ADVANCES IN HARDWOOD TREE IMPROVEMENT

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ABSTRACT.--Hardwood tree improvement has advanced significantly both as to number of species being studied and numbers of workers involved. Significant advances cited ;were the adoption of hardwood research by Industry - University cooperatives, and the organization of the Genetics of Urban Trees and Metropolitan Tree Improvement Alliance Groups. Important questions in the field of silviculture of treatment of hardwoods must be answered before the use of genetically improved hardwoods will be feasible.

TWENTY-FIVE years ago - 1955 - the Third Northeast Forest Tree Improvement Conference convened at Cornell University (Schreiner, 1956). A look at the program gives us the following fare. Jesse Diller reported on screening American Chestnut for blight resistance. C. Heimburger discussed blight resistance in white pine. Robert Zabel presented a paper on decay resistance variation in northeastern species. Jonathan Wright presented a report on a Scotch pine provenance test followed by Henry Baldwin with winter color in Scotch pine. Frank Santamour discussed hermaphroditism in Poplars. Robert Echols covered sporogenesis in hemlock and Bill Gabriel presented a paper on clonal differences in the wood and phloem of two populus species. Ed Wollerman talked about borer resistent black locust and Ernst Schreiner gave a report on his Pinus sylvestris reconnaissance in Spain. Svend Heiburg discussed silviculture in relation to forest tree improvement and Francois Mergen told us how much improvement we could expect from genetical methods. The meeting closed with three papers by Ehrhart, Giddring and McLintock covering the applied aspects of tree improvement.

Four of the 15 papers dealt with hardwoods. At this NEFTIC there are 11 of 26 papers concerned with hardwoods. I would say that that is one indication of an advance in hardwood tree improvement. Twenty-five years ago about the only hardwood species of commercial importance being improved were the poplars. Today there are a number of hardwood species in active breeding programs, another significant advance.

Although there were many research stations both federal and academic which included hardwood studies, I believe that the most significant stimulus to hardwood tree improvement occurred in the late fifties when papermakers found that they could include a percentage of the then, inexpensive hardwood pulpwood in the furnish and still make excellent paper. This soon led to overcutting of the better hardwood species and once hardwoods were a desirable part of the mill furnish, it was inevitable that artificial regeneration would become necessary and that tree improvement efforts would follow.

In 1963, the well-known Cooperative North Carolina State Industry pine program under Bruce Zobol was expanded to include hardwoods (Anon, 1964). Ten cooperators provided the initial stimulus. Since there was a dearth of silvicultural information for the southern hardwood species, their first goal was to complete silvicultural studies in the following priorities.

1. Site Index
2. Comparative Site Indices among Hardwoods and Pines
3. Hardwood Nursery and Planting Studies
4. Tree Improvement and Hereditary Variation
5. Natural Regeneration
6. Timber Stand Improvement Methodology.

Sweetgum (Liquidambar styraciflua) was the species most important to the early cooperators. Earliest seed orchards were planted to yellow poplar (Liriodendron tulipifera), sweet gum, tupelo gum (Nyssa sylvatica) and red maple (Acer rubrum).

By 1977, the Hardwood Cooperative listed 18 members, and with Zobel's semi-retirement became a separate entity under Robert Kellison. Although they have been and are working with other species, their main emphasis is on sweet gum, sycamore (Platanus occidentalis), the water-willow oak complex and green ash (Fraxinus pennsylvanica) (Pers. Comm., Talbert 7-1980).

A noteable shift in the direction of the North Carolina State hardwood program was initiated in 1977 (Anon, 1977). Studies of natural regeneration, and its management were to be emphasized. This direction change did not preclude plantation management, but was to complement the use of site preparation, and artificial regeneration in establishing stands with desirable species composition at appropriate densities.

A second important advance in hardwood genetics was occasioned by the recent trend to urban forestry and the Consortium for Environmental Forest Studies. This sent up a framework under which a working group for genetics was organized by Henry Gerbold. Titled "Genetics of Urban Trees," but better known as GUT, this group developed a problem analysis and working plan under which were enumerated several high priority research objectives leading to the development of high quality trees for urban use. These are:

1. Performance testing of cultivars
2. Introduction of cultivars from other countries
3. Research for optimizing improvement programs
4. Assembling germ plasm of important species
5. Conducting breeding programs
6. Developing selection methods for tolerance of urban stress
7. Improving methods for vegetative propogation of superior cultivars.

