

Use of *Pumila* in Iris Breeding

Bee Warburton

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Iris pumila is one of the most important new things to hit iris breeding. This little species has been known a long time but breeders have just begun to realize what a treasure-trove it is. As the news about it has spread, more and more forms have been collected and garden bred so that now it is available in a wide range of plant types and a color spread nearly as complete as that of the tall bearded. The excitement that followed the discovery of what it could do in breeding was like the excitement in the iris world when the use of the tetraploid tall species started breeders off on the modern tall bearded, and this is partly because *pumila* is a tetraploid, too. It gives the same sort of chance for fertility and wide variability; that is, the chance to cross it onto other tetraploids, especially the modern tall, and to exploit the resulting seedlings to the fullest because they may be raised in large quantities and may then be interbred or line bred or outcrossed or backcrossed with most satisfactory results. Such crosses of tetraploids giving fertile seedlings have a much brighter future than crosses that give only a very few dead end seedlings, interesting though they may be.

Part of the excitement came from the discovery that species *pumila* seems to have three separate color factors, for purple, for yellow, and for blue. In *pumila* itself, combinations of these three color factors give a very wide range of expression. There are pumilas in white and all shades of yellow, from palest cream to deep yellows; pastel orchid, lavender and lilac to red-violets to nearly black; pale to aqua tinted blues, clear spectrum blues through deeper violet-blues to the richest blue-violet; and greens from chartreuse to mustard shades to true leaf green. These greens, of course, come from blending of blue and yellow, and in *pumila* they combine in a manner impossible in the tall bearded. Blue-violets such as 'Sulina' are apparently combinations of blue with purple, and yellow with purple seems to give blended reds and near blacks, such as 'Nana'.

Much charm is added to the pumilas by the prevalent pattern of the signal patch in their falls, in colors matching or contrasting with the petal color. The creams and yellows usually have these patches in brown, green, or deeper yellow; the blues have brown, reddish, or navy blue spots, and the pastels often have bright red spots, but there are many new combinations, and recently pumilas have been bred with white spots overlaid on a colored petal, as though the factor for the cell-structure of the patch had been divorced from its factors for color. Apparently this fall-blotch factor comes in dosages, from one to four since *pumila* is a tetraploid. In light dosages the spot shows as a faint blur or an etching of color, and in heavy dosages as a very solid, color-saturated patch, sometimes velvet. It may be absent altogether giving self-colored varieties. Probably this is not as simple as it sounds, and it is hard to judge by eye whether or not small dosages of spot are present; at any rate, pumilas without spot are a rarity. The only named one certified to breed as a self is 'Hanselmayer', a pale yellow, and this one will give pumilas in self colors, but since the signal patch is one of the distinctive charms of the species and its hybrids, it would seem more profitable to make crosses to bring out this pattern rather than to try to eliminate it.

Pumila also differs from the tetraploid tall in the relation of its blue and yellow color factors. In the tall yellow is dominant. In *pumila*, the blue is dominant (or epistatic) to the yellow, so that *pumila* yellows seem to be true-breeding, or homozygous; they have no blue factors at all. Apparently the blue *pumilas* may contain yellow factors, and it seems that even one factor for blue in *pumila* is enough to suppress all appearance of yellow coloring, although it seems to be present in most blue *pumilas*; blue varieties such as 'April Morn' are reported as giving yellows when selfed or intercrossed. If this yellow is actually recessive, it is the first example of recessive yellow to be found among iris. All of these *pumila* color factors seem to be due to entirely different genes from those that influence tall color, and the chemical processes they control seem to be quite different. Much of the puzzling behavior of the *pumila* color factors has been recently explained by the preliminary findings, reported by Dr. Hertha van Nes in the *Dwarf Iris Society Portfolio*, 1956, that the yellow of the *pumilas* is not a plastid yellow as in the tall, but is due to flavonols, a type of sap coloring made from the same basic ingredients as the anthocyanins that look blue or purple to our human eyes. Although this discovery has yet to be confirmed, it gives answers to so many puzzling questions that it is certainly well worth considering by breeders planning their crosses. Such soluble dye-stuffs, both blue and yellow, would naturally blend together in a different effect from the blending of a transparent blue dye with a solid ingrained yellow pigment, hence perhaps the greener greens of the *pumila*-tall blends.

