COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY 40601

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March 3, 1971

H. 2. 33

MEMORANDUM TO: J. R. Harbison, State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report; "Establishment of Woody Plants on Roadsides," KYHPR-65-33; HPR-1(6), Part II.

Complete clearing within earthwork construction boundaries is unavoidable; the intent to preserve "designated" trees, etc., outside earthwork limits is traceable to 1930 (...**Standard Specifications, 1930**). Assent to "roadside beautification" is traceable to 1929 (**Ninth Biennial Report**, State Highway Commission, Kentucky, p. 11). Clearing away scrubby growths or thickets interferring with construction, drainage, surveying, fencing, sight distance, mowing, etc., connotes necessary practices. Indeed, encroaching overgrowths are unwanted. However, ground covers of grasses and (or) woody plants are desirable and essential. Ideally, roadsides should at least match or otherwise enhance the complexion of the landscape. This basic principle is now reflected in the Department's policy statements regarding mowing practices.

Eventually, exposed earth will revegetate naturally if erosion does not progress too rapidly. Seeding (grasses) and plantings of vines and woody plants apparently date from the 1930's. A prominent landscaping project in the 30's was on US 42 between Louisville and Carrollton. After World War II, machinery for blowing mulches and seed became available. More recently, hydro-seeders have come into use. Most recently, anti-pollution measures have made early protection against erosion much more compelling.

The mowing policy, previously mentioned, together with anti-pollution control have developed during the term of study covered by the report submitted herewith. The study was conceived somewhat intuitively and now complements the actions above. During the study, direct seeding of woody plants was specified on an Interstate construction project (I 75-2(16)32, Laurel County); the contractor's

bid was discouraging. It seemed more feasible to defer this type of seeding to a later time. Two controlling considerations emerged. The first involves so-called stage-two fertilization of grasses. It seems that second-year fertilization (even withholding a portion of the first dosage for later application) assures more abundant growth and produces a denser sod. Most woody plant seedlings cannot compete with thick growths of fescue or crown vetch but will survive where grasses and legumes are somewhat stunted. Therefore, by merely withholding second-stage fertilization, natural or seeded regrowths of woody plants is encouraged. Of course, where woody plants are not wanted or where erosion is likely to occur, second-stage fertilization preferentially favors abundant growth of grasses and legumes. Border trees may supply enough windblown seed or root fragments to assure re-establishment of indigenous species. Direct seeding of woody plants in lieu of second-stage fertilization would, thereby, offer further assurances of early establishment and provide control of the species if desired. These summary conclusions are supported by other independent observations made by Roadside Development -- and which only here are merged into a more general overview.

This report completes the phase of study planned insofar as woody plants are concerned. The whole study includes another phase devoted to the establishment of turfs. Progress reports on the turf phase have been made but the final report remains pending. Both phases have been conducted entirely by the Division of Roadside Development. Implementation of several side benefits from the work has already been effected.

Respectfully submitted,

Jas. H. Havens
Director of Research

Enclosure

cc: Assistant State Highway Engineer, Research and Development
Assistant State Highway Engineer, Planning and Programming
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JHH:sg

ABSTRACT

ESTABLISHMENT OF WOOD PLANTS ON ROADSIDES

Recommendations for woody plant materials to be used in direct seeding are given on the basis of the plant's ability to regenerate from roots and natural seedings. Species are recommended for each of the relief and drainage subdivisions of the study area, southeastern Kentucky. Plant information on recommended native species has been summarized to provide basic data relevant to or needed by the highway landscape designer in selecting native plant combinations to be used in direct seeding.

Research Report

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ESTABLISHMENT OF WOOD PLANTS ON ROADSIDES (Southeastern Kentucky)

KYHPR-65-33
HPR-1(6), Part II

by

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Commonwealth of Kentucky

In cooperation with the
U. S. Department of Transportation
Federal Highway Administration

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INTRODUCTION

Naturalized roadside plantings are becoming more and more preferred as Kentucky and the nation seeks to preserve rural scenery, minimize erosion, and minimize the burden of mowing.

Hardy grasses and legumes suffice for ground covers where trees and shrubs are unwanted; native woody plants should suffice above mowing lines -- for forest regeneration, erosion control and aesthetics. These woody plants would soon blend into the more or less mature forests adjacent to a highway. Whereas spontaneous or volunteer regrowth may eventually arise, direct seeding and (or) other methods of propagation may prove to be feasible. Studies concerning the varieties of woody plants indigenous to a locale, together with propagation evaluations and field trials, are prerequisite to the formulation of planting guidelines and practices. This basic concept would be especially applicable to Eastern Kentucky and the Appalachian Region -- where forests abound and where highway construction involves deep cuts through mountainous terrain (see Figure 1).

Until the middle 1960's, Southeastern Kentucky had only a maturing system of first-generation, paved roads. Changing employment patterns and other economic needs have conduced the development of many new and improved arterial highways. The Interstate, Appalachian, and Parkway systems already serving the region and (or) under construction or planned will invite new industry and tourism. I75 and I64; US 23, 25E, 119, 421, and 460; KY 15 and 80; and the Daniel Boone Parkway serve or will serve the region.

The study region is that part of Southeastern Kentucky bounded by I75 and I64. The study involved three phases, as follows:

1. A survey of the native woody plant material growing alongside and close to the highways.

2. Selecting and testing native woody plant material for success of propagation and establishment on roadsides.

3. An evaluation of the suitability and usefulness of respective species for roadside enhancement.

FIELD SURVEY

The study region encompasses 35 Kentucky counties; these were grouped into six areas -- based on the relief and drainage. These divisions are also associated with the major highway arteries of Southeastern Kentucky (see Figure 2). The relief areas and associated major highways are US 119 and I75 -- Upper Cumberland River; US 23 -- Big Sandy River; Daniel Boone Parkway and KY 15 -- Upper Kentucky River; I75, US 421 and Mountain Parkway -- Lower Kentucky River; US 60, US 460 and I64 -- Licking River; US 60 and I64 -- Little Sandy River.

Each sample site was 200 feet parallel to the roadside by 75 feet perpendicular to the road edge. Samples were taken at approximately 10-mile intervals in order to obtain a systematic analysis of existing plant materials. Exceptions to the 10-mile interval were necessary in cases of extreme road hazard or cliffs along the roadside. The system of sites at which counts made during Phase 1 is shown in Figure 3.

The procedure used in the field study was to mark the plot with surveyor's ribbon and on the field map. Trees were named, counted and observed for associations in plant groupings and age. Ecological

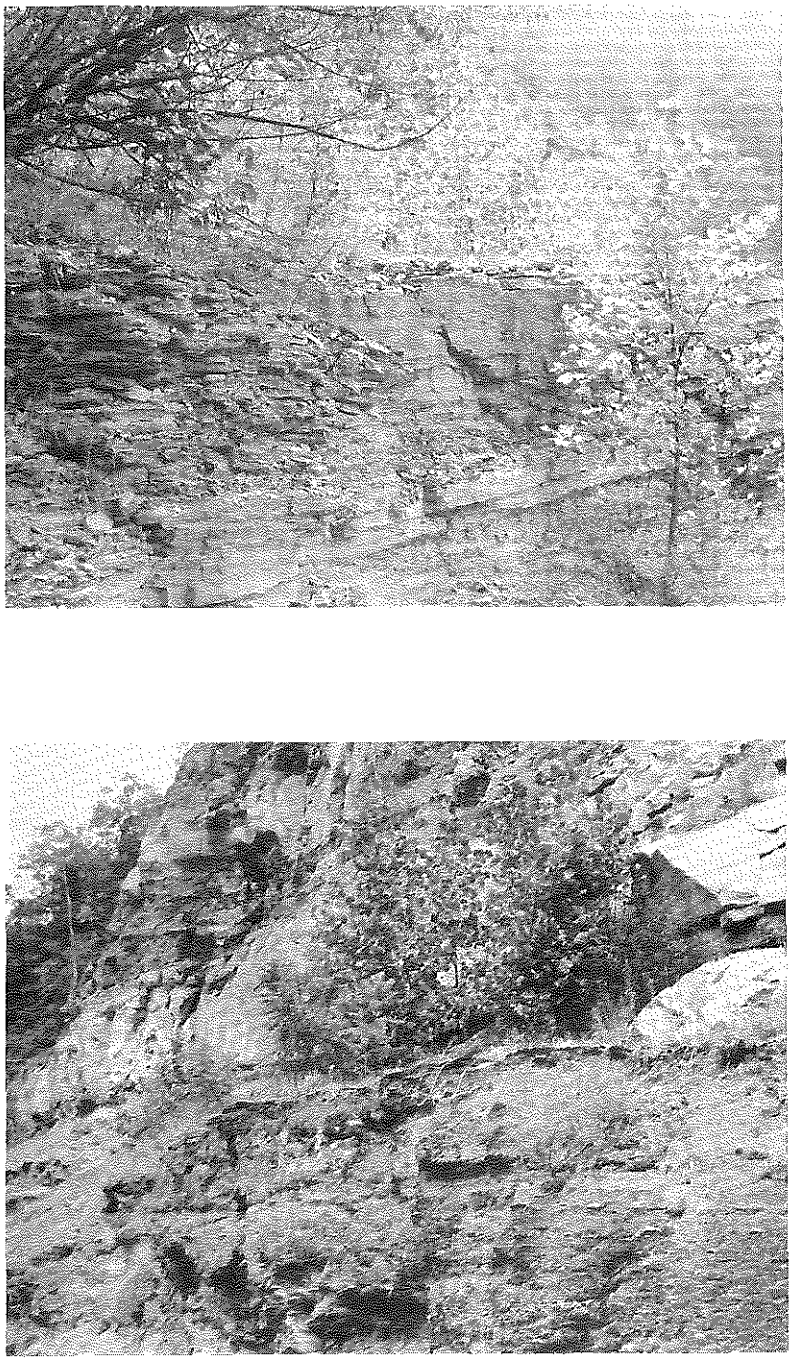

Figure 1. Plant material resulting from natural regeneration, located on KY 15 northwest of Jackson, Kentucky, helps to hold these existing benches. Deterioration of the bench is evident on this four-year old cut. The plants seem to be curbing the general breakdown of the bench.

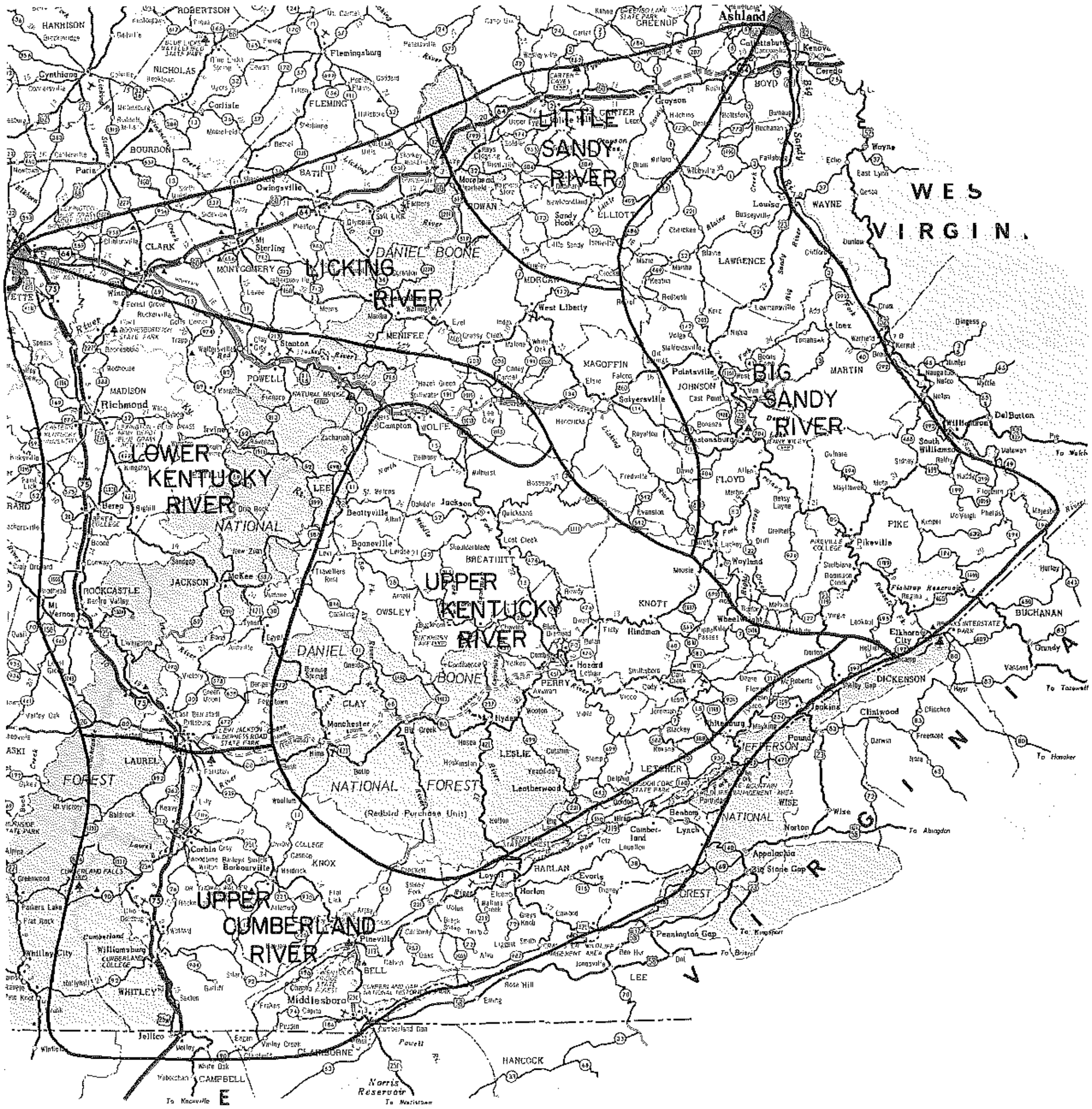

Figure 2. Major relief and drainage areas in Southeastern Kentucky.

