Author: Pennsylvania Dept. of Forests and Waters

Title: Bulletin, no. 33, 1932 - no. 35, 1927

Place of Publication: Harrisburg, Pa.

Copyright Date: 1932 - 1927

Master Negative Storage Number: MNS# PSt SNPaAg250.7

<2255739> * *OCLC* Form:serial 2 Input:HHS Edit:FMD
008 ENT: 990128 TYP: d DT1: 1923 DT2: 19uu FRE: u LAN: eng
035 (OCoLC)40694346
037 PSt SNPaAg250.7-251.6 $bPreservation Office, The Pennsylvania State University, Pattee Library, University Park, PA 16802-1805
090 00 SD12 $b.P33 $l+no. $caxPX $s+U23-U37+U56 $ckp
090 20 Microfilm D344 reel 250.7-251.6 $l+no. $cmc+(service copy, print master, archival master) $s+U33(1923)-U55(1936)
110 1 Pennsylvania. $bDept. of Forests and Waters.
245 00 Bulletin $cPennsylvania, Department of Forests and Waters.
260 Harrisburg, Pa. $bThe Department $c[1923]-
300 v. $bill. $c22 cm.
362 0 no. 33 (1923)-
515 Each vol. has also a distinctive title.
515 Some nos. issued in revised editions.
515 Some issues lack numbering and dates.
533 Microfilm $mno.33 (1923)-no.55 (1936) $bUniversity Park, Pa. : $cPennsylvania State University $d1999. $e2 microfilm reels ; 35 mm. $f(USAIN state and local literature preservation project. Pennsylvania) $f(Pennsylvania agricultural literature on microfilm).
650 0 Forests and forestry $zPennsylvania.
780 00 Pennsylvania. Dept. of Forestry. $tBulletin
830 0 USAIN state and local literature preservation project. $pPennsylvania.
830 0 Pennsylvania agricultural literature on microfilm.

FILMED
AS
BOUND

no. 33 - no. 35

1932 - 1927

THE COMMON
TREES AND SHRUBS
of
PENNSYLVANIA

Native and Introduced

By

Geo. S. Perry

Bulletin 33

Revised

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS

Harrisburg

[1932]

Hemlock, the State Tree of Pennsylvania, grown under open, full light conditions

CONTENTS

FOREWORD

THIS handbook is based on careful observation and study of the trees and shrubs of Pennsylvania over a period of more than twenty years, most of which was spent as instructor in dendrology and silviculture at the Pennsylvania State Forest School at Mont Alto. The descripfive notes have been compared with and checked against statements in several textbooks on trees and shrubs. It is hoped the facts and arrangement have been chosen wisely, and may serve as an accurate and useful guide to the student and nature lover who wishes to identify the woody plants usually met in the Pennsylvania outdoors.

Although this book is primarily intended for the use of those with some knowledge of plants and their systematic classification, it contains a minimum of technical terms, and anyone may understand every statement. The use of abbreviations, contractions and symbols is a departure from good usage, but justified in behalf of brevity. With two exceptions, scientific names and the arrangement of the species follow the International Code as exemplified in the seventh edition of Gray's *New Manual of Botany*.

The illustrations, from the photographic collection of the Pennsylvania Forest Research Institute, are the work of Josef N. Knull, Forest Entomologist. All photographs are backed on inch squares.

Trees and shrubs are the most outstanding objects in animate nature. It is difficult to overestimate their absolute importance to man. To know them is the first step toward their true appreciation, proper protection, and cultivation or rational treatment. A knowledge of trees and shrubs fills every leisure hour in the open with wholesome interest, and tends to arouse or stimulate latent powers of observation. Planters of trees and shrubs in the forest, or for ornamental purposes, will find the notes on habitat an aid in choosing species adapted to the areas to be planted. They may also be helpful to foresters in the assessment of site quality of forest stands and the selection of areas to be reforested.

Geo. S. Perry

Pennsylvania Forest Research Institute,
Mont Alto, Pa.

First edition, January, 1924.
Corrected, illustrated, and revised, November, 1931.

HOW TO USE THE TREE KEY

To use the tree key to advantage, it is best to have a twig with leaves, or buds in season, as well as a sample fruit. It may prove even more helpful to take the key to the field, where the whole tree is available for examination.

Let us suppose that the material we wish to identify belongs to the sycamore or buttonwood. Beginning with the two alternate number 1's on the left, we find that it fits the statement of the second—"*leaves net-veined; sap not resinous.*" Opposite this group, on the right, occurs the successive number 12, which refers us back to the alternate number 12's. Here we find that our specimen fits the second statement number 12—"*leaves not fan shaped or divided at tips,*" which refers us to the numbers 13. Our leaf fits the first statement—"*leaves alternate,*" which refers us to 14. It fits the first statement 14—"*leaves simple,*" referring us to 15. We select the second statement—"*erect trees or shrubs*" which leads us to 19. Since the buds of our sample twig have but one bud scale, we look to numbers 20. We choose the second statement—"*leaves broad; bark shed in large, thin flakes,*" which places it definitely in the genus Platanus, or the sycamores, followed by the tree number 128 in parentheses. Since the trees in this booklet are numbered consecutively, number 128 is found to occur on page 61.

For meaning of technical words, see pages 107-110.

Trees and shrubs not native to Pennsylvania are marked with an asterisk (*).

KEY TO THE GENERA of the WOODY PLANTS OF PENNSYLVANIA

(Numbers in parentheses refer to type species of genera in the text)

1. Leaves needle—or scale-like; sap resinous 2
1. Leaves net-veined; sap not resinous 12

CONIFERS

2. Fruit a berry 3
2. Fruit a cone 4
3. Needles or scale-like leaves opposite or whorled **Juniperus** (38)
3. Needles not opposite or whorled .....**Taxus** (42)
4. Leaves linear to needle-shaped 5
4. Leaves scale-like, close overlapping 11
5. Needles in fascicles of 2 to 5, except in young seedlings .....**Pinus** (2)
5. Needles solitary or in rosettes of more than 5 6
6. Needles deciduous 7
6. Needles persistent,—evergreen 8
7. Needles solitary and in rosettes, except on 1-yr.-old trees .....**Larix** (19)
7. Needles solitary only,—many on fine twigs seem compound .....**Taxodium** (34)
8. Needles minutely stalked .....**Tsuga** (33)
8. Needles not stalked 9
9. Needles leave twigs rough when shed ....**Picea** (23)
9. Needles leave twigs smooth when shed 10
10. Buds very acute,—red brown, scales numerous **Pseudotsuga** (29)
10. Buds blunt or ½-acute: cone-scales deciduous **Abies** (30)
11. Twigs very flat; cone-scales overlap ....**Thuya** (36)
11. Twigs flattened; cones globose, scales valvate **Chamaecyparis** (35)

BROADLEAF SPECIES WITH SIMPLE LEAVES ALTERNATELY ARRANGED

12. Leaves fan-shaped with divided tips ....**Ginkgo** (1)
12. Leaves not fan-shaped or divided at tips 13
13. Leaves alternate 14
13. Leaves opposite or whorled in whole or part 69
14. Leaves simple 15
14. Leaves compound 60
15. Twining or climbing vines 16
15. Erect trees or shrubs 19
16. Thorny climbers 17
16. Smooth climbing vines 18
17. Half-erect, often unarmed .....**Lycium** (250)
17. Climbing briars .....**Smilax** (44)
18. Twining climbers; leaves small .....**Celastrus** (185)
18. Tendril-climbers; leaves large .....**Vitis** (206)
19. Buds with but one scale 20
19. Buds with two or more scales 21
20. Leaves narrow; bark tight or shed in thick strips and very slowly .....**Salix** (46)
20. Leaves broad; bark shed in large, thin plates **Platanus** (128)
21. Leaf-stalks more or less vertically flattened **Populus** (55)
21. Leaf-stalks terete or horizontally flattened 22
22. Fruit a cone-like structure 23
22. Fruit not a cone-like structure 27
23. Leaves 4-lobed, apex truncate; buds large and flattened .....**Liriodendron** (116)
23. Leaves not lobed or truncate 24
24. Buds hairy within or without; cones fleshy **Magnolia** (113)
24. Buds not hairy; cones dry; small 25
25. Cones woody, persistent; buds stalked ....**Alnus** (79)
25. Cones fall apart at maturity; buds sessile 26
26. Cone hop-like,—built of little sacks with stinging hairs .....**Ostrya** (72)
26. Cone scaly; seeds very small and light **Betula** (73)
27. Leaves pinnatified; sweet-scented low shrub **Myrica** (61)
27. Leaves usually wider, margins often entire; scent absent or pungent 28
28. Seeds borne on a 3-pointed bract; bark tight, blue-gray .....**Carpinus** (71)
28. Seeds not borne on 3-pointed bract 29
29. Seeds borne in prickly burs 30
29. Seeds not borne in prickly burs 31

30. Seeds triangular; burs small and weakly armed **Fagus** (83)
30. Seeds not triangular; burs large and sharply armed .....**Castanea** (85)
31. Fruit a nut borne singly in a basal involucre .. 32
31. Fruit not a nut 33
32. Involucre around nut leafy .....**Corylus** (80)
32. Involucre woody and cup-like; buds clustered toward tip of twigs .....**Quercus** (88)
33. Leaves unequal-based and terminal bud absent .. 34
33. Leaves symmetrical 36
34. Seeds flattened, surrounded by papery wings; leaf pinnate-veined .....**Ulmus** (103)
34. Seeds fleshy or dry nutlets 35
35. Leaves 3-nerved; pith chambered in part; nutlet fleshy, later dry .....**Celtis** (108)
35. Buds oblique; pith continuous; dry nutlets attached to leafy bract .....**Tilia** (209)
36. Leaves variable and entire on one and same tree 37
36. Leaves all lobed or all entire on a given tree .. 38
37. Sap milky; fruit a fleshy aggregate ....**Morus** (109)
37. Sap watery-aromatic; fruit a drupe ..**Sassafras** (119)
38. Twigs thorny at nodes 39
38. Twigs unarmed except for modified twigs in a few species 40
39. Fruit a pome; sap watery .....**Crataegus** (143)
39. Fruit an orange-size aggregate; sap milky **Maclura** (112)
39. Low shrubs; fruit a many-seeded berry; thorns absent at times .....**Ribes** (123)
40. Fruit like a small banana; buds red-velvety, terminal flattened .....**Asimina** (118)
40. Fruit not banana-like 41
41. Twigs with typical taste and odor 42
41. Twigs without specially distinctive flavor 47
42. Fruit a fleshy drupe 43
42. Fruit a several-seeded berry or dry capsule 44
43. Seeds stony; twigs with odor of bitter almonds **Prunus** (158)
43. Seeds bony, thin-shelled; twigs with skunk-like odor .....**Benzoin** (120)
43. Twigs leathery-tough; sap acrid; buds subpetiolar and velvety .....**Dirca** (214)
44. Low near-herb with wintergreen flavor **Gaultheria** (230)
44. Trees and shrubs 45
45. Leaves star-shaped; twigs usually corky ridged **Liquidambar** (126)
45. Leaves not lobed or twigs corky 46

46. Leaves peach-like; sap sour; fruit in terminal panicles ..... **Oxydendron** (238)
46. Twigs scurfy tipped; buds flattened **Hamamelis** (125)
46. Twigs bright brown; buds smoky; leaves entire, near round ..... **Rhus Cotinus** (180)
47. Bark exfoliates in papery layers 48
47. Bark not papery 49
48. Leaves small; fruit a dry capsule **Physocarpus** (130)
48. Leaves large; fruit a fleshy aggregate ..... **Rubus odoratus** (150)
49. Twigs very fine, golden brown, numerous; shrubs **Spiraea** (131)
49. Twigs intermediate to heavy 50
50. Twigs bright green; leaf 2-serrate, acute; birch-like ..... **Kerria** (133)
50. Twigs gray to brownish or leaves small and entire 51
51. Fruit a pome or several-seeded berry 52
51. Fruit not a pome or several-seeded berry 54
52. Fruit a typical pome; flowers 5-part ..... **Pyrus and Amelanchier** (134)
52. Fruit a berry 53
53. Berry black, nauseous, usually 2-seeded ..... **Rhamnus** (203)
53. Berry tomato-like; leaf-margins variable; ½ herbaceous ..... **Solanum** (251)
53. Berry with several bony seeds (often 1 in **I. opaca**) ..... **Ilex & Nemopanthus** (181)
53. Seeds small, leathery; leaves small; shrubs .. **Gaylussacia & Vaccinium** (231)
54. Fruit a bean-like pod; leaf cordate ..... **Cercis** (168)
54. Fruit not a bean; leaf not cordate 55
55. Leaves 3-nerved 56
55. Leaves not 3-nerved 57
56. Twigs dead at tips; roots red; flowers small **Ceanothus** (204)
56. Twigs gray, filamentous stipules persist; flowers showy ..... **Hibiscus** (240)
57. Leaves clustered at tip of twigs 58
57. Leaves not clustered at tip of twigs 59
58. Low creeping evergreen ..... **Epigaea** (229)
58. Small tree; fruit a small, globose drupe ..... **Cornus alternifolia** (221)
58. Flowers showy; capsules oblong ..... **Rhododendron** (223)
58. Flowers showy; capsules globose ..... **Kalmia** (226)
59. Fruit a drupe; leaf-scars show 3 fibro-vascular bundles; tree ..... **Nyssa** (222)

59. Fruit a persistent, dry, globose capsule; shrub **Lyonia** (228)

BROADLEAF SPECIES WITH COMPOUND LEAVES ARRANGED ALTERNATELY

60. Leaves palmately compound 61
60. Leaves pinnate—or double-compound 62
61. Prickly shrub or ½-herb with fleshy aggregate fruit ..... **Rubus allegheniensis** (151)
61. Smooth vine with tendrils disc-tipped; leaflets 5 **Psedera** (205)
62. Leaves 2-compound as a rule 63
62. Leaves not 2-compound as a rule 64
63. Twigs "clubby"—prickly ..... **Aralia spinosa** (215)
63. Twigs very heavy, smooth; buds sunken ..... **Gymnocladus** (166)
64. Leaves sometimes 2-compound; irregularly spiny twigs and limbs ..... **Gleditsia** (167)
64. Leaves never 2-compound 65
65. Sap milky ..... **Rhus** (174)
65. Sap not milky 66
66. Fruit a nut enclosed in a husk 67
66. Fruit not a nut 68
67. Pith chambered; husk indehiscent .... **Juglans** (62)
67. Pith continuous; husk more or less dehiscent-valvate ..... **Carya** (65)
68. Fruit a small pome in large flat cymes ..... **Pyrus americana and aucuparia** ..... (139)
68. Fruit a fleshy aggregate; prickly shrubs, scarcely woody ..... **Rubus** (147)
68. Fruit a small leathery button; prickly shrubs, **Rosa** (154)
68. Fruit small fleshy capsules; prickly shrubs, pungent-aromatic ..... **Zanthoxylum** (171)
68. Fruit a small bean; twigs thorny or hairy .... **Robinia** (169)
68. Seeds flat, surrounded by leaf-like wings, leaflets 3 ..... **Ptelea** (172)
68. Seeds flat, surrounded by leaf-like wings; leaflets many; odorous ..... **Ailanthus** (173)

BROADLEAF SPECIES WITH SIMPLE LEAVES ARRANGED OPPOSITELY

68. Both opposite and alternate leaves on same tree **Broussonetia** (111)
69. All leaves opposite or whorled 70
70. Leaves simple 71
70. Leaves compound 84

71. Leaves commonly in whorls of 3 72
71. Leaves rarely or never whorled 73
72. Leaves large; fruit a cigar-shaped pod **Catalpa** (253)
72. Leaves medium; fruit a dry globose aggregate **Cephalanthus** (256)
72. Leaves small; fruit a dry globose capsule .... **Kalmia angustifolia** (227)
73. Buds sub-petiolar; twigs bright brown ..... **Philadelphus** (122)
73. Buds not sub-petiolar in fact, but sometimes seem so 74
74. Buds small, black silky; twigs dull brown, typical odor ..... **Calycanthus** (117)
74. Buds not black silky but scaly 75
75. Fruit a typical key borne in pairs ..... **Acer** (188)
75. Fruit not a key nor borne in pairs 76
76. Twigs pithy, bright brown; leaf long-stalked **Hydrangea** (121)
76. Twigs with small pith or hollow between nodes 77
77. Twigs hollow; leaves large, at times whorled **Paulownia** (252)
77. Pith continuous; leaves very rarely or never whorled 78
78. Twigs 4-angled in tendency, green with white stripes ..... **Evonymus** (186)
78. Twigs terete in general or not green with white stripes 79
79. Fruit a dry many-seeded capsule 80
79. Fruit a drupe or berry 81
80. Leaves narrow-oblong, punctate; twigs fine **Hypericum** (213)
80. Leaves ovate; twigs medium, angled in tendency **Diervilla** (257)
80. Leaves ovate; twigs fairly heavy, terete; buds blunt, large ..... **Syringa** (249)
81. Fruit a berry with several seeds 82
81. Fruit a drupe with but one seed 83
82. Twigs fine, leaves small ..... **Symphoricarpos** (263)
82. Twigs and leaves medium; some species twine or creep ..... **Lonicera** (259)
83. Fruit like an olive; flower-clusters fringe-like **Chionanthus** (246)
83. Fruit a small drupe with an oval, flat seed **Viburnum** (265)
83. Fruit a small drupe; seed not flat; leaf coriaceous, subevergreen ..... **Ligustrum** (247)
83. Seeds ribbed or globose; bark bitter with tonic properties ..... **Cornus** (216)

BROADLEAF SPECIES WITH COMPOUND LEAVES ARRANGED OPPOSITELY

84. Leaves palmately compound ..... **Aesculus** (200)
84. Leaves pinnately compound 85
85. Trifoliate with bladder-like fruit; shrubs **Staphylea** (187)
85. Leaflets more than 3 (often only 3 in A. Negundo) 86
86. Climbing vine ..... **Tecoma** (255)
86. Shrubs with pithy stems; berries..... **Sambucus** (271)
86. Trees; fruit,—symmetrical keys ..... **Fraxinus** (241)
86. Trees; fruit,—unsymmetrical paired keys; leaflets 3 or 5 ..... **Acer Negundo** (194)

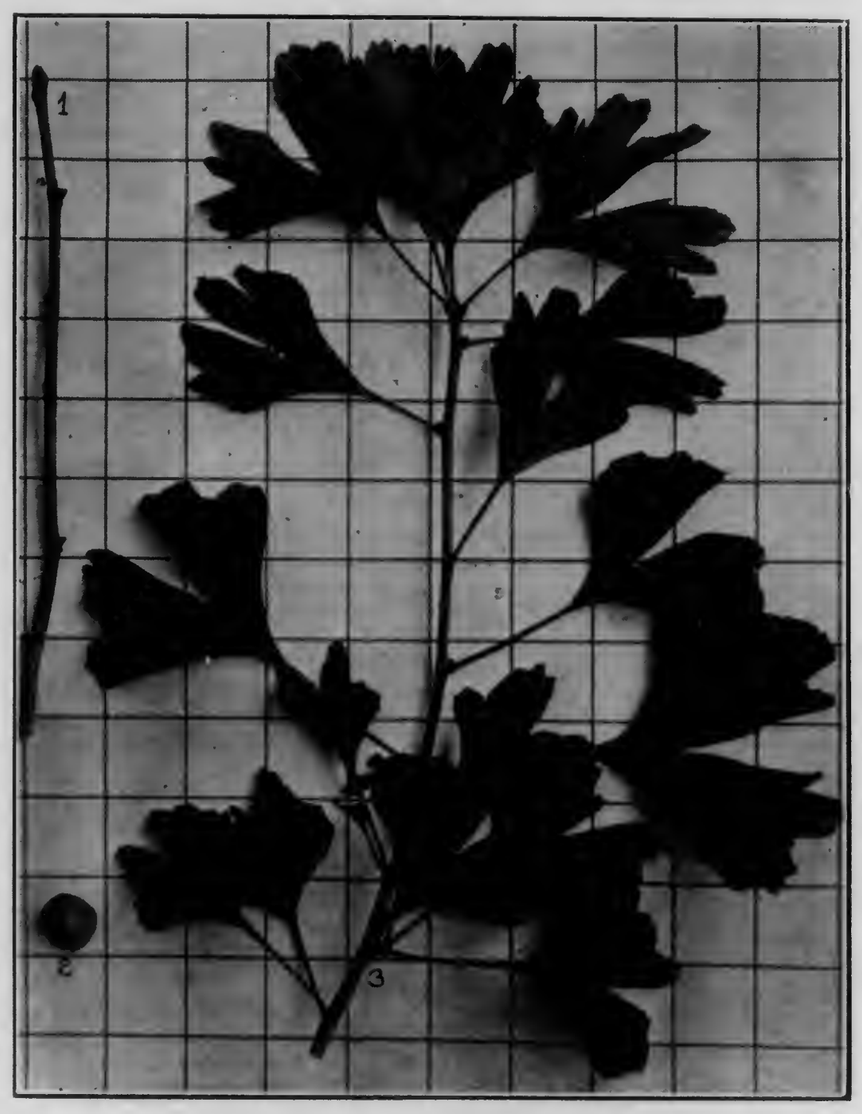


Figure 1

GINKGO. 1. Twig in winter. 2. Seed. 3. Twig in summer showing leaves on elongating shoot and short spurs

FIELD IDENTIFICATION OF THE COMMON TREES AND SHRUBS OF PENNSYLVANIA

Native and Introduced

1. *Maiden-Hair Tree or Ginkgo,—Ginkgo biloba, L.

Leaves fan-shaped like those of Maiden-Hair Fern, but coriaceous; deciduous.

Buds red-brown, conical, obtuse, with few scales.

Twigs pale yellow-brown, relatively heavy, sparse, rigid and *of two types,—short spurs and elongating shoots.*

Tree has normally strong monopodial tendency.

A rather rare ornamental exotic from China where it was long considered sacred. (Fig. 1)

PINES,—PINUS, (Tourn.) L.

Needles in fascicles of 2 to 5 *with filmy basal sheath,* which is *permanent in the Hard Pines* (Yellow Pines), *but shed at end of the first season in the Soft Pines* (White Pines).

Twigs of but one type.

Cones require two seasons to mature.

2. White Pine,—Pinus Strobus, L.

Twigs more or less rusty pubescent at first; finally smooth.

Buds gray-brown with close-apprest striate scales.

Needles 5, 2½"—5" long, soft and flexible; with white lines of stomata between, giving foliage characteristic blue-green appearance in mass.

Growth in regular whorls.

Cones stalked, unarmed, very resinous at maturity. (Fig. 2)

3. Pitch Pine,—Pinus rigida, Mill.

Twigs heavy, *golden-brown, angled in x-section.*

*Trees and shrubs not native to Pennsylvania are marked with an asterisk.

For meaning of technical words see pages 107-110.

Buds red-brown and resinous; scales indistinct.

Needles 3, rarely 4; heavy, stiff, 2½"—5" long, yellowish green.

Cones with short rigid prickles, wide base, *thick tipped scales;* sessile and very persistent.

Growth irregular; form often poor because of insect attacks.

Common on poor, sandy soils and areas where forest fires have raged. (Fig. 2)

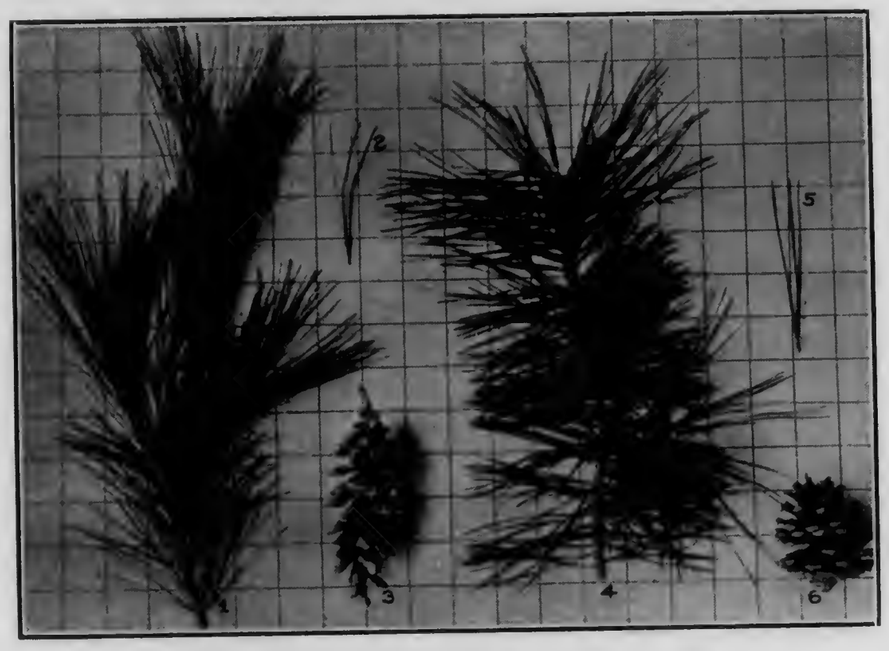


Figure 2

WHITE PINE. 1. Twig and foliage. 2. Fascicle of foliage in winter. 3. Cone

PITCH PINE. 4. Twig and foliage. 5. Foliage fascicle. 6. Cone

4. Shortleaf Pine,—Pinus echinata, Mill.

Twigs pale *glaucous* to *purple*-brown; *circular x-section.*

Buds striate; with *pale gray-brown*, close-lying, acute scales; very *seldom resinous.*

Needles 2, 3 or even 4; slender and rather flexible; 3"—4" long, dark green,*close-set on twigs, not twisted.*

Bark much like pitch pine but slightly smoother.

Cones narrow-based; with thin-tipped, weakly armed scales.

Growth irregular. Form excellent.

Occurs on medium to good soils and at rather *low elevations* in Pennsylvania.

5. Jersey Pine,—Pinus virginiana, Mill.

Twigs usually slender and *curved*, flexible, *terete, glaucous brown to purple.*

Buds brownish, more or less resinous.

Needles 2 (very rarely 3), *diverging and twisted*, 1½"—3" long, *stout*, dark *green*, fragrant, *sparse on twigs.*

Crooked tree of poor form unless crowded; *with smoothest thinnest bark of any native pine. Crown open.* Growth irregular.

Tree of poor soils, but absent at higher elevations in Pennsylvania. Often killed by bark beetles.

6. Table Mountain Pine,—Pinus pungens, Lamb.

Needles 2, very stiff and sharp; 2"—4" long.

Cones as large as the clenched fist; scales very thick, with *stout* claw-like *spines.* Seeds trianglar.

Otherwise like pitch pine; but usually of poorer form, because it *grows on the most adverse sites;* common on windswept mountain slopes and ridges.

7. Red Pine,—Pinus resinosa, Ait.

Twigs heavy, ridged; *yellow-brown to red-brown.*

Buds large; brown at first, later *silvery;* scales loose-lying and fringed.

Needles 2, rather slender *and flexible*, 4"—6" long.

Cones unarmed, glossy brown. *Growth regular. Form excellent.*

Tree of poor, dry soils; sparsely occurring in mountainous northern Pennsylvania.

8. *Northern Jack Pine,—Pinus Banksiana, Lamb.

Twigs olive-green to brown; angled.

Buds very resinous (Young seedling trees have less resin and longer needles.)

Needles 2, sparse, stout, curved or twisted, ¾"—1¼" long.

Bark thin, dark brown. *Growth* irregular; *very rapid.* Form fair.

Cones unarmed when mature, unsymmetrical, often persist unopened for years.

Native to Lake States, and northern New England northward. Introduced for forest planting.

9. *Lodgepole Pine,—Pinus contorta, Loud. (Variety)

Quite like Jersey and *jack pine* in general, but has longer curved and twisted needles. Form fair. Growth rapid.

Buds large, rounded, *resinous*, with knobs that indicate next season's lateral shoots.

Used experimentally in forest planting. Native to western North America.

10. *Scotch Pine,—Pinus sylvestris, L.

Twigs fairly stout, brittle, *olive-brown.*

Buds usually resinous, sometimes with loose scales.

Needles 2; fine *lines of stomata on all sides;* blue-green to dark-green; 1½"—3" long.

Cones slender-stalked, knobby but not prickly; *scales narrow but thick.*

Like red pine in bark and regularity of growth, but of *poorer form.*

Commonly planted in Pennsylvania forests; rare ornamentally. Native to Scotland and northern Europe. The Finnish variety grows slowly but with good upright habit. *Foliage shows yellowish coloration in autumn and winter.*

11. *European Mountain Pine,—Pinus montana, Mill.

Like Scotch pine in general but numerous variations occur; mostly of *poor form and only of ornamental* interest.

Twigs dark, *very densely set with stout needles.*

Buds resinous, with fringed scales usually more or less reflext. Native to south-central Europe.

12. *Western Yellow Pine,—Pinus ponderosa, Laws.

Twigs heavy, ridged, *glaucous* gray to dark olive-brown.

Buds large, silvery gray.

Needles tufted at ends of shoots; usually 3, rarely 2; pale to dark-green and usually about 5" *long* in Pennsylvania. Sap has odor of oil of oranges.

Growth regular but slow.

Cones larger than those of native hard pines; scales thick tipped and glossy, weakly armed. Native to Pacific and Rocky Mountain regions.

13. *Japanese Red Pine,—Pinus densiflora, Sieb. et Zucc.

Like Scotch pine in general but foliage is longer and more flexible, cones smoother and shorter stalked. Foliage in mass is yellowish—to dark-green.

Buds wine-red with numerous *reflext filamentous scales.*

Growth very rapid. Form fair but many stems arise from one base. Cones borne at very early age.

Planted experimentally for forestry purposes on poor and open sites. Native to Japan and Korea.

14. *Japanese Black Pine,—Pinus Thunbergii, Parl.

Like American red pine in general but needles are shorter, and much *stiffer and sharper;* buds more silvery and twigs paler. Many odd variations have been developed in Japan where it is a common ornamental and forest tree.

In utility and silvics, like Japanese red pine, but less hardy. Native of Japan.

15. *Austrian Pine,—Pinus austriaca, Hoss.

Similar to Japanese black pine in general, but darker in appearance thru-out, and needles are closer on twigs.

Buds usually *have broad basal reflext scales.*

Cones cream-colored at maturity and unarmed. Native to southern Europe.

16. *American Nut Pine (Pinyon),—Pinus edulis, Engelm.

Very *stiff needles* in bundles of 2 or 3 and lying so close together during their first season as to seem fused. Primary foliage common on young trees. *Foliage during first season looks like that of Colorado blue spruce.* Buds small, slender, gray-striate.

Growth very slow in Pennsylvania and form poor; hardy; best on dry but fine soils.

A "soft pine" of experimental interest because of its large seeds. Native of eastern and southern foothills of Rocky Mountains.

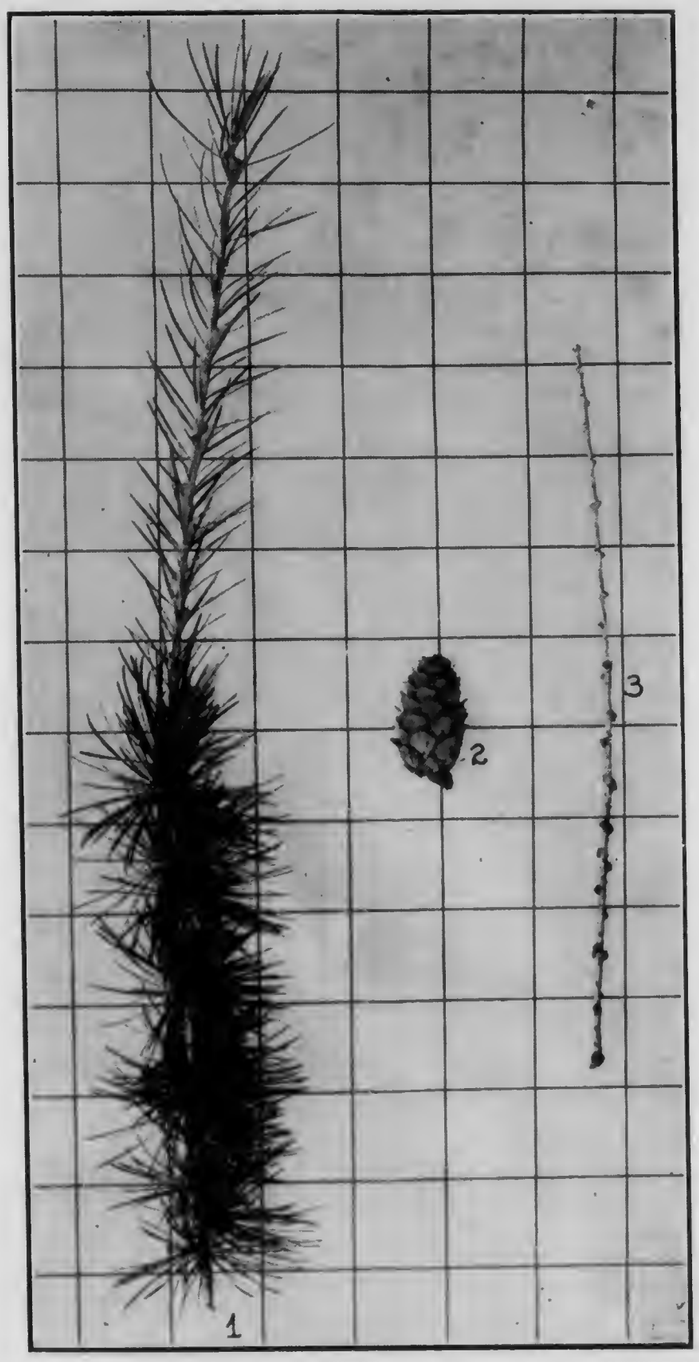


Figure 3

EUROPEAN LARCH. 1. Twig and foliage showing individual needles on elongating twig and needles in rosettes on short spurs. 2. Cone. 3. Twig in winter showing growth during past two years

17. *Himalayan White Pine,—Pinus excelsa, Wall.

Twigs rather heavy, smooth glaucous-green.
Bud-scales lie loosely.
Needles about 6" long as a minimum, more or less *drooping.*
Usually of poor form in Pennsylvania. In general quite like white pine but cones are much larger.
Only met as ornamental. Native to Himalayan Mountains of Asia.

18. *European Stone Pine,—Pinus Cembra, L.

Twigs covered with short rusty hairs; needles fairly stiff; otherwise quite like white pine in appearance, but growth is very slow and seeds resemble those of nut pine. A rare ornamental. Native of Alps of Central Europe, and to Central Asia.

LARCHES,—LARIX. (Tourn.) Adans.

Needles deciduous, occurring *singly on elongating shoots* and in *rosettes* of 10 or more *on the short spurs.*
Growth irregular and rapid. Cones mature in one season; borne upright.

19. American Larch,—Larix laricina, (DuRoi) Koch.

Foliage blue-green; finer than in other species.
Twigs glaucous rose-brown. Branches crooked and very irregular.
Bark dark brown. Cones about ¾" long.

20. *European Larch,—Larix decidua, (Mill).

Foliage yellow-green.
Twigs yellow-gray. Branches aspiring, rather straight.
Bark gray-brown. Cones 1½" long. Native to northern and central Europe. (Fig. 3)

21. *Siberian Larch,—Larix sibirica, Lebedour.

Like European larch but needles are longer and wider; form is even better, and *branches are sparser.* Native to northern Asia.

22. *Japanese Larch,—Larix leptolepis, Gordon.

Needles glaucous beneath.
Tree has a distinctive fragrance. Native to central Japan.

SPRUCES,—PICEA, Link.

Needles occur singly and *leave branches quite rough when shed;* 4-angled or flattened; persist 7-10 yrs.
Buds with imbricated scales.
Cones pendant, unarmed; mature in one season.
Growth half-regular (i. e.—Leaders and laterals of current years are commonly unbranched, but branches develop during second season from irregularly located buds.)
Form very good.

23. *White Spruce,—Picea canadensis, (Mill.) BSP.

Needles callus-tipt; at first pale blue, usually becoming dark blue-green; when crushed *sap has typical odor* like that of spice bush.
Buds and twigs yellow-gray; latter often glaucous.
Cones about 2″ long; pale brown. Native to northern North America.

24. Red Spruce,—Picea rubra, (DuRoi) Dietrich.

Foliage yellow-green. *Buds red-brown.*
Twigs orange-brown with a *very fine short pubescence.*
Cones 2″ or less in length; red-brown with entire margined scales.

25. Black Spruce,—Picea mariana, (Mill.) BSP.

Like red spruce but foilage is blue-green with needles round-tipt; *cones smaller, more persistent* and with jagged-tipt scales.
The commonest spruce in Pennsylvania—grows slowly and is essentially a swamp tree.

26. *Colorado Blue Spruce,—Picea pungens, Engelm.

Needles very rigid and acute, often incurved.
Twigs and buds like white spruce but heavier, not glaucous. Bud-scales often reflexed.

Cones about 3″ long with irregular papery-tipt scales.
Tree of rather slow growth, but adapted to drier soils than most spruces. Native to Rocky Mountain region.

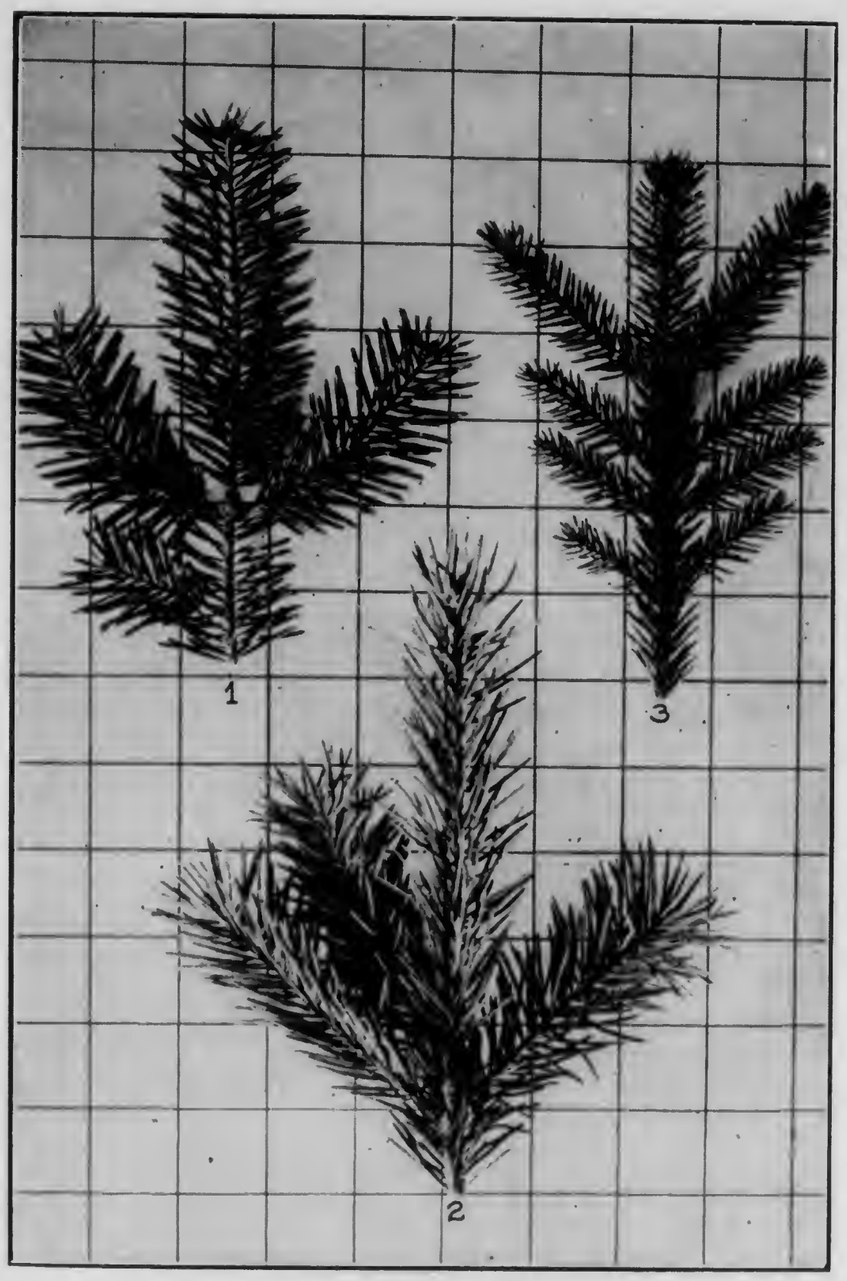


Figure 4

1. Balsam Fir twig. 2. Douglas Fir twig. 3. Norway Spruce twig

27. *Sitka Spruce,—Picea sitchensis, Carr.

Foliage in general like white spruce, but *needles* are *flattened*, rather *flexible* and lack the disagreeable odor; very sharp.

Buds and twigs gray-brown with yellow cast.

Cones 2½"—4" long; scales papery-tipt and toothed. Native from Alaska to California.

28. *Norway Spruce,—Picea Abies, (L.) Karst.

Needles sharp, 4-angled, dark green.

Twigs bright red-brown with buds darker; bud-scales reflext on tips of vigorous shoots.

Cones 4"—7" long. Native to Europe. (Fig. 4)

29. *Douglas Fir,—Pseudotsuga taxifolia, Britt.

Needles solitary, flat, round to acuminate at tips, grooved on top, stomatiferous beneath; mid-rib prominent; persist about 8 yrs.; blue-green to dark green.

Twigs terete; resin-blisters on young bark.

Buds very acute, red-brown; scales imbricated.

Growth ½-regular. Form very good. Pacific Coast and Rocky Mountain tree, native from British Columbia to northern Mexico. (Fig. 4)

FIRS,—ABIES, (Tourn.) Hill.

Needles flat in most species; solitary; *attached by a "frog's-toe"-like appendage, leaving* a round scar and *smooth twig when shed.*

Cones borne *upright; fall apart at maturity* leaving persistent axes.

Resin-blisters prominent on smooth young bark.

Growth ½-regular. Form very good.

30. Balsam Fir,—Abies balsamea, (L.) Mill.

Needles minutely notched at apex; apparently 2-rankt except on leaders; glossy dark green above, two clear white bands of stomata beneath; very fragrant.

Buds blunt and buried in clear resin.

Twigs fine to medium in size but rather stiff; tend to be opposite on lateral branches, unless frosted which is rare in natural range. (Fig. 4)

Figure 5

1. Hemlock twig with foliage and cones
2. Arborvitae or Northern White Cedar twig showing scale foliage and cones
3. Red Cedar twigs showing scale and awl-shaped foliage types. 4. Berry type of fruit characteristic of *Juniperus* species

31. *American Silver Fir,—Abies concolor, Lindl. & Gord.

Needle-tips entire. Foliage pale to bright blue-green, usually glaucous. Stomata usually on upper sides of needles as well as two bands beneath.

Buds ½-acute, pale yellow to light brown, usually glossy. Native to western United States and northern Mexico.

32. *Nordmann's Fir,—Abies, nordmanniana, Spach.

Needles like balsam fir but longer, heavier and *glossier,*—obviously notched at tips.

Buds red-brown, scaly, *not resinous.* Native to southeastern Europe and Asia Minor.

33. Hemlock,—Tsuga canadensis, (L.) Carr.

Needles of two types,—larger ones *combed apart to stand at right-angle* to the twig, smaller ones lying on top of twigs and parallel to them; about ½" long as a maximum; *mounted on minute stalks* (sterigmata); two white bands of stomata beneath; round or notched at tips; persist about 3 yrs.

Twigs very fine, pubescent, rough when needles are shed.

Bark shows alternate layers of brown and red when cut.

Cones ¾" long, ovoid, unarmed.

Form very good; growth very irregular; *leaders nod.* (Frontispiece and Fig. 5)

34. *Bald Cypress,—Taxodium distichum, Richard.

Deciduous. Has appearance of pinnate-compound foliage in summer, because of numerous *fine twigs which are also deciduous.*

Buds inconspicuous. Permanent twigs yellow-brown. Entirely hardy at Mont Alto, Pennsylvania.

Bark fibrous; cut into flat ridges.

Cones globose, 1" thru, rugose, fall apart easily; seeds angular and nearly as large as scales.

Form very good. Atlantic Coastal and Mexican Gulf tree, native from New Jersey southward. (Fig. 6)

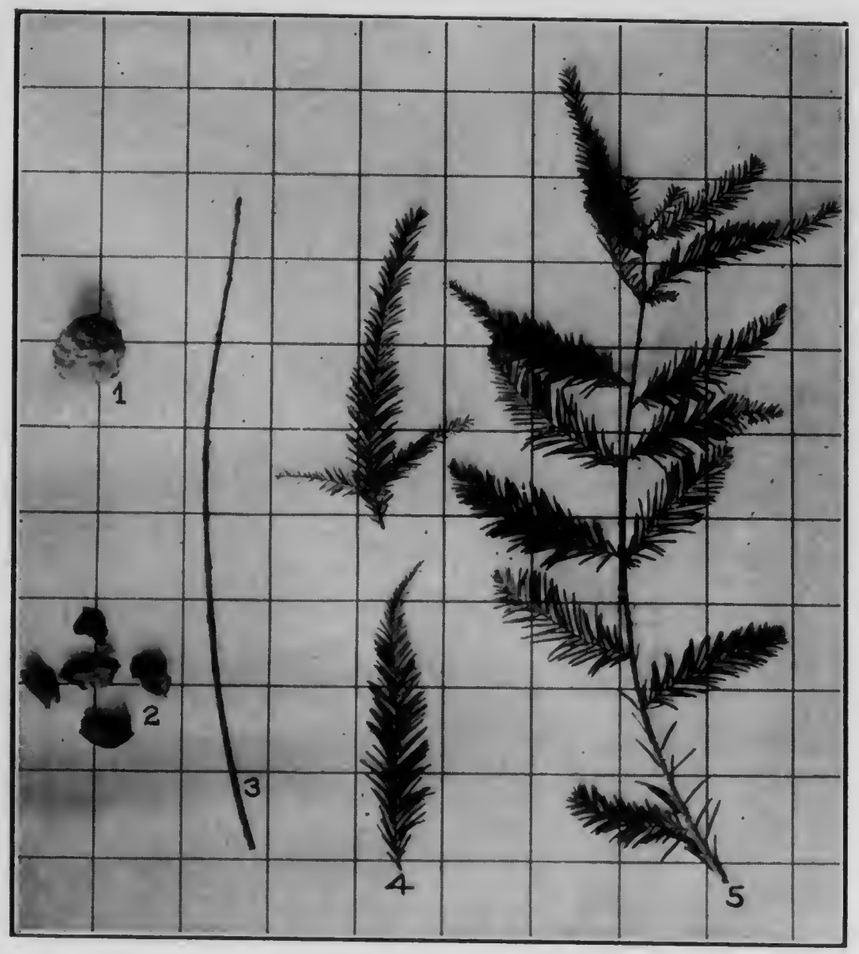


Figure 6

BALD CYPRESS. 1. Globose fruit. 2. Seeds. 3. Winter twig of woody non-deciduous type. 4. Delicate deciduous twigs with typical foliage. 5. Large woody twig of current summer growth showing deciduous twigs and the two types of foliage

35. Southern White Cedar,—Chamaecyparis thyoides, (L.) BSP.

Foliage scale-like on flattened twigs; blue-green; glandular below.

