REPORT OF TECHNICAL COMMITTEE V.

TREE BREEDING

This year's report consists of two parts--a summary of current tree breed ing activities in the Northeast prepared by Dr. Graves and a list of reco- mmdations for people desiring to exchange pollen.

We have just started on the other tasks assigned us. Before preceedng further, we want to learn the reactions of the conference as a whole. For example, the preparation of a list of available bree ding material in the North- east is a monumental task if we are to cover all species and genera completely. A short, incomplete list would be almost useless to those likely to be engaged in active cortrolled pollination operations in the next year or two, since most of these people already have their major sources of breeding material al- ready in mind. On the other hand, if we can decide, in collaboration with other subcommittees, on one or a few major species or groups of species on which intensive work will be done by a member of agencies, we can make complete lists which will be worthwhile. Too, the preparation of breeding plans can only be done on individual groups in which the selection work and racial studies are considered at the same time as the breeding work.

This subcommittee feels that in many respects it would be better to organ- ize the subcommittees by species or genera than by lines of work such as selec- tion, racial studies, breeding, etc. As an example, it now appears that the development of a variety of white pine resistant to the white pine weevil will entail evaluation of weevil resistance in exotic white pine species, inter specific hybridization, selection and crossing of individual trees with varying resistance to weeviling, studies of resistance to weeviling in different races of eastern white pine, grafting of individual trees, and the field testing of many types of progenies.

Tree Breeding Now Under Way or Projected in the Northeastern Section of the U.S.

The records which follow are derived fron a questionnaire sent out in June of this year, 1954. The term "tree breeding" has been construed, by the conference to mean sexual breeding, i.e., by cross pollination. But, of course, selection, i.e., choosing the best individuals of a population is a necessary adjunct of breeding by cross pollination: in fact, it is hard to separate these two forns of breeding. The breeding by natural selection where, for example, man or animals naturally select the best fruits and thus disseminate their seeds, has been going on for ages, with what spectacular results we all know. How different is a modern "eating apple" from a wild crab? And so we have included in our report some of the work that is being done along the line of selection and also some fundamental studies leading to a better understand- ing of tree genetics; this in addition to the work which is concerned mainly with cross pollination.

The institutions or agencies sponsoring the work are taken up in alpha- betical order.

Boyce Thompson Institute for Plant Research, Inc., Yonkers N. Y. During the past five years, most of the forestry work has been on provenance tests and propagation methods or elite trees of larch. Dr. Clyde Chandler is in charge.

A small cross-pollination program has been carried on, using elite trees of L. decidua (European larch); L. leptolepis (Japanese); L. lep tolepis var. murrayana, L. laricina (American larch); L. gmelini (Dahurian larch); L. occidentalis western larch); and the hybrid L. eurolepis (European x Japanese). They have about a thousand hybrid seedlings which involve various combinations of selected trees of the above species. They are testing about 500 hybrid seedlings obtained from seed produced at the Horsholm Arboretum in Denmark.

They plan to include in this program some studies on the periodicity of flowering and its inheritance. They have induced tetraploidy into seedlings of L. decidua and L. leptolepis by soaking seeds in aqueous solutions of colchicine.

Cabot Foundation, Petersham, Massachusetts. Forest-tree genetic research was first formally recognized at Harvard University with the establishment of the Maria Moors Cabot Foundation for Botanical Research in 1937 by Dr. Godfrey L. Cabot of Boston. Since that time, a number of basic studies have been undertaken, employing the valuable botanical collections or research facilities afforded by other units of the University, especially the Arnold Arboretum, Bussey Institution, Harvard Forest, and the Biological Laboratories. The principal lines of investigation upon which the attention of the Cabot Foundation is focused in the field of forest genetics include: (1) studies of natural variability in various physiological and morphological characteristics of the following genera: Populus, Pi nus, Quercus, Betula, and Acer; (2) inter- and intraspecific hybridization studies, and tests of such hybrid progenies; (3) testing of rious hybridizing techniques and methods for the induction of early flowering; (4) asexual propagation; (5) studies designed to determine the degree of correlation existing between the expression of certain juvenile and adult characteristics in trees; and (6) disease and insect resistance investigations.

