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VARIATION IN BALD CYPRESS FROM DIFFERENT HABITATS

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Abstract

Leaves of bald cypress (*Taxodium distichum*(L.) Rich.) trees growing in three different habitats were found to have variations in length and stomatal frequency. These variations seemed to be directly related to soil moisture of the habitat. Subsidiary cell complex remained constant in all cases.

Introduction

Bald cypress is restricted in its natural range to deep, fertile swamplands because of lessened competition (Demaree, 1932). Its geographic range extends along the Atlantic coast from southern Delaware to Florida and westward along the gulf to Texas and north into the Mississippi Valley to southwestern Indiana and southern Illinois (Welch, 1931). Mattoon (1915) states that bald cypress possesses unusual ability to tolerate conditions of soil and water regimes generally considered extremely unfavorable to tree growth. As a result, the tree occurs in various forms differing quite widely in respect to leaf, bark, shape, size, and to a limited extent, wood characteristics. It is important to determine which features vary and to what extent these variations are controlled by differences in habitat. The primary objective of this experiment was to study variations in leaf length, leaf width, stomatal frequency, and subsidiary cell complex of the bald cypress leaf.

Soil moisture was the significant environmental variable in this study. The moisture regimes varied from an aquatic habitat at the Reelfoot Lake to a terrestrial habitat in Martin, Tennessee. Reelfoot Lake is in extreme northwestern Tennessee, about five kilometers from the east bank of the Mississippi River. The city of Martin is approximately 60 kilometers east of the Reelfoot Lake. Leaves for this study were collected from these two locations. Dickson and Broyer (1972) note that cypress appears very sensitive to soil-moisture stress. Several other studies indicate that bottomland species grow better in saturated soil (Dickson *et al.*, 1965; Dickson and Broyer, 1972). It is, therefore, clear that a swampland species such as bald cypress should show a reduced leaf area in a relatively dry terrestrial habitat. Thames (1963) found the internal structures of the needles of several conifers were modified to adapt to a more xeric habitat.

Methods and Materials

Fully mature leaves of bald cypress were collected from an aquatic habitat at Reelfoot Lake, a terrestrial habitat at Reelfoot Lake, and a terrestral habitat in Martin. Measurements of the leaf length and width were recorded for 1,000 leaves from each of the three habitats. The leaves were washed and rinsed with distilled water. They were air-dried and Duco cement was applied to the leaves to obtain impressions of the upper and lower leaf surfaces (Williams, 1973). A small portion from the central section of these imprints was used to prepare six slides from each population, three of the adaxial and three of the abaxial leaf surfaces. Stomatal frequency was studied from the slides of these imprints by selecting randomly 25 fields (N=25) from each microscopic slide and using a 40x objective and 10x oculars. Subsidiary cell complex was also recorded from these slides.

Results and Discussion

The data collected are summarized in Table 1. Leaves from terrestrial habitats were found to have a decreased length and increased stomatal frequency as compared to leaves from the aquatic habitat. No definite difference was found in leaf width between the terrestrial populations and the aquatic population. The pattern of stomatal distribution was the same in that the stomata on the upper leaf surface were restricted in their occurrence to a single or double row parallel and directly adjacent to the midvein. The lower leaf surface, however, had stomata located randomly throughout the leaf surface excepting the vein and outer edges of the leaf. The midvein was usually composed of six to eight rows of elongated cells. The subsidiary cell complex, consisting of four cells, remained uniform throughout the three populations, as did the absence of trichomes.

The reduction in leaf length in terrestrial habitats and, in the case of terrestrial population from Martin, a coinciding decrease in width could, probably, be related to an inadequate water supply.