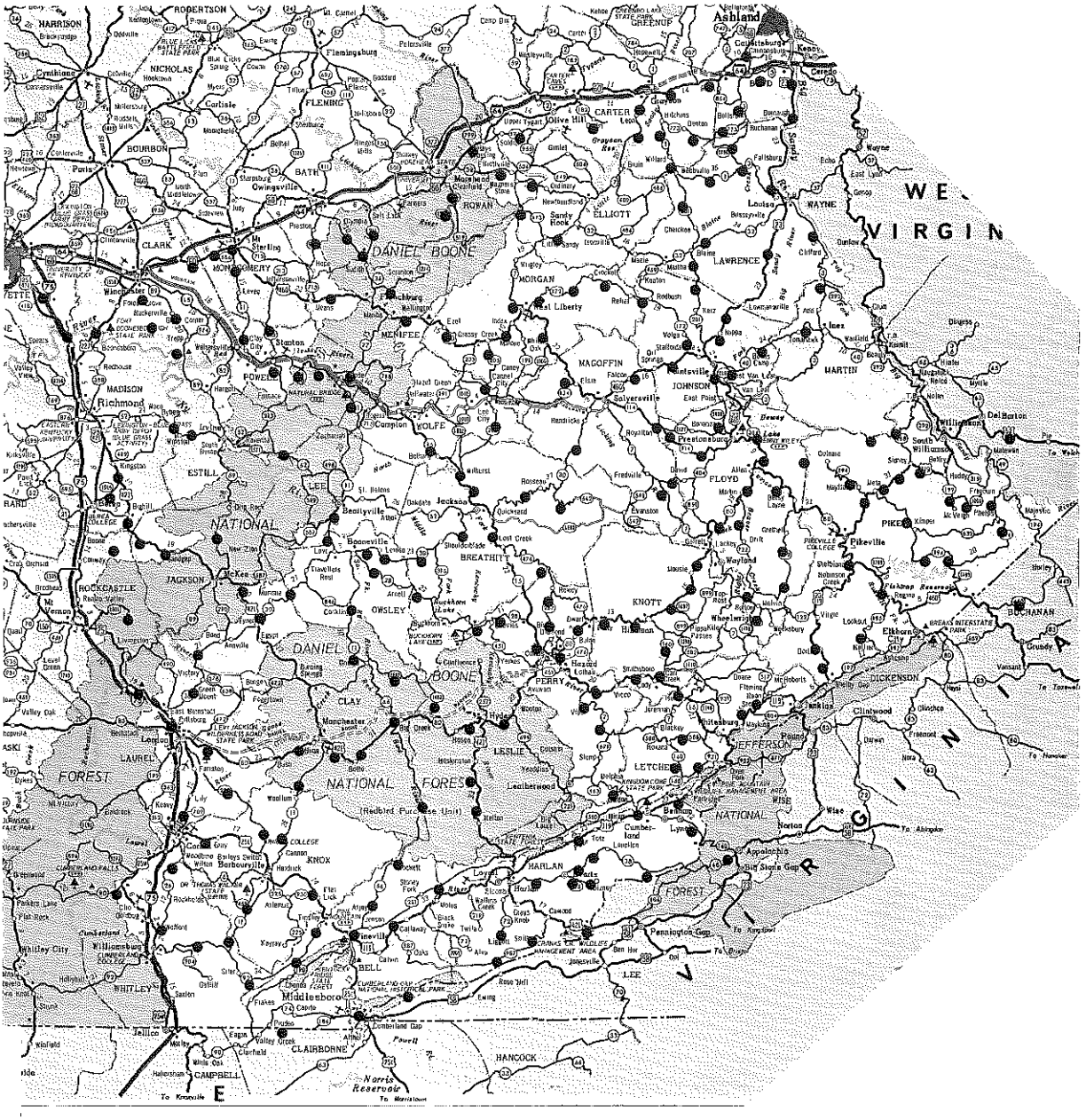

Figure 3. Sites sampled in field survey.

evaluations were made in terms of specific characteristics of soil, kind and amount of mulch, general elevations, slope direction and general ground covers. Leaf and twig samples were mounted, and pictures were taken for supporting evidence.

Seventy-one native species were studied in the field. A species appearing at least five times on two or more sites was considered significant. Table 1 is a listing of the species of plant material observed. Predominant species were determined by selecting those which appeared on one out of four sites with a plant count of ten or more trees and seedlings. The predominant woody plants, by relief areas, are listed in Table 2.

PROPAGATION STUDIES

Phase 2 included the collection of seedlings, propagation by cuttings and seeds, and observation of plant regeneration and soil erosion in new highway cuts.

Live Plant Collections

The collection of live material was made from selected sites well populated by respective species along secondary roads within a 60-mile radius of Riclumond, Kentucky. The purpose was to find a procedure for maintaining and growing natural cultures for controlled nursery production.

A further purpose of collecting live plants was to test the feasibility of a state nursery site for pre-selection and maintenance of materials for later use in pre-planned natural settings. These materials would not be of ornamental cultivar and would not otherwise be readily available for selection by the landscape designer. Unfortunately, designers may often recommend only ornamental species which are available on order from nurseries when a native species would be more desirable.

The plants were merely dug up -- saving as much soil on the roots as possible -- and then placed in mulch flats and transported to the Eastern Kentucky University nursery area. The following treatments were used for survival tests:

1. Lining out seedlings direct into nursery area.

2. Placing seedlings in a lathe house after potting (Figure 4) to hold for late fall lining out.

3. Placing seedlings in the greenhouse after potting to hold for late fall lining out.

Fifteen plants each of 30 different species were collected; the survival counts are listed in Table 3.

The high mortality rate of seedlings placed directly in the nursery and in the greenhouse was due to sun scorch and prevalent high temperature of late spring and summer -- eventually dehydrating and killing the plant. The same soil was used on all plants, and water was applied as the plants were in need.

The partial cover provided by the lathe house was enough to prevent sun scald, hold temperatures 7 to 10 degrees cooler during days with temperatures in the high 90's, and decrease the rate of evaporation from the plant and soil. Wintering the collected materials in a lathe house was also desirable because of the windbreak and moderating effects on outside conditions. The shade provided to winter sun was also important in preventing dehydration of evergreen materials. Mountain Laurel, Rose Bay Rhododendron and Hemlock should be grown and maintained in the lathe house until planted in a

Table 1: NATIVE MATERIAL SURVEYED

COMMON NAME	BOTANICAL NAME	COMMON NAME	BOTANICAL NAME
American Beech	Fagus grandifola	Pignut Hickory	Carya glabra
American Elm	Ulmus americana	Pitch Pine	Pinus rigida
American Holly	Ilex opaca	Post Oak	Quercus stellata
American Basswood	Tilia americana	Red Bud	Cercis canadenais
Bitternut Hickory	Carya cordiformis	Red Cedar	Juniperus virginiana
Black Cherry	Prunus serotina	Red Maple	Acer rubrum
Black Gum	Nyssa sylvatica	Red Mulberry	Morus rubra
Black Jack Oak	Quercus marilandica	River Birch	Betula nigra
Black Locust	Robinia pseudocacia	Rose Bay	Rhododendron maximum
Black Oak	Quercus velutina	Shortleaf Pine	Pinus echinata
Black Walnut	Juglana nigra	Sandbar Willow	Salix interior
Black Willow	Salix nigra	Sassafras	Sassafras albidum
Boxelder	Acer negundo	Shagbark Hickory	Carya ovata
Buckeye	Aesculus glabra	Shingle Oak	Quercus imbricaria
Carolina Beech	Fagus caroliniana	Silver Maple	Acer saccharinum
Catalpa	Catalpa speciosa	Slippery Elm	Ulmus rubra
Chestnut Oak	Quercus prinus	Smooth Sumac	Rhus glabra
Cucumber Magnolia	Magnolia accuminata	Sourwood	Oxydendrum arboreum
Devil's Walking Stick	Aralia spinosa	Southern Red Oak	Quercus falcata
Dogwood	Cornus florida	Spice Rush	Lindera benzoin
Downy Hawthorn	Crategus mollis	Staghorn Sumac	Rhus typhina
Dwarf Sumac	Rhus copallina	Sugar Maple	Acer saccharum
Fragrant Sumac	Rhus aromatica	Sweet Birch	Betula lenta
Green Ash	Fraxinus pennsylvanica	Sweetgum	Liquidambar styraciflua
Hackberry	Celtis occidentalis	Sycamore	Platanus occidentalis
Hemlock	Tsuga canadensis	Tree of Heaven	Ailanthus altissima
Honey locust	Gleditsia triacanthus	Tulip Poplar	Liriodendron tulipifera
Ironwood	Ostrya virginiana	Umbrella Magnolia	Magnolia tripetala
Mimosa	Albizia julibrissin	Virginia Pine	Pinus virginia
Mockernut Hickory	Carya tomentosa	White Ash	Fraxinus americana
Mountain Laurel	Kalmia lalifola	White Mulberry	Morus alba
Northern Red Oak	Quercus rubra	White Oak	Quercus alba
Osage Orange	Maclura pomifera	White Poplar	Populus alba
Paper Mulberry	Broussonetia papyrifera	Winged Elm	Ulmus alata
Paw Paw	Asimina triloba	Witch Hazel	Hamamelis virginiana
Persimmon	Diospyron virginiana		

NOTE: Common names of plant materials are used throughout the text. Botanical names of a species not listed here but introduced for discussion will be given with the common name.

Table 2: PREDOMINANT TREES BY RELIEF AREAS

BIG SANDY

Northern Red Oak
White Oak
American Beech
Chestnut Oak
Sassafras
Virginia Pine
Sugar Maple
Smooth Sumac
Tulip Poplar
Shagbark Hickory
Dogwood
Slippery Elm
Redbud
American Elm
Black Willow
Tree of Heaven
Black Locust
Red Maple
Dwarf Sumac
Pignut Hickory
Southern Red Oak
Black Oak
Ironwood
Paw Paw
Hemlock
Boxelder
Carolina Beech
Red Mulberry
Sandbar Willow
White Ash
Sycamore
Green Ash
Black Gum
Sourwood

LOWER KENTUCKY

White Oak
Sassafras
Tulip Poplar
Shagbark Hickory
Dogwood
Slippery Elm
Redbud
American Elm
Red Maple
Black Locust
Red Cedar
White Ash
Sycamore
Green Ash
Mockernut Hickory
Black Walnut

UPPER KENTUCKY

Northern Red Oak
White Oak
American Beech
Sassafras
Virginia Pine
Sugar Maple
Smooth Sumac
Tulip Poplar
Shagbark Hickory
Dogwood
Slippery Elm
Redbud
American Elm
Black Willow
Tree of Heaven
Black Locust
Red Maple
White Ash
Sycamore
Green Ash
Black Walnut

LITTLE SANDY

White Oak
Sassafras
Smooth Sumac
Tulip Poplar
Black Locust
Redbud
American Elm
Black Willow
Dwarf Sumac
Dogwood
Persimmon
Shagbark Hickory
Virginia Pine
Slippery Elm
American Beech
Red Maple
Pignut Hickory
Black Oak
Red Cedar
Devil's Walking Stick
White Mulberry
Boxelder
Black Pine
Sandbar Willow
White Ash
Sycamore
Green Ash
Black Walnut
Black Gum
Mockernut
Sweet Birch
Sourwood

UPPER CUMBERLAND

Northern Red Oak
White Oak
American Beech
Chestnut Oak
Sassafras
Virginia Pine
Smooth Sumac
Tulip Poplar
Shagbark Hickory
Dogwood
Slippery Elm
Redbud
American Elm
Black Willow
Tree of Heaven
Black Locust
Red Maple
Sugar Maple
Pignut Hickory
Black Oak
Ironwood
Umbrella Magnolia
Cucumbertree
Paw Paw
Buckeye
Hemlock
Boxelder
White Ash
Sycamore
Green Ash
Black Walnut
Black Gum
Sourwood

LICKING

Northern Red Oak
White Oak
American Beech
Sassafras
Virginia Pine
Smooth Sumac
Tulip Poplar
Shagbark Hickory
Dogwood
Slippery Elm
Redbud
American Elm
Black Willow
Black Locust
Red Maple
Sugar Maple
Pignut Hickory
White Ash
Sycamore
Green Ash
Mockernut Hickory
Black Gum

Figure 4. Collected materials and propagated stem cuttings survived well in lathe house, while other materials in an open condition suffered high mortality rates. These materials can be handled well in the nursery after summer hardening-off is complete.

Table 3: PERCENT SURVIVAL OF LIVE TRANSPLANT MATERIAL

	DIRECT-PLANTED SURVIVAL	LATHE HOUSE SURVIVAL	GREENHOUSE SURVIVAL
American Basswood	0	40	0
American Elm	20	80	40
American Holly	0	100	40
Black Gum	0	100	20
Black Locust	40	100	60
Black Walnut	20	60	60
Buckeye	20	80	20
Chestnut Oak	40	80	60
Cucumber Magnolia	0	40	20
Dogwood	0	100	40
Dwarf Sumac	0	80	20
Hemlock	20	100	40
Mimosa	80	100	60
Mountain Laurel	0	40	0
Paw Paw	20	60	0
Red Mulberry	40	80	60
Rose Bay Rhododendron	0	60	20
Sassafras	0	80	60
Shagbark Hickory	0	100	40
Silver Maple	40	100	60
Slippery Elm	40	80	20
Southern Red Oak	20	80	0
Sugar Maple	40	100	40
Sweet Gum	20	60	0
Sycamore	40	80	40
Tulip Poplar	20	100	40
Umbrella Magnolia	0	40	20
Virginia Pine	40	80	40
White Ash	20	80	60
White Oak	0	100	20

select shaded site.

A procedure for collecting specific native plants would be:

1. Collect the seedlings in the months of May and June. Plants in growth are more easily identified because native materials tend to hybridize -- making it often difficult to determine the correct classification. Seedlings easily identified would be best transplanted in late fall or early spring.

2. Select seedlings from populated areas and place in a soil substance to hold moisture on roots until transplanting or potting.

3. Provide partial shade for late spring and early summer collections through first summer. (Canvas, mesh saran cloth or lathe provides excellent cover.)

4. Place late spring and early summer collections in full sunlight in the spring of second year. Potted, container-grown materials would best be transferred to a larger container and left until transplanted to the roadside.

Propagation From Cuttings

Propagation from stem cuttings was intended to determine the usefulness of this method for mass collection. Fifty stem cuttings were prepared from each of fifteen selected trees. Root cuttings were also taken from Mountain Laurel, Hemlock and Rose Bay Rhododendron. Eight-inch stem cuttings and root modules of an equivalent size were treated with indobutyric acid, placed in flats of vermiculite, and placed under the misting system in the greenhouse at Eastern Kentucky University for 60 days. The mist system was cycled 5 seconds "on" and 54 seconds "off". Table 4 lists the plant materials and percentages of cuttings giving root and shoot formation.