Connecticut Agricultural Experiment Station, New Haven, Connecticut. A study of the genetic variation and ecology of eastern hemlock, Tsuga canadensis, is now under way. In a preliminary indoor study of the effects of daylight and temperature on the growth of hemlock, it was confirmed that a short pre-chilling is normally necessary for the species to break seed or bud dormancy. Long day - short night conditions were necessary to keep the seedlings from returning to dormancy. Plants grown at night lengths of 12 and 16 hours went into dormancy about 60 days after growth was initiated, whereas the plants growing at 4 hours of darkness remained active for 180-200 days and elongated most of all. Both continuous light and 8 hours night length resulted in intermediate growth.

The studies were most restricted to a local seedling source. A larger study of racial variation involving some thirty different seed collections from the entire range of the species is now under way.

Dr. Hans Nienstaedt and Dr. Jerry S. Olson, who are doing this work, would Like any information pertaining to the racial or individnal variation within the species, or to the ecological responses of the species under different climatic conditions. They would like to know of exceptionally good stands or individuals of hemlock and of the occurrence of natural sports. Offers of help in the collection of seed and/or pollen from all species of hemlock will be appreciated.

Under the sponsorship of the Brooklyn Botanic Garden, a chestnut tree breeding program was commenced by A.H. Graves on the Sleeping Giant Mountain in the spring of 1926. The primary object was to develop a blight resistant

chestnut of tall, timber type to replace the practically defunct American species. This was to be done by breeding together the more resistant, but lower-growing oriental species with the blight susceptible, tall growing American species. A secondary object was to produce good blight resistant nut-bearing hybrids.

In 1947, the Connecticut Agricultural Experiment Station took over the sponsorship of the work. Dr. Hans Nienstaedt of the Genetics Department of the Station is now in charge, with Dr. A. H. Graves as consultant. Control poflinations have been carried on now for 25 years, and many hybrids including some new to science have been developed. It has been found that, in general, chestnut species and varieties can be crossed with ease. Five of the best hybrids are being described by Dr. Graves in a forthcoming bulletin.

Harvard Forest, Harvard University, Petersham, Massachusetts. Dr. Wang Chi-Wu reports that the forest genetics experiments include racial tests (white birch and red maple) and inter- and intraspecific crosses of birches.

University of Massachusetts, Amherst, Massachusetts. Professor W. L. Doran is propagating white pines vegetatively from elite individuals.

Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. The following notes indicate the breeding work which has been and is being done.

Betula. Various species crossed--1938-40 and in 1949. Much information gained about technique. White crossed with black seems promising.

Liriodendron. Crossing in 1940 and 1948-52. Interracial hybrids. Fifty planted specimens of the Chinese sp. have not thrived: Central States Station has extensive breeding program.

Quercus. Interspecific crossing, 1937-41 and 1947-48. Alba x Robur and borealis x velutina obtained but showed no special promise. Technique difficult.

Acer. 1937-41 and. 1947-52. Interracial crosses of red and sugar maple made recently. Much learned about flowering conditions.

Fraxinus. 1937-40 and 1947-51. "There seems little future in interspecific hybridization and we are now concentrating on studies of ecotypes and crosses between ecotypes." Much information has been collected. on flowering conditions and technique.

Populus. Present work is testing of clones of hybrids made in 1924-26. In 1940 and 1950 tried making F2's and also back crosses to P. deltoides. Conditions for propagation of control-pollinated seedlings carefully worked out.

Pinus. "In the periods 1937-41 and 1947-54 we have stressed (1) determination of crossability patterns in the white pines, (2) determination of crossability patterns in the series Lariciones, (3) mass production trials of certain Lariciones crosses, and (4) interracial crosses in eastern white pine."

