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Those Captivating Irids

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An examination of the subjects covered by former presidents indicates that I am not setting a precedent by presenting material drawn from my avocation. This avocation had so many interesting features that at times it threatened to become my vocational classification. Although my professional assignments have been continuously in the field of Zoology most of my spare time since 1926 has been spent in the field of plant breeding. Many problems in plant genetics have been encountered, some have been reported in publication, but these items have largely been considered the tools in production and not the end product. It is the end product that spells success in plant breeding, especially when that product has commercial value and is produced at considerable cost. It is obvious that information that would be used directly by competitors would not be published. Unless plant breeding is restricted to the status of a mere hobby, certain conditions must exist: (1) there must be facilities for work and production; (2) the breeder must know the medium (genera, species, varieties) which must be responsive to the techniques available; (3) there must either be an established market or opportunity for establishing one; and (4) there must be acceptable publicity. These are major items required in a successful plant breeding program, however minor items not mentioned may arise and become of major importance in special cases.

My own work has been mainly with Iridaceae, whose ancestors were natives of South Africa; namely, the genera Freesia and Gladiolus. Both these genera are quite variable and beautiful; brightly colored hybrids have been produced and used in Europe and America for nearly a century. Both produce corms which are solid and lack the concentric scales found in the true bulbs, such as onions, lilies, tulips, etc. However, it is the general practice among growers to call the corms bulbs, and this I have done. Facilities in addition to those present in the college laboratories have been quite adequate. This has been due to the location of a large commercial greenhouse establishment near the college campus and the interest and experience of its owners[1] in the introduction to the florist trade of new varieties of flowers. As previously published, I immediately fell heir to a small stock of freesia seedlings, largely nondescript and of unknown parentage, except that the original stock had been commercial varieties purchased several years earlier. They had not been subjected to the usual culling because there was a demand for freesia blossoms in bunches of mixed colors. This was

[1] Len S. Elder and W. Russell Elder of Elder Brothers, Inc., Indianapolis, Indiana.

fortunate because here had accumulated a veritable reservoir of plant breeding material. Thus it was not necessary to begin from scratch.

One outstanding white seedling had been selected from the lot and its bulb stock increased sufficiently to demonstrate its merits as a commercial form. White freesias were in greatest demand as florists cut flowers and the new seedling was better than any white variety available. At that time an improved form of the old Refracta Alba, known as Purity, was being grown in California in large quantity for the florists of America and Europe. This new variety, named Elder's

Fig. 1. Commercial variety "Giant White" with Freesia species *Hurlingii* which was pictured in the Botanical Register of 1816.

Fig. 2. Golden-yellow "double" variety "Judy".

Fig. 3. White "double" showing many petals.

Giant White (Fig. 1), was granted plant patent number 17. Its commercial possibilities seemed attractive enough to induce these greenhouse owners to launch a new enterprise devoted to the large scale production of bulbs to be sold through dealers to florists for forcing in greenhouses for the cut flower trade. Freesias from field grown bulbs

are blossomed in cool greenhouses similar to and often with carnations. Florists usually found it more profitable to purchase new stock each year rather than use their valuable greenhouse space in maturing the forced bulbs. This was an established market with which these owners were quite familiar. Such an enterprise required considerable faith, energy and financial investment, since greenhouse maintenance for the breeding program was costly and a suitable location for field production had to be established. This last item was an entirely new undertaking and especially difficult when one considers the fact that the parties to the decisions were two florists and a professor of Zoology, all throughly Hoosiers by birth and residence. The three possible locations were Florida, Rio Grande Valley of Texas, and the coastal region of southern California. The studying of weather records, visiting locations and checking conflicting statements and advice were certainly confusing. One decision remained unchanged: to directly control the field growing of our bulb stock and not submit to the offers of established growers to produce our varieties on a contract basis. After one year of unsatisfactory climatic conditions in Florida, field culture was removed to California, first to Solano Beach and later to the vicinity of Oceanside. The peak area under intensive cultivation was ten acres. The accompanying illustration (Fig. 4) shows a part of this planting devoted

Fig. 4. A planting of "Giant White" near Oceanside, California, illustrating the field production of Freesia bulbs.

entirely to the variety Giant White. The greenhouse space for this work reached a peak total of five 100 foot houses which in later years was reduced to two houses and finally to one narrow 100 foot house. A part of the greenhouse space was taken up with an assemblage of all obtainable freesia varieties. One or more pots of each named variety, which at one time numbered over one hundred, was grown in order that direct comparisons could be made, and they also served as a source of breeding material. These were obtained from sources in America, England and Holland. In addition more than fifty species of bulbous plants of South African origin were grown for breeding or observation. Several of these, some not Irids, were introduced and continue to be grown by American florists.

