Populational Differences in Survival Patterns of Sweetgum

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Abstract

Exposure of progeny from 6 different populations of *Liquidambar styraciflua* to climatic conditions of south-central Kentucky for a 2-year period indicated different survival rates between the populations. Populations from sites of origin outside of a general latitude range of 34–37° N. Lat. showed very low survival values in a transplant garden near Bowling Green, Kentucky.

Introduction

In recent years, studies in the interactions of a species to its environment have shown that even though a species type may be morphologically identical throughout its geographical distribution, the species may show different populational patterns in regard to a population's response to the conditions of a selected habitat. In studies of plants, one of the first indications of such genetic diversity was by Turesson (1922), where reciprocal transplanting of different populations of several herbaceous species led to the development of the ecotype concept. Following his work, a multitude of experimental ecologists have documented the fact that ecotypes are populations of a species genetically adapted to a given habitat. The most recent review of scientific literature by Hiesey and Milner (1965), concerning experimental evidence of the evolution of genetically different populations of a species, indicates that selection of genetic variants of a species is the rule rather than an exception. Academically, such knowledge has been valuable in answering questions of how an organism survives in its habitat, and has led ecologists to move away from emphasis on studies of what is located where. Due to man's influence on environmental quality as well as quantity in the last few years, serious questions have arisen about conservation practices that may require answers developed from the knowledge of just how much genetic diversity is present in a species type. It is the purpose of this report to show that experimental knowledge of ecotypes in a species type may be utilized in a practical application to show the value of retention of populational diversity.

Acknowledgments

Special thanks are due Dr. R. D. Williams, Jr., who aided in the planting of the various populations.

Materials and Methods

From January to March 1969, 1-year-old seedlings of sweetgum *Liquidambar styraciflua* were supplied by Forestry Departments of Ohio, Illinois, North Carolina, Kentucky, Mississippi, and Louisiana. Upon arrival in the labortory, the packaged seedlings were stored in the dark in a cold room maintained at a constant temperature of 4 C to prevent bud bursting before planting. The various forestry departments indicated the source of the seeds from which the seedlings were germinated and it was found that the material from North Carolina was grown from seeds collected from trees at an unknown site in Tennessee. In March 1969, the seedlings were removed from the cold chamber and planted in a level plot provided by the University Farm. Twenty seedlings of each population (with the exception of the Kentucky material where only 18 seedlings were available) were planted in rows with a distance of 1 m separating each row and each seedling. Upon planting, each seedling was watered and native grasses removed in the vicinity of the plant. Seedlings were periodically watered until the end of April, at which time it was felt that the seedlings were sufficiently estab-

lished to begin the survival test. Observations were made on the test plot over the next 2 years, and the test was terminated when indiscriminate spraying for thistles in the area on 19 May 1971 seriously damaged the surviving trees.

RESULTS

By 30 September 1969, a general trend of survival by seedling populations whose origins were between 34 and 37° N latitude was evident (Table 1). The populations from Mississippi and Louisiana showed the lowest survival value during that time. A frost on 31 March 1969 (low –6 C) caused severe damage to the stem tips of the 2 southern populations, but the seedlings later showed partial recovery, and leaves were produced on the lower portions of the stems. After a very wet June (28.2 cm rainfall), followed by a very dry July with rainfall of only 4.03 cm, only 2 seedlings each of these populations survived. The Ohio population seemed to also be affected by the dry month. Only the Illinois, Tennessee, and Kentucky populations showed survival patterns of 50 percent or more during the first growing season in the transplant garden. A similar pattern was observed during 1970, and when the program was terminated in 1971, 27 seedlings of the original 58 planted from Illinois, Kentucky, and Tennessee had survived.

Other very subtle differences between the seedlings that survived were apparent in the falls of 1969 and 1970. By mid-October 1969, the seedlings from Ohio, Illinois, Tennessee, and Kentucky were showing some fall coloration patterns in their leaves; but the 4 surviving plants from Louisiana and Mississippi were still green. The next year, noticeable coloration differences were not apparent, but surviving populations from Tennessee and northward were noticed to exhibit patterns of leaf fall in November before the seedlings from Mississippi and Louisiana. Also in 1970, the surviving seedlings from Ohio were the first to show evidence of dormant terminal buds, where bud scales had formed in those seedlings by the last week in July. By the first week in September 1970, the Illinois and Tennessee seedlings were 65–70 percent dormant, but the seedlings from Kentucky, Mississippi, and Louisiana had not shown evidence of forming dormant apical buds.

TABLE 1.—SURVIVAL PATTERNS OF TRANSPLANTED SWEETGUM SEEDLINGS

Population	Latitude of Origin (°N)	Number Planted	Percentage Survival		
			30 Sep 1969	30 Sep 1970	19 May 1971
Ohio	39.5	20	35	10	10
Illinois	37	20	50	50	50
Kentucky	36.5	18	94	55	50
Tennessee	34–36	20	70	45	40
Mississippi	31	20	10	10	10
Louisiana	31.5	20	10	5	5

DISCUSSION

The results demonstrated by this survival test indicate greater coherence and similarity of those populations whose origins were in similar habitats. The Illinois, Kentucky, and Tennessee populations are adapted to growing conditions similar to those in the Bowling Green area in relation to length of growing season and annual climatic cycles. Those populations from Mississippi and Louisiana have a naturally longer growing season (approx. 235) than the usual frost-free period of south central Kentucky (approx. 204). It is the adaption to such a longer growing season that probably resulted in later leaf coloration, leaf fall, and dormant bud formation of the more southern populations in this test, although the low survival of those populations does not allow such a statement to stand unchallenged. The low survival value of the Ohio population also poses the question of why an organism adapted to a shorter growing season (approx. 170 days) would not flourish if subjected to a longer growing season. Laboratory experiments of *Liquidambar* under controlled and uniform growing conditions by the author (1968 unpublished doctoral dissertation, University of Texas, Austin, Texas) and by Williams and McMillan (1971), where seedling progeny from the full range of geographical distribution of this species was tested, showed that seedlings from more northern provenances were

more sensitive to cooler temperatures and shorter photoperiods. This could account for the demonstration of the surviving Ohio seedlings showing earlier dormant bud formation as the photoperiod in Kentucky would be shorter during the growing season than in Ohio. Although this test involved only seedlings from 6 different locations, it confirms the results of the previous works, and is an indirect reflection of the effects of natural selection upon different *Liquidambar* populations, ensuring survival of the species in various habitats.

Such a practical demonstration as this would seem to be obvious when involving populations of plant species that have been demonstrated under laboratory conditions to be composed of ecotypes. The question is raised of just how important such knowledge is. Recently, Odum (1970) has suggested that biotic diversity of ecosystems is important in maintaining physical stability. It would seem that the diversity present in different populations of the same species type is equally important in the maintenance of the species when it has widespread distribution. An important conservation practice could well be to ensure that sufficient genotypes of a species are maintained to assure their replacement or reestablishment in areas that have been or will be disturbed by man. It is evident from the simple survival test shown here that large reserves of sweetgum in Mississippi and Louisiana would not ensure the successful replanting of such a species in more northern areas if needed. The evolution of populations of species like *Liquidambar* to specific habitat requirements has required hundreds if not thousands of years. As more and more natural resources are removed, there may be the danger of removing ecotypes that would not be easily replaced. It is hoped that as more knowledge is gained through ecological studies of species interactions with environmental parameters, logical and practical applications can be made with such information.

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