Bark shreddy.

Cones ¼" thru, globose with peltate scales; small *winged seeds.*

Small tree of slow growth; form often poor in open. Occured originally in a few swamps in southeastern Pennsylvania. Now extinct in the State except as an ornamental.

36. *Arborvitae; Northern White Cedar,—Thuya occidentalis, L.

Like preceding tree but twigs are flatter; cones oblong, nearly ½" long with 6-8 scales.

Sap has *typical odor.* Form fair. Native from Quebec to North Carolina, but not within Pennsylvania. (Fig. 5)

37. *Oriental Arborvitae,—Thuya orientalis, L.

Like No. 35 but foliage and twigs are flatter; *seeds are wingless,* look like those of an apple but gray-brown with typical basal scar: cones are larger and scales have projecting curved prickles.

Form rather poor. Size small. Native to China.

JUNIPERS,—JUNIPERUS (Tourn.), L.

Leaves in whorls of 3 or opposite. Buds small to minute. Flowers dioecious. *Fruit a berry.* Bark shreddy.

38. Red Cedar,—Juniperus virginiana, L.

Foliage of two types,—scale-like occurring alternately in opposite pairs, giving twigs an apparent square x-section, and *awl-shaped* usually in pairs but at times in whorls of 3. These latter carry faint bands of stomata.

Terminal shoots sometimes droop and are always quite fine.

Berry about ¼" thru, red-brown to blue and often glaucous; requires *one or two seasons to mature;* contains one or two seeds.

Growth slow. Form good. (Fig. 5)

39. Common Juniper,—Juniperus communis, L.

Like red cedar but lacks scale-leaves; awl-shaped ones are twice as long and wide as in red cedar and spine-tipt, occur in whorls of 3, *obviously stomatose and glaucous.*

Often only a prostrate shrub; at best but a small tree. A species of world-wide range and many variations.

40. *Chinese Juniper,—Juniperus chinensis, L.

Like red cedar but slower in growth, probably never getting as large. No scale *needles* occur and the *awl-shaped* ones *bear 2 obvious stomatose lines* and have *bright green margins;* commonly in whorls of 3.

An attractive ornamental. Native to China, Japan and the Himalayan Mountains.

41. *Japanese Common Juniper,—Juniper rigida, Sieb. et Zucc.

Needles size of our common juniper but stronger and Sharper; foliage gray-green in summer becoming *bronzed in winter with a yellow cast.*

A bush or small tree of fair form; used ornamentally to a limited extent. Native to Japan, Korea and Manchuria.

42. Ground Hemlock; American Yew,—Taxus canadensis, L.

Foliage yellow-green, *superficially like hemlock,* but needles are acute, sessile and larger.

Twigs green, much coarser than hemlock.

Fruit a waxy-looking, orange-red, fleshy, cup-shaped, 1-seeded berry.

Habit procumbent to ½-erect; about 3′ tall.

43. *English Yew,—Taxus baccata, L.

Quite like American yew but erect in habit, *attaining small tree size.*

Rarely completely hardy against winter-cold and summer drought. Native to Europe, northern Africa and western Asia.

GREEN BRIERS,—SMILAX, (Tourn.) L.

Woody, climbing briers with simple net-veined leaves.

Fruit small nearly dry berry.

44. Common Green Brier,—Smilax rotundifolia, L.

Leaves deciduous, green on both sides.

Stalks angular in tendency, green, with minute variegated dots and scattered, stout, straight thorns.

45. Saw Brier,—Smilax glauca, Walt.

Leaves partly persistent, glaucous below and at times above.

Stalks terete, glaucous brown, variegated with *obvious speckles; stout curved prickles.*

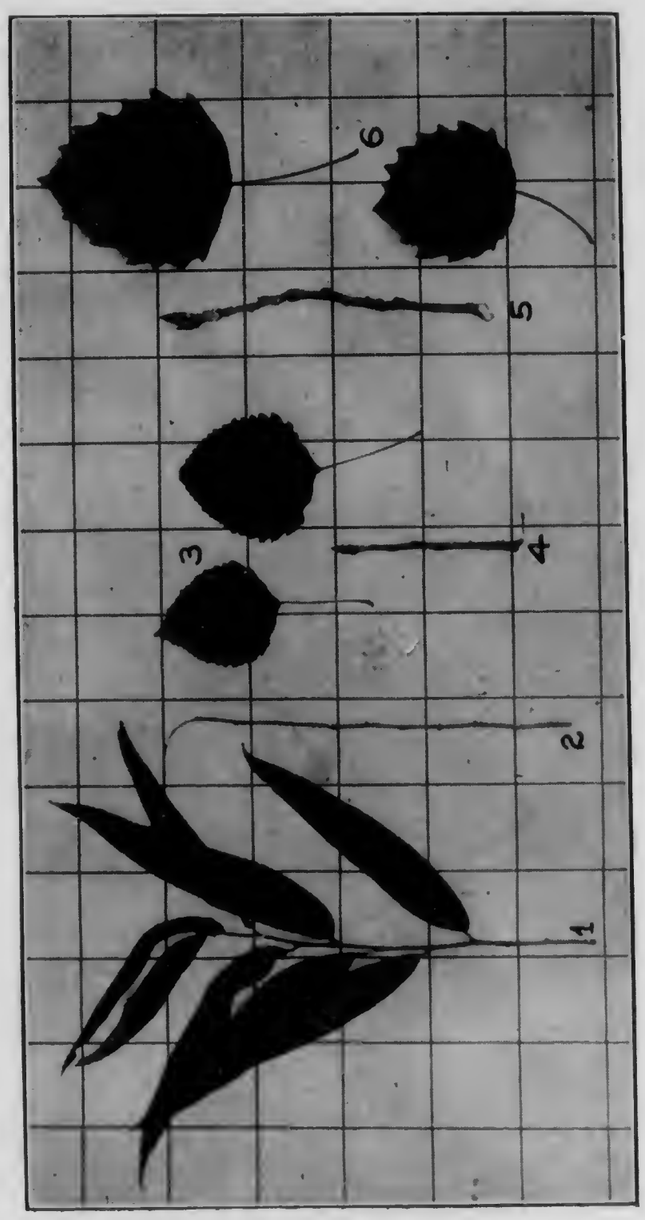


Figure 7

BLACK WILLOW. 1. Twig and leaves. 2. Twig in winter.
TREMBLING ASPEN. 3. Leaves. 4. Twig
LARGE-TOOTHED ASPEN. 5. Twig. 6. Leaves

WILLOWS,—SALIX, (Tourn.) L.

Leaves usually narrow and short-stalked.
Buds 1-scaled; terminal bud absent.
Trees and shrubs; usually of poor form; associated with moist habitats.

46. Black Willow,—Salix nigra, Marsh.

Leaves narrow-lanceolate-attenuate, smooth and bright green when fully developed. *Persistent ½-oval stipules,* or sometimes small ovate ones soon deciduous. *Buds conical-acute. Twigs fine, brittle,* many deciduous. Bark dark, deeply fissured or rarely plated. (Fig. 7)

47. *Weeping Willow,—Salix babylonica, L.

Leaves very slender-attenuate, sharp toothed.
"Duck-bill" buds close apprest to twigs.
Twigs fine, drooping, weakly attached to branchlets.
Common ornamental tree of unique habit.

48. *Crack Willow,—Salix fragilis, L.

Leaves coarse-serrate, *silvery beneath;* medium wide for a willow, as is also true of twigs.
Buds of apprest "Duck-bill" type.
Twigs always smooth, *yellow in winter, brittle.*
Gray bark breaks into plated ridges with exfoliating tendency.
Common ornamental or shade tree on fertile and moist soils; propagating vegetatively along stream-courses by its brittle branches. Native to Europe.

49. *Purple Willow,—Salix purpurea, L.

Leaves oblanceolate to tongue-shaped, slightly serrulate; rarely opposite.
Duck-bill buds, red to purple,—nearly same color as twigs.
Twigs rather tough and heavy; usually pubescent toward tips. Native to Europe where it is grown for basket making.

50. *American Green or Peach-leaf Willow,—Salix amygdalina, L.

Leaves pale or glaucous below, slender petioles ¼"—1" long.

Duck-bill buds, *at times sub-opposite.*
Twigs tough and slender,—well adapted to basketry.
Usually a small tree, but attains to 50′ tall. Native of Europe.

51. Glaucous Willow,—Salix discolor, Muhl.

Leaves coarsely toothed, oblanceolate to elliptical, *white or glaucous below, smooth* green above; margins often ruffled.
Leaf-buds of duck-bill type; floral larger and fuller with acute tips; reddish.
Twigs rather heavy flexible; downy at first, becoming smoother; red-purple to dark green. Bark smooth, greenish; rarely scaly.
Usually a stream-bank shrub or small tree; occasionally planted.

52. Sage or Dwarf Gray Willow,—Salix tristis, Ait.

Leaves 1″—2″ long, lanceolate to oblanceolate, *margins rolled under, white wooly below, gray olive-green above;* petioles very short.
Twigs slender, densely tomentose.
Tufted shrub, less than 4′ tall.

53. Silky Willow,—Salix sericea, Marsh.

Leaves at first quite silky especially below, becoming dark green above and pale or glaucous beneath; 2″—4″ long, usually narrow-acute.
Twigs slender, slightly downy.
Occurs along streams and on moist areas; 15′—20′ tall.

54. Prairie Willow,—Salix humilis, Marsh.

Leaves intermediate between sage and glaucous willows with which it probably often hybridizes; undulate, coarse-toothed or crinkled; floccose-pubescent below; 2″—3½″ long.
Twigs wooly-pubescent, slender.
Rarely above 6′ tall. Commonest "dry-land willow" in Pennsylvania.

ASPENS, POPLARS AND COTTONWOODS,—POPULUS, (Tourn.) L.

Leaves toothed, more or less *cordate or ovate, stalks* usually *flattened.*

Buds scaly, acute; *terminal* ones *prominent.* Leaf-scars show 3 bundle-scars.
Trees of fair form.

55. American or Trembling Aspen,—Populus tremuloides, Michx.

Leaves with thin, flat petioles; fine-serrate margins; blade round-ovate.
Twigs terete, usually slender, sparse, red-brown.
Flower—and vegetative—*buds*—distinct: *brown* with *glossy-varnished* appearance.
Bark yellow-green to white; smooth, becoming dark and fissured on old boles. (Fig. 7)

56. Large-toothed Aspen,—Populus grandidentata. Michx.

In general like trembling aspen but coarser in all features; *buds more divergent and pale dusty;* twigs paler in color. (Fig. 7)

57. Cotton-wood,—Populus deltoides, Marsh.

Broad *wedge-shaped acute leaves with stout flat stalks;* deep glossy green above, pale green below.
Buds large, resinous, glossy, chestnut brown; under-side of scales sticky and odorous.
Twigs stout, yellow tinged with green or brown, *round to angular* in x-section depending on rate of growth.
Good form; branches ascending in habit; very rapid grower. Has other features in common with aspens. Possibly not native to Pennsylvania.

58. *Balm of Gilead,—Populus candicans, Ait.

Like cotton-wood in many ways but of poorer form and with great tendency to sucker from roots.
Leaves glossy, often cordate, hairy below at times; *petiole slightly flattened.*
Buds varnished with copious *sticky, fragrant* resin. Native to northern Asia.

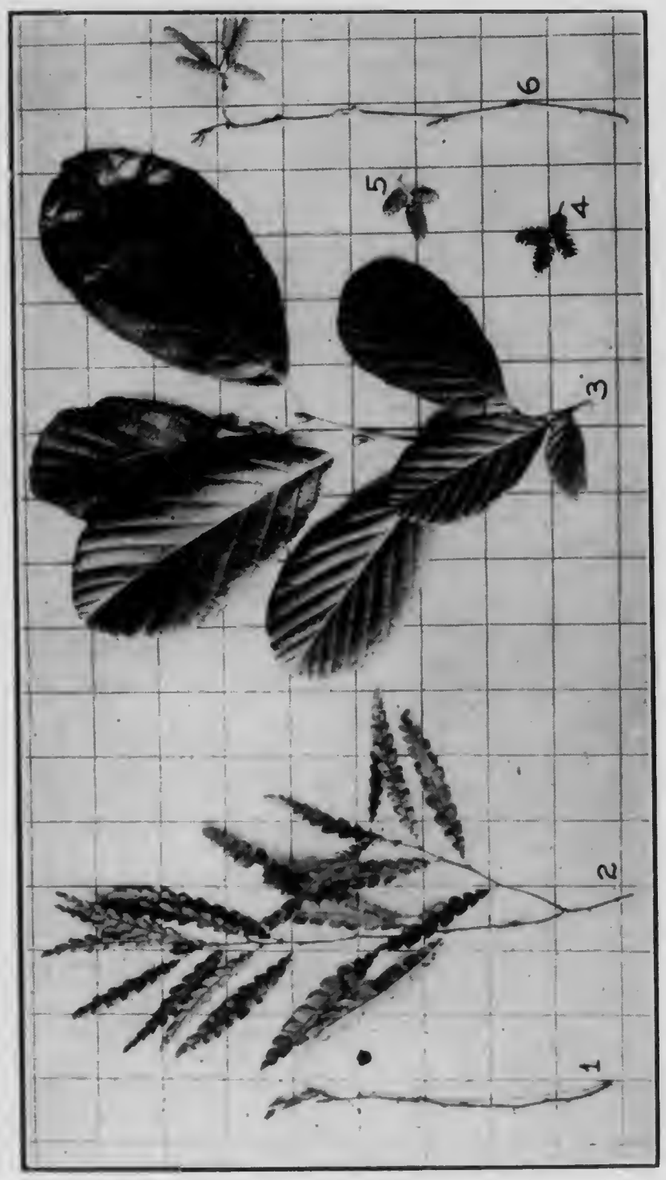


Figure 8

SWEET FERN. 1. Twig in winter with staminate catkins. 2. Twig and leaves
BLACK ALDER. 3. Twig and leaves. 4. Persistent cones which have opened and shed seeds. 5. Cones of the current season whose seeds are just ripening. 6. Twig showing stalked vegetative buds, a cluster of small pistillate catkins and a cluster of larger staminate ones

59. *Lombardy Poplar,—Populus nigra variety italica, Du Roi.

Like cottonwood, but of a finer pattern and with *dense upright habit.*

60. *White Poplar,—Populus alba, L.

Leaves deep green above, white-tomentose beneath; undulate margins remotely 5-lobed; *pentioles only slightly flattened, densely tomentose*, as are *twigs and buds* also.

Bark like that of the aspens but whiter as a rule.

Broad crown-form. Root-suckers common. Native to Europe.

61. Sweet Fern,—Myrica asplenifolia, L.

Leaves fern-like,—pinnatified, *sweet-scented*, linear-lanceolate.

Twigs fine, brown pubescent; staminate catkins present in winter.

Both monoecious and dioecious plants occur.

Fruit a globose, bur-like catkin about ¾″ long.

Rather common on poor sandy soils; attains to 5′ tall, usually much less (Fig. 8)

WALNUTS,—JUGLANS, L.

Trees in this genus *have* pinnate-compound leaves, *chambered central pith*, unbranched staminate flower stalks, and typical sculptured nuts with an indehiscent husk. Sap is aromatic.

62. White Walnut or Butternut,—Juglans cinerea, L.

Terminal leaflets well developed,—about equal to lateral ones in size.

Twigs with *brown pith*. "*Mustache*" just above leaf-scars.

Buds angular or flattened when terminally located, lateral ones smaller and often superposed; all are pale downy. Staminate, catkins of next season appear like pine-apple shaped buds.

Nuts long-ovate, deeply sculptured; with a hairy, sticky husk.

Unless crowded, crown-form is wide with large branches.

Bark gray to ashy-white, separating into wide flat ridges.

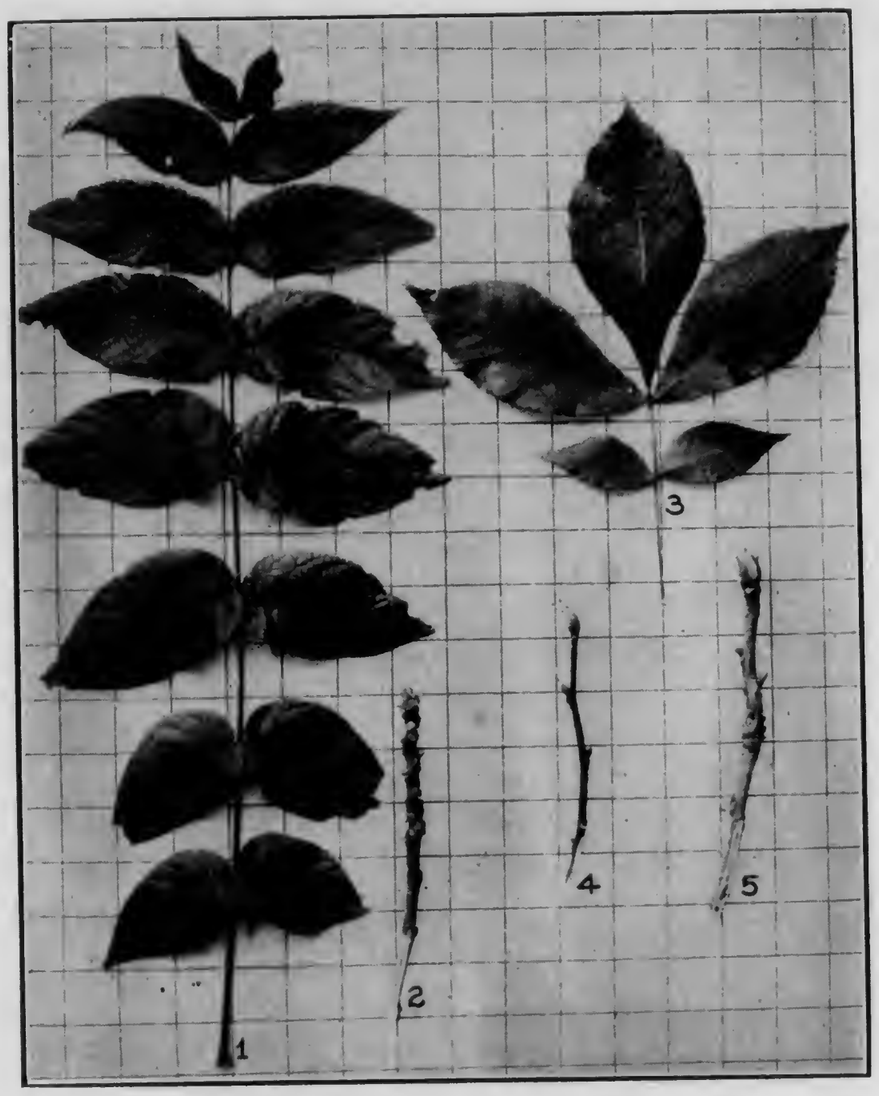


Figure 9

BLACK WALNUT. 1. Leaf. 2. Twig cut to show chambered central pith
PIGNUT HICKORY. 3. Leaf. 4. Twig
BIG SHELLBARK HICKORY. 5. Twig

63. Black Walnut,—Juglans nigra, L.

In general *like butternut*, but a better formed and larger tree; fruit globose and less deeply sculptured, enclosed in nearly smooth husk.

Terminal leaflet usually absent or atrophied. Pith gray to light brown.

Bark gray-brown and narrow ridged. (Fig. 9)

64. *English Walnut,—Juglans regia, L.

Like butternut, but buds blunter and not flattened; twigs smoother.

Leaves usually smooth-glossy above, with terminal leaflets larger than laterals.

Not quite hardy in Pennsylvania but variable in this feature: also in fruit, which however is usually only obscurely sculptured. Native to Europe.

HICKORIES,—CARYA, Nutt.

Like walnuts, but flower-stalks branch; *pith is continuous; nuts have 4-valved, more or less dehiscent husks.*

Wood tough and strong.

65. Pignut Hickory,—Carya glabra, (Miller) Spach.

Leaflets average 5, acute, smooth.

Twigs usually *smooth, medium size.*

Buds ¼"-½" long, ovate, scaly.

Bark usually tight; breaking into narrow flat-topped ridges, which sometimes scale off in narrow strips.

Fruit pear-shaped, with thin ½-dehiscent husk; nuts variable in size and quality, sweet but with bitter after taste.

Tree of poor to medium soils. (Fig. 9)

66. Mockernut Hickory,—Carya alba, (L.) K. Koch.

Leaflets average 7. Petioles downy.

Twigs stout, sparse; more or less *downy.*

Buds broad-ovate, large, outer scales shed early.

Bark tight and ridged.

Fruit large, sub-globose; thick dehiscent husk.

Nuts thick-shelled; small sweet kernels.

Tree of medium quality soils.

67. Shellbark Hickory,—Carya ovata, (Mill.) K. Koch.

Leaflets average 5. Buds large, ovate; outer scales acute, inner velvety, brown to gray.
Twigs intermediate between two preceding species; red-brown to gray; sometimes pubescent.
Bark shed vertically in large plates.
Fruit like mockernut, but nuts are acute at one end, usually thin-shelled with large sweet kernels.
Tree of medium to good soils.

68. Big Shellbark Hickory,—Carya laciniosa (Michx f.) Loudon.

Like the shellbark but *twigs are* heavier, sparser, usually tomentose, *buff to orange; leaflets average 7;* buds have more evenly tomentose scales.
Nuts often very large, strongly flattened, *acute at both ends;* thick-shelled.
A tree of fertile alluvial soils. (Fig. 9)

69. Bitternut Hickory,—Carya cordiformis, (Wang.) K. Koch.

Twigs medium fine, smooth.
Buds yellow-glandular with valvate scales; terminal ones flattened.
Leaflets ovate-lanceolate; average 9.
Fruit like pignut, but thin-shelled and very bitter-astringent.
Bark tight; flat, narrow ridged. Wood inferior in strength.
A tree of fertile valleys, stream-banks and swamps.

70. *Pecan,—Carya illinoensis, (Wang.) K. Koch.

Like bitternut, but buds are bright brown with yellow hairs; nuts sweetest and most edible of the genus.
Leaflets 9-17; giving tree the appearance of a walnut.
Native to Mississippi Valley.

71. Blue Beech or Water Beech,—Carpinus caroliniana, Walter.

Twigs fine; silky at first, becoming *smooth;* shiny brown to orange; *birch-like.*
Buds ovate-acute, *small,* red-brown, *with 8-12 visible 4-rankt scales* which increase in size toward the apex; terminal buds absent.

Leaves simple, small, ovate-acute, 2-serrate,—birch-like.
Bark tight, smooth, blue-gray, vertically corrugated.
Fruit a ridged nutlet, 1/3" long, borne on a 3-lobed leafy bract and arranged in pendant clusters.
Wood very hard and strong.
Small tree of poor form occurring on fertile lower hill-slopes and stream-banks.

72. American Hornbeam or Ironwood,—Ostrya virginiana, (Will.) K. Koch.

Quite like blue beech but twigs in mass form a more zig-zag pattern, lighter in color, tougher.
Buds are gummy; 8 visible scales. Bark is shed in shreddy scales.
Nutlets are enclosed in little sacks armed with stinging hairs and arranged in a hop-like aggregate about a central stem from which they are shed one by one.
Staminate aments are present in winter; usually occur in threes.

BIRCHES,—BETULA, L.

Twigs fine; two types occur,—"short spurs" with leaves more or less clustered, and *"elongating shoots"* with leaves single.
Buds acute; terminal ones absent. Sterile aments present in winter.
Fruit a small cone-like structure falling apart at maturity.
Seeds winged, very small and light.
Most large trees.

73. Black Birch,—Betula lenta, L.

Twigs smooth, shiny red-brown; *strong wintergreen flavor.*
Leaves simple, fine-serrate,—rarely 2-serrate.
Bark smooth and cherry-like at first with laterally elongated lenticles; later shed in thick plates. (Fig. 10)

74. Yellow Birch,—Betula lutea, Michx.

Like black birch but twigs are paler with some persistent down; leaves 2-serrate; bark at first shed laterally in yellow papery scales, later becoming quite tight and finally breaking into plates and wide ridges.
Wintergreen flavor faint.

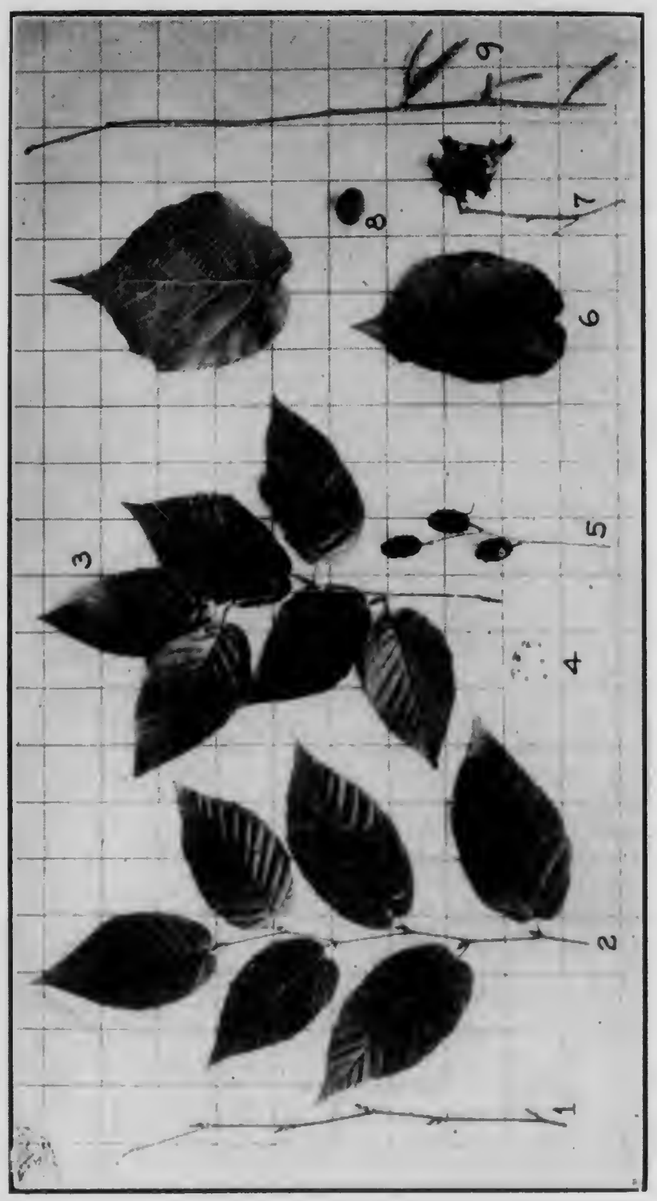


Figure 10

BLACK BIRCH. 1. Elongating twig in winter. 2. Elongating twig with individual leaves. 3. Twig with short spurs and clustered leaves. 4. Seeds and bracts. 5. Twig with cones composed of deciduous bracts and seeds borne around a central axis

AMERICAN HAZELNUT. 6. Leaves showing upper and lower surfaces. 7. Twig with fruit. 8. Nut. 9. Winter twig with staminate catkins

75. Red or River Birch.—Betula nigra, L.

Twigs more or less hairy-tomentose.

Leaves broadly ovate, *strongly 2-serrate; deep glossy green above, pale tomentose below. Seeds mature in spring.*

Bark on boles and limbs of 4"—10" thru is shed in ragged orange-brown papery sheets; later close or fissured and dark brown.

A stream-bank tree but not found along headwaters.

76. Gray Birch,—Betula populifolia, Marsh.

Twigs with warty dots and raised lenticles.

Buds 2-rankt, slightly resinous; ¾ visible brown scales with downy margins.

Leaves deltoid-ovate, 2-serrate; petioles long and slender.

Bark dull white, close, smooth, with triangular black patches below limbs; black and fissured on old boles; *inner bark pale orange.*

Small short-lived tree of rapid growth; commonly occurring in clumps.

77. Paper Birch,—Betula alba, variety papyrifera, (Marsh.) Spach.

Twigs red-brown, smooth or hairy-tomentose. *Buds resinous.*

Leaves firm in texture.

Bark creamy to chalky white, shed in regular filmy sheets. On old boles rough flat-ridged or plated.

Usually a tree of good form; boreal in range,—restricted to the higher mountains in Pennsylvania.

78. *White Birch,—Betula alba, L.

Quite *like paper birch but twigs are finer and with drooping habit;* bark is whiter, shed less evenly and abundantly. *Black patches prominent* below branches. Native from Europe to Japan.

79. Black Alder,—Alnus rugosa, (Du Roi) Sprengel. (Fig. 8)

Twigs medium in size, green—to dark-brown or grayish. Lenticels prominent and numerous.

Buds stalked, ½" long, green-red, comprest, *covered by 2 valvate scales* which are stipular in morphology; terminal absent.

Staminate aments and old cones present in winter; bloom very early.

Leaves obovate, blunt or rounded, evenly serrate; base wedge-shaped.

Bark thin, smooth, fluted, astringent, yellow within.

Small clumpy stream-bank or moist-soil species; often with shrub form. Replaced in northern Pennsylvania by the very similar but *coarser* speckled alder *(Alnus incana,* (L.) Moench).

HAZELNUT,—CORYLUS, L.

Mostly shrubs, occasionally specimens approach tree-size. *Twigs hairy. Sterile catkins present in winter.*

Buds blunt with imbricated scales. *Leaves thin,* 2-serrate.

Fruit a nut enclosed in a leafy bract.

80. American or Common Hazelnut,—Corylus americana, Walt.

Twig medium size; scattered or dense bristly red hair.

Catkins usually obviously *stalked.* Buds have more than 2 pairs of scales visible.

Fruit husk composed of two distinct bracts.

Found on fairly fertile or moist soils. (Fig. 10)

81. Beaked Hazelnut,—Corylus rostrata, Ait.

Like No. 80 but smaller in every feature, except *fruit-husk* which has component bracts fused into *a tube about 3" long.*

Buds usually expose only 2 pairs of scales. *Catkins sessile* or nearly so.

Shrub on poor, sandy or rocky sites.

82. *European Hazel or Filbert,—Corylus Avellana, L.

Like No. 80 but larger in every feature; makes quite rapid growth; twigs usually less pubescent. Bud-scales have ciliate margins.

Var. *atropurpurea* has dark purple foliage. A pendulous form and numerous other variations occur. Native to Europe, northern Africa and western Asia.

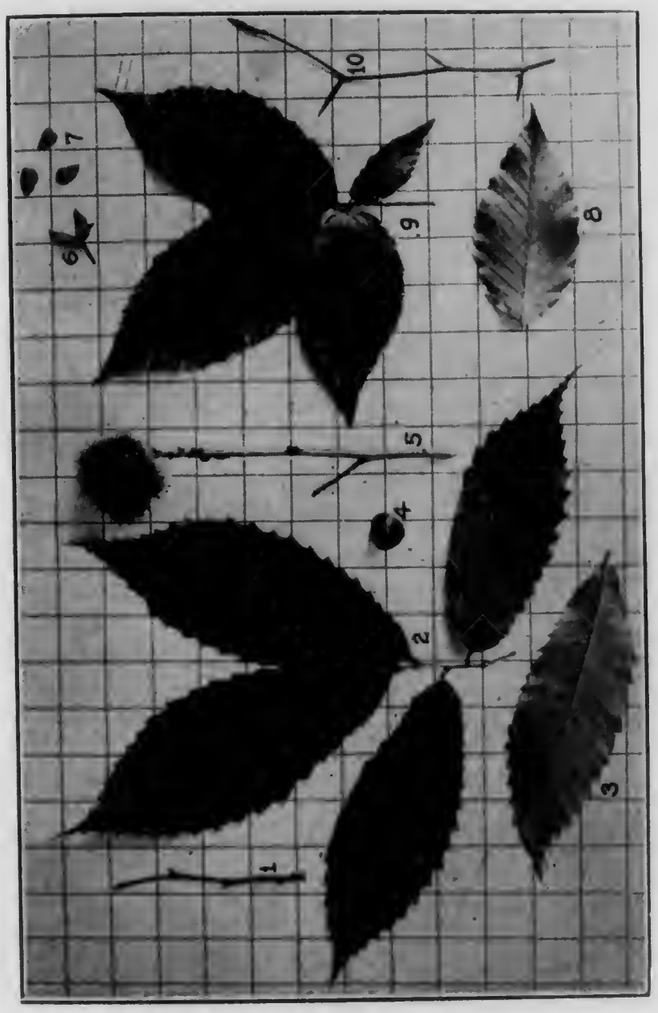


Figure 11

CHESTNUT. 1. Twig. 2. Twig and leaves in summer. 3. Leaf showing under surface. 4. Nut. 5. Twig with bur.

AMERICAN BEECH. 6. Bur. 7. Nuts. 8. Leaf showing under surface. 9. Short spur twig and leaves. 10. Elongating twig in winter condition

BEECH,—FAGUS, (Tourn.) L.

Trees with *close, smooth, grayish bark; long slender-conical, very acute buds.*

Triangular shiny brown nuts, borne in pairs in a stalked, 4-valved, prickly bur. Kernels sweet.

Wood compact; pith-rays prominent.

Found on moist and fertile soils; very tolerant of shade.

83. American Beech,—Fagus grandifolia, Ehrh.

Twigs medium to slender; hairy at first, later smooth; somewhat zigzag.

Leaves stiff, tough, sharp-toothed, ovate-acute; often persist into winter. (Fig. 11)

84. *European Beech,—Fagus sylvatica, L.

Like its American cousin but *leaves are more delicate,* smaller and rounder, *with ciliate, less acutely toothed margins.* Native from Central Europe to the Caucasus.

CHESTNUTS,—CASTANEA, (Tourn.) L.

Leaves like beech but longer-acute. Terminal buds absent; lateral 2-rankt.

Nuts sweet, edible; borne in velvet-lined burs densely armed with very sharp prickles.

Bark furrowed. Wood durable, ring-porous; rays very fine.

85. Chestnut,—Castanea dentata, (Marsh). Borkh.

Twigs rather heavy, smooth, green-brown. Pith star-shaped.

Buds like a grain of wheat. Leaf-scars raised ½-oval.

Leaves smooth. Nuts usually 3 in a bur.

Common tree on sandy and loam soils; rare on limestone areas. (Fig. 11)

86. Chinquapin,—Castanea pumila, (L) Mill.

Small tree or *shrubby counterpart of the chestnut,* but nuts are usually borne singly and *twigs are more or less wooly-pubescent,* as *also* are *under surfaces of leaves.*

87. *Chinese Chestnut,—Castanea mollissima, Bl.

Much *like the American chestnut* but of poorer form and does not become as large; *leaves shorter, glossy, more*

leathery; twigs grayer with scattered hairs towards tips: stipules large, triangular and rather persistent. Native to China.

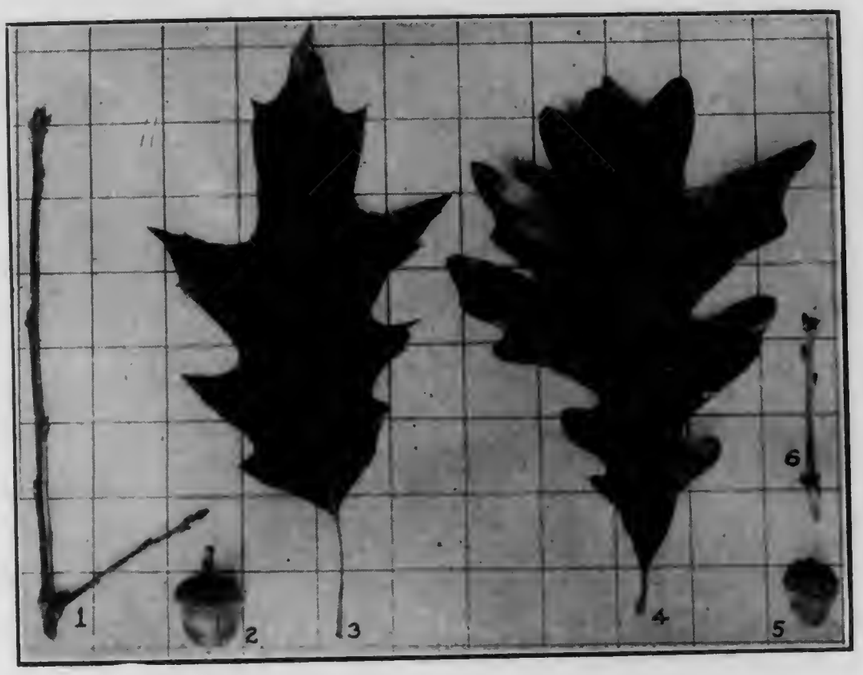


Figure 12

RED OAK. 1. Twig. 2. Acorn. 3. Leaf
WHITE OAK. 4. Leaf. 5. Acorn. 6. Twig

OAKS,—QUERCUS, (Tourn.) L.

Twigs have 5-sided or star-shaped pith. *Terminal buds present* and *laterals* tend to be *clustered near tips of twigs.*

Acorn fruit typical. Wood usually ring-porous; *pith-rays prominent.*

The oaks are divided into two groups with characteristics as follows:

	White Oak Group	*Black or Red Oak Group*
Buds	Usually blunt.	Usually acute.
Leaf	*Tip and lobes* rounded, *unarmed.*	*Tip and lobes end in a bristle.*
Fruit	Requires one season to mature.	Two seasons required to mature.
Nut-shell	Usually smooth within.	Usually pubescent within.

88. White Oak,—Quercus alba, L.

Twigs slender to medium, red-gray, smooth. *Buds obtuse, red-brown.*

Leaves obovate in general outline, usually 7-lobed and about 7" long.

Bark shed in narrow plates or ridged.

Acorn ovoid, shiny pale brown, with sweet astringent meat.

Tree of medium to good soils. (Fig. 12)

89. Swamp White Oak,—Quercus bicolor, Willd.

Twigs stout, yellowish to red-brown, nearly or quite smooth.

Branches of ½" thru and larger *exfoliate their bark.*

Buds pale chestnut-brown: at times slightly hairy at tips.

Leaves coarse-dentate with short rounded lobes; deep glossy yellow green above, *pale green and fine hairy below.*

Acorns on stalk usually 2" long; cups tend to be miniatures of those of bur oak. Meat quite sweet.

Found on stream-banks and similar sites where soil is moist and fertile.

90. Bur Oak,—Quercus macrocarpa, Michx.

Twigs stout, yellow-brown; hairy at first, later smooth *with corky excrescencs.*

Buds slightly pubescent, acute or obtuse; lateral ones apprest.

Leaves oborate, usually lobed with terminal one largest; about 10" long.

Nuts 1"—2" long. Cups deep, large, often with bird's-nest appearance.

91. Post Oak,—Quercus stellata, Wang.

Twigs stout, *rusty pubescent;* orange-gray to dark brown.

Buds red-brown, slightly pubescent.

Leaves thick-leathery, usually 5-lobed with middle pair largest. Lobes separated by broad sinuses. Leaves shiny deep green above, paler and rusty pubescent below.

Medium-size tree of dry sandy soils in valleys and foothill regions.

92. Chestnut or Rock Oak,—Quercus Prinus, L.

Twigs green at first, becoming purplish, then orange—or red-brown.

Buds ovate-conical-acute, ¼"—½" long, pale chestnut-brown.

Leaves quite like chestnut but thicker, with round-toothed coarse dentations.

Acorns short-stalked; nut about 1" long; cup shallow and basally knobbed.

Bark at first smooth, later breaks into sharp, hard ridges.

Bole and crown-form not as good as in preceding species.

Found on poorest, dry and rocky soils.

93. Yellow Oak,—Quercus Muhlenbergii, Engelm.

Quite like chestnut oak, but buds shorter and less acute: leaves more acuminate; *acorns sessile or nearly so; bark* breaks into rather flat *gray-scaly ridges.*

Occurs on dry soils and seems to prefer limestone regions.

94. Scrub Chestnut Oak,—Quercus prinoides, Willd.

In general a *miniature of chestnut oak* ranging from 2'—18' tall, but *buds are blunt* and pale brown; leaves pale tomentose beneath.

Found on poor to medium sites.

95. Red Oak,—Quercus rubra, L.

Is a representative of the biennial fruiting group. It is a well-groomed, rapid-growing tree, found on medium to good cool and moist sites.

Buds ovoid-acute, pale—to red-brown, *smooth,* but scales often have slightly pubescent margins.

Leaves oval to obovate in outline, about 8" x 5" and 7 to 9-lobed; *sinuses reach halfway to midrib;* stem and midrib often red.

Bark on old trees shows wide flat-topped ridges.

Acorns have shallow cups, velvety within; nuts average 1" long. (Fig. 12)

96. Scarlet Oak,—Quercus coccinea, Muench.

Rather *like red oak but buds are ½-pubescent;* leaves shorter, with narrow lobes; sinuses extend more than halfway to midrib. *Dead limbs commonly persist on boles.* Acorn-cups half cover nuts.

Common on soils somewhat poorer and drier than occupied by red oak.

97. Black Oak,—Quercus velutina, Lamb.

Twigs stout, rusty-pubescent or smooth, red-brown and angular.

Buds average nearly ½" long, ovate, *5-angled, yellowish to* dirty-white *pubescent;* quite acute.

Leaves obovate to oblong, usually 7-lobed: dark green and usually glossy above, yellow-green below with tufts of rusty hairs in axils of veins; *variable.*

Bark with narrower ridges than red oak, darker at base of boles. *Inner bark orange-yellow.* Acorn-cups covered with loose gray scales.

In soil choice intermediate between red and scarlet oaks.

98. Pin Oak,—Quercus palustris, Muench.

Like scarlet oak, but buds smaller, brown, *smooth;* leaves smaller and more deeply incised: limbs more persistent: *twigs rather slender, often spiky* or thorny in appearance.

Acorns small with *very shallow cups.* Young trees show good crown-form when open grown.

Occurs on moist, medium to very fertile soils.

99. Spanish Oak,—Quercus falcata, Michx.

In general *like pin oak* but *twigs are stouter; buds hairy; leaves* larger and *irregular in lobing,* tomentose below.

100. Scrub Oak,—Quercus ilicifolia, Wang.

Twigs gray-tomentose or smooth dark brown.

Buds ovate-*obtuse,* chestnut-brown; scales dark margined.

Leaves obovate, usually 5-lobed; sinuses shallow; glossy dark-green above, pale tomentose below; leathery.

Scrubby tree or shrub of poor soils, often forming dense stands on burnt areas.

101. Laurel Oak,—Quercus imbricaria, Michx.

Like pin oak in many ways, but *lacks spiky twigs and leaves are entire;* acorn-cups half-cover nut; acorns stalked; leaves hairy beneath.

Buds silky, at times scales have serrate margins.

102. Willow Oak,—Quercus phellos, L.

The narrow leaf, smooth beneath, distinguishes this oak in summer.

Buds strongly angled. Acorn-cups shallow. Bud-scales slightly serrate.

Usually found on moist sandy or swampy soil. Limited in Pennsylvania to southeastern counties.

ELMS,—ULMUS, (Tourn.) L.

Terminal buds absent. *Leaves* simple, *2-rankt, pinnate-veined; base unequal.*

Most *elms bloom in spring before leaves appear. Seeds mature quickly,* are flat and surrounded by a thin papery wing.

103. American Elm,—Ulmus americana, L.

Mature *twigs red-brown,* slender, nearly smooth; at first greenish-pubescent.

Buds ovate-acute, slightly flattened, usually smooth, red-brown, with 6-10 dark margined scales. Flower buds much larger and blunt.

Leaves 2-serrate, acute, 4"—6" long, *soft and nearly smooth below.*

Flowers slender-stalked.

Bark gray-brown; paler with age; breaks into irregular flat ridges; at times scaly.

Drooping branchlets and deliquescent crowns are typical. (Fig. 13)

104. Slippery Elm,—Ulmus fulva, Michx.

Twigs medium stout, *grayish and rather rough* when mature.

Buds ovate, dark chestnut-brown, velvety with 12 rusty-haired scales; at times enlarged by gall insects.

Leaves like American elm but larger and *rough on both sides.*

Flowers nearly sessile.

Inner bark fragrant-mucilaginous; ridges wider than in American elm.

Grows on drier soils than American elm.

105. *English Elm,—Ulmus campestris, L.

Like American elm in many features but lacks its marked drooping habit; leaves very rough above; *buds smoky brown to near-black.* Twigs often corky. Root-suckers may occur.

Bark on boles dark; inner bark not mucilaginous. Native from middle Europe and North Africa to Japan.

