BREEDING FOR THE COLOR ORANGE

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There are reports and rumors, and rumors of reports, that orange-colored peonies are springing up in scattered gardens throughout the world. Maybe such reports are premature. I have no orange peonies in MY garden, and have seen none in the few other gardens visited. However, I do think that reports of "orangish" or orange-tending seedlings are entirely credible. Pure orange colored flowers has been a dream of some hybridizers for many years.

In Paeonia (a newsletter for peony hybridizers), articles have appeared on this subject in recent years. For non-subscribers and APS members who might like to join the quest, this article reviews some of the ideas, theories, and experiences discussed so far.

My first awareness of the quest for orange came about 1969-70 when the late Roy Pehrson of Lafayette, Minn. mentioned that he had a P. lobata (now called P. peregrina) clone that was a particularly bright red-orange, and therefore promising in breeding for orange. He mentioned that petals of it had been analyzed by a Mr. Cooper who, via paper chromatography tests, gave a very favorable report on it. "Favorable" is all I can say about it as I do not recall any of the details. I obtained the Pehrson clone and several other lobata clones. Sun- beam was one of these and I thought it equally bright in coloration. Another clone was a more rosy red. All have since died except for the Pehrson clone, which struggles for survival in the dry shade at the base of a Turkish Filbert tree. Alas, my interest in breeding for orange was not so intense that I made many crosses with any of them.

However, Mr. Cooper must be F. C. Cooper of the National Research Council of Canada, and his article on Peony Flower Pigment should ABSOLUTELY be read and studied by anyone seriously interested in this subject. At one point he writes " ... chalcones are miscible (mixable) with red anthocyanidins and should give clear orange shades." Now if that isn't a roadmap to success, I don't know what is! But note the word "should." Much of this is theoretical, and it remains for hybridizers to put the theory to the test. (I recall that in daylily breeding, theoreticians had laid out a roadmap to reach the goal of blue daylilies; those breeders that followed the plan arrived at dead-ends.)

Also in the quote appear a couple of chemical names that will be unfamiliar to most people, which tells me that I cannot continue any further without summarizing the Cooper article, a daunting task that I had hoped to avoid. I've written this up as a supplementary article. All I did was to take Mr. Cooper's own Summary of Pigments, already in outline form, and included information from his previous text that seemed significant in understanding the problems to be faced in breeding for orange. Left out are the

accounts of how purple, violet, and lavender shades are produced in peonies-even though anthocyanidins for those colors are lacking-and how the col- or blue might be attained.

Where to begin in breeding for orange? With lactifloras? No, you can breed for orange lactifloras 'til your face turns the complementary color, and you won't come close. Why? Because peonidin, the red pigment in lactiflora, can't do the job. In fact, people with a good eye for color claim that there are really no true reds in any of the lactifloras. (In writing this article, I've developed the notion that peonidin is a "bad" red, and that it's related pigments, pelargonidin and cyanidin, are the good guys.) In the absence of the specific anthocyanidin for orange, the experts seem to think the best route to orange is the interaction of the two reds, pelargonidin and cyanidin-in the absence of peonidin-with one or more of the yellow pigments.

The hybrids of lacti x lobata yield some fine reds because lobata contributes a higher proportion of cyanidin. The higher flavone-con- tent in some lobatas accounts for the brighter red-orange hybrids. And when the lactiflora parent is white, the salmon-coral colors result because the white lactiflora contributes a minimal amount of peonidin (that "bad" red again), allowing the flavones and cyanidin to express themselves.

A good example of this is Coral Charm, which I believe is the white lactiflora, Minnie Shaylor, x lobata. This is a triploid from a dip x tet cross, therefore sterile and dead-end in hybridizing. Well, not so fast! Prof. Saunders is well known for his statement that all triploids eventually produce a few seeds, so there is hope. More about that later.

High flavone-content in mlokoswetschii, combined with the flavones and high cyanidin in lobata, may aid in developing orange. This is the combination behind Aurelia (see back cover, upper right, and p. 4). The photo was sent by Ray Cobb (England) to the Editor who sent it to me for use in this article. The startling thing about this flower is the flares. Herbaceous hybrids do sometimes have flares but never as dark and sharply defined as these, something ordinarily found only in the tree peony section of the genus. The ploidy of the parents, mlokoswetschii (diploid) x lobata (tet), suggests this, too, is a sterile triploid. Too bad! With line breeding, one might well develop a good orange strain from these genes alone.

(During a "grafting party" at my lot last August, I showed this photo to two knowledgeable peony friends, and both said-independently of each other-it looked like a marigold. Could the British be playing a trick on us?! Of course not, but all three of us had seen a bleeding heart pictured in some of the Chinese tree peony picture books being touted as a tree peony worth $60 per plant! So we had our suspicions.)