Pumilas as a rule are resistant to selfing, and it is much easier to outcross them. As a matter of fact, good breeding stocks and very fine garden *pumilas* may be developed by simple selection, that is, letting the bees do the pollinating and growing the seed from choice colors or forms. As the *pumilas* are the first bearded irises to come into bloom, the earliest pods set, at least, will be pure *pumilas*; later there may be hybrids. Sometimes the bees get excellent results, probably because they aren't afraid of mismatching colors, but if you want to learn anything much of genetic value you must control your crosses, and there is nothing more frustrating than some startling break with parentage unknown.

Labeling *pumila* crosses is a problem. The pods are right on the ground so that paper tags become defaced. Plastic tags are better, but it is hard to get the string below the ovary, and any tag looped around the long perianth is sure to get separated when the blossom withers. Initialing the basal leaves with a ball-point pen works fairly well if the pods that set are tagged later. Perhaps the best method is to make the same cross on an entire clump, and to grow the pods separately in case of contamination.

Hybrids of *Pumila* with Tall Bearded Irises

Crosses of the *pumilas* with the tall bearded irises may be made either way, and the experts say the seedlings will be the same, but it is a great deal easier to put the *pumila* pollen onto the tall, for mechanical and seasonal reasons. There will be more takes and more seeds per pod when *pumila* pollen is put on the tall. *Pumila* pollen may easily be saved for the tall season, if it is kept dry and refrigerated. It has recently been sent back and forth between America and Europe with complete success, and has remained viable after deep-freezing. The one most important point in preserving it is to dry it before storing. Sealing it immediately after collection in air-tight vials seems to be fatal.

In its hybrids with the tall, *pumila* has a strong dominance for size, so that they range usually from about 8 to 16 inches in height, rather than the 18 to 24 inches which would be the half-way mark. Most of the progenies are uniform in size, and on further inbreeding these progenies, many of them remain uniform without much segregation, but some segregate within the height limits of the cross, that is, from 8 to 16 inches. Such segregation is supposed to be chiefly due to varying height factors in the tall

parent, in which case these segregations should be in a simple diploid ratio. This is because these hybrids are amphidiploids, or double diploids. They carry in their cells two sets of chromosomes from their tall parent, which pair together at gamete formation, and two other sets from their *pumila* parent, which also pair only with each other. These two different types of chromosomes coexist in the cells of the hybrid and have a composite effect on its appearance; the strange thing is that the 16 chromosomes of little *pumila* should have so much stronger an effect than the 24 chromosomes of the tall parent.

Besides their dominance in height, and in plant character, *pumilas* also have a strong dominance for color. This is partly because they carry an inhibiting factor which may or may not be the same as the inhibitor in the dominant white talls. This inhibitor usually stops every bit of anthocyanin or sap color of the tall parent from coming down into the hybrids, but naturally has no effect on the *pumila* sap colors. This is a general rule that seems to have its exceptions, as indicated by the appearance of *plicatas* from crosses of Mariposa Mia with the *pumila* variety 'Cretica'. It is probable that *pumilas* lacking the inhibitor will soon be discovered, but it is generally true that the blue or purple coloring in *pumila*-tall hybrids will have come from the *pumila* parent. It seems that the plastid yellow coloring of the talls does come down into the hybrids, but not with the dominance that it has in strictly tall breeding. The effect of this plastid coloring will be the same in the hybrids whether the tall parent was a dominant or a recessive yellow, or a tangerine bearded pink, or a blend of any depth from light to very dark, as long as it carried the plastid yellow coloring. Hence it is a very general rule that yellow *pumilas* on any tall will give yellows; that blue and purple *pumilas* on talls containing plastid yellows will give blends, and that blue and purple *pumilas* crossed onto blue or white talls, dominant or recessive, will give blues and purples.

