PLANT PROPAGATION QUESTION BOX

FRIDAY EVENING SESSION
December 5, 1958

The Plant Propagation Question Box Session of the Eighth Annual Meeting convened at 8:00 P.M Dr. Sidney Waxman, University of Connecticut presiding.

The transcript of this session of the annual meeting is not recorded in these Proceedings.

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SATURDAY MORNING SESSION
December 6, 1958

The meeting was called to order at nine-ten o'clock by President Steavenson.

PRESIDENT STEAVENSON. We are honored and privileged to have with us this morning as our panel moderator Mr. Albert G. Johnson, of the Department of Horticulture, University of Minnesota. Mr. Johnson is engaged in ornamental plant breeding at the new Minnesota Landscape Arboretum. Mr. Johnson.

MODERATOR JOHNSON: It is my privilege and honor to act as moderator at this session

Our first speaker, as you all know, is Dr. Karl Sax. I first became aware of Dr. Sax's name when I was in school. It was in a bibliography I was preparing on the subject of genetics. Later when I became interested in conifers, I saw his name in the bibliographies of articles on the morphology of these plants. Then I heard of him as an eminent horticulturist in connection with the work conducted at the Arboretum in Montreal He is president of the Genetics Society of America, and Professor of Forestry How many fields a man can be versed in I don't know, but apparently Dr. Sax has no limit Dr Karl Sax.

Dr. Karl Sax presented his prepared address on "Breeding Ornamental Trees and Shrubs ' (Applause)

BREEDING ORNAMENTAL TREES AND SHRUBS

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In some respects the breeding of ornamental trees and shrubs is easier than breeding crop plants. Woody plants can be propagated by cuttings or by grafting so that it is not necessary to produce homozygous segregates which will breed true from seeds For the same reason, it is

not necessary to produce a fertile hybrid, if fruit is no ornamental asset.

Some knowledge of genetics and cytology can be helpful. The plant breeder should have some knowledge of the breeding behavior of heterozygous and homozygous varieties, the inheritance of dominant and recessive characters and the cytological basis of hybrid sterility. In past years plant breeders wasted considerable time and effort in crossing commercial double forms of carnations to get new types, not realizing that these types are hybrids between worthless "bullhead" doubles and single flowered forms As a result they obtained only fifty per cent commercial doubles, whereas if they had crossed "bullheads" with singles they would have obtained 100 per cent commercial doubles

Often, however, the "shotgun" technique is adequate, especially if one is crossing horticultural varieties which are of hybrid origin Crosses are made and large populations are grown from which the desired types can be selected for vegetative propagation. In most cases we are looking for small segregates which bloom at an early age, so that the hybrid segregates do not need excessive space or time in the test plots

In most breeding systems it is desirable to control cross pollination. The first step is the prevention of pollination by insects, or by the wind, so that only the pollen from the desired male parent will function in the production of the hybrid. The anthers of the tree or shrub selected to be the female parent must be removed before the pollen is shed in order to avoid self-pollination Even when the species is self-sterile, the flowers should be emasculated and the petals removed before the flower opens to avoid insect pollination. In many genera the petals and anthers can be removed together by inserting the thumb nail below the sepals and pulling or breaking off the sepals, petals and the anthers in a single operation. Plants with conspicuous flowers are usually insect pollinated, and if the petals are removed the insects do not carry pollen to the stigma.

Flowers which are wind pollinated, such as the poplars, willows and conifers, must be protected from foreign pollen. This can be done by enclosing the female flowers with paper bags before the pollen from the male flowers is shed and removing the bags only long enough to pollinate with the desired pollen. This method has two disadvantages In the Arnold Arboretum the paper bags are vulnerable to small boys, especially those on hunting expeditions with BB guns. In the case of conifers, the removal of the bag to permit artificial pollination exposes the female cone to air borne pollen This can be avoided by injecting the pollen through a hole in the bag, but this method has disadvantages. A method developed by the foresters avoids some of these troubles. The female clones are enclosed in a polyethylene or paper bag a few weeks before normal pollination time. The heat within the bag hastens cone development so that it is receptive before the air is filled with pollen The male cones are forced in the same way so that pollen can be collected to dust on the female cones when they are receptive

Pollen can be collected from dehiscing anthers in the field early in the morning, but it is better to collect flowers about to open, spread them on a sheet of paper, or float them in a shallow pan of water, and collect the pollen the next morning Branches with flower buds about to open can also be brought indoors and will provide pollen the follow-

ing day. The pollen can be collected in small vials and applied with a small camel's hair brush, or the opening anther can be picked up with a pair of forceps and used to brush the pollen on the stigma.