With regard to the breeding value of triploid clones, the reason for hope is this-a triploid parent on rare occasions will produce an unreduced gamete (an ovule or pollen grain with three sets of chromosomes) which on rare occasions will meet and unite with a normal- ly reduced gamete (one set of chromosomes) from a diploid parent. Voila!-a tetraploid seed! Over eons of evolution this happens many times in nature. But we can't wait for insects and wind to effect this happy meeting. We have to act as chaperones and make as many hand-pollinations as possible, else we'll not see any such unions in

our lifetime. The most efficient method is to use pollen from a diploid parent on the triploid; the triploid parent need not be bagged to pre- vent accidental pollination by bees or wind since ANY seed will be most welcome. The reverse cross will require bagging, though time- consuming, to spare you from caring for lots of seedlings not of the intended parentage.

There is a second reason for hope-doubling the chromosomes of a triploid clone (by chemical treatment) would yield a fertile hexaploid. Two or more such conversions, when crossed with each other, could be the start of a hexaploid strain of orange peonies. Several breeders of tet daylilies work diligently to convert superior diploid clones-like Barbara Mitchell-to tetraploids, and then incorporate them into their ongoing tet strain. It would be a lot tougher to do this with peonies; professional reseachers may be needed. But this seems more achievable than relying on luck in the reduced gamete method. Also, the cross of hexaploid x diploid, with normally reduced gametes, would yield tetraploids. The arithmetic is easy. The possibilities are staggering. Reality gets in the way.

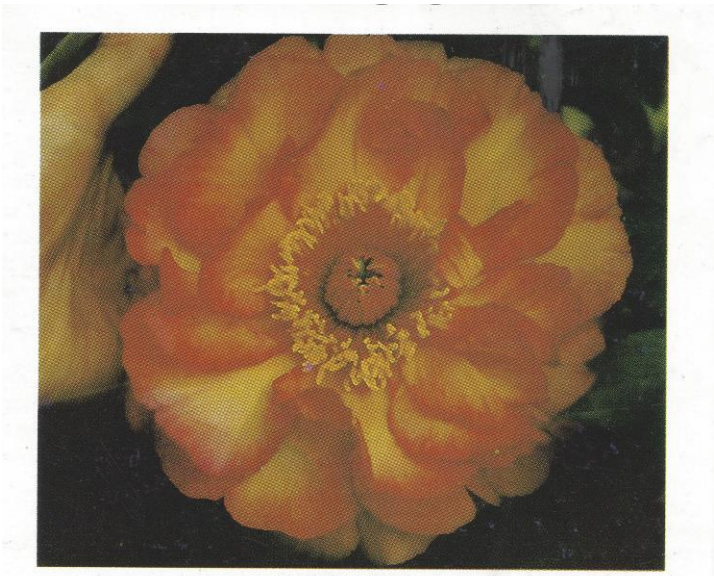
During visits to the Reath Nursery years ago, David sometimes discussed the above approaches. He also thought that conversion to hexaploids should be tried with the i-hybrids ("i" for intersectional), assuming they are triploids. (They should be counted, he said.)

David Reath was an early seeker for orange. I don't recall what road map he was using, but he had converted germinating lacti seeds to tetraploids. Some were probably white, with the idea that white lacti x lobata would yield coral hybrids of a fertile, tet constitution. I don't know at what stage progress slowed. In daylilies the first con- verted or induced tets were not very fertile; peonies might have presented worse problems. To one who had many irons in the fire, there was little time to overcome such vexing roadblocks.

As for orange colors in tree peonies-within the suffruticosas (moutans), I'd say there is little hope. The desired pelargonidin is present in some varieties, but yellow is lacking, discounting the paler flavones, and also discounting Yao Yellow as an important reservoir of yellow pigment.

The hybrids with lutea are a different story. Mr. Cooper's view is that the yellow carotenoids of lutea, combined with the red anthocyanidins (esp. pelargonidin) of moutan could be expected to yield orange shades. But not so, in practice one gets "earthy or dusky hues and shades." The reason, Mr. Cooper points out, lies in differences in water solubility and location in the cells, but primarily that the two classes of pigments occupy different cell layers in the petals so that one views one color through the other.

I can attest to those results, having bloomed about 200 "shrub hybrid" seedlings; many descriptions on index cards include the words "dull" or "muddy" blends. However, many are also "beautiful and curious blends and suffustions of yellow with red," quoting Mr. Cooper again. Mr. Bernard Chow (Australia) recently sent a photo of such a flower, Pomona, raised from seed produced in my garden.



POMONA

Hybrid tree peony grown by Bernard Chow (Melbourne, Australia) from seed. An example of the exotic blends that often occur—in place of the anticipated orange—when crossing red and yellow-pigmented hybrids.