Extensive flower exhibits were made at the National and International Flower shows in America and especially arranged exhibits were made in London, England; Haarlem, Holland; Cannes and Nice, France and Florence, Italy. These exhibits with the extensive descriptive material about our giant-flowered colored varieties published in popular and trade magazines resulted in our freesias being well received and their use by florists increased.

The above has largely been a statement of how a professor in a small college located in Indiana could have the needed extensive facilities for carrying on a program with plants largely of South African origin. My part in the program was to produce new varieties whose bulbs were then grown in quantity in California and distributed to florists for the production of cut flowers. In this work the hybridizing by hand pollination was done during the blooming season which ranged from January through April. This resulted in thousands of pedigreed seed each year from several hundred planned crosses. Seed harvested during the summer was planted in flats the following fall and produced bulbs that were planted on the greenhouse benches. These were ready for check and selection or destruction during their second season following the planting as seed. Where selections were made for further observation, these were grown until the stock of bulbs reached a quantity large enough to require final judgment of: (1) destruction, (2) limited introduction to the private estates as novelties or (3) sent to California for further increase preparatory to commercial introduction. We planned to introduce only a limited number of varieties of sufficient merit to replace those being offered by competitors, therefore a final recheck by flowering in the greenhouse of the field produced bulbs was a necessary precaution. At times this required rather hard-hearted actions. As an example of this, one variety had reached the 10,000 bulb stage when its growth characteristics under certain conditions resulted in the decision to destroy the whole stock. Greenhouse culture in the breeding of freesia varieties was essential because their final use would be under greenhouse conditions. Another factor was that field grown blossoms were seldom of the same quality and color as the same variety grown under glass. All of the actual crosses, seed gathering, record keeping and selection was my own assignment while other items were handled by the close supervision of reliable

employees. The digging, handling and replanting of the bulbs in the greenhouses was all done in the summer, during the college vacation. Little attention was given to the production of plants suitable for the back yard garden. Two or three departures into this field revealed the fact that the correspondence resulting was too time consuming to be continued. Since the florists using freesia bulbs also used other forms requiring similar growing conditions, attention was attracted to the possibilities of additional South African genera, including Gladiolus, Lachenalia, Lapeyrousia, etc., etc.

As previously shown, ample facilities were provided without restrictions. This is most unusual in a program that had to be self supporting. As a consequence many items were undertaken that offered little, if any, hope of financial return. Much data was accumulated and some of the results have been published, such as: Flower Forms in Hybrid Freesias, Growth Irregularities in Hybrid Freesias Induced by X-ray, Color Inheritance in Hybrid Freesia, etc. The use of the x-ray, special chemicals, high and low temperature treatment was made at various times with results that were seldom more than interesting.

Two "breaks" in the freesias gave valuable working material. One was a triploid with 33 instead of the usual 22 chromosomes. Although it was almost sterile, it was used in producing several giant-flowered seedlings which have become commercial varieties. This was possible due to the fact that "varieties" are in reality clones and each clone results from asexually reproduced bulbs (6 to 30 or more per year) from a single seedling.

The second "break" was a small, double-flowered white with modified spike that, except when carefully grown, gave it a grotesque, stunted appearance which caused certain florists to advise that it be destroyed since it obviously was a case of disease. Its genetic possibilities were recognized and immediately tested. The utilization of this form resulted in many interesting, although not always commercially valuable, large double-flowered hybrids. The first double-flowered freesia to be introduced was the yellow variety, named sentimentally for my youngest daughter, Judy, (Fig. 2). This was exhibited for the first time by G. C. Van Meeuwen, of Heemstede, Holland and pictured in their catalogues with the caption: *"Judy, de errste dubbelbloemige Freesia"*. This variety and Elders Double White (Fig. 3) were the only two double flowered varieties considered worthy of commercial introduction and both are still being produced for florists by the California bulb growers.