This is a very great over-simplification of what happens when the diverse genes of these two types of tetraploid irises are combined. The *pumila* gene for blue seems to be unique among bearded irises; several recorded crosses of blue *pumilas* crossed onto white or blue talls have shown as many whites, creams, and yellows combined as there are blues in the progenies. In these progenies, the blues have been distinct and there have been no purples. This has been interpreted as meaning that these blue *pumilas* had only one gene for blue coloring, as this is the ratio to be expected if the blue coloring comes from the one blue factor of the *pumila* and none of it from the blue of the tall parent, all tall blue being prevented from appearing by the inhibitor present in the *pumila*. The occurrence of the creams and yellows in such progenies can only mean that they are present in a recessive state in the blue *pumila* and are completely dominated in the *pumila* itself by the single gene for blue. This is a highly unorthodox state of affairs.

When these *pumilas* of distinct blue, as apart from the purple or violet, are crossed onto the blended talls, there will be blue and yellow seedlings as well as blends. A large part of these blends seem to be in ugly mustard or smoky colors, but among them may be acceptable green, tan, or gray blends and some odd color combinations, such as blue with yellow patch, yellow with white patch, or white with ice-green patch. When the blue-violet 'Sulina' is crossed onto recessive white talls, it will give both blues and purples, with a few intergraded colors. The red-violet *pumilas* seem to produce very good red coloring. The variety 'Nana' seems to be a blend of all three *pumila* color factors, for when it is crossed with whites it segregates out blues, purples, and yellows. In combination with talls having plastid coloring it gives excellent reds.

The rather common occurrence of green coloring in these hybrids is of special interest to a great many people. When it first occurred, it was hoped that it could be crossed into tall strains by back-crossing

these hybrids with the tall, but people who tried this met with disappointment for the green disappeared after the first back-cross. So did the lovely blue that came from *pumila* into these hybrids, and so did the *pumila* signal patch. Although studies on the chromosome pairing of the first generation back-cross hybrids, with 44 chromosomes, had showed that there was some pairing between the tall bearded and the *pumila* chromosomes, apparently all these factors were in the loose and unpaired *pumila* chromosomes that finally became lost in continued back-crossing with tall bearded irises. Paul Cook thinks that the height factors of *pumila* are in the chromosomes of *pumila* that pair with those of the tall in these backcrossed hybrids and that they may become separated from the genes for season of bloom, so that there are possibilities in these backcrosses for dwarfs and Lilliputs that will bloom with the tall. Dr. Randolph intends to make some studies of the pairing behavior in these backcrossed 44's this spring, so we should soon know more about this.

The little *pumila* variety 'Cretica' has proved a real oddity in breeding behavior. It is a watery pinkish purple with apparently only one purple factor, since when it is crossed onto recessive whites it gives half whites; and it has given two plicatas from crosses onto Mariposa Mia, which might be called either a recessive white or a plicata. The secrets of 'Cretica' are being searched out intensively by breeders of small irises, for apparently it could have a plicata factor itself, or it could lack the inhibiting factor for tall anthocyanins, as otherwise the plicata pattern of the tall-bearded should not be permitted to show itself. Recently the tall-*pumila* cross has been made in great numbers, and within the next few years we should learn a great deal more about it.

Other *Pumila* Hybrids

When *pumilas* are crossed with the *chamaeir*is [*I. lutescens*] varieties the results are much the same in color effect as in the *pumila*-tall hybrids, but this cross gives excellent miniature dwarfs; crossing the Lilliput hybrids with the *pumilas* gives even better. Seedlings from both these types of crosses are fairly sterile, but some of our best new miniature dwarfs have come from advanced generation breeding from such crosses. *Pumilas* have been crossed with the *mellit*as [*I. suaveolens*], with difficulty: Doc Jonas' "Petite" series is from such crosses. Curiously enough he has used only yellow *pumilas* and has got some really rich dark colors in his hybrids. The first hybrids of *pumila* with *arenaria* [*I. humilis*], the bright yellow dwarf species, produced by Jay Ackerman, were with yellow *pumilas* and it isn't known how the color genes of these two species will combine when other *pumila* colors are used. Judging by results of breeding *arenaria* with the *chamaeir*is varieties, there should be bright reds, whites, and even blues from such breeding, but that is sheer speculation. The yellow coloring in Mr. Ackerman's hybrids is very clean and rich.

