Tilia americana L. American Basswood

Tiliaceae Basswood family

T. R. Crow

American basswood *(Tilia americana),* northernmost *Tilia* species, is a large, rapid-growing tree of eastern and central hardwood woodlands. Best growth is in the central part of the range on deep, moist soils; development is vigorous from sprouts as well as seed. American basswood is an important timber tree, especially in the Great Lakes States. The soft, light wood has many uses in wood products. The tree is also well known as a honey-tree, and the seeds and twigs are eaten by wildlife. It is commonly planted as a shade tree in urban areas of the eastern states where it is called American linden.

Habitat

Native Range

American basswood (fig. 1) ranges from southwestern New Brunswick and New England west in Quebec and Ontario to the southeast corner of Manitoba; south through eastern North Dakota, South Dakota, Nebraska, and Kansas to northeastern Oklahoma; east to northern Arkansas, Tennessee, western North Carolina; and northeast to New Jersey.

Climate

Climatic conditions associated with the species range are generally continental-cold winters, warm summers, and a humid to subhumid moisture regime. Mean annual precipitation within the species range is 530 mm (21 in) at the western limit and 1140 mm (45 in) in the northeast. The northern limit of basswood approximates the -18" to -17" C (0° to 2° F) isotherm for mean daily minimum January temperature. Basswood reaches its maximum development in areas averaging 18" to 27" C (65" to 80" F) in July and receiving 250 to 380 mm (10 to 15 in) of precipitation during the growing season. The frost-free growing period varies from 80 to 180 days within its range.

Soils and Topography

Studies relating to the presence of basswood to soil characteristics in Minnesota, Wisconsin, and Michigan indicate that stands in which basswood shared dominance were generally confined to sandy loams, loams, or silt loams, with basswood obtaining maximum development on the finer textured soils. Most soils were classified as Hapludalfs within the Alfisols order, although some Eutrochrepts (Inceptisols), Cryandepts (Inceptisols), mesic families of entic Fragiorthods (Spodosols), and Haplorthods (Spodosols) were noted.

Basswood grows best on mesic sites, but it is also found on coarse soils such as the sand dunes near Lake Michigan *(17)* and on dry, exposed rock ridges in Ontario and Quebec (25).

The species grows on soils ranging in pH from 4.5 to 7.5 but occurs more often in the less acidic to slightly basic part of this range. In fact, calcareous soils have been associated with the presence of basswood *(9,17).*

The importance of aspect and edaphic factors to local distribution is reflected by the restriction of basswood throughout much of its range to moist sites on north- and east-facing slopes. Maple-basswood forests in southern Wisconsin are largely restricted to northerly exposures (19). Basswood is restricted to more mesic sites in southern Illinois and in northern Kentucky (5). At the western limit of its range, basswood frequently grows on the eastern side of lakes and along major drainages. This localized growth is often ascribed to fire protection. Although lack of fire may be a reason for the persistence of a fire-sensitive species such as basswood, presence and distribution are controlled more by soil moisture and the ameliorating effects of water on the local climate.

Basswood is classified as a nitrogen-demanding species because it grows poorly on sites deficient in nitrogen. With increasing nitrogen supplies, basswood growth increases markedly, approaching a maximum radial increment when 560 to 670 kg/ha (500 to 600 lb/acre) of nitrogen are added. Basswood leaves have high contents of nitrogen, calcium, magnesium, and potassium at the time of leaf fall and they contribute most of these nutrients to the forest floor *(13,28).*

Associated Forest Cover

American basswood (fig. 2) grows in mixture with other species and only rarely forms pure stands. It is dominant in a single forest type, Sugar Maple—Basswood (Society of American Foresters Type 26). This cover type is most common in central Minnesota

