THE BOTANICAL, EROSION CONTROL, AND ECONOMIC SIGNIFICANCE OF WHITE POPLAR IN MARYLAND

by

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WHITE POPLAR

Selection of the desirable variety now being grown by the S.E.C. for farm planting. Such trees bring more than $100⁰⁰ each.

Common, valueless variety of white poplar.

HIGH VALUE SELECTION FOR CONSERVATION PLANTING ON FARMS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE RESEARCH, HILLCULTURE DIVISION

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INTRODUCTION

White poplar, including the species *Populus alba* L. and *P. canescens* Smith, was originally introduced from Europe and is now distributed over a large part of the United States. During the past few years, the white poplar has been considered for erosion control planting for the following reasons:

1. It has a widespread, shallow root system which effectively binds the soil.
2. The roots generally send up large numbers of sprouts (Fig. 1) which form a vegetative cover for the surface of the soil.
3. It is a rapidly growing tree.
4. It can be easily propagated by root sprouts.

Fig. 1. Sprouts from the mature tree.

The wood of white poplar varies widely in value. While most white poplar trees have little or no wood value, certain types have special qualities for production of furniture and other decorative veneers (Frontispiece). Such desirable types occur occasionally among the white poplars in Maryland, and are also found in other states. Trees of the desirable types have been sold by their owners for $25 to $800 each, depending on the size of the tree and the quality of the wood. Since most of the desirable trees have already been cut for veneer, there is only a limited supply available, and consequently the market for the veneer is similarly limited. With an increased supply of the highly figured white poplar wood, a larger market is likely to follow.

The distinction between the high value and low value types has arisen out of the experience of veneer manufacturers as a result of cutting many trees. It is now recognized that most of the white poplars are of little value for veneer production, but that there are certain distinct types from which clear, highly figured veneer is obtained. The purpose of this study has been to investigate the variations in white poplar from the viewpoint of their botanical and economic significance. This would serve two purposes. One, it would serve as a basis for segregating the several genetic types according to their botanical characters, and two, it would serve as a basis of selecting the most valuable types for erosion control planting.

REVIEW OF LITERATURE

White poplar, Populus alba L., native of central and southern Europe, west central Asia, and the Orient east to the Caucasus (12), has been known and cultured for many years. It was described by Linnaeus in 1753 as having a dense white tomentum on the underside of the fast growing shoot leaves. Some trees were found to have a grey pubescence on the underside of the fast growing shoot leaves, and Smith (13) named these P. canescens in 1804. Because of the widespread cultivation of the white poplars, many varieties and forms were named.

While means of distinguishing between P. alba and P. canescens and the various synonyms of these species have been presented by Tidestrom (15), the hybrid nature of P. canescens has been considered by some taxonomists (5,6,12, 15,17) since it has characters intermediate between P. alba and P. tremula. This is further substantiated in America by the close resemblance of P. canescens to some natural hybrids between P. alba and P. grandidentata (11). Hybrids between P. alba and P. tremula have been artificially produced (6,14,16).

The frequency of the sexes of these species in Great Britain is discussed by Elwes and Henry (5) who indicate that the male tree of P. alba and the female form of P. canescens are very rare. Tidestrom (15) reports that he has never seen the male P. alba in this country. The different appearance of male and female P. alba in the vicinity of Ottawa, Canada, is reported by

Peto (11). These suggest that there is possibly some relationship between the sex of the tree and some of its other taxonomic characters.

Numerous common names have been used for the white poplars. P. alba L. has been called white poplar, while P. canescens has been called gray poplar. Frequently, however, no distinction is made between these, and they are called "silver maple" because of the resemblance of the leaves on fast growing white poplar to silver maple leaves. In the trade, the veneer from the white poplars is called "aspen" (1).

MATERIALS AND METHODS

In this study, the term white poplar will refer to the entire group of trees studied, including P. alba, P. canescens and their intermediate forms. Several white poplar trees were first located and their value determined, based on the judgment of experienced veneer men.[1/] A great many other trees were then examined and their characters compared with those of known value. Later several trees were examined while being manufactured into veneer, and their value checked with their external identifying characters. For the trees investigated, the following procedure was followed: leaves and twigs, and buds of fast- and slow-growing shoots were collected for taxonomic study; wood samples at breast height were collected by means of an increment borer. Data were taken on the growth habit of the mature trees and of younger trees around them. In addition, photographs were taken of the majority of the trees and of the bark for subsequent comparison, and in most cases the height and diameter were taken. A total of 64 trees at 59 different locations[2/] were studied, and as a check many other trees were examined for various identifying characters. Two different

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1/ The writer expresses his grateful appreciation to Mr. Fred C. Williamson and Mr. Earl Donaldson, of Cockeysville, Md., for their cooperation in various phases of this study.

2/ A list of the trees studied and their locations is presented in the Appendix.

kinds of white poplar trees were found growing together at five locations. Most of the trees studied are located in Maryland, the others being in Vermont, New York, Pennsylvania, West Virginia, Virginia, and Kentucky. For anatomical study of the wood, the usual methods of sectioning and staining were followed.

RESULTS

The following lines of approach to this study were planned in order that it would serve not only as a basis for selecting white poplars of high value, but also that it would enlarge the understanding of the factors which create figured grain. The latter would serve to evaluate the importance of these factors during the growth of the tree. Thus there would be established the identity of these high value trees as well as the factors which make these trees valuable for veneer production.

The results of this study are divided, therefore, into two main sections: (1) the differentiation between the several types of white poplar on the basis of taxonomic characters; and (2) the recognition and isolation of the several types of wood grain development which cause figure in wood.

Taxonomic Characters of the Major Groups of White Poplars

The white poplars in Maryland may be classified into four major groups based upon external and internal differences in leaves, vegetative buds, sex, growth form, wood ray anatomy, and certain qualities of the wood.

A type tree of each of the four groups is illustrated in Plate 1 and the trees are located at the following stations:

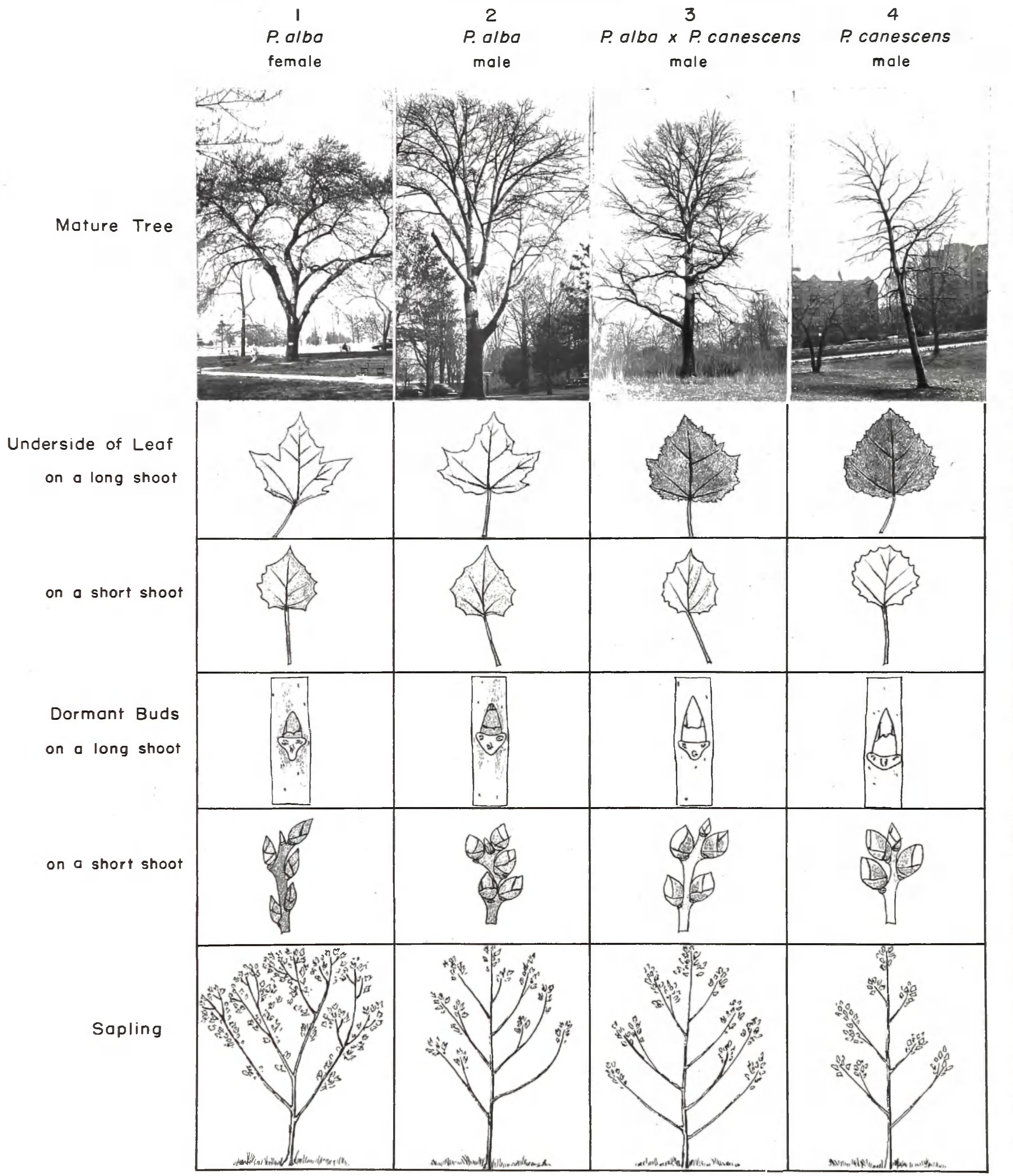
Group 1. S.E. corner of Constitution Avenue and 12th St., N. W., Washington, D. C., on the grounds of the National Museum of Natural History.