[Pictured on front cover; APS Bulletin March 2000.] The exact parentage is unknown, having mixed together one or two seeds from several crosses.

However, orange-tending colors ARE appearing. Mr. Chow has sent photos of such flowers in his garden; most are from the seed-parent, #16. His first reports concerned the cross, 16 x Golden Era. A later cross, 16 x Brassy Lady (#127) turned out to be more productive. Three photos appear on the back cover and are identified on p. 4. Mr. Derek Irvine (NZ) reports that he had received 10 seeds of 16 x 127. Eight germinated; two bore orangey-toned flowers, two had not yet flowered, and four were rose-colored and discarded as he already had so many of that color. Harold Entsminger writes that he has a seedling of lutea from Galen Burrell which is described as orange-ish. My #16 is from A198 x Chinese Dragon and the original description is "Flesh blended rose. Large plant, 9-10 petals. Drips pollen. Small flower. Petioles, very red, especially near main stalk. Nice leaves." In my mind's eye, it is flesh blending toward rose flares. The original plant was lost when my landlord plowed under that section of the garden, but it was salvaged by grafting. (I don't know why I didn't simply cut it back hard and transplant it, no matter what time of year.) To explain 16's seemingly good breeding potential for orange, I've assumed Chinese Dragon contributed pelargonidin to its makeup. So I've checked the list of 28 tree peonies (p. 143, APS 75 Years), moutans and hybrids, at the end of Mr. Cooper's article that he had analyzed for pigment content. Chinese Dragon appears in a list of fourteen evaluated as having peonidin with no detectable pelargonidin. But Mr. Cooper admits to uncertain results due to minimal amounts of petals available for analysis. So, maybe #16 has it, anyway. Also, pelargonidin may be in the ancestry of the Reath yellows,. A198 and Golden Era (A199).

Paeonia delavayi
(potaninii variety trollioides)

The last pigment to consider in tree peonies is the chalcones-found only in P. potaninii var. trollioides and, I assume, in any other yellow form. (Tall Yellow was a clone sold at one time by the Reath Nursery.) Both chalcones and pelargonidin are Class II pigments (Flavonoids) and therefore miscible with each other.

Here's where I started; go back to paragraph four. Mr. Cooper opines (this was back in 1970) that trollioides will cross with both moutan and the herbaceous species-prophetic. In France, 1980, Jean Cayeux introduced Helene Martin from trollioides x suffruticosa Gessekai, and Roger Anderson (Ft. Atkinson, WI) came with Unique from Martha W. (lacti, pink) x potaninii Tall Yellow. They are basically white and pink, respectively, not orange. For this and other reasons Don Smith, editor of PAEONIA, opines (Vol. 28, #3, Summer, 1998) that potaninii will NOT be effective in producing orange. But no matter- Helene Martin remains a hot item with hybridizers.

The first true orange color may well appear in the tree hybrids because (1) the most effective pigments, pelargonidin, carotenoids, and chalcones, appear only in the tree peonies, (2) orange-tending flowers have already appeared, and (3) there is a good degree of fer- tility between them. This latter point is VERY important. It means amateur hybridizers have the tools needed to raise large numbers of increasingly advanced generation hybrids on which to practice selective breeding. This is the technique used by daylily breeders to develop the existing array of colors, starting with species that were yellow or fulvous in color.

However, herbaceous peonies, especially those with the admirable traits of lactiflora, will be the preferred type among the general gardening public, and so hybridizers will not rest until they transfer orange (and other colors) from the tree peonies to the herbaceous state. So, intersectional crosses will be tried in large numbers. Some hybridizers are already at it, but until the sterility barrier is overcome in the i-hybrids, any successful transfer of the three t.p. pigments will not be further refined by selective breeding. During the transfer it might be well to avoid pink and red lactiflora parents because they carry a load of peonidin. One hybridizer says she prefers white lactifloras like Minnie Shaylor and Miss America for this reason. She also focuses on suffruticosa parents rich in pelargonidin. At the end of his article, Mr. Cooper lists eleven that fall in the group pelargonidin with minor amounts of peonidin. The only two that I grow are Shin Kagura and Hinode Sekai. But there are untested varieties out there whose value can be judged visually. Besides breeding moutans rich in pelargonidin, one might also strive for another improved hybridizing tool, a strain of white lactis amenable to the i-cross, by intercrossing the most effective whites we presently have with Martha W., the pink lactiflora superior for this cross.

To accomplish these goals PERSISTENT EFFORT is needed on many fronts, and there are precious few hybridizers devoted to that end. If peonies could be as easily grown from seed as daylilies, this would not be a problem. Older hybridizers should be willing to share or make available seeds, pollen, plants and information, not only to their peers, but to young, newer hybridizers before their initial interest and enthusiasm wanes and withers away, and before experiencing that first thrill of victory-which hopefully will be addictive.