In March and April 1970, root cuttings of Hemlock, Rose Bay Rhododendron and Mountain Laurel were taken and prepared for field propagation. The purpose was to introduce these plants into areas of Kentucky where they are not presently growing. Roots were taken from along roadsides. The roots were cut in 6-inch lengths and placed in a diluted solution of indobutyric acid (rooting hormones -- shoot inducing hormones – were not used), zineb (fungicide) and malathion (insecticide) for 24 hours. The cuttings were planted on sites where high moisture and partial shade persisted. Planting was at the rate of approximately 100 cuttings per site, with each site varying in size from 100 to 1000 square feet. A description of the sites follows:

Site 1 Two miles west of Irvine (northern exposure, shaded) - KY 52

Site 2 Bench four miles west of Irvine (shaded) - KY 52

Site 3 Bench and waterway six miles east of Richmond - KY 52

Site 4 Bench and waterway 5 1/2 miles east of Richmond - KY 52

Site 5 Bench ten miles east of Pineville (seepage area) - KY 119

Site 6 Bench and waterway at Wallins Creek exit - KY 119

Site 7 Waterway two miles east on new construction - KY 119

Table 4: PERCENT OF STEM OR ROOT CUTTINGS ROOTED (GREENHOUSE)

PLANT MATERIAL	PERCENT OF CUTTINGS ROOTED OR SHOWING SHOOT FORMATION
American Elm	38
American Holly	62
Black Willow	84
Boxelder	70
Dogwood	44
Mountain Laurel	6
Quaking Aspen	16
Redbud	58
Red Maple	66
Red Mulberry	40
Sweet Birch	26
Sycamore	38
Virginia Pine	60
White Ash	52
White Oak	12
Hemlock *(Root Cuttings)*	17
Mountain Laurel *(Root Cuttings)*	32
Rose Bay Rhododendron *(Root Cuttings)*	16

Site 8 Waterway three miles southeast of Campton - Ky 119

Site 9 Waterway twenty miles northeast of Paintsville - KY 23

Site 10 Waterway fifteen miles northeast of Paintsville - KY 23

Site 11 Waterway three miles northeast of Paintsville - KY 23

There were no visible results of shoot formation in June. Factors contributing to negative results were:

1. Damp, shaded sites selected in late fall and winter proved to dry out quickly and have actually little shade during late spring and summer months.

2. Waterway sites selected immediately following completion of earthwork eroded very badly covering and washing away the root cuttings.

These sites will be observed again in June of 1971 for more conclusive results.

If propagation of these materials proves effective, the procedure would be to follow direct seeding and natural regeneration four to five years later with selected root cutting on desirable roadside sites. Desirable conditions necessary for Rose Bay Rhododendron, Mountain Laurel and Hemlock are shaded sites and moist soils. They display lush growth in organic and moist soils of mature forest areas of the Upper Cumberland River, the Upper Kentucky River and the Lower Big Sandy River.

Propagation by Direct Seeding

Direct seeding was planned for the fall of 1969. The commercial seed company failed to honor the order until late December, forcing the seeding date to February 1970. Seed of black gum, boxelder, shortleaf pine, slippery elm, sourwood, sycamore and Virginia pine were not received.

The sites selected were on US 119, US 23, KY 15 and KY 52. The characteristics of the sites were varied in order that comparisons could be made with respect to slope direction, percent of slope, location on the cut, soil description and regional location. The purpose for selecting sites having varied conditons was to demonstrate field tests similar to actual roadside direct seeding. Each site is not individually described in this report; however, specific details of major influencing factors relating to these plots are discussed.

Seed for this test was not stratified or scarified; no treatment was administered. The purpose of limiting treatment was to set up a close similarity to commercial hydroseeding which is expected to be done on highway construction projects. The available seed materials were grouped by association and tolerance. Deciduous and conifers were placed together on each of the test sites.

Seeding rates varied with kind and size of seed on each plot. Two to 10 seed per square foot was the seeding rate. The seed numbers were varied in relation to different plant materials based on laboratory germination tests. Table 5 lists sites, highway locations and plant material groupings.

The field procedure was to group the seed in containers and mix with 10-10-10 fertilizer for broadcasting (fertilizer was used at the rate of 23 pounds per 1,000 square feet, which is the Kentucky Highway Department's standard fertilization rate), to broadcast the seed over the site area of 1,000 square feet, and to cover with straw at a thickness of approximately 1.5-inch loose depth. Two miles of KY 52 were direct seeded with a hydroseeder in March 1970. The hydroseeding rate was raised to

	SITE 1		SITE 2		SITE 3		SITE 4		SITE 5		SITE 6		SITE 7		SITE 8		SITE 9		SITE 10		SITE 11	
	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970
Red Maple												Site Lost To Landslide							600	2		
Sugar Maple	600	4			600	1					600										300	4
Mimosa	600	4					600	3			600				100	2	200	2	200		200	2
Paw Paw							100				100											
American Hornbeam	100	2	100	3	100	1																
Hackberry							600				600											
Redbud	600	2					600	1			600				100	1			600	2	100	1
Dogwood	600	1			600	1					200				600	4					200	2
Downy Hawthorn			100	1											100				100		200	
Persimmon																						
Kentucky Coffee Tree	100		100		100														100		50	
American Holly	100		100	1	100										100	1			100		200	
Red Cedar			200	4			100								100		200	6	100	1		
Sweetgum			600		600		600	1			600				600	1					300	1
Tulip Poplar			600	2			600	1							600	3					300	1
Red Mulberry			600	2	600	1					600											
Black Pine	100	} 3	100	} 6	100	} 3	100	2			100				100	} 2			100	} 4	100	2
White Pine	600		600		600										600		600	2	600			
Black Cherry							100															
Fragrant Sumac					600	2					600				600	1			600	1	200	
Dwarf Sumac			600	4			600												600		200	
Staghorn Sumac	600										600		2000	1			1000	3				
Black Locust			200	17	600	8	600	14	2000	33	200		2000	28			1000	11	200	10	100	14
Canadian Hemlock	600				600						600				600	1			100		200	1
American Elm																						
TOTAL SEEDS	4600		3900		5200		4600		2000		6000		4000		4200		3000		4000		2650	

SITE 1 - US 23 (1/4 mile northeast of Paintsville) 4600 seeds
SITE 2 - US 23 (4 miles northeast of Paintsville) 3900 seeds
SITE 3 - US 23 (6 miles northeast of Paintsville) 5200 seeds
SITE 4 - US 23 (8 miles northeast of Paintsville) 4600 seeds
SITE 5 - US 23 (8 miles northeast of Paintsville) 2000 seeds
SITE 6 - US 119 (6 miles southwest of Harlan) 6000 seeds
SITE 7 - US 23 (5 miles northeast of Paintsville) 4000 seeds
SITE 8 - US 23 (5 miles northeast of Paintsville) 4200 seeds
SITE 9 - US 23 (5 miles northeast of Paintsville) 3000 seeds
SITE 10 - US 119 (8 miles northeast of Pineville toward Harlan) 4000 seeds
SITE 11 - KY 15 (4 miles north of Hazard) 2650 seeds

Table 5: TEST PLOT OBSERVATIONS

	SITE 12		SITE 13		SITE 14		SITE 15		SITE 16		SITE 17		SITE 18		SITE 19		SITE 20		SITE 21		SITE 22		SITE 23	
	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970	SEEDED FEB 1970	PERCENT GERMI-NATED JUN 1970
Red Maple																								
Sugar Maple	300	2			150	3	150	1	200	1	200	4	200	3	200		200	2	200	1	200	2		
Mimosa					1200	2	200	2	200	1			200	1			200	4			200	1	2000	1
Paw Paw											200						100							
American Hornbeam									100	1			100				100	1			100			
Hackberry											100	2			100				100	2				
Redbud	100						200	5	100	3	100	2	100	2	100		100	1	100		100	1		
Dogwood	200	2			500		200	1	200	1	200	3	200		200	3	200		200	1	100			
Downy Hawthorn	100				200										200	1								
Persimmon															200	1								
Kentucky Coffee Tree					25		10		20															
American Holly	200								100				100				100	1			100			
Red Cedar			800	3							100				100	2			100				1000	1
Sweetgum	300				400	1	100	3	100		100		100	1	100		100		100	1	100		5000	1
Tulip Poplar	300	3			300	1	300	2	100	1	100	2	100	1	100		100	1	100		100	3	5000	1
Red Mulberry	200	1	800	1	1200	1	200	2			200				200				200		100			
Black Pine	100 }	1							100 }	4			100 }	2			100 }	2			100 }	1	2000 }	2
White Pine	200 }				800	3	1000	4	200 }		200	3	200 }				200 }				200 }		2000 }	
Black Cherry											100	2			100				100	1				
Fragrant Sumac					200		400	2			100		100		100	2			100					
Dwarf Sumac	200						100		100	1							100				100		4000	
Staghorn Sumac	300		800	4					100	2	100	2	100				100				100		6000	2
Black Locust	100		2000	7	1200	12			100	8	100	11	100	7	100	13	100	1	100	2	100	6	3000	8
Canadian Hemlock	200	2			800	2	100	2	100		100				100	1	100		100		100	1		
American Elm									200	3											200	3		
TOTAL SEEDS	2800		4400		6975		2960		2020		2000		1700		1900		1900		1500		2000		30000	

SITE 12 - KY 15 (west of Hazard) 2800 seeds
SITE 13 - KY 15 (ledge across from Site 12) 4400 seeds
SITE 14 - KY 52 (5 miles northeast of Richmond) 6975 seeds
SITE 15 - Control Greenhouse (Richmond) 2960 seeds
SITE 16 - KY 52 (8 miles west of Irvine, south slope) 2020 seeds
SITE 17 - KY 52 (7 miles west of Irvine, west slope) 2000 seeds
SITE 18 - KY 52 (6-1/2 miles west of Irvine, south slope) 1700 seeds
SITE 19 - KY 52 (5 miles west of Irvine, east slope) 1900 seeds
SITE 20 - KY 52 (4 miles west of Irvine, north slope) 1900 seeds
SITE 21 - KY 52 (3 miles west of Irvine, north slope) 1500 seeds
SITE 22 - KY 52 (3 miles west of Irvine, south slope) 2000 seeds
SITE 23 - KY 52 (1 mile of hydroseeding, both sides of highway) 30000 seeds

Table 5: TEST PLOT OBSERVATIONS (Continued)

20 seed per square foot because of seed settling to the bottom of the seeder and seed lost from the area during the seeding process. An observation following the hydroseeding process showed success in even seed distribution and points to the expected success of hydroseeding woody plant seed simultaneously with seeding ground covers.

Each direct-seeded plot was observed during June and early July of 1970 (see Figure 5). The following observations and conclusions were made on the early spring seeding test. Approximately two percent of the deciduous plant materials were germinated in spring growth. The conifers germinated at the rate of approximately four percent. The rate of germination for each plant is listed in Table 5.

In order to view the condition of the ungerminated seed, a 6-inch square plug was taken from each site for laboratory study. An average of five ungerminated seeds per plug were found. There were no visible signs of injury to the seed. A germination test produced no seedlings after eight weeks; however, the test is being continued.

Black locust is the only deciduous plant in this test proven to be useful with treatment in early spring seeding. It was used on 40-percent slopes which had two to three inches of soil covering. In June, the slope was heavily eroded, but the black locust was becoming established with a germination rate of one percent. On four bench sites, black locust had germination rates ranging from 8 to 33 percent -- shale banks having a pH of 2.5 - 3.5 were unfavorable.

It is often that a commonly found plant may thrive in adverse growing conditions, as in the case of black locust. Black locust generates rapidly, but is often intolerant to other plants and serves to assist the establishment of other woodys at the expense of its own perpetuation. Black locust is not competitive with heavy turf grass nor other ground covers.

The pines (Pinus ssp) have given the best germination results among the conifers. There is approximately six percent germination. On August 20, 1970, an obeservation of six plots on US 23 showed pines at various seedling and embryonic stages, indicating continued germination through the spring and early summer months. An acceptable germination and seedling rate may be maturing by the summer of 1971.

Pines are seen in Southeastern Kentucky in mass plantings. This suggests the idea of seeding many roadsides in pines. It should be recognized that the natural setting for Kentucky is a mature hardwood forest with occasional conifer thickets. Mixed seedlings of deciduous material and conifers would contribute greatly to the natural restoration of these areas.

SUMMARY AND DISCUSSIONS

This study phase began the second week of June 1968. Testing of mass propagation of selected woody materials was undertaken in 1969. The purpose of this evaluation is to report progress and to give proper recognition to field tests and to point up significiant observations. The mass collection procedure and cuttings propagation can be evaluated here. However, the direct seeding tests have not had enough time for full evaluation. It should also be noted here that only spring seeding has been tested. Fall testing could also be investigated. Recommendations for direct seeding fall and spring tests will follow.

Plant Regeneration Observations

Plant regeneration is used here to describe seedlings produced from covered over roots and twigs

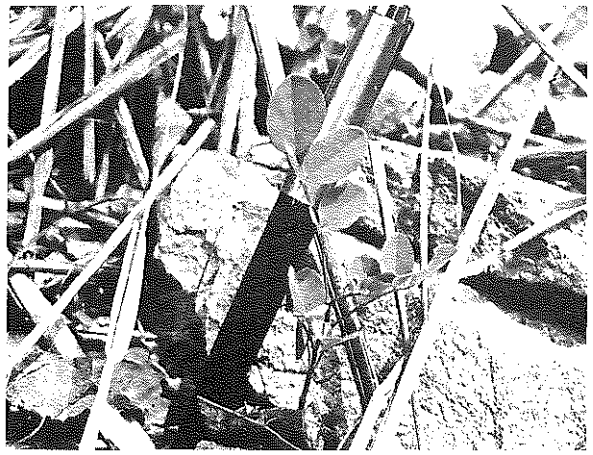

Figure 5. Seedling examples resulting from direct seeding. Seedlings do not compete with grasses and other dense vegetation. They do, however, show sustained growth when mulched with straw in low competition situations.

and from seed deposited bv nature on roadside cuts. Root materials may be several and relocated by the construction equipment and left for regeneration. Seed is normally produced in low numbers and may experience low germination; however, this is one of the important methods of plant regeneration.

Observations on KY 23 showed that east-facing slopes regenerate at a much faster rate than do west-facing slopes when mature parent plant material is adjacent to the roadside cut. An example of one plot two miles southwest of Louisa gave the following regeneration results:

EAST-FACING SLOPE	WEST-FACING SLOPE
Red Bud	American Beech
Black Locust	Black Gum
Black Gum	Black Oak
Black Walnut	Dwarf Sumac
Dogwood	Pignut Hickory
Sassafras	Sassafras
Staghorn Sumac	Sourwood
Sycamore	White Ash
Tulip Poplar	
White Ash	
White Mulberry	

Plant numbers for this site was 1 to 10 seedlings per 1,000 square feet on the west-facing slope and 5 to 25 seedlings per 1,000 square feet on the east-facing slope. Probable factors giving higher plant counts on east-facing slopes is:

1. The eastward prevailing wind deposited significantly higher numbers of seed across the slope.

2. Limited natural mulch of leaves was deposited over the seed, aiding in collecting soil particles and providing better winter protection.

3. The mulching material aided in retaining moisture around the seed early in the germination season.

4. Western exposures are dryer than eastern exposures.

Five bench sites were also observed on US 23; the results are shown in Figures 6 and 7. Comparison of east-facing slopes to west-facing slopes indicated that east-facing slopes generate much higher numbers with more species showing seedling growth.

Natural regeneration could take the place of the need for direct seeding if it were not for the fact that high numbers of seedlings are only produced one out of every ten to twelve years. Some major factors responsible for the low seedling years are:

1. A small portion of the total seed produced is normally mature, viable seed.

2. Poor growing conditions resulting from a lack of moisture or essential nutrient elements may not allow seed to develop properly.

