PÆONIA

Volume 25, No. 1 **January 1995**

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Subscription Rates:

U. S. and Canada	Outside U. S.
5 yrs.-- $20.	$30.
10 yrs.– $35.	$55.

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INTERSECTIONAL PEONY HYBRIDS; THE RECIPROCAL CROSS

Donald Smith

Introduction: Over the past several decades many hybridizers have reported various degrees of success with the intersectional cross (P. lactiflora x T.P. hybrids). This cross was first accomplished in Japan by Tochi Itô in 1948 or 49 and is often still referred to as the Itô cross. In the U.S., this cross has been successfully repeated many times by a number of hybridizers resulting in at least several hundred hybrid progeny. To date a total of only 28-30 intersectional hybrids have been named and/or introduced by several different breeders including the 4 original Itô hybrids.

The first report of success with the reciprocal intersectional cross (Tree peony x Herbaceous peony) came from Bill Seidl in 1973 (Paeonia, Vol. 4, No. 1, March 1973). He reported seeds from two F_1 lutea hybrids (*Age of Gold* and *Thunderbolt*) by using pollen from fertile tetraploid herbaceous hybrids. These seeds were described as large, black, and almost-firm, but apparently none of these seeds ever germinated. Later (APS Bulletin No. 216, Dec. 1975), Bill suggested using the lutea hybrid *Alice Harding* as the seed parent in the intersectional cross (i.e. the reverse Itô cross).

Table 1

Results of Reverse Intersectional Cross
Summary of 3 Years (1992-94)

Cross T. P. Lutea Hyb. x Herb.	No. of crosses	No. of pods	No. of seeds	Seeds per cross
L. H.(F_2) x M. Washington	14	50	116	8.3
L. H.(F_2) x M. Wash.(Frozen Poll)	8	28	9	1.1
L. H.(F_2) x Tet. Herb. Hybrid.	6	23	17	2.8
L. H.(F_1) x M. Washington	25	134	15	0.6
L. H.(F_1) x Tet. Herb. Hybrid.	4	16	2	0.5
Total -T. P. Lutea H. x Herbaceous	57	251	159	2.8

L. H.(F_1) = Age of Gold, Banquet
L. H.(F_2) = Golden Era, Exotic Era
Tet. Herb. Hybrid = Requiem, Paula Fay

Recently, Roger Anderson stated that he has made the reverse cross repeatedly for more than ten years but has yet to produce a single hybrid plant.

I have experimented with the reciprocal intersectional cross for the last three years with results similar to those of Seidl and Anderson. This cross has proved to be one of the most interesting and frustrating crosses which I have ever encountered. It consistently produces a large number of big, shiny black, slightly under-filled seeds most of which float when placed in water. Some of these seeds were simply huge, but only a rare few seemed fully plump and firm. To date however, only two seeds have germinated and thus far no plants have been produced. When P. *Martha Washington* pollen was used on T.P. *Golden Era* it was extraordinarily effective with an average seed production rate of over 8 seeds/cross (or 2.3 seeds/pod). I know of no other cross which "takes" better. When less fertile parents are used the results are considerably more modest, but in general, seeds are never difficult to produce. Getting them to germinate and grow, however, is quite another matter. Maybe one seed in 30 is plump and firm enough to merit an attempt at germination, and yet many of these are also "floaters". I have examined the endosperms of a number of these seeds by cutting them open with a knife. Most of these seeds contain a small void (hole) in the center about the size of a BB-shot.

The results of numerous reverse "I" crosses made over the last 3 years are summarized in Table 1:

From these results, a number of general conclusions concerning the reverse intersectional cross can be drawn. Some of these conclusions may apply more generally to other crosses as well. These are:

1. F_1 Lutea Hybrids are about 14 x less effective(fertile) as pod parents than fertile F_2 Lutea Hybrids(such as Golden Era, etc.).

2. Fresh pollen is about 7.5 x more effective than stored (frozen) pollen.

3. Tetraploid herbaceous hybrid pollen is 3 x less effective than P. Lactiflora (Martha Washington) pollen.

It is interesting to compare these results with other crosses which we might expect to be far more successful. For example, when Moutan pollen is used on Golden Era (or other fertile F_2s), the cross takes rather poorly (~0.3 seeds/cross). It is also important to note that all of the Lutea Hybrids (F_1s,F_2s, and advanced generation hybrids) appear to be self sterile (at least, the ones which I have tried so far). This fact simplifies breeding with these hybrids

considerably, making it unnecessary to protect these crosses against self-contamination.