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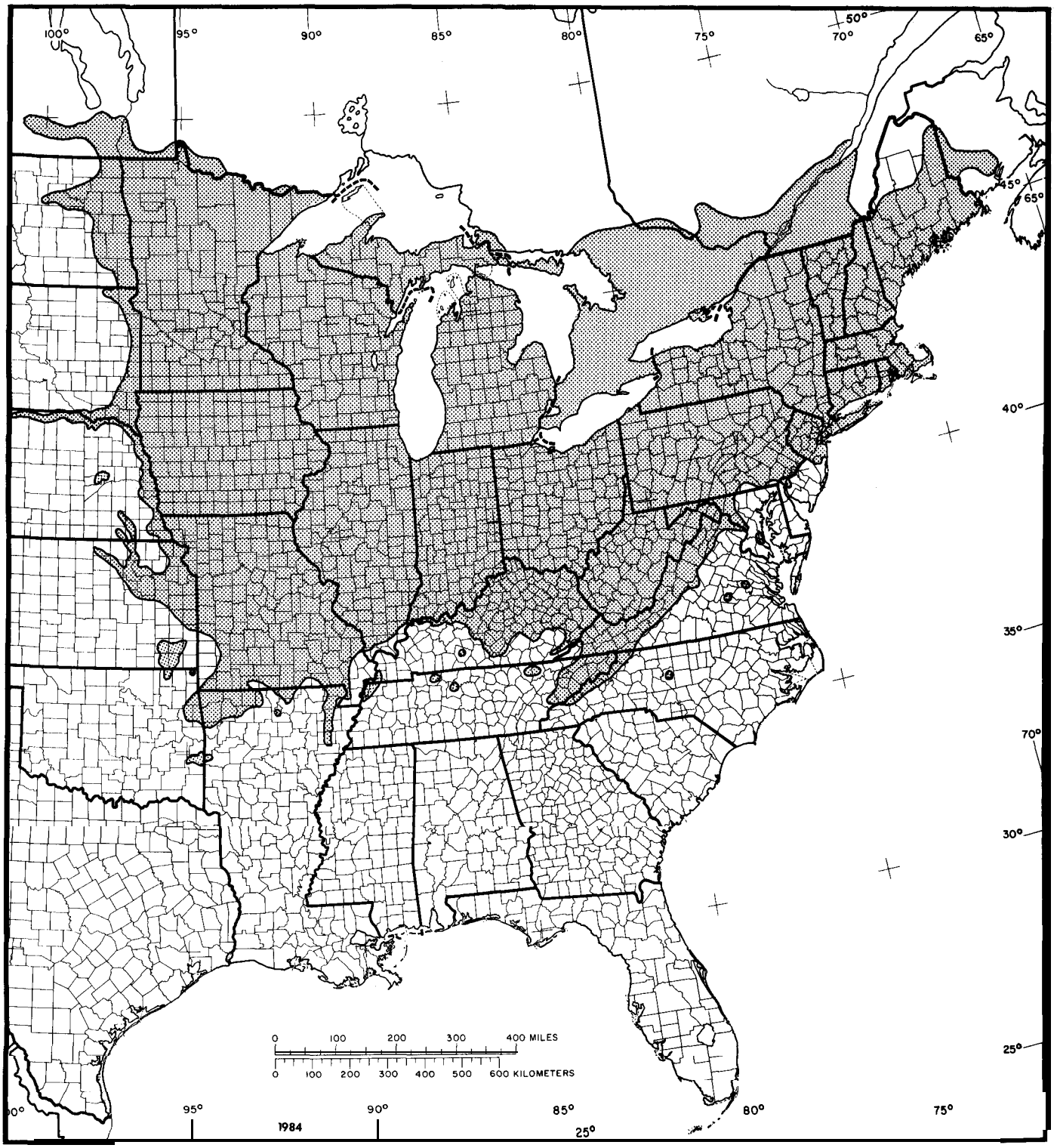

Figure *l-The native range of American basswood.*

and western Wisconsin but is represented elsewhere from central Illinois, northward to southern Ontario and Quebec, eastward to northwestern Ohio, and westward along valley slopes of the prairie-forest transition *(15)*.