3. Temperate winters which inhibit the natural stratification process.

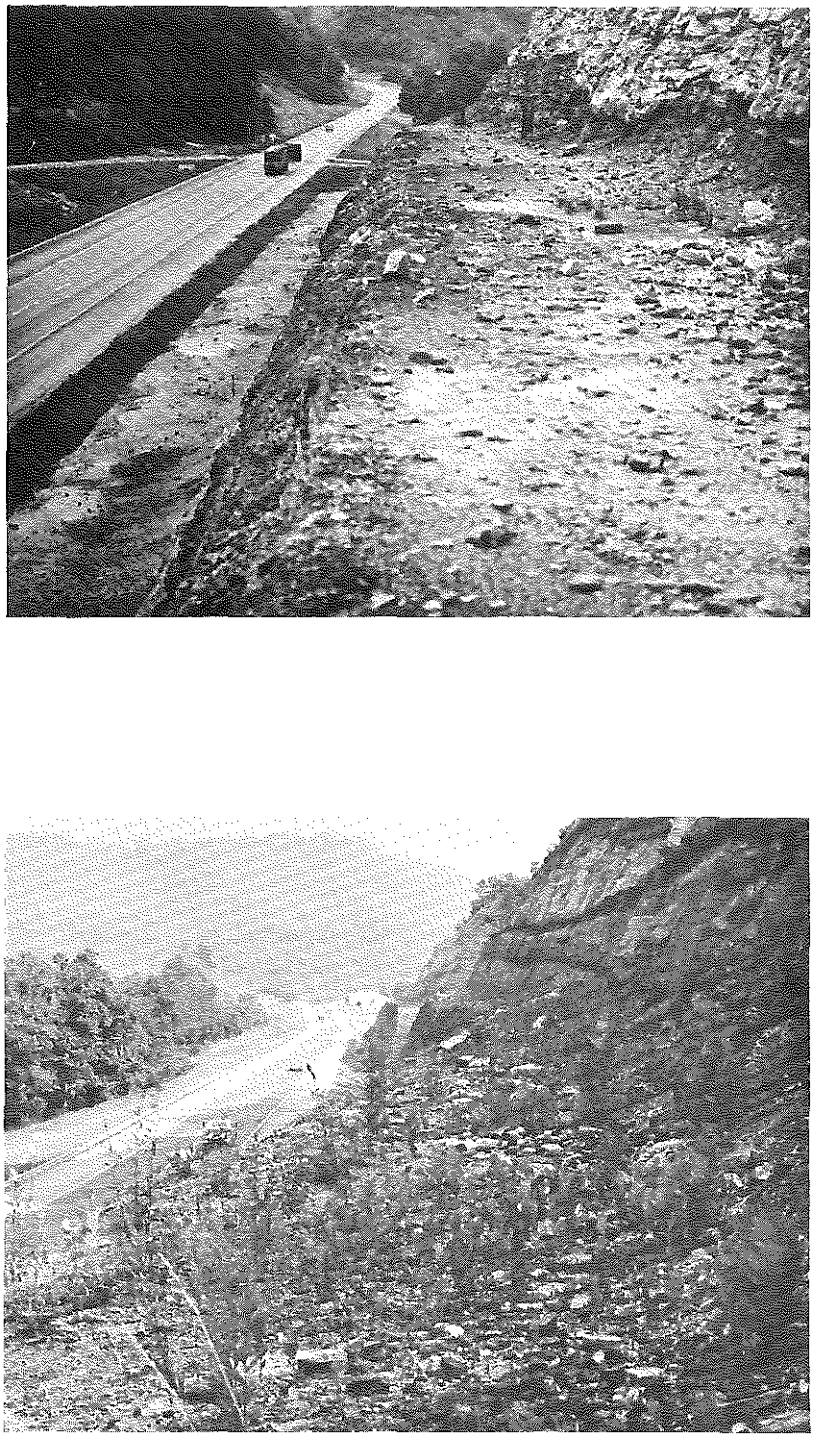

Figure 6. Two-year old seedlings assist in erosion control. The benches with no plant material offer little scenic beauty. New cuts can be established early with woody materials, but an early start is necessary. Upper photograph shows a bench on US 23 southeast of Louisa soon after construction. Lower photograph shows the same bench two years later. The natural regrowth there is Sycamore, Red Maple, and Boxelder.

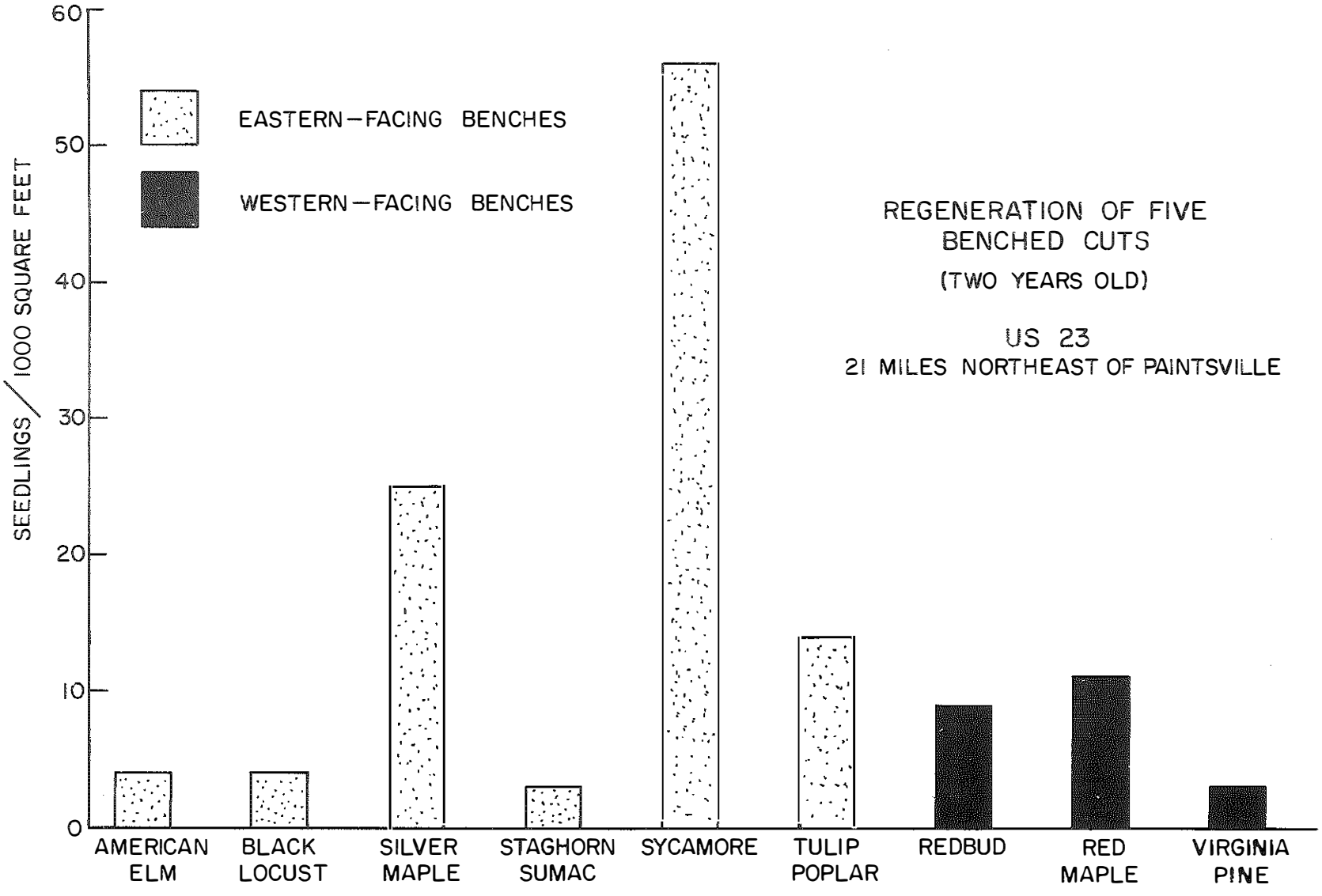

Figure 7. Regeneration results on eastern-facing and western-facing benches.

4. Low moisture content of soil before and during the stratification process.

Mass Propagation

Direct Seeding

The most desirable season to direct seed woody materials is in the fall. Natural stratification takes place during the winter months, and the seed is ready for germination as the spring temperatures start to rise. Seed of most woody materials requiring 60 to 90 days stratification are best sown in the fall unless pretreatment of the seed is completed before sowing. Plant materials which require a few days stratification or those requiring no treatment may be best sown in the spring.

Direct seeding is the preferred procedure for establishing seedings on the roadside. The application of woody seeded materials would best be handled by commercial landscape contractors, but these companies would have difficulty in purchasing uniformly treated seed in large quantities. Because of this problem there should be a policy of a no-treatment requirement -- which should entail a lower seeding cost. It should also be recognized that seeding would be done from August 15 to December 15 in order for natural stratification to take place when using unstratified seed. It is desirable to hydroseed turf grasses, legumes and woody plant material within the same operation if seeding can be done before October 15. Dual seeding with ground covers gives less tolerant woody plants a chance for early establishment. Most woody plants germinate best in conditions of low competition; this, however, is not possible because of the soil erosion problem. It should be noted that on occasion seeding must be done at undesirable times -- erosion control is a major concern.

Asexual Propagation

Mass propagation of native materials by stem cuttings would be one good procedure for acquiring planting material in large numbers. A major advantage of stem cuttings is that a desirable plant can be reproduced to be genetically the same as the parent plant. Reproduction of native material by implanting cuttings in situ or in a nursery would be more expensive than seeding because of the higher labor and facilities requirement; perhaps this method is best reserved for nursery conditions.

The importance of mass propagation might have less significance if use is made only of limited transplant material in Southeastern Kentucky. The Department may elect to use direct seeding and regeneration for natural landscaping insofar as practical.

Factors Influencing Germination

Soil Description

The major soil materials encountered in this area were shales and sandy to silt loams. The shale soils gave no positive results to germination tests -- little trace of plant life is found on these roadside cuts (Figure 8). These shale soils were fertilized (10-10-10) at the rate of 1,000 pounds per acre and limed at the rate of 3.5 tons of agriculture limestone. The low pH of shale soils is due to oxidation and release of sulfuric acid. Tests on shale banks revealed a pH range of from 2.8 to 3.4. This range is too critical for most plant growth. Acid-tolerant plants may persist at this low level and assist with the erosion control in these areas. Such a plant as the European Alder, is presently being tested by the U.S. Forest Service on spoil banks in Southeastern Kentucky. The European Alder thrives in a pH of 3.0 and has shown signs of its adaptation to the condition of shale soils.

The sandy to silt loam soils provide an excellent soil media for germination and establishment of seeded woody plant materials. The sandy soils are more porous than the silt soils and relinquish moisture rapidly. This condition can be eased by a vegetative or mulch cover. The erosion hazard is normally so great that a mulch is also necessary to hold soil and seed for germination.

Figure 8. An example of shale movement at the crest of a bench as compared to a slowly deteriorating sandstone bench. The Virginia pine shown in the top photograph has been covered with debris to a depth of about ten inches within a two-month period. The sandy soil in the lower photograph resulting from the sandstone parent material provides an excellent propagation medium for the black locust.

The pH of the sandy and silty soils range from 4.5 to 6.5, depending upon the type of underlying, unweathered material. They react well to fertilizer and lime applications except on steep grades where applications are eroded before they become fixed in the soil. Lime is normally applied at the rate of 3.5 tons per acre. Fertilizer is applied at the rate of approximately 1,000 pounds per acre.

Soil Moisture and **Mulches**

Moisture is the most important agent to the seed after it has been sown. Seed germination is dependent upon sufficient rainfall to keep the uppermost layer of soil adequately moist. Mulching slows the loss of water from the soil. The amount of mulch needed is directly related to the moisture intake of the soil, especially on steep slopes. Mulch stabilizers are effective in decreasing the amount of erosion. Asphalt has been used effectively in the past by the Highway Department as a stabilizer. A germination test is presently in progress to determine the effect of asphalt on deciduous and conifer seed.

Plant Competition

Woody plants in the seedling stage are not competitive in growth with grasses and herbaceous plants. Some woody plants such as oaks go through a *die-back* process which makes them more tolerant than other genera. The *die-back* process allows the plant to flourish during early spring, but the plant soon loses its leaves and becomes dormant in early summer. The following spring, the plant will continue gorwth as a larger and stronger plant. This condition will continue until the plant is tolerant to the existing enviromnent or the plant dies. Most woody materials cannot compete with a heavy growth of fescue or crown vetch but will begin growth in a sparsely populated area. As seedlings continue growth, ground covers are weakened, and less tolerant seedlings then have an opportunity for growth.

Erosion Observations

Ground covers are necessary to keep down splash, sheet, and gully erosion. Leaves from trees assist in minimizing splash erosion, and their roots assist in controlling the formation of gullies.

On KY 15, approximately three miles northwest of Jackson, there is a classic example of what plant material can do to assist in erosion control (Figure 9). Sycamore seedlings have regenerated on the cut slopes and are assisting with the establishment of other plant materials and with conservation of soil on the slope. These trees are also enhancing the appearance of this road cut.

Highway Bench Treatment

Benches in cut slopes were originally intended for two purposes; one was a slope-stability consideration; the other was to catch falling rock and debris from higher scarps. The fallen rock and debris was to be periodically removed with heavy equipment and cleared from the area.

A close inspection of two- and three-year old cuts on KY 15 and US 23 shows eroding of the bench areas. It would be impractical to clear some of these benches because of their partial and sometimes complete deterioration. Grading of old benches could be dangerous for both machine and man. For this reason, direct seeding on the benches may relieve the necessity of cleaning and arrest erosion. The sketch in Figure 10 illustrates a degree of erosion control provided by the plant material on these benches. It should also be pointed out that trees on the benches would screen the rock ledges and cover the nakedness of the general roadside view.