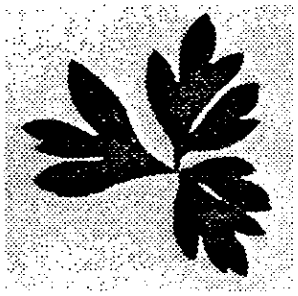
One of the more curious aspects about this cross relates to the pod parents of the few "good" seeds thus far produced. To date, the only seeds to "germinate" have come from a single fairly infertile F_1 parent (*Age of Gold*). Although these plants (F_1s) produce far fewer seeds overall (by a factor of ~ 15), those which are produced are much more likely to germinate. Despite an overall germination rate of only 1.5%, *Age of Gold* seed have germinated at a 40% rate (2 of 5). Unfortunately, both of these seeds have failed to grow normally after initial germination which occurred in approximately 6-7 weeks. At first, growth appeared normal and a short normal-looking root about 2-3 mm long was produced. Then something seemed to go wrong and these roots simply "refused" to grow any longer even after a month or more. One seed, held longer at room temperature began to rot, the other was transferred to the refrigerator, but I am doubtful that it will grow after the winter dormancy period. And so it goes.

Despite the lack of success to date, I will continue to pursue this cross for a few more years as I am convinced that this effort will eventually result in at least a few hybrid plants. I would encourage others to try this cross as well. The more total seeds produced, the sooner we will achieve some degree of success.

OBSERVATIONS ON THE DEVELOPMENT, GERMINATION AND GROWTH OF INTERSECTIONAL HYBRID SEEDS

Donald Smith

Over the past few years I have had moderate success with the intersectional cross (P. lactiflora x T.P. lutea hybrids) obtaining 75-100 seeds per year. The majority of these seeds have come from the *M. Washington* x *Golden Era* pairing originally discovered by Roger Anderson. During this period I have kept accurate records on the development, germination, and first year growth of the seeds and seedlings resulting from this cross. A summary of the results for 1993 is shown in Table 2 below. All seeds were germinated indoors in plastic bags containing damp sphagnum moss (natural long fibered-not milled). Results were checked and recorded about once per week. On average, these seeds germinated in approx. 10 weeks and (after about 18 weeks in the refrigerator) grew into strong, healthy, and vigorous plants averaging 3.0" tall with light green foliage measuring 2.5 x 3.0" across. All seedlings were grown indoors under artifical lights, each in a separate 4" plastic pot. Although the first year foliage varied markedly from individual to individual, nearly all exhibited clear indications of their tree peony heritage. The leaf structure of a typical intersectional hybrid seedling is shown below.



The results so far for 1994 are quite similar to those for 1993 except that the percentage of ruptured seeds was significantly higher at 25%. Amoug the *Martha Washington* X *Golden Era* seeds the percentage of ruptured seeds was even higher at 33%. Do not discard these ruptured seeds when they appear along with the "good" ones from the intersectional cross, as a few of these seeds (5-10%) will germinate and grow with no special care or handling, so long as they are started immediately upon harvest. They can not be allowed to dry-out. I believe that many of the resulting plants from these seeds may turn out to be **tetraploids**. I will explain why I believe this to be true and give some ideas for how to bring more of these "special" seeds to successful germination in a subsequent article.

TABLE 2

INTERSECTIONAL HYBRID SEED DEVELOPMENT,
GERMINATION and FIRST YEAR GROWTH SUMMARY
1993 RESULTS

Ave. Seed Development Time (pollination-harvest)	89 ± 13 days
	13 ± 2 weeks
Average Seed Production Rate (from A-199 pollen)	4.1 seeds/cross
% of Ruptured Seeds	15%
Average Seed Germination Time	74 ± 26 days
	10.5 ± 5 wks
Germination Range	48-118 days
	7-17 weeks
Germination Rate	40.5%
Ave. Root Growth Time Prior to Refrigeration	15 ± 10 days
Ave. Winter Dormancy Time (Total Refrig. Time)	128 ± 34 days
	18.5 ± 5 wks
Average Cold Time to Produce Root Splitting	110 ± 31 days
	15.5 ±4.5 wks
Ave. Time - Root Splitting to Plumule Emergence	18 ± 13 days
	2.5 ± 2 weeks
% of Germinated Seeds Resulting in Plants	85.3%
Ave. Growing Time Before Normal Die-Back	218 ± 64 days
(stem emergence to winter dormancy)	31 ± 9 weeks
First Year Survival Rate	89.7%
Overall Plant Production Rate	31.0%

LETTERS:

The following paragraphs are excerpted from a letter by Don Hollingsworth responding to a friend regarding the development of garden worthy, red-flowering intersectional hybrids. This material is published here with the author's permission.