Sugar maple *(Acer saccharum)* dominates both overstory and understory layers, with basswood achieving the position of second dominant in the tree layer. Common associates are white ash *(Fraxinus americana),* northern red oak *(Quercus rubra),* eastern hophornbeam *(Ostrya virginiana),* red maple *(Acer rubrum),* and American elm *(Ulmus americana).*

Although not a dominant species, basswood is also found in the following forest cover types:

21 Eastern White Pine
23 Eastern Hemlock
20 White Pine-Northern Red Oak-Red Maple
24 Hemlock-Yellow Birch
27 Sugar Maple
25 Sugar Maple-Beech-Yellow Birch
28 Black Cherry-Maple
60 Beech-Sugar Maple
39 Black Ash-American Elm-Red Maple
42 Bur Oak
58 Yellow-Poplar-Eastern Hemlock
62 Silver Maple-American Elm

Basswood is one of the major species, with sugar maple, beech *(Fagus),* ash *(Fraxinus),* hickory *(Carya),* and oak *(Quercus),* in the Deciduous Forest Region of southern Ontario. It is a minor component of the sugar maple-yellow birch-hemlock-white pine climax forest type in the southern districts of the Great Lakes-St. Lawrence regions of Ontario (32).

In the Mixed Mesophytic forests of the southern Appalachians, *Tilia americana* is replaced by *T. heterophylla* (9). The genotypic distinction between these species is not always clear, and *T. americana* does appear in the northern part of the Mixed Mesophytic region.

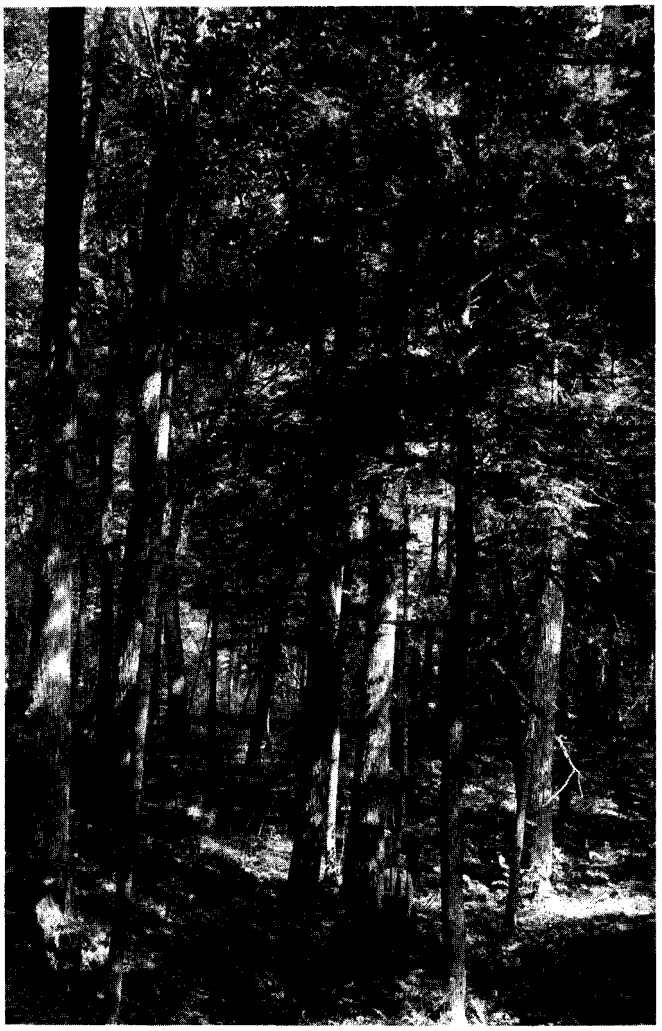

Figure *2-Stand of virgin mixed hardwoods in Nicolet National Forest, WI. All large trees* are basswood. *Conifers are hemlock.*

Life History

Reproduction and Early Growth

Flowering and Fruiting-The fragrant, yellow-white, perfect flowers are borne on loose cymes on long stalks attached to leafy bracts. Flowering generally occurs in June but can begin in late May or early July, depending on latitude and annual variations in temperature. Flowering follows initial leaf-out and lasts approximately 2 weeks. During this period, all stages of floral development are present on a single tree or even in a single inflorescence (4 to 40 flowers per inflorescence). The flowers attract a number of insect pollinators. In a study of the pollination biology, 66 species of insects from 29 families were identified as pollinators of *Tilia* flowers. Bees and flies were the most common diurnal pollinators; moths were the primary nocturnal visitors (2).