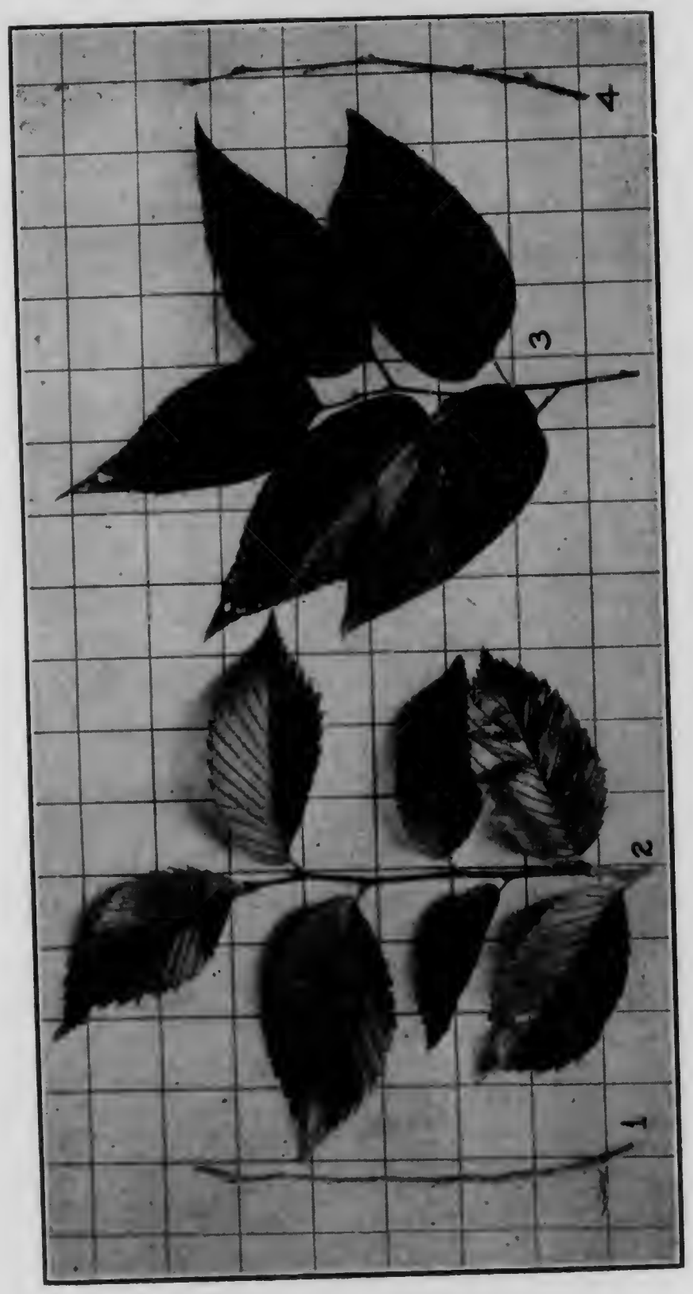


Figure 13

AMERICAN ELM. 1. Winter twig. 2. Twig and leaves showing pinnate veining.
HACKBERRY. 3. Twig and leaves showing 3-nerve type of veining. 4. Twig showing close appresst type of buds

106. *Cork Elm,—Ulmus racemosa, Thomas.

Twigs fine with zigzag ramifications, red-brown, smooth or short-hairy; corky bark at bases of many twigs and branchlets.

Buds acute, red-brown; fine hairy scales.

Leaves small, ovate, more or less rough; badly *attacked by elm leaf beetle. Bark dark on old boles*, separated into narrow, broken ridges.

Large tree of Lake States forests. Native from Quebec to Tennessee and Nebraska, but not within Pennsylvania.

107. *Chinese Elm,—Ulmus pumila, L.

Twigs fine to medium; *gray* at maturity, green to brownish at first; *smooth.*

Buds small, ovate-*obtuse, gray*-brown. *Inner bark mucilaginous.*

Leaves smooth, near-symmetrical; stalk ¼″ long. Attacked by elm-leaf beetle. Native from Siberia to Turkestan and Northern China.

108. Hackberry,—Celtis occidentalis, L.

Twigs slender, usually dead-tipped, smooth or with a little down; *pith* white and *chambered in larger twigs*. Witches-brooms common.

Buds small, 2-rankt, ovate-acute, close apprest; 3-4 scales visible.

A *gall often distorts and enlarges buds* and adjacent twigs.

Leaves palmately 3-nerved, acute, serrate; base oblique.

Berry purplish, about 1/3″ thru, occurs singly, sweet, seed stony, ripe in September, persisting until eaten by birds.

Bark, gray to blue-brown; smooth at first, later more or less regular *warty-ridged*. (Fig. 13)

MULBERRIES,—MORUS, (Tourn.) L.

Terminal buds absent, lateral 2-rankt.

Leaves serrate, entire or *variably lobed; milky sap.*

Flowers unisexual; either monoecious or dioecious.

Inner bark strong, *with whitish-silky fibres. Roots bright yellow.*

Fruit a sweet aggregate,—resembling a blackberry in structure.

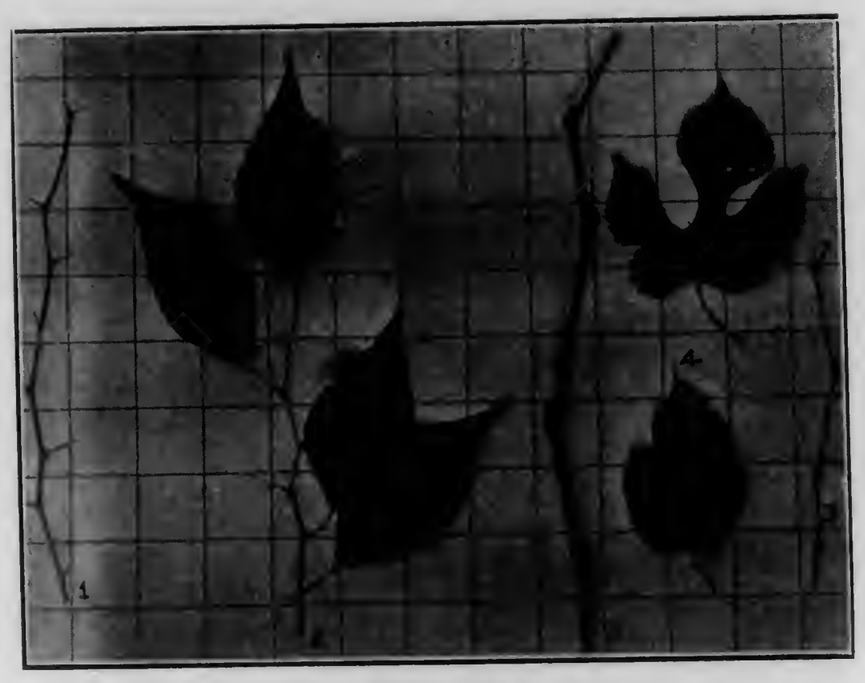


Figure 14

OSAGE ORANGE. 1. Twig with characteristic thorns. 2. Twig and leaves. The latter show typical acute tips and entire margins

RED MULBERRY. Twigs of varying size. 4. Leaves of typical form

109. Red Mulberry,—Morus rubra, L.

Twigs medium heavy, smooth, greenish brown tinted with red.

Buds diverge somewhat from twigs; greenish-brown with dark margined scales.

Leaf-scars raised, concave, nearly circular with irregular bundle-scars.

Leaves often cordate; acute-tipped, 3-nerved, *slightly rough above.*

Bark gray-brown, cut into low flat ridges which often exfoliate in narrow scales.

Fruit about 1″ long, dark purple when entirely ripe. (Fig. 14)

110. *White Mulberry,—Morus alba, L.

Twigs finer and yellower than in red mulberry; leaves smaller, *glossy above.*

Buds apprest; scales red-brown and evenly colored.

Bark yellow-brown. Fruit variable from cream-white to violet and black. Native to China.

111. *Paper Mulberry,—Broussonetia papyrifera, (L.) Vent.

Twigs gray-pubescent with strong fibrous inner bark.

Buds both alternate and opposite; terminal absent.

Leaves like Morus sp. but longer stalked, coarse dentate and *velvety;* bark grayer.

Dioecious, and usually only staminate trees are met in Pennsylvania. Root-suckers are freely produced; resulting in small and short-lived trees. Native to Asia.

112. *Osage Orange,—Maclura pomifera, (Raf.) Schneider.

Like *Morus* sp. in many ways, but *leaves are entire, smooth and glossy; twigs* often *spiny* at nodes and rather fine.

Dioecious; with yellow-green, orange-size, aggregate fruit.

Sap acrid and *milky. Buds knobby* and inconspicuous.

Wood very hard, yellow, durable. Roots yellow and sucker freely. Native to Arkansas, Oklahoma and Texas. (Fig. 14)

MAGNOLIAS,—MAGNOLIA, L.

Buds ovate to conical-acute, hairy without or within: scales valvate.

Leaves large, entire; scars lunate to oval.

Flowers single, large, showy, perfect. *Fruit an aggregate cone of fleshy* follicles. *Sap* watery, pungent-*peppery. Roots fleshy.*

113. Cucumber Tree,—Magnolia acuminata, L.

Twigs brown, terete, usually smooth: white pith tends at times to be chambered. Bark brownish; old boles show long, loose-scaly ridges.

Buds dense pale-silky; terminals often nearly an inch long, laterals much smaller and nearly encircled by leaf-scars.

Leaves ovate to oblong, delicate, 4″—12″ long, acute, slightly downy below with veins prominent. Fruit 2″—3″ long, cucumber-like at first, later red.

Large tree of good form; found on lower mountain slopes and fertile valleys. (Fig. 15)

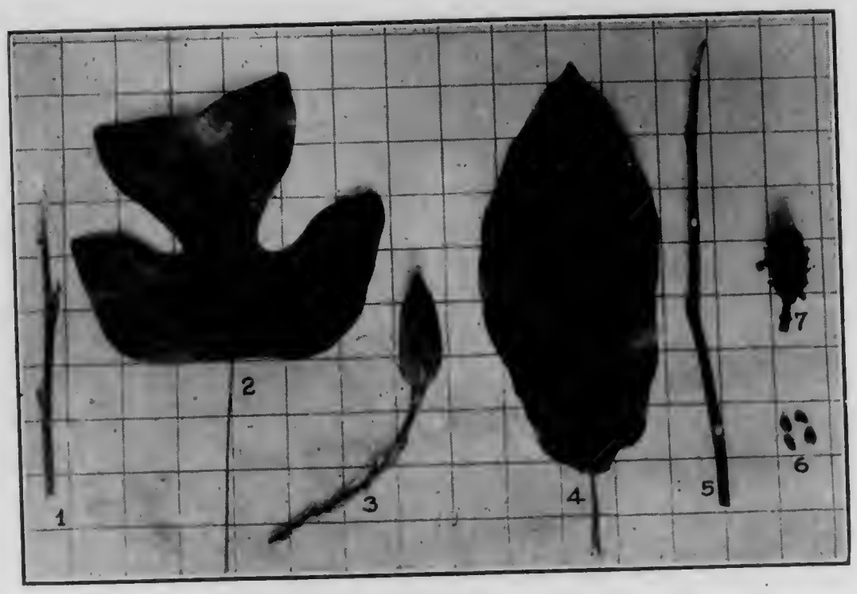


Figure 15
TULIP TREE. 1. Twig. 2. Leaf. 3. Twig with cone
CUCUMBER TREE. 4. Leaf. 5. Twig. 6. Seeds. 7. Cone with protruding seeds

114. Laurel Magnolia,—Magnolia virginiana, L.

Like cucumber but much smaller in all respects; attains only shrub size in Pennsylvania where it is a rare occurrent in swamps or planted ornamentally.

Twigs greenish, sap bitter. *Leaves pale glaucous below;* look like those of rhododendron and are *sub-evergreen.*

Flowers white globular and very fragrant.

115. Umbrella Tree,—Magnolia tripetala, L.

Small tree resembling cucumber but larger in most of its parts.

Buds smooth; terminal *up to 2" long*, lateral very small.

Leaves 1' to 2' long. Flowers 4"—6" across; *odor unpleasant.*

A rare ornamental, native in Pennsylvania only on banks of the lower Susquehanna River.

116. Tulip Tree,—Liriodendron tulipifera, L.

Like cucumber except that *terminal buds are smooth, flattened, blunt;* lateral ones much smaller and divergent;

leaves broad-ovate *with truncate apex, usually 4-lobed; fruit is a pointed cone of dry carpels.* (Fig. 15)

117. *Sweet-scented Shrub,—Calycanthus floridus, L.

Twigs dark brown, lack terminal buds, flattened at nodes; *but very small.*

Leaves opposite; ovate-acute, small pubescent underneath.

Buds small; black; silky; apparently sub-petiolar.

Native of Southern Alleghenies.

Flowers like a small rose, dark red, have fragrance of ripe strawberries.

Fruit a brown leathery, indehiscent capsule about 3" long containing many parietally borne seeds about the size of coffee grains.

Common ornamental with height of 8'—12'. Native from Virginia southward thru coast states.

118. Pawpaw,—Asimina triloba, Dunal.

Twigs terete, brown, evenly tapering.

Buds brown, naked, hairy, 2-rankt; *terminals flattened;* lateral ones small and close apprest. Leaves entire, lanceolate-obovate, 4"—12" long .

Flowers 3-lobed, red to purple.

Fruit like a small banana but in taste and seeds somewhat like a persimmon.

Shrub or small tree on moist soils of varying fertility.

119. Sassafras,—Sassafras variifolium, (Salisb.) Ktze.

Twigs slender, brittle, *yellow-green to reddish*, slightly hairy, *aromatic, inner bark mucilaginous;* pith large and white.

Terminal buds ovate-acute, rather large if flowers are enclosed; laterals small with few gaping scales.

Leaves like mulberry. Green-yellow flowers are unisexual but borne together.

Fruit a dark blue shiny drupe, eagerly sought by birds.

Bark on old boles red-brown deeply cut into flat topped ridges.

Small scrubby tree in Pennsylvania, often spreading by root-suckers.

120. Spice-bush,—Benzoin aestivale, (L.) Nees.

Twigs fine, smooth, with *typical aromatic taste.*

Flower buds globose, numerous, super-posed; vegetative smaller, flatter.

Leaves entire, ovate-acute. Yellowish flowers appear before leaves.

Fruit a scarlet drupe. This large shrub is said to occur only where permanent ground-water level lies within 6′ of the soil surface.

121. Wild Hydrangea,—Hydrangea arborescens, L.

Twigs bright brown, faintly 5-sided, smooth; pith large and white.

Buds acute apprest, opposite. Leaves long-stalked, ovate-acute, dentate.

Flowers in terminal cymes,—*like those of common elderberry.* Seeds in small dehiscent capsules which persist over winter.

Found on banks of mountain streams; rarely above 6′ tall.

122. *Mock Orange,—Philadelphus coronarius, L.

Twigs smooth, *orange-brown, telescoped in appearance,*—due to swelling at leaf bases.

Buds brown, *flat-conical, subpetiolar;* true terminals absent.

Leaves opposite, short-stalked, oval-elliptic, smooth above, short hairy below; *3-nerved,* distantly dentate.

Flowers with creamy-white petals; abundant; very fragrant; *calyx persistent.*

Seed capsules are top-shaped and rather persistent.

Popular ornamental shrub; rarely escaped; attains to 10′ tall. Native to southeastern Europe and the Caucasus.

CURRANTS AND GOOSEBERRIES,—RIBES, L.

Shrubs with alternate stalked *leaves* which are *usually lobed* and often fascicled. *Bear pulpy ovoid-globose berries, with persistent calyx.*

Usually less than 5′ tall in Pennsylvania.

123. Wild Gooseberry,—Ribes Cynosbati, L.

Twigs dull gray-brown; *spines few or absent.* Buds divergent.

Fruit prickly; sweet. Leaves round in outline, deeply 3-or 5-lobed.

Most common in central and northern Pennsylvania.

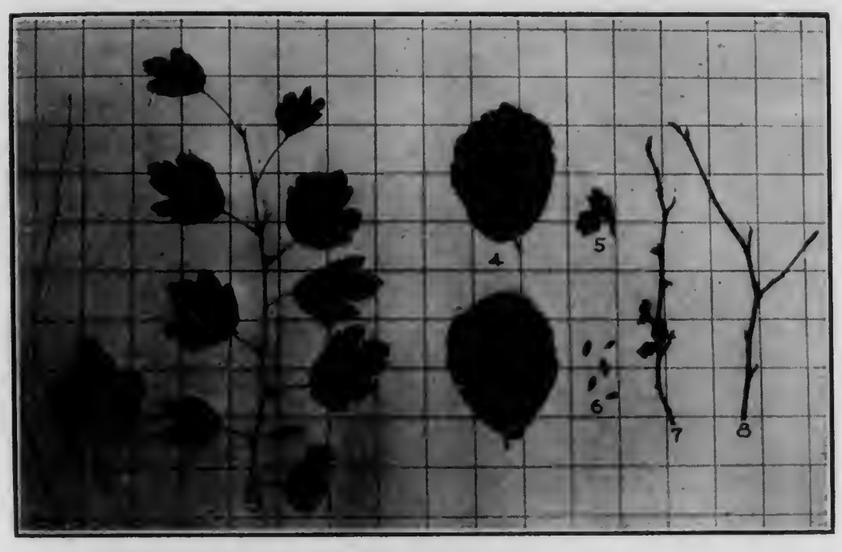


Figure 16

WILD GOOSEBERRY. 1. Twig. 2. Leaf showing under surface on which may occur the orange colored fruiting bodies of the alternate stage of the white pine blister rust. 3. Twig and leaves with typical thorns

WITCH HAZEL. 4. Leaves showing upper and under surfaces. 5. Fruit capsules. 6. Seeds. 7. Twig with fruit, globose flower buds, and flattened vegetative buds. 8. Twig with typical branching

124. Eastern Wild Gooseberry,—Ribes rotundifolium, Michx.

Like No. 123, but *twigs* are quite *prickly* and darker colored; *fruit smooth.* (Fig. 16)

Most common in forests of southern Pennsylvania.

125. Witch Hazel,—Hamamelis virginiana, L.

Twigs rather slender, zigzag, scurfy toward tips.

Buds 2-rankt, flattened, curved, scales consist of undeveloped leaves covered with dense short brown hairs; terminal ¼″-½″ long, lateral very small.

Leaves oval, wide-dentate; base oblique; veins prominent below. (Fig. 16)

Perfect yellow *flowers borne October-November*, at same time woody pods dehisce and forcibly expel the smooth, shiny-black seeds;—the only woody plant native in Pennsylvania that bears ripe fruit and flowers at one and the same time.

Bark light brown, often mottled; *inner bark red-purple.*

Shrubby tree of moist soils.

126. Sweet Gum,—Liquidambar Styraciflua, L.

Twigs medium in size, obscurely *angled; Corky projections developed* about the second season; pale—to red-brown; smooth.

Buds with about 6 scales; if crushed emit incense-like fragrance characteristic of the genus.

Leaves star-shaped, serrate, shiny above, broader than long; petioles long.

Fruit a long-stalked, drooping globose head of many spiny capsules, like that of sycamore as to size and shape.

Forest tree in southeastern Pennsylvania; elsewhere in the state an interesting ornamental; crown-form good. (Fig. 17)

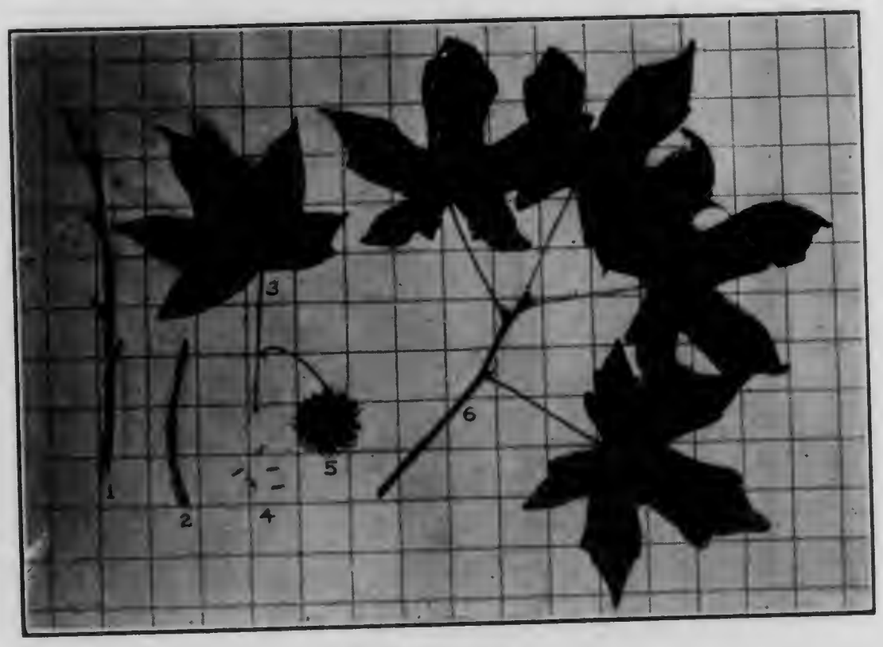


Figure 17

SWEET GUM. 1. Twig with typical corky bark and short spur laterals. 2. Twig with smooth bark. 3. Leaf showing under surface. 4. Seeds. 5. Fruit ball. 6. Twig and leaves in summer

127. *Oriental Sweet Gum,—Liquidambar formosana, Hance.

Is quite similar to preceding, but *finer textured* thruout with tendency to pubescence. *Corky twigs* absent on all specimens yet noted. Crowns spreading.

Interesting ornamental tree introduced by U. S. D. A. Bureau of Plant Industry. Native to Asia.

128. Sycamore or Buttonwood,—Platanus occidentalis, L.

Twigs rather stout, brown to gray, smooth, enlarged at nodes where they are encircled by stipule scars. *Tips often killed back in spring* by a fungus.

Buds sub-petiolar conical-obtuse, *only one scale visible;* terminal absent.

Leaves broad-ovate, 3-to 5-lobed, dentate; light green above, paler and woolly beneath; stalk about 2″ long.

Fruit an aggregate *ball* or head of *many hairy achenes;* about 1″ thru: hangs *solitary*, or rarely 2, *on* a slender but *very tough stem.*

Bark brown, cut by shallow fissures into broad thin plates which are *shed and expose greenish-white inner layer.*

Tree of moist, fertile soils; especially common along larger streams. Michaux called it the "Most massive vegetable of Eastern North America."

129. *Oriental Plane Tree,—Platanus orientalis, L.

Is quite like our sycamore but free of fungous and insect enemies; resistant to smoke; *compact-conical in crown-form; inner bark shows yellow-green; leaves* not so broad and *more cuneate* at base by extension of blade down along petiole. *Balls usually 2 or more on a stem.* Native from southeastern Europe to India.

130. Ninebark,—Physocarpus opulifolius, (L.) Maxim.

Twigs smooth, slender, *golden-brown; fine ridges extend down from each leaf base; bark shed from trunks* and branches in *thin papery layers.*

Buds small, apprest. Fruit a *persistent 5-celled capsule.*

Leaves smooth, ovate-orbicular, usually sharply 3-lobed, ruffled-dentate.

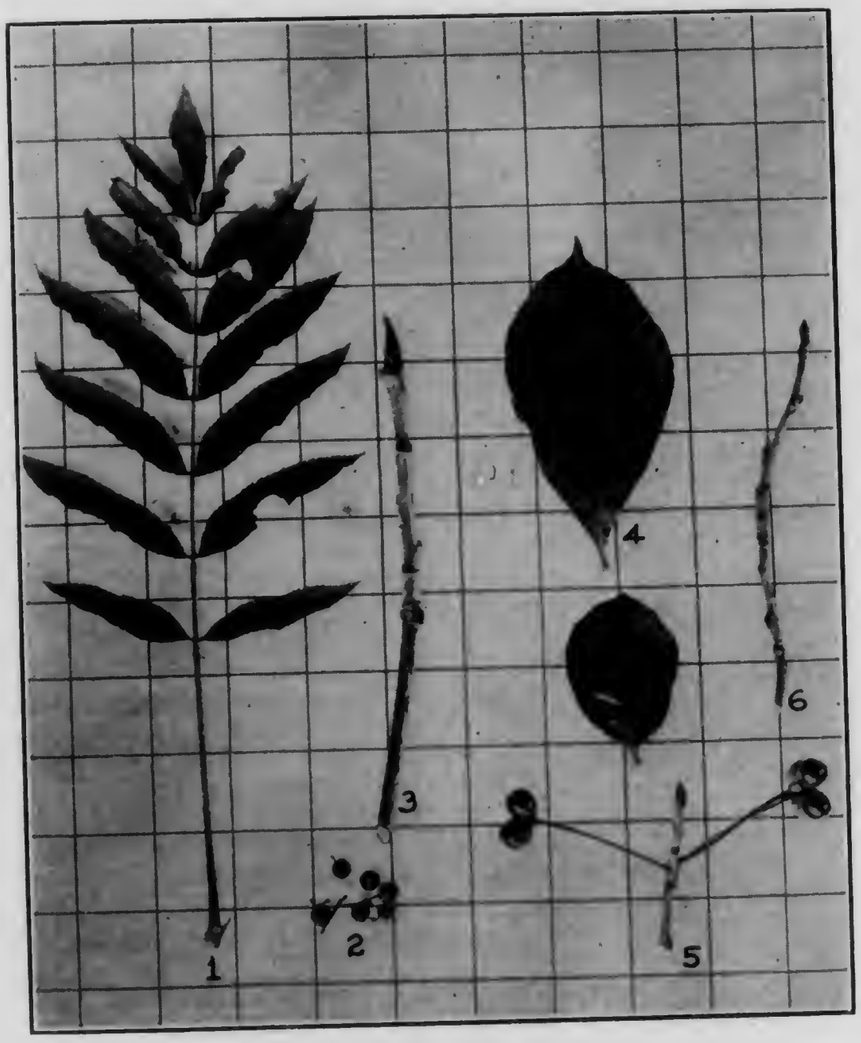


Figure 18

American Mountain Ash. 1. Leaf. 2. Fruit. 3. Winter twig

Black Gum. 4. Leaves showing variation in size and form. 5. Twig with fruit on typical stalks. 6. Winter twig

White,—rarely red-tinted, flowers occur in terminal corymbs.

Usually 3′—10′ tall; along stream-banks.

131. Meadow-sweet,—Spiraea salicifolia, L.

Twigs very fine, orange-brown and smooth. Buds small, acute-apprest.

Leaves stalked, *obvate* or lanceolate, *smooth, sharp-serrate above middle.*

Flowers white or pink-tinted; in dense terminal panicles. *Capsules persistent.*

Occurs on moist to swampy soils; 4′ tall as a maximum.

132. Steeple-bush,—Spiraea tomentosa, L.

Quite *like meadow-sweet but twigs and* under sides of *leaves are woolly;* leaves ovate; *flowers* usually *pink to purple.*

133. *Japanese Rose or Globe Flower,—Kerria japonica, DC.

Erect shrub, 4′—10′ tall, with double or single yellow flowers; an old-fashioned ornamental often met around abandoned homesteads.

Twigs slender, *angular, bright green.*

Leaves acute, birch-like, 2-serrate. Native to China; introduced from Japan.

APPLES, PEAR, CHOKEBERRIES, AND MOUNTAIN ASHES,—PYRUS, L.

Trees or shrubs with fleshy or berry-like pome fruits; *carpels soft* or *papery and 2-seeded.* Flowers showy, in corymbs or cymes, have *5 blunt-ovate petals,* and an equal number of more or less persistent sepals.

Elongating twigs and short spurs present. *Terminal buds* well developed.

134. *Common Pear,—Pyrus Communis, L.

Twigs orange-brown, smooth; often with spiny spurs.

Leaves usually smooth, ovate, fine-serrate or entire.

Buds brown, *smooth,* close apprest. *Fruit* fleshy, *obovoid.*

Small cultivated tree; rarely escaped. Native to southern Europe and Asia.

135. *Common Apple,—Pyrus Malus, L.

This spreading branched tree escapes cultivation frequently. It is *like the pear but twigs are pubescent* especially near buds, *reddish to dark brown;* thorns rare.
Fruit variable but usually *sub-globose or ovoid.* Native to southeastern Europe and western Asia.

136. American Crab-Apple,—Pyrus Coronaria, L.

Like apple but nearly or quite *smooth; very thorny; fruit, small,* yellow-green, *sharply acid.*
Flowers occur later than common apple; beautiful,—pink, very fragrant.
Leaves sharp-serrate, at times lobed. Variety *lancifolia* has quite narrow-acute leaves.
Small spreading tree common on medium to good soils in mountains of central and southern Pennsylvania. (Fig. 28)

137. Red Chokeberry,—Pyrus arbutifolia, (L.) L. f.

Twigs and under leaf-surfaces dense tomentose.
Leaves oval to obovate, smooth above, very fine serrate.
Berries dark red at maturity, about ¼" long; often slightly pear-shaped; *quite persistent.*
Buds reddish, acute—like those of shad-bush but smaller.
Shrubs of fairly moist to wet areas; rarely 8′ tall.

138. Black Chokeberry,—Pyrus melanocarpa, (Michx.) Willd.

Like No. 137, but smooth or nearly so. *Fruit* near-*black; shed* rather *early.*

139. American Mountain Ash,—Pyrus americana, (Marsh.) DC.

Twigs rather stout, smooth, gray to red-brown; pith large, brownish.
Buds purple-red, acute, glossy-gummy; terminals much the larger, often with tips curved, laterals close apprest.
Leaves pinnate-compound; about 15 leaflets.
Flowers resemble those of common elder; as does fruit also, except that it is harder, larger and bright red.
Occurs on moist mountain-sides and stream-banks; rarely above 20′ tall. (Fig. 18)

140. *European Mountain Ash,—Pyrus aucuparia, L.

Like its American cousin but buds are silky-pubescent; leaflets short-hairy on both sides. Native from Europe to Siberia.

141. Juneberry or Shad-bush,—Amelanchier canadensis, (L.) Medic.

Twigs green to purple-brown, smooth or with a silvery film, slender.
Buds slender, conical-acute,—up to ½" long; greenish brown, often red tinged; smooth or hairy-tipped; laterals often quite small and apprest.
Leaves ovate-acute, *fine-serrate,* finally *smooth.*
Flowers early, in drooping racemes. Fruit late June, sweet, about 1-3" long, red to purple.
Bark blue-gray, smooth; shallow fissured on old boles.
Small tree; sparse but general thru-out Pennsylvania. (Fig. 19)

142. Low Juneberry,—Amelanchier oblongifolia.

Infrequent *miniature of shad-bush,* but commonly *spreads by root-suckers;* leaves sub-orbicular to oblong.
Rarely above 8′ tall.

HAWTHORNS,—Crataegus, L.

Resemble Pyrus sp. in most features but *bear only one seed to a carpel;* pomes are small, yellow, red, brown or even black; *carpels bony.*
Thorny shrubs or small trees of many species; difficult to identify. Only four of the most common are listed here.

143. Cockspur Thorn,—Crataegus Crus-galli, L.

Twigs gray-brown, smooth, rather slender, with *nearly straight thorns about 3" long.* Buds very blunt-spherical; chestnut-brown.
Leaves obovate, *with long-tapering base* so as to be practically *sessile, leathery,* shiny above, serrate toward tips.
Fruit nearly ½" long, crimson at maturity.
Tree at times 20′ tall, with poor form. Largest and most frequent on moist bottoms.

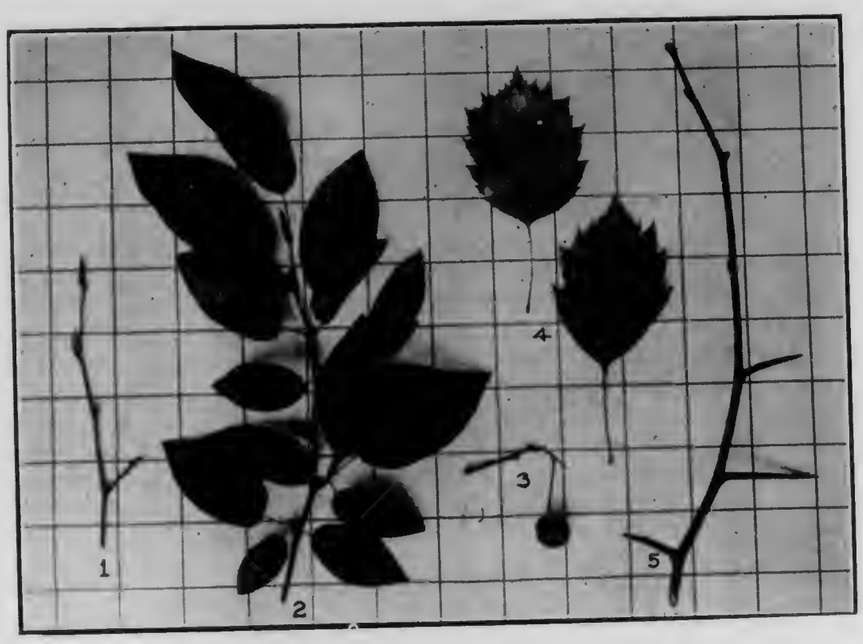


Figure 19.
JUNEBERRY. 1. Twig in winter. 2. Twig and leaves SCARLET THORN. 3. Twig with fruit. 4. Leaves showing under and upper surfaces. 5. Winter twig with typical thorns

144. Scarlet Thorn,—Crataegus coccinea, L.

Like cockspur but spines are less numerous and *not more than 2" long;* twigs stiffer, *leaves* broad-ovate, *dentate- serrate, with petioles* more than ½" long, often rough-pubescent.

Ripe fruit varies from yellow-green to dark red-brown; pubescent sometimes. (Fig. 19)

145. Dotted Hawthorn,—Crataegus punctata, Jacq.

Much *like cockspur but leaves are duller above with sunken veins* and *have longer petioles;* thorns much smaller.

Fruit yellow or red; commonly brown-dotted.

Small bushy tree of fertile stream-bottoms. Common northward.

146. Washington Thorn,—Crataegus phaenopyrum, (L.f.) Medic.

Like scarlet thorn in general features, but *leaves* are more variable in form and size, *cordate* or truncate *at the base,* and *triangular* in outline.

Fruit is borne *in profusion, glossy red* and highly *ornamental,* about half the size of scarlet thorn apples, with relatively large bony seeds, and *deciduous calyx* vestiges giving a characteristic "½-bald" effect.

Rare native tree in southern Pennsylvania, and occasional as a park or lawn specimen. The best American hawthorn for ornamental use.

BRIERS OR BRAMBLES,—RUBUS, (Tourn.) L.

Prickly, bristly or thorny *shrubs with large pith.*
Fruit an aggregate of fleshy achenes.
Stems usually biennial from perennial root-systems.

147. Wild Red Raspberry,—Rubus idaeus, L. var. aculeatissimus, (C. A. Mey.) Regel & Tiling.

Stems terete, upright, hispid-bristly, yellow-brown.
Leaves pinnately 3- to 5-*compound.*

Red fruit separates whole from receptacle on which it is borne.

148. Black Raspberry,—Rubus occidentalis, L.

Like wild red raspberry in general *but glaucous all over; stems recurved* with *tips rooting, reddish* to purple; *leaflets* usually 3; *hooked prickels* on stalks and petioles; ripe fruit black. A yellow-brown fruited form occurs.

149. *Wineberry or Japanese Raspberry.—Rubus phoenicolasius, Maxim.

Like our black raspberry but *fruit is* sub-acid, *orange-red, and calyx covers fruit until ripe;* not glaucous but *bristly-hispid* with *red-glandular* hairs.

Commonly escaping cultivation in southern Pennsylvania. Native to Japan.

150. Purple Flowering Raspberry,—Rubus odoratus, L.

Stems unarmed, glandular-hairy; bark shed in 2nd season.

Leaves simple, 3—or 5—lobed, fine-toothed. *Flowers like a wild rose.*
Common on moist, cool mountain slopes.

151. Wild Blackberry,—Rubus allegheniensis, Porter.

Stems near-erect, angular, greenish to red, *stout-thorny.*
Leaves palmate-compound (pedate); petioles thorny.
Flowers large white. *Fruit* black; *does not separate from receptacle.*
Common on open areas of acid soil.

152. Running Swamp Blackberry,—Rubus hispidus, L.

Stems prostrate or creeping, terete, more or less *weak-prickly.*
Leaflets smooth, glossy green, tough. Flowers small, white.
Fruit scarce, small, red-purple, with a few nutlets, very sour.

153. Dewberry,—Rubus villosus, Ait.

Like preceding species but *coarser* and *rougher;* in *flowers, fruit and habitat more like the blackberry.*
Spreads by root-suckers and stolons.

ROSES,—ROSA, (Tourn.) L.

Shrubs; usually *prickly or thorny*, especially at base of the *odd-pinnate leaves.* Flowers with 5 to many pink or vari-colored petals; fragrant.
Fruit a tough-fleshy orange to *red button* or "hip" containing bony seeds, which are often aborted or undeveloped.

154. *Sweetbrier,—Rosa rubiginosa, L.

Stems near-erect, *stout, greenish;* with *strong, brown, recurved thorns.*
Leaflets resinous below, aromatic, *2-serrate. Fruit obovoid.*
Long naturalized: in many places the commonest wild rose; at times 10′ tall.
Native to Europe.

155. Smooth Meadow Rose,—Rosa blanda, Ait.

Stems seldom 3′ tall, smooth or quite prickly, *red.*
Leaflets serrate, not resinous, 5-7.
Flowers usually large, often solitary. Fruit obovoid.

156. Swamp Rose,—Rosa carolina, L.

Stems purplish, up to 7′ tall; *stout prickles, straight or* curved.
Leaflets average 7, fine serrate, usually *pubescent below. Fruit globose.*
Often abundant on wet sites.

157. Pasture Rose,—Rosa humilis, Marsh.

Usually *less than 2′ tall;* erect slender stems *with fine straight prickles* and spines. Leaflets 5 or 7, coarse-serrate. Fruit globose.
Occurs on dry soils. Spreads by root-suckers.

CHERRIES AND PLUMS,—PRUNUS, (Tourn.) L.

Mostly small trees or shrubs; *fruit a fleshy drupe with a stony seed;* inner bark often bitter-aromatic.
Leaves simple. Flowers perfect, 5-part, usually white.

158. Wild Black Cherry,—Prunus serotina, Ehrh.

Twigs smooth, brownish; pale lenticels later elongate horizontally; have *strong taste of prussic acid.* Old bark cut into rough, thick, near-black plates.
Buds ovate-acute smooth, bright red-brown; *terminal well developed.*
Leaves oblong-lanceolate, serrate.
Flowers late in May, in drooping racemes. Fruit finally black, juicy, ¼″—½″ thru.
Common "fence-corner weed" in parts of southern Pennsylvania, large forest tree on good soils northward.

159. Choke Cherry,—Prunus virginiana, L.

Twigs rather stout, gray to red-brown; lenticels dull yellow; very *disagreeable in taste and odor.*
Buds conical to ovate-acute, smooth, brownish, 6-8 scales visible; terminal present.
Leaves oval to obovate, abrupt-acute, sharp-serrate; stalks show small *greenish scabs at base of blade.*

Flowers and fruit like wild black cherry, but *larger, astringent, dark red.*

Seldom 20′ tall; often forms thickets on talus slopes and ledges; spreads by root-suckers.

160. Fire Cherry,—Prunus pennsylvanica, L.

Twigs slender, glossy bright *red*, at times gray-filmy; *yellow lenticels* elongate prominently; *typical odor and taste.*

Buds small, obtuse, smooth, *clustered at ends of twigs;* terminal present.

Leaves like wild black cherry but more delicate.

Flowers in umbels. Fruit July, light red, about ¼″ thru, sour-bitter.

Small, shortlived tree; northward common after fire and lumbering, elsewhere rare-sporadic.

161. *Sweet Cherry,—Prunus Avium, L.

Twigs rather stout, grayish brown.

Buds broad ovate-acute; flower buds often numerous and prominent.

Leaves like choke cherry but larger; *red scabs on petiole.*

Flowers April, in open umbels. Fruit sweet-edible; variable in size and color.

Native to Europe and western Asia.

162. *Sour Cherry,—Prunus Cerasus, L.

Like sweet cherry but smaller and of poorer form; *twigs and branches ramify* intricately while the bole soon loses its identity.

Fruit red, very juicy and sour. Native to Asia Minor and perhaps to southeastern Europe.

163. Appalachian Cherry,—Prunus cuneata, Raf.

Erect smooth shrub about 2′ tall with oblong to obovate leaves; *bases cuneate.*

Flowers 2-4 *in an umbel. Fruit nearly* ½″ *thru*, almost black.

Rare shrub on dry rocky and sandy sites.

164. Wild Plum,—Prunus americana, Marsh.

Mature twigs smooth, red-brown, often with *spur-like spines.*

Buds small, brown, broad conical-acute; *terminal absent.*

Leaves narrow-obovate, acute, *2-serrate.* Flowers Apr.-May, in umbels of 2-5.

Fruit red, sub-globose, 1″ thru; skin tough; stone flattened and oval.

Occurs in dense clumps from root-suckers; at times 20′ tall.

165. *Peach,—Prunus persica, (L.) Stokes.

Small cultivated and escaped tree, with *sessile pink flowers* and large *downy fruit* containing a 2-pointed sculptured *stone* surrounded by juicy-sweet flesh.

Twigs green or red.

Buds downy; vegetative are apprest; floral more rotund, collateral and often numerous. In other respects much *like wild black cherry.* Native to Asia, supposedly to China.

166. Kentucky Coffee Tree,—Gymnocladus dioica, (L.) Koch.

Twigs very stout, lack terminal buds, silvery film-covered; *pith large, pink.*

Buds small, downy, often superposed, *sunken, surrounded by* circle of stiff *red hairs.*

Leaves 1′—2′ across, pinnately 2-compound.

Flowers regular, dioecious, green and white, in terminal corymbs about 4″ long.

Fruit a red-brown, leathery pod, about 5″ x 2″; containing one to several smooth, very hard beans about ¾″ long; surrounded by sweet-sticky pulp.

Bark breaks into small, laterally attached scales.

167. Honey Locust,—Gleditsia triacanthos, L.

Twigs medium stout, zigzag, smooth; no terminal bud; red-brown axillary *thorns* often borne, at times *branched and up to 6″ long.*

Buds small, tuberculate, superposed.

Leaves fine and lacy in mass; *pinnate, 1- or 2-compound.*

Bark of young trees has prominent lenticels; break later into near-black, firmly-attached, thick plates.

Flowers borne in short greenish racemes.

Pods like Kentucky coffee tree but about 12″ x 2″, finer in texture, flatter and with flattened seeds.

Sporadic individual tree on fertile soils. Free of insect and fungous pests. (Fig. 20)

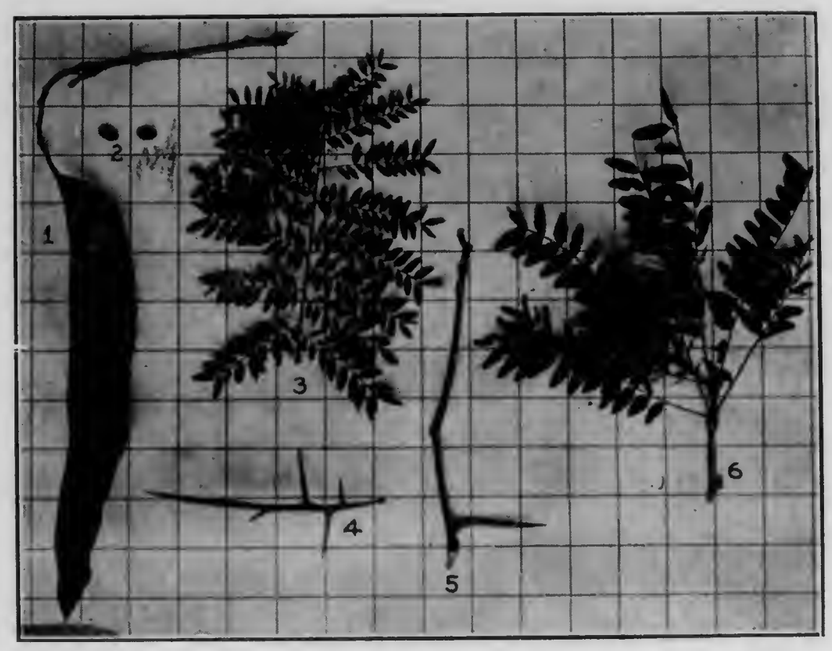


Figure 20
HONEY LOCUST. 1. Twig with fruit pod. 2. Seeds. 3. Bipinnately compound leaf. 4. Branched thorn. 5. Winter twig with simple thorn. 6. Twig with pinnately compound leaves

168. Red Bud,—Cercis canadensis, L.

Twigs fairly slender, gray-brown, *zigzag; terminal bud absent.*

Buds small, blunt, dark red, often superposed; apprest, except for the near-spherical flower-buds.

Leaves simple, entire, heart-shaped, 5- or 7-nerved; petioles enlarged at both ends. Flowers expand *before leaves.*

Pink to red, "sweet pea" flowers occur on short stems, 4-8 at a node; perfect.

Pods about 3" x ½", light brown; seeds small, very flat.

Small tree, rarely 25' tall in Pennsylvania. Common fence-row species in many places. (Fig. 21)

169. Common or Black Locust,—Robinia Pseudo-Acacia, L.

Twigs angled, brown, usually with *two stipular thorns at nodes;* no terminal bud.

Buds sub-petiolar, super-posed, sunken in winter, *later* develop a *"monkey-face."*

Leaves pinnate-compound; about 9 ovate leaflets.

Flowers in large pendant racemes, very fragrant, perfect, irregular, cream-white. Pods and seeds quite like red bud.

Common fence-row tree; making rapid growth on fertile soil; often spreads by root-suckers.

170. *Clammy Locust,—Robinia viscosa, Vent.

Like common locust, except that *twigs are terete, red glandular-hispid, free* of thorns; *flowers rose-red.*

Shrubs used ornamentally; locally escaped. Native to southern Appalachians.

171. Prickly Ash,—Zanthoxylum americanum, Mill.

Is seldom above 10' tall and superficially *resembles common locust. All its parts are pungent-aromatic.*

Buds red-brown, small, obtuse. Leaflets dotted with oil-glands.