With respect to the Itoh Hybrids group cultivars (those from Lactiflora seed parents and Lutea Hybrid pollen parents), the universally reported problem for breeding efforts is that the mating is highly incompatible, although not entirely so. For example, I have made hundreds of crosses with few seeds produced and no hybrid seedlings--those which grew all proving to have been from matings contaminated by unwanted pollens. Another time, from several flowers pollinated, I obtained five true hybrid seedlings all from two carpels having a total of eight seeds (this was the seed lot in which *Garden Treasure* appeared). Based upon this and subsequent observations, considering weather records of the days the pollinizations were accomplished, I hypothesized that there is a pollen incompatibility in the cross, which may be somewhat reduced when subjected to substantially above average temperatures during the time the pollen tube is growing. While this is not an established fact, the idea has thereafter guided my choice of priorities for expending effort in making the crosses.

So, when gathering materials with which to make such a difficult cross, one is well advised, I believe, to early in the effort obtain prospective parent plants showing favorable ornamental anatomy in both plant and flower, and, growth habits suitable to garden production and propagation. Having made such an all-inclusive statement, I must now say that I can not confidently tell you which of the many available clones are best for all of these purposes. That is, of course, where the "art" of plant breeding comes to the forefront. I feel competent, however, to speak to the question of selecting for ornamental characters, and, I feel, the utilitarian qualities tend to "come" when we have included a preference for parent clones which grow well and remain healthy under the conditions we can give them.

You have shared your intention to work in the area of red-flowered Itoh Hybrid cultivars. Some observations about the flaws found in the red-flowered clones so far produced may be useful to you. First the quality or hue of red.

Roy Pehrson (deceased) who made a prodigious effort with the Itoh cross around 25 years ago had opportunistically gathered pollens of flowers brought to the peony society exhibition. The pollens were mixed together and I am unaware whether the source cultivars were all recorded. Pehrson did share that *Corsair* pollen was a major component of the mix. His efforts proved fortuitous in that he eventually obtained in excess of 100 hybrid seedlings, perhaps most of them from that particular pollen collection. We are fortunate in that he was also a mentor to others working on the cross, sharing his observations and divisions of seedlings. There is much to report on this that must wait. Now I will share what I believe to be significant observations concerning the achievement of desirable red color and improved doubleness in the hybrids.

We see a great prevalence of unappealing, dull red hues among a random batch of Lactiflora Group seedlings and most of the introduced cultivars. A reason for this has been offered by persons competent to do biochemical study of pigments. This is that the opacity, or density of flower hues seen in the most preferred of white and lighter pink flowered peonies is due to color factors which in the presence of red pigment results in dull, bluish colors. Red flowers dominated among Roy Pehrson's Itoh Hybrid seedlings and they were almost all dull and drab in flower colors, very disappointing to most persons who had envisioned the expressions of red seen in the tree peonies. I believe it will be necessary to somehow get around this dullness in order to have red flowered Itoh hybrids which are appealing to most observers--in other words, to the "market".

It is worth noting here that Pehrson had initially advocated the avoidance of pollen bearing Lactiflora cultivars in a breeding collection, in order to reduce the risk of pollen contamination. He said that when he commenced gathering mother plants for his breeding project he chose Lactiflora cultivars which were not pollen bearing and with generally normal carpels (principally of Japanese and anemone form flowers) and that he acquired, quite cheaply, a quantity of such kinds from the "close-out plants" price list of a specialist grower. He also reported that among his mother plants one of the best seeders for hybrid crosses was one of these which he referred to as Lavender Japanese, a characterization which, to me, invokes the image of "dull pink"! In retrospect I see two problems here-- first, flower types having minimum doubleness--even the center petals are of small size, as contrasted with the widely available flower-in-flower form and larger petals of the fuller flower types, and, secondly, typically dulled colors.

Edward Auten (deceased) set out many decades ago to produce sharper red colors in the Lactis. His early introductions (ca1930) include the singles *Arcturus* and *Kickapoo*. These have fair color quality and are fine for their time and their flower type. However, I am seeking to add some of his later originations (ca1960). One of these I have now, *Maestro*, a near shining spectrum red with semi-double to double form flower, which I hope will prove to have usable breeding fitness.