The fruit, a nutlike drupe 5 to 10 mm (0.2 to 0.4 in) in diameter, usually contains one seed but in collections from both open- and forest-grown trees, 12 percent of the fruit contained two seeds and less than 1 percent contained three seeds. The seeds have a crustaceous seed coat (testa), a fleshy yellowish endosperm, and a well-developed embryo. A variety of forms of fruit and seed have been noted, including egg-shaped, round, onion-shaped, conical, and pentagonal (34). Individual trees tend to consistently produce fruit of a particular form and size.

Seed Production and Dissemination-Fruits ripen in September and October and are soon dispersed by such mechanisms as wind, gravity, and animals. Although the flower bracts are reported to aid in wind dispersal, fruits rarely are carried more than one or two tree lengths from the parent (24). In addition to their limited role in seed dispersal, bracts may act as "flags" to attract pollinators (especially nocturnal ones) to the inflorescences (2). Animals probably increase the seed dispersal significantly.

The seed-bearing age for basswood generally ranges from 15 to 100 years, but seed production at age 8 years (10 years from seed) has been noted (45). The number of ripened fruits averages 9,700 to 13,200/kg (4,400 to 6,000/lb); green fruit averages 5,070 to 5,950 seeds per kilogram (2,300 to 2,700/lb) of fruit *(17,33,35)*. Based on a number of collections, seed weights varied from 12 to 38 mg (0.18 to 0.59 gr) and averaged 31 mg (0.48 gr) (4). In a study for 26 years of 19 species in northern Wisconsin, basswood was one of the most consistent fall-maturing seed producers *(18)*. It produced good seed crops 62 percent of the time from 1949 to 1974. When crown-released, basswood that were about 50 years old did not increase their fruit production during the 5-year period following release. Moreover, the quality of fruit remained poor throughout this period. In the third year after release, for example, only 5 percent of the fruit collected from the ground contained sound seed (37).

The production of fruit without seed (parthenocarpy) and seed infestation by a lepidopterous larva are two common defects that affect seed viability, A pin hole in the pericarp indicates the presence of the larvae. The percentage of fruits with the pin hole was 3 percent in a September collection and 7 percent for an October collection in southeastern Ontario (35); 30 percent of fruits were insect infested in 45 collections from various parts of the natural range of basswood (4). In the same collections, the percentage of fruits with seed ranged from 0 to nearly 100, but the lack of sound seed on the forest floor seems to be the rule. Only 2 percent were sound out of more than 7,400 identifiable basswood seeds found in the litter in a northern Wisconsin stand. Seeds covered by leaves had rotted and most of the seeds lying on or in the upper litter layers had been destroyed by rodents *(18)*.

Seedling Development-Basswood seeds show a pronounced dormancy and generally germinate poorly regardless of seedbed conditions. The primary cause for the lack of quick germination is an impermeable testa. Using organic acids to digest the pericarps of the fruits and to render the testas permeable improves germination *(17)*. Correctly treated seeds commonly average from 20 to 30 percent germination following stratification at 2" to 5" C (36" to 41" F) for 110 to 130 days. Germination is epigeal. Early harvesting followed by immediate sowing has also been suggested for overcoming dormancy of basswood seeds. Collections should be made when seed coats turn brown but before they become dry and hard, or more specifically, when the moisture content is 20 to 40 percent of the green weight *(7,29)*.

Shading aids the establishment and initial survival of basswood seedlings but heavy shade limits subsequent growth and development, and vigorous growth is unlikely under the forest canopy. Likewise, higher soil temperatures found in forest openings are suitable for greatest growth of basswood seedlings *(3)*.