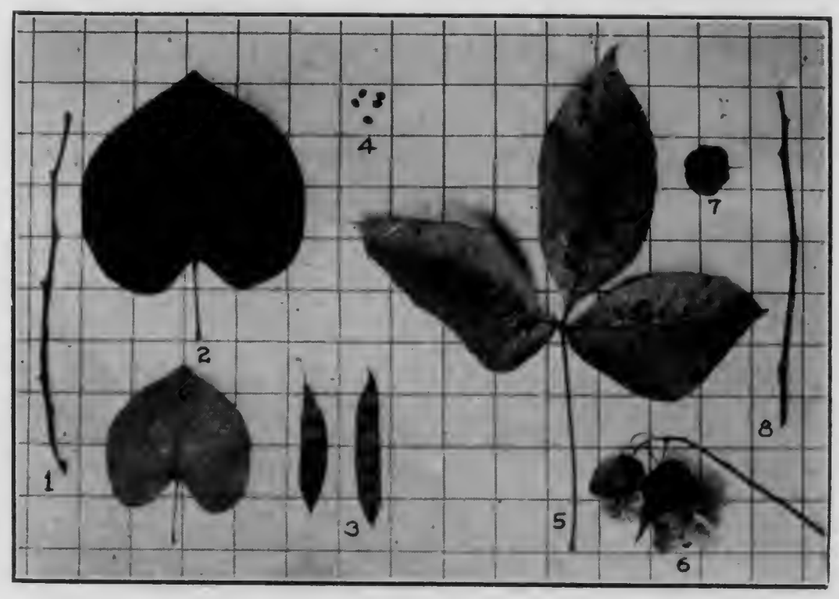


Figure 21
RED BUD. 1. Twig with vegetative and flower buds. 2. Leaves showing size variation, venation, upper and lower surfaces. 3. Fruit pods. 4. Seeds
WAFER ASH. 5. Leaf. 6. Twig bearing fruit cluster. 7. Single fruit. 8. Winter twig

Flowers small, green-white, dioecious.
Fruit a small, fleshy capsule enclosing 1 or 2 smooth black seeds.

172. Wafer Ash,—Petlea trifoliata, L.

Twigs brown and smooth without terminal buds.
Buds white-pubescent, obtuse, *sub-petiolar.*
Leaflets three,—like poison ivy in appearance.
Flowers small and green. *Seeds* borne in pairs forming a *flat wafer*, winged entirely around; about 1" across.
Rare shrub or small tree. (Fig. 21)

173. *Tree of Heaven,—Ailanthus glandulosa, Desf.

Twigs clumsy, yellow-green to brownish; no true terminal bud; *very large pith.*
Buds red-brown, downy, relatively small; leaf-scars large, shaped like foot-print of horse.
Leaves pinnate-compound, 1'-3' long; leaflets ovate-lanceolate, on margins near base are glands secreting an oil with a *mouse-like odor.*
Flowers small, green, in large terminal panicles; dioecious.
Fruit leaf-like, 1½" x ½", twisted, bearing a small seed in its center.
Bark smooth, thin, grayish; later cut by shallow fissures.
Spreads by root-suckers. Undesirable "weed tree," but very resistant to smoke and gas, without insect or fungus enemies. Requires fair to good soils. Native to China.

SUMACHS,—RHUS, L.

Milky-acrid sap and large central pith characterize this genus.
Fruit a sort of small dry drupe. Flowers greenish-white or yellowish.
Small trees, shrubs or vines; often spreading by root-suckers.

174. Staghorn Sumach,—Rhus typhina, L.

Twigs heavy, velvety; lenticels often prominent; *no terminal bud.*
Buds conical-obtuse, dense hairy; nearly sub-petiolar.
Leaves pinnate-compound, 1'-2' long; *margins serrate.*
Fruit red-hairy, in dense, erect, conical clusters.
Common small tree; rarely 25' tall.

175. Smooth Sumach,—Rhus glabra, L.

Like staghorn but smooth-glaucous thruout when young and considerably *smaller.*

176. Dwarf Sumach,—Rhus copallina, L.

In general, *like smooth sumach*, but *twigs are finer, browner* and with very *obvious lenticels; leaf-margins are entire; petioles feathered.*

177. Poison Sumach,—Rhus Vernix, L.

Like smooth sumach, but twigs are yellow-gray *with terminal buds.*
Leaflets have entire margins. *Fruit pearly white, in drooping clusters.*
Usually found near water; attains to 20' tall; *exhales an irritant alkaloid poison.*

178. Poison Ivy,—Rhus Toxicodendron, L.

Like poison sumach except that it is a *sub-erect*, scrambling *or trailing vine; has only 3 leaflets* which are sometimes coarse-incised; fruit-stalks short and not always drooping.

179. Fragrant Sumach,—Rhus canadensis, Marsh.

Like poison ivy in many ways, *but leaves are firmer* in texture, smaller, *obscurely toothed or lobed; fruit is red; sub-erect;* 5' tall at times.
Flower spikes or *aments in winter are distinctive;* as *also* are *taste and odor* of twigs.

180. *Smoke Tree,—Rhus Cotinus, L.

Small tree with very crooked, rather *fine, orange-brown twigs with a terminal bud; typical taste and odor.*
Buds small and *smoky. Leaves entire*, smooth, nearly round.
Usually dioecious; bearing scattered brown drupes in *large smoky panicle* of hairy pedicels that develop after flowering. Native to Europe and Asia.

HOLLY,—ILEX, L.

Small trees or shrubs bearing small *red berries with 4-6 hard bony seeds.*

Leaves simple. Flowers small, white or greenish. Terminal buds present.

181. Christmas Holly,—Ilex opaca, Ait.

Twigs slender; fine-hairy at first, later smooth; light brown.

Buds small, blunt, slightly downy.

Leaves oval-acute, *leathery, evergreen; waxy margins* armed with *spiny* teeth, petioles short.

Rare tree: usually below 20′ tall in Pennsylvania.

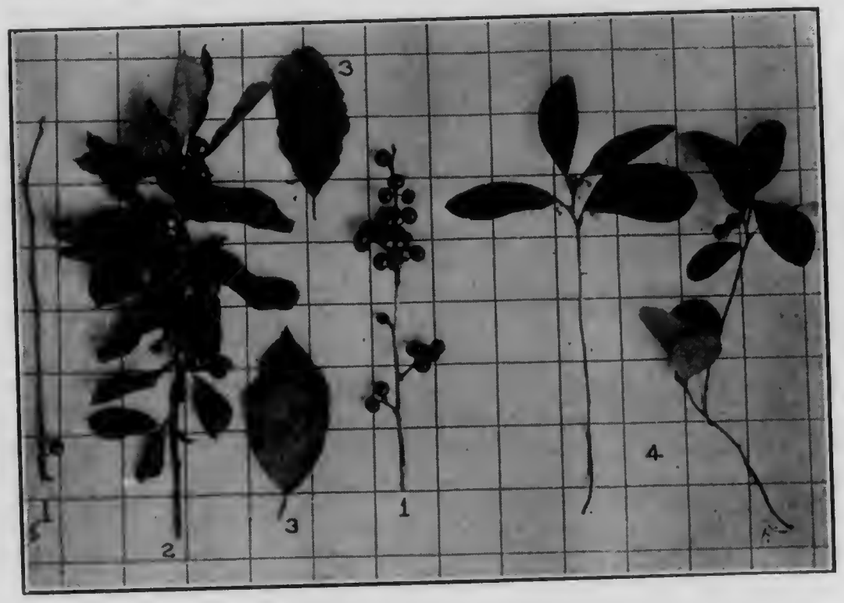


Figure 22
WINTERBERRY. 1. Twigs with berries. 2. Twig with leaves and berries. 3. Leaves showing upper and lower surfaces
TEABERRY. 4. Stalks with leaves and fruit

182. Winterberry or Deciduous Holly,—Ilex verticillata (L.) Gray.

Twigs fine; lenticels quite obvious.

Buds small, brown, *conical-obtuse*, sometimes superposed.

Leaves ovate, serrate, about 2″ long, *deciduous; finely reticulate veined.* Fruit unaffected by frost.

A low-ground shrub or small tree, rarely 8′ tall. When fruit is absent, it looks like a scrubby, thornless plum-tree. (Fig. 22)

183. Large-leaf Holly,—Ilex monticola, Gray.

Like winterberry but larger in all its parts: at times 20′ or more tall; *seeds striate-ribbed.* Fruit rendered watery by frost.

Occurs on well-drained, cool, mountain *soils* in northern and central Pennsylvania.

---

184. Mountain Holly,—Nemopanthus mucronata, (L.) Trel.

Quite *like winterberry but paler and very smooth* thruout; leaves elliptic-oblong, *entire or obscure-serrate; buds red.*

Found in clumps or thickets in cool, moist woods.

185. Climbing Bittersweet,—Celastrus scandens, L.

Twining shrubby vine. Twigs show tough, *silvery filaments* when broken.

Buds small, blunt, pale brown. Leaves ovate-oblong, acute, serrate.

Small greenish flowers occur in terminal racemes.

Orange-scarlet, 3-valved, globose *berry* holds 3-6 seeds. Very ornamental in autumn and early winter.

186. Burning Bush or Waahoo,—Evonymus atropurpureus, Jacq.

Tree-like shrub, up to 10′ tall; found on fertile valley soils.

Twigs 4-angled, green with white stripes.

Leaves opposite, simple, stalked, oval-oblong, acute

Flowers small, dark *purple*, perfect. *Fruit 3-to 5-lobed*, red; borne on drooping stems.

187. American Bladder Nut,—Staphylea trifolia.

Like waahoo except that leaves are 3-pinnate; fruit an inflated, 3-horned bladder containing hard, glossy, pale or yellow brown, pea-like seeds. The bladder is about 2″ long and half as thick. *No true terminal bud.* (Fig. 23)

MAPLES,—ACER, (Tourn.) L.

Leaves opposite. Fruit winged, borne in pairs. Flowers usually dioecious.

Our most important shade and ornamental trees.

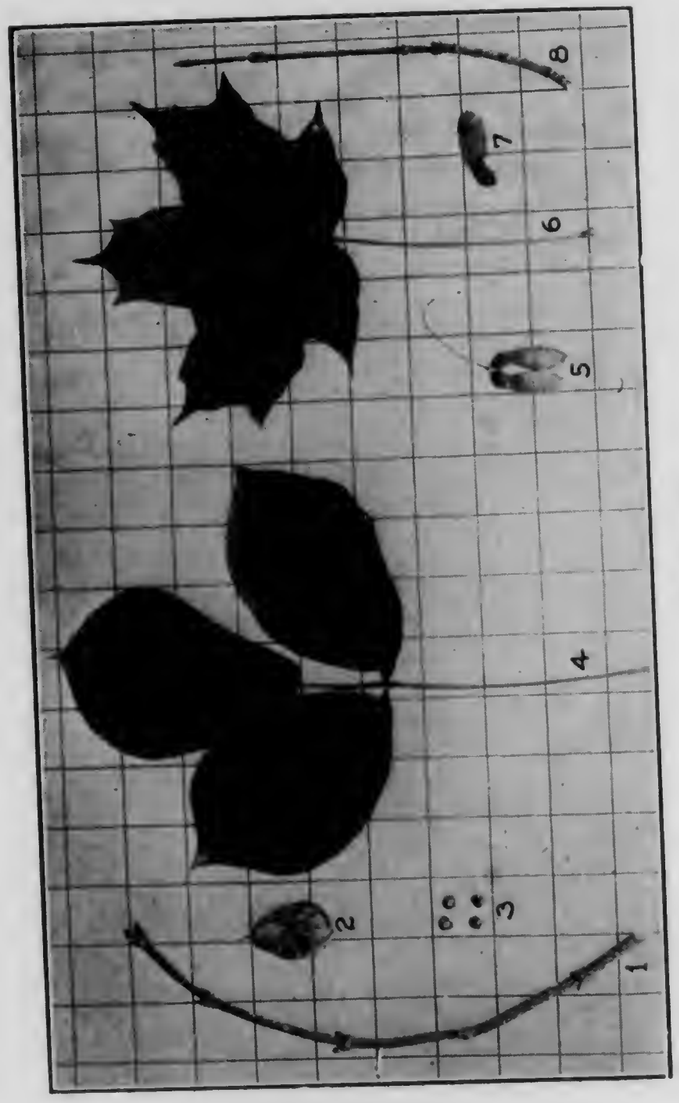


Figure 23
BLADDERNUT. 1. Winter twig. 2. Fruit. 3. Seeds. 4. Leaf
SUGAR MAPLE. 5. Paired seeds and stem. 6. Leaf. 7. Single winged seed (key or samara). 8. Twig.

188. Red Maple,—Acer rubrum, L.

Twigs slender, green to red.

Buds red, blunt, with 6-8 scales; near-spherical flower-buds often collateral or superposed.

Leaves smallest of the large *tree maples;* simple; 3- or 5-lobed, basal ones small; coarse-serrate; *silvery beneath. Bark* flat-ridged or nearly smooth, *tight.*

Sessile red flowers open very early. Fruit May-June; 1" long.

Grows well on moist to wet soils, poorly on dry ones.

189. Silver Maple,—Acer saccharinum, L.

Like red maple but leaves and seeds are *larger; leaves more deeply cut* and obviously 5-lobed; *twigs chestnut-brown, fragrant* in winter; branches tend to droop but tips are ascending; *bark separates* in plates.

190. Sugar or Hard Maple,—Acer saccharum, Marsh.

Twigs slender, *stiff, brownish.* Bark hard, fissured; finally shed in plates.

Buds brown, acute-conical; terminal nearly twice as large as somewhat apprest lateral ones; *8-18 exposed scales.*

Flowers in *drooping* corymbs. *Seeds autumnal; wings 1"* long, *diverge* but slightly. *Leaves* usually 5-lobed, cordate; *sinuses shallow; coarse-dentate.*

One of the commonest trees in Pennsylvania, prefers cool sites but grows on all but the poorest soils; very tolerant of shade. (Fig. 23)

191. Black Sugar Maple,—Acer saccharum var. nigrum, (Michx. f.) Britton.

Is distinguished by *leaves often slightly downy beneath* with *entire or undulate margins.*

192. Mountain Maple,—Acer spicatum, Lamb.

Twigs yellow-green to red, glaucous.

Buds short-stalked, with 1-2 pairs of *valvate scales.*

Leaves 3- or 5-lobed, coarse-serrate, cordate, somewhat hairy below; petioles long and slender.

Flowers in terminal racemes; borne erect, but fruit droops.

Seed-wings about ½" long. Bark thin, gray-brown blotched.

Found on cool, rocky soil; up to 30′ tall, usually 10′ or less.

193. Striped Maple,—Acer pennsylvanicum, L.

Like mountain maple but larger in all parts; *flowers* in *drooping racemes;* red and *greenish* young *bark is white-striped.* Leaves 3-lobed.

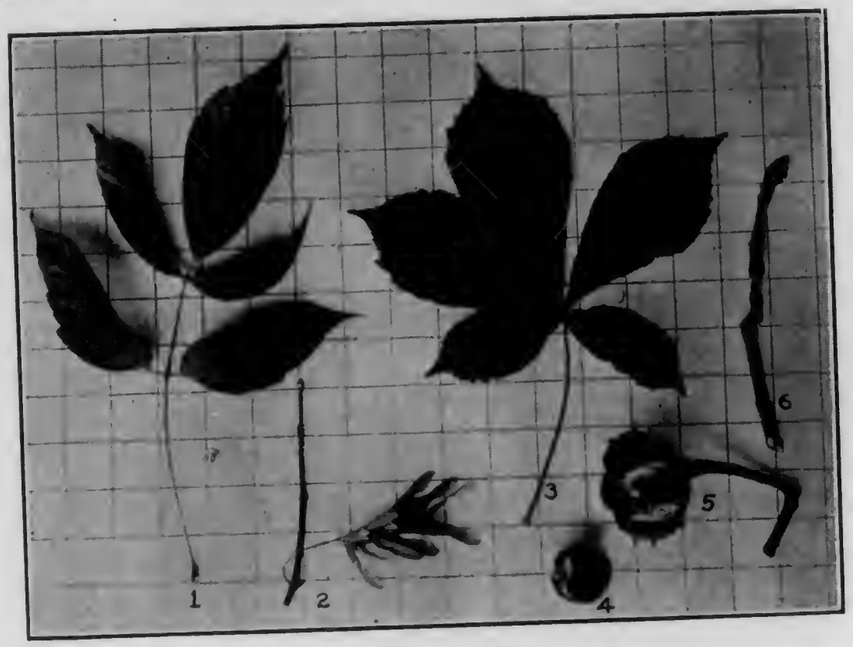


Figure 24
ASH-LEAVED MAPLE. 1. Leaf. 2. Winter twig with cluster of seed keys
HORSE CHESTNUT. 3. Leaf of small size. 4. Nut. 5. Dehiscing bur or husk. 6. Twig

194. Ash-leaved Maple or Box Elder,—Acer Negundo, L.

Twigs purplish to green, often pale glaucous, encircled by leaf-scars.

Buds short-stalked, *obtuse*-ovoid, *white woolly.*

Leaves 3- or 5-pinnate compound; leaflets ovate, coarse-serrate.

Fertile flowers occur in drooping racemes, sterile on hairy, drooping stems.

Fruit ripe in September, persistent; wings up to 2″ long and nearly parallel.

Tree of rapid growth and medium size; prefers moist soils, yet thrives on all but the poorest. (Fig. 24)

195. *Norway Maple,—Acer platanoides, L.

Broad-crowned European tree much planted for shade. *Twigs heavy. Buds red,* blunt. *Sap milky.* Leaves large; broad with shallow sinuses and dentations.

Fruit large, flat, in autumn; *wings diverge* widely.

Bark cut into narrow flat ridges. Native to Europe.

196. *Sycamore Maple,—Acer pseudo-platanus, L.

Much *like Norway maple but leaves* are 3- or 5-lobed, *sharp-serrate and firm in texture; sap watery; buds green; bark breaks into thick dark plates; seeds* smaller, *in pendant racemes* and *wings diverge* but *little.* Native to Europe.

197. *English Field Maple,—Acer campestre, L.

Has *smaller leaves than any* foregoing species, usually 3-lobed without serrations.

Twigs fine, often corky-ridged. Buds small, acute, apprest.

Seeds ripe in fall; wings divergent.

Rare ornamental small tree; escaped in a few places. Native to Europe and western Asia.

198. *Chinese Maple,—Acer buergerianum, Miq.

Resembles the preceding species but always *lacks corky twigs; leaf-lobes* are more acute than rounded, small *secondary leaves* develop *in axils of larger* ones.—Branches commonly leaf-clad. Not quite hardy in Pennsylvania. Native to China.

199. *Japanese Maples,—Acer polymorphum, S. & Z., varieties.

Show many leaf-types,—scarlet, dissected, and palmate are most commonly met.

In general, they attain *only small tree-size. Fruit autumnal, like mountain maple.* Native to Japan.

BUCKEYES AND HORSE CHESTNUT,—AESCULUS, L.

Trees or shrubs with very *large, smooth, brown seeds;* borne *in 3-valved leathery husks. Twigs heavy,* with *large terminal buds.*

Leaves opposite, palmately compound; leaflets serrate and veined like leaf of the chestnut. Leaf-scars large.
Flowers in large, dense, terminal panicles. Require good soil.

200. Sweet Buckeye,—Aesculus octandra, Marsh.

Twigs slightly odorous if bruised. *Buds smooth,* red-brown; outer scales usually pale blue glaucous.
Leaflets and bundle-scars average 5.
Flowers small, yellow, purplish or red.
Fruit obovoid, 1"-2" thru; husk smooth.
Attains to fair tree-size; rare ornamental, only native in western Pennsylvania.

201. Fetid Buckeye,—Aesculus glabra, Willd.

Like sweet buckeye but not as large a tree.
Twigs and foliage *rank-odorous* when crushed.
Fruit smaller than that of sweet buckeye; *husk prickly*

202. *Horse Chestnut,—Aesculus Hippocastanum, L.

Common exotic ornamental tree; *like our buckeyes* but *buds are glossy-resinous; leaflets and bundle-scars average 7.*
Flowers showy,—white with yellow and purple spots. *Husks sparse-prickly.* Native from Himalayan Mountains of Asia to Northern Greece; introduced from Europe. (Fig. 24)

203. Lance-leaved Buckthorn,—Rhamnus lanceolata, Pursh.

Twigs rather fine, smooth; buds small, alternate.
Leaves oblong-lanceolate, smooth, fine-serrate; veining typical.
Flowers small, yellow-green, perfect; *4 deeply notched petals.*
Fruit a black, nauseous, 2-seeded berry.
Clumpy shrub up to 10′ tall; superficially *resembling cultivated plum.*

204. New Jersey Tea,—Ceanothus americanus, L.

Twigs fine, yellow-green to red, *dead tips or bearing old capsule-bases.*
Leaves ovate-acute, 3-nerved, serrate, often cordate-based.

Flowers July, in attractive white clusters. Fruit small, *3-lobed capsule.*
Low shrub with red roots; found on dry soils.

205. Virginia Creeper,—Psedera quinquefolia, (L.) Greene.

Woody *vine, climbing by disc-tipped tendrils.*
Leaves palmately 5-compound; scars raised with sunken center, *near-round.*
Flowers small, yellow-green, paniculate.
Fruit small, red-black, large-seeded berry.
Common on tree-trunks, rock-cliffs and slopes.

GRAPES,—VITIS, (Tourn.) L.

Woody *vines climbing by coiling tendrils.*
Fruit a pulpy berry with several pear-shaped seeds, borne in compound clusters. Flowers small, yellow-green, 5-part, fragrant. *Bark shreddy.*
Leaves simple, rounded-heartshaped; *petioles long and stout, make angle of about 120 degrees with* plane of the leaf.

206. Fox Grape,—Vitis labrusca, L.

Leaves evenly short-woolly,—white or rusty *beneath;* large entire or lobed, obscure-dentate.
Fruit large, fragrant, sweet; tough skin; blue to red or rarely yellowish.
Usually found on fertile, moist soils.

207. Pigeon Grape,—Vitis aestivalis, Michx.

Leaves tufted hairy below, especially in axils of veins; *glossy green above, about same shade below;* broad-dentate.
Fruit black-glaucous, size of "buck-shot"; pleasant.
Found on fertile, cultivated soils.

208. Chicken Grape,—Vitis cordifolia, Michx.

Like pigeon grape but leaves are more variable with *floccose hairs independent of veins; fruit smaller, very tart, seedy.*
Occurs on all sites; especially poor ones, unless they are very dry.

BASSWOODS,—TILIA, (Tourn.) L.

Trees with heart-shaped, serrate, 2-rankt, oblique leaves. Buds unsymmetrical; terminal absent. Inner bark very strong fibrous.

Flowers 5-part, perfect, cream-colored, borne *in drooping clusters attached beneath a narrow leafy bract* which serves seeds as a helicopter.

Seeds globose, woody, nut-like, indehiscent, containing 1 or 2 embryos.

Occur on fertile, well-drained soils. (Fig. 25)

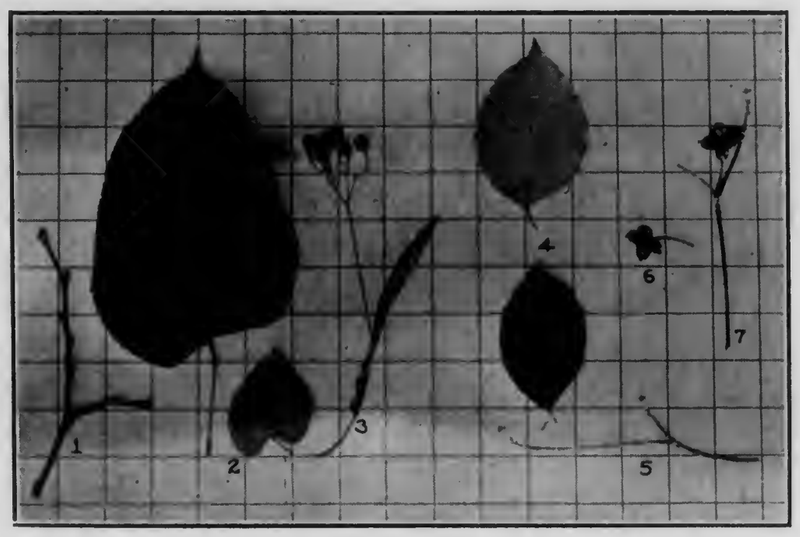


Figure 25

BASSWOOD. 1. Twig. 2. Leaves showing size variation, with upper and lower leaf surfaces. 3. Bract with appended fruit cluster.

FLOWERING DOGWOOD. 4. Leaves showing upper and lower surfaces. 5. Twig with typical branching and prominent flower buds. 6. Fruit cluster. 7. Twig with vegetative terminal bud, fruit cluster, and flower bud

209. Basswoods,—Tilia americana, L.

Twigs bright *red.* Bark olivaceous to gray; scaly-ridged on old trunks.

Buds usually show 3 visible scales. Leaves have rusty hairs beneath in axils of veins; bases oblique.

210. White Basswood,—Tilia heterophylla, Vent.

Is like somewhat larger relative, but has slightly larger leaves, silvery white and fine-downy beneath.

211. *European Broadleaf Linden,—Tilia grandifolia, Ehrh.

Like American basswood but hairy on ribs and sometimes whole *underside of leaves; fruit* is thicker-shelled and *4- or 5-ribbed; leaves* near-symmetrical. Native to Europe.

212. *European Small-leaf Linden,—Tilia parvifolia, Ehrh.

Is a *commoner ornamental* than its larger relative, compared to which it is smaller in every way.

Leaves cordate, *silvery beneath; tufts of rusty hairs in axils of veins.*

Fruit globose, thin-shelled. Native to Europe.

213. Shrubby St. John's Wort,—Hypericum prolificum, L.

Twigs fine; *buds* small, *opposite.* Brown, 3-part, many seeded capsules persist.

Leaves simple, entire; average 2″ long, *often* with smaller *axillary* ones; *translucent-dotted, narrow-oblong,* mostly obtuse; *midrib prominent, others obscure. Flowers July-September,* perfect; *many* conspicuous *stamens; yellow.*

Found on sandy or rocky soils; 2′ to 3′ tall.

214. Leatherwood,—Dirca palustris, L.

Twigs yellow-gray, smooth- *"telescoped"* in appearance due to raised and near-encircling leaf-scars. Inner *bark has* very *tough fibres.*

Sap acrid-nauseous. Buds brown-velvety, sub-petiolar; terminal absent.

Leaves simple, entire, 2″-3″ long, oval or obovate, cuneate, obtuse; stalks short.

Flowers pale yellow; perfect. Fruit a red, leathery, 1-seeded drupe.

Understory shrub; 3′-5′ tall; moist soil species.

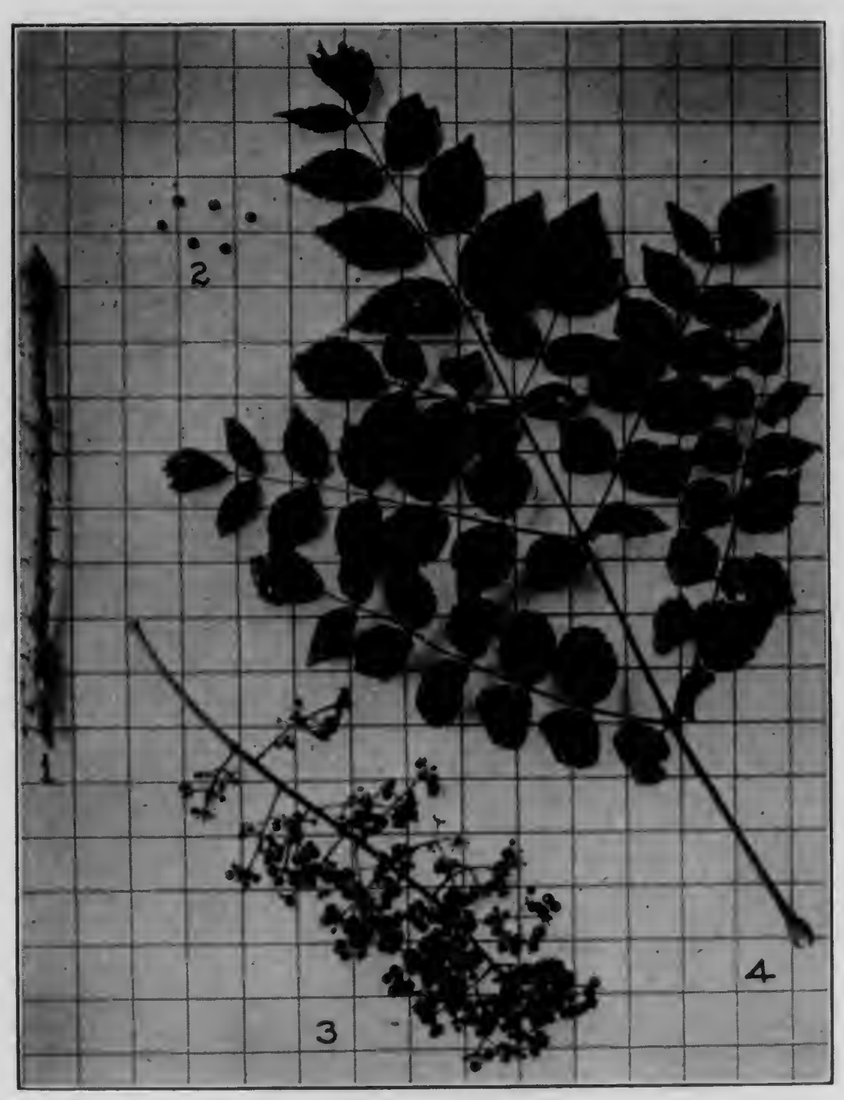


Figure 26

HERCULES CLUB. 1. Twig. 2. Berries. 3. Cluster of over-ripe berries. 4. Double-pinnately compound leaf with thorny stalk

215. Hercules Club,—Aralia spinosa, L.

Twigs very stout with strong scattered prickles; nearly encircled by narrow leaf-scars.

Terminal buds large, brown, conical-obtuse; lateral apprest, often triangular.

Leaves 1 or 2-compound, up to *3' x 2½' (largest of any native Pennsylvania tree);* stalks prickly.

Flowers small, cream-white, perfect, in large panicles.

Fruit an angled, ovoid, black berry, ¼" long style persistent.

Locally abundant; usually occasional on moist, fertile soil; 10'-20' tall. (Fig. 26)

DOGWOODS,—CORNUS, (Tourn.) L.

Species native in Pennsylvania bear perfect flowers. *Leaves opposite* with one exception. *Fruit a small drupe with a stony seed.*

Understory shrubs and small trees. Wood dense and hard.

216. Flowering Dogwood,—Cornus florida, L.

Twigs red tinged with green, smooth, glaucous often; *tips* with *upturned* "digitate" effect. Leaf-buds small, often covered by persistent petiole bases; flower-buds terminal, button-like. All *buds have two valvate scales.*

Leaves ovate-acute; *clustered toward tips of twigs.*

Flowers subtended by large, white, petalloid bracts.

Fruit scarlet, ovoid; stone grooved; borne in capitate clusters of 2-5; more than ½" long.

Bark on old trees breaks into an "alligator" pattern.

Largest and most attractive dogwood of Pennsylvania. (Fig. 25)

217. Round-leaved Dogwood,—Cornus circinata, L'Her.

Twigs warty dotted, greenish. Buds acute, short-stalked, apprest.

Leaves broad-ovate to orbicular, dense hairy below.

Flowers in flat cyme or umbel. *Fruit pale blue* or lead-white, *globose*, bitter.
Shrub of cool, rocky sites; 6′-10′ tall.

218. Red Osier Dogwood,—Cornus stolonifera, Michx.

Like preceding species but twigs are shiny, dark *red to bright purple; leaves ovate to lanceolate-oblong, entire,* acute or *acuminate; fruit whitish* and only ¼″ *thru.*
Shrub of water-courses and marsh margins; 3′-8″ tall.

219. Panicled Dogwood,—Cornus paniculata, L'Her.

Twigs finer than in other species, smooth, gray to brownish.
In general, *like red osier but flowers* are *panicled; leaves narrower;* forms thickets, often on dry soil; 2′-10′ tall.

220. *Cornelian Cherry,—Cornus Mas, L.

Twigs green; *stalked flower buds in nearly every leaf-axil.*
Leaves 2″-3″ long, entire, ovate-acute, glossy.
Flowers 4-part, profuse, clustered, *before leaves, small yellow,* delicate-scented. *Fruit ¾″ long, oblong, cherry-red, fleshy.*
Round-headed small tree or shrub; very attactive ornamental. Native to southern Europe and the Orient.

221. Alternate-leaved Dogwood,—Cornus alternifolia, L.

Twigs rather slender, flexible, glossy dark green or brownish; branches white-striped.
Buds small, acute; 2-3 brown scales.
Leaves alternate, clustered at tips of twigs, ovate-acuminate; *base cuneate; veining distinctive.*
Like round-leaf dogwood but larger,—*becoming 25′ tall—berries nearly black.*

222. Black Gum,—Nyssa sylvatica, Marsh.

Twigs smooth, gray to red-brown; *leaf-scars with 3 conspicuous bundle-scars.*

Leaves simple, oval-acute, entire, cuneate; autumnal color red, early. (Fig. 18)
Branches from trunk usually numerous and nearly horizontal in habit.
Bark light brown to gray or gray-black; smooth, ridged or "alligator" patterns occur.
Male and female flowers separate in stalked heads and clusters; yellow-green. Fruit a dark blue, fleshy, ovoid, drupe, over ½″ long, 1-3 in a cluster; seeds bony, white striate.

AZALEAS AND GREAT LAUREL,—RHODODENDRON, L.

Shrubs or small trees, variable in character. Require acid soil.
Leaves clustered toward tips of twigs.
Flowers showy, perfect, *funnel-form,* in umbelled clusters *from large terminal buds formed the previous season.*
Seed capsules 5-celled, 5-valved; seeds very small, scale-like. Vegetative reproduction prevails for most species.

223. White Swamp Azalea,—Rhododendron viscosum, (L.) Torr.

Twigs bristly as well as margins and midribs of leaves.
Lateral buds many scaled, acute.
Leaves obovate to oblong-acute, base cuneate; serrulate; *glossy green; about 3″ long.* Var. *glaucum* is *pale green* and very smooth above, *glaucous* or pale hairy below.
Flowers June-August, very fragrant, *white to pale pink, all parts viscid*-glandular.
Found on moist soils: 3′-8′ tall.

224. Purple Azalea,—Rhododendron nudiflorum, (L.) Torr.

Like preceding species and much more common, especially on dry sites.
Leaves acute at both ends, serrate, *dull green,* scattered hairy below.
Blooms May-June,—before or at time leaves unfold. (Fig. 27)

225. Great Laurel,—Rhododendron maximum, L.

Twigs green becoming red-brown; bark peels in thin shreddy scales; capsules persist over winter. Leaf-buds conical; rarely terminal. Flower-buds large, ovoid, imbricate—scaly.

Leaves ovate to oblong, acute, 4"-11" long, leathery, smooth and dark green above, pale below; *evergreen.* Flowers late June; gorgeous; rose to white, irregular.

Occurs in wet mountain swamps, moist valleys and slopes 5'-20' tall. *Looks like "rubber plant."*

226. Mountain Laurel,—Kalmia latifolia, L.

Like great laurel in general; but *leaves much smaller,* acute at both ends; *flowers regular,* stamens show special adaptions; *twigs viscid at first;* occurs on drier sites; *seed capsules much smaller.* (Fig. 27)

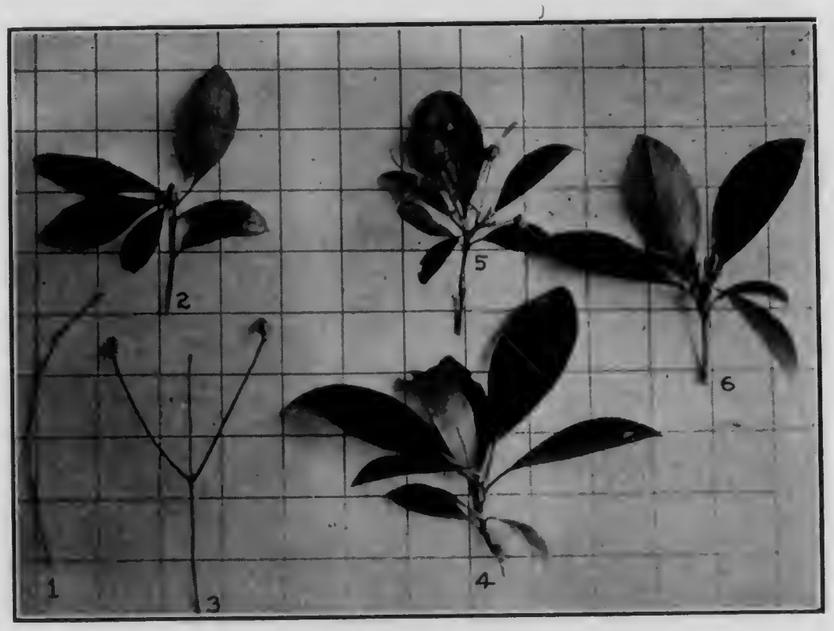


Figure 27

PURPLE AZALEA. 1. Twig with vegetative buds. 2. Twig with leaves and terminal flower bud. 3. Twig with two flower buds and showing typical branching

MOUNTAIN LAUREL. 4. Twig with leaves and vegetative buds only. 5. Twig with leaves and fruit capsules. 6. Twig and leaves with clusters of flower buds

227. Sheep Laurel,—Kalmia angustifolia, L.

Resembles mountain laurel but smaller in all respects,—seldom 3' tall—*leaves paler, opposite or in whorls of 3; flowers crimson.*

228. Maleberry,—Lyonia ligustrina, (L.) DC.

Twigs minute hairy; variegated ashy-gray to near-black. Buds reddish, apprest.

Leaves simple, oblong to oval, 1"-2" long, acute, entire or very fine-serrate, glabrous or short-downy.

Flowers perfect; small white globes; June.

Capsules small, *subglobose, 5-celled, very persistent.*

Bushy shrub of wet or moist soils; 3'-10' tall. (Fig. 31)

229. Trailing Arbutus,—Epigaea repens, L.

Small prostrate or trailing *evergreen shrub, in spreading patches* on rather poor dry soils.

Leaves about 2" long, ovate to orbicular, base cordate or rounded; usually smooth above, *hairy below;* reticulate veined.

Flowers April-May, perfect or dioecious, pink to white, 5-part, delicately fragrant. Fruit a small dry capsule.

230. Teaberry,—Gaultheria procumbens, L.

Creeping shrub, throwing up erect shoots 3"-5" tall, which bear *evergreen, leathery leaves* with typical *wintergreen flavor;* small, 5 part, white, urnshaped, perfect flowers, and red fleshy berries that increase in size toward spring.

Found on dry mountain soils. (Fig. 22)

HUCKLEBERRIES,—GAYLUSSACIA, HBK. BLUEBERRIES AND CRANBERRIES,—VACCINIUM, L.

These genera differ chiefly *in* structure of the *ovary; huckleberries having* normally *10 seeds, each in a separate cell,* while blue berries have 4-5 cells each with several small seeds.

Except in the very rare evergreen box huckleberry, Gaylussacia is deciduous with *undersides of leaves resin-dotted.*

Both genera bear small, fleshy, *edible fruit with persistent calyx-lobes.*

231. Dangleberry,—Gaylussacia frondosa, (L.) T. and G.

Bushy shrub. Twigs fine, red-yellow to bronze, with a pearly film.

Leaves oval to oblong, 1"-2" long,—most *delicate* leaves of the group,—*entire, pale to glaucous; minute resin specks below*, sometimes fine-downy.

Flowers perfect, *little green-pink bells on a loose raceme 2"-¼" long.*

Berry globose, dark blue-glaucous.

Prefers moist, cool, mountain soils; 3'-6' tall.

232. Black Huckleberry,—Gaylussacia baccata, (Wang.) C. Koch.

Like dangleberry but found *on drier soil;* rarely above 3' tall; *leaves* slightly *smaller, tougher, obviously resinous* below; flowers red-yellow; fruit black, often glossy, on short stalks.

Commonest species of this group in many parts of Pa.

233. Deerberry,—Vaccinium stamineum, L.

Twigs fine, much branched; green and fine-pubescent at first, later brown.

Leaves average 1½" long, ovate to oblong, acute; base round or cordate; underside silvery, glaucous or even downy. Attains height of 1'-4'.

Flowers white, with prominently *exserted stamens.*

Berries about ½" thru, green or tinted with yellow *and red, tart.*

234. Early Low Blue-berry,—Vaccinium pennsylvanicum, Lamb.

Twigs green with *olive cast;* buds scaly, reddish.

Leaves oblong to *ovate-lanceolate; acute at both ends;* dark green to olive green. Occurs on poor, sandy soil; ½'-2' tall; often carpets open spaces.

Fruit very juicy and sweet; earliest of the group.

235. Late Low Blue-berry,—Vaccinium vacillans, Kalm.

Like preceding species but *twigs and leaves are paler* in color: *leaves broader*, average nearly 1" long, *silvery beneath;* ½'-4' tall.

Commonest blue berry in southern and central Pennsylvania.

236. High-bush Blue-berry,—Vaccinium corymbosum, L.

Quite *like preceding* species *but* much larger,—*up to 15' tall; leaves smooth to downy beneath.* Found on moist or wet soils.

237. Black High Blue-berry,—Vaccinium atrococcum, (Gray) Heller.

Like the preceding species *but fruit is glossy black* without bloom; *leaves* slightly *thicker and more downy* beneath.

238. Sourwood,—Oxydendron arboreum, (L.) DC.

Rare small native and ornamental tree, named for its *sour sap.*

Twigs slender, yellow to red-brown. *No terminal buds;* lateral small, acute apprest.

Leaves simple, oblong, stalked, acute at both ends, serrate, smooth, about 6" long,—*peach-like.*

Flowers perfect, white, corolla cylindric; in racemes 6"-8" long.

Fruit a small 5-celled capsule with persistent terminal style.

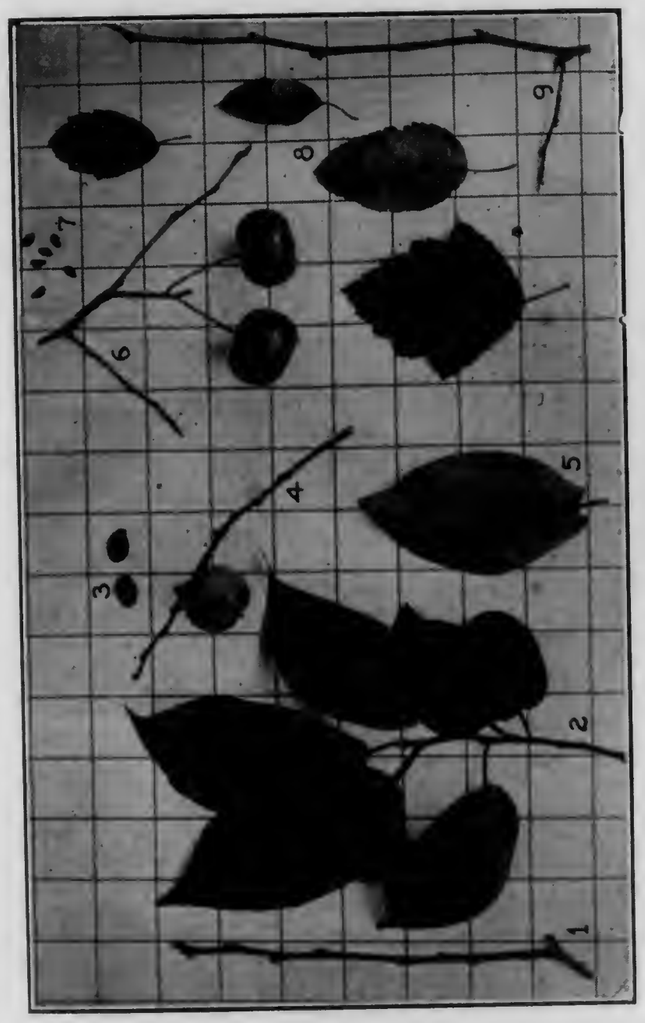


Figure 28

PERSIMMON. 1. Twig. 2. Twig and leaves. 3. Seeds. 4. Twigs and fruit. 5. Leaf showing under surface 6. Twig and fruit. 7. Seeds. 8. Four leaves showing variation in size and shape. One next to largest shows lower surface. 9. Twig with typical spine-tipt lateral spur

AMERICAN CRAB-APPLE.

239. Persimmon,—Diospyros virginiana, L.

Twigs bitter-astringent, gray to red-brown, usually pale minute-hairy.

Buds broad-ovate, acute, apprest, *2 glossy dark brown scales visible; terminal absent.*

Leaves oval-acute, entire; base cuneate to cordate; 4″-6″ long; dark green glossy above, often hairy below; scars have one near-black bundle-scar.

Flowers white; late May; staminate in cymes of 2-several, pistillate solitary and short-stalked.

Fruit large, juicy, *orange to red, fleshy berry,* with persistent terminal style and basal calyx; often very *astringent;* seeds flattened, about ½″ long.

Tree of medium size; occasional in fertile vales. (Fig. 28)

240. *Rose of Sharon,—Hibiscus syriacus, L.

Twigs grayish with *flower-scars and* persistent *filamentous stipules at nodes. Buds inconspicuous.*

Flowers July-August, *like hollyhocks,* variable in color. *Capsules* are *ovoid,* 5-celled, *1″ long; persistent. Seeds* small, kidney-shaped, *hair winged.*

Leaves simple, 3-nerved, about 3″ long; *base cuneate; almost 3-lobed, variable* coarse-serrate; bright green above, paler below.

An erect ornamental from Asia Minor; 10′-20′ tall; often spreading by root-suckers.