One of the most intriguing phases of this work was that dealing with the original freesia species which had been used by the first breeders that produced the hybrid forms. Some of these were collected for me from the same area in South Africa that supplied the botanists of the late 18th century with their taxonomic specimens. In the case of the "pink" species *Armstrongi*, the specimens were dug from the original clump of bulbs growing near Humansdorp. These species were valuable both in the analysis of hybrid forms and in the introduction of

entirely new characters. Two examples were in fragrance, one similar to gardenia, the other to rose-geranium, both entirely different from that found in the common hybrids. Some of the species had only recently been described and some were received and grown before botanical descriptions had been published. The principal localities supplying freesia species were Southern Ethiopia, Assegai Bosch, Hanover, Bonnie Vale, Stellenbosch, and Humansdorp. With the exception of the first, all are within Cape Province. The original intent involving the acquiring of the species was to unravel the history of the commercial hybrids. In this work several helpers made very useful contributions. Dr. Ragionieri of Florence, Italy was one of the first to use the "pink" *F. Armstrongi* after it became available in 1904. He supplied, via amiable correspondence, detailed data concerning his own results which included one of the first freesia hybrids. It was described and illustrated in a color print in an Italian publication dated 1884. Dr. David Griffiths of the Dept. of Agriculture sent me the complete file of early articles and related materials on freesia compiled by that remarkable plant breeder of the past generation who worked with many kinds of plants, Dr. Walter Van Fleet. Help in acquiring photo copies from rare volumes in Dr. Green's library of Notre Dame was provided by Father Nieuwland. G. H. Dalrymple of Southampton, England supplied data concerning his work with freesia, also unpublished details of hybridizing by that notable plant breeder of an earlier period, Rev. Joseph Jacob. He also arranged our exhibits at the Royal Horticulture Society's shows in London, England. Much of this material was used in my exhibit in the Floriculture Division at the 6th International Congress of Genetics.

Although my main interest has been with freesias, the gladioli were especially attractive. Due to the extensive planting of the garden type hybrids in the northern part of Indiana and Michigan, I felt the breeding of this plant was already in a highly competitive state. However, one phase of their breeding efforts seemed to have been neglected: the production of varieties that blossom in the greenhouses during the winter. At that time the cost of fuel and labor had not reached the war-time and post-war levels and florists could profitable compete with the gladiolus blossoms shipped from the Florida fields. The hybrid gladiolus varieties so extensively grown during our summers are very diffcult to force into winter blooming without artificial lighting. Early blooming strains of gladioli had been produced some years earlier, mainly in Haarlem, Holland by the the firm of E. H. Krelage and Son and later by C. G. Van Tubergen. These were the so-called "baby glads" which never made any head-way in America because they were not impressive enough to be commercially profitable as a greenhouse crop. Here seemed to be another opportunity for plant breeding to offer a profitable solution.

Another item that had been neglected was the production of varieties with desirable fragrance. Since my collectors in South Africa were more familiar with the gladiolus species than the freesia species, it was relatively easy to acquire several with which to work. Preparatory for this, a survey of the historical items concerning the gladi-

olus species and work of English breeders, revealed several suggestions as to procedure. As might be expected, I made the usual start in this direction by attempting the cross between the night fragrant species *tristis* and the day fragrant *recurvus* which producted the variety Fragrans for Dean Herbert of Manchester, England many years ago. The species *tristis* and *recurvus* were the first obtained and used. The following species with some collected types of questionable classification were added for use in breeding: *alatus, brevifolius, formosus, viperatus, hirsutus, pulchellus, namaquensis, grandis, gracilis, orchidiflorus, communis, watermeyeri, psittacinus,* and *odoratus.* With the exception of *psittacinus* none are to be classed among the tall broad leaved types that may have entered into the making of our common garden hybrids. Most of these are classed as either narrow-leaved or rush-leaved and had not been particularly attractive to plant breeders.

My work with the fragrant gladiolus hybrids began at about the same time as that of Dr. Forman McClean, then at the New York Botanical Garden. From his published statements and by way of our conversations it was learned that our findings in the use of the *recurvus-tristis* hybrid had much in common, however my work included several more species and obviously gave different results. Due to the fact that my hybrids were both winter flowering and fragrant, they were described with very favorable editorials in American and Dutch Florists magazines just prior to the onset of the war. An example is the following quotation taken from an editorial written by T. A. Weston[2] of New York City about blossoms sent to him in February: "Dr. W. P. Morgan . . . has favored us with seven spikes of these gladiolus and the perfume is so strong that hours after unpacking, the delicious odor reaches us as we write, though the flowers are several feet distant. The individual flowers range to 3¾ in. with 10 or more on a stem. To us the odor savors of Freesias and Wallflowers".

Another item that must be taken into consideration in the production of flower fragrance was covered by Dr. Albert F. Blakeslee some years ago in his published studies on scent perception. As an example, I have found many people entirely "blind" to the odor of violets, hence they thought the gladiolus species *recurvus* was scentless. Another example was the variety named "Spicy", the only fragrant variety which we introduced. This had fragrance quite unlike any species being used which, to me, was similar to the heavy, sickening odor of nicotiana or flowering tobacco, however both my colleagues in this project considered it entirely odorless. In keeping with the professional tendency, to date, none of my gladiolus breeding records have been published. My experience has been that such published records usually tell the truth but not the whole truth, hence the breeding can be repeated only with great difficulty, if at all.