Group 2. Beginning of Goldsborough Walk on the grounds of the U. S. Naval Academy, Annapolis, Md.

PLATE I

Taxonomic and growth features of the four principal groups of white poplar in Maryland.

Plate I


1
P. alba
female
2
P. alba
male
3
P. alba x P. canescens
male
4
P. canescens
male
Mature Tree
Underside of Leaf
on a long shoot
on a short shoot
Dormant Buds
on a long shoot
on a short shoot
Sapling

Group 3. N.E. corner of York Road and Walker Ave. at the northern city limit of Baltimore, Md.

Group 4. S.W. corner of Connecticut and Tilden Aves., Washington, D.C., on the grounds of the National Bureau of Standards.

External Characters

1. Leaves

White poplars produce two distinct kinds of leaves on the same tree, so that in comparing different trees, the proper leaf material must be selected. The leaves on rapidly growing shoots differ from those on slow-growing shoots. The former, which are from suckers, shoots, and rapidly growing branch ends, will be referred to as long shoot leaves. The latter, which occur on slowly growing shoots and at the base of long shoots, will be referred to as short shoot leaves. Following is a tabulation of the characters of long shoot and short shoot leaves of the four groups of white poplar.

	Groups 1 and 2	Group 3	Group 4
Long Shoots: shape	Orbicular, clearly 3-5 lobed	Sub-orbicular, tending to deltoid, 3 poorly defined lobes	Broadly ovate to mostly deltoid; teeth may be uneven but not lobed
margin	Indentations irregular in size, teeth blunt, scattered, interspersed with short intervals where margin is sinuate.	Indentations irregular in size, teeth sharp, numerous along entire length of margin	Indentations sharp, fairly uniform in size and distribution
pubescence on underside	Cottony white, dense, closely appressed	Grey, loose, not appressed	Grey, loose, not appressed
Short Shoots: shape	Ovate to occasionally sub-orbicular	Same as 1	Orbicular to occasionally sub-orbicular
margin	Crenate-dentate upper quarter of leaf margin with few to no teeth	Same as 1	Crenate serrate margin, teeth distributed fairly uniformly over entire length of margin
pubescence (Figs. 1 and 2)	Very fine bloom-like pubescence, persistent especially along veins and upper portion of leaf throughout season	Pubescence present while leaves are young, absent when mature, except occasionally a fine pubescence remains along veins	

Since there may be wide variations in the shape of the leaves (Plates 2, 3, and 4) even on a single plant, typical leaves should be used for identification. Comparison of the two kinds of pubescence on the underside of fast-growing shoot leaves of Groups 1 and 3 is made in Plate 5.

At several locations where male and female trees were growing together, it was found that in the fall of the year the leaves of the female trees fell from one to two weeks earlier than those of male trees. This difference was also found between male and female trees at different locations throughout Maryland.

2. Vegetative Buds

In order to separate the groups on the basis of vegetative buds, long shoots of uniform size were used. The differences in buds can be studied most satisfactorily in the middle portion of fast-growing stems after the leaves have fallen. Five consecutive buds on each of five stems at 4-6 mm. diameter were measured from each of 15 trees. The data in Table 1 indicate that the buds of Groups 1 and 2 are shorter and narrower, but relatively wider, as measured by the length-width ratio than the buds of Groups 3 and 4.

Table 1. Measurements of vegetative buds on long shoots. Basis: 375 buds.

Group:	1	2	3	4
Bud height, mm.	3.4	3.7	6.5	5.5
Bud width, mm.	2.3	2.5	3.0	2.9
Height:width ratio	1.5	1.5	2.1	1.9

Observations on the leaf scars at the same nodes at which the buds were measured show that there is a difference between the groups. While the leaf scars are too small to permit accurate measurement in the field to make this method of identification usable, the leaf scars of Group 4 are relatively narrower than those of Groups 1, 2, and 3 (Plate 6) and may also be used as an identification aid.

3. Flower Buds

The flower buds of white poplar, which are visible on short shoots during the fall and winter, serve to distinguish the male and female trees (Plate

1). Group 1 consists of all female trees, Groups 2, 3, and 4, all male trees.

Group:	1	2	3 & 4
Shape	Buds ovate.	Buds globose.	Buds globose.
Apex	Pointed.	Blunt.	Blunt.
Bud scales	Grey pubescence present over all bud scales.	Scales partly to completely covered with pubescence.	Slight pubescence may be present on the lower portion of bud scales. Upper part generally lacking pubescence and shiny.

When in blossom, the female catkins (Fig.2a) are about one inch long and are greenish white. The male catkins (Fig.2b) are 2 to 4 inches long and reddish brown in color.

Fig. 2a. Female catkin.

Fig. 2b. Male catkin.

4. Growth Form

Since white poplar trees send up large numbers of root sprouts, it has been possible to observe at the same location trees of the same clone at various ages, from one-year sprouts to mature trees. Root sprouts grow very vigorously and many side branches may develop from the axillary buds the first year. Thus at a node on a fast-growing one-year stem there may be both a leaf and a branch present.

At the end of the first season, therefore, the plant consists of a single shoot on which lateral branches may be present. In subsequent years shoots develop on both the main stem and the lateral branches. However, the relative dominance of the shoots varies with the sex. Following is a description of the male and female growth forms as well as a description of the development of these forms from the one-year-old sprout.

<u>Female</u>

<u>Fig</u>. <u>3</u>. Deliquescent form, lacking a main stem extending into the crown.

The most characteristic feature of the growth form is the wind-blown appearance of the crown caused by the many long, thin, horizontal branches in the upper part of the crown.

There are many main branches, forming long sweeping curves into the crown. The lower branches and, to some extent, the ends of the upper branches, generally droop.

<u>Male</u>

<u>Fig</u>. <u>4</u>. Excurrent form, with main stem extending well into the crown.

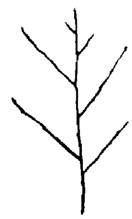
The characteristic feature of the crown is the numerous small erect branches.

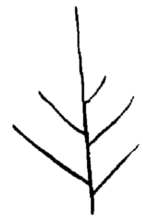
There are few main large branches and these are relatively straight and erect, even the lowest ones seldom drooping.

No distinctive form characters could be noted between the three male types except in Group 2, in which the branches tended to be somewhat longer than those of Groups 3 and 4 (Plate 1).

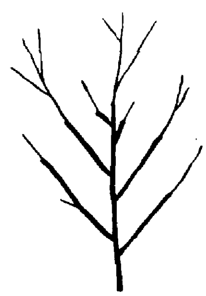
Since the growth form of mature white poplars is the result of distinctive branching habits recurrent year after year, it is possible not only to distinguish the growth forms at an early stage in the growth of the tree, but also to study the development of the two main growth forms. The following description of the development of the two main growth forms is based on observation at locations where trees of the same clone varying in age from one-year sprouts to mature trees were found growing together.

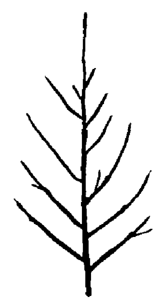
	Female		Male
1-yr. tree	Fig. 5. The main stem has numerous side branches which are generally distributed over the entire length of the stem. Top of stem is not much higher than tips of branches.		Fig. 6. Main stem has several side branches which are generally distributed on the lower half of the stem. Top of stem considerably higher than the tips of branches.



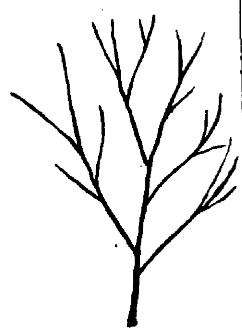


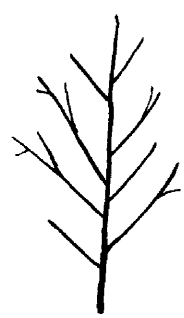
2-yr. tree	Fig. 7. Terminal extension of the main stem and some of the side branches compete for dominance. Thus, several side branches may be as tall as the main stem, forming several forks.	Fig. 8. Terminal extension of first year's main stem is dominant, becoming taller and greater in diameter than the side branches. Thus a distinct single main stem is formed.



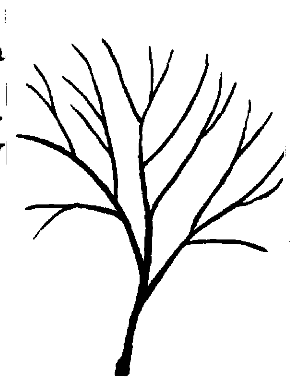


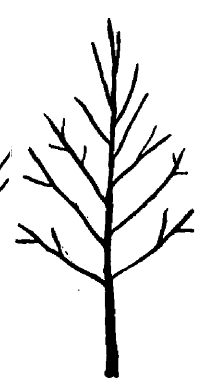
Sapling	Fig. 9. The original stem and large side branches have continued to elongate, forming several large forks. A dominant main stem is no longer distinguishable.	Fig. 10. The main stem has continued to elongate and remains dominant. Relatively few of the original larger side branches persist to form main limbs.





ature ree	Fig. 11. Most of the main branches have continued to branch the lower ones drooping, the upper ones relatively erect, ending in many long, fine, curved branchlets.	Fig. 12. The main stem has continued to maintain its dominance, eventually breaking up high in the crown. The branches are mostly erect, ending in numerous small, straight branchlets.