It is generally true that more stomata occur on the lower surfaces than on the upper surfaces of leaves. This was quite evident for the three habitats in this study. Stomata were consistently more numerous on the lower leaf surfaces of bald cypress. Stomatal frequency values from the upper and lower leaf surfaces show that the two terrestrial habitats had a larger number of stomata per unit area (0.152 mm^2) than the aquatic habitat. Since all other environmental conditions were assumed to be fairly similar in the three habitats, the difference in stomatal frequency was probably due to the difference in soil moisture. Similar studies have found stomatal frequencies to be higher in relatively dry habitats as compared to wet habitats (Sharma and Dunn, 1968; Sharma, 1972).

It seems clear from this preliminary study that the leaf characteristics in bald cypress vary according to changes in the immediate habitat. Leaf elongation and stomatal frequency were the primary features affected by moisture in the habitats, while the subsidiary cell complex remained unaffected. Similar constancy of subsidiary cell complex has been reported for other taxa (Sharma and Butler, 1975). While it is suggested in this study that the variations are due to a difference in soil moisture, further investigation of other factors such as aeration, manganese and/or iron toxicity, and eves pollution may also be essential to establish a comprehensive relationship.

TABLE 1: *Quantitative characteristics of bald cypress in three habitats in northwest Tennessee.*

Feature		Habitat A	Habitat B	Habitat C
Leaf length (mm), X±S.D.[a]		14.86±2.7	14.49±2.5	15.31±2.6
Leaf width (mm), X±S.D.		0.96±0.1	1.08±0.1	1.08±0.3
Stomatal frequency,[b] X±S.D.	upper	7.40±4.2	10.90±1.9	1.10±0.2
	lower	27.00±3.8	25.50±3.7	22.31±3.9
Subsidiary cell complex (cells)		4	4	4

A. Martin, Tennessee (terrestrial)
B. Reelfoot Lake (terrestrial)
C. Reelfoot Lake (aquatic)
[a] X mean; S.D. standard deviation
[b] mean stomatal frequency = stomata of the leaf surface observed through a 40x objective and 10x oculars (field area = 0.152 mm^2).

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BARK CHARACTERISTICS AS INDICATORS OF ENVIRONMENTAL POLLUTION IN *LIQUIDAMBAR STYRACIFLUA* L.

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ABSTRACT

The thickness and pH of bark of *Liquidambar styraciflua* L. (sweetgum) were investigated from relatively unpolluted locations at Reelfoot Lake, Tennessee, and from locations with varying degrees of pollution in Memphis, Tennessee. Relatively little variation in bark pH range values was found in areas of varied pollution. No significant variation was evident in the values of bark thickness. Bark color was darker in heavily polluted areas.

INTRODUCTION

Recent research (Staxang, 1969; Grodzinska, 1971; Johnsen and Søchting, 1973; Lotschert and Kohm, 1973) indicates a correlation between increasing bark acidity and increasing levels of environmental pollution. Staxang (1969) determined that the major pollutant involved in bark acidification was sulfur dioxide evolved during the combustion of sulfur-rich fuels commonly used in industry. Grodzinska (1971) found those trees with rough bark to be better indicators of pollution in contrast to trees with smooth, thin bark.

Liquidambar styraciflua L. (sweetgum) is a major component of the plant community in West Tennessee. It is found in a wide variety of microhabitats ranging from relatively polluted urban areas, such as industrial areas in Memphis, to relatively less polluted rural areas, such as the Reelfoot Lake locale. Owing to its distribution and its characteristically rough bark, the sweetgum tree lends itself well to studies of pollution effects on bark.

The purpose of this investigation was to determine the effect, if any, of increasing levels of environmental pollution present on the pH, thickness, and color of the

bark of the sweetgum tree. Sample sites included wooded areas on the south side of Reelfoot Lake and selected sites in Memphis with varying degrees of pollution. Reelfoot Lake, in northwest Tennessee, is located in rural surroundings while Memphis, in southwest Tennessee, is one of the largest urban centers in the southern part of the United States. It has a large population and an industrial complex emitting a variety of pollutants into the environment.