Often it is necessary to store pollen if the blooming times of the parental species or varieties do not overlap The pollen of many species can be stored for long periods of time by placing it in a vial in a desiccator in a refrigerator. The vial itself can be made into a desiccator by putting some calcium chloride in the base of the vial and covering it with a disc of porous paper The pollen can be placed on top of the paper plug properly sealed, the vials kept under refrigeration will preserve the pollen of some species for as long as a year

Trees which mature their seeds rapidly can be crossed in the greenhouse by using flowering branches. Branches of poplars, willows, elms and some of the maples, when cut off just before the flowers open, and the stems kept in fresh water, will produce mature seeds when crossed in the greenhouse.

Often the trees and shrubs which bloom early in the spring set a poor crop of seeds due to injury by the cold weather We have had much better results in producing plum X peach hybrids when dwarf plants are planted in tubs and moved into a cool greenhouse at flowering time. The peaches and plums are dwarfed by budding them on *Prunus tomentosa* so that they can be more easily grown in tubs in the greenhouse.

Crosses between distant species or genera can sometimes be induced by use of a fruit setting hormone. Brock, working at the John Innes Horticultural Institute in England, was able to cross pears with apples by treating the cut calyx of the female flower with a fruit setting hormone, thus preventing the abscission of the flower before fertilization and embryo development occurred

In some cases fertilization may occur in species hybrids, but the embryo does not develop to maturity. In such cases embryo culture will save these embryos. Embryo culture in plant breeding was first used by Laibach in Germany and more refined techniques, using nutrient agar and auxins, have been used in this country.

In peach hybrids, the late Dr Blake of New Jersey used to extract the seed and culture it before it became dormant, thus getting a seedling the year the cross was made. A similar technique has been used in the breeding of roses in California by Lammerts. Taylor uses vermiculite for growing nectarine hybrids, and in the long season of California they become large enough to bud on a standard rootstock the same summer, thus speeding up the breeding program. Sphagnum is a good medium for growing the mature naked seed since it is a natural antibiotic and reduces danger of fungus infection.

A wide species hybrid may produce a viable embryo, but the young seedling may die at an early age or grow very slowly. This behavior was found by Brock in apple X pear hybrids, but when the hybrid was budded on either apple or pear it made better growth. We have had similar experiences with our plum X peach hybrids About 100 hybrids have been obtained during the past four years, but only three have survived on their own roots One of these was budded on *P. tomentosa* four years ago and on *P persica* three years ago. In 1958 the original

hybrid was less than a foot tall and very feeble at the age of four years. On *P. tomentosa* it was about 3 feet tall after three years, and on peach it was nearly 5 feet tall and reasonably vigorous at the age of two years after budding. Apparently some of the weak hybrids can be saved if propagated on suitable rootstocks.

This technique has also been used with lilac hybrids. The "Chinese" lilac, *Syringa chinensis*, is a hybrid between *S laciniata* from China and *S vulgaris* from the Balkans The cross is easily made and the hybrids make good growth the first year. In subsequent years they begin to die and after five or six years almost all are dead. Some of these weak hybrids can be saved by grafting them on *S. vulgaris* seedlings or on cuttings of established clones of *S chinensis*.

In some cases it is much more efficient to let the insects do the hybridizing. We have in the Arnold Arboretum a single specimen of *Syringa laciniata* surrounded by varieties of the common lilac *S vulgaris* Since the lilacs are largely self-sterile, most of the seeds set by *S laciniata* produce hybrid seedlings

About ten years ago we produced a hybrid plum involving *P. besseyi*. It is a very hardy plum with larger and better fruits than those of *P besseyi*. It was grown in a collection of other plums including *P. domestica, P. incana,* and other species The hybrid produced open pollinated segregates, among which were several with the vigor and leaf characters of the *P domestica* variety. Since the *besseyi* hybrid is a diploid and the Stanley is a hexaploid the hybrid should be a tetraploid, and preliminary somatic chromosome counts confirm this assumption. Hybrids between diploid and hexaploid plums have been made by artificial pollination in both England and Canada, but it is easier to let the bees do the work

Induced polyploidy is a useful tool in producing new types of horticultural plants. Tetraploid plants usually have larger and more deeply colored flowers than do diploids The chromosome number of diploids can be doubled by soaking the seeds in 0 1 per cent colchicine solution for a day or two, by treating the growing point of the seedling with the solution for several days or smearing the young seedling with a 0.5 per cent colchicine solution in lanolin paste The tetraploids may be of immediate horticultural value, such as the tetraploid snapdragons, but often their greatest value is in the production of triploids by crossing them with diploids