The formation of a specific growth form is the result, therefore, of a series of very definite developments on the part of the growing stem (Plate 7). These developments effect not only the formation of the main stem and limbs, but, through the growth of side branches, they determine the character of the crown. Consequently the basic appearance of any portion of the crown is essentially the same as that of the tree as a whole.

The development of a specific growth form in the white poplars appears to be genetically controlled. This is indicated at the five locations where both male and female trees have been growing close together under similar site conditions. At one of these locations, (Fig. 13) the distinctive growth form of each sex is clearly illustrated. The two trees on the left are males, each with its single main stem and excurrent form. The tree on the right is a female and shows a typical deliquescent form. In the males, each of the main branches has remained relatively distinct through the crown, while in the female each main branch has forked and forked again, giving the appearance of a dichotomous branching system. The genetic nature of the growth form as well as of the other diagnostic features presented, has been further indicated by a preliminary nursery planting of several different clones. One-year-old root sprouts in the nursery show characters similar in all observable respects to normal root sprouts in the field.

Fig. 13. Male trees at left have an excurrent growth form, while female tree at right has a deliquescent growth form.

Internal Characters

1. Wood Ray Anatomy

Microscopic study of the wood shows that the wood rays, as seen in tangential section, differ among the four previously established groups. The features in which differences have been observed are: (1) number of cells in a ray; (2) total height of the ray; (3) average height of the individual ray cells; and (4) the average width of the rays. The data are taken for the most part from one-year-old sprouts and from mature trees of the same clones, growing at the same locations.

Table 2. Microscopic features of ray structures of white poplar types as seen in tangential view. Basis--24 trees.

Character	Group	First-yr. wood of sprouts	Outer wood of mature trees
Number of cells in ray	1	10.1	13.9
	2	11.0	14.0
	3	6.7	8.4
	4	12.1	12.7
Average height of ray, in microns	1	221	292
	2	242	287
	3	191	214
	4	229	267
Average height of ray cell, in microns	1	21.9	21.0
	2	22.0	20.5
	3	28.5	25.5
	4	18.9	21.0
Average width of ray, in microns	1	7.3	8.4
	2	7.6	10.2
	3	8.9	9.9
	4	6.6	8.8

The data (Table 2) show that the rays of Group 3 are different from those of the other three groups in the following respects (Plate 8):

1. The average height of the individual ray cells is greater.
2. There are fewer cells in the height of the ray.
3. The rays are shorter in height.

In relation to these results, it is significant that, even when comparing figured and unfigured wood from adjacent parts of the same tree, the individual ray cells from the former are larger than those of the latter, (Plate 9, Figs. 3 and 4). The rays themselves are likewise shorter in the figured wood. In other words, the difference in the ray anatomy between the two types of wood from adjacent parts of the same tree is similar to the differences between the high value and low value trees.

The increased size of the ray cells and the decreased height of the ray are also found at nodes and at other places where any other irregularity, such as birdseye, occurs in the wood. Frequently, not only are the rays shorter, but contrasted to the normal uniseriate condition, they may also be bi- and triseriate. Short rays, which are a reflection of some disturbance in the figure of the wood, may be extended radially and accentuated as diameter increase takes place. The nodal disturbance of the ray structure and its radial extension has been reported also by Barghoorn (2).

These observations show that the wood rays from the high value trees are different from those of the low value trees, and therefore the wood rays may be used to identify such high value white poplars. However, certain precautions must be observed since the data in all four groups indicate that the ray cells from the outer wood of the individual trees are wider and the rays themselves higher than those of the wood of the first year's growth. For this reason, comparative material must be used.

2. Wood Quality

Several veneer log buyers have found that certain kinds of white poplars have a dark shaky wood, which makes the trees useless for veneer manufacture. These trees have been called "wrong kind aspen". Even when the wood is sound, it generally has a dull greyish brown color rather than the lustrous light-colored wood which is so highly desirable. They have also noted that, when such trees are cut, the wood is unusually wet and has a disagreeable odor.

In order to determine some of the features of wood quality, other than the figure of the wood itself, increment borings were collected from 71 trees representing about fifty clones. The observations on these increment borings show (Table 3) that, of the 35 trees classed in Groups 1 and 2, only two had a sound, light-colored wood. All the other 33 trees had wet, discolored wood, twenty of which were shaky.[1/]

Table 3. Some features of wood quality in relation to the four major groups of white poplar. Basis: 71 trees.

	Group 1		Group 2		Group 3		Group 4	
	No. of trees	%	No. of trees	%	No. of trees	%	No. of trees	%
Wood sound and light-colored	2	6	0	0	22	100	11	79
Wood sound and dark (discolored by dark sap)	9	29	1	25	0	0	3	21
Wood shaky and dark	20	65	3	75	0	0	0	0
Total	31		4		22		14	

In some trees where the wood was wet, the flow of sap was very great after the boring was made. Sometimes the pressure even forced the core out of the increment borer while the latter was still in the tree, and the sap flowed steadily for as long as five minutes. Many trees have been found to exude this dark, smelly sap for several weeks after a boring was taken. In Group 3, namely, the high value white poplars, all the trees have a sound, light-colored wood. In Group 4, namely, the lower value trees, all but three have sound, light-colored wood. Since all the trees have at least some characters of P. alba in

1/ Shakiness of the wood is indicated by the number of pieces in the increment core. When the wood is sound, the core comes out in one piece.

their genetic makeup, there seems to be a relationship between the wood qualities and the sex of the tree. From this standpoint, it appears then that most male trees have characters which make the wood adapted to veneer production and the females do not. Although it has been observed that the wood of female trees may be figured, the shakiness and color of the wood make these trees worthless for this purpose (Fig. 14).

Fig. 14. Dull colored and split veneer made from wood of a female tree.

The Development of Figured Wood in White Poplar

Since all wood is formed by the cambium, any configurations in the wood must naturally be those of the cambium at the time that particular portion of the wood was formed. For the same reason, any changes in the configuration of the wood grain are reflections of changes which have taken place in the cambium. Several distinct types of configuration which are formed as the wood is laid down by the cambium may be identified and recognized.

Identification of Major Types of Configuration

1. Major and Minor Spiral

The most extensive configuration in the tree is due to a spiral twist of the grain. The direction of the spiral changes at irregular intervals both longitudinally along the stem and horizontally along the radius from the pith to the bark. This spiral will here be termed the major spiral and may extend longitudinally in one direction along the stem from several inches to several feet. After this, it gradually alternates its direction from, for example, 10 degrees to the right to 10 degrees to the left as it courses up the stem. Since the direction of the spiral varies both longitudinally and horizontally, a cross grain (10) or interlocking grain is formed (Fig. 15).

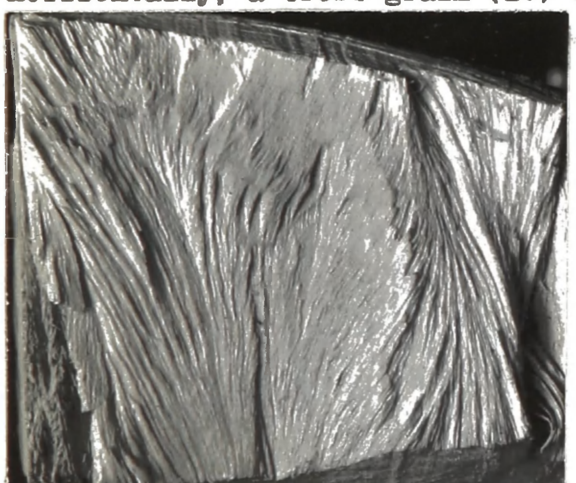


Fig. 15. Well developed cross-grain from the outer wood portion of a high value tree.

This makes the wood exceedingly difficult to split. When the wood is cut so that a radial surface is exposed, as in veneer, these differences in spiral direction appear as alternately light and dark bands. These are due to the changes in direction of the long axis of the longitudinal elements of the wood. Such alternating bands of light and dark areas on the quartered grain are called in the trade "stripe" (9) figure. While stripe figure is valuable in some woods, such as in mahogany, it in itself is not considered especially desirable in white poplar.

Superimposed on this major spiral may be a smaller curl which will be termed the "minor spiral", that is, there are minor undulations in the major spiral (Fig. 16). This results in the curl superimposed on the stripe, forming a "broken stripe" or a "mottle" (Plate 12, Fig. 1). These types of figure are very desirable and are found most highly developed in the main stem, but may occur in the larger limbs as well.