RECOMMENDATIONS OF NATIVE SPECIES

The recommendations for woody plant materials to be used in direct seeding is based on the plant's ability to regenerate from roots and from natural seedings, and is based on results from direct seeding

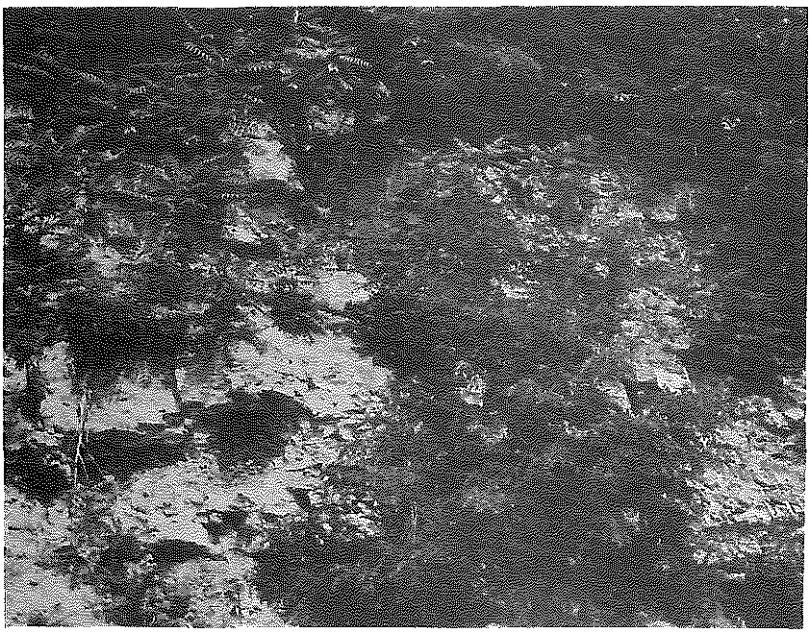

Figure 9. This regrowth of native material on US 23 near Ashland, Kentucky, is a result of natural forest regeneration. Had this regrowth been supported by direct seeding and soil treatment, there would have been a more rapid stabilization of the slope and less erosion of existing soil. The predominant woody plants shown here are sycamore, staghorn sumac and black locust.

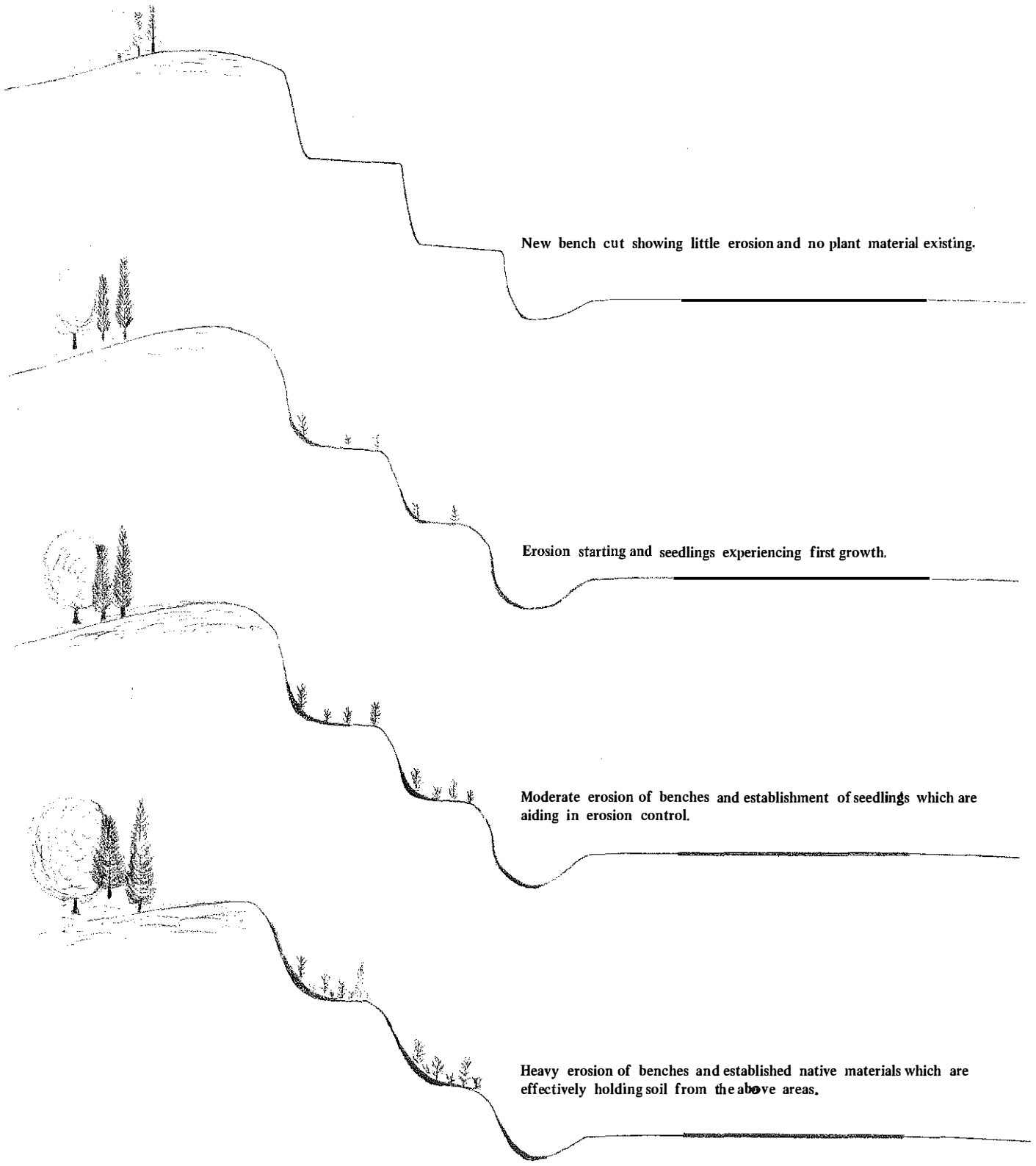

Figure 10. Illustration of bench erosion and native plant establishment.

field tests. The species recommended for each relief and drainage division are listed in Table 6.

The recommendations are based upon the following observed facts:

1. These materials have regenerated through natural means on old highway cuts.
2. They are becoming effectively established on new bench and highway cuts.
3. They are growing effectively in adverse conditions where erosion is a major problem.
4. Field tests demonstrate their germination and establishment ability.
5. No special maintenance is required during establishment period.

Plant information on recommended native species has been summarized in Table 7 to provide basic data (based on observations from this study and additional information from related literature) relevant to, or needed by, the highway landscape designer in selecting native plant combinations to be used in direct seeding. Leaf mount photographs are presented in the Appendix to assist in characterizing each recommended plant. The *DESCRIPTION* gives the botanical name, common name, and usage classification. *PHYSICAL CHARACTERISTICS* provides information on the root system, seedling tolerance, associated plants in native growth, and desirable soil and moisture conditions. *ESTABLISHMENT* relates to stage and maturity of trees and seedlings for transplanting and direct seeding, preparations, and capability of regeneration in Southeastern Kentucky. *SPECIAL FEATURES* of the plant relates to adaptability, roadside desirability, use for erosion control, and major pests and diseases associated with the plant.

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Table 6: RECOMMENDED SPECIES FOR DIRECT SEED BY MAJOR DRAINAGE AND RELIEF AREAS

LOWER KENTUCKY

Black Gum
Black Locust
Dogwood
Green Ash
Redbud
Red Cedar
Red Maple
Sycamore
Tulip Poplar
Virginia Pine
White Pine

BIG SANDY

Black Gum
Black Locust
Boxelder
Dogwood
Dwarf Sumac
Redbud
Shortleaf Pine
Sourwood
Sweet Birch
Sycamore
Tulip Poplar
Virginia Pine
White Pine

LICKING

Black Gum
Black Locust
Dogwood
Green Ash
Redbud
Red Maple
Shortleaf Pine
Sycamore
Tulip Poplar
Virginia Pine

UPPER CUMBERLAND

Black Locust
Black Gum
Boxelder
Dogwood
Green Ash
Pitch Pine
Redbud
Red Maple
Sourwood
Sweet Birch
Sycamore
Tulip Poplar
Virginia Pine
White Ash

LITTLE SANDY

Black Gum
Black Locust
Boxelder
Dogwood
Dwarf Sumac
Redbud
Red Cedar
Red Maple
Shortleaf Pine
Sourwood
Sweet Birch
Sycamore
Tulip Poplar
Virginia Pine
White Pine

UPPER KENTUCKY

Black Locust
Black Gum
Dogwood
Green Ash
Redbud
Red Maple
Shortleaf Pine
Sourwood
Sweet Birch
Sycamore
Tulip Poplar
Virginia Pine
White Ash

DESCRIPTION			PHYSICAL CHARACTERISTICS					
BOTANICAL NAME	COMMON NAME	USE CLASSIFICATION	ROOT SYSTEM	SEEDLING TOLERANCE	PLANT ASSOCIATIONS	TOLERANT pH LEVEL	MOISTURE REQUIREMENTS	DESIRABLE SOIL CHARACTERISTICS
Acer Negundo	Boxelder	Commercial Ornamental	Shallow	Intermediate	Most Oaks, Maples, Hickories	5.0 - 8.0	Intermediate	Sandy Loam. Not Successful in Shallow Soils with Rock Outcrop.
Acer Rubrum	Red Maple	Commercial Ornamental	Shallow	Intermediate	Black Tupelo, American Elm Bottomland Oaks	6.0 - 8.0	Intermediate	Dry to Moist Sandy Loam.
Betula Lenta	Sweet Birch	Commercial	Shallow	Tolerant	White Pines, Hemlocks, Sugar Maples, Beech	5.0 - 6.0	Intermediate	Well Drained Sandy Loam.
Cercis Canadensis	Red Bud	Scrub Ornamental	Shallow	Tolerant	Black Locust, Most Oaks, Hickories	5.0 - 8.0	Intermediate	Moist Loam. Grows Well in Adverse Conditions.
Cornus Florida	Dogwood	Scrub Ornamental	Shallow	Tolerant	White Oaks, Red Oaks	6.0 - 8.0	Intermediate	Moist Loam.
Fraxinus Pennsylvania	Green Ash	Commercial	Shallow	Intermediate	Boxelders, Hickories, Sweetgums Willows, Red Maples	5.0 - 8.0	Intermediate	Moist Loam. Grows Well in Adverse Conditions
Juniperus Virginiana	Red Cedar	Commercial Ornamental	Shallow	Intermediate	Dry Soil Oaks, Hickories Virginia Pine	6.0 - 7.0	Intermediate	Sandy Loam to Loam. Best Growth in Deep Alluvial Soils.
Liriodendron Tulipifera	Tulip Poplar	Commercial Ornamental	Tap	Intolerant	Most Oaks, Hickories, American Beech, Sweetgums, Maples	6.0 - 7.0	Intermediate	Sandy Loam to Loam. Well Areated.
Nyssa Syluatica	Black Gum	Commercial	Fiberous	Tolerant	Hardwoods, Softwoods	6.0 - 7.0	Intermediate	Sandy Loam to Silt Loam. Grows Well in Adverse Conditions.
Oxdendrum Arboreum	Sourwood	Scrub Ornamental	Shallow	Tolerant	Most Eastern Hardwoods	4.0 - 8.0	Intermediate	Moist, Rich Sandy Loam. Grows Well in Adverse Conditions.
Pinus Echinata	Shortleaf Pine	Commercial Ornamental	Tap	Tolerant	Loblolly, Virginia Pines, Post Chestnuts, Oaks	5.0 - 6.0	Intermediate	Moist, Silty Loam to Sandy Loam.
Pinus Rigida	Pitch Pine	Commercial	Tap	Intolerant	Chestnut Oaks, Hickories, Black Tupelos, Red Maples	5.0 - 6.0	Intermediate	Moderately Acid, Sandy Loam.
Pinus Strobus	White Pine	Commercial Ornamental	Shallow	Intermediate	Most Central Hardwoods and Hemlocks	5.0 - 6.0	Intermediate	Moist Sandy Loam.
Pinus Virginiana	Virginia Pine	Commercial	Shallow	Intolerant	Usually Pure Stands	5.0 - 6.0	Low	Clay Loam or Sandy Loam.
Platanus Occidentalis	Sycamore	Commercial Ornamental	Shallow	Intolerant	American Elms, Most Maples, Sweetgums, Willows, River Birch	5.5 - 8.0	Intermediate	Moist Loam along Streams, But Will Grow Well in Most Adverse Conditions.
Rhus Copollina	Dwarf Sumac	Scrub	Shallow	Intermediate	Hickories, Oaks, Elms	6.0 8.0	Intermediate	Dry to Moist Sandy to Clay Loam.
Rhus Typhina	Staghorn Sumac	Scrub	Shallow	Intermediate	Elms, Hickories, Oaks	5.0 - 8.0	Intermediate	Sandy to Silt Loam. Grows Well in Adverse Conditions.
Robinia Pseudocacia	Black Locust	Commercial	Shallow	Intolerant	Hickories, Yellow Poplars, White Ashes, Black Walnut	6.0 - 8.0	Intermediate	Moist, Rich Loam. Found on Wide Variety of Sites.
Ulmus Rubra	Slippery Elm	Scrub	Shallow	Intermediate	Red and White Oaks, Ashes, Hickories, Maples, Black Cherry Yellow Poplars	6.0 - 8.0	Intermediate	Moist Loam. Grows Well in Adverse Conditions.