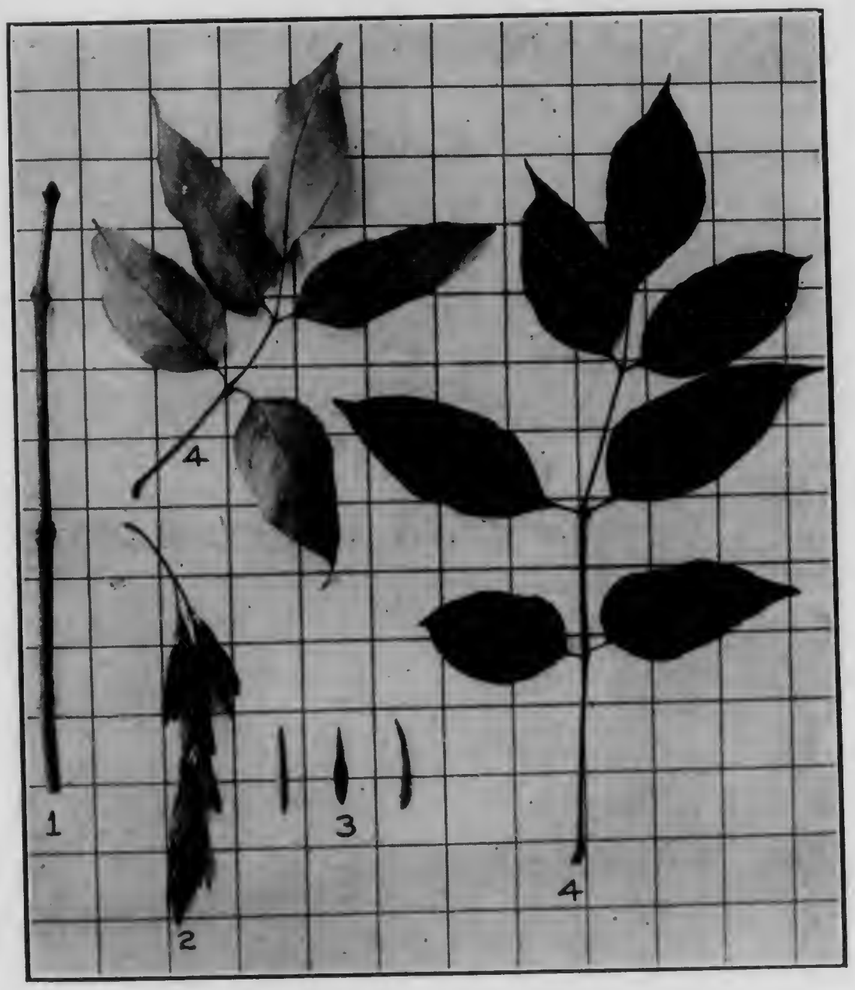


Figure 29
WHITE ASH. 1. Twig. 2. Cluster of typical seeds. 3. Three seeds showing wing variations. 4. Leaves with under and upper surfaces exposed

ASHES,—FRAXINUS, (Tourn.) L.

Timber trees with oddly *pinnate-compound opposite leaves.*

Flowers small, in dense panicles or racemes, usually dioecious; 2-part, without petals; calyx even absent sometimes.

Buds have 3-4 pairs of scales. Fruit a dry, winged samara.

Require fertile, moist to wet soils for good growth.

241. White Ash,—Fraxinus americana, L.

Twigs stout, usually *smooth,* gray-brown lustrous with few large pale lenticels.

Leaflets entire or obscurely toothed, silvery beneath, have short petioles; leaf-scars semi-circular, notched above.

Buds blunt, ovate, dark brown. Bark ridged with diamond-shape fissures.

Keys 1″ long; seed terete, overlapped but slightly by wings.

Best tree of the genus; makes straight, stiff growth. (Fig. 29)

242. Red Ash,—Fraxinus pennsylvanica, Marsh.

Differs from white ash chiefly in *having short-hairy twigs* and leaf-stalks, but also is a smaller tree in all respects; *leaflets narrower,* often nearly sessile; seeds thinner with wings extending well down their sides; bark ridges wider and more scaly.

243. Green Ash,—Fraxinus lanceolata, Borck.

Is commonly considered a variety of red ash but differs in being *smooth;* having *sharp-serrate leaflets quite green beneath; terminal buds acute;* keys narrower and very acute.

Twigs often curve or droop because of rapid growth. *Leaf-scars lunate.*

Occurs on stream-banks and fertile bottomlands.

244. Black Ash,—Fraxinus nigra, Marsh.

Twigs like white ash but paler in color and with more *obvious lenticels.*

Buds black; terminal acute. Leaflets sessile.

Bark irregular corky-ridged or scaly; becomes mealy in appearance when rubbed.

Tree of cool, moist to swampy soils.

245. *European Ash,—Fraxinus excelsior, L.

Is very much *like black ash but buds* are even *deeper black;* leaves are not quite as large, nor leaflets quite sessile; prefers well drained soils.

Planted as ornamental and shade tree. Native to Europe and western Asia.

246. Fringe-Tree,—Chionanthus virginica, L.

Twigs rather stout, pale green-brown, somewhat angular. *Buds opposite*, ovoid, acute.

Leaves simple, leathery, ovate, 4"-8" long. entire, cuneate-acute; dark green above, paler below and only hairy on veins.

Flowers perfect, in *drooping white panicles, fringe-like*, 4"-6" long.

Fruit dark blue, over ½" *long,—like an olive.*

Small tree; rare, met mostly as an ornamental in Pa.

247. *Common Privet,—Ligustrum vulgare, L.

Twigs fine. *Buds* small; *opposite; sub-evergreen.*

Leaves ovate-oblong, average 1", *dark green;* free of pests and smoke trouble.

Flowers small, white, like lilac in miniature. Fruit a black berry.

When not trimmed back, attains height of 10'. Native to Europe, northern Africa and western Asia.

248. *California Privet,—Ligustrum ovalifolium, (Hort.)

Like common privet but not quite so hardy; *leaves broader*, with *yellow-green* tendency. Native to Japan.

249. *Lilac,—Syringa vulgaris, L.

Twigs rarely have terminal buds, but are *opposite* and fork or ramify in *dense thickets* that spring up *from root-suckers.*

The *opposite buds* are *of two types; large* greenish, blunt, 4-angled floral, and smaller brown leaf-buds.

Leaves entire, ovate-acuminate; base truncate to near-cordate; slender-stalked.

Flowers pale violet to rose or white, *fragrant, in dense panicles.*

Fruit a 2-celled dehiscent capsule. Native from southeastern Europe to Afghanistan.

250. *Matrimony Vine,—Lycium halimifolium, Mill.

Shrubby, *often spiny*, half-erect, ornamental or escaped vine forming dense thickets. *Leaves alternate, spatulate-lanceolate*, often fascicled.

Twigs gray. Flowers regular; corolla funnel-form. Berry small, ovoid, orange-red, many seeded. Native from China to southeastern Europe.

251. *Shrubby Bitter-sweet,—Solanum Dulcamara, L.

Climbing or half-erect, barely woody, gray, more or less short-hairy.

Buds small, apprest; leaf-scars raised.

Leaves alternate, ovate-cordate or variable, with *two lobes or leaflets at base* of blade.

Flowers small, purple-blue; June-September. Berries ovoid, red about ½" thru.

Found on shady, moist soil; escaped around gardens and old houses; 1'-3' tall. Native to Europe.

252. *Empress Tree,—Paulownia tomentosa, (Thunb.) Steud.

Small to medium tree depending upon climate; ornamental or escaped.

Twigs heavy, tips usually frozen, no terminal bud; usually *hollow except at nodes. Leaves large, hairy, cordate*, stalked.

Buds small, hairy, obtuse, *opposite or 3-whorled; floral-buds present in large terminal panicles. Flowers* perfect, irregular. corolla 5-lobed, violet, *fragrant.* Fruit a brown, ovoid-acute, dehiscent pod, about 2" long, full of dandruff-like winged seeds.

CATALPAS,—CATALPA, Scop.

Like empress tree in a general way, but *leaves* are usually *3 whorled; twigs with large pith;* flowers whitish; *fruit cigar-shaped*, seeds much larger; *flower-buds develop after leaves appear.*

Require fertile soil for good growth.

253. *Eastern Catalpa,—Catalpa bignonioides, Walt.

Twigs stout, tips usually frozen back; yellow-brown. Lateral buds small,—appear embedded in bark.

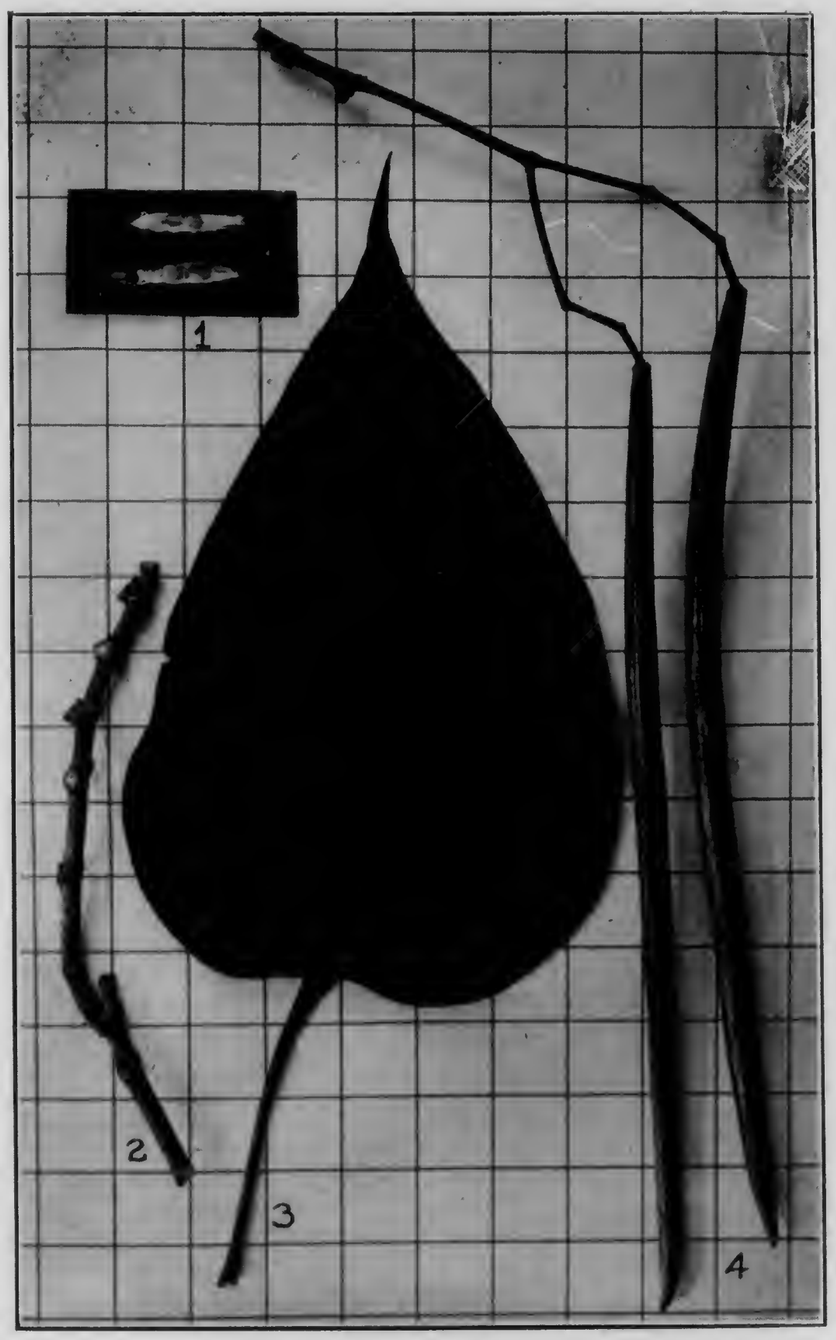


Figure 30
HARDY CATALPA. 1. Winged seeds. 2. Twig. 3. Leaf. 4. Twig and fruit pods

Leaves fall quickly after first hard frost; leaving large nearly round scars.

Bark light brown, flat ridged-scaly.

Flowers June-July; less than 2" long; in large showy panicles.

Fruit about as *thick as a lead-pencil, thin walled.* The flat *seeds have narrow*-fringed *wings.*

Rarely become 30'-40' tall. Native to southern Gulf States.

254. *Hardy Catalpa,—Catalpa speciosa, Warder.

Like eastern catalpa but twigs show somewhat less injury from frost; grows faster and attains larger size; bark thicker; pods larger and thicker walled; seeds larger, with broad fringed wings.

Flowers May-June, more than 2" long. Tree of better form than preceding. Native to Mississippi Valley. (Fig. 30)

255. Trumpet Creeper,—Tecoma radicans, (L.) Juss.

Vine creeping or *climbing by aerial rootlets;* twigs yellow-brown.

Leaves opposite, pinnate-compound; leaflets ovate-acute; toothed.

Large trumpet-shaped, 5-part, *orange-red flowers* in open corymbs.

Fruit pods like catalpa but smaller; seeds much smaller.

Found as an ornamental or "escape" usually.

256. Button-bush,—Cephalanthus occidentalis, L.

Twigs usually dead at tips; no terminal bud, laterals small.

Leaves 3-whorled or opposite, simple 3"-6" long, oblong to ovate, acute, glossy green above, veins prominent below; base round to acuminate; petioles ½"-1" long.

Flowers July-August, white, tubular *in close globose heads;* rich in nectar and remain *long in bloom.* Fruit small *sycamore-like balls;* quite persistent.

Found about ponds and on undrained areas.

Rarely over 8' tall in Pennsylvania, but attains 20' at times.

257. Bush Honeysuckle,—Diervilla Lonicera, Mill.

Low shrub, 2'-4' tall; often occurs in dense patches on open mountain-slopes.

Twigs smooth yellow-gray, *often dead at tips or bearing dry capsules.*

Buds acute, *opposite, apprest.*

Leaves simple, 2"-5" long, irregular-serate, ovate-acuminate smooth, short-stalked; base rounded.

Flowers small, *usually yellow,* terminal or nearly so.

Fruit smooth, slender, *beaked capsule,* ¾" *long,* carrying 5 *persistent calyx-lobes.*

258. *Weigela,—Diervilla florida, S. & Z.

This native of China surpasses its American relative in every way except abundance of fruit and ability to reproduce by seed and root-suckers.

Twigs show 4-angled tendency, *have two bristly lines under each internode.*

Leaves somewhat hairy beneath, especially on veins.

Flowers large, rosy red or variable.

Ornamental, at times persisting; up to 10′ tall.

HONEYSUCKLES,—LONICERA, L.

Shrubs or woody *climbers* with simple, *opposite, entire leaves.*

Flowers usually *showy* and *fragrant; corolla tubular,* usually *5-lobed.*

Fruit a several-seeded *berry.*

259. American Fly Honeysuckle,—Lonicera canadensis, Marsh.

Leaves ovate-oblong, acute, downy below when young, stalked; base round or cordate.

Flowers green-yellow, perfect, ¾" long. *Berries red,* ¼" long, usually in pairs.

Understory shrub on moist soils; *rarely* exceeds *5′ tall.*

260. *Tartarian Honeysuckle,—Lonicera tartarica, L.

Smooth, erect shrub; up to 8′ tall. Flowers showy, white to rose-red.

Berries orange to red; basally united. Ornamental; sometimes escaped. Native to Russia and Siberia.

261. Glaucous Honeysuckle,—Lonicera dioica, L.

Twining or ½-erect, smooth vine. Seldom above 8′ tall.

Leaves oblong, *glaucous below; upper* one to four *pairs*

fused around stems, bearing yellowish to purple flowers in their axils. Berries red.

Found in moist woods and on bushy stream-banks.

262. *Japanese Honeysuckle,—Lonicera japonica, Thunb.

Vigorous twining or trailing *vine* with fine *short-hairy stems.*

Leaves ovate-oblong, short stalked, rather tough; *subevergreen in tendency.*

Flowers fragrant; corolla white to pink or yellow. Berries black.

Serious forest-weed on fertile soil when once established, often choking out all young growth of other species and very hard to eliminate. Native to China and Japan.

263. Indian Currant,—Symphoricarpos orbiculatus, Moench.

Ornamental shrub, at times escaped and forming dense patches 2′-6′ tall.

Twigs fine, pale brown, *short hairy;* berries often persist.

Leaves opposite, simple, entire, about 1" long, round-ovate, tips acute at times, short-stalked, persistent in autumn.

Flowers in axils of nearly every leaf; small, greenish, pink-tipped bells.

Berries numerous, small, red, ovoid; calyx persistent.

264. Snowberry,—Symphoricarpos racemosus, Moench.

Smooth shrub, like preceding in most features *but leaves* are *larger and finer* in texture, dentate in tendency on rapid-growing shoots; flowers are terminal or nearly so; *fruit much larger, white,* fleshy and not so persistent.

ARROW-WOODS AND HAWS.,—VIBURNUM, (Tourn.) L.

Shrubs or small trees. *Leaves opposite, simple, stalked.* Buds naked or 2-scaled.

Flowers usually white, small 5-part, in flat cymes or umbels.

Fruit a pulpy drupe with one flattened seed of "melon *type.*"

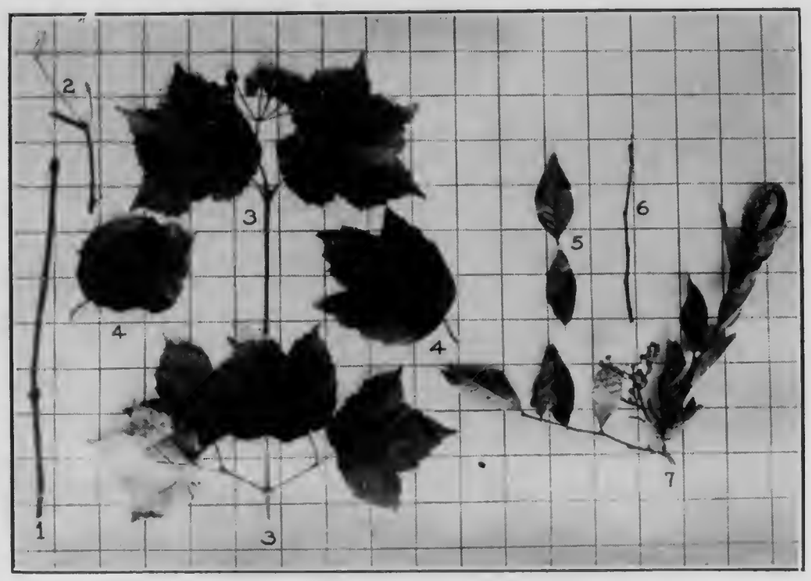


Figure 31

MAPLE-LEAVED ARROW-WOOD. 1. Elongating twig. 2. Twig with typical short spurs and remnant of the fruit stalk from the preceding year. 3. Twig with leaves and fruit cluster. 4. Leaves showing variation in form

MALEBERRY. 5. Leaves showing under and upper surfaces. 6. Twig. 7. Twig with leaves and fruit cluster

265. Maple-leaved Arrow-wood,—Viburnum acerifolium, L.

Stems straight, slender, smooth, terete, dark brown. Leaves maple like.

Buds dark brown, acute, only slightly apprest. Fruit purple-black.

Straight-growing shrub; 2′-5′ tall; spreading by root-suckers. (Fig. 31)

266. Dentate Arrow-wood,—Viburnum dentatum, L.

Twigs brown to ash-gray, 4-sided in tendency; lateral buds, acute, *brown, close-apprest.*

Leaves pinnate-veined, about 2″ long, *broad ovate to rounded;* base at times cordate; *serrations coarse and sharp.* Fruit dark blue.

Found on moist to wet soils; 6′-10′ tall,—a much branched shrub.

267. Sweet Viburnum,—Viburnum Lentago, L.

Twigs reddish to orange, smooth; odorous when crushed.

Buds long, slender, scurfy red-brown; laterals close-apprest; terminals enclosing flowers are much swollen at base.

Leaves ovate-acute, about 2½″ long; *serrations close and sharp.*

Fruit black or dark blue, sweetish.

Small tree or large shrub of moist woods and stream-banks; 10′-20′ tall.

268. Wild Raisin,—Viburnum cassinoides, L.

Is a smaller swamp-loving species quite similar to sweet viburnum, but its *leaves are often obtuse, wavy-toothed or entire; twigs scurfy dotted.*

269. Black Haw,—Viburnum prunifolium, L.

Twigs numerous, gray, spiky, often with a film-like bloom; make an angle of about 75, degrees with the parent branches. In mosts other respects *like sweet viburnum,* which it surpasses in palatibility of fruit and ability to spread by *root-suckers* so as to commonly *form dense thickets.*

Buds shorter and paler than those of sweet viburnum.

Grows on fertile to mediocre well-drained soils.

270. Hobble-bush,—Viburnum alnifolium, Marsh.

Bark purplish gray; *branches often long, prostrate and rooted at tips; twigs stellate hairy.*

Leaves pinnate-veined, broad ovate to round, 3″-8″ long, cordate, serrate, abrupt-acute, dep-corrugated above.

Flowers of two types commonly occur in each cluster. Berries red to purple.

Native in moist shady woods,—associated with virgin hemlock forests.

ELDERS,—SAMBUCUS, (Tourn.) L.

In many respects like Viburnum, but *leaves are pinnate-compound* with serrate and acute leaflets; *terminal buds absent; twigs fragile and pithy;* flowers smaller; fruit smaller and 3-to 5-seeded; buds conical-acute.

Shrubby species, 2′-12′ tall; give off vile smell when bruised.

271. Common Elder,—Sambucus canadensis, L.

Twigs brown with yellow cast; *pith white. Leaflets* 5-11. *Flowers in flat spreading cymes. Berries near-black; insipid.*

Occurs on fertile moist soils; forms thickets by root-suckers.

272. Red-berried Elder,—Sambucus racemosa, L.

Twigs warty and more woody than in common elder; *pith brown; odor rank.*

Leaflets 5-7. Flowers early; in dense panicles. Berries red; persistent, as birds only eat them under compulsion. Shrub of cool moist mtn.-slopes.

MEANING OF TECHNICAL WORDS.

Achene.	A small, hard dry, 1-celled, 1-seeded indehiscent fruit.
Acuminate.	Sharply tapering at the end.
Apical.	Pertaining to the tip, end, or apex.
Axil.	The upper angle formed by a leaf or branch with the stem.
Axillary.	Situated in an axil.
Bract.	A modified leaf subtending a flower or fruit, or related thereto.
Bundle-Scars.	Ends of fibro-vascular bundles showing as scars on the surface of leaf-scars.
Calyx.	Outer part of a flower,—sepals, usually green in color.
Catkin.	A spike of flowers all of the same sex.
Ciliate.	Having margins fringed with hairs.
Cordate.	Heart-shape.
Coriaceous.	Tough; leathery.
Corolla.	The petals of a flower. The bright colored part of most flowers.
Corymb.	A flat or convex-topped flower cluster.
Cuneate.	Wedge-shaped.
Dehiscent.	Splitting open.
Deliquescent.	Broad spreading habit,—said of the form of a tree-crown.
Digitate.	Members arising finger-like from a common origin.
Dioecious.	Male and female flowers borne on different plants.
Excrescences.	Outgrowths, usually irregular or deforming in appearance.
Exfoliate.	To split or cleave off, as outer layers of bark often do.
Exserted.	Prolonged past surrounding organs.

Fascicle. A small close bundle or cluster.

Follicles. Dry, 1-celled fruits, splitting open on one side only.

Genus. (pl. Genera) A group of related species, as the pines or oaks.

Glaucous. Covered with a bluish-white waxy coating or bloom.

Habitat. The home of a plant.

Helicopter. A flying-machine with propellers turning horizontally.

Hispid. Having stiff-bristly hairs.

Imbricated. Overlapping like shingles on a roof.

Indehiscent. Applied to fruits that do not open to emit seeds.

Involucre. A circle of bracts about a flower or flower cluster.

Lanceolate. Lance-shaped; several times longer than wide.

Lenticels. Corky growths on young or older bark which admit air to the interior of the twig or branch.

Lunate. Crescent-shaped.

Morphological. Relating to the form and structure of an organism.

Ob-. A prefix meaning inverted or reversed.

Orbicular. Circular or nearly so.

Ovary. Part of the pistil bearing the seed.

Ovate. Egg-shaped.

Ovoid. Nearly or quite egg-shaped.

Palmate. Hand-shaped; radically divided.

Panicle. A branched flower-cluster of which the lower branches are longest and bloom first.

Pedate. Palmately divided.

Peltate. Shield-shaped.

Perfect. A flower with both male and female organs.

Petaloid. Like petals in appearance; showy.

Petiole. The stalk of a leaf.

Pinnate. Having leaflets on both sides of a stalk.

Pinnatified. So deeply cleft as to appear pinnate-compound.

Pistillate. Bearing *pistils* or female organs, but no stamens.

Pith rays. Radial lines of tissues crossing the annual growth rings and extending into the bark.

Pome. A fleshy fruit with seeds arranged in a core, as the apple.

Pubescent. Hairy.

Raceme. Flowers borne on stems of equal length and arranged on a common elonged axis.

Receptacle. The end of a flower stalk bearing the floral organs.

Reticulate. Forming a network.

Ring porous. Said of wood with the larger pores concentrated in the spring growth of the annual rings.

Rugose. Wrinkled.

Samara. An indehiscent winged fruit.

Serrulate. Diminutive of *serrate;* fine toothed.

Sessile. Without a stalk.

Silvics. The body of facts fundamental to growth of trees in forest stands.

Sinus. Cleft or opening between two lobes.

Spatulate. Spoon-shaped.

Species. A group of like individuals, sexually compatible.

Staminate. Bearing *stamens* or male floral organs, but no pistils.

Stellate. Star-shaped.

Sterigmata. Very small leaf-stalks of certain conifers.

Stipule. An appendage at base of the leaf-stalk.

Stolon. A basal branch rooting at nodes.

Stomata. Plural of *stoma;* openings in epidermis of leaves for purpose of respiration.

Stomatiferous or stomatose.	Bearing stomata in large numbers.
Sub-.	A prefix meaning under or nearly.
Superposed.	Said of buds when arranged one above another.
Terete.	Circular in cross-section.
Terminal bud.	Buds at end of twig when not axillary to any leaf.
Tomentose.	Densely short-hairy.
Truncate.	Ending abruptly, as if cut off.
Umbel.	A flower cluster with all stalks originating from one point.
Valvate.	Said of buds when scales merely meet without overlapping.
Vascular.	Having vessels or ducts.
Verticillate.	Arranged in a whorl.
Whorl.	Arrangement of 3 or more organs in a circle around an axis.

INDEX OF BOTANICAL NAMES

INDEX OF COMMON NAMES

Numbers in ordinary type refer to major discussion, while italics indicate incidental mention.

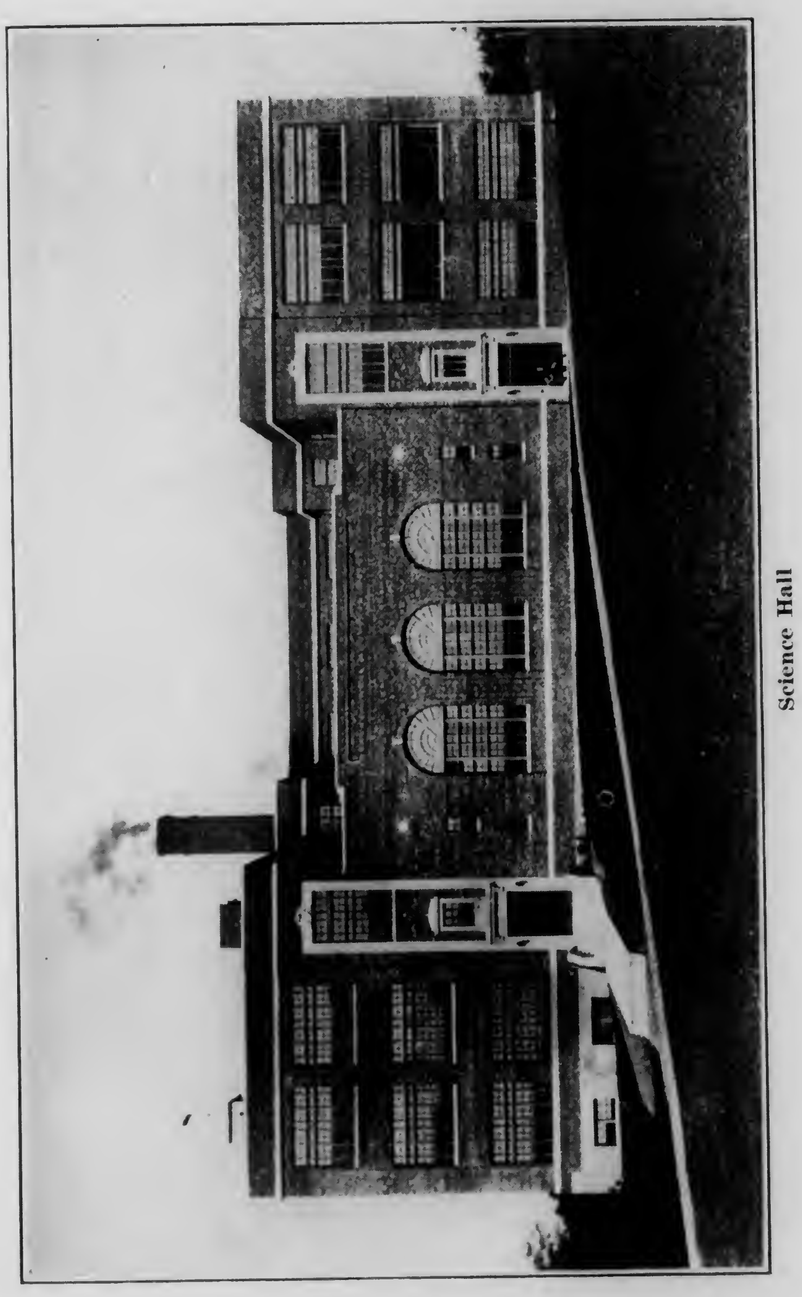
PENNSYLVANIA STATE FOREST SCHOOL

Twenty-Seventh Year
1929-1930

BULLETIN 34

Commonwealth of Pennsylvania
Department of Forests and Waters

Charles E. Dorworth, Secretary
Joseph S. Illick, State Forester



Science Hall

INSTRUCTION STAFF

EDWIN ALLEN ZIEGLER
Director and Professor of Forestry
A. B. Franklin and Marshall College, 1902; A. M. ibid. 1913; Sc. D. ibid. 1922.

J. V. HOFMANN
Professor of Forestry
B. S. F. University of Minnesota, 1911; M. F. ibid. 1912; Ph. D. ibid. 1914.

GEORGE S. PERRY
Professor of Forestry
B. F. Pa. State Forest School, 1913; Fellow, American—Scandinavian Foundation, 1925.

COLEMAN J. HARRIS
Professor of Biology
A. B. Bucknell University, 1912; A. M. ibid. 1914; M. S. ibid. 1918.

JOHN T. AUTEN
Professor of Soils and Chemistry
B. S. University of Illinois, 1916; M. S. Iowa State College, 1923.

DANIEL A. DOLLARHIDE
Professor of Social Science
A. B. Henderson—Brown College, 1916; A. M. George Washington University, 1922.

W. HAROLD HORNING
Assistant Professor of Forestry
B. F. Pa. State Forest School, 1914; M. S. F. University of California, 1928.

T. EDWARD SHAW
Registrar and Instructor in Forestry
B. F. Pa. State Forest School, 1921.

SCHOOL CALENDAR FOR 1929-1930

1929

Jan. 2	Wednesday	Christmas recess ends
Jan. 3	Thursday	Class work begins
Jan. 21	Monday	First semester examinations
Jan. 26	Saturday	
Jan. 28	Monday	Second semester begins
Feb. 22	Friday	Washington's Birthday—Holiday
Mar. 28	Thursday	Easter recess begins
April 3	Wednesday	Easter recess ends
June 3	Monday	Second semester examinations
June 8	Saturday	
June 12	Wednesday	Twenty-third Commencement
June 13	Thursday	Commencement recess begins
June 17	Monday	Commencement recess ends
June 18	Tuesday	Summer session begins
Aug. 2	Friday	Summer session ends
Sept. 9	Monday	Students report—First semester opens*
Sept. 10	Tuesday	Students register
Sept. 11	Wednesday	Class work begins
Nov. 11	Monday	Armistice day—Holiday
Nov. 27	Wednesday	Thanksgiving recess begins
Dec. 1	Sunday	Thanksgiving recess ends
Dec. 20	Friday	Christmas recess begins

1930

Jan. 6	Monday	Christmas recess ends
Jan. 20	Monday	First semester examinations
Jan. 25	Saturday	
Jan. 27	Monday	Second semester begins
Feb. 22	Saturday	Washington's Birthday—Holiday
April 17	Thursday	Easter recess begins
April 24	Wednesday	Easter recess ends
June 2	Monday	Second semester examinations
June 7	Saturday	
June 11	Wednesday	Twenty-fourth Commencement
June 12	Thursday	Commencement recess begins
June 16	Monday	Commencement recess ends
June 17	Tuesday	Summer session begins
Aug. 1	Friday	Summer session ends
Sept. 8	Monday	Students report—First semester opens**
Sept. 9	Tuesday	Students register
Sept. 10	Wednesday	Class work begins
Nov. 11	Tuesday	Armistice day—Holiday
Nov. 26	Wednesday	Thanksgiving recess begins
Nov. 30	Sunday	Thanksgiving recess ends
Dec. 19	Friday	Christmas recess begins

All recess periods begin at 4 P. M. on the opening date and end at midnight of the closing date.

*Freshmen report Tuesday, September 3

**Freshmen report Tuesday, September 2

FOREWORD

THE Pennsylvania State Forest School, located at Mont Alto, in Franklin County, among the foothills of the South Mountains, is the only forest school of collegiate grade in America developed independently of existing colleges or universities, and surrounded by a working forest for a teaching laboratory.

This institution, which is destined to hold such great significance for the State of Pennsylvania, was the outgrowth of necessity. In 1898 the Commonwealth of Pennsylvania made its first purchases of land for forestry purposes. Practical forestry was then a thing almost unknown in America. There were no trained foresters to be had to care for the State Forests—or practically none. It was necessary either to import foresters from abroad or to train our own foresters. The former course seemed both unwise and impracticable. That great prophet and servant of the people, Dr. J. T. Rothrock, who at great sacrifice had given up his professorship in the University of Pennsylvania in order to take charge of these new State Forest lands, as Pennsylvania's first Commissioner of Forestry, decided to establish a school of forestry under the control of the Department of Forestry, and to locate it in a State forest, where students could study the forest, rather than study *about* the forest. In 1903 the Pennsylvania Legislature acted favorably upon his suggestion, and the Pennsylvania State Forest School came into being.

Pennsylvania has 13,000,000 acres of natural forest land that once supported one of the richest stands of both hardwoods and conifers to be found in the entire world. That forest has been wiped out. The forest area that remains contains practically nothing but second or third growth timber, much of it of sapling size, and thousands of fire-ravaged acres that will not produce even saplings. The main forest problem of this and neighboring states is no longer one of large-scale logging or other questions having to do with harvesting timber, but is a problem of restoration, reforestation, of silviculture and forest management. To develop the strongest possible courses in silviculture and forest management, including forest protection, is, therefore, the immediate aim of the Pennsylvania State Forest School.

Though this is a small institution—kept so purposely by limiting the student body to approximately 80 men—it is ideally equipped to train foresters. The popular idea of a forester is that of a man with

The Main Student Dormitory

an axe on his shoulder, or of one battling desperately against a forest fire. To be sure, a forester must at times be both a woodsman and a fire fighter; but he must also be far more. He must be something of a chemist, to understand about the products which science has developed from the forests; he must be an engineer, able to handle a modern logging operation, build roads and make bridges, or carry on other engineering tasks; he must be something of a business man and an economist, in order to make a financial success of his forest operations; he must have some acquaintance with law, for often he must assist in litigation; he must be a soil expert and a nurseryman, in order to handle the problems of reforestation. And, finally, because he constantly handles men, large properties and public interests, he must be both administrator and executive.

The Pennsylvania State Forest School is equipped to turn out general forestry practitioners with something of all these qualities. For the teaching of the sciences necessary in forestry, it has ample facilities in the way of laboratories and school equipment in the new Science Hall. There is a herbarium that contains more than 4,000 native and foreign woody and herbaceous plants. A collection of forest tree fruits, seed, and seedlings is available. Typical specimens of wood-destroying and parasitical tree fungi, and many specimens of forest insects have been collected. There is a collection of important commercial woods of the United States, together with some foreign woods. The arboretum already contains more than 150 species, and more specimens are added each year. The library includes all the standard texts on forestry published in the English language and some foreign languages. All the principal forestry periodicals and lumber trade journals are received.

For the practical work that must be done in the forest, the Pennsylvania State Forest School has more than ample facilities. Its practice forest consists of 23,000 acres of woodland—the Mont Alto State Forest. This forest adjoins the Michaux State Forest of 41,000 acres. A five minutes' walk from the class room brings the student to the Mont Alto nursery, where 4,000,000 forest tree seedlings are raised annually. Here the student learns, not by general observation alone, but by actual work, in preparing and sowing seed-beds, growing the trees, packing and shipping them, and planting thousands of them himself during the silviculture practicum in the nearby State Forest. Equally accessible to the student is the great practice forest. In ten minutes the student can walk from the halls of science deep into the very heart of a large forest in the process of organization. Here again he learns by doing. For 25 years this forest has been under the careful and efficient management of the State. It is dotted with plantations and

experimental sample plots, set out by the students. Improvement cuttings have been made—also by the students—every year since the School was started. A study of the effect of light, medium and heavy thinnings has been in progress for some years. One wooden and two steel towers have been erected at commanding points, for adequate protection from fire. The utilization operations are among the most interesting and instructive activities in the forest. Chestnut has been

Students off to a forest fire

removed for fuel and extract-wood, poles and posts, ties and lumber, staves and shingles. A State-owned portable sawmill, a shingle mill, and a lath mill are available for operation by students. Thus these future foresters, by their work in the forest, learn something of every job connected with forest management and with lumbering, from that of felling a tree to acting as head sawyer and scaler. Through actual practice the students are taught the best and most efficient methods of handling a forest property.

To find a forest better suited to the teaching of forestry than the Mont Alto State Forest would be practically an impossible task. For this forest is the meeting ground of northern and southern varieties of trees and other forest plants, and it includes both highlands and lowlands. The southern trees troop north along the warm bottom lands in the valleys: the northern species creep south in the cooler elevations of the mountain tops. The student at the Pennsylvania State Forest School is required to know 150 trees and 300 plants of the

forest. He must know the trees, not only when they are in leaf in summer, but he must also be able to distinquish them in winter by their buds and bark. The richly varied flora of the Mont Alto State Forest is wonderfully helpful in acquainting the future foresters with the growths of the woodlands.

When the student graduates from the Pennsylvania State Forest School after four years of study—four years of 11 months each—he is well equipped for his future work. That is evident from the fact that Pennsylvania-trained foresters are in demand everywhere. Pennsylvania's own district foresters are practically all graduates of the Mont Alto School. Other states have chosen Pennsylvania foresters to care for their woods. Many of its graduates have found responsible work in the U. S. Forest Service, and with lumber, paper and mining companies.

The State of Pennsylvania welcomes applicants for training in her Forest School. But she wants only the best material. Only men of sterling character are accepted. The best 20 to 25 men of those qualifying are taken as students. For the present its enrollment is limited to residents of Pennsylvania, due to an excess of applicants for enrollment from within the State. What is required to gain admission to the School, and what is required of those who are admitted is set forth in some detail in the following pages of this bulletin.

THE COURSE

The School offers a four-year course of study in forestry leading to the bachelor's degree. Three summer terms are required. The first two summers are spent at the school and the summer of the junior year is spent in a logging camp.

REQUIREMENTS FOR THE FORESTRY DEGREE

The degree of Bachelor of Science in Forestry will be conferred upon completion of the following requirements:

1. Successful completion of the four-year course of study as fixed by the School; or in case of transfer from another college, a minimum residence study period of two years, unless the student was previously enrolled in a course leading to a forestry degree, in which case one year's minimum residence is required.
2. The completion and approval of a satisfactory thesis, to be submitted to the faculty in outline at the beginning of the second semester, junior year.
3. The payment of all school dues.

The School is accredited and the degree authorized by the Pennsylvania State Council of Education.

REQUIREMENTS FOR ADMISSION

For entering the Freshman Class:

1. Applicants must be 17 years old.
2. They must submit three references showing that they possess good moral character.
3. They must submit a medical certificate showing that they have reasonably good health.
4. They must submit a certificate from a standard four-year high school (or six-year junior-senior high school) or college preparatory school, showing college entrance work totaling 15 credits (a credit consists of 5 hours a week for 36 weeks). An entrance examination to the equivalent of the above credits must be passed if an acceptable certificate cannot be furnished.

The 15 credits must be distributed as follows:

Algebra, complete high school, including logarithms	2
Plane geometry	1
English	4
History	1
Science (elective)	2
Elective (commercial work not accepted)	5

5. All applicants, except for advanced standing, will be required to take the competitive entrance test during June. An outside board prepares and grades this test, and applicants will be accepted by the School in order of certification by this board. Classes of 20 to 25 men are accepted, and applicants reasonably well prepared should not have difficulty in gaining admission.

   The entrance test covers algebra, through quadratics, plane geometry, arithmetic, English (grammar, compostion, and rhetoric), U. S. history, civil government, and biology. The examination in biology is optional.

6. Among electives are recommended:

Science:	
Biology	1 year
Botany	1 year
Physics	1 year
Chemistry	1 year
Physical geography	½ year
Language:	
German (preferred)	2 years
French	2 years
Spanish	2 years
Latin or Greek	2 years
Miscellaneous:	
Civics	1 year
Economics	1 year
Drawing	1 year

7. No student will receive high school credit for a subject if the grade is less than 70, and the general average for all subjects submitted must be 80 or equivalent.

APPLICATION FORMS

Each applicant must fill in the School's entrance form, which may be had upon request.

ADVANCED STANDING

Students will be granted advanced standing on certificates from other colleges of recognized standing. Since forestry is a science course, it is very difficult to transfer from an arts course to an equivalent advanced rating in the forestry course.

TEN STATE SCHOLARSHIPS ARE OFFERED

The State offers five scholarships for the junior year and five for the senior year. These scholarships are awarded to the five men having the highest standing in scholastic and field work at the end of the preceding year, and carry the allowance of board and room. Scholarship students must each give bond of five hundred dollars to enter the State service, if needed, for a period of one and one-half years for each year of scholarship grant. Each year scholarship men are required to give 180 hours of laboratory or other assistance.

SCHOLARSHIP STANDARDS

To continue to hold a scholarship, a student is required to pass his subjects with the average of 80, on the basis of 100. The passing grade for the individual subject is 70.

Non-scholarship students must secure an average grade of 75, with the single subject minimum of 70.

If a student's average grade falls below 75, or he is conditioned in more than two subjects, he may not continue with his class.

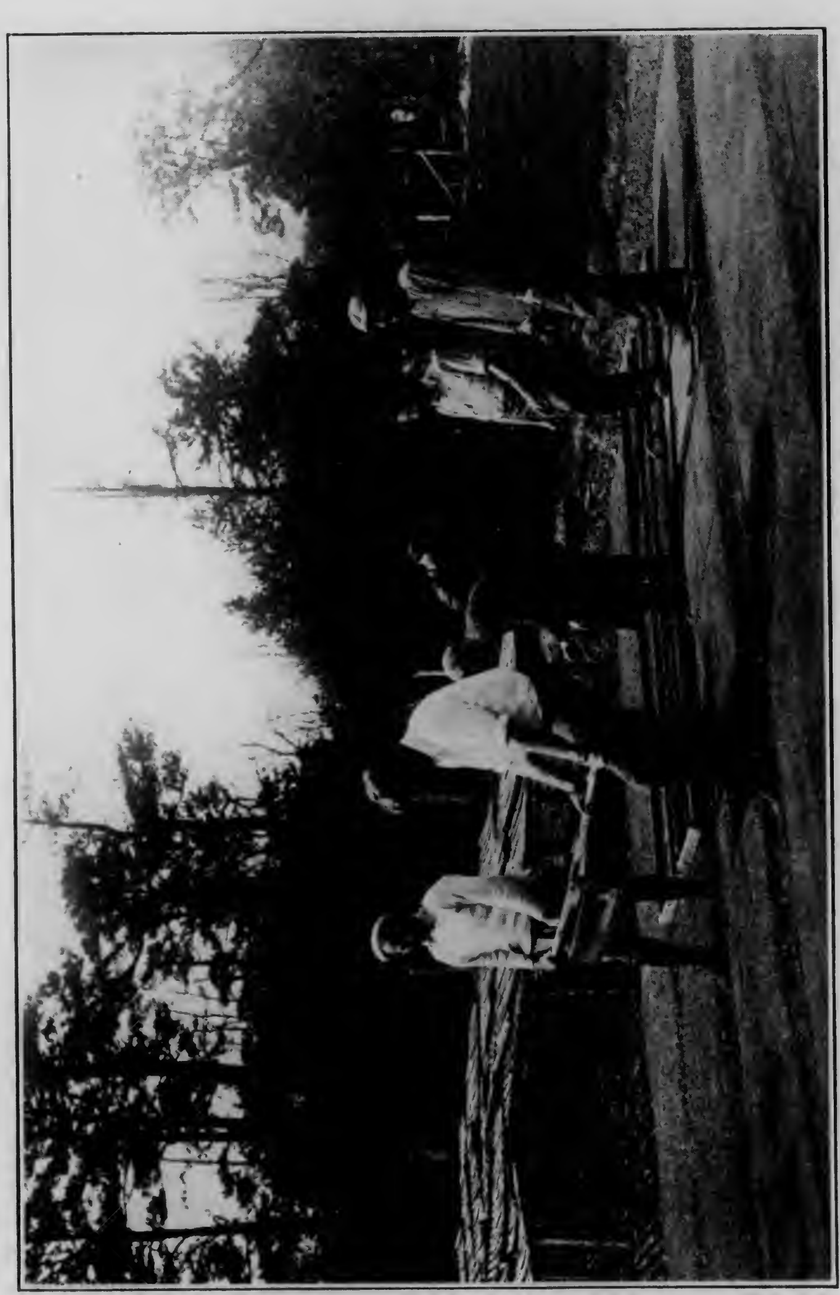
Any incomplete monthly grade must be made up by the middle of the following month.

