being laid low by cold. One of the less vigorous but more Yuzu-like forms was eventually worked onto *P. trifoliata* rootstock and brought to fruit in 1987. By that time I had moved to Franklin, and the new owner blindly mowed it down with a bush-hog tractor mower in the tall grass of that August and September. Its fruits never reached maturity. One not too-distant summer, the third seedling succumbed to drought, as it had been missed for one time too many outside the reach of the irrigation setup.

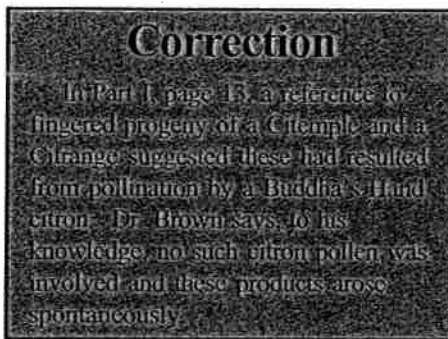
Dr. W.P. Bitters of Orlando wrote me, when I first requested seed, that he had produced many hardy hybrids, and many good hybrids, but never a good, hardy hybrid. His dictum still stands... even if there might have been many near-hardy, good hybrids, made by us in Texas during recent decades. Certainly there have been no good hardy hybrids, if "good" is restricted to sweet, dessert-quality fruit. I eat Thomasville citrangequat fruit when at

hand, and enjoy Morton citrange when available, notwithstanding.

An article published in 1981 by Dr. H.C. Barrett of USDA in Orlando, identified from among all the possible combinations of *P. trifoliata*, orange, tangerine, pummelo, and grapefruit, the hybrid (*C. paradisi* x *P. trifoliata*) x *C. sinensis*, as producing edible dessert-type fruit, and hardy. This might qualify for both hardy and good, unless we exclude it by setting our hardiness goal at the *Poncirus trifoliata* level. But I have learned not to be too ambitious, and leave to another the project to produce a citrus hybrid for the folks in St. Louis. I will be satisfied to have a good citrus hybrid, hardy enough for me here in Franklin, Texas, if I can ever again get a Morton large enough to fruit again.

By way of solemn charge, amateur citrus breeders, I would say: Ignore not F2 and F3 open-pollinated progeny in great numbers, plant in hedgerows wherever

feasible, and keep looking. Forget not the resinous-modifying effects of Yuzu and Kumquat blood, nor the seedlessness potential of Meiwa x Nagami including Nagami hybrids out of Thomasville. Remember the lack of peel bitterness in Bloomsweet, Yuzu and the 'quats, to put into grapefruit. Consider the other "edible" citrandarins, citrangors, and especially the monoembryonic ones on which to use Morton pollen. With them I foresee worthy lines to pursue for another generation of hardy citrus breeding. ■



Philippine Fruits

(continued from page 7)

in oil until they puff up into crisp cakes. The young leaves of the melinjo are also edible, as are the tender shoots that are eaten as a vegetable. The final nut, the **kubili**, is an oddity in its family, the Sapindaceae. In this family, the edible portion of the fruit is normally the flesh surrounding the seed. In the kubili however, the aril (the outer covering of the seed) does not completely surround the seed, thus making the flesh useless. But the nut is edible and much larger than the flesh, so the nut is roasted or boiled and its taste is acceptable.

Altogether this was a most rewarding slide presentation—so it was gratifying to be able to give an expert like Dr. Coronel an opportunity to learn something in return. Before this visit, Dr. Coronel considered the rose apple tropical in its requirements. But after seeing it happy at several southern California locations, he quickly changed his mind and added it to his list of fruits that can grow outside the tropics. ■

Editor's Note: The presentation is available on VHS tape for \$15 (US), \$17 (Canada and Mexico), and \$18 (Foreign), including a list of the fruit slides with their Common name, Genus/Species, Family and Filipino Name. Send check or money order to: David Guggenheim, 4601 Murphy Ave., San Diego, CA 92122. For a free copy of the list alone, send a self-addressed, stamped envelope to Editor, FRUIT GARDENER, 11439 Laurelcrest Dr., Studio City, CA 91604.

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Election Results

At the CRFG General Meeting on March 7, 1992, four directors were re-elected for three-year terms: James Bathgate, George Emerich, David Guggenheim and Arno Kutzner; newly elected was Edward Hager. The Board then met and elected the following officers: president, David Guggenheim; Don Gholston, vice president; treasurer, Claire Guggenheim, and secretary, Robert Chambers. The proposed amendment to the by-laws was approved.