Another area of interest to me in the Itoh hybrids is increased doubleness. Except for multiplied petals and multiplied flower segments (as compared to the wild-type flower)--"multipetally" is a Pehrson coinage which I often use--the hybrid tree peonies seldom offer much doubleness, while the few which produce pollen have low fertility. (Of those showing both fertility and substantial doubleness is Lutea Hybrid *Alice Harding*, pollen parent of the Itoh Hybrids which were earliest to reach commerce.)

To obtain greater doubleness in the first generation Itoh Hybrids, I believe we must look to the Lacti parents. The more double forms, even semi-doubles as in *Maestro*, are more of a challenge to work with. However, these are amenable to favorable modification of the flower form upon deliberate effort, such that the carpels and stigmas will be improved and thereby having better anatomy for producing seeds. The "mechanics" of the procedure is to cut off the young shoots at a stage of growth when secondary shoots will arise from the remaining stubs. The "art" of the procedure is in the choice of timing. Cut off the new stems in early spring near or below the lowest normal leaf. Do so by the time they have reached 15-30 cm.. height, at a stage of development when the branch buds (axillary meristems) remain under control of apical dominance alone and before the onset of dormancy factors. This stimulates and enables the plant to regenerate stem growth from the branch meristems which occur at the leaf axials or further down-stem at the bud-cover axials. The secondary stems which grow afterwards will number from one to three or four per cut-off stem and some of them will produce a reduced flower (reduced in its doubleness).

That is the basic technique. You soon realize that the degree of success is variable and may prove to vary by cultivar and by other factors. The quality of the response perhaps partly reflects some optimum relationship between the amount of stored food remaining (at the time of pruning) and the number of secondary stems which are stimulated to grow. In this connection a report attributed to another deceased breeder of Lactis, Art Murawska, states he successfully produced seeds in normally sterile, doubled flower forms by pruning the spring shoots after having replanted divisions the previous autumn (presumably divisions of mature plants which would have flowered had they been left undisturbed). This might seem especially severe inasmuch as the process of dividing would ordinarily involve a reduction in the amount of stored food available to the shoots.

Persons who report using the pruning technique sometimes associate the benefit with "stressing" of the plant, suggesting that something like the flush of fruiting often seen in a dying tree has been stimulated. A recent report by Steve Varner (APS Bulletin 292, Dec. 1994, p. 18) speaks of this in explaining the approach which he used in obtaining the recently registered peony, *Major Steve*, a seedling of the inter-species hybrid *Red Charm*. It was long believed that *Red Charm* was entirely infertile, but not obviously due to anatomy, inasmuch as its flowers typically have large carpels which appear to be normal (although the stigmas often have a poor receptive surface). Varner's result seems to support the idea that something more than apportionment of the remaining stored food is at work.

On the pollen side of the Itoh Hybrids cross, I have little information as to the most reliable sources of fertile pollen among the red-flowered Lutea Hybrids. I grow only a limited selection of those presently in commerce and have had only a few of them under observation for pollen production. An inquiry to David Reath of the Reath Nursery (Vulcan, Michigan) may be productive in this respect, inasmuch as he has long been active in breeding among the Lutea Hybrids.

Of course, there is also the prospect of obtaining additional and possibly more desirable selections of red Lutea Hybrids pollinators using the red flowered Paeonia *delavayi* and, to seek enhanced doubling, by giving priority to the more doubled, red-flowered forms of the *P. suffruticosa* cultivars as the other parent.

In all of the above, diligent effort, using as wide array of materials as can be assembled and making as many crosses as possible would seem to support the highest probability of success. Past experience shows that all the crosses and techniques discussed above yield poorly--Lutea Hybrid and Itoh Hybrid, as well as the uncertainty of obtaining usable fertility in the more doubled flower forms of the Lacti Group cultivars. A larger number of crosses (using pollen which has at least some fertility) predicts better chance of success. I can report from personal experience that having a little success helps greatly to sustain one's enthusiasm.

Editorial Note: Roger Anderson has shared with me a few colored slides showing some of his recent "I" hybrid seedlings. One of these flowers was a beautiful bright red which appeared to be of excellent color (not dull at all). I believe it is the same one that appeared in his 1992 colored catalog/brochure which is called *Scarlet Heaven*. It does not look to be a double, but the color does appear to be good. Maybe Roger has a record of the parentage of this one and would be willing to share it with the group.