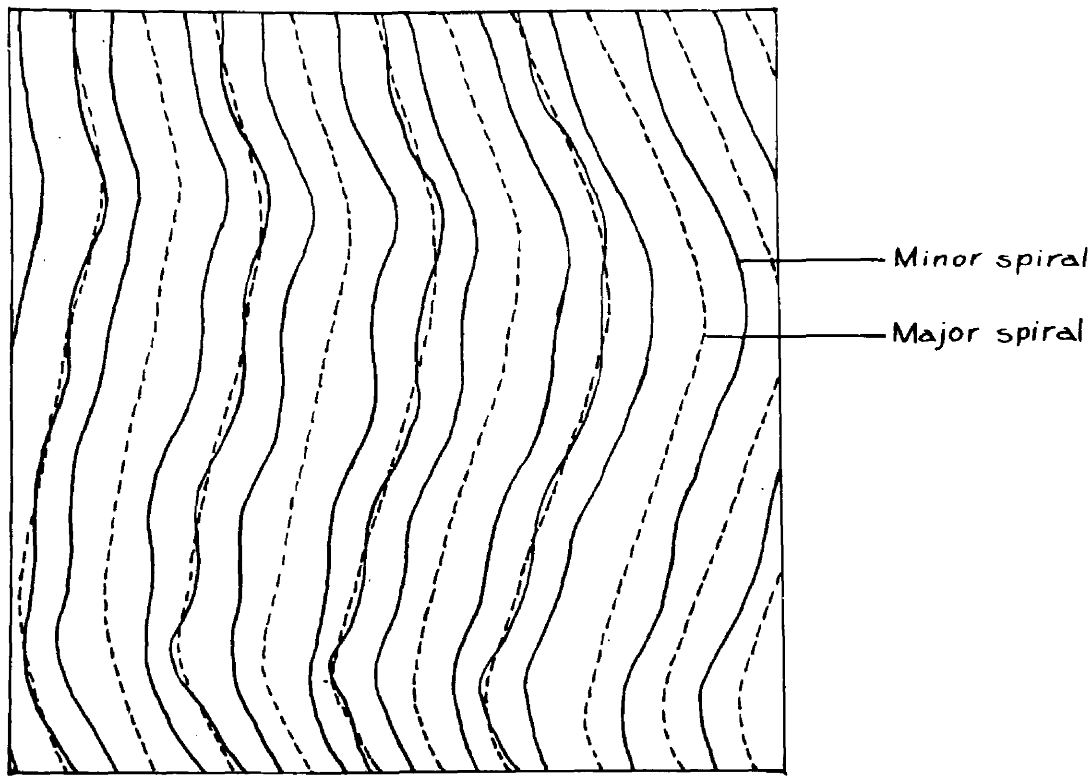


Fig. 16. Diagrammatic representation of major and minor spirals. The solid line indicates the actual direction of the grain.

2. Radial Curl

A third type of figure is a curl which occurs on the stem below branches. This figure appears as a wrinkle and may be seen on the surface of small stems before the bark breaks up and becomes platy. In contrast to the major and minor spirals which undulate in a tangential plane, this latter type of wrinkle undulates in a radial direction. Since this wrinkle in the wood occurs chiefly below branches, and occasionally in the stump, it is relatively limited in extent. It ordinarily does not contribute greatly to the total figure of the wood.

3. Birdseye

Another type of figure is that due to structures similar to birdseye, which usually originate at or near the pith and extend radially to the cambium. Frequently, these structures may actually protrude as sharp points into the bark. They differ from true birdseye (4), however, because they do not contain pith, and do not appear to be dormant buds (Plate 10). These structures may originate in several ways. Some originate in the pith independent of the nodes. Others originate at or near nodes from the leaf, stipular, and branch traces. Occasionally they originate independent of both the pith and node. In the one-year-old stem, these structures appear as localized convolutions in the cambium. Subsequently, they extend radially, contemporaneously with the normal diameter increase of the stem. As they extend radially, they become larger and branched. As a result, the cambium of an old stem has a gnarled bumpy appearance (Plate 11) because of the great numbers of these convoluted structures. When these configurations are sectioned on the quarter, they form narrow bands. If the entire section were on the exact quarter face, these bands could frequently be traced back to the first year's growth. Since they form horizontal curls across the wood, and also further break up the basic stripe or mottle figure of the wood, the figure of the wood grain is greatly enhanced (Plate 11) (Figs. 2 and 3).

4. Crotch Figure

Where the stem forks, a "feather" figure (Frontispiece) is produced in the wood between the two branches. This feather figure is a result of the increased compression of the cambial and immature wood cells and of their reorientation from a vertical to a horizontal position as the two stems of the crotch increase in diameter.

The angle at which the two limbs come together is important. If the angle is wide, there will be only a small amount of crotch figure. If it is narrow, old bark and other debris is likely to be enveloped by wood growth as the crotch increases in height and the value of the veneer produced is greatly reduced in value. In general, crotches having a 35° to 50° angle between the two limbs produce the best figured wood.

Effect of Branching

The presence of branches causes a distortion of the several basic types of configuration presented above. Where a limb occurs on the stem, the grain necessarily curves around the limb. Thus the direction of the major spiral is altered while the degree of curl in the minor spiral is generally accentuated. Thus where the stem branches, the figure may be changed from what would basically be a stripe to a mottle. As the distance from the branch increases, the mottle becomes less intense and may change to a stripe (Plate 12, Fig. 1). While the presence of a branch causes a distortion of the wood grain configuration, its effect on the gross figure of the wood may be either beneficial or harmful. When a great many branches, particularly small persistent ones, are present all along the stem, they form numerous knots and other defects and thus reduce considerably the value of the veneer. This is one of the reasons why only the stump and the crotches are used in some white poplars. On the other hand, when the main stem has only a few main branches along its merchantable length, it produces highly figured wood with few defects. In some of the most valuable trees, even the larger limbs, themselves produce clear, highly figured wood. Therefore, in evaluating the effect of branches on the value of a tree, their size, number, and location in the tree must be taken into consideration.

DISCUSSION

The taxonomy of the white poplars has been made rather difficult by their natural hybridization with Populus tremula and by subsequent crossing between progeny and parents. The condition has been further complicated by the wide-spread vegetative propagation and dissemination of individual trees and the naming of various horticultural selections. Since the white poplars in America are all introduced, they must represent only a small section of the range in variation to be found among these trees in their native habitat. This is particularly true since the introduced trees have probably been selected for the most part from the white poplars already in cultivation in Europe. Although the white poplars are reproduced chiefly by vegetative propagation, there is, however, sufficient variation between trees within the four groups to indicate that many clones are represented.

From the best available descriptions, the trees classed in Groups 1 and 2, are _Populus alba_ L., Group 1 consisting of female trees, and Group 2, male trees. During the present investigation only two male clones of _P. alba_ at two locations have been found. The trees classed as Group 4 are all male trees and conform to descriptions of _Populus canescens_ Smith. This species is believed to be a natural hybrid between _P. alba_ L. and _P. tremula_ L., (5,6,12,15,17) and, indeed, the trees in Group 4 clearly have characters which are intermediate between these two species. Moreover, the wood is not as highly figured as that of the other three groups, further indicating certain characters of _P. tremula_ in the genetic makeup of the species _P. canescens_. The trees classed in Group 3, namely, those which produce the highest quality wood, are all male trees and appear to be hybrids between _P. alba_ and _P. canescens_ since they have features which are intermediate between these two species.

The recognition of the two principal growth forms associated with sex among the white poplars presents a valuable method of selecting and evaluating these trees, particularly in seasons of the year when the commonly used taxonomic features are lacking. Study and recognition of different growth forms within a species or closely related species has been accomplished in only a few cases, such as in Scot's Pine, Douglas Fir, and most recently, in black locust (38). While such factors as growth rate and density of stand may temporarily affect the branching of one- or two-year-old trees, so that its form may not be immediately recognized, the tree is not many years old before its form can be determined. The recognition of growth form when the trees are only one to several years old represents a useful advance in the evaluation of tree form.

The economic value of the white poplars for veneer production depends principally upon two factors, first, the presence of a light, lustrous, and highly figured wood, and second, the form of the tree. In regard to the first factor, all white poplars have figured wood at least to some degree. However, the dark sap in Populus alba so discolors the wood that, together with the shaky character of the wood, the trees of this species are of little commercial value. Regarding the form of the tree, the male form lends itself better to veneer production than does the female. A male tree generally has a large main stem with only a few large limbs. Thus long logs with few knots and other defects may be flitched out, giving a high value to the veneer produced. Moreover, the limbs themselves, when large enough, are relatively straight and free of defects and may be utilized. In the female form, however, the main stem usually breaks up too close to the ground to produce many long logs. In addition, the limbs, even when large enough to be utilized, have both a wide sweep and many smaller branches. Any veneer produced would therefore have to be heavily trimmed to account for the sweep, and in addition would have a great many knots in it, thus further decreasing its value.

The relationship between sex, growth form, and the quality of the wood indicates the possibility that these two latter characters are in some way related to sex. This relationship seems particularly plausible, since all the trees have, either in part or in their entirety, genetic material of *P. alba*. The erect and excurrent growth form of the two male *P. alba* clones which were found definitely suggests such a relationship.

These considerations indicate that, within the scope of the present study, the evaluation of white poplars for veneer purposes may be made on the basis of taxonomic characters, with further consideration to sex and associated growth form.

SUMMARY

1. The white poplars, introduced from Europe, have certain growth characteristics which make them valuable erosion control trees.

2. The wood of certain types of white poplar is more valuable than others for veneer manufacture.

3. The white poplars in Maryland may be divided into four groups on the basis of external characters, namely, leaves, vegetative buds, flower buds, sex, and growth form; and internal characters, namely, wood ray anatomy and wood quality.

4. These four groups are: (1) *Populus alba* L. female; (2) *P. alba* L. male; (3) *P. alba* x *P. canescens*, male; and (4) *P. canescens* Sm.

5. The trees in Group 3 are most valuable for veneer production. Those in Group 4 are of low value, and those of Groups 1 and 2 of no value.

6. There are two principal growth forms among the white poplars, and these growth forms are related to the sex of the tree.

7. The male and female growth forms may be distinguished during various stages in their development.

8. The formation of a figured grain in the wood of the white poplars is the result of certain definite features of wood formation which may be identified and evaluated.

9. The frequency of the sexes of the several types of white poplar and the relationship between sex and growth form and wood quality suggest that there is some association between these three characters.

*

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APPENDIX

Following is a list of the locations at which white poplars were studied, arranged according to the four main groups. Included are such pertinent data as diameter height of tree and soil type on which it was growing. At most of the locations, there were several trees of the same clone.