Picea. Interspecific crosses made in 1940 and 1948-54. Crossability pattern determined resulting from 69 hybrid combinations. Few technique difficulties. Time of receptivity easily determined and pollen stores well for a year.

Rutgers University, New Brunswick, New Jersey. Professor Richard. F. West of the Department of Forestry states that they are breeding holly for ornamental purposes.

State University of New York, College of Forestry, Syracuse, New York. 1000 three-year old white pine seedlings are being tested for rust resistance. These come from apparently resistant parent stock, but are results of open pollinations Dr. Ray Hirt is in charge of the work.

U. S. Plant Industry Station, Section of Fruit and Nut Crops, Beltsville, Maryland. The chestnut breeding work is continuing with emphasis on (1) making new crosses between the surviving American chestnuts and selected Chinese chestnuts, (2) intercrosses between Chinese-American hybrids, (3) back-crosses of Chinese-American hybrids with selected Chinese chestnut trees, (4) crosses between selected Chinese chestnuts. The object is to obtain disease resistant chestnuts for forest, wild-life, orchard, and ornamental plantings. Many progenies will be tested for resistance to chestnut blight and Phytophthora root disease by innoculation. Progenies of large surviving American chestnuts are being grown. Frederick H. Berry is conducting the chestnut breeding, with Richard. H. Day and G. Flippo Gravatt working on some phases. Jesse D. Diller is continuing the testing of certain chestnut hybrids in Forest Service plantations.

Crosses between English walnut and black walnut are being made and a survey of such existing hybrid trees is under way. Progenies of hybrids are under study. Different species and selections of hickory are being intercrossed on a small scale. The hickory and walnut work is being conducted by John W McKay. The nut work of the section is under the general direction of Harley L. Crane.

Vermont Forest and Farmland Foundation, Inc., West Rupert, Vermont. William H. Meyer, Executive Director, states that selected material furnished by such groups as the Cabot Foundation has been planted and that they would like to do more of this (Field Trials) if deer browsing does not continue to be a severe problem. They have collected seeds and similar material and would continue to help other groups and agencies in this manner. They would also like to help in the locating of promising strains and individuals.

Recommendations for Pollen Exchange

Where to Obtain Pollen. The Arnold Arboretum, Jamaica Plain, Mass.; New York Botanical Garden, Fordham P. O., Bronx, N. Y.; Brooklyn Botanic Garden; Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y.; Rochester Park System, Rochester, N. Y.; Morris Arboretum, Chestnut Hill, Philadelphia 18, Pa.; and the Mont Alto Forest School, Mont Alto, Pa., have excellent collections and can together fill about 90 percent of the probable requests for species' pollen for use in interspecific hybridization. The states of New Hampshire and New York (Scotch pine, Norway spruce, red pine), Pennsylvania State University (Scotch pine, douglas fir), and the Harvard Forest (aspen, eastern cottonwood) can supply breeding material of several geo graphic races of known origin. As yet, there are virtually no sources of pollen from elite trees within the region; the person doing the crossing work must also make his own selections. For most interracial crosses, it is necessary to contact foresters living in the desired areas. Many tree breeding members of this Conference have foreign contacts and can supply names of foreign corres pondents in Canada, Europe (outside Iron Curtain), Australia, Japan, and South Africa.

Timing Relations in Obtaining "Foreign" Pollen. In 1954, eastern white pine had the following flowering dates:

North Carolina,	1500 feet	Day 1
eastern Pennsylvania,	700 feet	Day 6
eastern Pennsylvania,	[illegible]00 feet	Day 19
central New York		Day 15
northern Wisconsin		Day 29

In having pollen shipped in, allow about 3 days transit time; in other words, obtain pollen from a locality 3 days earlier than your own. Except for yellow-poplar, our native tree species remain in bloom for only 3 or 4 days; it is not usually possible to avoid timing difficulties by using the later flowers on a tree.