Any incomplete semester grade must be made up within six weeks after the next semester begins.

A fee of one dollar will be charged for each extra examination.

FIELD WORK REQUIRED

To correlate theory with practice, each student is required to do a certain amount of field work. During the spring practicum period 80 hours' work in forest and nursery is required from each student.



Pennsylvania Forest School Students planting seeds in the Mont Alto State Forest Tree Nursery

ESTIMATED ANNUAL EXPENSES

(Excluding clothing and personal expenses)

Board, 46 weeks @ $5.50	$253.00*
Room, furnished, heat, light, bed, laundry	69.00*
Books and instruments	35.00
Laundry, 46 weeks @ .50	23.00
Forest Club, Athletic Association, social dues	25.00
Personal expense, field and inspection trips	10.00**
Breakage deposit	5.00
Hospital fee	10.00
Incidental fee, to cover trucks, graduation expenses, and laboratory maintenance, outside of special breakage:	
Senior year	40.00
Freshman, sophomore and junior years	55.00 to 75.00

Students from outside the State, when it is possible to accept them, will be charged a tuition fee of $150.00.

During the spring of the senior year there is an elective study trip through the forests of Germany, Switzerland, and France. The cost of this trip is approximately $550.00.

DEPOSITS AND PAYMENTS

Accepted applicants will make a room deposit of $10.00 by August first, as a guarantee of good faith. When the student enters, $5.00 of this amount will be credited to the breakage deposit, and $5.00 will apply on the first month's board and room charges. Board and room charges are payable in advance, at the beginning of each month. The hospital fee is payable at the beginning of the school year. A bond in the sum of $100 for the payment of all school bills must be filed with the Registrar on registration day in September.

All students will bring the breakage deposit up to $5.00 at the beginning of each succeeding year. The incidental fee covering supplies and materials for courses and truck maintenance is payable as follows:

	September	*January*
Freshmen	$28.00	$27.00
Sophomores	35.00	30.00
Juniors	37.00	38.00
Seniors	20.00	20.00

* Free to scholarship students.

** During the summer term of the junior year there is a six weeks' study of a large scale lumbering operation. Living expenses will exceed those at the School. This study may require, therefore, an extra expenditure of $30.00 to $50.00 for travel and excess board.

COURSE OF STUDY

FIRST YEAR

First Semester

Subject	*Credit Hours*
Botany I	4
Chemistry I	3
Elementary Forestry	2
English I	3
German I (elective)	3
Trigonometry	3
Fish Culture (elective)	3

Second Semester

Subject	*Credit Hours*
Botany II	3
Chemistry II	3
Drawing	1
German II (elective)	3
English II	3
Compass Surveying	1
Physics	3
Silviculture Practicum	2
Mathematics (elective)	3

Summer Session

Botany III	2
Silviculture	1
Dendrology	1
Compass Surveying Practicum	1

SECOND YEAR

First Semester

Zoology I	3
Chemistry III	2
English III	3
Geology	3
German III (elective)	3
Plane Surveying	4
Dendrology	2
Psychology (elective)	3

Second Semester

Botany IV	2
English IV	3
Dendrology	3
German IV (elective)	3
Meteorology	3
Soils	2
Plane Surveying	2
Silviculture Practicum	2
Statistics (elective)	3

Summer Session

Forest Soils	1
Forest Map	4

THIRD YEAR

First Semester

Accounting	2
Forest Mensuration	3
Forest Engineering	3
Wood Technology	3
Silviculture	3
Zoology II	2
Economics	2
Public Speaking (elective)	2

Second Semester

Business Law	2
Forest Pathology	2
Forest Mensuration	2
Economics	3
Forest Utilization	3
Forest Geography	3
Forest Entomology	3
Silviculture Practicum	2

Camp

Logging and Milling	4

FOURTH YEAR

First Semester

Forest Economics and Policy	3
Forest Finance	3
Forest Organization I	3
Silviculture	3
Wood Uses	3
Sociology	2
Public Speaking (elective)	2

Second Semester

Silviculture	3
Forest Appraisal	2
Forest Laws	3
Forest Organization II	3
Sociology	3
Seminar	1
Thesis	3
Forest Management Practicum (elective)	4
Forest Practice (elective)	2

FORESTRY AS A PROFESSION

The term "Forestry" has an attractive sound to the young men reviewing the many courses of training available in the secondary schools of the nation. The more thoughtful students, and particularly parents of students, look beyond the glamour of the word and the pleasant associations connected with the term "forest." They wish to have an opinion on:

(1) The type of student likely to do well in the study of forestry.

(2) The field of employment after securing a degree or degrees.

The type of student likely to do well in the study of forestry is not very different from the type that does well in any other profession. He must first have ability to do persistent study (his high school record usually shows this). He should have promising powers of observation and a keen interest in the natural sciences. Above all he must have a clear understanding of English composition and pre-college mathematics.

It is a great mistake to assume that because the central subject matter of a forestry course is the outdoor forest, a student who has done poorly in language, mathematics and science in high school may still do well in professional forestry; that forestry is an outdoor work that may be done with the hands rather than with the head.

There are specialized fields in forestry, as in all professions, such as research, administrative, industrial (forest products), and the silvical or forest management field. Many widely varying mental bents may be employed in these different fields, but success in all must be backed by persistent work and thorough basic training in language, mathematics, natural and economic sciences. The forestry profession is not one in which to expect to dodge hard work, or one to try to enter with the idea that it is less exacting in applicational effort than other professions.

For those who desire to go far in specialized professional work, a fifth year leading to the Master's degree is desirable, and the Doctor's course (Ph. D.) is now available to foresters in American universities.

There is sub-professional field in forestry mainly filled now by local outdoor trained men—men with practical experience in routine woods work, road and range work, and trail building. A few ranger schools in the country accept men with less than college preparation, furnish a short course of one or two years, and endeavor to give them a superior start in entering this field. The Pennsylvania State Forest School is not a ranger school. While this is a distinct field, there is no absolute dividing line, and the exceptional sub-professional man can occasionally win entrance into the professional-technical field.

To employ a professional forester, forest land owners or wood users

must have a business or forest interest of considerable size. It follows that foresters usually work on salary, and therefore the financial return of the forester has the advantages and disadvantages of salaried men in the service of large organizations.

The main sources of employment are:

Governmental Agencies
- State Forest and Conservation Departments
- The National Forest Service
- The National Indian Service
- City Park and Tree Commissions
- Agricultural Extension Service

Corporations and Private Enterprises
- Lumber Companies
- Pulp and Paper Companies
- Mining Companies
- Railroad Companies
- Water and Power Companies
- Rubber Companies
- Timberland and Wood Products Associations

The salary of a professional forester on leaving college varies between $1,500 and $2,000 per year. District Foresters in the State Forest service of Pennsylvania receive from $2,750 to $3,500 per year, and Bureau Chiefs from $4,000 to $5,500 per year. The salaries of State Foresters range from $3,500 to $7,500 or more. Salaries in private forestry are somewhat in keeping with government salaries, with an occasional salary running to a higher figure. The number of employes in the higher salary classes are few in number and are generally executive positions. These salaries may be taken as more or less typical of the profession, with some rather wide variations in non-governmental work.

It should not be overlooked that the broad basic training in professional forestry is well suited for teaching natural science (with extra work in pedagogical subjects for public school work), for business and for other pursuits.

The seventy-eight graduates of the classes of 1924-1928 from this School were employed as follows:

United States Government	20	per cent
Pennsylvania Government	18	"
Other State Government	15	"
Private Forestry	17	"
Teaching	5	"
Graduate Study	4	"
Scout Executive	1	"
Other Pursuits	19	"

Those desiring more information should write to the Department of Forests and Waters, Harrisburg, Pa., or the Director of the State Forest School, Mont Alto, Pa.

LESSONS IN FOREST PROTECTION

BY

GEORGE H. WIRT
Chief,
Bureau of Forest Protection
And
Chief Forest Fire Warden.

Bulletin 35

DEPARTMENT OF FORESTS AND WATERS

R. Y. STUART, Secretary
Harrisburg, Pa., 1924

INTRODUCTION

The greatest curse of our forests is fire. Nature's product of years can be wiped out in a moment by this devastating element. Fire has been the principal cause of the extensive forest devastation throughout the United States. In Pennsylvania alone there are over 3,500,000 acres of land which have been reduced to idleness through devastation. There are 81,000,000 acres of such devastated land in the United States. These lands, good for no other purpose than to produce wood, should be made to work. They will do so if fire is kept out of them.

The amazing feature about forest fires in Pennsylvania is that they are practically all of human origin. Discarded lighted matches, burning tobacco, deserted camp fires, careless brush burning, defective spark arresters and ash pans on locomotives, all contribute their share to forest destruction. It is a queer psychology that permits a citizen who takes the utmost precaution against fire in his home to be careless with fire on or near forest land. As appalling as has been the loss of life and property through forest fires, the average citizen is just beginning to realize the necessity for caution against them. Forest fires will not be stopped until he becomes determined that they shall be prevented. He can be expected to do so when he understands fully the vital respects wherein his welfare is affected by fires.

The main purpose of the accompanying lessons in forest protection by the Chief Forest Fire Warden, George H. Wirt, is to enlighten our citizens on the menace from forest fires, the trail of destruction left in their wake, and our responsibility to provide a forest heritage to our children. The Department needs the active cooperation of all public-spirited Pennsylvanians in its effort to instill in the mind of every man, woman and child in the State the need to keep fire out of the woods that our forest land may be restored to productivity. You can assist by giving these lessons earnest consideration and wide distribution among your friends.

R. Y. STUART
Secretary of Forests and Waters

LESSONS IN FOREST PROTECTION

LESSON 1.

BURNING UP MILLIONS

In the forests of America fires set by lightning or by Indians have occured since before the time of Columbus. Some of them burned over extensive areas. After the first settlers came forest fires were more frequent, notwithstanding the fact that most of the early settlers came from countries where it was a serious matter to cause a forest fire. But in this country, they found too many forests. Their enemies, wild animals and Indians, were in the forests. It mattered little, therefore, if fire raged unchecked. In fact it was felt that the forest had to be done away with.

Settlements increased and farms had to be hewn out of the forests. Trees were cut and piled for burning in clearings. Log rollings were made the object of festive occasions. The demand for wood increased as population and business developed. Wagons and ships had to be built to transport the products of the new land. Lumbering began and soon railroads were extended in all directions on a bed of wood. The opening of the forests and the slash left by the lumberman made unnatural conditions favorable to fires. There was a great accumulation of inflammable material ready to feed the flames started by someone's careless fire or by an engine spark.

In Pennsylvania, climatic conditions with the disturbed forest conditions developed two seasons of the year when forest fires became so common that until recently it was generally believed that fire and smoke were a natural part of the seasons. Generation after generation has grown up with the impression that forests needed no protection. The line of least resistance has become ingrained with most people.

The result has been that millions of acres of forest land have been burned over and kept from producing a wood crop. It has been estimated that at least five million acres of forest soil in Pennsylvania have been kept in a waste condition by fire and that the annual loss to the Commonwealth has been as much as $100,000,000. Even now with a somewhat awakened public one quarter million acres burn over each year in Pennsylvania. It seems certain that more timber has been kept from reaching merchantable size, and consequently not available for use as a result of such fires, than was ever harvested in the State by lumbermen. Verily we have been and still are burning up millions and bringing about very unsatisfactory living conditions without a thought for the future.

Now the forests are limited in extent. Of Pennsylvania's 28,000,000 acres of primeval forests, stocked with timber, in quality unequaled by anything found in the eastern states, there are now about 13,000,000 acres of woodlands. Only a few million acres have merchantable material upon them. The balance has only young growth and vast areas have nothing but brush of valueless species.

But with the decreasing area of the forest and the decreased crop on the remaining forest area, the demands for wood have increased until almost four-fifths of the wood used in Pennsylvania must be brought great distances from other states. In this way everything we use is more expensive because of the lack of a local supply of wood. The forest is no longer our enemy, but it is the most essential natural resource for our continued welfare. Therefore, our slogan must be "Prevent Forest Fires, It Pays."

LESSON 2.

THE FOREST IN EVERY DAY LIFE

Our most essential every day needs are food, water, clothes, shelter, heat, labor, recreation, health, transportation, and education. You may never have thought about how the forest affects these necessities. Does it aid or hinder man in obtaining his needs? Does it furnish any of them?

In the early days, the pioneers got practically everything they wanted from the forest. Even now a considerable quantity of food products are obtained directly from it, as nuts, fleshy fruits, berries, grapes, maple sugar and syrup, honey, flavoring extracts, meat from wild animals, as well as many minor products. But the forest plays a larger part in our food supply because of its influence on moisture supply of air and soil, which is beneficial to agriculture. The birds of the forest hold in check the insect hordes which would destroy all food crops if uncontrolled. Wood is used in the fences of the fields, the machinery and equipment of the farm and garden. Crops are gathered, transported and stored in wooden containers.

The forest is nature's reservoir and filter system to supply us with a constant and pure supply of water not only to drink but to fill our streams for power and navigation.

The forest also furnishes us with clothing. First comes the skins of animals, and the fur industry is still of considerable importance. Now all sorts of clothing are made from wood fibres. Likewise wood enters largely into the harvesting, marketing, and manufacturing of clothing made from wool, cotton, etc.

The forest furnishes dyes, wood buttons, wooden lasts for shoes, shapes for hats, and the tanning materials for the leather of our shoes, gloves, coats and other leather goods.

Needless to state that the forest has furnished us our shelter. Wooden houses are still most common in our country. Where brick and stone have been used for outside walls wood has entered most largely into the interior finish and equipment of our homes.

Our fuel comes directly or indirectly from the forest. Wood is a direct product of the forest. Coal is mined by using large quantities of wood for mine timbering. Electricity is developed from water power kept constant by forested hills, is transmitted over wires on wooden poles.

The forests of any state furnish a large demand for labor. Eighty per cent of wood prices is made up of labor values. Likewise the forest areas with streams and game, beautiful quiet spots, trees and flowers are constantly calling to our people to find recreation within their limits.

Forests influence beneficially the health of a community, because of their pure air, pure water, and facilities for recreation. Planted forests have changed a region of swamps, mosquitoes and malaria into a beautiful, healthy, prosperous and well inhabited community. Deforestation has changed populous regions into uninhabited wastes.

Transportation is essential for civilization and forest products are essential in minor as well as greater transportation activities, from the lowly sled to the most wonderful aeroplane. Railroads are dependent upon the wooden cross-tie; navigation still depends upon wood for ships, even in the steel clad liners. Most of the material shipped from one point to another is shipped in a wooden container of some kind.

Civilization is the result of commerce and of exchange of ideas. Our books are the products of the forest. Our ideas of each other, of religion, of patriotism, are determined by and kept alive by the books we read, and by the daily papers. Diminished forests are making these things more expensive. There may be a time when papers and books will be beyond the reach of the average individual resulting in wide-spread influence and a backward step in civilization.

It is, therefore, evident that the forest and its products enter largely into our every day needs. Everybody loses when timber burns.

LESSON 3.

WHAT THE FOREST DOES

The more we know about the forest and what it does for our welfare, the more we appreciate its presence and the more we will do to protect and perpetuate it.

The forest is a soil saver.

Every acre of land should be kept productive. The forest utilizes soil too poor to produce food crops. There are at least thirteen million acres of such land in Pennsylvania.

A forest increases the value of bare soil by the production of a crop with very little labor, and thus bears its just share of taxation, tending by so much to reduce the taxes on farm land.

A forest increases the fertility of the soil on which it grows and prepares it for agricultural use when needed for that purpose.

The forest is a renewable natural resource.

It uses the productive powers of nature and furnishes a timber crop.

The parts of trees, leaves, branches, bark, stem, roots, sap, and fruit enter into the necessities, comforts, and luxuries of each citizen's every day life.

The forest insures continued prosperity.

To supply these products capital and labor must be employed. There must be machinery, transportation, exchange, and research.

The development of a natural resource usually means the establishment of a local population, wages, demand for local food products, and general increase in business and prosperity of the community.

It provides homes for insectiverous birds which hold insect hordes in check.

The forest is a water conserver.

A forest increases the relative humidity of the atmosphere nearby, benefiting agricultural and horticultural crops.

It raises the water table of the soil in hill countries to the advantage of food crops nearby.

It reduces evaporation of moisture from crops and soil to the leeward side thus saving food crops.

It tends to induce rains during the growing seasons, and tends to reduce frost damage to crops.

The forest cover prevents the packing and erosion of soil, and also retards the surface run-off of rain and melted snow.

It changes rainfall, snow, and other precipitation from surface run-off to under ground flow, thus regulating the flow and purity of water in springs and streams.

It helps to lessen the frequency of floods and to lower the flood stages of streams.

The forest provides recreation and health.

It furnishes favorable conditions for game and fish, and for the sport of hunting and fishing. It supplies the factors which make a beautiful and healthful country.

It reduces the extremes of temperature in both summer and winter.

In fact it furnishes food, water, clothes, labor, recreation, health, wealth. An old German proverb has it that "The care of the forest brings all blessings". Certainly for Pennsylvania, forest protection, regulation and wise use mean continued prosperity.

Forest destruction means economic suicide.

LESSON 4.

WHAT FOREST FIRE DOES

The factors determining the extent of damage done by forest fire are general or climatic conditions, and local conditions.

Climatic conditions. The amount of damage done by fire in the forest depends to a great extent upon the season of the year in which it occurs. It has been found that the living parts of trees are most sensitive during the early part of the growing season when active cell division is taking place. Surface fires in April or May are likely to kill hardwoods which would escape injury from a fire of equal severity in the fall.

The spring fire season begins with the disappearance of snow and the first drying out of the surface leaves. In the hardwood or mixed forests the forest floor is exposed to sun and wind until vegetation is far enough advanced to protect the moisture of the floor from evaporation by these two forces. After the leaves are out and several good rains have again soaked the floor there is little danger. In autumn, when the dead leaves fall, the same drying effect of sun and wind is active and continues until fall rains and snow have packed the new layer of leaves and soaked the forest floor with moisture.

During periods of drought, conditions of air, surface litter, and growth combine to produce a severe fire and considerably more damage is done than during times of even average atmospheric moisture.

Strong winds not only cause a more rapid spread of fire, but increase the severity of the fire, and may change surface fires to crown fires. In local areas an up hill wind may cause much more damage than a draft down a valley. High winds may produce favorable conditions for a fire within a very short time after a heavy rain during the fall and spring fire seasons.

The amount and kind of soil covering also help to determine the damage done. The greater the amount of litter, grass, brush, etc., and the more inflammable it is the more severe the fire.

Certain species are more liable to damage than others. Conifers are damaged more than hardwoods. Resinous species especially are liable to crown fires. The stems of species exuding resin from the bark catch fire quickly and carry it into the crowns. The resin adds to the intensity of the fire, as in the case of balsam fir, spruce, and white pine. When conifers are killed above ground, with but a few exceptions as pitch pine, they will not grow again.

Smooth barked species as beech, and thin sapped species as tulip, are especially liable to fire damage. Species with flaky bark are likely to suffer. Shallow rooted species may be killed by the burning humus injuring the roots, or simply by the exposure of the roots.

Hardwoods are likely to have crown fires only in thicket or pole stage, or in dense stand when dead or new leaves are on the twigs.

The amount of damage varies greatly according to the age of the woods. In old timber the soil covering is usually scantier than in young wood, consequently there is less fuel and less damage. Surface fires usually burn more slowly in old timber because protected from the wind. As trees grow older the bark of most species grows thicker and more corky. It is a non-conductor of heat, hence it protects the cambium from being scorched. Even to such trees every fire does some damage and a severe fire or frequent fires will kill them. Young seedlings and coppice growth of most species, and even poles of some species are killed by very light fire.

Necessarily the kind and severity of the fire will influence the resulting damage. A fire in one tree does little damage unless it becomes the means of starting other kinds of fires. Crown fires are destructive because the burning of the foliage usually results in the killing of the tree. Even in hardwoods the leaves, buds, and twigs are so badly scorched that death results. In many cases the finer

twigs are consumed. Under-ground fires kill everything in their path, by killing or consuming roots, by exposure of roots, or by removal of material from on top and around roots so that it is only a matter of a short time until the trees are blown over by wind, or gradually die. Surface fires vary in their effects from slight injuries to complete destruction, depending upon their severity. Living tissue is killed when heated to 54°C. (129.2°F). If under-bark is brown or black, after a fire, it is an indication that the cambium layer is dead.

Climatic conditions may not be changed, but local conditions may be very much improved by the removal of unnecessary debris and by the opening of roads and trails. It pays to prevent forest fires.

LESSON 5.

A HERITAGE DESTROYED BY FIRE

Few people realize the *amount* of *damage* done by forest fires because they do not take time to go into detail, to follow from cause to effect, or to trace back from effect to cause. There are direct and immediate losses, but there are also indirect and future losses. The latter are more difficult to analyze and to appraise, but nevertheless, are usually far greater than the former.

Fire injures growing timber. When the trees are large, the bark heavy, and the fires light not many trees are killed and perhaps only a few may be injured. But with heavier fires or lighter bark the damage increases. The removal of the litter and humus from the soil may be sufficient to injure the roots, or to scorch the cambium layer at least partly around the tree. On the leeward side of trees the material burns a little longer by reason of the tree itself, shielding the fire from the wind. Debris frequently accummulates on one side of a tree more than on another, especially on the uphill side. In this way the trees are partially girdled, bark drops off on one side of the base, insects and fungi begin work, and succeeding fires continue to eat into the tree and finally destroy a good part of it or kill it. It is subject to breakage by sleet, snow or wind.

The removal of the humus, as mentioned before, either by one or more fires will weaken the vitality of the tree because of changed soil conditions. The blossoms and fruit may be injured directly or indirectly by the fire. Trees of weakened vitality are always more subject to insect and fungi attack even though the bark is not broken.

Not only is the rate of growth retarded in trees injured by fire but the quality of the wood produced, and the quantity finally harvested

are also reduced. Though a tree may have sufficient vitality to cover a fire scar, nevertheless the defect is still there and in the majority of cases it grows with the size and age of the tree.

When the injured tree is cut there is considerable loss due to heart rot, stain, wind shake, etc. This is particularly so in coppice forests.

Fire kills growing timber. As noted above, if a tree is girdled by the scorching of its cambium layer or of its roots, it dies. Fire thus kills a varying proportion of the stand through which it burns, but especially the small growth, and the sensitive species. Trees that are not killed immediately, die later as a direct result of the fire. Recent plantations are therefore, liable to destruction by fire and demand extra means for protection. If this cannot be given them it is taking a great risk to make them.

Such damage to standing growth results in an immediate loss made up of several items.

1. There is the loss of dead trees of merchantable size which, for various reasons, cannot be marketed while still sound, or decrease in market value by reason of some delay before harvesting.

2. The loss of value occasioned by the marketing of material not yet grown to the size which would yield the highest value per unit of measure.

3. The loss in final cut which must be expected if injured trees are permitted to stand until they reach what would otherwise be a merchantable age.

4. There should also be considered the fact that there may be and usually is some expense connected with the inconvenience of harvesting before maturity or of harvesting a smaller crop at the proper age for maturity.

Fire destroys seeds, small seedlings, and sprouts. Upon the forest floor, mixed with leaves and humus, and preserved by the latter, are many tree seeds of various kinds waiting for favorable conditions to germinate and grow into trees. In most places where stock and fire have been kept out of woodland for several years, thousands of young trees have started to grow either from seed or from roots, but they are hardly noticeable. Fire destroys all of these as a very small amount of heat will destroy the germ within a seed, and cook the life out of the tender plants. Even the lightest fires do considerable damage in this way, destroying the germs of prospective forests. On the basis of the value of seed or seedlings for a new crop of trees after the older growth was removed, it can be figured out that this loss amounts to from $3.00 to $10.00 per acre.

By reason of these three effects of forest fires, repeated burnings may change entirely the character of a forest in almost all of its phases, or forest conditions may be destroyed totally. The better species of trees may give place to fire cherry, quaking aspen, birch, or other light winged and inferior species. All tree growth may give place to scrub oak, sweet fern, huckleberry, bracken, or common herbaceous weeds. So it is reasonable to say that forest fires destroy forests and the possibilities of future forests.

LESSON 6.

THE FOREST FIRE FIEND

Forest fire destroys not only present or prospective tree growth but also destroys other values of immediate importance.

Fire causes the loss of felled timber. Felled trees represent time and money. The further the process of manufacture is carried the more valuable the product. Every year thousands of dollars worth of logs, bark, cordwood for various purposes, ties, poles, post and sawed lumber is destroyed. The workman may be out his wages; the owner may be out the wages paid and the profits; the user must so much the sooner pay a higher price for his wood because the supply is decreased by just so much; the Commonwealth at large suffers because property is destroyed, everybody concerned is made poorer, and no further wages, taxes, or use are possible.

Fire causes a loss to equipment for forest operations, to live stock, to farm crops, to various buildings, fences, etc. Every year the timber operators lose a great amount of property of various kinds, by reason of forest fire. Figures on this loss are hard to obtain, but if the value of mills, engines, tools, buildings, tram roads, etc., completely or partly destroyed by fire were known it would surprise the lumbermen themselves. The same thing is true of the loss to farmers and owners of property adjoining woodland. The individual loss may or may not be large in any one instance, but when such losses are totaled it soon amounts to unbelievable figures.

Fire in the forest causes the loss of homes. Not infrequently have forest fires furnished the spark that burned the homes and possessions of families living within or near the forest. In cases whole towns have been dangerously threatened, and in some instances completely consumed. The stories of some of the northwestern fires are heartrending and the loss cannot all be included in a tabulated inventory of property destroyed.

Fire causes the loss of human lives. The fire which starts from someone's brush pile or careless act may be the direct cause of snuffing out any number of human lives, as witness the results of many of the awful conflagrations of the West, of Canada, and of some few in the East. The recent fires in Minnesota and Wisconsin took a large toll of human life and will go down in history among the horrible catastrophies resulting from someone's thoughtlessness. But here again the loss cannot be counted in dollars.

Fire destroys game and fish. Spring fires, especially, are fatal to young animals of all kinds, and many eggs of game birds are destroyed. Not infrequently both spring and fall the water of some of the small streams has been heated sufficiently to kill fish. By destroying the factor which largely regulates the steady flow of streams and by making the banks of streams bare of their natural protection, fish life is seriously affected. The Secretary of the Pennsylvania Game Commission states that forest fires do more to destroy game than all other forces put together. The Pennsylvania Fish Commissioner states that the native brook trout of the East is almost a thing of the past because the waters are too warm for it. The California trout is being planted instead.

Fire causes a decrease in insectivorous bird life. Insectivorous bird eggs and young birds are destroyed directly, especially the ground and low nesting species. By reason of frequent disturbance birds are driven away from a region of forest fires. By the destruction of the forest and the making desolate of hills, conditions favorable to bird life are destroyed and birds become scarce. Scarcity of birds adversely influences agriculture.

Fire causes the loss of bee colonies. This loss may or may not be small but it must be remembered that bees are of value in the production of seed crops and of a valuable food product.

Fire destroys the beauty of a region. The beauty of certain regions is responsible for bringing to them millions of dollars each year. Green forests covering mountains and keeping the streams steady and clear are the most important factors in the maintenance of this asset. Fire promotes desolation rather than life and beauty. A fire swept region is anything but beautiful.

LESSON 7.

THE CURSE OF THE FOREST

There is still one more thing which we shall mention as being directly destroyed by forest fire, but in final analysis the indirect losses resulting from its destruction are far greater than the immediate ones. It is like killing the goose that lays the golden eggs.

Fire destroys wholly or in part, the litter and humus which form the forest floor. Light fires burn some leaves and small branches. Heavier fires burn everything down to mineral soil or rock. In some cases, the fire even follows roots and other vegetable matter into the soil.

A fire which consumes only the material above the general level of the soil is called a *surface fire.*

A fire which burns beneath the general surface level, as in old swamps, or on areas where the soil is filled with a mass of roots and other vegetable matter, as in bracken or huckleberry regions, is known as an *underground fire.*

It is well to remember a few of the most important functions of a natural forest floor:

(a) Forest litter and humus are a mechanical hindrance to the run-off of precipitation, allowing water to reach the stream slowly.

(b) Humus absorbs and holds rains and melted snows, giving it to the soil for underground supply which feeds springs.

(c) Humus keeps the soil open summer and winter permitting it to take moisture rapidly.

(d) Litter and humus act as a mulch preventing rapid evaporation of soil moisture.

(e) Humus keeps the surface soil fertile, which helps to make good tree growth.

(f) Humus protects the soil from erosion.

Changing humus to ashes eliminates all of the above benefits. Floods, erosion, irregularity and impurity of water supply, both for home supply and for power, and all the calamities attendant upon these conditions are the results. This loss cannot be determined because there is no way in which all the facts can be tabulated. Inconvenience, sickness, and death cannot be appraised in dollars and cents.

From the standpoint of forest growth and continued forest production, the humus is very valuable. In silviculture (the production of a forest crop) the efforts of the forester must always be directed toward a most "Careful preservation of the productive powers of any given locality, so as to render possible the production of the same effect, or even an increased one, regularly and indefinitely.

"Experience has shown that in forestry the safest method of preserving the productive powers of a locality consists in maintaining uninterruptedly a crop of forest vegetation on the area. The more frequently and the longer the ground is uncovered and exposed to the full effects of sun and air currents, the more, in the majority of cases, is the productive power liable to be reduced".[1]

The active agencies of the locality depend upon the nature of the soil and the climate. Man can do little toward regulating the local climate, but he can control to a great extent the soil factor of his locality. "Water is the most important component part of the soil",[1] and next to this are its physical properties and then its available chemical constituents. Almost any soil can furnish a sufficient quantity of mineral substances for the production of a crop of trees, provided the leaf mould (humus) is not removed. To insure a favorable condition of the physical properties, should be the forester's chief aim, and this he can do best by preserving the humus, especially on poor soils, and those of medium quality. "The poorer the soil the more important is the preservation of the humus, providing it is not acid".[1] Indeed, "humus forms the most important factor relative to tree-growth, and is a priceless treasure as regards the production of woodland crops".[2]

In foreign countries where the right to remove litter and humus has been acquired by the people neighboring upon a forest, the restrictions are rigid and experience has shown it to be so harmful to productiveness of the soil that forest owners are buying the rights as rapidly as possible.

The opening of the forests and the removal of humus by fire bring about conditions which make it easier for fires to rage. Each successive fire makes conditions more favorable for the next until in time everything of value is destroyed and desolation results.

1. Schlich's "Manual of Forestry," Vol. I.
2. Gayer's "Waldbau".

LESSON 8.

EVERY MAN'S ENEMY

Forest fire is a force which does immediate damage. If uncontrolled there is no way to tell how much damage may be done. It may result in a holocaust as in the West or in Canada. But the indirect damage from forest fire is far reaching, of inestimable amount and yet its effects are so insidious that few of us place the blame where it belongs. No forest means no water; no water means no agriculture. Then come floods, drought, pestilence and death.

Loss of soil productivity. The death of a number of trees in a stand of any age results in the opening of the canopy and the density is destroyed. This in itself exposes the floor to sun and wind and a more rapid disintegration of humus results. When there is added to this condition the removal of the litter or humus the soil is so much the more exposed and deterioration of soil qualities takes place rapidly. On the more humid soils, grass, weeds and brush grow up robbing the remaining trees of much nutriment and moisture. On the poorer, or sandy soils, sand drifts may be started. On practically all slopes leaching and erosion begin.

The loss of soil productivity is shown in a decreased annual production, a decreased yield at a given age, or by the requirement of a longer rotation age for the trees to reach a specified dimension or to yield a specified volume. In other words a forest on a certain soil is capable of producing a certain amount of material per year, or in 100 years. It is run over by fire once, or periodically. How much less is produced? The difference in value of the products from the unburned and burned areas is the amount of loss resulting from forest fires.

Increase in number and damaging power of many injurious kinds of insects and fungi. These attacks follow quickly after fires. However, there may be no indication of such trouble until several years later and the attack appears to be almost instantaneous. The insects find breeding places in foliage, stems, stools, and roots of growth weakened in consequence of being scorched by fire. Fungi enter at scarred bases and at other points where the bark is broken either by expansion or by breaking branches.

Modification of past stands. As noted before there is a modification of growth conditions even after one moderate fire. Less resistant species are killed and the number of species is reduced. Sprouts take the place of seedlings. Whatever seed happens to be exposed or finds lodgment on the area is likely to germinate and become es-

tablished. Winged seed species especially are likely to come in. The crop after fires varies in different localities. There may be birch, aspen, bird cherry, scrub oak, or by chance some valuable species. Species requiring protection from sun, drought, or frost in their early stages cannot regenerate until some nurse crop is established.

Extra expense and difficulty of reforesting burned areas. The exposure of soil results in a dry condition which limits the success of artificial regeneration. The exposure is severe upon the young transplanted seedlings. The grass and weeds which develop compete with the young seedlings for moisture and food. The lack of humus in the soil delays the growth of the seedlings which do become established. On other sites the debris may handicap the planting operation to such an extent that the number of trees planted per man may be reduced over 50%. And last but not least, the debris is likely to be fuel for the next fire and furnish the heat with which to kill the whole plantation.

Miscellaneous. We have already mentioned the indirect results on stream flow, erosion, and health. There are still such effects as the decrease of labor by reason of the lack of a natural resource, decrease of taxes upon land which ought to be producing a revenue and the consequent rise in taxes on that land which is producing, the scattering of the population of a township or county, the general decrease in land value in such cases; the local inconvenience of wood scarcity, the increased cost of wood products, the bearing on such questions as the housing of city dwellers and other economic and welfare problems.

To sum the whole matter up briefly, FOREST FIRES ARE CALAMITIES. They destroy great values without the least compensating benefit, and the trail of loss in wages, industry, taxes, revenue, prosperity, sport, health, comfort, and even life, leads to every home in the land.

LESSON 9.

A FOREST FIRE *

"Long before I reached the fire I could feel the heat in the air, could see the rolling smoke waves on high, and could hear the crackle and the crashing and the crunching of falling tree-trunks. Birds in alarmed flight winged ahead of the danger. Small game, squirrels, chipmunks, rabbits, and groundhogs, were getting out of the way and were heedless of man. There was even increased activity and excitement among the bugs. I never saw such swarms of Camberwell beauties, banded purples, angle-wings, swallow-tails, tortoise-shells, and dog-faced sulphurs. Deer clung to the shores, ready to take to the water. Bradshaw reported a big bull moose hanging out with his cattle, as if sensing comparative safety near to man. The fire caught a lot of pestiferous army worms and destroyed no end of vermin in its course.

*By Chas. S. Osborn. By permission of "The Outlook".

"The fighters had brains and willingness and courage and resource, but we had nothing to fight the fire with. There wasn't a drop of water nearer than the shore. The main fire front was over two miles long. It would take an ocean to conquer it. The trail was rocky. We had shovels, picks, hoes, rakes, and axes. We could not get a shovelful of non-combustible soil. All we could do was to whip at the fire with bundles of green withes. Bradshaw said that it would not run through a certain big green alder swamp, which would help check it. When the fire reached those alders, there was a hissing of a million serpents' tongues, and then a frying, sizzling sound as of the broiling of countless earth demons, and the alder swamp became blackish ashes on the ground. On came the fire. It consumed every particle of the covering of the rocky land, leaving it as bare, except for ashes, as when it left the bosom of the glacier that bore it. When it got to the trail, we could make only a brief resistance, that was more futile than the prattle of babes. Then we had to run for it or roast. Long before the ground fire got to the trail the aerial flames and cinders had passed over us, igniting the forest beyond. There was nothing to do but pray, and there was a mighty lot of praying. The Indians said if Chief Mendoskong were alive and White Loon, the medicine man, was not dead they would make rain. Even Greensky, who had been a famous rainmaker, had gone to the land of crippled deer and tame beaver. There was no hope.

"Only one thing can prevent forest fires: education of the people to a point where they can appreciate the danger and will practice adequate care. I have known careful woodsmen to start a tea fire on a rocky shore covered with fibrous roots and dusty ligneous substance and use plenty of water in an attempt to put it out before they proceeded. But the fire had eaten its way inch by inch between rock and soil where it was hidden and where the water did not reach it, only to burn through later and destroy miles of growth. So one must be very, very careful where he builds a fire in a dry time and more careful still about putting it out.

"When forest fires reach their maximum, they are more than terrible in their fury. The very air seems afire. There are those who believe that the air decomposes at a certain heat and that the gases ignite, forming an atmosphere of liquid flames. In the Peshtigo fire the flames appeared to jump forty miles through the grimy air. In

that holocaust a queer thing transpired difficult of physical explanation. A new house, partially completed and in course of construction, located near the center of the town, was not even scorched. Not an ember was otherwise left. Some sort of a cold air zone formed around the house, like the air pockets encountered by aviators or something similar. Anyhow, there was this freak case.

"There is such a thing as the air being so filled with carbon that it burns in advance of a gale of fire. I have seen and have run before forest fires that were advancing with hurricane swiftness through the top of trees. The tops half-way to the ground would melt in the sea of flame like soft lead bars in a furnace. These would intensify the more slowly advancing ground fire until everything in its path would be consumed and melted, even the rocks themselves. Once some of my men in my absence, took refuge on the summit of a bare mountain of stone. They were suffocated by the hot air. During the historic fires in the 'Thumb of Michigan' people descended into wells to escape, only to be caught like rats and asphyxiated. Dozens of corpses were pulled out of wells.

"Nothing is so terrible as a fire in a great forest in a dry time. More timber has been burned than has been lumbered. There never was a greater menace to the only great fringing forests remaining in North America. These great zones of wild life are on the way to becoming treeless, birdless, and waterless unless we save the forests at least in spots. Not flood, nor storm, nor famine, nor earthquakes, nor volcano, is more destructive than wild fires. We must become a Nation of fire wardens.

"Will you help?"

LESSON 10.

KINDS OF FOREST FIRES AND HOW THEY BURN

Fire in the forest may assume one or more of the following characteristics: those of a stem fire, a surface fire, a crown fire, or an underground fire.

A stem or tree fire is one in which a single tree is affected, and the fire extinguished before it has spread to adjoining litter or to other trees. Such a fire occurs usually in a dry snag struck and ignited by lightning, or ignited by a spark from a nearby engine; or in a hollow tree set on fire by some unsportsmanlike hunter to smoke out game, or in a bee tree in order to smoke bees.

Stem fires are dangerous because the wood of the tree is usually partly decayed, the hollow tree acts as a flue, the great draft causes many sparks to be given off and these may be blown great distances.

Stem fires when not extinguished gradually spread to adjoining litter or the wind driven sparks start surface or crown fires, or even an underground fire.

Crown fires are those where the flames consume the leaf canopy formed by the crowns of the trees. They may develop from surface fires, in fact they usually do. Further they are usually accompanied with surface fires. Conifers are most subject to such fires, but young hardwoods with new or dead leaves are also liable. Thicket and pole stages are most likely to suffer in the East, especially new coniferous plantations.

Crown fires occur when the wind is high and the woods are very dry. The strong draft carries sparks far ahead starting new fires either crown or surface. The general shape developed is that of a "V", although the same factors influencing the shape of a surface fire affect the development of a crown fire. Without a wind, however, crown fires are practically impossible.

The rate, of progress is ordinarily from two to three miles an hour or in extreme cases, six to ten miles. It depends upon density of crowns, regularity of heights of trees, and of species. An admixture of non-inflammable crowns or a belt of hardwoods may entirely break a crown fire.

Underground fires are those which burn beneath the general surface of the soil. They occur where the mineral soil is covered with an accumulation of vegetable material, and which, on account of its peaty character, burn more slowly than surface fires. They are common in the northern woods where fallen leaves, needles and other debris decomposes very slowly and a deep layer of partly decayed vegetable matter accumulates. Sometimes this may be two or three feet deep. Sphagnum swamps, dried up lake basins, and areas covered with a dense mass of bracken and ericaceae roots are also likely to be visited by ground fires. When this material becomes dry it burns slowly but with intense heat and is difficult to extinguish. Ordinarily they will not cover more than a few acres a day. They may be accompanied by a surface fire, or even a crown fire, and may develop from either.

In Pennsylvania most of our forest fires are surface, or brush fires. A few are stem fires, resulting in surface fires, and only in periods of severe drought do we have a crown or an underground fire.

LESSON 11.

KINDS OF FOREST FIRES (Cont'd.)

THE SURFACE FIRE

A surface fire is one which passes over the surface of the soil and feeds upon dead foliage, dead weeds, dry grass, dry moss, and scattered inflammable debris littering the ground, also occasionally brush and small trees. Apart or all of the litter and humus which make up the forest floor is consumed and quickly changed from its organic form to ashes. If the fuel on the ground is sufficient a surface fire may develop into a crown fire, especially in young coniferous stands.

The manner of burning, the form of area burned over, the rapidity of progress, and the intensity of the fire, depend upon the following factors:

1. Character and quantity of inflammable material.
2. Topography.
3. Character of soil.
4. Condition of atmosphere.

A surface fire on level ground and with all factors constant, is at first a small circle of flame, gradually spreading in all directions. If the least wind is blowing it burns more rapidly in the direction toward which the wind is blowing. If no wind was blowing at the time of starting it is not long until the fire itself creates a draft and it travels most rapidly in the direction of the draft. More or less of an oval form is assumed and sooner or later a V shape.

The side lines develop at an angle with the wind or draft and burn more slowly. If much wind is present the windward side may die out entirely. As the factors vary, the shape of the fire varies according to the resultant of their forces. As for example the apex or head may be acute or broad, according to wind, fuel, or slope. A change in topography or in wind may result in the development of several heads, or "headers".

Other things being equal the severity of the fire depends upon the quantity and kind of fuel in its path, but necessarily the amount of moisture in the material determines the amount of fuel available for the fire. Dry material will burn readily and the heat from this fuel will dry out additional stuff rendering it inflammable. But the heat may not be sufficient to dissipate the moisture from all the litter, consequently a part may be saved and the severity of the fire lessened to that extent.

The accumulation of undecayed leaves depends upon the species, season, soil, exposure, and length of time since previous fire or litter removal. Species having large crowns and large leaves, as maples and oaks, make a heavier litter than ash and birch. A layer of resinous needles burns more rapidly and with a hotter fire than does a layer of hardwood leaves.

In some forests there is a varying amount of dead wood made up of standing dead trees or snags, fallen trees, dead branches, slashings, or the debris of previous fires. Any of this material in a dry condition means additional fuel and greater severity for a fire.

A surface fire runs up hill rapidly because heated air currents draw flames upward and more fuel is exposed at the same time to the heat of the fire. After passing the crest a fire travels slowly in its descent on the other side. On extensive level ground, fires burn more uniformly, gather greater volume, generally do more damage and extend over a larger area than in rugged topography. Abrupt walls, narrow ridges, ledges, etc., tend to check fire and prevent its gathering volume.

Any influence which tends to dryness increases the intensity of a fire. Southern and western slopes are apt to burn more severely than others because of warm and dry exposures. The southern slopes have more sunlight and heat and the western slopes are exposed to the prevailing winds. Sand soils warm up and dry out readily and fires are apt to be severe.

Generally the greater the velocity of the wind the more rapid the progress of the fire. A steady wind makes a more severe fire than one which is gusty or intermittent.

Fire is more severe and rapid when the atmosphere is dry, as in the hottest part of the day when fanned by a dry wind. Moist atmosphere retards a fire, as in the night when air is damp and heavy, and there is little wind.

We have little data of value upon the subject of the rapidity with which surface fires travel. In the East, surface fires may travel before a high wind and up a slope as fast as a mile in three minutes, or twenty miles an hour, but in broken country and in varied growth, surface fires seldom travel more than five to eight miles in twenty four hours. In coniferous forests of the West they are said to travel as much as ten miles in twenty four hours.

A great many surface fires occur on what is known as brush lands. The growth consists of sprouts of tree species and brush of various kinds, as scrub oak, bird cherry, aspen, laurel, etc. Oak especially is

apt to hold a number of old dry leaves, both during the fall and spring fire seasons. Surface fires running through such growth set fire to the leaves and in a number of cases burn everything. Or if the brush are not consumed the heat is sufficient to kill everything down to the ground. This kind of growth is usually found on areas previously burned and in about 3 years it developes sufficient fuel to entirely kill everything again.

In young growth just after the leaves have opened in spring, surface fires are likely to cause the burning of the new foliage and a very fierce fire results, accompanied by a great amount of dense smoke.

LESSON 12.

HOW TO FIGHT FOREST FIRES

There are many methods of fighting forest fires. Some are good and some are not. A good Warden is always ready for useful suggestions, and is willing to give them fair trial. Methods of fighting vary with the character of the fire, type of the forest, condition of the atmosphere, strength and direction of the wind, rapidity of the fire's advance, topography and material on the ground.

TREE FIRES: These are stopped by shutting off the air which makes a draft through the hollow trunk. Close the hole at the ground if possible with dirt. If this cannot be done, the ground around the burning tree should be cleared, and the tree should be felled. The fire can then be smothered inside and outside the tree. If water is available, the fire may be put out with force pump or sprayer or chemical extinguisher without felling the tree. Dead snags in forests should be felled as a matter of fire prevention as well as for the benefit of the forest.

UNDERGROUND FIRES: These fires can be stopped only by digging deep enough to prevent their spread. The ditch, as well as the surface should be flooded if possible. This, however, is seldom possible. Where a soil fire has a good start it may be cheaper to blast a ditch than to dig one. Well-placed dynamite will do effective work in a short time.

CROWN FIRES: We have few crown fires in Pennsylvania. Natural conditions as to topography and growth which serve as a check are the most effective means of stopping any that may occur.

