

scion variety. Further, it appears the rootstock may exert its effect on scion hardiness by speeding maturity in the fall or by delaying bud break in the spring, as 'EM26' did, rather than by increasing scion hardiness by use of a rootstock which has the inherent capacity to become more cold resistant in mid-winter.

LITERATURE CITED

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MODERATOR PINNEY: Thank you very much, Harold. Are there any questions?

JOHN MCGUIRE: How long were the tissues held at the temperatures you mentioned?

HAROLD PELLET: They were just brought down to the temperature and then they were removed from the freezer. They were not held at this temperature.

CASE HOOGENDOORN: Are the dwarf rootstocks as hardy as your Minnesota seedlings?

HAROLD PELLET: No they are not, but 'EM 26' can be used quite successfully in Minnesota. 'EM 7' and 'EM 9' give us problems unless we mulch.

MODERATOR PINNEY: To continue this afternoon's program, we next have Dr. Elwin Orton who will speak to us on breeding woody ornamental plants.

HYBRIDIZING WOODY ORNAMENTALS

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The development of new and superior cultivars is the primary objective of the breeding program with woody ornamentals at Rutgers University — The State University of New Jersey. For the most part, the improvements sought are increased winter hardiness, increased resistance to insect pests, and improved foliage and fruiting characteristics and, in some cases, decreased plant size. Work is also being devoted to the development of plants that exhibit characteristics quite novel for the plant material in question.

The plant species currently receiving most attention in the breeding program belong to the genera *Ilex* and *Cornus*. The starting point of the breeding project with each species has been the initiation and maintenance of a cultivar performance trials. Such trials are important as they make it possible

to evaluate plants of the currently available cultivars under reasonably uniform conditions at one planting site and, thus, to assess the variability present within the cultivated plants of each species. The performance trials also provide parent material for hybridization and provide various standards of comparison for evaluating the seedlings resulting from controlled matings.

American holly, *Ilex opaca*, was chosen for first consideration in the breeding program as a performance trial of more than 200 named cultivars and/or numbered selections of this species was available as parent material. This collection had been assembled by the late Dr. Charles Connors. Evaluation of this plant material revealed tremendous variability within the species for a wide range of plant characteristics. This variability was to be expected since plants of the genus *Ilex* are dioecious; thus, cross-pollination is the rule.

The dioecious nature of the species simplifies pollination techniques and small plants are readily manipulated in the greenhouse to obtain controlled crosses. Plants are merely caged in the greenhouse to exclude insects and the pollinations are made by hand. The objective of intraspecific hybridization with plants of *Ilex opaca* is to develop clones that make vigorous growth, that are reliably winter hardy in U.S.D.A. hardiness zone 6b, that possess a dense self-compacting habit, that have dark green, glossy foliage which remains attractive throughout the year and that possess brilliantly colored fruit, well displayed on the plant. To date, crosses have been accomplished with 40 select plants in 150 different parental combinations; approximately 40,000 seedlings have been acquired for evaluation under field conditions where they are planted at a spacing of 5' x 5'.

Select seedlings from the first series of crosses are now approximately 12 feet in height, have been transplanted to the performance trials for further evaluation, and are being propagated for distribution to interested nurserymen.

Since it was felt that the ideal specimen-tree type of evergreen holly would be one which possessed a degree of winter hardiness equal to that of the better selections of American holly (*I. opaca*) in combination with the desirable foliage and fruiting characteristics of English holly (*I. aquifolium*), interspecific hybridization of plants of these species was initiated. Having obtained coincident periods of bloom of plants of the two species, thousands of hand-pollinations were accomplished using a select plant of *I. aquifolium* as the male parent. Female plants utilized in these crosses include the winter hardy cultivars, *I. opaca* 'Judge Brown', selected on the estate of the late Judge Thomas Brown of Locust, New Jersey, and *I. opaca* 'Hedgeholly', an excellent self-compacting, pyramidal type introduced by Mr. Paul Bosley of Bosley Nurseries, Mentor, Ohio. Despite the high degree of cross-incompatibility between plants of these species, flowering seedlings of the F₁

generation have been obtained. These plants are being utilized to obtain subsequent generations of seedlings which combine the desirable characteristics of both parent species.