Location	Owner or Tenant	DBH in inches	Height in ft.	Soil Class
		Group 1 (*P. alba*, female)		
1. Woolford, Md.	Charles Asplen	17	55	Elkton silt loam
2. Church Creek, Md.	Josiah Linthicum	20	35	" " "
3. Madison, Md.	Ex-Gov. Harrington	28	40	" " "
4. Madison, Md.	Mr. Bromwell	16	40	" " "
5. Cambridge, Md.	C. A. Le Compte	28	59	" " "
6. St. Michaels, Md.	Mrs. Parkerson	35	56	Keyport silt loam
7. Wye Mills, Md.				Sassafras loam
8. Grasonville, Md.		38	70	Elkton silt loam
9. Pomona, Md.	V. M. Ingersoll	37	70	Sassafras loam
10. Chestertown, Md.	Vacant lot along Chester River	44	80	Keyport silt loam
11. Elkton, Md.	Mr. Van Reynolds	48	72	
12. Fair Hill, Md.	Leslie Pennock	39	65	Chester loam
13. Towson, Md.	Andrew Simon	two forks 52, 42	70	Chester loam
14. Manor, Md.	Mrs. Hutchins	42	70	Chester loam
15. Jefferson, Md.	C. H. Lewis	38	65	Porters silt loam
16. Frederick, Md.	Marshall Miller			Frankstown silt loam
17. Unionville, Md.	Mrs. Mary Dudwa			Congaree silt loam
18. Landover, Md.				Sassafras fine sandy loam

Location	Owner or Tenant	DBH in inches	Height in ft.	Soil Class
19. Berwyn, Md.	Mrs. Leypoldt			Sassafras sandy loam
20. Queens Chapel Rd. Hyattsville, Md.	Mr. Smith	28	65	Sassafras sandy loam
21. Capitol Hts., Md.	Dr. Ivar Tidestrom			Sassafras gravelly loam
22. Washington, D. C.	Grounds of National Museum			
23. South Hero, Vt.	Mrs. Jarvis	15	40	
24. Syracuse, N. Y.	Thornden Park	26	65	
25. Bronx, N. Y.	N.Y. Botanical Garden	20	40	
26. Bedford Valley, Pa.	Mr. Aschenfelter	35	72	
27. Summersville, W. Va.	Rader Hotel	18	52	
28. Pine Ridge, Ky.	Mr. Koomer			

Group 2 (P. alba, male)

1. Brookville, Md.	H. L. Bruenings	32	80	Chester loam
2. Annapolis, Md.	U. S. Naval Academy	37	76	Collington fine sandy loam

Group 3 (P. alba x P. canescens, male)

1. Woolford, Md.	Charles Asplen	28	60	Elkton silt loam
2. Morris Neck, Cambridge, Md.	C. A. Gabler	21	57	" " "
3. Morris Neck, Cambridge, Md.	C. A. Le Compte	7	25	" " "
4. Easton, Md.	Mr. Newton	33	65	Keyport silt loam
5. Easton, Md.	Mrs. H. B. Lockwood	26	80	" " "

Location	Owner or Tenant	DBH in inches	Height in ft.	Soil Class
6. St. Michaels, Md.	Mr. Cone	35	58	Elkton silt loam
7. Wye Island, Md.	Mrs. Glenn Stuart	36	64	Keyport silt loam
8. Pomona, Md.	V. M. Ingersoll	37	55	Sassafras loam
9. York Rd., City line of Baltimore, Md.		37	80	Chester loam
10. Ellicott City, Md.	Mr. Carroll (Doughoregan Manor)	47	78	
11. Manor, Md.	Mr. Kieffer (Inverness Farm)	42	75	Chester loam
12. Petersville, Md.	Mr. Huffman	37	67	Ashe loam
13. Petersville, Md.	Petersville church	19	45	Ashe loam
14. Urbana, Md.	"The Maples"	26	50	Chester loam
15. Middletown, Md.	Catoctin Country Club	33	75	
16. Cumberstone, Md.	W. H. Kirkpatrick	51	65	Sassafras very fine sandy loam
17. Laurel, Md.		25	67	Leonardtown silt loam

Group 4 (*P. canescens*, male)

1. Taylors Island, Md.	Mr. Geoghegan	18	45	Elkton silt loam
2. " " "	Mr. Keene			" " "
3. Church Creek, Md.	Josiah Lenthicum	7	25	" " "
4. Easton, Md.	Mrs. H. B. Lockwood	7	20	Keyport silt loam
5. St. Michaels, Md.	Mrs. Parkerson	25	55	" " "
6. Grasonville, Md.	Fred Risley	23	38 (top pruned)	Elkton silt loam
7. Quaker Neck Landing, Md.	Mr. Craner			

Location	Owner or Tenant	DBH in inches	Height in ft.	Soil Class
8. Jefferson, Md.	Mr. Kemp	15	40	Ashe gravelly loam
9. West River, Md.	Christ Church			Sassafras fine sandy loam
10. Beltsville, Md.	Beltsville Research Center	20	47	Sassafras fine sandy loam
11. Washington, D.C. (24th & N Sts., NW)				
12. Washington, D.C. (Woodley Rd. & 29th St., NW)		9	46	
13. Lincoln Road, Washington, D.C.	Catholic University			
14. Washington, D.C. (Conn. & Tilden Aves., NW)	U.S. Bureau of Standards	22	70	
15. Capon Springs, W. Va.	Capon Springs Hotel	20	70	

For each group of four leaves in Plates 2, 3, and 4, there is the following arrangement:

Long shoot leaf upper side	Long shoot leaf lower side
Short shoot leaf upper side	Short shoot leaf lower side

PLATE 2

Leaves from six trees representative of Group 1.
1/4 natural size.

- -

PLATE 3

Leaves from six trees representative of Group 3.
1/4 natural size.