SURFACE FIRES: This is the kind of fire which occurs most frequently in Pennsylvania. If there is little wind the flames may be put out by beating with branches (pine preferred), shovels, and wet burlap. Fire fighters should beat the flames with a side sweep toward the fire to avoid spreading sparks. The burning material may be pushed back upon the burned-over ground with brooms, rakes, sticks, forks, or other tools. The idea is to separate the burning material from that not yet afire. Water is always effective, but too frequently dependence is placed on it and when it is not available fire fighters seem to be at a loss to know how to make their attack. The fire can be smothered by throwing on dry or moist sand or dirt. If it is possible to plow, a furrow may be thrown up quickly to restrict the spread of the fire. If no trail is cleared to the bare ground entirely around the burned area, here and there small pieces of smouldering wood may be fanned into flame and the fire may again break out. The only safe practice is to make a clean trail with exposed mineral earth entirely around the burned area.

Chemical extinguishers are sometimes used. Careful tests have been made by foresters and it has been found that the chemical spray is of no more value in the woods than is plain water with a little force back of it. This force can be supplied by a foot pump, or by air pressure, as in the ordinary fruit spraying devices. Sprinkling water in front of the fire reduces the force of the flames and permits close beating and raking. To be effective, considerable water is required when it is sprinkled directly on the flames. Water is used to the best advantage when the stream is thrown at the ground immediately in front of the flames. The water and force combined will stop the flames' advance. It is also satisfactory to spray water against the base of the flames from the rear particularly if there is much smoke.

BACK-FIRING: When the wind is strong or when the flames are in slash, fallen logs, dead ferns, bracken, or grass, fire becomes so intense that it is unsafe and impracticable to attempt close attack. Back-firing is resorted to in such cases. It should be remembered that fire is a dangerous force and that when fire is fought with fire extreme care and keen judgment must be used. If a fire starts some area will be burned-over and some growth will be damaged, but in order to reduce the damage as much as possible some additional sacrifice may have to be made by starting a back-fire. The area to be covered by the back-fire should, however, be kept as small as is practicable.

A satisfactory arrangement of crews is as follows: the warden or foreman directs the course and location of the fire-break, if one must be made. He is in charge of the whole fire-fighting force and should

urge each man to do his best. According to the amount of brush to be cut one or two axemen or brushcutters follow the warden. Four men with small wooden rakes, or some other tool, one working close to the other, make a clean trail, exposing the mineral soil, raking the material to the side away from the fire unless it is needed to start a back-fire. Next comes a man with a torch. He must not set fire too rapidly for the nearest raker, nor for the guards who follow him. If the torchman sets fire too rapidly for the rakers the heat may drive them off their course, and if too rapidly for the guards, the fire may not burn away from the trail fast enough to permit their moving up with the torchman. As a result sparks may blow across the trail where there will be no one to discover and stamp them out immediately. Four alert and active guards can take care of a long line of back-fire. They should have three-gallon spray tanks and a continuous supply of water. They should have also a rake or broom. Pine brush may be used in the absence of a better tool. The rear guard must be the most dependable man in the crew for he must determine when the line is safe and must not leave it until it is safe. It is important that someone who knows the woods after dark should be detailed to carry water.

THE LAST SPARK: Sometimes wardens and men leave as soon as the flames have been extinguished, with the result that frequently the fire has started up again at one or more places. Then the fire has to be fought again; it is larger, is harder to subdue, takes more time, costs more, burns over more area, and does more damage than the first fire. No chances should be taken with its breaking out a second time. All but the most dependable men should be discharged. The burned area should be inspected to see there is no danger of fire creeping across the trail which ought to have been cleared around the burned area. Threatening brands should be thrown far into the burned area; logs and branches holding fire should be rolled over and sprinkled with water or covered with dirt until they are safe. Punky stumps should be examined and broken apart to see that they can give off no sparks. Burning snags standing within several hundred feet of the unburned area should be cut down. Every precaution should be taken to prevent a recurrence of the fire. If a fire has been put out during the day, the tract should be patrolled until the wind goes down in the evening, or until dew falls. If the fire has been extinguished in the morning and there is the least danger of its starting again, the area should be patrolled until the next afternoon or evening.

No fire is out until the last spark is dead.

LESSON 13.

WILFUL WASTE MAKES WOEFUL WANT

We have set forth thus far the need of forest protection, the necessity of protection from fire, the kinds of fire, how they burn, and the damage they do. We are now fully convinced that they should be eliminated, if possible. But, before a logical and practical plan for their elimination can be formulated, much less put into operation, we must investigate the cause of forest fires. From a study of past causes we may obtain data upon which to work for fire prevention, for we may reasonably suppose that the same causes in the future will continue to result in forest fires.

As fundamental facts it must be remembered that a piece of woodland is a piece of property which is of value. The value is not only to the individual who happens to claim possession, but to the people of the immediate neighborhood and very probably to the State and to the Nation. From the inherent nature of forest property there are times when it becomes very inflammable. At such times a small spark of fire may destroy in a few hours what has required years to develop. Once it has been destroyed, man may never be able to replace it, or at best it can be replaced only at considerable trouble, time and expense.

Our next step, then, is to discover how the sparks which cause forest fires get into the forest. Naturally the first thing we think of are the forces of nature. We know that lightning causes some fires.

In Pennsylvania, only 1½% of the 1915 fires, 1% of 1916 fires and .1% of the 1917 fires or 32 fires in three years out of a total of 4200 reported, were caused by lightning. Since 1917 the percentage has been only three tenths of one per cent.

Occasionally we hear of fires caused by spontaneous combustion. Such fires are unquestionably possible, but are also most likely to be very few in number. Other than from these two causes, forest fires originate as a result of human action, (and are either intentional, or in the last analysis, the result of carelessness and indifference.) "When a man touches a match to a clump of dry brush and a fire results there is a physical action, a mechanical cause of the fire; but the cause of the fire contains another element—the phychological back-ground for the physical action, the mental process, the activity of the man's mind which preceded the act and resulted in his setting fire".* This mental attitude may be one of hate as the malicious incendiary; self-interest, as the huckleberry picker; carelessness as the brush burner; mind upon something else than what is being done,

what ought to be done or what ought not to be done, as the camper and smoker; ignorance, as the child and many people; indifference, as railroad employees; irresponsibility, as drunks, lunatics and idiots.

The causes of fires as shown by the reports from any State prove beyond a doubt that while natural conditions are contributory causes to forest fire yet unquestionably the greatest factor is that of carelessness on the part of man, therefore it is with man that we must deal in our efforts to prevent and control forest fire.

*DuBois in Systematic Fire Protection in California.

LESSON 14.

THE FOREST FIRE PROBLEM

The timber cut of State and Nation is far in excess of what is grown, consequently there is urgent need of protection of the forests which we now have and of care in their utilization. Almost four-fifths of Pennsylvania's timber supply is obtained beyond her border. It is a law that when a natural resource becomes scarce, as wood now is in Pennsylvania, management with a view of protection, better utilization and future production becomes necessary.

However the first measure necessary for successful practice of forestry is protection from forest fires. "As long as there is any considerable risk from fire, forest owners have little incentive to make provision for natural reproduction, to plant trees, to make improvement cutting or to do other work looking to continued forest production."[1]

"To be most useful and generally understandable the value of forest protection must be measured in dollars and cents whenever that is possible. Excess in money value of products of a protected forest over money value of products of an unprotected forest is the worth of protection to the public. With a forest, the capital value is the soil—it, with sunlight, air and moisture has power to produce an income in shape of wood and expressible in terms of dollars—When the timber is cut the producing power of the capital is as great as before."[2]

"Every avoidable forest fire is not merely a severe loss to the country at present and for the future, but it is in itself an accusation against our people's lack of public consciousness. We are too apt to think in terms of our individual interests. Community interests apparently have little weight with us, and that can only come from failure to think in community terms."[3]

1. Dubois
2. H. S. Graves
3. Editor "Echo," Halifax, Nova Scotia.

We have noted the duty of the forester toward the preservation of the productive powers of the forest soil and that forest fire destroys not only the present crop but the possibility of future forest crops. Without a doubt we can agree that the "issue of forest fires stands paramount in forest protection."[1] Without protection from fire all forest operations are equivalent to gambling with fate. The odds are against winning. It has been said that the success of the whole conservation movement depends largely upon the elimination of forest fires, and there is a great deal of truth in the statement.

The problem stated in its simplest terms, is how close can we come to the ideal condition of no fires with an expenditure of a minimum amount of money? The ideal, of course, is impossible. As long as human beings get in contact with forests there will be fires. A decrease in number can be expected only as our people establish a fixed habit of mind associating fire in forests, with danger, loss, public disapproval, criminality and punishment. The first factor of our problem then is education, or the problem of indirect control, which seeks to reduce the number of fires.

The second factor in the problem is that of direct control which seeks to suppress all fires as quickly as possible, within a minimum area with a minimum loss and at a minimum expense. This implies an efficient organization with proper equipment and methods.

The third factor of the problem is that of adequate finances, and the proper distribution of the same. Without sufficient funds, indirect and direct control are crippled and results are uncertain, unsatisfactory and discouraging. This, too, is largely a factor of education for unless the individuals who furnish the funds have the right attitude to the forest, the funds needed will not be forthcoming.

The fourth factor is that of cooperation. An individual owner of forest lands protects his property at high rate per unit of area and protects his neighbors' property to a certain extent in order to protect his own. Adjoining owners and other people of the neighborhood should be interested in the protection of the forest. The township, county and state government should be interested also. Each party must see some return for the expense incurred. Here again is the factor of education. But all these factors react upon each other, while to a certain extent they are independent.

1 C. A. Schenck.

LESSON 15.

THE STATE CARES FOR FORESTS

Beginning with the founding of the Province of Pennsylvania efforts have been made almost continually to induce individual owners of woodlands to protect them from fire. For various reasons, these efforts until very recently have failed signally. In the course of time, however, because of the value of forests to the Commonwealth in addition to their direct value to the owners who happen to hold title to the land, and because of the failure of forest owners to accomplish satisfactory protection, the State government entered upon a policy of land purchase. It is a well recognized fact that when individuals cannot or will not do what is necessary for society, the State must take such measures as will provide for its own welfare.

With its own land the State recognizes that protection from fire is the first principle of sound forestry practice. But the State owns only a little more than 1,000,000 acres of forest land. Conditions in Pennsylvania are such today that this small proportion of the forest area cannot possibly bring about the satisfactory conditions which can come and be maintained only by an area large enough to meet the timber needs of an increasing population. Neither is it probable that the State will or ever can own enough forest land to guarantee a sufficient timber crop. Therefore, it recognizes its duty in the matter of protecting the general forest area within its boundaries from its worst internal enemy, forest fire.

This policy has been expressed in law and provision has been made for a State forest fire organization, but not until the Legislature of 1921 had there been sufficient money appropriated to equip the organization or to complete it and make it effective. With the million dollars appropriated by the 1921 Legislature and approved by Governor Sproul it has been possible to expand the State's Forest Fire Organization and to develop it to suit the conditions in different parts of the State.

Steel fire towers have been built so that now almost the entire forest area of the State is under constant observation during the fire seasons. For fires will start and they must be detected promptly. These towers have been manned for from two to three months each spring and fall.

Each tower is connected by telephone so that the existence of a fire may be reported at once to the nearest forest fire Warden. This has necessitated the building of approximately 700 miles of telephone line.

There are almost 3,000 forest fire Wardens, including State Foresters, State Forest Rangers, State Game Protectors, Special Wardens, and Local Forest Fire Wardens. Every State Policeman is also a Forest Fire Warden. From the Local Wardens, towermen, inspectors, patrolmen and fire bosses are chosen. Each fire boss is expected to have a regular fire crew of from 6 to 12 men. Many of the wardens who have crews are now supplied with some forest fire fighting tools.

This organization tries not only to extinguish fires promptly but also to eliminate the cause of forest fires by having hazards cleaned up and by educating the people generally to appreciate the forests and to be careful with fire in and near them. This organization with the exception of the State Police is under the direction of Chief Forest Fire Warden who in turn is under the direction of the Secretary of Forests and Waters.

The State is trying to do its part in the protection of forests from fire, but it cannot do much without the help of woodland owners and of every good citizen of the Commonwealth. You can help by being careful with fire in the woods.

LESSON 16.

FOREST THRIFT

Forest protection has been, is now, and always will be the keystone of forest conservation. From Canada comes the statement: "Conservation and good forest management are meaningless terms as long as the plague of flames sweeps off in a week more than the constructive forester can accomplish in ten years. Until fire is eliminated conservation of forests can make no real headway."

Fire strikes at the existence of the forest and destroys the factors which make it of most value to man. If forests are to be grown, fires must be prevented; and it is not enough to prevent them or to keep them under control for one year or a short period of years. It is a long time between the seedling stage of a tree and the harvesting stage. The protection work must be complete and continuous in order that forests once started, may reach maturity.

That fire can be kept from forests is not disputed. In Europe, before the war, fire was considered as the least important of all the dangers to which forests were exposed. Fires can be kept from Pennsylvania forests also, but it will take time, work, and money. There must be education, organization, and cooperation.

There is no better time than the present for our people to consider the protection of forests from fire. The prosecution of the war made necessary the marshalling of every resource in order to equip and maintain our army, our navy, our commerce, the existence of our Allies, and very probably, our own existence. It has been discovered that in war as well as in peace, wood plays a most important part. It is still the common thing for the Allied Governments to call upon their people to "save and give," to practice "thrift," in every line of activity. It is not a good indication of thrift in Pennsylvania as long as it is possible for 380,000 acres to burn over in one year, as occurred in 1923, or 95,000 acres in one week in May of 1922.

Wood in various forms is needed at every turn and the tremendous demand upon our forest will continue for some time to come. The forests can meet the demand if properly cared for, but they cannot if they are to be continually subject to damage from fire. Forest fires must no longer be regarded as inevitable, unpreventable, and as accidents. They must be considered in their true light, namely that they are a curse which must be done away with, and the person or corporation who does not use every possible means to prevent damage while using fire must suffer because of the abuse of his liberty and of his neighbors' rights.

LESSON 17.

AN OUNCE OF PREVENTION

While it is true that it is the duty of the Commonwealth to take care of its own interests, both as a timber land owner, and because of the benefits of forests to society, it must be distinctly understood that the Commonwealth is made up of the individuals who live within its borders. The results of forest fires touch the life of every individual in the Commonwealth. It is the duty, therefore, of every citizen to do his share, not simply in the suppression of forest fires, but also in their prevention.

"Important as fire extinction is, greater stress must be placed upon fire prevention. The evil must be eliminated at its source."

"Safety First," efficiency, and conservation, are three terms that are upon the lips of the people upon all occasions. They are easily understood and appreciated. They are being applied to all phases of work, private and governmental. Efficiency commissions and the conserving of material and human wealth by national and state governments are in vogue. Although this condition exists, the people are not yet entirely awake to the foundation principle of these three

ideas. The best conservation of effort, time, money, resources, health, and life is expressed in the idea of the prevention of waste. The remedying of ills and the restoration of things which can be restored are noble actions, but many ills cannot be remedied and many resources cannot be restored. The prevention of accidents and of unsatisfactory conditions is wiser, cheaper and more far reaching than amelioration. The old saws "An ounce of prevention is worth a pound of cure" and "A stitch in time saves nine" are just as true to day as they were when first uttered. Efficiency implies "safety first" and conservation.

Forestry is one branch of conservation, and the protection of forests from fire is a part of forestry. Safety first in forest management is just as wise and just as important as in manufacturing or in railroading. It is, in fact, more so. Industries could continue without the safety first idea being developed very far, but forestry is impossible without protection from fire. Any system of forestry is doomed, and is the limit of inefficiency if forest fires are not suppressed.

It is a recognized principle that the Commonwealth has an important interest in the forests within its borders. But the peculiar relation with respect to ownership of property which exists under our form of government is rather difficult to handle. We hesitate to have the State tell us what to do with what belongs to us. In the majority of cases attempts to meet the problem have resulted in the purchase or retention of certain lands to be held by the State for forest management of one kind or another. Other efforts have been education, reduction of taxes, distribution of seeds and seedlings, and fire extinction. Usually the last effort has been the weakest one.

In Pennsylvania, more recent agitation for a proper care of forest dates from 1877, and an active State policy dates from 1893. The danger and results from forest fires have been recognized all the time but the idea that the prevention of fires should take the lead of all other moves seems even yet to be foreign to the majority of our people.

There are approximately 13,000,000 acres of so-called forest land in Pennsylvania. All of it is exposed to the curse of fire. An average of 300,000 acres burns over each year. Most of it is burned over once every ten years. No system of forest management can flourish under such a condition. In the face of this fact, no Commonwealth can provide for future welfare. The direct loss from these fires is close to $1,000,000 a year, and what the indirect loss is, no one can calculate. No people can forever suffer such a use-

less loss, nor is it sensible to expect them to. The mere fact that they do not realize their loss is no excuse for the State's permitting the condition to exist. Education must continue until every citizen knows how he is concerned.

LESSON 18.

SHALL WE PREVENT FOREST FIRES OR MERELY CONTROL THEM?

The earlier we recognize the human side of the forest fire problem, and exert our efforts to change it, so as to have it in our favor, the earlier the solution of the problem may be obtained. Of course, the forest will burn as long as trees produce leaves and branches fall to the ground and become dry as tinder. Some of the debris may be cleaned up and disposed of at a certain expense and to the satisfaction of some people. The fuel for fires can be regulated to a certain extent. The fire itself can be extinguished under even unusual and unfavorable conditions, but this work too, is more largely dependent upon human, than upon physical factors.

But how are fires in Pennsylvania's forests started? Spontaneous combustion may cause a few. Lightning causes a few—probably ten or twelve a year. The other 1,500 to 3,000 are caused directly or indirectly by the deliberate action of man. Of course, a few are started by irresponsible individuals. Unquestionably the prevention of fires is a human problem. Why does any individual with brains permit a spark to come into contact with highly inflammable, extensive and valuable property, as for example a forest? Perhaps psychology may give the answer. Common sense certainly will. But at any rate there must be a study of local relationship. The so-called careless fires do just as much damage as the intentional fires. Why are the people careless, or why do so many accidental (?) forest fires happen in spring and fall, and not so many in winter and summer?

How, then, can the minds of men be reached so as to change their attitude from one of thoughtlessness and indifference to one of carefulness, of community interests? Even without this change fire extinction, the physical operation, is not a difficult operation wherever force is available for the purpose. But in the majority of cases this means men, women, and boys with equipment. How is it possible to get this force? Was there willingness or unwillingness? Even though this force was present under duress, who exerted the pressure? Was it law? Who enacted the law, or who would enforce it? No matter from what angle you look at it, you face a human problem.

The only logical way we have of producing change in the human mind is by education. It is well to investigate and tabulate causes, but it is better to control and extinguish fires when they occur. To do these things there must be an organization large enough to cover the forest to be protected. There must be a head to the organization and sufficient help to keep it going. There must be inspection, and there must be a number of alert, interested, efficient men ready to do promptly, whatever must be done. Fires must be detected promptly, reported promptly, extinguished promptly. A force of helpers and sufficient equipment must be available at a moment's notice. Other details must be worked out and through all the details runs the human element that can't be avoided. The point of contact may be established by education, and education will result in prevention.

LESSONS

IN

FOREST PROTECTION

BY

GEORGE H. WIRT

Bulletin 35 (Revised)

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF FORESTS AND WATERS

Charles E. Dorworth, Secretary
Joseph S. Illick, State Forester

1927

"First learn, yourselves, the best considered plan,
Then teach the careless what their duties are,
And never more the running flame shall scar
These timbered hills, God's generous gift to man."

Douglas Malloch

LESSONS IN FOREST PROTECTION

BY

GEORGE H. WIRT
Chief, Bureau of Forest Protection
And
Chief Forest Fire Warden

Bulletin 35 (Revised)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
Charles E. Dorworth, Secretary
Joseph S. Illick, State Forester
Harrisburg

LESSONS

IN

FOREST PROTECTION

BY

GEORGE H. WIRT
Chief, Bureau of Forest Protection
And
Chief Forest Fire Warden

Bulletin 35 (Revised)

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF FORESTS AND WATERS

Charles E. Dorworth, Secretary
Joseph S. Illick, State Forester

Harrisburg

SURE

LESSONS IN FOREST PROTECTION

LESSON ONE

BURNING UP MILLIONS

In the forests of America, fires set by lightning or by Indians have occured since before the time of Columbus. Some of them burned over extensive areas. After the first settlers came forest fires were more frequent, notwithstanding the fact that most of the early settlers came from countries where it was a serious matter to cause a forest fire. But in this country, they found too many forests. Their enemies, wild animals and Indians, were in the forests. It mattered little to them, therefore, if fire raged unchecked. In fact it was felt that the forest had to be done away with.

Settlements increased and farms had to be hewn out of the forests. Trees were cut and piled for burning in clearings. Log rollings were made the object of festive occasions. The demand for wood increased as population and business developed. Wagons and ships had to be built to transport the products of the new land. Lumbering began and soon railroads were extended in all directions on a bed of wood. The opening of the forests and the slash left by the lumberman made unnatural conditions favorable to fires. There was a great accumulation of inflammable material ready to feed the flames started by someone's careless fire or by an engine spark.

In Pennsylvania, climatic conditions with the disturbed forest conditions developed two seasons of the year when forest fires became so

Worthless Growths Usually Follows Forest Fires

common that until recently it was generally believed that fire and smoke were a natural part of the seasons. Generation after generation has grown up with the impression that forests needed no protection. The line of least resistence has become ingrained with most people.

The result has been that millions of acres of forest land have been burned over and kept from producing a wood crop. It has been estimated that at least five million acres of forest soil in Pennsylvania have been kept in a waste condition by fire and that the annual loss to the Commonwealth has been as much as $100,000,000. Even now with a somewhat awakened public one quarter million acres burn over each year in Pennsylvania. It seems certain that more timber has been kept from reaching merchantable size, and consequently not available for use as a result of such fires, than was ever harvested in the Commonwealth by lumbermen. Verily we have been and still are burning up millions and bringing about very unsatisfactory living conditions without a thought for the future.

Now the forests are limited in extent. Of Pennsylvania's 28,000,000 acres of primeval forests, stocked with timber, in quality unequaled by anything found in the eastern states, there are now about 13,000,000 acres of woodlands. Only a few million acres have merchantable material upon them. The balance has only young growth and vast areas have nothing but brush of valueless species.

But with the decreasing area of the forest and the decreased crop on the remaining forest area, the demands for wood have increased untill almost four-fifths of the wood used in Pensylvania must be brought great distances from other states. In this way everything we use is more expensive because of the lack of a local supply of wood. The forest is no longer our enemy, but it is the most essential natural resource for our continued welfare. Therefore, our slogan must be "Prevent Forest Fires, It Pays."

LESSON TWO

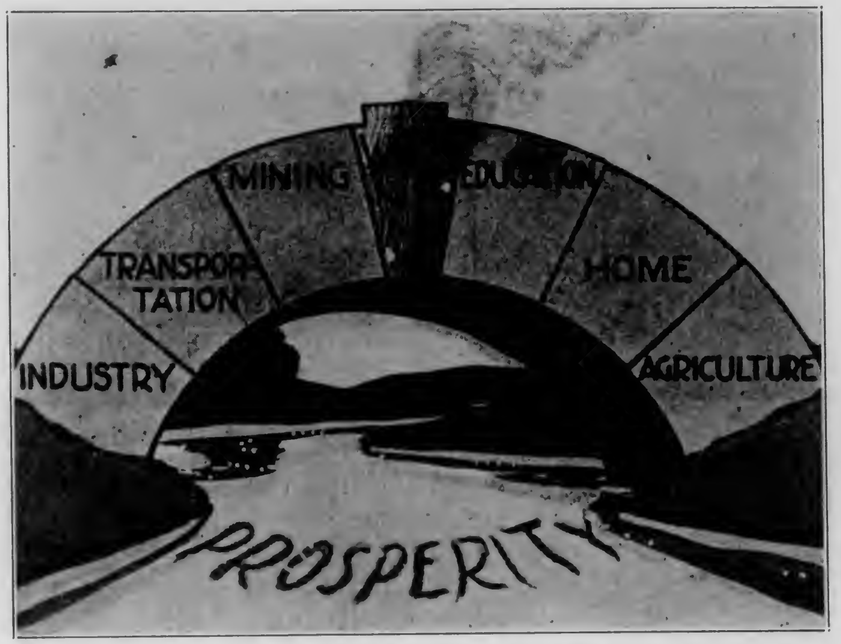
THE FOREST IN EVERY DAY LIFE

Our most essential every day needs are food, water, clothes, shelter, heat, labor, recreation, health, transportation, and education. You may never have thought about how the forest affects these necessities. Does it aid or hinder man in obtaining his needs? Does it furnish any of them?

In the early days, the pioneers got practically everything they wanted from the forest. Even now a considerable quantity of food products is obtained directly from it, as nuts, fleshy fruits, berries, grapes, maple sugar and syrup, honey, flavoring extracts, meat from wild animals, as well as many minor products. But the forest plays a larger part in our food supply because of its influence on the moisture supply of air and soil, which is beneficial to agriculture. The birds of the forest hold in check the insect hordes which would destroy all food crops if uncontrolled. Wood is used in the fences of the fields, the machinery and equipment of the farm and garden. Crops are gathered, transported and stored in wooden containers.

The forest is nature's reservoir and filter system to supply us with a constant and pure supply of water not only to drink but to fill our streams for power and navigation.

The forest also furnishes us with clothing. First comes the skins of animals, and the fur industry is still of considerable importance. Now all sorts of clothing are made from wood fibres. Likewise wood enters largely into the harvesting, marketing, and manufacturing of clothing made from wool, cotton, etc.



Without Wood the Arch of Prosperity Falls

The forest furnishes, dyes, wood buttons, wooden lasts for shoes, shapes for hats, and the tanning materials for the leather of our shoes, gloves, coats and other leather goods.

Needless to state that the forest has furnished us our shelter. Wooden houses are still most common in our country. Where brick and stone have been used for outside walls wood has entered most largely into the interior finish and equipment of our homes.

Our fuel comes directly or indirectly from the forest. Wood is a direct product of the forest. Coal is mined by using large quantities of wood for mine timbering. Electricity developed from water power kept constant by forested hills, is transmitted over wires on wooden poles.

The forests of any state furnish a large demand for labor. Eighty per cent of wood prices is made up of labor values. Likewise the forest areas with streams and game, beautiful quiet spots, trees and

flowers are constantly calling to our people to find recreation within their limits.

Forests influence beneficially the health of a community, because of their pure air, pure water, and facilities for recreation. Planted forests have changed a region of swamps, mosquitoes and malaria into a beautiful, healthy, prosperous and well inhabited community. Deforestation has changed populous regions into uninhabited wastes.

Transportation is essential for civilization and forest products are essential in minor as well as greater transportation activities, from the lowly sled to the most wonderful aeroplane. Railroads are dependent upon the wooden cross-tie; navigation still depends upon wood for ships, even in the steel clad liners. Most of the material shipped from one point to another is shipped in a wooden container of some kind.

Civilization is the result of commerce and of exchange of ideas. Our books are the products of the forests. Our ideas of each other, of religion, of patriotism, are determined by and kept alive by the books we read, and by the daily papers. Diminished forests are making these things more expensive. There may be a time when papers and books will be beyond the reach of the average individual resulting in wide-spread influence and a backward step in civilization.

It is, therefore, evident that the forest and its products enter largely into our every day needs. Everybody loses when timber burns.

LESSON THREE

WHAT THE FOREST DOES

The more we know about the forest and what it does for our welfare, the more we appreciate its presence and the more we will do to protect and perpetuate it.

The forest is a soil saver.

Every acre of land should be kept productive. The forest utilizes soil too poor to produce food crops. There are at least thirteen million acres of such land in Pennsylvania.

A forest increases the value of bare soil by the production of a crop with very little labor, and thus bears its just share of taxation, tending by so much to reduce the taxes on farm lands.

A forest increases the fertility of the soil on which it grows and prepares it for agricultural use when needed for that purpose.

The forest is a renewable natural resource.

It uses the productive powers of nature and furnishes a timber crop. The parts of trees, leaves, branches, bark, stem, roots, sap, and fruit enter into the necessities, comforts and luxuries of each citizen's every day life.

The forest insures continued prosperity.

To supply these products capital and labor must be employed. There must be machinery, transportation, exchange, and research.

THRIFTY FORESTS WILL GROW UP IF FIRE IS KEPT OUT OF THE WOODS

The development of a natural resource usually means the establishment of a local population, wages, demand for local food products, and general increase in business and prosperity of the community.

It provides homes for insectiverous birds which hold insect hordes in check.

The forest is a water conserver.

A forest increases the relative humidity of the atmosphere nearby, benefiting agricultural and horticultural crops.

It raises the water table of the soil in hill countries to the advantage of food crops nearby.

It reduces evaporation of moisture from crops and soil to the leeward side thus saving food crops.

It tends to induce rains during the growing seasons, and tends to reduce frost damage to crops.

The forest cover prevents the packing and erosion of soil, and also retards the surface run-off of rain and melted snow.

It changes rainfall, snow, and other precipitation from surface run-off to under ground flow, thus regulating the flow and purity of water in springs and streams.

It helps to lessen the frequency of floods and to lower the flood stages of streams.

The forest provides recreation and health.

It furnishes favorable conditions for game and fish, and for the sport of hunting and fishing. It supplies the factors which make a beautiful and healthful country.

It reduces the extremes of temperature in both summer and winter.

In fact it furnishes food, water, clothes, labor, recreation, health, wealth. An old German proverb has it that "The care of the forest brings all blessings." Certainly for Pennsylvania, forest protection, regulation and wise use mean continued prosperity.

Forest destruction means economic suicide.

~~LESSON FOUR~~

W~~HAT FOREST FIRE DOES~~

This is the season of forest fires.

~~The factors determining the extent of damage done by forest fire are general or climatic conditions, and local conditions.~~

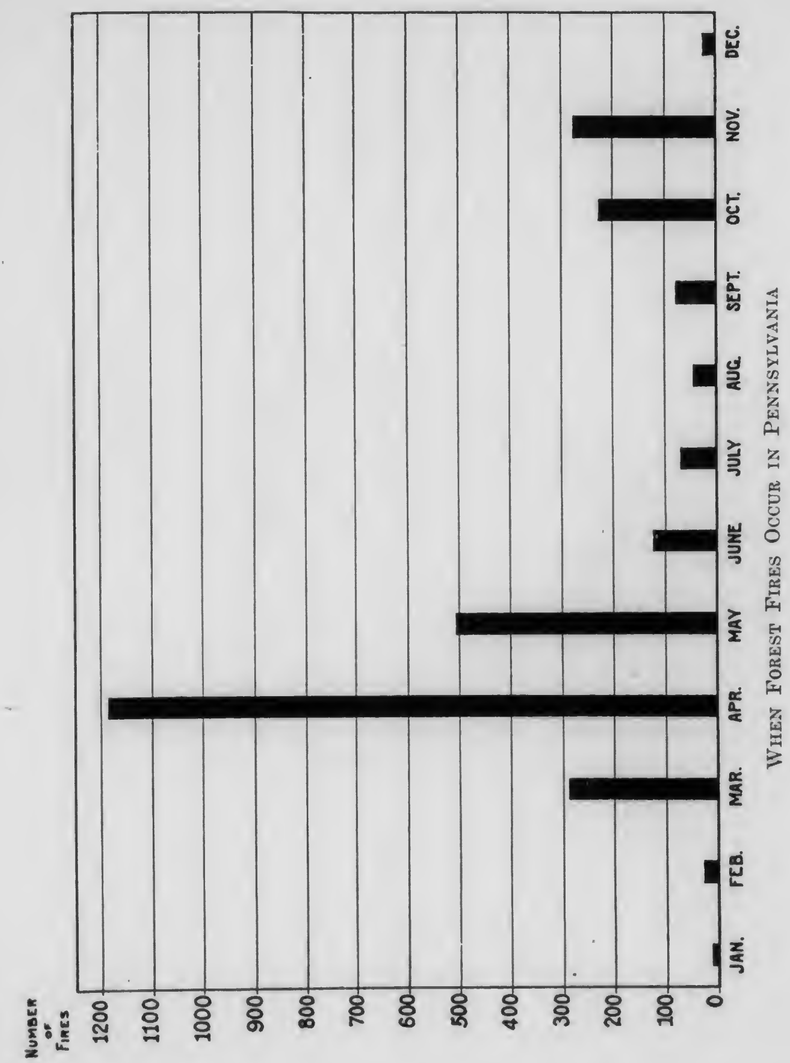
~~*Climatic conditions.*~~ The amount of damage done by fire in the forest depends to a great extent upon the season of the year in which it occurs. It has been found that the living parts of trees are most sensitive during the early part of the growing season when active cell division is taking place. Surface fires in April or May are likely to kill hardwoods which would escape injury from a fire of equal severity in the fall.

The spring fire season begins with the disappearance of snow and the first drying out of the surface leaves. In the hardwood or mixed forests the forest floor is exposed to sun and wind until vegetation is far enough advanced to protect the moisture of the floor from evaporation by these two forces. After the leaves are out and several good rains have again soaked the floor there is little danger. In autumn, when the dead leaves fall, the same drying effect of sun and wind is active and continues until fall rains and snow have packed the new layer of leaves and soaked the forest floor with moisture.

During periods of drought, conditions of air, surface litter, and growth combine to produce a severe fire and considerably more damage is done than during times of even average atmospheric moisture.

Strong winds not only cause a more rapid spread of fire, but increase the severity of the fire, and may change surface fires to crown fires. In local areas an up hill wind may cause much more damage than a draft down a valley. High winds may produce favorable conditions for a fire within a very short time after a heavy rain during the fall and spring fire seasons.

The amount and kind of soil covering also help to determine the damage done. The greater the amount of litter, grass, brush, etc., and the more inflammable it is the more severe the fire.



When Forest Fires Occur in Pennsylvania

Certain species are more liable to damage than others. Conifers are damaged more than hardwoods. Resinous species especially are liable to crown fires. The stems of species exuding resin from the bark catch fire quickly and carry it into the crowns. The resin adds to the intensity of the fire, as in the case of balsam fir, spruce, and white pine. When conifers are killed above ground, with but a few exceptions as pitch pine, they will not grow again.

Smooth barked species as beech, and thin sapped species as tulip, are especially liable to fire damage. Species with flaky bark are likely to suffer. Shallow rooted species may be killed by the burning humus injuring the roots, or simply by the exposure of the roots.

Hardwoods are likely to have crown fires only in thicket or pole stage, or in dense stand when dead or new leaves are on the twigs.

The amount of damage varies greatly according to the age of the woods. In old timber the soil covering is usually scantier than in young wood, consequently there is less fuel and less damage. Surface fires usually burn more slowly in old timber because protected from the wind. As trees grow older the bark of most species grows thicker and more corky. It is a non-conductor of heat, hence it protects the cambium from being scorched. Even to such trees every fire does some damage and a severe fire or frequent fires will kill them. Young seedlings and coppice growth of most species, and even poles of some species are killed by very light fire.

Necessarily the kind and severity of the fire will influence the resulting damage. A fire in one tree does little damage unless it becomes the means of starting other kinds of fires. Crown fires are destructive because the burning of the foliage usually results in the killing of a tree. Even in hardwoods the leaves, buds and twigs are so badly scorched that death results. In many cases the finer twigs are consumed. Under-ground fires kill everything in their path, by killing or consuming roots, by exposure of roots, or by removal of material from on top and around roots so that it is only a matter of a short time until the trees are blown over by wind, or gradually die. Surface fires vary in their efforts from slight injuries to complete destruction, depending upon their severity. ~~Living tissue is killed when heated to 54°C. (129.2°F).~~ If under-bark is brown or black, after a fire, it is an indication that the cambium layer is dead.

Climatic conditions may not be changed, but local conditions may be very much improved by the removal of unnecessary debris and by the opening of roads and trails. ~~It pays to prevent forest fires.~~

LESSON FIVE

A HERITAGE DESTROYED BY FIRE

Few people realize the *amount* of *damage* done by forest fires because they do not take time to go into detail, to follow from cause to effect, or to trace back from effect to cause. There are direct and immediate losses, but there are also indirect and future losses. The latter are more difficult to analyze and to appraise, but nevertheless, are usually far greater than the former.

Fire injures growing timber. When the trees are large, the bark heavy, and the fires light not many trees are killed and perhaps only a few may be injured. But with heavier fires or lighter bark the damage increases. The removal of the litter and humus from the

soil may be sufficient to injure the roots, or to scorch the cambium layer at least partly around the tree. On the leeward side of trees the material burns a little longer by reason of the trees' shielding the fire from the wind. Debris frequently accumulates on one side of a tree more than on another, especially on the uphill side. In this way the trees are partially girdled, bark drops off on one side of the base, insects and fungi begin work, and succeeding fires continue to eat into the tree and finally destroy a good part of it or kill it. It is subject to breakage by sleet, snow or wind.

FIRE-SCARRED TREES MAKE POOR LUMBER

The removal of the humus, as mentioned before, either by one or more fires will weaken the vitality of the tree because of changed soil conditions. The blossoms and fruit may be injured directly or indirectly by the fire. Trees of weakened vitality are always more subject to insect and fungi attack even though the bark is not broken.

Not only is the rate of growth retarded in trees injured by fire but the quality of the wood produced, and the quantity finally harvested are also reduced. Though a tree may have sufficient vitality to cover a fire scar, nevertheless the defect is still there and in the majority of cases, it grows with the size and age of the tree.

When the injured tree is cut there is considerable loss due to heart rot, strain, wind shake, etc. This is particularly so in sprout forests.

~~*Fire kills growing timber.*~~ As noted above, if a tree is girdled by the scorching of its cambium layer or of its root, it dies. Fire thus kills a varying proportion of the stand through which it burns, but especially the small growth, and the sensitive species. Trees that are

not killed immediately, die later as a direct result of the fire. Recent plantations are therefore, liable to destruction by fire and demand extra means for protection. If this cannot be given them it is taking a great risk to make them.

Such damage to standing growth results in an immediate loss made up of several items.

1. There is the loss of dead trees of merchantable size which, for various reasons, cannot be marketed while still sound, or which decrease in market value by reason of some delay before harvesting.

2. The loss of value occasioned by the marketing of material not yet grown to the size which would yield the highest value per unit of measure.

3. The loss in final cut which must be expected if injured trees are permitted to stand until they reach what would otherwise be a merchantable age.

4. There should also be considered the fact that there may be and usually is some expense connected with the inconvenience of harvesting before maturity or of harvesting a smaller crop at the proper age for maturity.

Fire destroys seeds, small seedlings, and sprouts. Upon the forest floor, mixed with leaves and humus, and preserved by the latter, are many tree seeds of various kinds waiting for favorable conditions to germinate and grow into trees. In most places where stock and fire have been kept out of woodland for several years, thousands of young trees have started to grow either from seed or from roots, but they are hardly noticeable. Fire destroys all of these as a very small amount of heat will destroy the germ within the seed, and cook the life out of the tender plants. Even the lightest fires do considerable damage in this way, destroying the germs of prospective forests. ~~On the basis of the value of seed or seedlings for a new crop of trees after the older growth was removed, it can be figured out that this loss amounts to from $3.00 to $10.00 per acre.~~

By reason of these three effects of forest fires, repeated burnings may change entirely the character of a forest in almost all of its phases, or forest conditions may be destroyed totally. The better species of trees may give place to fire cherry, quaking aspen, birch, or other light winged and inferior species. All tree growth may give place to scrub oak, sweet fern, huckleberry, bracken, or common herbaceous weeds. So it is reasonable to say that forest fires destroy forests and the possibilities of future forests.

LESSON SIX

THE FOREST FIRE FIEND

Forest fire destroys not only present and prospective tree growth but also destroys other values of immediate importance.

Fire causes the loss of felled timber. Felled trees represent time and money. The further the process of manufacture is carried the more valuable the product. Every year thousands of dollars worth of logs, bark, cordwood for various purposes, ties, poles, posts and sawed lumber is destroyed. The workman may be out his wages; the owner may be out the wages paid and the profits; the user must so much the sooner pay a higher price for his wood because the supply is decreased by just so much; the Commonwealth at large suffers because property is destroyed, everybody concerned is made poorer, and no further wages, taxes, or use are possible.

A Logging Operation Where a Forest Fire in two Hours Swept Over two Million Feet of Timber. Besides the Loss in Logs, Many Cords of Tanbark Were Destroyed

Fire causes a loss to equipment for forest operations, to live stock, to farm crops, to various buildings, fences, etc. Every year the timber operators lose a great amount of property of various kinds, by reason of forest fire. Figures on this loss are hard to obtain, but if the value of mills, engines, tools, buildings, tram roads, etc., completely or partly destroyed by fire were known it would surprise the

lumbermen themselves. The same thing is true of the loss to farmers and owners of property adjoining woodland. The individual loss may or may not be large in any one instance, but when such losses are totaled it soon amounts to unbelievable figures.

Fire in the forest causes the loss of homes. Not infrequently have forest fires furnished the spark that burned the homes and possessions of families living within or near the forest. In cases whole towns have been dangerously threatened, and in some instances completely consumed. The stories of some of the northwestern fires are heartrending and the loss cannot all be included in a tabulated inventory of property destroyed.

Fire causes the loss of human lives. The fire which starts from someone's brush pile or careless act may be the direct cause of snuffing out any number of human lives, as witness the results of many of the awful conflagrations of the West, of Canada, and of some few in the East. The recent fires in Minnesota and Wisconsin took a large toll of human life and will go down in history among the horrible catastrophies resulting from someone's thoughtlessness. But here again the loss cannot be counted in dollars.

Fire destroys game and fish. Spring fires, especially, are fatal to young animals of all kinds, and many eggs of game birds are destroyed. Not infrequently both spring and fall the water of some of the small streams has been heated sufficiently to kill fish. By destroying the factor which largely regulates the steady flow of streams and by making the banks of streams bare of their natural protection fish life is seriously affected. The Secretary of the Pennsylvania Game Commission states that forest fires do more to destroy game than all other forces put together. ~~The Pennsylvania Fish Commissioner states that the native brook trout of the East is almost a thing of the past because the waters are too warm for it. The California trout is being planted instead.~~

Fire causes a decrease in insectivorous bird life. Insectivorous bird eggs and young birds are destroyed directly, especially the ground and low nesting species. By reason of frequent disturbance birds are driven away from a region of forest fires. By the destruction of the forest and the making desolate of hills, conditions favorable to bird life are destroyed and birds become scarce. Scarcity of birds adversely influences agriculture.

~~*Fire causes the loss of bee colonies.* This loss may or may not be small but it must be remembered that bees are of value in the production of seed crops and of a valuable food product.~~

Fire destroys the beauty of a region. The beauty of certain regions is responsible for bringing to them millions of dollars each year. Green forests covering mountains and keeping the streams steady and clear are the most important factors in the maintenance of this asset. Fire promotes desolation rather than life and beauty. A fire swept region is anything but beautiful.

LESSON SEVEN

THE CURSE OF THE FOREST

There is still one more thing which we shall mention as being directly destroyed by forest fire, but in final analysis the indirect losses resulting from its destruction are far greater than the immediate ones. It is like killing the goose that lays the golden eggs.

Fire destroys wholly or in part, the litter and humus which form the forest floor. Light fires burn some leaves and small branches. Heavier fires burn everything down to mineral soil or rock. In some cases, the fire even follows roots and other vegetable matter into the soil.

Destructive Forest Fires often Leave Little More Than Bare Soil

A fire which consumes only the material above the general level of the soil is called a *surface fire.*

A fire which burns beneath the general surface level, as in old swamps, or on areas where the soil is filled with a mass of roots and other vegetable matter, as in bracken or huckleberry regions, is known as an *underground fire.*

It is well to remember a few of the most important functions of a natural forest floor:

(a) Forest litter and humus are a mechanical hindrance to the run-off of precipitation, allowing water to reach the stream slowly.

(b) Humus absorbs and holds rains and melted snows, giving it to the soil for underground supply which feeds springs.

(c) Humus keeps the soil open summer and winter permitting it to take moisture rapidly.

(d) Litter and humus act as a mulch preventing rapid evaporation of soil moisture.

(e) Humus keeps the surface soil fertile, which helps to make good tree growth.

(f) Humus protects the soil from erosion.

Changing humus to ashes eliminates all of the above benefits. Floods, erosion, irregularity and impurity of water supply, both for home supply and for power, and all the calamities attendant upon these conditions are the results. This loss cannot be determined because there is no way in which all the facts can be tabulated. Inconvenience, sickness, and death cannot be appraised in dollars and cents.

From the standpoint of forest growth and continued forest production, the humus is very valuable. In silviculture (the production of a forest crop) the efforts of the forester must always be directed toward a most "Careful preservation of the productive powers of any given locality, so as to render possible the production of the same effect, or even an increased one, regularly and indefinitely.

"Experience has shown that in forestry the safest method of preserving the productive powers of a locality consists in maintaining uninterruptedly a crop of forest vegetation on the area. The more frequently and the longer the ground is uncovered and exposed to the full effects of sun and air currents, the more, in the majority of cases, is the productive power liable to be reduced".[1]

The active agencies of the locality depend upon the nature of the soil and climate. Man can do little toward regulating the local climate, but he can control to a great extent the soil factor of his locality. "Water is the most important component part of the soil",[1] and next to this are its physical properties and then its available chemical constitutents. Almost any soil can furnish a sufficient quantity of mineral substances for the production of a crop of trees, provided the leaf mould (humus) is not removed. To insure a favorable condition of the physical properties, should be the forester's chief aim, and this he can do best by preserving the humus, especially on poor soils, and those of medium quality. "The poorer the soil the more important is the preservation of the humus, providing it is not acid".[1] Indeed, "humus forms the most important factor relative to tree-growth, and is a priceless treasure as regards the production of woodland crops".[2]

1. Schlich's "Manual of Forestry," Vol. I.
2. Gayer's "Waldbau"

In foreign countries where the right to remove litter and humus has been acquired by the people neighboring upon a forest, the restrictions are rigid and experience has shown it to be so harmful to productiveness of the soil that forest owners are buying the rights as rapidly as possible.

The opening of the forests and the removal of humus by fire bring about conditions which make it easier for fires to rage. Each successive fire makes conditions more favorable for the next until in time everything of value is destroyed and desolation results.

It does pay to prevent forest fire.