Pollen of most elms, poplars, willows, maples, and birches can be forced by as much as 2 or 3 weeks if cut branches are brought into a cool greenhouse and placed in water 2 or 3 months ahead of time, the pollen being allowed to shed onto waxed paper. The longer the period of forcing, the more difficult it is to keep the branches alive. It is usually surer to graft the cut branches onto potted greenhouse plants. Ash, oak, pine, and spruce force with difficulty.

Spruce pollen can be stored very successfully for a year in a refrigerator at about 25 percent relative humidity. Pine pollen so stored usually germinates well but gives poor seed sets. Recent tests with fruit tree pollens show that yearlong storage in the deepfreeze with relative humidity uncontrolled is promising for many genera. It is successful in pine, but has not yet been tested in other forest trees.

In most breeding work so far, it has been necessary to use as females the later blooming trees or species.

Collecting and Extracting Pollen. For conifers, collect nearly open catkins they should be mealy rather than juicy and should show some evidences of opening naturally; if collected more than 1 or 2 days ahead of time, they fail to open), place on paper in a draftless room, allow to open for 1 or 2 days, sieve to remove coarse debris. The extracting and shipping time can be combined by placing small quantities (not over 1 catkin deep) in sausage casings which are mailed in ordinary envelopes. This is especially desirable if time is at a premium. The secret is to include few enough catkins that they will dry out rather than mold en route. Collecting is wasted effort if the catkins are more than 50 percent shed when collected.

Most hardwood pollens are best extracted from cut branches placed in water and allowed to shed over paper; usually some brushing or shaking is necessary to dislodge pollen. Most hardwoods shed small quantities of pollen.

In insect pollinated basswood, Norway maple and yellow-poplar, pollen is produced in small quantities. It is better not to extract the pollen; rather, flowering branches in the field, using freshly opened anthers as pollinating brushes. This procedure is mandatory in yellow-poplar, whose pollen is very shortlived at ordinary temperatures.

There seems to be little danger of contamination from extracting 2 or more lots of pollen in the same room, even when placed only 2 or 3 feet apart. This danger may be entirely eliminated by the use of pollen extractors (conifers only) which consist of porous canvas bags emptying into a glass vial through a sieve. Simpler extractors may be made of sausage casings; in emptying the pollen into a vial, the constricted neck of the casing acts as a sieve. Any extractor should be loosely packed.

Shipping of Pollen. Cut branches are usually shipped ahead of time at a cool time of year; they may be shipped via express or ordinary mail. They should be packed in moist sphagnum and placed in a polyethylene bag; dried out branches are useless. Have such shipments inspected.

Extracted pollen is best shipped in a sausage casing in both ends of which cotton is inserted prior to stapling to prevent leakage. The casings are light

enough to be shipped via air mail for 6 cents. Do not ship in polyethylene bags or other impervious materials. Label the outside of the envelope "POLLEN" so that it may be refrigerated on delivery and hurry the shipment as much as possible.

Unextracted conifer catkins should be packed very loosely in sausage casings, enclosed in an ordinary envelope (so that they may dry en route), and shipped air mail.

Special Points to Remember. Most foresters are quite unacquainted with tree flowers and require descriptions of male and female flowers as well as of flowering stages and phenology if they are to serve as useful collaborators.

Experienced tree breeders knowing just where and when to obtain pollen can usually fulfill a single request in from 1 to 2 hours. Cooperators with 1 year's experience in collecting pollen require from 1 to 6 man hours to fulfill a single request field foresters collecting pollen for the first time require from about 4 to more than 18 man hours to fulfill a single request; much of this time is spent in searching for trees of the species desired and in periodic examinations of the progress of flowering. People requesting pollen can shortec the time involved by addressing only cooperators known to have convenient material and by including material on phenology which will keep periodic examinations to a minimum.

J. W. Wright, Chairman
A. H. Graves
Clyde Chandler
A. G. Johnson