Most retail florists show little concern about the fragrance of their flowers. This is largely due to the fact that the flowers they handle are continuously kept chilled by refrigeration and the fragrance

[2] Editor, Florists' Exchange and Horticultural Trade World.

does not become apparent until the flowers reach the warm homes of their customers. The one item that both florist and customer usually agree on is this: are the flowers large and showy?; are they of pleasing color and form? In respect to these items it can be definitely stated that practically all colors, flower forms, blossom size and spike length of the garden gladiolus hybrids have been duplicated. In addition to these, many new flower types were produced in the multi-species hybrids. Each seedling selected to be saved for further observation and bulb increase was given a number and a file card record as to parentage, blooming date, size and number of flowers, length of stem, color and fragrance. Then a "close-up" kodachrome photograph was made of either a single flower or the whole spike. The slides shown are from these routine records. (Figures 5, 5A, 6, 7 and 8 were made from these slides.)

Fig. 5. The dwarf (six to eight inches) Gladiolus species *alatus*.

The many breeders of the gladiolus hybrids produced millions of seedlings, many with gloriously colored blossoms of great size, but none really fragrant and few, if any, responding to greenhouse forcing. This is easily explained since the species that went into the making of our garden forms lacked the genes essential to the production of these characteristics. Efforts to determine the definite species that were used by the originators in England, Holland, France, and America have been rather confusing. Most agree that only a few of the more than 150 known species including *psittacinus*, *cardinalis*, and *oppositiflorus* were used by the hybridizers. These are all robust growers and, without the background of modern genetics, few breeders would risk using

Fig. 5A. Gladiolus *viperatus*. The easily grown fragrant green Kalkoenje of South Africa.

Fig. 6. The fragrant Gladiolus species *odorata* which was the seed parent of the hybrid shown in Fig. 8. Corms of this species are tall and pointed instead of the usual broad, flat form.

frail, inconspicuous species that possessed a single desirable characteristic.

Since our post-war conditions are even worse than those of wartime in the production of bulbs that require a lot of costly hand labor, it is doubtful that my findings will be needed by us in any future commercial bulb production; therefore any information I have is passed on in the hope it may be of some value to those interested in gladiolus breeding. The seed of gladiolus species can readily be obtained from the Cape due to the fact that several companies and individuals specialize in these items. The importation of bulbs is restricted. I would definitely recommend the purchase of collected seeds from South Africa rather than that which might be supplied by American seed or bulb specialists. This is due to the fact that many species are quite variable. For example *recurvus* may vary from lemon-yellow through various shades of light blue to deep reddish-purple. Furthermore, there is great variability in fertility. This was true in one lot of bulbs of *tristis* purchased in California. They were almost sterile while *tristis* obtained from Africa produced full pods of seed when the same crosses were repeated. Seedlings of the species may be grown in the open ground in our locality and they flourish under the climatic conditions of southern California. I have found that the cross between the species *recurvus*

and *tristis* produced hybrids having several types of day fragrance differing from the violet-like odor of *recurvus*. Although I have back-crossed and inbred several of these hybrids with interesting results, the quickest method of getting large flowered types would be crossing this hybrid using a garden gladiolus as a pollen parent. Many of the resulting seedlings will be mildly fragrant and nearly as large and robust as the garden types. Garden type varieties were grown for me in Florida and the flowering spikes shipped to Indianapolis where the pollen was used in hybridizing. More than fifty named varieties were used. In general, the older namer varieties and *primulinus* hybrids were the most viable. Some species failed to make seeds with either *tristis* or *recurvus* or the other species crosses attempted, however they crossed with the *recurvus-tristis* hybrid which served as a convenient medium to combine one or more forms with it into a multi-species hybrid. The resulting plant could then be used as a seed parent and crossed finally with the garden hybrids to produce a plant with the large, showy flowers that we have come to expect when the gladioli are used in decoration.

The species *tristis* was used by some of the first hybridizers of gladioli. An English form produced by Colville in 1823 and known as Colvillei and later the "baby-glads" from Holland's C. G. Van Tubergen, all had *tristis* as one parent. These and most of the hybrids between the garden gladioli and *tristis* are practically scentless. Contrary to the published work of McClean, by own results have been much better by using *recurvus* as the seed parent. Most of the resulting plants are sturdy with broad leaves and large, showy flowers on tall stems. They are winter blooming and most of them are mildly fragrant similar to *recurvus*.