Individual projects have been prepared under the umbrella of these objectives. Obviously, the GUT program does not limit the species which can be studied to hardwoods, but since the majority of the trees in the urban environment are shade trees, broadleaf species will predominate in this program.

A corolary group, the "Metropolitan Tree Improvement Alliance" or METRIA has the development of better trees for metropolitan landscapes as its goal. Again the emphasis is on shade trees and therefore broadleaf species. This group brings together geneticists and commercial nurserymen and promises to be a factor in the development and release of tree species specially designed for ornamental and shade use in the metropolitan or urban environment.

Both GUT and METRIA bring a new dimension to forest genetics. It is appropriate for the forester to become functional in the breeding of urban trees and in the development of ornamental arboreal propagules. Although breeding criteria may differ, breeding and testing techniques are similar, to a point. Real differences in forest and urban tree production appear only after the breeding work is done when the final product is marketed. Even here, it is basically a difference in value due to the final crop, numbers produced and time in nursery production.

Among the advances in program development, that of the Cooperative at Texas A & M University must be added. Hardwoods were added to this program in 1963 when the first cottonwood (Populus deltoides) selections were made (van Buijtenen, 1963). In 1969, the hardwood program was expanded to include sweet gum, sycamore, green ash and cherrybark oak (Quercus falcata var. pagodiglia) (van Buijtenen, 1969). In 1970, a cooperative effort was initiated with hardwood forest trees, and in 1973 (Anon, 1973) a unique cooperative effort was initiated when representatives for 10 cities in Dallas county met to discuss urban tree improvement possibilities. As a result of this meeting, work with Shumard oak (Quercus shumardii) was begun. This is the first time I believe that urban arborists have joined the forest geneticists in identifying a species for improvement efforts. Identifying the previous programs as what I consider landmark changes in hardwood tree improvement in no way reflects on the importance of any other effort. These simply seem to be points at which conceptual changes have occurred.

With the great number of hardwood species which could be selected for improvement, choice of species for concentrated efforts becomes a formidable problem. Several attempts have been made to formalize a selection procedure, probably best represented by Farmer's paper (Farmer, 1973). Thor also addressed this problem in a presentation at the Southern Forest Tree Improvement Conference, classifying the native hardwoods into four urgency groups.

1. Real urgency which is recognized
2. Real urgency which is not recognized
3. No real urgency, but has geen recognized as urgent
4. No real urgency and has not been recognized as urgent.

He recognized as urgent southern work with the poplars, sweet gum and sycamore because of real shortages and the heavy use of the species by the pulp industries. In group 2 as urgent but unrecognized, he places American Chestnut and black locust. It is in group three, the no real urgency but has been recognized as urgent, that he places yellow poplar, using his own seed orchard as an example. Here he notes that yellow poplar is abundant, long lived, and in low demand currently. He, therefore, suggests that the superior phenotype-clonal orchard approach is unnecessary and in fact inefficient. With species in this category, it would have been better to have taken a different approach – e.g. provenance studies to characterize the genetic variation in the natural population followed by development of genetic strategies for first generation breeding (Thor, 1977).

I find it hard to disagree with him. I hate to think of the numbers of hours – and dollars we spent looking for superior trees of several species with the intentions of starting clonal seed orchards, only to find that contrary to early expectations, the seed was not needed, much less needed urgently. Our time would have been much better spent establishing provenance studies and/or half sib progeny tests in those species.

The various regional genetic committees, S-23 in the south, NE-27, in the northeast and NC-99 in the central states provide an ideal framework for investigating range wide variation. Each of the three have provenance studies with species important to their areas. The following species appear in the annual reports and project outlines.