Plate 2

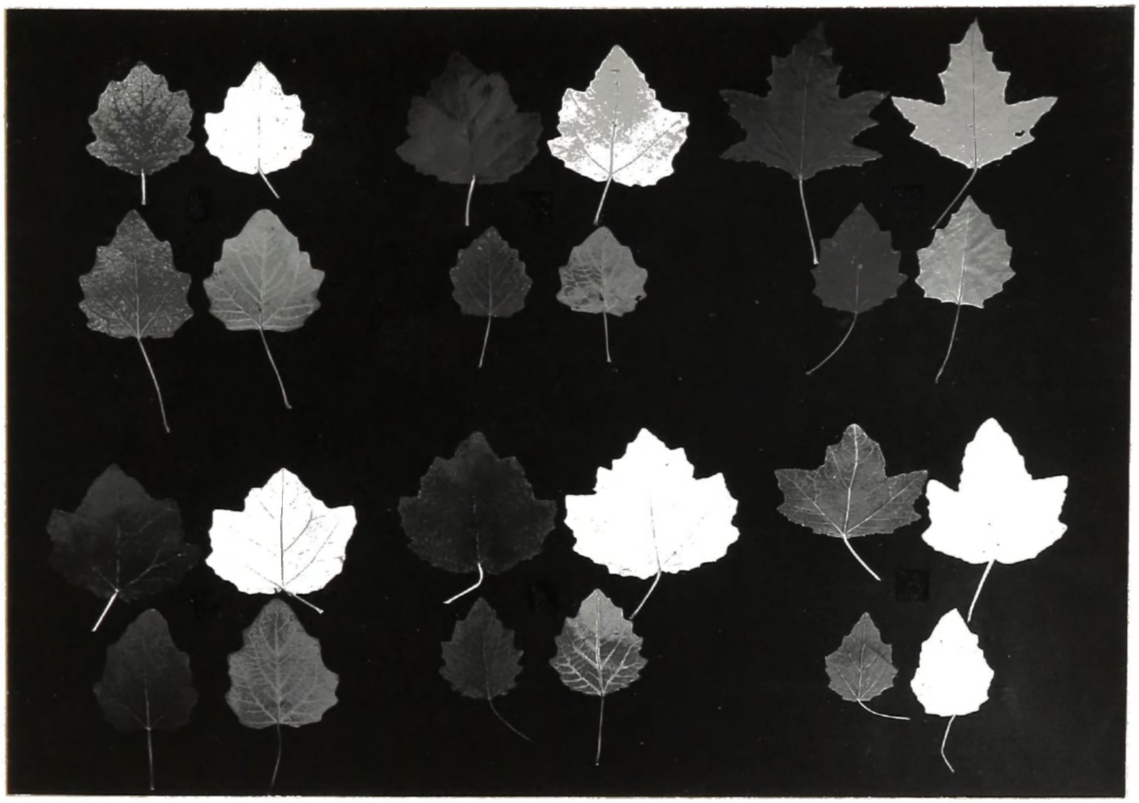

Plate 3

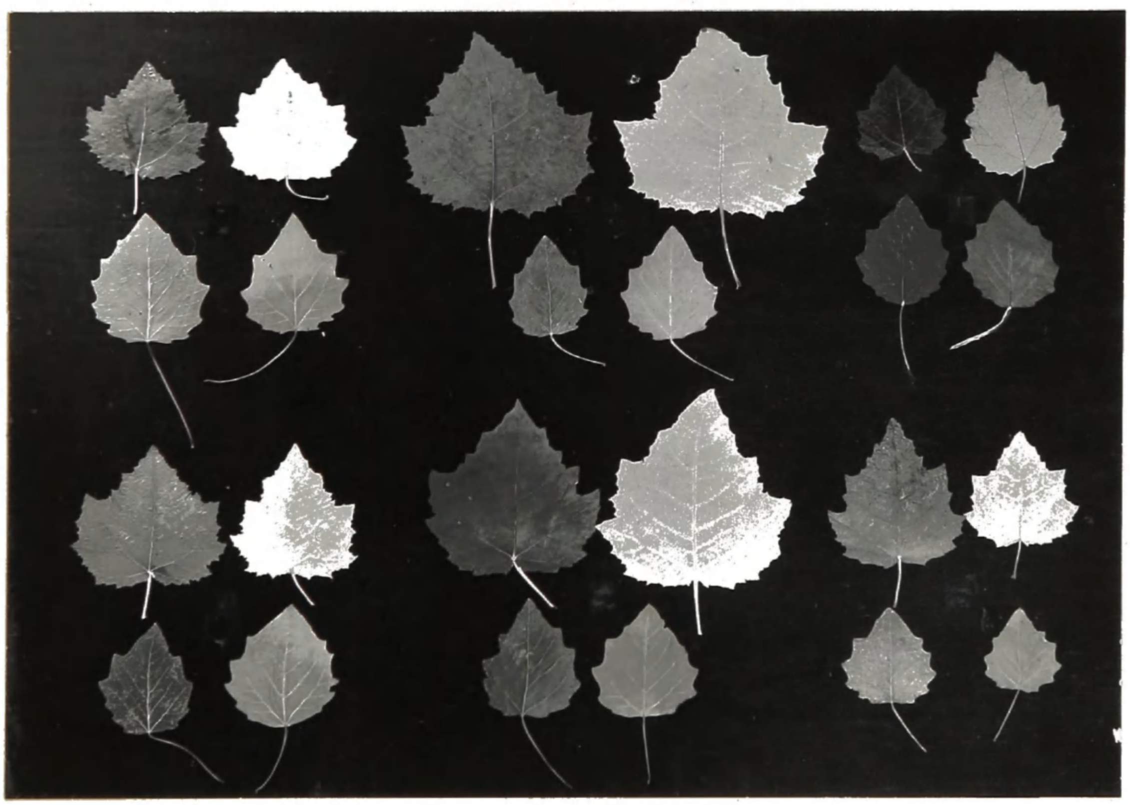

PLATE 4

Leaves from six trees representative of Group 4. 1/4 natural size.

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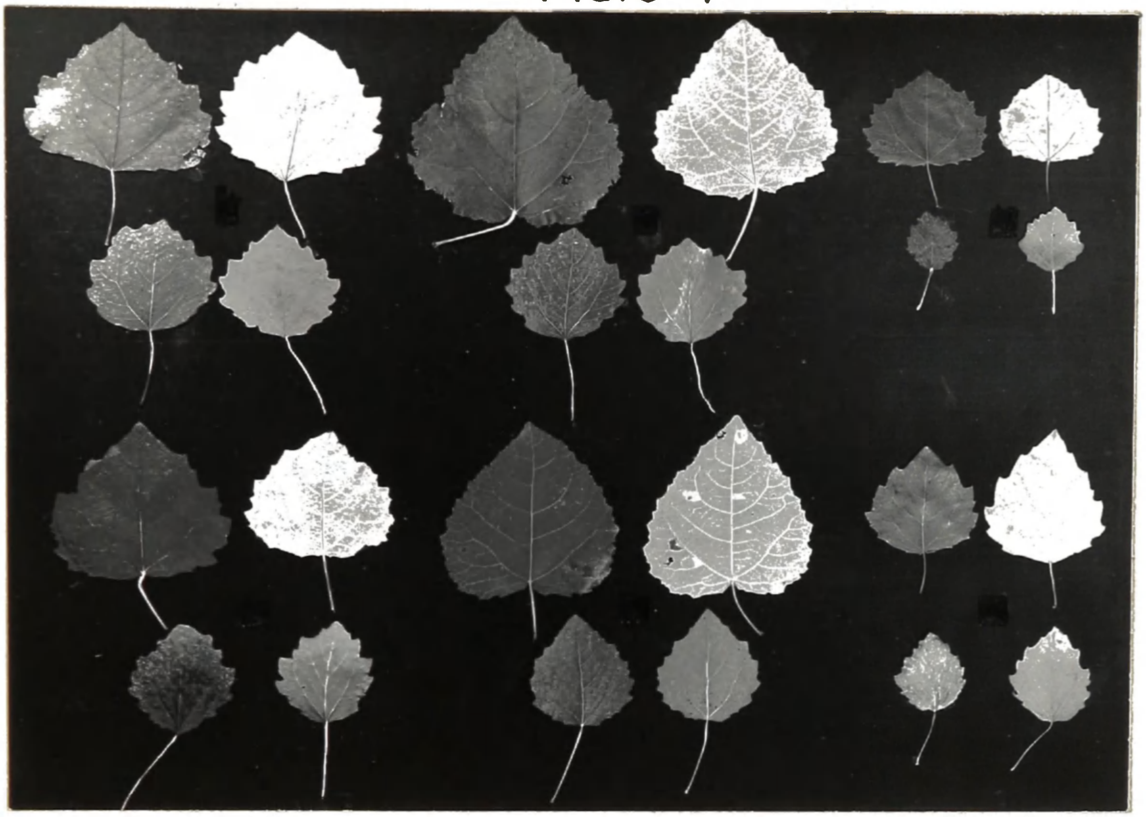
PLATE 5

Under surface of leaves to show pubescence typical of Groups 1 and 2 (Fig. 1) and Groups 3 and 4 (Fig. 2). 3/4 natural size.

Plate 4



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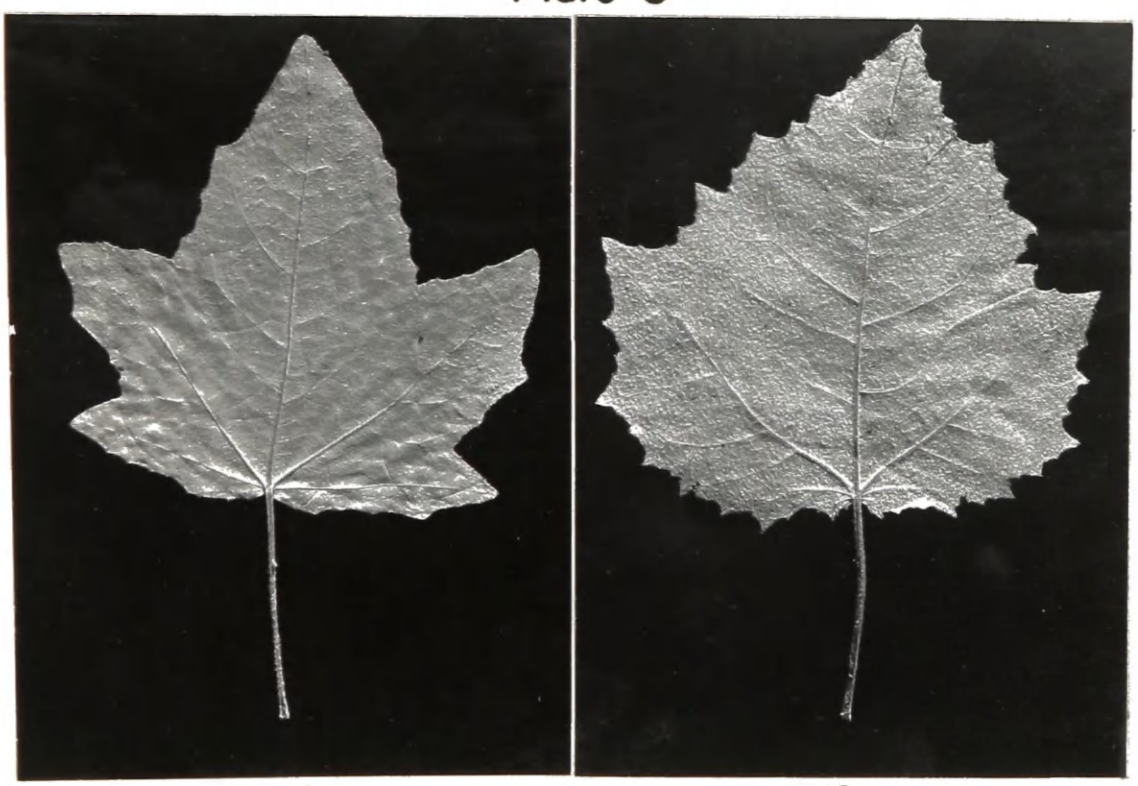