Due to the seasonal publicity accorded English holly and American holly (*I. opaca*) during the Christmas season, plants of these species are very popular with the homeowner. However, plants of *I. crenata* undoubtedly constitute the hollies of most commercial importance in the Northeast. Intraspecific hybridization has been initiated with the objective of producing superior cultivars of various habits of growth that are reliably winter-hardy, that have dark green, glossy foliage which remains attractive throughout the year, and that possess mite resistance. A cultivar performance trial encompassing 5 plants each of 120 different named cultivars and/or numbered selections of this species has been field-planted. The plants are spaced 15' x 15' in order to provide sufficient room for each plant to develop its natural habit of growth.

One mating that has been accomplished on a large scale is that of *I. crenata* 'Convexa' x *I. crenata* 'Stokes'. Plants of the cultivar 'Convexa' have been very popular in the commercial trade due to their dark green, glossy, convex leaves and vigorous habit of growth; however, plants of this cultivar become too large for proper use in foundation plantings, develop brittle branches which break under the weight of a heavy snow, exhibit extreme discoloration of the foliage under heavy mite infestations or under the nutritional stress accompanying heavy fruiting, and are not reliably winter hardy in the colder areas of the Northeast. Plants of the male clone, 'Stokes', exhibit more hardiness than plants of 'Convexa' and develop a dense, self-compacting habit of growth, but the leaves are light green and lack gloss.

Approximately 21,000 seedlings resulting from a controlled mating of 'Convexa' x 'Stokes' were transplanted directly from 2¼" peat pots to field beds at a spacing of 9" x 9". Two years later, the surviving plants (ca. 18,000) were dug and critically examined. Plants exhibiting any signs of winter injury, poor foliage characteristics, heavy mite infestation, or a poorly developed root system were discarded. More than 6000 seedlings were retained during this initial screening and were field-planted at a spacing of 5' x 5' to permit later evaluations under relatively exposed conditions. Each spring these plants are sprayed with Sevin to reduce the natural predators of mites, and thus encourage heavy infestations of mites as an aid in determining the relative susceptibility or resistance of the plants. More than 100 plants have been selected from this planting for further evaluation and possible selection for propagation and testing at other sites.

Interspecific hybridization is being utilized in work designed to replace the inconspicuous black fruit of *Ilex crenata* with brilliant red fruit that add to the landscape value of the plants. Female plants of *I. sugeroki* and *I. yunnanensis* develop

red fruit and plants of both of these species are similar to certain cultivars of *I. crenata* in general foliage characteristics. Although neither of these red-fruited species is grown commercially, they are useful as a source of genes conditioning the red-fruit character. These species have been successfully hybridized with *I. crenata* as the first step in developing cultivars which possess the desirable characteristics of both parent species. A yellow-fruited clone of *I. crenata* which was introduced by the U.S.D.A. is being utilized in this work.

Both intraspecific and interspecific hybridization is being utilized to develop superior cultivars of *I. glabra*. The objective of intraspecific hybridization with plants of this species is to develop winter-hardy cultivars having a compact habit of growth with desirable evergreen foliage free from the purple mottling characteristic of many existing cultivars. Interspecific into plants of *Ilex glabra* type.

Unlike the evergreen species, the deciduous hollies have received relatively little attention from nurserymen or plant breeders. A performance trial of cultivars of *I. verticillata*, *I. serrata*, and *I. decidua* is being assembled and both intra- and inter-specific hybridization is in progress. This work was initiated with crosses of *I. serrata* x *I. verticillata* and two cultivars resulting from this work have recently been introduced under the names 'Harvest Red' and 'Autumn Glow'. The original plants of these cultivars are intermediate to the parent plants with regard to such characteristics as number, size, and gloss of the fruit, exhibit attractive fall coloration of the foliage, have developed a symmetrical vase shape, and appear to be more dwarf than is typical for either parent species. These cultivars are being propagated for release to interested nurserymen.

The most recent work with the deciduous hollies includes plants of *I. decidua*. The characteristic of importance in this species is the retention of the fruit in an attractive appearance throughout the winter months; fruit of *I. verticillata* and *I. serrata* are seldom retained on the plant beyond late December in the Northeast. Many selections of *I. decidua* have been made available to the breeding program by Mr. J. Bon Hartline, Hartline's Holly Nursery, Anna, Illinois. As is true for all hollies, the genetic variability within the deciduous hollies is ample for the needs of the plant breeder. Thus, the outlook for the development of improved cultivars through hybridization and selection is very good.

Two species of flowering dogwood, *Cornus florida* and *C. kousa*, are now receiving attention in the breeding program at Rutgers University. A cultivar performance trial has been established and both intra- and inter-specific hybridization has been initiated. The objectives of this work are the development of winter hardy cultivars that exhibit different seasons of bloom and growth habit, that develop large showy bracts of long duration, and that possess resistance to attack by borers.