S-23	NE-27	NC-99	
Sweet Gum	Black Alder	Green Ash	Red Oak
Yellow Poplar	Black Walnut	White Ash	Pin Oak
Sycamore	Black Cherry	Basswood	White Oak
Oaks	Green Ash	Paper Birch	Hackberry
red	Pin Oak	Yellow Birch	Honey Locust
cherrybark	Yellow Birch	Cottonwood	Red Maple
water	Sweet Gum	Elms	Silver Maple
willow		Black Walnut	Sugar Maple
			Sycamore
			European Alder

Under the regional framework, seed collection, seedling production and plantation establishment can be facilitated and several widely separated plantations can be established to do a better job of evaluating species response to varying environmental conditions. Thus, species-site interactions can be delineated, or the fact of the absence of species-site interaction can be established. Once this information has been gathered, half sib tests can be undertaken, followed, when appropriate, by selection and seed or clonal production of desirable selections.

I have deliberately avoided mentioning the rather extensive work being done with a number of species, for example, black walnut, black cherry, sweet gum, sugar maple, the birches, yellow poplar and the ashes. While these are contributing to the advances in genetic knowledge of the various species, and this of course is important to the eventual development of breeding strategies, they do not generally add to the use of genetically improved material in silvicultural and management procedures. This work does not come to fruition until the genetically improved material gets to the field. In our NE 27 meeting Monday, a number of you joined in a discussion whigh might have been titled "We now have genetically improved seed from species X! So What!" It's nice to have the seed, but until it will be planted it is useless. Unfortunately very few hardwoods are being planted. There is not much demand, even for hardwoods that will grow more timber faster. Jack Winieski told us that Pennsylvania is decreasing the number of hardwood seedlings being grown because they do not feel justified in producing seedlings of species when they cannot advise their customers as to the best method of site preparation and planting. Hardwood silviculturists are absorbed in studies of natural regeneration and are not even considering artificial regeneration. They, with few exceptions, are convinced that natural regeneration is sufficient for most situations. Artificial regeneration with hardwoods is too difficult and too expensive.

So - after outlining briefly some advances in hardwood tree improvement concepts, and recognizing that there is much work being done with gathering of genetic information for hardwoods, let me itemize a few problem areas which together prevent the use of genetically improved hardwood material. 1) Can we produce good planting stock? I think we can, at least we're far enough along in nursery techniques that it would take little time to produce such stock. 2) Is containerization a viable means of producing better planting stock? In spite of some negative comments concerning containerization, I believe that we can produce larger, better planting stock and can extend the planting season if we use the larger containers. 3) How can we site prepare for hardwood planting given the terrain conditions in much of the best hardwood areas? How specifically do we handle the prolific and vigorous stump sprouts left after clear cutting? What about possible allelopathy as shown by mortality of black cherry seedlings planted in bracken fern? What grass species can be tolerated and which are allelopathic? What tree species are allelopathic to other tree species? Are seedling trees in fact, better formed than sprouts? 4) What is the cause of the die back following planting of most hardwood seedlings and how can it be prevented? We can top prune and still have as much first year growth as on unpruned seedlings and the pruned seedlings appear to be healthier at the end of the first growing season. But if early height growth is important, then we must learn how to prevent die back so that we can take advantage of all the nursery growth. 5) How do we handle competition that comes in after planting? Can we find a really selective herbicide. 6) How do we prevent browsing? We cannot erect deer proof fences around our plantations. 7) We need to sharpen specific selection techniques. Getting the right species in the right site is extremely important with the hardwood species. We need growth and yield data from plantation grown material. 8) What is the effect of pollution on species which might be planted? 9) Vegetative propogation. 10) Clone identification.

All of this information is silvicultural in nature, but the silviculturist is not going to get it. He has enough problems of his own. Which leaves the problem squarely in our hands.

Who will finance the research? There will be insufficient funding until companies with large land bases and huge lumber and fiber appetites become interested, or until it is recognized that problems exist which can be solved best or only through genetic manipulation of hardwood species. In general, the hardwood geneticist is handicapped because his clientele in the hardwood region generally is made up of small sawmillers who own little or no land, furniture companies who believe that lumber comes from boxcars, and many small land owners. Until we can demonstrate that some of these problems can be solved, hardwood tree improvement will be generally of the fact finding nature. Until we demonstrate that a planted stand of genetically improved seedlings is superior to a natural stand regenerated from sprouts and occasional seed and until we demonstrate that the artificially regenerated stand is economically superior, there will be little use of our improved material.

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