Table 7: PLANT INFORMATION DATA

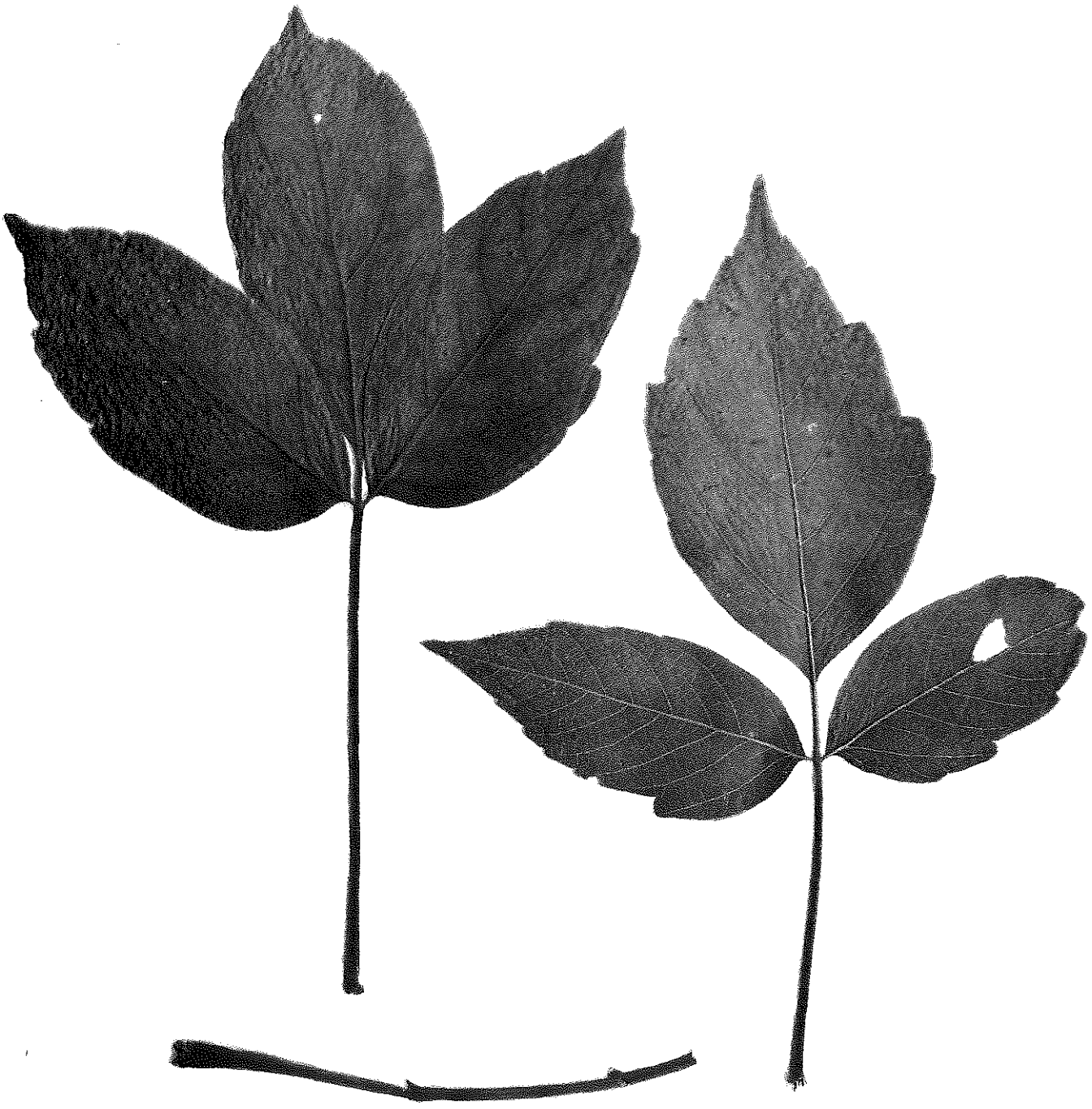
BOTANICAL NAME	ESTABLISHMENT				SPECIAL FEATURES				
	METHOD OF ESTABLISHMENT	STRATIFICATION REQUIRED	CAPABLE OF RE-GENERATION	KENTUCKY NATIVE	ADAPTABLE TO ROAD-SIDE SOIL TYPES	CREATE ROADSIDE PROBLEM	EROSION CONTROL RATING	PEST INFESTATIONS	PARASITIC DISEASES
Acer Negundo	Seedling Transplant, Direct Seeding	90 Days @ 40°F	Yes	Yes	Yes	No	Fair	Epiophyid Mites	White Wood Rot
Acer Rubrum	Seedling Transplant, Direct Seeding	None for Immediate Seeding of Spring Seed; 90 Days @ 40°F for Year-Old Seed	Yes	Yes	Yes	No	Good	Epiophyid Mites	Butt Rot, White Wood Rot, Wilt Disease
Betula Lenta	Direct Seeding	60 to 90 Days @ 40°F	Yes	Yes	Yes	No	Excellent	None	Leaf Rust, Leaf Spot Disease
Cercis Canadensis	Ball and Burlap, Seedling Transplant, Direct Seedling	90 Days @ 75°F to 40°F	Yes	Yes	Yes	No	Good	None	None
Cornus Florida	Ball and Burlap, Seedling Transplant, Direct Seeding	120 to 180 Days @ 40°F	Yes	Yes	Yes	No	Good	Borers	None
Fraxinus Pennsylvania	Seedling Transplant, Direct Seeding	60 to 120 Days @ 40°F	Yes	Yes	Yes	No	Good	Mites	Wood Rot, Butt Rot
Juniperus Virginiana	Direct Seeding	None	Yes	Yes	Yes	No	Good	Bag Worms	Wood Rot, Rusts
Liriodendron Tulipifera	Seedling Transplant, Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Good	None	Leaf Rust, White Wood Rot
Nyssa Sylvatica	Seedling Transplant, Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Excellent	Tupeloleuf Miner	Heart Rot
Oxdendrum Arboreum	Seedling Transplant, Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Good	None	None
Pinus Echinata	Seedling Transplant, Direct Seeding	60 to 90 Days @ 32° to 40°F	Yes	Yes	Yes	No	Good	Tip Moth (Nantucket Pine)	Some Leaf Disease
Pinus Rigida	Seedling Transplant, Direct Seeding	60 to 90 Days @ 32° to 40°F	Yes	Yes	Yes	No	Good	Tip Moth	Oak Rust, Blister Rusts
Pinus Strobus	Seedling Transplant, Direct Seeding	60 to 90 Days @ 32° to 40°F	Yes	No	Yes	No	Good	White Pine Weevil	White Pine Blister Rust
Pinus Virginiana	Seedling Transplant, Direct Seeding	None	Yes	Yes	Yes	No	Good	Tip Moth	Blister Rusts. Wood Rots
Platanus Occidentalis	Seedling Transplant, Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Good	Eriophyid Mites	Leaf and Twig Blight
Rhus Copollina	Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Good	None	None
Rhus Typhina	Direct Seeding	60 Days @ 40°F	Yes	Yes	Yes	No	Good	None	None
Robinia Pseudocacia	Direct Seeding	None	Yes	Yes	Yes	No	Good	Locust Borer	Yellow Wood Rot
Ulmus Rubra	Seedling Transplant, Direct	60 Days @ 40°F	Yes	Yes	Yes	No	Good	Bark Beetles	Dutch Elm Disease

Table 7: PLANT INFORMATION DATA (Continued)