1 2

PLATE 6

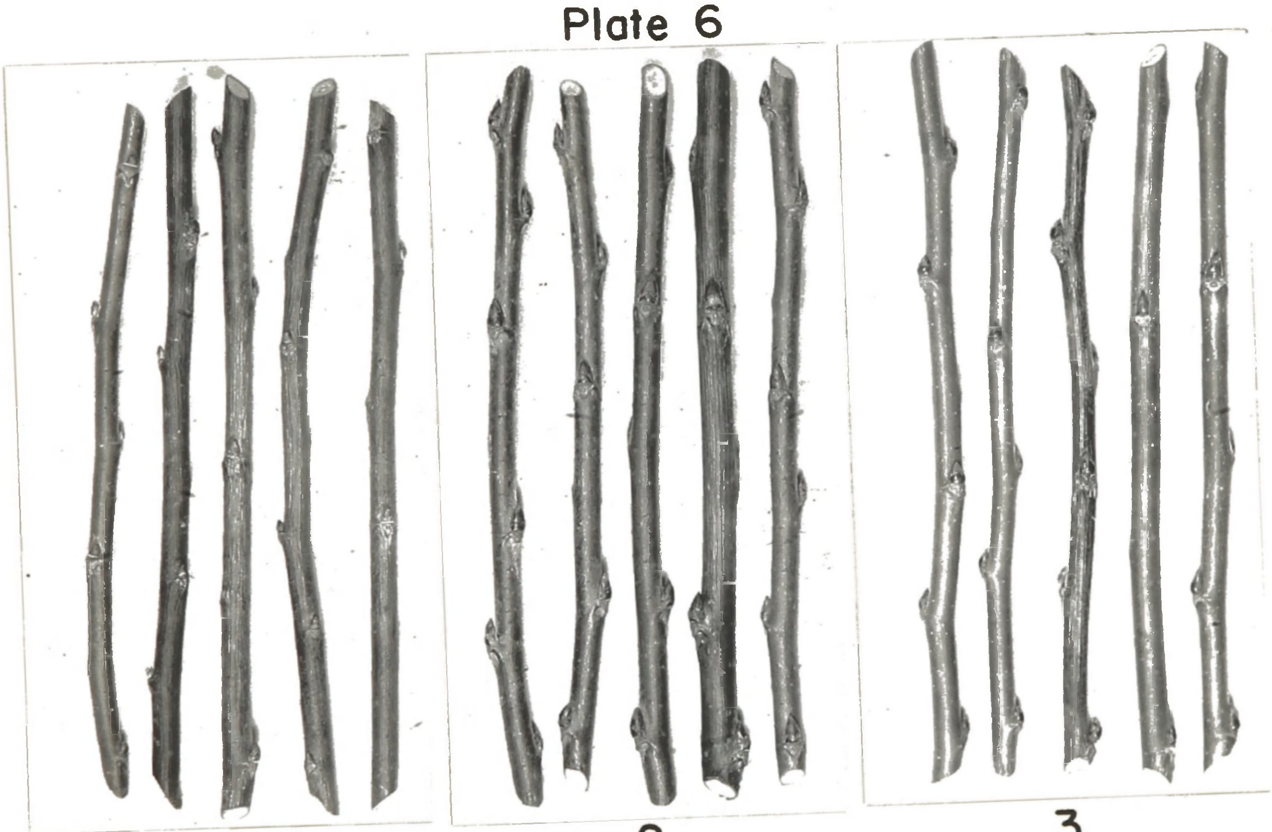
Sections of long shoots, showing lateral bud and leaf scar characters of the four major groups. 3/4 natural size.

Fig. 1. Groups 1 and 2

Fig. 2. Group 3

Fig. 3. Group 4

Plate 6



1 2 3

PLATE 7

Stages in the development of the two principal growth forms of white poplar.

Figs. 1, 2, and 3:	2-year sprout, sapling, and mature tree, respectively, of female growth form.
Figs. 4, 5, and 6:	2-year sprout, sapling, and mature tree, respectively, of male growth form.

Plate 7

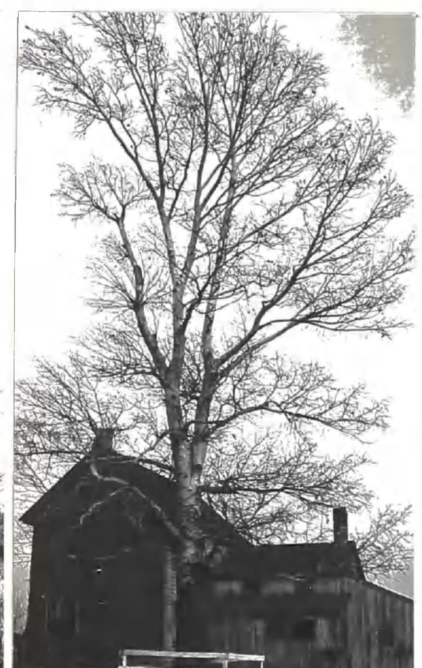
1

2

3

4

5



6

PLATE 8

Photomicrographs showing the ray anatomy of the four principal groups, tangential sections from outer wood of mature trees. X 125.

Fig. 1. Group 1

Fig. 2. Group 2

Fig. 3. Group 3

Fig. 4. Group 4

The rays of Group 3 (P. alba x P. canescens) are shorter, and the individual ray cells larger, than those of the other three groups.

Plate 8

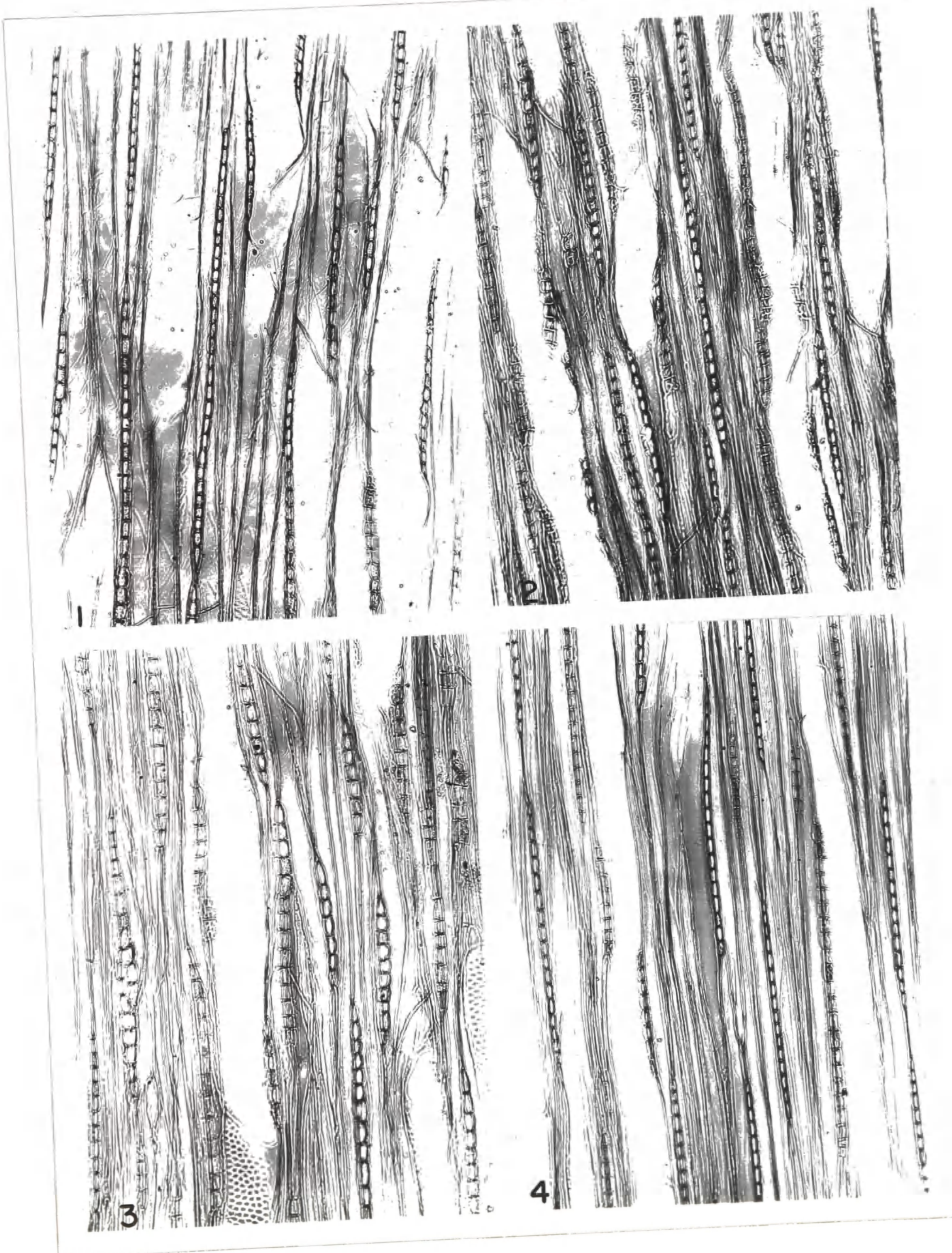


PLATE 9

Photomicrographs showing variation in ray anatomy from the wood of the same tree, tangential section. X 125.

Figs. 1 and 2. First-year wood from sprout, and outer wood from mature tree, respectively, of same clone. Group 2.

Figs. 3 and 4. Unfigured and highly figured wood from adjacent parts of the same tree. Group 4.