Vigorous F₁ seedlings resulting from crosses of *C. kousa* and *C. florida* have been obtained and are being grown for further evaluation. Should these F₁ hybrids prove to be fertile, they will be used in subsequent crosses to incorporate borer resistance in cultivars of *C. florida* type, as well as to obtain plants of *C. kousa* habit, and intermediate types, that exhibit the red-bract characteristic. To increase the efficiency of this work, initial efforts have been directed toward developing lines that breed true for the red-bract character. Many matings of pink- or red-bracted cultivars of *I. florida* have proven to be incompatible but several parental combinations utilized have been cross-fertile and, judging from seedling characteristics, all of the progeny from these matings will develop red or pink bracts.

Breeding work with woody ornamentals that have a generation cycle of 3 to 7 years is, by definition, a long-range program involving extensive field trials and years of evaluation. Thus, it is appropriate that such work be conducted at state and federally-supported institutions that can insure continuity of the program. The development of superior cultivars of woody ornamentals through formal programs of hybridization and selection is relatively new, but the prospects for success are very good.

MODERATOR PINNEY: Thank you very much, Dr. Orton. We do have time for a question or two.

CASE HOOGENDOORN: I occasionally see ads for self-pollinating hollies; is there such a thing?

ELWIN ORTON: Not to my knowledge. What they are referring to are ones which will set parthenocarpic fruit; that is, they'll set fruit without seed. These fruit are normally smaller and drop sooner and are usually less pigmented than fruit which contain viable seed. There are, however, no self-pollinating hollies; the sexes are separate.

BILL FLEMER: Can you cross *Ilex yunnanensis* and *I. crenata*?

ELWIN ORTON: Yes, we have hybrids of these. In fact, we're finding that many of the species which one would not expect to cross will do so. For example, I have hybrids of *I. glabra* and *I. serrata*.

VOICE: Have you done any work with *Ilex pedunculosa*? Plants of this species grow well for us in Canada.

ELWIN ORTON: No. We have not initiated intraspecific hybridization with *I. pedunculosa* as this is not commercially important in the Northeast. Plants of this species might be considered useful in interspecific hybridization since they exhibit considerable winter hardiness, but research by Dr. John L. Frierson indicates a somatic chromosome number of 110 for *I. pedunculosa*, whereas the commercially important species, such as *I. opaca*, *I. aquifolium*, *I. cornuta*, *I. pernyi*, and

I. crenata, reportedly possess 40 somatic chromosomes. Thus, it is unlikely that *I. pedunculosa* would be cross-compatible with any of these other species.

PETER VERMUELEN: Have you tried *Ilex rugosa*?

ELWIN ORTON: Yes, I have that crossed with *I. x aquipernyi* and have crossed it with plants that are hybrids of *I. cornuta* and *I. aquifolium* and several others. Most of the plants are not very vigorous however.

MODERATOR PINNEY: We thank you again, Dr. Orton. At this time I'd like to introduce Mr. Al Fordham of Arnold Arboretum who will take over the next segment of the program on new plant introductions.

AL FORDHAM: As Tom mentioned, we now come to that part of the program that deals with new plant introductions. I would like to remind you of the regulations dealing with the showing of new plant introductions; that is, each exhibitor shall be prepared to furnish propagating material at the proper time for each plant material to any member who makes a request. Commercial members will be allowed to sell plants to any interested member. At the end of the session there will be a few slides which Dr. Mehlquist and Mr. James Wells will show which are just for the opinions of the members with respect to identification, possibilities, etc. Our first exhibitor will be Mr. Joe McDaniel of the University of Illinois.

'GRIFFIN' EVERGREEN MAGNOLIA

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Seedlings grown as *Magnolia grandiflora* are a variable complex. In the opinion of the first author, this variation is, so far as horticulturally superior forms are concerned, in large part associated with long-continued introgression of *M. grandiflora* by *M. virginiana australis* in areas of the southern U. S. coastal plains where their ranges overlap. A high proportion of the new and old select cultivars of *M. grandiflora*, including the 'Exmouth' which has been propagated for 230 years, have characteristics, particularly in their foliage, resembling those of indisputable hybrids such as 'Freeman' and others bred since 1930.

The distinctive clone now offered as 'Griffin' is believed to be the result of chance hybridization. It is probably a later-generation hybrid, which appears to be fully fertile, unlike the known F₁ hybrids between diploid *M. virginiana* and hexaploid *M. grandiflora*, which are often highly sterile.

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