The *pumilas* are sympatric with the *aphyll*as in some places, and natural hybrids of the two have been collected. These are small branched dwarfs, and this cross of *aphylla* with *pumila* looks promising to follow up. Since the true species *aphylla* has 48 chromosomes in four sets of 12, like the tetraploid tall, these hybrids of *aphylla* x *pumila* will have the same type of genetic make-up as the tall-*pumila* hybrids; they will also be amphidiploids with 40 chromosomes in two sets of 12 and two sets of 8. The *chamaeir*is complex has exactly the same chromosomal composition, though the exact source of the 12's and 8's of the various species and garden varieties in this complex is not known. Among this so-called "chamaeir is complex" we have not only the recently improved garden varieties, but also some recently collected species. Some of these are quite handsome, particularly the *italicas*; and species *chamaeir*is is a very small and fragrant yellow, well worth using in breeding. Intercrossing these *chamaeir*is with the tall-

pumila hybrids seems to improve both types. In fact, hybridizers are throwing in all the genes they can at this 40 chromosome level. Another source of 40 chromosome hybrids comes from Cook's 'Progenitor', the very famous progenitor of his blue-falled amoena line of tall. Progenitor has 48 chromosomes and is from a cross of a tall parent with some form of 48 chromosome dwarf, probably in the *reichenbachii* complex. Cook has crossed 'Progenitor' with *pumila* to give 40-chromosome hybrids, and is crossing these into his lines along with the Lilliputs, the *chamaeiris*, the hybrids of *aphylla* with *pumila*, and other hybrid combinations. Since all these 40-chromosome species and hybrids are quite interfertile, and seedlings may be raised in numbers large enough for careful selection, and because of the diversity among them of desirable qualities, it doesn't take much imagination to see that a wonderful garden group is certain to be developed out of this 40-chromosome pot.

Tip for Beginners

If you are just starting to breed the small irises and have no stock of species, your best bet is to get some *pumila* pollen from the Median Iris Society pollen exchange and put it on your tall. Tall known to be good breeders, disregarding color more or less, will be equally good here. An excellent tip from Paul Cook is to mismatch the *pumila* and the tall colors. Results of this advice indicate that the most interesting color breaks come from crossing the blue *pumilas* onto the blended tall.

While you are waiting for these seedlings to bloom, buy or swap for 'Fairy Flax', 'Green Spot', 'Baria', and 'Brite'. 'Fairy Flax' has a lovely blue, 'Baria' the finest form found in these *pumila*-tall hybrids; 'Green Spot' and 'Brite' both breed as whites with the addition of the spot pattern, which is more emphatic in 'Green Spot'. 'Little Rosy Wings' is an excellent parent and has fertile pollen, as does 'Green Spot'. The others mentioned do not have pollen, and in general the *pumila*-talls are more fertile as pod than as pollen parents. 'Pogo' is a very fertile pod parent and its seeds germinate easily, even those from wide cross combinations. Besides these get a few of the improved *chamaeiris* forms. 'Orange Glint' is an excellent parent with bright color, and 'Whitone' is nearest to a white of the improved forms. When your first tall-*pumila* seedlings bloom, very likely you will find some excellent selections. You may start intercrossing them, or crossing them with the *chamaeiris*, or you can do other things with them. You can cross them again with *pumila* for neat miniature dwarfs; or cross them again with the tall for handsome taller intermediates.

You may want to try growing some *pumilas* for breeding stocks (and you might fall in love with them for themselves). Cook 1546 is one that is passed from hand to hand and is a good breeder for greens. 'Blue Spot' is useful for correcting the worst fault of these hybrids, which is coarse foliage and too big flowers on too short stems. 'Sulina' breeds rich purple colors. 'Remnant' is nearly spectrum blue and has super form. You might try 'Red Amethyst' for reds, and 'Hanselmayer' for the self pattern. It is a good breeder for flower form but it makes chunky plants with wide foliage and short stems.

Anyway, it's a good idea to be prepared for anything further you might want to do with these first tall-*pumila* hybrids of yours, for you will find them an irresistible challenge.