A tetraploid *Forsythia* was produced at the Arnold Arboretum nearly 20 years ago by treating a seedling of *F. intermedia* with colchicine. It has large, deep yellow flowers It was awarded the Lindley medal of the Royal Horticultural Society, but has not been very popular in this country because of its rather stiff growth habit. It was crossed with the diploid to produce triploids Of the several dozen progeny one was named Beatrix Farrand, in honor of America's leading woman landscape gardener. This triploid variety has very large flowers and vigorous vegetative growth. Another segregate is of more compact growth and with deep, orange-yellow flowers turned out to be a tetraploid This was unexpected since forsythia's are self-sterile. Perhaps polyploidy restored self-fertility and the tetraploid parent was accidentally self-pollinated.

The use of facultative apomicts permits the production of hybrids which breed true from seed. This feature is not important in horticultural plants which can be propagated vegetatively by cuttings or grafts, but it could be of great importance in developing "clonal" varieties of rootstocks which could be grown from seed and thus avoid the possibility of virus infection from infected rootstocks Apomixis is common in apples, hawthorns, cotoneasters and other *Pomoideae.* We have been using the facultatively apomictic *Malus sargenti* and the variety *rosea* in our breeding work This species and its variety normally produce 90 per cent or more of maternals, but hybrids can be obtained. The variety *rosea* is probably a spontaneous hybrid between the tetraploid *M sargenti* and a neighboring diploid, since it is a triploid.

Hybrids of *Malus sargenti* include a variety named "Mary Potter," one of Professor Sargent's daughters It is similar to *M. sargenti rosea,* but more vigorous Another hybrid, 33340, is a cross between *M. sargenti rosea* and *M. astracanica.* It has the growth habit of the mother plant, although larger, and has large, flat, pink flowers which are fragrant, but unfortunately the fruits are not attractive. This hybrid is triploid and tends to breed true from seed, indicating that facultative apomixis is dominant Some of the progeny are tetraploids, indicating that the unreduced egg cell may be pollinated by pollen from neighboring diploids. The tetraploids resemble the mother plant, but bloom a few days earlier and have larger flowers.

It is often desirable to obtain ornamental plants which bloom later in the spring in order to avoid early frosts. The Star Magnolia is a lovely plant with us, but too often the flowers are injured by cold weather. Crossed with a late flowering species, such as *Magnolia virginiana,* it should be possible to get segregates in the second generation which would have the *M. stellata* type of flower and growth habit and yet bloom several weeks later. Miss Renshaw, at the Arnold Arboretum, has been working on this combination for several years.

In order to combine the desired characters of two parental varieties it is often necessary to grow large numbers of segregates. If the hybrids require many years to come into flower and fruit, a breeding project can consume a lot of time and money. In order to speed up flowering of hybrid seedlings and to conserve space, many plant breeders graft the young seedlings into mature bearing trees. When they flower and fruit, the desired ones can be propagated and the others cut out and discarded

If mature plants are not available as nurse trees, the seedlings must be grown to the flowering and fruiting stage We grow the young seedlings in the nursery for a year or two and then transplant them four or five feet apart in rows ten feet apart. In more recent years we have tried to select the desired type in the nursery row, since we were primarily interested in small ornamental trees which bloom early. By culling out the very vigorous trees it is possible to keep them in the nursery with rows four feet apart, and the trees spaced two feet apart, for three or four years Scoring the stems of the larger trees can check growth considerably, but it does not hasten the time of flowering.

Certain varieties or species are superior to others as breeding stocks. Among the apples *Malus spectabilis* is the maternal parent of such out-

standing varieties as 'Katherine' produced at Rochester Park, 'Blanche Ames' produced at the Arnold Arboretum, and probably 'Dorothea,' a spontaneous seedling found in the Arnold Arboretum by Dr. Wyman. Among the flowering cherries *P. subhirtilla* has produced a number of interesting segregates, including the beautiful, small 'Hally Jolivette' cherry with its semi-double flowers and long period of bloom.