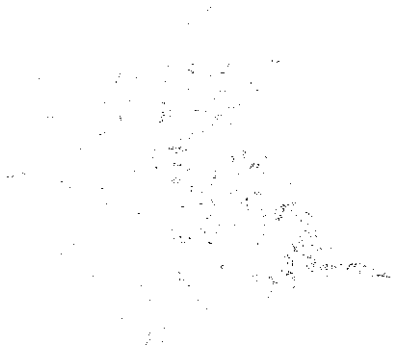
APPENDIX

Leaf Mount Photographs

BOX ELDER

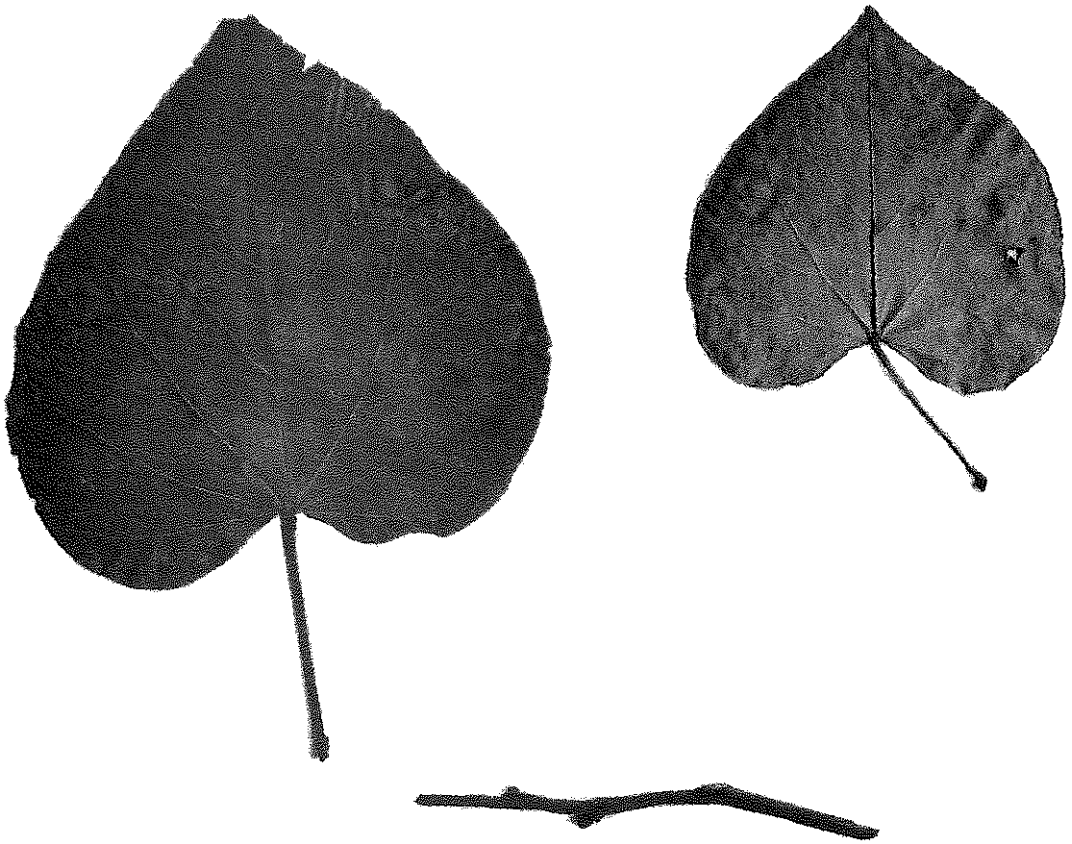


RED MAPLE

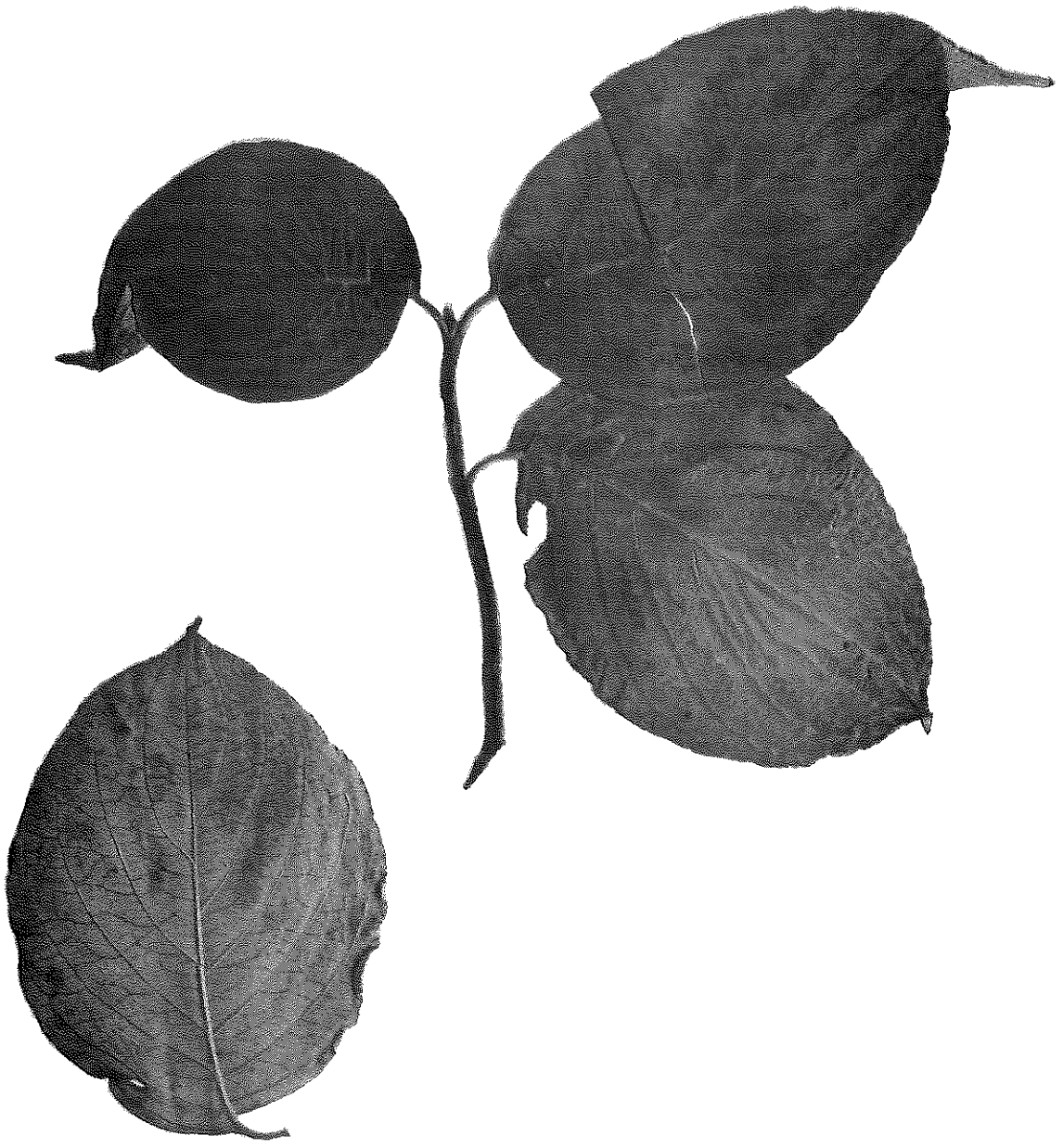


SWEET BIRCH

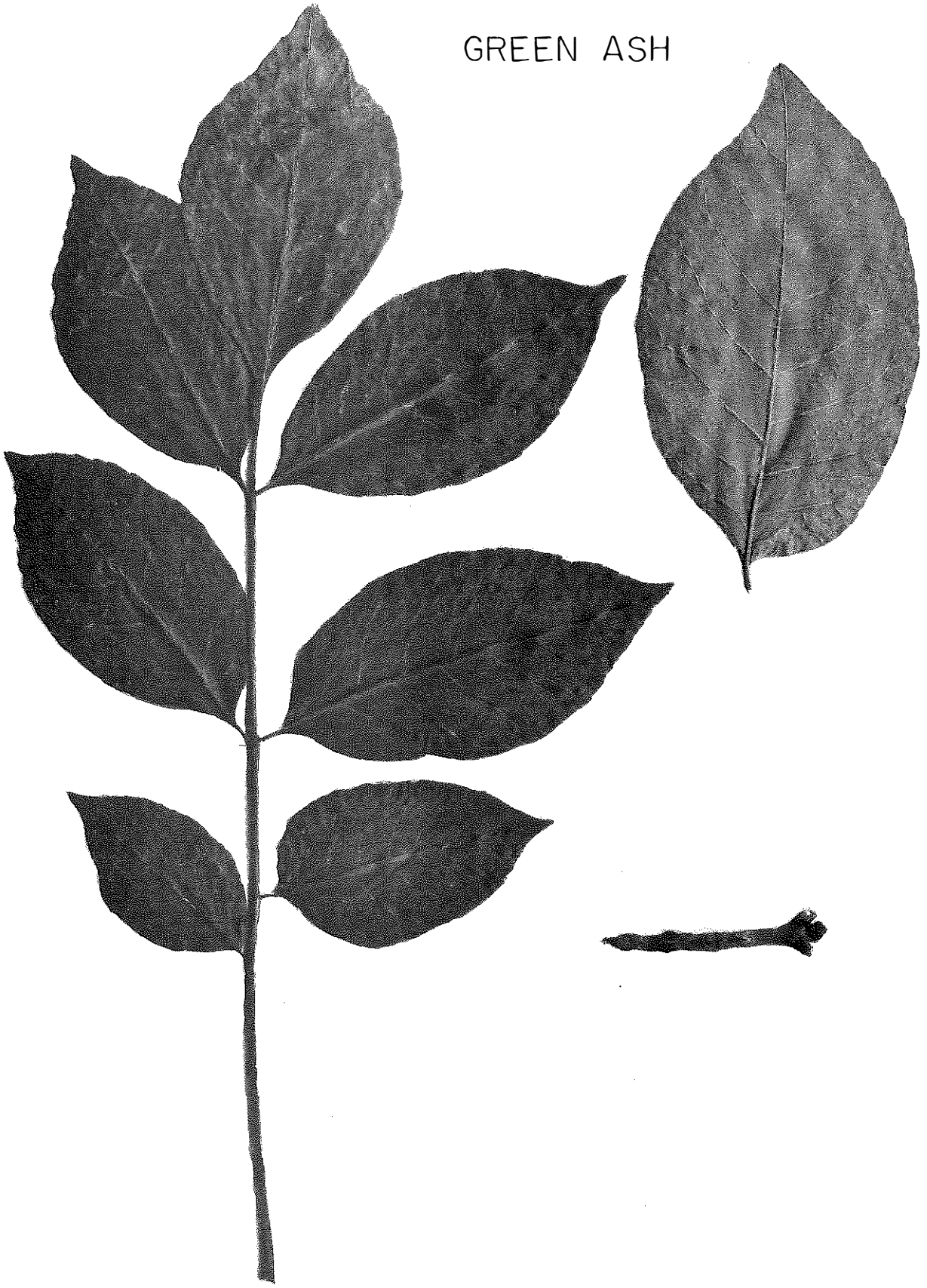
RED BUD



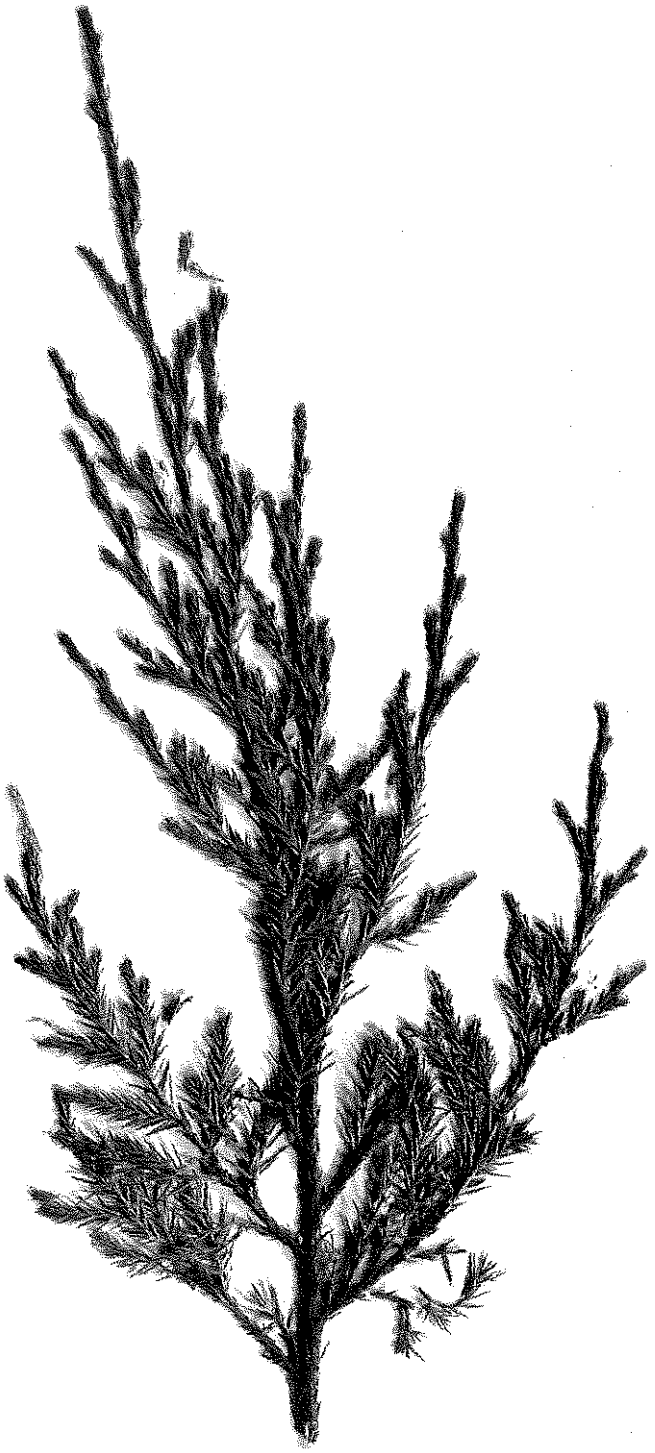
DOGWOOD



GREEN ASH

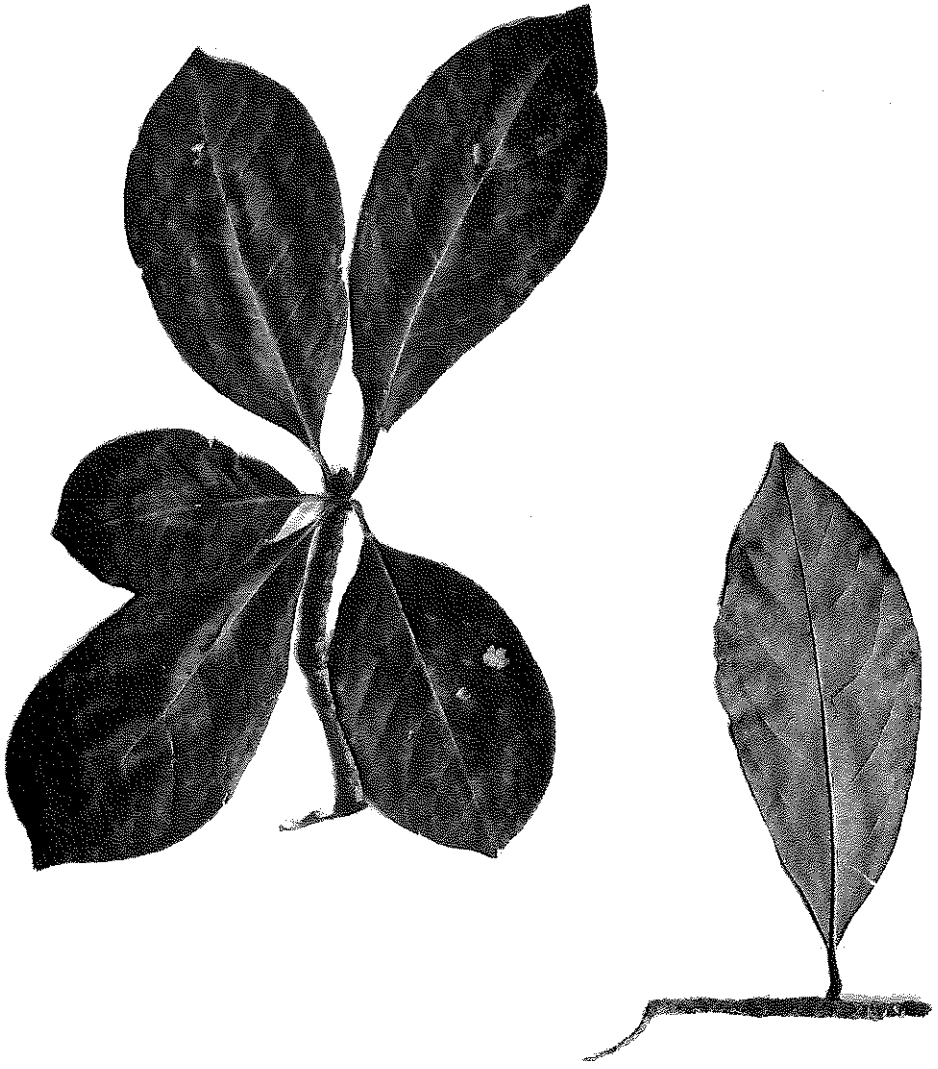


RED CEDAR

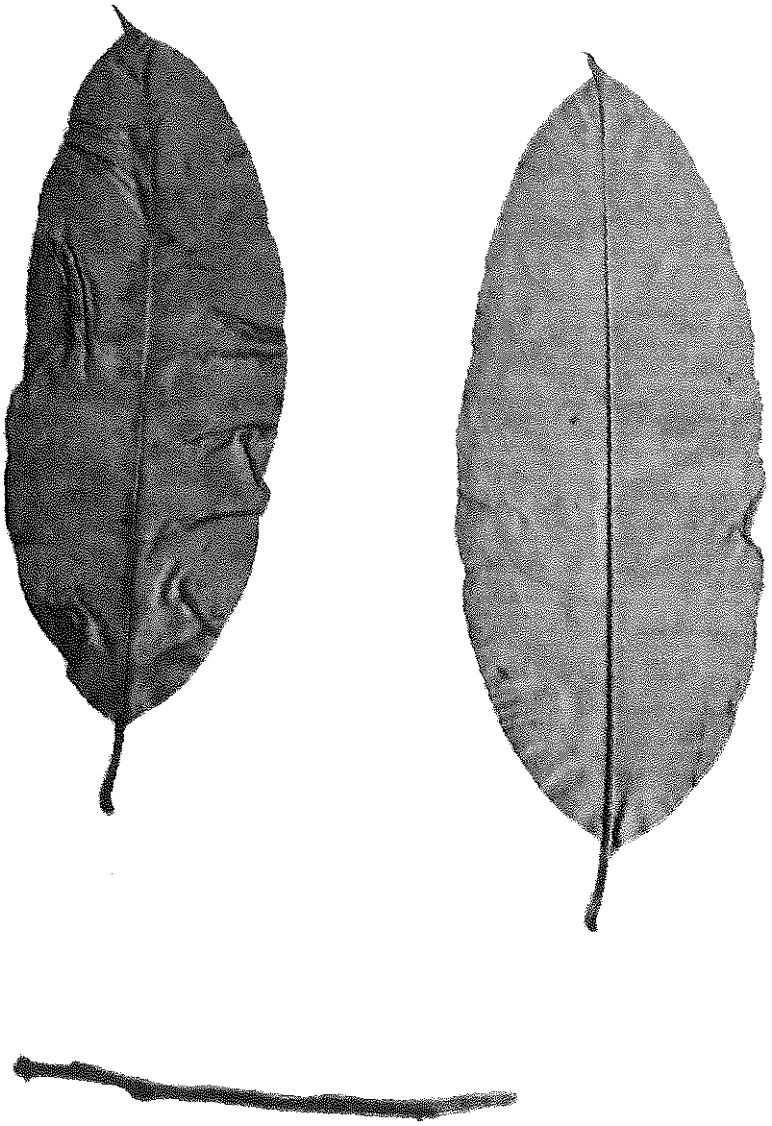