LESSON EIGHT

EVERY MAN'S ENEMY

Forest fire is a force which does immediate damage. If uncontrolled there is no way to tell how much damage may be done. It may result in a holocaust as in the West or in Canada. But the indirect damage from forest fire is far reaching, of inestimable amount and yet its effects are so insidious that few of us place the blame where it belongs. No forest means no water; no water means no agriculture. Then come floods, drought, pestilence and death.

Loss of soil productivity. The death of a number of trees in a stand of any age results in the opening of the canopy and the density is destroyed. This in itself exposes the floor to sun and wind and a more rapid disintegration of humus results. When there is added to this condition the removal of the litter or humus the soil is so much the more exposed and deterioration of soil qualities takes place rapidly. On the more humid soils, grass, weeds and brush grow up robbing the remaining trees of much nutriment and moisture. On the poorer, or sandy soils, sand drifts may be started. On practically all slopes leaching and erosion begin.

The loss of soil productivity is shown in a decreased annual production, a decreased yield at a given age, or by the requirement of a longer rotation age for the trees to reach a specified dimension or to yield a specified volume. In other words a forest on a certain soil is capable of producing a certain amount of material per year, or in 100 years. It is run over by fire once, or periodically. How much less is produced? The difference in value of the products from the unburned and burned areas is the amount of loss resulting from forest fires.

Increase in number and damaging power of many injurious kinds of insects and fungi. These attacks follow quickly after fires. However, there may be no indication of such trouble until several years later and the attack appears to be almost instantaneous. The insects find breeding places in foliage, stems, stools, and roots of growth weakened in consequence of being scorched by fire. Fungi enter at

scarred bases and at other points where the bark is broken either by expansion or by breaking branches.

Modification of past stands. As noted before there is a modification of growth conditions even after one moderate fire. Less resistant species are killed and the number of species is reduced. Sprouts take the place of seedlings. Whatever seed happens to be exposed or finds lodgment on the area is likely to germinate and become established. Winged seed species especially are likely to come in. The crop after fires varies in different localities. There may be birch, aspen, bird cherry, scrub oak, or by chance some valuable species. Species requiring protection from sun, drought, or frost in their early stages cannot regenerate until some nurse crop is established.

Extra expense and difficulty of reforesting burned areas. The exposure of soil results in a dry condition which limits the success of artificial regeneration. The exposure is severe upon the young transplanted seedlings. The grass and weeds which develop compete with the young seedlings for moisture and food. The lack of humus in the soil delays the growth of the seedlings which do become established.

A Forest Fire Swept Over two Million Feet of Timber in This Logging Operation. Besides the Loss in Logs, Many Cords of Peeled Tanbark Were Destroyed

On other sites the debris may handicap the planting operation to such an extent that the number of trees planted per man may be reduced over 50%. And last but not least, the debris is likely to be

fuel for the next fire and furnish the heat with which to kill the whole plantation.

Miscellaneous. We have already mentioned the indirect results on stream flow, erosion, and health. There are still such effects as the decrease of labor by reason of the lack of a natural resource, decrease of taxes upon land which ought to be producing a revenue and the consequent rise in taxes on that land which is producing, the scattering of the population of a township or county, the general decrease in land value in such cases; the local inconvenience of wood scarcity, the increased cost of wood products, the bearing on such questions as the housing of city dwellers and other economic and welfare problems.

To sum the whole matter up briefly, FOREST FIRES ARE CALAMITIES. They destroy great values without the least compensating benefit, and the trail of loss in wages, industry, taxes, revenue, prosperity, sport, health, comfort, and even life, leads to every home in the land.

LESSON NINE

A FOREST FIRE*

"Long before I reached the fire I could feel the heat in the air, could see the rolling smoke waves on high, and could hear the crackle and the crashing and the crunching of falling tree-trunks. Birds in alarmed flight winged ahead of the danger. Small game, squirrels, chipmunks, rabbits, and groundhogs, were getting out of the way and were heedless of man. There was an even increased activity and excitement among the bugs. I never saw such swarms of Camberwell beauties, banded purples, angle-wings, swallow-tails, tortoise-shells, and dog-faced sulphurs. Deer clung to the shores, ready to take to the water. Bradshaw reported a big bull moose hanging out with his cattle, as if sensing comparative safety near to man. The fire caught a lot of pestiferous army worms and destroyed no end of vermin in its course.

"The fighters had brains and willingness and courage and resource, but we had nothing to fight the fire with. There wasn't a drop of water nearer than the shore. The main fire front was over two miles long. It would take an ocean to conquer it. The trail was rocky. We had shovels, picks, hoes, rakes, and axes. We could not get a shovelful of non-combustible soil. All we could do was to whip at the fire with bundles of green withes. Bradshaw said that it would not run through a certain big green alder swamp, which would help check it. When the fire reached those alders, there was a hissing of a million serpents' tongues, and then a frying, sizzling sound as of the broiling of countless earth demons, and the alder swamp became blackish

*By Chas. S. Osborn. With permission of "The Outlook".

ashes on the ground. On came the fire. It consumed every particle of the covering of the rocky land, leaving it as bare, except for ashes, as when it left the bosom of the glacier that bore it. When it got to the trail, we could only make a brief resistance, that was more futile than the prattle of babies. Then we had to run for it or roast. Long before the ground fire got to the trail the aerial of flames and cinders had passed over us, igniting the forest beyond. There was nothing to do but pray, and there was a mighty lot of praying. The Indians said if Chief Mendoskong were alive and White Loon, the medicine man, was not dead they would make it rain. Even Greensky, who had been a famous rainmaker, had gone to the land of crippled deer and tame beaver. There was no hope.

A Forest Fire Starting on its Way of Destruction

"Only one thing can prevent forest fires: education of the people to a point where they can appreciate the danger and will practice adequate care. I have known careful woodsmen to start a tea fire on a rock shore covered with fibrous roots and dusty ligneous substance and use plenty of water in an attempt to put it out before they proceeded. But the fire had eaten its way inch by inch between rock and soil where it was hidden and where the water did not reach it, only to burn through later and destroy miles of growth. So one must be very, very careful where he builds a fire in a dry time and more careful still about putting it out.

"When forest fires reach their maximum, they are more than terrible in their fury. The very air seems afire. There are those who

believe that the air decomposes at a certain heat and that the gases ignite, forming an atmosphere of liquid flames. In the Peshtigo fire the flames appeared to jump forty miles through the grimy air. In that holocaust a queer thing transpired difficult of physical explanation. A new house, partially completed and in course of construction, located near the center of the town, was not even scorched. Not an ember was otherwise left. Some sort of cold air zone formed around the house, like the air pockets encountered by aviators or somthing similar. Anyhow, there was this freak case.

"There is such a thing as the air being so filled with carbon that it burns in advance of a gale of fire. I have seen and have run before forest fires that were advancing with hurricane swiftness through the top of trees. The tops half-way to the ground would melt in the sea of flame like soft lead bars in a furnace. These would intensify the more slowly advancing ground fire until everything in its path would be consumed and melted, even the rocks themselves. Once some of my men in my absence, took refuge on the summit of a bare mountain of stone. They were suffocated by the hot air. During the historic fires in the 'Thumb of Michigan' people descended into wells to escape, only to be caught like rats and asphyxiated. Dozens of corpses were pulled out of wells.

"Nothing is so terrible as a fire in a great forest in a dry time. More timber has been burned than has been lumbered. There never was a greater menace to the only great fringing forests remaining in North America. These great zones of wild life are on the way to becoming treeless, birdless, and waterless unless we save the forests at least in spots. Not flood, nor storm, nor famine, nor earthquakes, nor volcano, is more destructive than wild fires. We must become a Nation of fire wardens.

"Will you help?"

LESSON TEN

KINDS OF FOREST FIRES AND HOW THEY BURN

Fire in the forest may assume one or more of the following characteristics: those of a stem fire, a surface fire, a crown fire, or an underground fire.

A stem or tree fire is one in which a single tree is affected, and the fire is extinguished before it has spread to adjoining litter or to other trees. Such a fire occurs usually in a dry snag struck and ignited by lightning, or ignited by a spark from a nearby engine; or in a hollow tree set on fire by some unsportsmanlike hunter to smoke out game, or in a bee tree in order to smoke bees.

Stem fires are dangerous because the wood of the tree is usually partly decayed, the hollow tree acts as a flue, the great draft causes many sparks to be given off and these may be blown great distances.

Stem fires when not extinguished gradually spread to adjoining litter or the wind driven sparks start surface or crown fires, or even an underground fire.

Tools Used in Fighting Forest Fires

Crown fires are those where the flames consume the leaf canopy formed by the crowns of the trees. They may develop from surface fires, in fact they usually do. Further they are usually accompanied by surface fires. Conifers are more subject to such fire, but young hardwoods with new or dead leaves are also liable. Thicket and pole stages are most likely to suffer in the East, especially new coniferous plantations.

Crown fires occur when the wind is high and the woods are very dry. The strong draft carries sparks far ahead starting new fires either crown or surface. The general shape developed is that of a "V", although the same factors influencing the shape of a surface fire affect the development of a crown fire. Without a wind, however, crown fires are practically impossible.

The rate of progress is ordinarily from two to three miles an hour or in extreme cases, six to ten miles. It depends upon density of crowns, regularity of heights of trees, and of species. An admixture of non-inflammable crowns or a belt of hardwoods may entirely break a crown fire.

Underground fires are those which burn beneath the general surface of the soil. They occur where the mineral soil is covered with an

accumulation of vegetable material, and, on account of its peaty character, burn more slowly than surface fires. They are common in the northern woods where fallen leaves, needles and other debris decomposes very slowly and a deep layer of partly decayed vegetable matter accumulates. Sometimes this may be two or three feet deep. Sphagnum swamps, dried up lake basins, and areas covered with a dense mass of bracken and ericaceae roots are also likely to be visited by ground fires. When this material becomes dry it burns slowly but with intense heat and is difficult to extinguish. Ordinarily they will not cover more than a few acres a day. They may be accompanied by a surface fire, or even a crown fire, and may develop from either.

In Pennsylvania most of our forest fires are surface, or brush fires. A few are stem fires, resulting in surface fires, and only in periods of severe drought do we have a crown or an underground fire.

LESSON ELEVEN

KINDS OF FOREST FIRES (Cont'd.)

THE SURFACE FIRE

A surface fire is one which passes over the surface of the soil and feeds upon dead foliage, dead weeds, dry grass, dry moss, and scattered inflammable debris littering the ground, also occasionally brush and small trees. A part or all of the litter and humus which make up the forest floor is consumed and quickly changed from its organic form to ashes. If the fuel on the ground is sufficient a surface fire may develop into a crown fire, especially in young coniferous stands.

The manner of burning, the form of area burned over, the rapidity of progress, and the intensity of the fire, depend upon the following factors:

1. Character and quantity of inflammable material.
2. Topography.
3. Character of soil.
4. Condition of atmosphere.

A surface fire on level ground and with all factors constant, is at first a small circle of flame, gradually spreading in all directions. If the least wind is blowing it burns more rapidly in the direction toward which the wind is blowing. If no wind was blowing at the time of starting it is not long until the fire itself creates a draft and it travels most rapidly in the direction of the draft. More or less of an oval form is assumed and sooner or later a V shape.

The side lines develop at an angle with the wind or draft and burn more slowly. If much wind is present the windward side may die out entirely. As the factors vary, the shape of the fire varies according to the resultant of their forces. As for example the apex or head

may be acute or broad, according to wind, fuel, or slope. A change in topography or in wind may result in the development of several heads, or "headers".

Other things being equal the severity of the fire depends upon the quantity and kind of fuel in its path, but necessarily the amount of moisture in the material determines the amount of fuel available for the fire. Dry material will burn readily and the heat from this fuel will dry out additional stuff rendering it inflammable. But the heat may not be sufficient to dissipate the moisture from all the litter, consequently a part may be saved and the severity of the fire lessened to that extent.

The accumulation of undecayed leaves depends upon the species, season, soil, exposure, and length of time since previous fire or litter removal. Species having large crowns and large leaves, as maples and oaks, make a heavier litter than ash and birch. A layer of resinous needles burns more rapidly and with a hotter fire than does a layer of hardwood leaves.

Boy Scouts Receiving a Lesson in Forest Protection

In some forests there is a varying amount of dead wood made up of standing dead trees or snags, fallen trees, dead branches, slashings, or the debris of previous fires. Any of this material in a dry condition means additional fuel and greater severity for a fire.

A surface fire runs up hill rapidly because heated air currents draw flames upward and more fuel is exposed at the same time to the heat of the fire. After passing the crest a fire travels slowly in its de-

scent on the other side. On extensive level ground, fires burn more uniformly, gather greater volume, generally do more damage and extend over a larger area than in rugged topography. Abrupt walls, narrow ridges, ledges, etc., tend to check fire and prevent its gathering volume.

Any influence which tends to dryness increases the intensity of a fire. Southern and western slopes are apt to burn more severely than others because of warm and dry exposures. The southern slopes have more sunlight and heat and the western slopes are exposed to the prevailing winds. Sand soils warm up and dry out readily and fires are apt to be severe.

Generally the greater the velocity of the wind the more rapid the progress of the fire. A steady wind makes a more severe fire than one which is gusty or intermittent.

Fire is more severe and rapid when the atmosphere is dry, as in the hottest part of the day when fanned by a dry wind. Moist atmosphere retards a fire, as in the night when air is damp and heavy, and there is little wind.

We have little data of value upon the subject of the rapidity with which surface fires travel. In the East, surface fires may travel before a high wind and up a slope as fast as a mile in three minutes, or twenty miles an hour, but in broken country and in varied growth, surface fires seldom travel more than five to eight miles in twenty four hours. In coniferous forests of the West they are said to travel as much as ten miles in twenty-four hours.

A great many surface fires occur on what is known as brush lands. The growth consists of sprouts of tree species and brush of various kinds, as scrub oak, bird cherry, aspen, laurel, etc. Oak especially is apt to hold a number of old dry leaves, both during the fall and spring fire seasons. Surface fires running through such growth set fire to the leaves and in a number of cases burn everything. Or if the brush are not consumed the heat is sufficient to kill everything down to the ground. This kind of growth is usually found on areas previously burned and in about 3 years it develops sufficient fuel to entirely kill everything again.

In young growth just after the leaves have opened in spring, surface fires are likely to cause the burning of the new foliage and a very fierce fire results, accompanied by a great amount of dense smoke.

LESSON TWELVE

HOW TO FIGHT FOREST FIRES

There are many methods of fighting forest fires. Some are good and some are not. A good Warden is always ready for useful suggestions, and is willing to give them fair trial. Methods of fighting vary with the character of the fire, type of the forest, condition of

the atmosphere, strength and direction of the wind, rapidity of the fire's advance, topography and material on the ground.

TREE FIRES: These are stopped by shutting off the air which makes a draft through the hollow trunk. Close the hole at the ground if possible with dirt. If this cannot be done, the ground around the burning tree should be cleared, and the tree should be felled. The fire can then be smothered inside and outside the tree. If water is available, the fire may be put out with force pump or sprayer or chemical extinguisher without felling the tree. Dead snags in forests should be felled as a matter of fire prevention as well as for the benefit of the forest.

UNDERGROUND FIRES: These fires can be stopped only by digging deep enough to prevent their spread. The ditch, as well as the surface should be flooded if possible. This, however, is seldom possible. Where a soil fire has a good start it may be cheaper to blast a ditch than to dig one. Well-placed dynamite will do effective work in a short time.

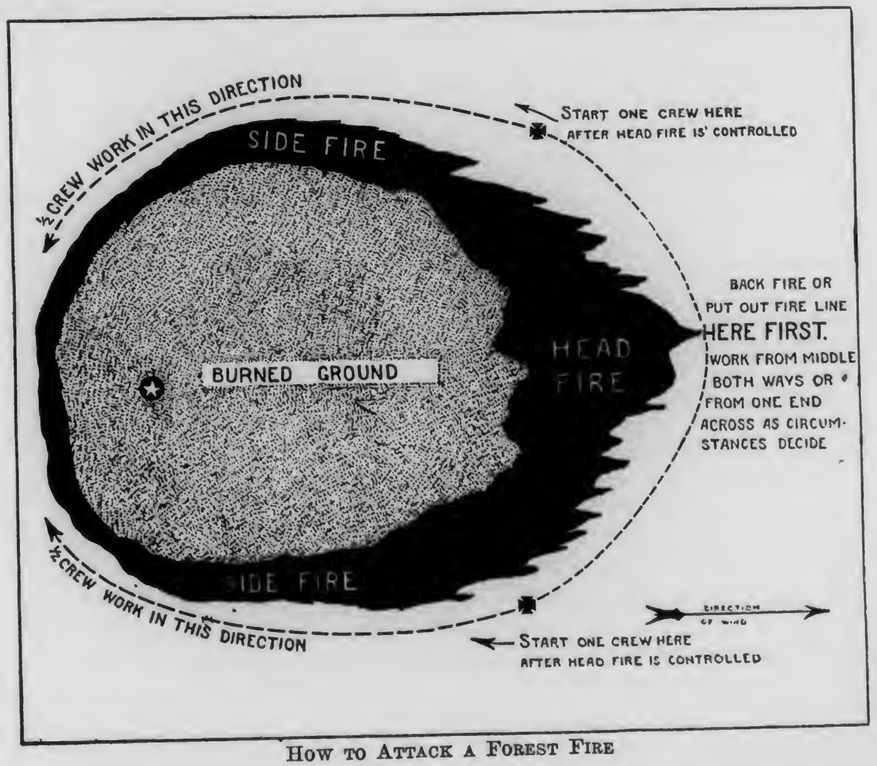
CROWN FIRES: We have few crown fires in Pennsylvania. Natural conditions as to topography and growth which serve as a check are the most effective means of stopping any that may occur.

SURFACE FIRES: This is the kind of fire which occurs most frequently in Pennsylvania. If there is little wind the flames may be put out by beating with branches (pine preferred), shovels, and wet burlap. Fire fighters should beat the flames with a side sweep toward the fire to avoid spreading sparks. The burning material may be pushed back upon the burned-over ground with brooms, rakes, sticks, forks, or other tools. The idea is to separate the burning material from that not yet afire. Water is always effective, but too frequently dependence is placed on it and when it is not available fire fighters seem to be at a loss to know how to make their attack. The fire can be smothered by throwing on dry or moist sand or dirt. If it is possible to plow, a furrow may be thrown up quickly to restrict the spread of fire. If no trail is cleared to the bare ground entirely around the burned area, here and there small pieces of smouldering wood may be fanned into flame and the fire may again break out. The only safe practice is to make a clean trail with exposed mineral earth entirely around the burned area.

Chemical extinguishers are sometimes used. Careful tests have been made by foresters and it has been found that the chemical spray is of no more value in the woods than is plain water with a little force back of it. This force can be supplied by a foot pump, or by air pressure, as in the ordinary fruit spraying devices. Sprinkling water in front of the fire reduces the force of the flames and permits close beating and raking. To be effective, considerable water is required when it is sprinkled directly on the flames. Water is used to the best advantage when the stream is thrown at the ground immediately in front of the flames. The water and force combined will stop the

flames' advance. It is also satisfactory to spray water against the base of the flames from the rear particularly if there is much smoke.

BACK-FIRING: When the wind is strong or when the flames are in slash, fallen logs, dead ferns, bracken, or grass, fire becomes so intense that it is unsafe and impracticable to attempt close attack. Back-firing is resorted to in such cases. It should be remembered that fire is a dangerous force and that when fire is fought with fire extreme care and keen judgment must be used. If a fire starts some area will be burned over and some growth will be damaged, but in order to reduce the damage as much as possible some additional sacrifice may have to be made by starting a back-fire. The area to be covered by the back-fire should, however, be kept as small as is practicable.



How to Attack a Forest Fire

A satisfactory arrangement of crews is as follows: the warden or foreman directs the course and location of the fire-break, if one must be made. He is in charge of the whole fire-fighting force and should urge each man to do his best. According to the amount of brush to be cut one or two axemen or brushcutters follow the warden. Four men with Rich fire rakes, or some other tool, one working close to the other, make a clean trail, exposing the mineral soil, raking the material to the side away from the fire unless it is needed to start

a back-fire. Next comes a man with a torch. He must not set fire too rapidly for the nearest raker, nor for the guards who follow him. If the torchman sets fire too rapidly for the rakers the heat may drive them off their course, and if too rapidly for the guards, the fire may not burn away from the trail fast enough to permit their moving up with the torchman. As a result sparks may blow across the trail where there will be no one to discover and stamp them out immediately. Four alert and active guards can take care of a long line of back-fire. They should have three gallon spray tanks and a continuous supply of water. They should have also a rake or broom. Pine brush may be used in the absence of a better tool. The rear guard must be the most dependable man in the crew for he must determine when the line is safe and must not leave it until it is safe. It is important that someone who knows the woods after dark should be detailed to carry water.

THE LAST SPARK: Sometimes wardens and men leave as soon as the flames have been extinguished, with the result that frequently the fire has started up again at one or more places. Then the fire has to be fought again; it is larger, it is harder to subdue, takes more time, costs more, burns over more area, and does more damage than the first fire. No chances should be taken with it breaking out a second time. All but the most dependable men should be discharged. The burned area should be inspected to see there is no danger of fire creeping across the trail which ought to have been cleared around the burned area. Threatening brands should be thrown far into the burned area; logs and branches holding fire should be rolled over and sprinkled with water or covered with dirt until they are safe. Punky stumps should be examined and broken apart to see that they can give off no sparks. Burning snags standing within several hundred feet of the unburned area should be cut down. Every precaution should be taken to prevent a recurrence of the fire. If a fire has been put out during the day, the tract should be patrolled until the wind goes down in the evening, or until dew falls. If the fire has been extinguished in the morning and there is the least danger of its starting again, the area should be patrolled until the next afternoon or evening.

No fire is out until the last spark is dead.

LESSON THIRTEEN

WILFUL WASTE MAKES WOEFUL WANT

We have set forth thus far the need of forest protection, the necessity of protection from fire, the kinds of fire, how they burn, and the damage they do. We are now fully convinced that they should be eliminated, if possible. But, before a logical and practical plan for their elimination can be formulated, much less put into operation, we must investigate the cause of forest fires. From a study of past causes we may obtain data upon which to work for fire prevention,

for we may reasonably suppose that the same causes in the future will continue to result in forest fires.

FOREST WASTE IS EXCELLENT FUEL FOR DESTRUCTIVE FOREST FIRES

As fundamental facts it must be remembered that a piece of woodland is a piece of property which is of value. The value is not only to the individual who happens to claim possession, but to the people of the immediate neighborhood and very probably to the State and to the Nation. From the inherent nature of forest property there are times when it becomes very inflammable. At such times a small spark of fire may destroy in a few hours what has required years to develop. Once it has been destroyed, man may never be able to replace it, or at best it can be replaced only at considerable trouble, time and expense.

Our next step, then, is to discover how the sparks which cause forest fires get into the forest. Naturally the first thing we think of are the forces of nature. We know that lightning causes some fires.

In Pennsylvania, only 1½% of the 1915 fires, 1% of 1916 fires and 1% of the 1917 fires or 32 fires in three years out of a total of 4200 reported, were caused by lightning. Since 1917 the percentage has been only three tenths of one per cent.

Occasionally we hear of fires caused by spontaneous combustion. Such fires are unquestionably possible, but are also most likely to be very few in number. Other than from these two causes, forest fires originate as a result of human action, (and are either intentional, or in the last analysis, the result of carelessness and indifference.) "When a man touches a match to a clump of dry brush and a fire results there is a physical action, a mechanical cause of the fire; but the cause of the fire contains another element—the psychological back-ground for the physical action, the mental process, the activity of the man's mind which preceded the act and resulted in his setting fire".* This mental attitude may be one of hate as the malicious incendiary; self-interest, as the huckleberry picker; carelessness as the brush burner; mind upon something else than what is being done, what ought to be done or what ought not to be done, as the camper and smoker; ignorance, as the child and many people; indifference, as railroad employes; irresponsibility, as drunks, lunatics and idiots.

The causes of fires as shown by the reports from any State prove beyond a doubt that while natural conditions are contributory causes to forest fire yet unquestionably the greatest factor is that of carelessness on the part of man, therefore it is with man that we must deal in our efforts to prevent and control forest fire.

LESSON FOURTEEN

THE FOREST FIRE PROBLEM

The timber cut of State and Nation is far in excess of what is grown, consequently there is urgent need of protection of the forests which we now have and of care in their utilization. Almost four-fifths of Pennsylvania's timber supply is obtained beyond her border. It is a law that when a natural resource becomes scarce, as wood now is in Pennsylvania, management with a view of protection, better utilization and future production becomes necessary.

However the first measure necessary for successful practice of forestry is protection from forest fires. "As long as there is any considerable risk from fire, forest owners have little incentive to make provision for natural reproduction, to plant trees, to make improvement cutting or to do other work looking to continued forest production."[1]

"To be most useful and generally understandable the value of forest protection must be measured in dollars and cents whenever that is possible. Excess in money value of products of a protected forest over money value of products of an unprotected forest is the worth of protection to the public. With a forest, the capital value is the soil—it, with sunlight, air and moisture has power to produce an income in shape of wood and expressible in terms of dollars—When the timber is cut the producing power of the capital is as great as before."[2]

*Du Boise in "Systematic Fire Protection in California."

1. Dubois 2. H. S. Graves

"Every avoidable forest fire is not merely a severe loss to the country at present and for the future, but it is in itself an accusation against our people's lack of public consciousness. We are too apt to think in terms of our individual interests. Community interests

After Lumbering Provisions Should be Made for a New Crop of Forest Trees

apparently have little weight with us, and that can only come from failure to think in community terms."[3]

We have noted the duty of the forester toward the preservation of the productive powers of the forest soil and that forest fire destroys not only the present crop but the possibility of future forest crops. Without a doubt we can agree that the "issue of forest fires stands paramount in forest protection."[4] Without protection from fire all forest operations are equivalent to gambling with fate. The odds are against winning. It has been said that the success of the whole conservation movement depends largely upon the elimination of forest fires, and there is a great deal of truth in the statement.

The problem stated in its simplest terms, is how close can we come to the ideal condition of no fires with an expenditure of a minimum amount of money? The ideal, of course, is impossible. As long as human beings get in contact with forests there will be fires. A decrease in number can be expected only as our people establish a fixed habit of mind associating fire in forests, with danger, loss, public disapproval, criminality and punishment. The first factor of our prob-

3. Editor "Echo," Halifax, Nova Scotia. 4. C. A. Schenck.

lem then is education, or the problem of indirect control, which seeks to reduce the number of fires.

The second factor in the problem is that of direct control which seeks to suppress all fires as quickly as possible, within a minimum area with a minimum loss and at a minimum expense. This implies an efficient organization with proper equipment and methods.

The third factor of the problem is that of adequate finances, and the proper distribution of the same. Without sufficient funds, indirect and direct control are crippled and results are uncertain, unsatisfactory and discouraging. This, too, is largely a factor of education for unless the individuals who furnish the funds have the right attitude to the forest, the funds needed will not be forthcoming.

The fourth factor is that of cooperation. An individual owner of forest lands protects his property at high rate per unit of area and protects his neighbors' property to a certain extent in order to protect his own. Adjoining owners and other people of the neighborhood should be interested in the protection of the forest. The township, county and state government should be interested also. Each party must see some return for the expense incurred. Here again is the factor of education. But all these factors react upon each other, while to a certain extent they are independent.

LESSON FIFTEEN

THE COMMONWEALTH CARES FOR FORESTS

Beginning with the founding of the Province of Pennsylvania efforts have been made almost continually to induce individual owners of woodlands to protect them from fire. For various reasons, these efforts until very recently have failed signally. In the course of time, however, because of the value of forests to the Commonwealth in addition to their direct value to the owners who happen to hold title to the land, and because of the failure of forest owners to accomplish satisfactory protection, the Pennsylvania government entered upon a policy of land purchase. It is a well recognized fact that when individuals cannot or will not do what is necessary for society, the Commonwealth must take such measures as will provide for its own welfare.

With its own land the Commonwealth recognizes that protection from fire is the first principal of sound forestry practice. But the Commonwealth owns only a little more than 1,000,000 acres of forest land. Conditions in Pennsylvania are such today that this small proportion of the forest area cannot possibly bring about the satisfactory conditions which can come and be maintained only by an area large enough to meet the timber needs of an increasing population. Neither is it probable that the Commonwealth will or ever can own enough forest land to guarantee a sufficient timber crop. Therefore, it recognizes its duty in the matter of protecting the general forest area within its boundaries from its worst internal enemy, forest fire.

This policy has been expressed in law and provision has been made for a State forest fire organization, but not until the General Assembly of 1921 had there been sufficient money appropriated to equip the organization or to complete it and make it effective. With the million dollars appropriated by the 1921 General Assembly and approved by Governor Sproul it has been possible to expand the State's Forest Fire Organization and to develop it to suit the conditions in different parts of the Commonwealth.

Steel fire towers have been built so that now almost the entire forest area of the Commonwealth is under constant observation during the

One of Pennsylvania's Steel Forest Fire Towers

fire seasons, for fires will start and they must be detected promptly. These towers have been manned for from two to three months each spring and fall.

Each tower is connected by telephone so that the existence of a fire may be reported at once to the nearest forest fire warden. This has necessitated the building of approximately 800 miles of telephone line.

There are almost 4,000 forest fire wardens, including State Foresters, State Forest Rangers, State Game Protectors, Special Wardens, and Local Forest Fire Wardens. Every State Policeman is also a Forest Fire Warden. From the Local Wardens, towermen, inspectors, patrolmen and fire bosses are chosen. Each fire boss is expected to have a regular fire crew of from 6 to 12 men. Many of the wardens who have crews are now supplied with some forest fire fighting tools.

This organization tries not only to extinguish fires promptly but also to eliminate the cause of forest fires by having hazards cleaned up and by educating the people generally to appreciate the forests and to be careful with fire in and near them. This organization with the exception of the State Police is under the direction of the Chief Forest Fire Warden who in turn is under the direction of the Secretary of Forests and Waters.

The Commonwealth is trying to do its part in the protection of forests from fire, but it cannot do much without the help of woodland owners and of every good citizen of Pennsylvania. You can help by being careful with fire in the woods.

LESSON SIXTEEN

FOREST THRIFT

Forest protection has been, is now, and always will be the keystone of forest conservation. From Canada comes the statement: "Conservation and good forest management are meaningless terms as long as the plague of flames sweeps off in a week more than the constructive forester can accomplish in ten years. Until fire is eliminated conservation of forests can make no real headway."

Fire strikes at the existence of the forest and destroys the factors which make it of most value to man. If forests are to be grown, fires must be prevented; and it is not enough to prevent them or to keep them under control for one year or a short period of years. It is a long time between the seedling stage of a tree and the harvesting stage. The protection work must be complete and continuous in order that forests once started, may reach maturity.

That fire can be kept from forests is not disputed. In Europe before the war, fire was considered as the least important of all the dangers to which forests were exposed. Fires can be kept from Pennsylvania forests also, but it will take time, work, and money. There must be education, organization, and cooperation.

There is no better time than the present for our people to consider the protection of forests from fire. The prosecution of the war made

necessary the marshalling of every resource in order to equip and maintain our army, our navy, our commerce, the existence of our Allies, and very probably, our own existence. It has been discovered that in war as well as in peace, wood plays a most important part. It is still the common thing for the Allied Governments to call upon their people to "save and give," to practice "thrift" in every line of activity. It is not a good indication of thrift in Pennsylvania as long as it is possible for 380,000 acres to burn over in one year, as occured in 1923, or 95,000 acres in one week in May of 1922.

Protected Forests Yield Large Quantities of Wood for Our Industries

Wood in various forms is needed at every turn and the tremendous demand upon our forest will continue for some time to come. The forests can meet the demand if properly cared for, but they cannot if they are to be continually subject to damage from fire. Forest fires must no longer be regarded as inevitable, unpreventable, and as accidents. They must be considered in their true light, namely that they are a curse which must be done away with, and the person or corporation who does not use every possible means to prevent damage while using fire must suffer because of the abuse of his liberty and of his neighbors' rights.

LESSON SEVENTEEN

AN OUNCE OF PREVENTION

While it is true that it is the duty of the Commonwealth to take care of its own interests, both as a timber land owner, and because

of the benefits of forests to society, it must be distinctly understood that the Commonwealth is made up of the individuals who live within its borders. The results of forest fires touch the life of every individual in the Commonwealth. It is the duty, therefore, of every citizen to do his share, not simply in the suppression of forest fires, but also in their prevention.

Road Through Well-cared for Forests

"Important as fire extinction is, greater stress must be placed upon fire prevention. The evil must be eliminated at its source."

"Safety First," efficiency, and conservation, are three terms that are upon the lips of the people upon all occasions. They are easily understood and appreciated. They are being applied to all phases of work, private and governmental. Efficiency commissions and the conserving of material and human wealth by national and state governments are in vogue. Although this condition exists, the people are not yet entirely awake to the foundation principle of these three ideas. The best conservation of effort, time, money, resources, health, and life is expressed in the idea of the prevention of waste. The remedying of ills and the restoration of things which can be restored are noble actions, but many ills cannot be remedied and many resources cannot be restored. The prevention of accidents and of unsatisfactory conditions is wiser, cheaper and more far reaching than amelioration. The old saws "An ounce of prevention is worth a pound of cure" and "A stitch in time saves nine" are just as true today as they were when first uttered. Efficiency implies "safety first" and conservation.

Forestry is one branch of conservation, and the protection of forests from fire is a part of forestry. Safety first in forest management is just as wise and just as important as in manufacturing or in railroading. It is, in fact, more so. Industries could continue without the safety first idea being developed very far, but forestry is impossible without protection from fire. Any system of forestry is doomed, and is the limit of inefficiency if forest fires are not suppressed.

It is a recognized principal that the Commonwealth has an important interest in the forests within its borders. But the peculiar relation with respect to ownership of property which exists under our form of government is rather difficult to handle. We hesitate to have the Commonwealth tell us what to do with what belongs to us. In the majority of cases attempts to meet the problem have resulted in the purchase or retention of certain lands to be held by the Commonwealth for forest management of one kind or another. Other efforts have been education, reduction of taxes, distribution of seeds and seedlings, and fire extinction. Usually the last effort has been the weakest one.

In Pennsylvania, more recent agitation for a proper care of forest dates from 1877, and an active State policy dates from 1893. The danger and results from forest fires have been recognized all the time but the idea that the prevention of fires should take the lead of all other moves seems even yet to be foreign to the majority of our people.

There are approximately 13,000,000 acres of so-called forest land in Pennsylvania. All of it is exposed to the curse of fire. An average of 250,000 acres burn over each year. Most of it is burned over once every ten years. No system of forest management can flourish under such condition. In the face of this fact, no Commonwealth can provide for future welfare. The direct loss from these fires has been close to $1,000,000 a year, and what the indirect loss is, no one can calculate. No people can forever suffer such a useless loss, nor is it sensible to expect them to. The mere fact that they do not realize their loss is no excuse for the Commonwealth permitting the condition to exist. Education must continue until every citizen knows how he is concerned.

LESSON EIGHTEEN

SHALL WE PREVENT FOREST FIRES OR MERELY CONTROL THEM?

The earlier we recognize the human side of the forest fire problem, and exert our efforts to change it, so as to have it in our favor, the

earlier the solution of the problem may be obtained. Of course, the forest will burn as long as trees produce leaves and branches and they fall to the ground and become dry as tinder. Some of the debris may be cleaned up and disposed of at a certain expense and to the satisfaction of some people. The fuel for fires can be regulated to a certain extent. The fire itself can be extinguished under even unusual and unfavorable conditions, but this work too, is more largely dependent upon human, than upon physical factors.

FOREST PRODUCTION DEPENDS UPON FOREST PROTECTION

But how are fires in Pennsylvania's forests started? Spontaneous combustion may cause a few. Lightning causes a few—probably ten or twelve a year. The other 1,500 to 3,000 are caused directly or indirectly by the deliberate action of man. Of course, a few are started by irresponsible individuals. Unquestionably the prevention of fires is a human problem. Why does any individual with brains permit a spark to come into contact with highly inflammable, extensive and valuable property, as for example a forest? Perhaps psychology may give the answer. Common sense certainly will. But at any rate there must be a study of local relationship. The so-called careless fires do just as much damage as the intentional fires. Why are the people careless, or

why do so many accidental (?) forest fires happen in spring and fall, and not so many in winter and summer?

How, then, can the minds of men be reached so as to change their attitude from one of thoughtlessness and indifference to one of carefulness, of community interests? Even without this change fire extinction, the physical operation, is not a difficult operation wherever force is available for the purpose. But in the majority of cases this means men, women, and boys with equipment. How is it possible to get this force? Was there willingness or unwillingness? Even though this force was present under duress, who exerted the pressure? Was it law? Who enacted the law, or who would enforce it? No matter from what angle you look at it, you face a human problem.

The only logical way we have of producing change in the human mind is by education. It is well to investigate and tabulate causes, but it is better to control and extinguish fires when they occur. To do these things there must be an organization large enough to cover the forest to be protected. There must be a head to the organization and sufficient help to keep it going. There must be inspection, and there must be a number of alert, interested, efficient men ready to do promptly, whatever must be done. Fires must be detected promptly, reported promptly, extinguished promptly. A force of helpers and sufficient equipment must be available at a moment's notice. Other details must be worked out and through all the details runs the human element that can't be avoided. The point of contact may be established by education, and education will result in prevention.

LESSON NINETEEN

CAUSES OF FOREST FIRES

In Lessons 13 and 18 something has been said about how fires are caused. It must be remembered that fire is not natural or native to the forests. With the exception of a few fires from lightning, fire gets into the forest as a result of man's actions or his failure to act. A fire of any kind in the open is dangerous and when near inflammable property it is necessary that the person responsible for it be under constant care that it be restrained and limited to its purpose. If and when fire escapes into the woods, it does so not of its own accord or because of the forces of nature, but because man has not exercised care. A forest fire therefore is the direct result of someone's carelessness or deliberate intention.

The following is a classification of causes generally adopted for a study of past causes and for the uniform reporting of forest fires:

I. Practically not preventable:

(a) Lightning.

(b) Spontaneous combustion.

II. Mostly preventable:

(a) *Incendiary*—All fires maliciously set regardless of whether or not they can be classified under any other head. Purposely burning another's woodland for one's own advantage, apparent or supposed. (Does not include back-firing in good faith.).

INCENDIARY

To take revenge, or "to get even."

To force the sale of timber.

To force owner of woodlands to purchase interior holdings.

To get job at fire fighting.

To cover trespass or other crime.

To improve pasturage.

To gather nuts.

To uncover minerals for prospecting.

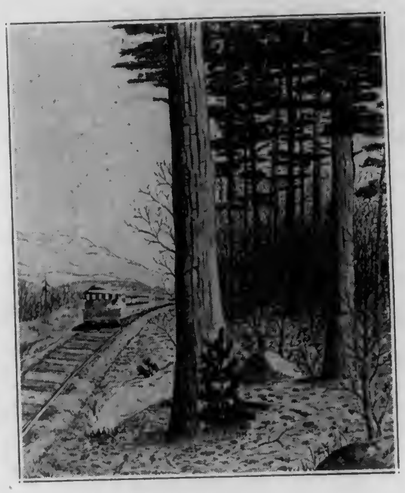
To improve huckleberry crop.

To drive away snakes.

To surround one's own land with a safety belt.

To see it burn.

(b) *Railroads*—Fires incidental to the construction, operation, or maintenance of all railroads, other than those used in connection with lumbering and other narrow gauge roads.



RAILROADS

1. From Engines.

Sparks from smoke stack of locomotives or construction engines.

Sparks from fire box or ash pan.

Cinders, waste, or paper thrown off by crew.

2. Right-of-way.

Burning of right-of-way, new or old.

Burning ties.

Fire escaping in any way from section gang, telegraph or telephone line crews, bridge, or other repair or construction crews.

Fire caused by track walkers, whether employes or trespassers.

Matches and tobacco thrown from trains.

Individual carelessness of any employee, passenger, or trespassers.

(c) *Lumbering*—Fires incidental to all lumbering operations.

Sawmill engines, whether permanent, temporary, stationary, or portable.

Refuse burners.

Dinkey engines.

Logging locomotives, except such as are common carriers.

Tractors.

Hoisting engines.
Logging camps.
Blasting in connection with logging.

LUMBERING

Carelessness of any lumbering employes.
Slash burning.
Charcoal burning and other wood utilization in the forest.

(d) *Burning Brush and Litter*—Fires incidental to clearing land (other than incendiary, railroad rights-of-way, and lumbering operation.)

BRUSH BURNING

Burning rubbish, or waste.
Burning garbage.

Burning range.
Burning stubble.
Burning meadows.
Burning fence rows.
Burning brush.
Burning weeds.
Burning off fields and pastures.
Burning "new ground."
Light burning.
Clearing land for agricultural purposes—cultivation, fencing, building, placing bee hives, etc.
Blasting stumps and rocks.
Burning out animals, insects, and reptiles.

(e) *Transients (Campers)*—Fires resulting in any manner from the carelessness of campers, stockmen, prospectors, picnickers, surveyors, laborers (other than railroad and lumbering) berry pickers, hunters, fishermen, automobilists, tramps, smokers, children, drunks, lunatics, and other travelers through the forest.

CAMPERS

Camp fires for cooking, warmth, or friendliness—with or without the permission of the land owner.

Smoking—unextinguished matches (storm matches, wet matches thrown away and afterward ignited), cigar and cigarette butts, pipe heels. (On holidays near large towns).

Hunters—fire on runways, fires in hollow logs or trees to smoke out game. Shooting with inflammable wads.

Bee-hunters—fires for heating honey, or other material to attract bees, fire to smoke bees while honey is being taken.

Children playing with matches.

(f) *Miscellaneous*—All fires the origin of which is known, but which cannot be classified properly under any of the above heads.

Engines on tram or narrow gauge roads.

Tractors and traction engines.

Sparks from forest cabins.

Fire works and toy balloons.

Breaking of electric transmission lines.

Burning buildings.

Broken glass or bottles.

Trees rubbing together.

UNKNOWN

(g) *Unknown*—All fires the origin of which can not be determined with such a degree of certainty as would justify their inclusion under any other head.

PENNSYLVANIA FOREST FIRE STATISTICS - SUMMARY BY CALENDAR YEARS

Year	Number of Fires.	Area Burned Acres.	Average Area Per Fire Acres.	Amount Damage	Cost to State for Extinction
1913	937	386,267.55	412.00	$719,426.67	$26,683.88
1914	1182	360,236.45	305.00	717,573.23	31,318.44
1915	1079	340,621.70	316.00	874,557.79	27,150.79
1916	1012	143,294.90	141.00	253,025.30	13,760.86
1917	1902	286,108.53	150.00	550,831.17	27,160.28
1918	1625	227,484.97	140.00	410,637.40	25,374.83
1919	950	126,626.07	133.29	279,395.50	13,264.79
1920	1597	256,158.21	160.39	1,007,868.30	43,105.97
1921	2409	188,535.97	78.26	329,738.64	60,941.12
1922	3635	332,326.72	91.42	670,149.11	185,041.77
1923	3539	375,737.11	105.17	794,727.37	158,825.45
1924	1997	95,792.26	47.97	204,296.60	63,793.35
1925	2562	125,150.56	48.85	380,357.64	85,777.64
1926	2917	224,255.60	76.88	1,186,326.65	177,353.41

PENNSYLVANIA FOREST FIRE STATISTICS - SPRING SEASON (Jan. 1st to May 31st Inclusive)

Year	Number of Fires.	Area Burned Acres.	Average Area Per Fire Acres.	Damage	Cost to State for Extinction
1913	686	344,751.70	502.00	$628,116.72	$21,112.11
1914	313	67,415.60	215.00	128,068.34	4,959.41
1915	899	321,341.95	357.00	840,079.08	24,654.55
1916	502	98,580.00	196.00	181,192.45	8,308.22
1917	1563	242,080.18	155.00	504,340.68	22,507.63
1918	1359	203,958.05	150.00	356,834.90	22,030.39
1919	828	113,805.15	137.00	247,493.50	11,201.94
1920	1286	240,263.14	186.00	960,450.35	38,239.39
1921	1978	161,594.00	82.00	282,503.52	44,225.32
1922	2258	256,238.31	113.00	456,198.23	122,794.06
1923	2805	340,370.19	121.00	711,657.97	128,727.15
1924	957	46,666.78	48.70	78,501.85	22,340.34
1925	2094	109,209.92	52.10	252,614.45	65,878.95
1926	2791	223,266.72	80.00	1,182,008.85	176,034.95

PENNSYLVANIA FOREST FIRE STATISTICS. - FALL SEASON (June 1st to Dec. 31st Inclusive)

Year	Number of Fires.	Area Burned Acres.	Average Area Per Fire Acres.	Damage	Cost to State for Extinction
1913	251	41,515.85	165.00	$ 90,859.95	$ 5,571.77
1914	869	292,820.85	337.00	589,504.89	26,359.03
1915	180	19,279.75	107.00	34,478.71	2,496.24
1916	510	44,714.90	87.00	71,832.85	5,452.64
1917	339	44,028.35	130.00	46,490.49	4,652.65
1918	266	23,526.92	88.00	53,802.50	3,344.44
1919	122	12,820.92	105.00	31,902.00	2,062.85
1920	311	15,895.07	51.00	47,417.95	4,866.58
1921	431	26,941.97	62.00	47,235.12	16,715.80
1922	1377	76,088.41	56.00	213,950.88	62,247.71
1923	734	35,366.92	48.00	83,069.40	30,160.05
1924	1040	49,125.48	47.20	125,794.75	41,453.01
1925	468	15,940.64	33.70	127,743.19	19,898.69
1926	126	988.88	7.90	4,317.80	1,318.46

The protection of forests from fire is fundamental in the perpetuation of a future timber supply.

George H. Wirt

"And, when the fury of the fiend was spent,
Burned out the fullness of its torrid wrath,
It left behind a devasted path—
To human carelessness a monument."

Douglas Malloch

END OF NUMBER

CONTINUED
ON
NEXT REEL

END OF REEL
PLEASE
REWIND