Conifer seedlings occasionally produce dwarf segregates of ornamental value. An outstanding example is *Picea glauca conica* In 1904 Professor J G. Jack of the Arnold Arboretum collected what he thought were seedlings of *P. albertiana* in Banff, Canada and sent them to the Arboretum One of them proved to be the juvenile dwarf which does not produce cones, but is easily propagated by cuttings. Some of the dwarf conifers, such as the dwarf *Pinus sylvestris,* produce cones and the seedlings are dwarfs. Nurserymen who grow large numbers of conifer seedlings should save the dwarfs and test them for their value as ornamentals

Mutations are the primary source of variation in plants and animals, but mutations are rare Mutations can be greatly increased by subjecting plants or animals to X-rays or other ionizing radiation. In the case of trees or shrubs the dormant scions can be irradiated with X-ray or neutron sources, which can not be transported to the field, and then grafted onto plants in the nursery or orchard. Granhall in Sweden, and Bishop in Canada have produced fruit color mutations in apples by such methods. We have a number of ornamental trees and shrubs growing in the "gamma field" at Brookhaven, but as yet no obvious mutations have appeared

Mutations can also be induced by treating the plant with radioactive isotopes. Solutions of radioactive phosphorus. P^{32}, are the best because it has a half life of only 14 days and emits short range radiation so that it can be handled in experimental work without excessive danger. It can be fed into a hole bored into the trunk of the tree or fed into a branch by slipping a corsage holder full of a P^{32} solution over the cut end of a young branch This work is also in the preliminary stage.

At best the production of new hybrid trees and shrubs requires many years Few seedlings will flower in less than three or four years and many will require five to ten years The selected types then have to be propagated by cuttings or grafts for further testing for size, growth habit, hardiness and adaptability This will require another five to ten years After the new variety is turned over to the nurseryman, it will require several years to build up stock for distribution. Thus it may take from ten to twenty years from the time the hybrid is made until it is available to the public The breeder of ornamental trees and shrubs should start his career early and live to a ripe old age.

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MODERATOR JOHNSON. I am sure Dr. Sax, after this most interesting talk, would be glad to answer questions. We have a few minutes, if there are questions on some of this material.

MR HANS HESS. Dr Sax, how has the tree "Hally Jolivette" been propagated, by budding, grafting or cuttings?

DR. SAX: We have propagated it very easily by softwood cuttings There is nothing to it You get almost 100 per cent take. You do have to be a little careful the first winter. It probably would be better to keep them overwinter the first year in a protective cold frame or pit. They will flower very early, sometimes when only two years old, from cuttings and almost invariably when three years old.

This would be the perfect plant to grow in containers. You can grow it in a rather small can and sell it in flower and double your price.

MR. J. C. McDANIEL (University of Illinois, Urbana, Ill.): Do many of these peach-plum hybrids have showy flowers? The only ones I have seen lost their buds before they opened.

DR. SAX. Ours have not flowered yet but I suspect that will be the case We have had crosses of *Prunus incana* and *P besseyi,* with nice vigorous plants and flowers, but no fruit The buds abort prior to flowering When you double the chromosomes you destroy some of the fertility If we can just get some of the *P. besseyi* blood into some of the peaches we would like that in the northern states

MR C. DeGROOT Dr Sax might be interested to know that we have had profuse flowering of the Arnold Dwarf forysthia.

DR. SAX. I suspect if we take our propagating wood from flowering shrubs they will flower earlier for us also. This is the old story of seedlings. They are very slow in coming into flower, but once they reach the adult stage they will come into flower very much quicker when vegetatively propagated

MR. JAMES WELLS: We are trying "Hally Jolivette" grafts. We find it flowers on the rooted cuttings and keeps on flowering from there on. It also grows beautifully in the can and has a splendid fall color.

What I want to ask you, Dr Sax, is what is the natural length of flowering time of this plant at Arnold Arboretum?

DR SAX· It depends on the season, but in most seasons it is good for at least ten days. Of course, it is usually fairly cool with us. This can be contrasted to *Prunus sargenti,* which is good for about two days.

MODERATOR JOHNSON. Our next speaker is one who needs no introduction to the majority of you. She has dealt with seed germination and seed germination problems for the past forty years at Boyce Thompson Institute Dr Lela Barton, Boyce Thompson Institute, Yonkers, New York

Dr. Barton presented her paper entitled, "Germination and Seedling Production of Species of *Viburnum.*" (Applause)

GERMINATION AND SEEDLING PRODUCTION OF SPECIES OF VIBURNUM

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Seedling production of the genus *Viburnum* has long been a problem. It has been discussed in the literature without any definite and satisfactory answer. Giersbach (2) summarized the work done up to 1937. As early as 1894, Jack reported "about seeds with a hard bony