MATERIALS AND METHODS

Fifteen trees of uniform dbh (45 cm) from each of the two study areas were examined for bark features. In Memphis, five were located in heavily polluted sites near industrial units in the downtown area, Riverside Park, and highway 51 North, and ten trees were located in moderately polluted locales near Memphis International Airport and Overton Park. Five measurements for bark thickness at breast height were made on each sample tree. Observations concerning habitat, visual evidence of possible sources of pollution, and the presence or absence of epiphytic growth on the bark were recorded. Bark color was also recorded for each sample tree. Samples of the bark were then removed from the sample trees and stored in plastic containers. Samples of bark were finely ground using a Wiley Mill (Mesh screen:40). Two grams of the bark were weighed and placed in small Erlenmeyer flasks containing deionized water. The flasks were shaken overnight to dissolve soluble constituents of the bark. Values of pH were determined on each sample using a Porto-matic pH meter. In addition, microscope slides showing bark cross-sections were prepared using a microtome and were stained for anatomical observations.

RESULTS AND DISCUSSION

Analyses of bark pH and thickness data are summarized in Table 1. The bark pH in the heavily polluted areas of Memphis ranged from 3.88 to 4.33, while the locality of presumably moderate pollution had a pH range of 3.77 to 6.48. The rural, low pollution area of Reelfoot Lake had a pH range of 4.01 to 5.75.

There was no significant difference in bark thickness among the different samples of polluted and unpolluted localities, although there was a trend for thicker bark (1.3 cm) in the heavily polluted areas of Memphis. There was visible decrease in general epiphytic growth in polluted areas, although no quantitative analysis was made. The trees growing in the heavily polluted areas of Memphis had dark colored bark while the bark color was light in other localities with less pollution. Anatomical observations of the bark confirmed the pigmentation of the tissues in the heavily polluted areas.

The pollution in the heavily polluted sections of Memphis is largely a result of an oil refinery. In the moderately polluted section of Memphis, pollution factors included automobiles and air traffic near Memphis International Airport. Reelfoot Lake is located in a rural area with neither local industrial nor urban pollution. The data collected on bark thickness showed no significant effect of pollution, although there was a trend for thicker bark in heavily polluted sections of Memphis—a fact which may become more clear if exposure to environmental pollution is prolonged. Relatively insignificant variation in pH range values (Table 1) in the two different areas of Memphis and Reelfoot Lake-areas with presumed variation in pollution levels, seems to indicate that the well-buffered bark of sweetgum may have some external defensive mechanism to act as a buffer against high acidity of the polluted areas. Studies conducted by Mathis and Tomlinson (1972) in the Nashville, Tennessee area add considerable evidence to indicate that the bark of trees in the metropolitan area of Nashville collects something which perhaps acts as a buffer against increasing acidity.

TABLE 1: *Analysis of bark pH and thickness for Sweetgum.*

Locality	Sample size	pH (range)	Thickness (cm)
Memphis*	5	3.88-4.33	1.3±0.3 [a]
Reelfoot Lake***	15	4.01-5.75	1.2±0.5
Memphis**	10	3.37-6.48	1.2±0.4
Reelfoot Lake	15	4.01-5.75	1.2±0.5
Memphis*	5	3.88-4.33	1.3±0.3
Memphis**	10	3.37-6.48	1.2±0.4

*heavily polluted area
**moderately polluted area
***low pollution area
[a] mean±standard deviation

The dark color of the bark in the heavily polluted areas is probably due to the obvious absorption of particulate matter and the pollutants affecting the tissues involved. A decrease in epiphytic cover in the heavily polluted areas suggests their sensitivity to pollution (Skye, 1968; Skye and Hallberg, 1969; Mathis and Tomlinson, 1972).

This preliminary study seems to indicate that for *Liquidambar styraciflua* the bark does not show a significant variation in pH range values with an obvious change in the degree of environmental pollution. Bark color undergoes darker pigmentation in polluted areas. Cover by epiphytes decreases with increased pollution level. Bark thickness is not significantly affected by pollution, although a slight trend for thicker bark in polluted areas is indicated.

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