TULIP POPLAR

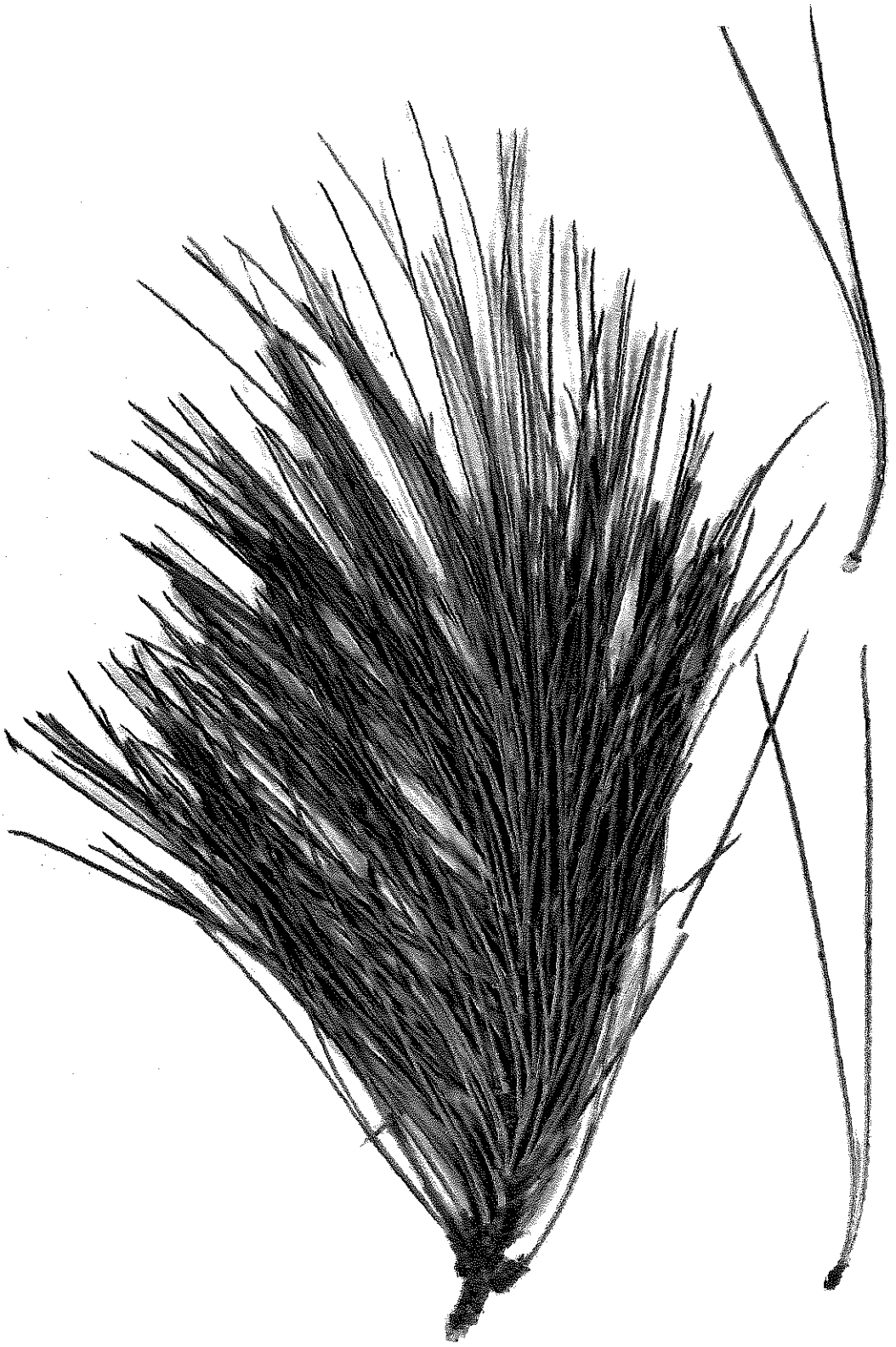
BLACK GUM



SOURWOOD

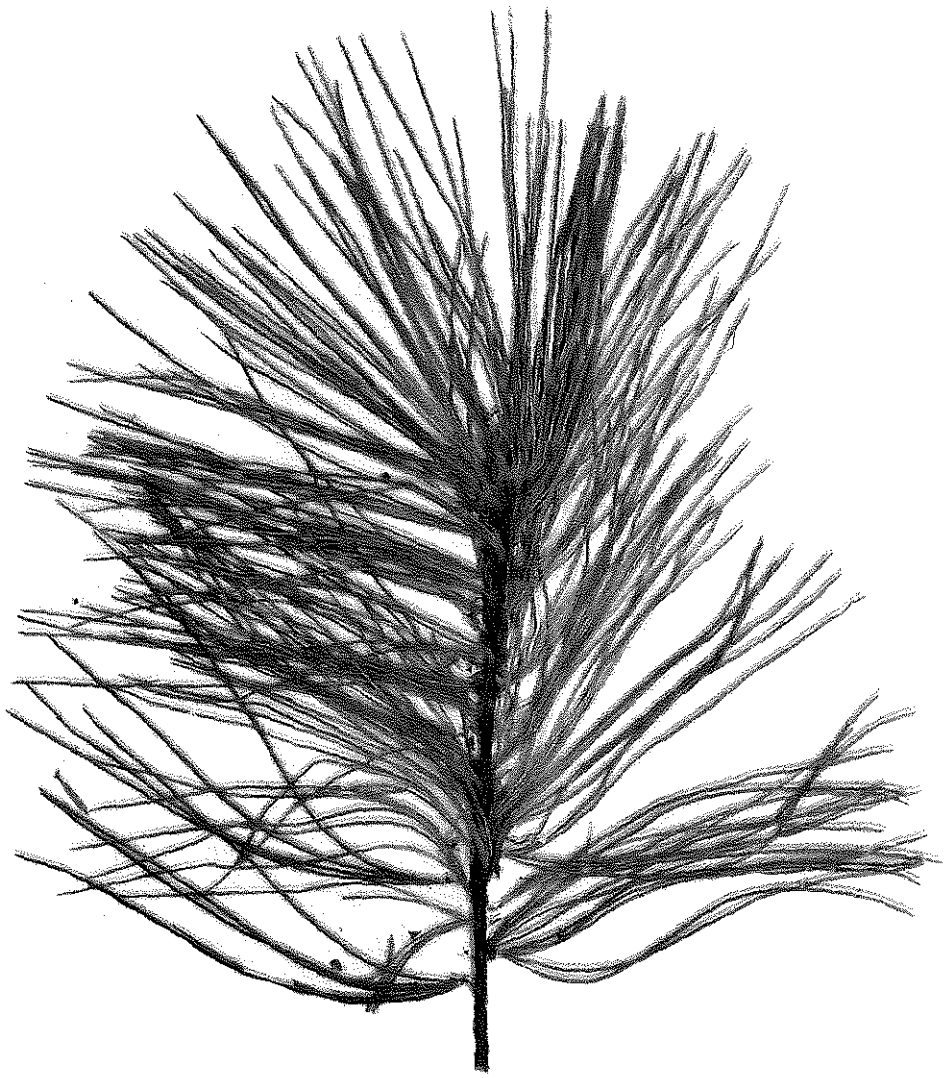


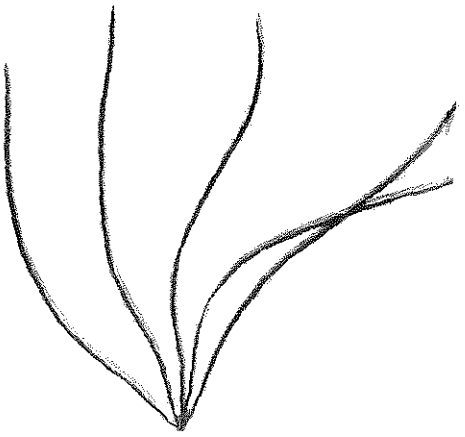
SHORTLEAF PINE



PITCH PINE

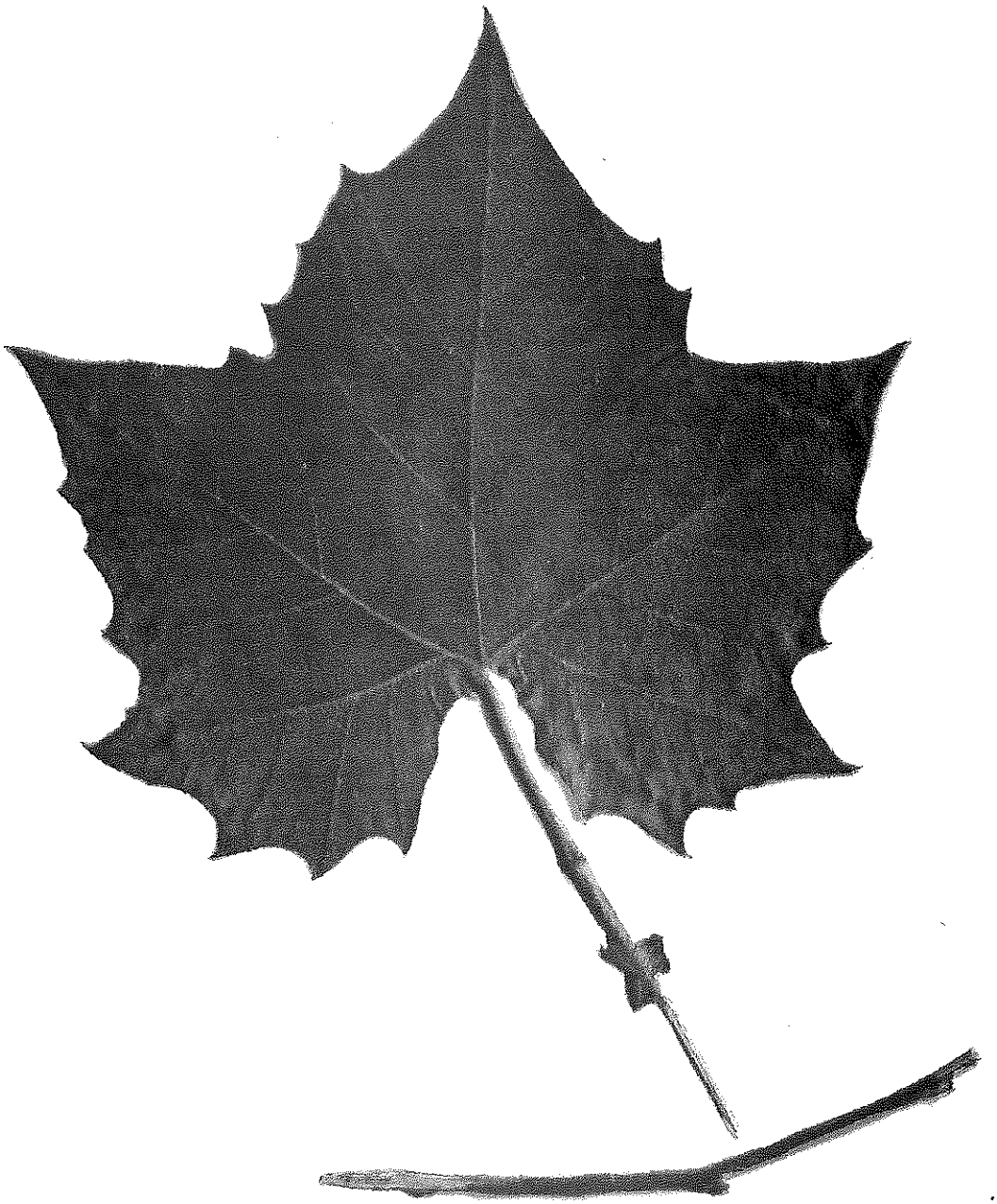
WHITE PINE



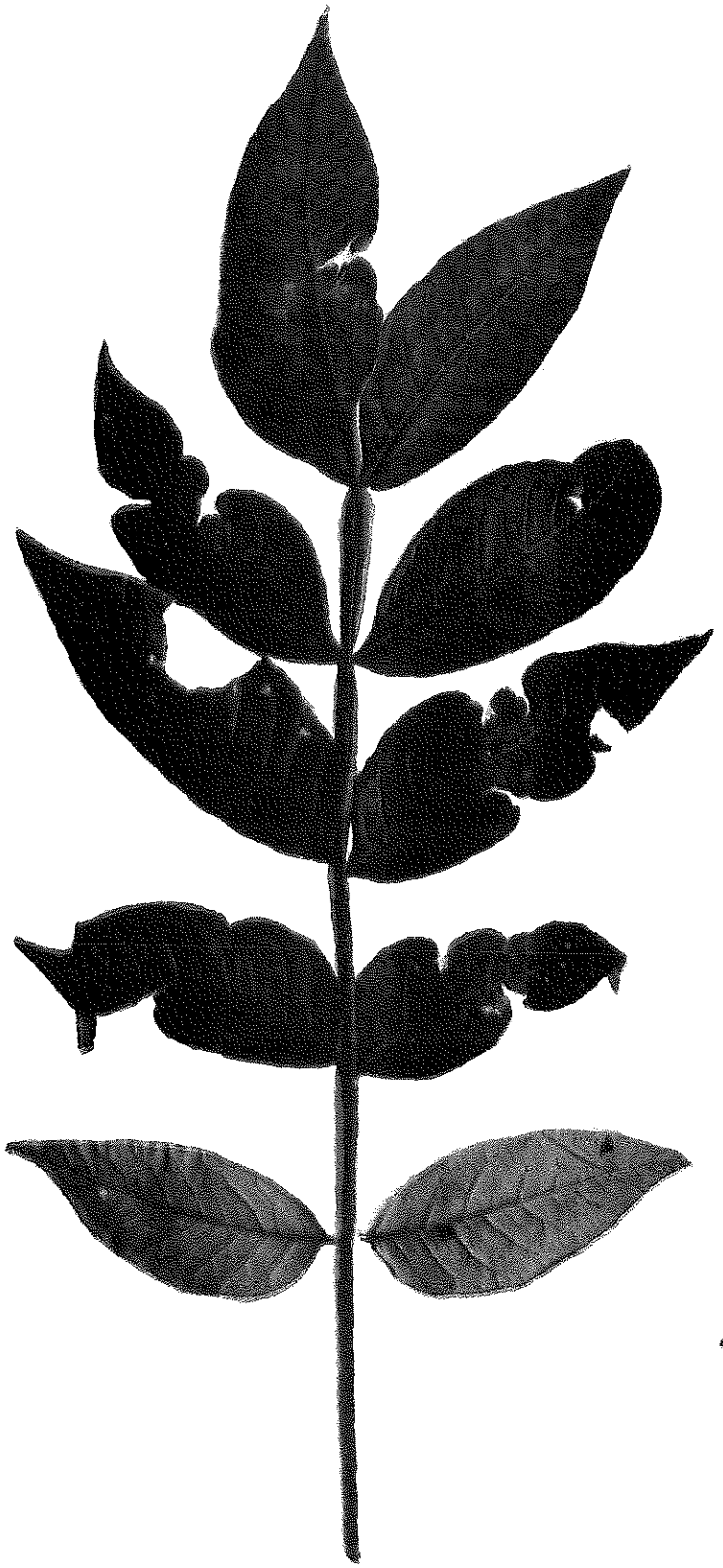


VIRGINIA PINE

SYCAMORE

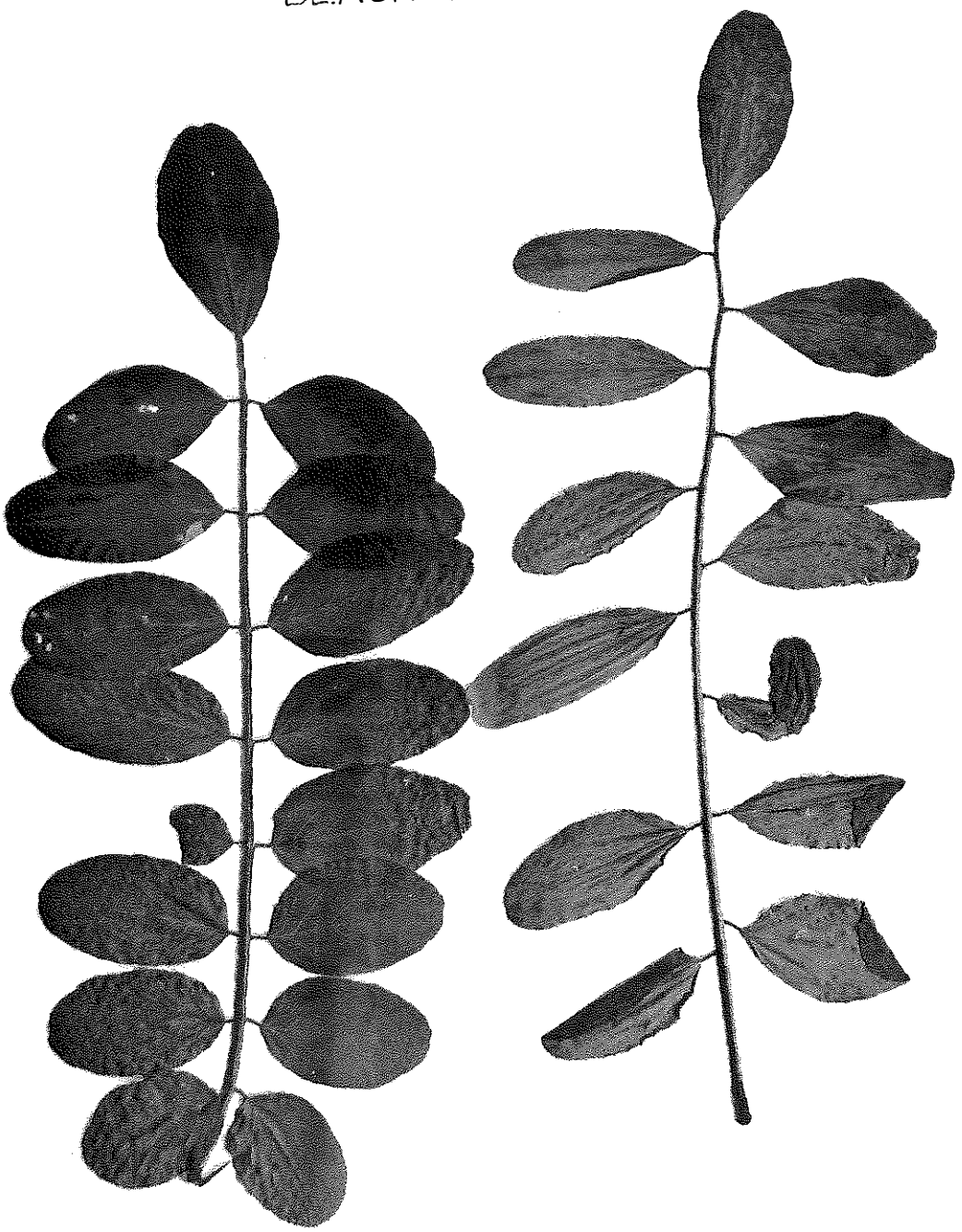


DWARF SUMAC



STAGHORN SUMAC

BLACK LOCUST



SLIPPERY ELM