Plate 9

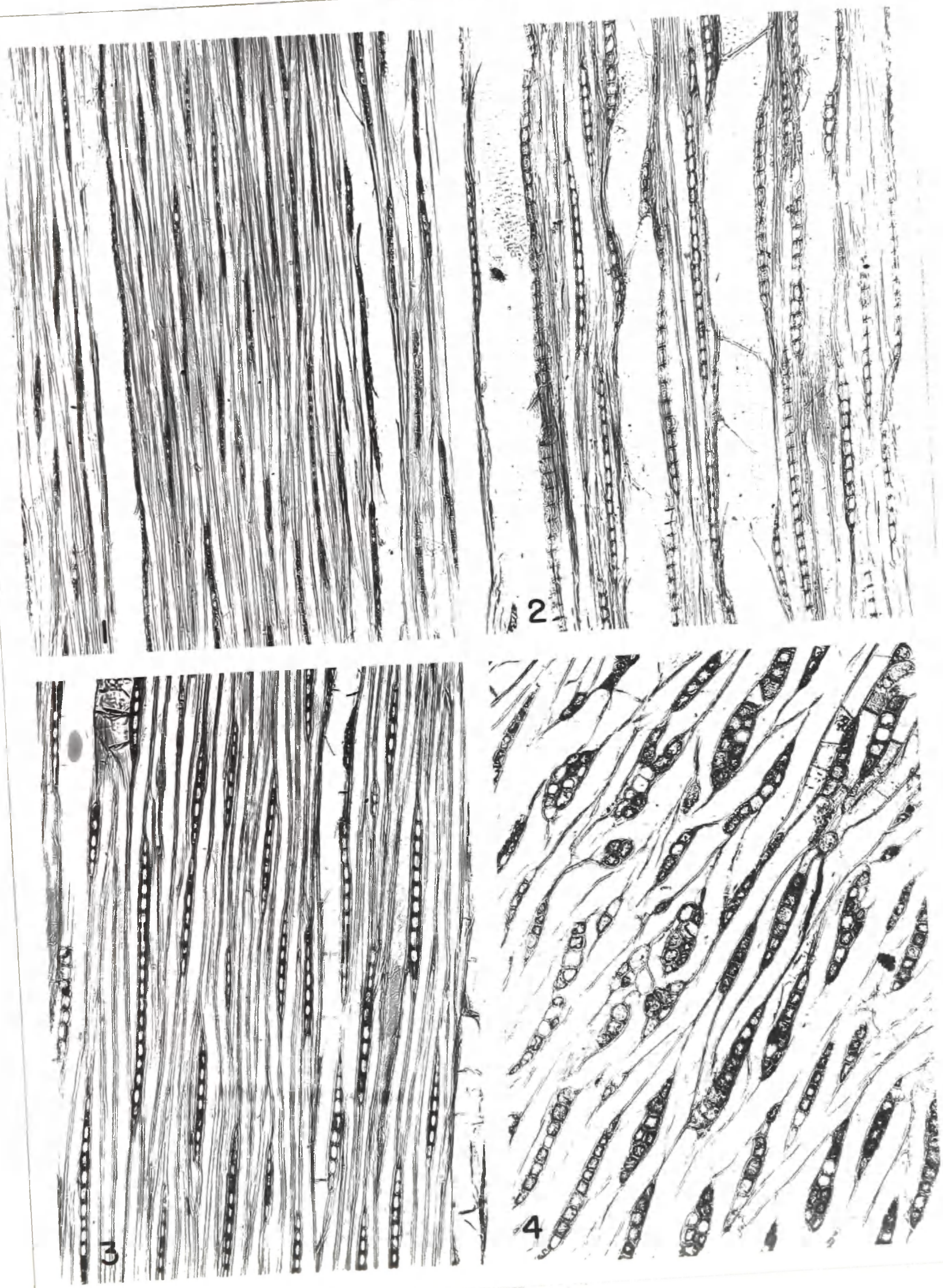


PLATE 10

Photomicrograph of birdseye formation in a one-year-old sprout, tangential section. X 200.

Fig. 1. Birdseye formation in the outer portion of the first year's wood.

Fig. 2. Same formation as Fig. 1, showing the origin in the pith.

Plate 10

1

2

PLATE 11

Cambium surface from several parts of a very high value tree, showing the highly developed configurations resulting from the radial proliferation and expansion of birdseye structures. 1/3 natural size.

Plate II

PLATE 12

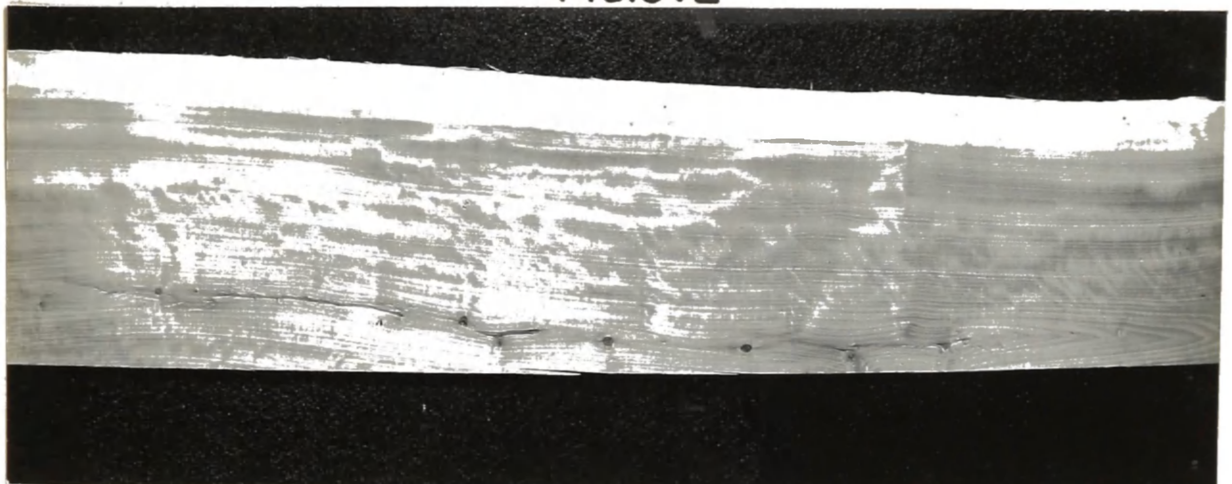
Sheets of commercial veneer showing different types and degrees of figured grain.

Fig. 1. A true quarter section showing the desirable effect of small branches on figure, the branches having abscissed while they were small. 1/6 natural size.

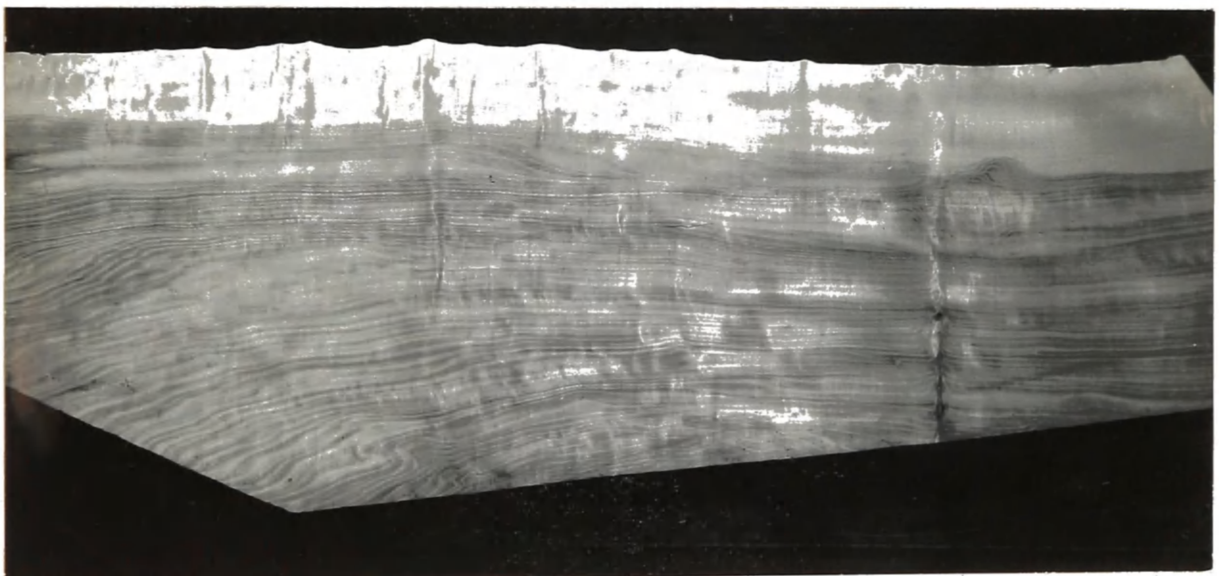
FFig. 2. A near quarter section showing the small radial curls due to birdseye. The small, dark line on the right is a defect due to a small persistent branch. 1/6 natural size.

Fig. 3. A highly figured sheet of veneer from the butt log of a high value tree. All the distinct types of wood configuration are present and interlocked, to form the unusually beautiful mottle figure. 1/10 natural size.

Plate 12



1



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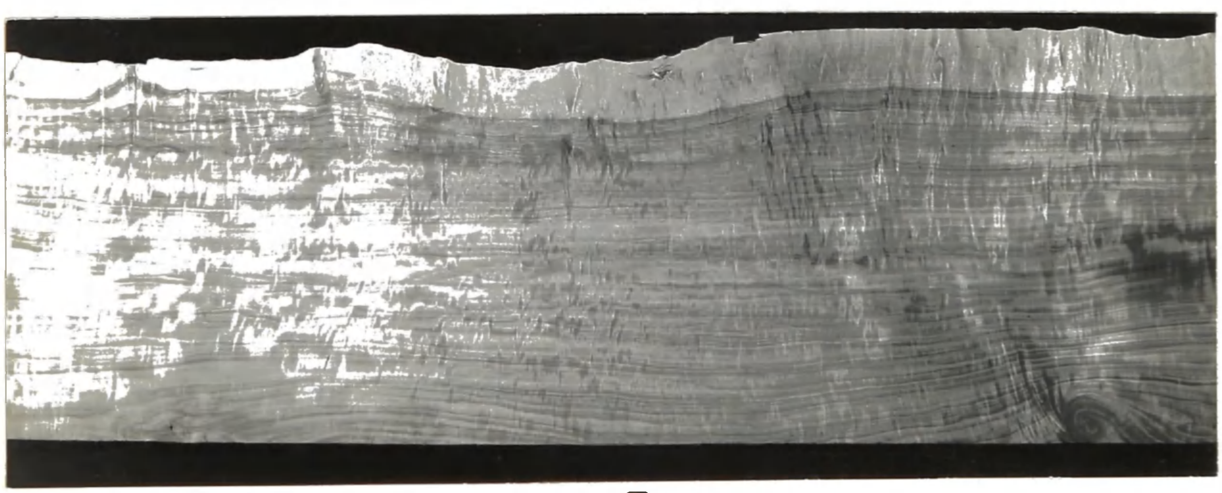

3