One question that has often been asked is, why do the species that you use, cross so freely? The suggested answer may be had by reviewing the cytological studies on the gladiolus species and garden varieties by Bamford. As indicated in these publications most of my species had a 2N chromosome number of 30. The exceptions were: *formosus* and *orchidiflorus* with 45, *psittacinus* with 90 and *cummunis*, a European species with 180. Hybrids among most of the South African species possess a diploid number of 30. The garden hybrids that have been studied are tetraploid with the 2N number of 60. The resulting plants produced by crossing a garden gladiolus with a species hybrid normally would be a triploid with 45 chromosomes and usually would be sterile. Sterility and fertility are not to be explained entirely by chromosome number but expected results in breeding largely support this interpretation.

One series of crosses has been especially interesting with further possibilities suggested. This utilizes the species *odorata* that blooms in the greenhouse from late November through January. This species has small, dull colored flowers with the clove-like fragrance of carnations, a type of fragrance that most people seem to like. This species was used in many crosses with little success but the following gave excellent results. The 30 chromosome species hybrid of *recurvus-tristis*

was crossed with the old variety Los Angeles having 60 chromosomes. Some of the flowers of the resulting hybrids resembled Los Angeles but blossomed at about the same dates as the *recurvus-tristis* hybrid and had faint tea-rose fragrance. Their chromosome number was never determined. These hybrids were then used as the pollen parents on the 30 chromosome species *odorata*. The resulting seedlings all had the intense carnation fragrance. The medium size flowers were much larger than *odorata* but varied in color from the clear, even, deep pink of Los Angeles to bright crimson. Some of these seedlings have produced seeds. Here seemed to be some interesting possibilities that should be pursued.

For anyone interested in the shorter stemmed gladiolus forms suitable for table decorations, the hybrids with the brick-red species *alatus* are truly beautiful. Using *alatus* as either pollen or seed parent with the *recurvus-tristis* hybrids give excellent results although they are not noticeably fragrant.

The foregoing description of methods and results have been illustrative of some of the plant breeder's "stock in trade" that at times have been acquired by devious and tedious trials over a period of years.

Fig. 7. Pink hybrid #95. Pollen parent garden variety "Los Angeles" and seed parent the hybrid *recurvus* x *tristis*.

Fig. 8. Crimson seedling #738 (Three species and a garden variety.) Pollen of seedling #95 on the species *odorata*. Has carnation fragrance.

Each project capitivates his interest and the future continuously reveals the success or failure of his planned combinations in a procession of living things. To see the results of several generations of genetic reassembling culminate in a flower of great beauty, in wanted color, size and form, brings an unforgetable thrill. All of this is quite fascinating and nice to reflect upon, however any comprehensive breeding program is usually dependent on commercial outlets for its existence. This has been the situation with our program which I have just described. Although it flourished and expanded during the years of depression, it could not withstand the war-time restrictions and rise in labor cost. The enterprise was devoted exclusively to the production of bulbs of freesia and related types. This required a large supply of hand labor at planting and harvest, and, to avoid diseased bulbs, the frequent shifting to suitable land with available irrigation. The strict restriction in the extension of irrigation, except for food production, and the shortage and cost of labor, forced the decision to abandon field production. This was done very near the end of the war in spite of a demand for our bulbs that was greater than the available supply. The growers that obtained the stock of our varieties, many of which were patented, were permanent residents of the area and bulb production was mainly a sideline to vegetable growing. The stock of several varieties of gladioli about ready for introduction were destroyed early in the war period and the stock of all other varieties reduced to the barest minimum to be increased for introduction after the war. This idea was quite a delusion because conditions favorable to our program have become worse during this so-called post war period. The present influx of Florida grown gladiolus blossoms for use by northern florists are now listed, not in dozens or hundreds, but by tons, therefore that potential market has changed. The continued rise in cost of fuel and labor has now dampened any idea of reentering commercial bulb production.

Each fall for the past five years it has been the decision to totally abandon the remaining aspects of the enterprise and to turn the space involved over to more profitable use. In spite of all those decisions, you will find that small house in a range of greenhouses otherwise entirely devoted to growing roses, planted with unnamed freesia varieties, freesia species, gladiolus species, and gladiolus hybrids to blossom again in an array of color and fragrance. With the memories of their past contributions and the thoughts of their war thwarted possibilities, *those captivating irids* "just naturally get under your skin and it is hard to let them go".

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