Basswood seedlings first develop a long taproot, which is soon supplemented by lateral roots. First-year seedlings had a root penetration of 20.3 cm (8 in) with a lateral spread of 7.6 cm (3 in), and second-year seedlings had a root penetration of 21.3 cm (8.4 in) and a lateral spread of 18.3 cm (7.2 in) *(30)*. Stem height was 5.6 cm (2.2 in) the first year and 9.4 cm (3.7 in) the second year.

Cold storage of autumn-lifted basswood seedlings maintains root growth capacity and overall seedling vigor for spring planting. Autumn-lifted stock should be stored at a temperature of 5" C (41" F) and a relative humidity of 70-85 percent (46).

Basswood has been successfully planted in Ontario on cutover land and abandoned farmland. On cutover land, survival was best when a light overhead canopy (8.0 m^2/ha or 35 ft^2/acre of residual basal area) controlled competing vegetation (36). Release of the seedlings from the residual overstory and undergrowth was recommended after three growing seasons. Fall plantings failed to survive. Early failures of hardwoods planted on old-field sites in Ontario have been attributed to the absence of mycorrhizal fungi *(30)*, insufficient site preparation, and insufficient postplanting weed control *(42,44)*. Fertilization at the time of planting had little effect on seedling survival or growth (43).

Vegetative Reproduction-Basswood (fig. 3) sprouts prolifically, and this vegetative regeneration can be managed for sawtimber. Sprouts commonly originate on the stump at the ground line, and vigorous sprouts occur over a wide range of diameter classes *(31)*. Almost all trees 10 cm (4 in) in diameter and smaller will produce sprouts and more than half of sawlog-size trees can be expected to produce stump sprouts (23). However, early thinning of stump sprouts (preferably before they reach 5 cm (2 in)

d.b.h. or about age 10) is needed to ensure both good quality and rapid growth. Clumps should be thinned to not more than two stems; such thinnings will reduce the incidence of stem degrade due to decay, seams, and sweep *(23,38)*.

Because an extensive root system already exists, a basswood sprout has a higher probability of replacing a parent stem than does a sugar maple seedling. Thus, the ability to produce abundant stump sprouts allows basswood to maintain itself in a stand with the more shade-tolerant maple despite the much larger numbers of sugar maple in the subcanopy *(13)*.

Sapling and Pole Stages to Maturity

Growth and Yield-This species reaches a height of **23** to **40** m (75 to 130 ft) with a d.b.h. of 91 to 122 cm (36 to 48 in). Under favorable conditions, trees sometimes attain a height of 43 m (140 ft) and a d.b.h. of 137 cm (54 in). Estimates of maximum longevity generally exceed 200 years.

Basswood grows faster than most other northern hardwood species. On the same site, basswood often exceeds sugar maple and yellow birch *(Betula alZeghaniensis)* in site index by 1.5 m (5 ft) and beech by 3 m (10 ft) *(11)*.

Diameter growth for basswood averaged 3 mm (0.11 in) per year in three unmanaged stands in northeastern Wisconsin (site index at base age 50 years for basswood of 21.3 m or 70 ft). The same site under managed conditions produced substantially higher growth rates. Annual diameter growth average for a crop tree release was 4.6 mm (0.18 in); for a 20.7 m^2 and 17.2 m^2/ha (90 ft^2 and 75 ft^2/acre) (residual sawtimber) selection cut, it was 3.8 and 4.8 mm (0.15, 0.19 in); and for a group selection cut, it was 3 mm (0.12 in). Relatively narrow bark ridges and V-shaped fissures, with new light-colored inner bark visible in the fissures, represent a high-vigor basswood. In contrast, low-vigor trees have scaly bark with wide bark ridges and shallow, short fissures, frequently producing a rather smooth surface *(12)*.

Two phases can be noted in the renewal of cambial activity for basswood. The first phase is the reactivity of cambium that occurs independently of the initial meristematic activity within the overwintering buds. The second phase, accelerating cambial activity after bud-break, is presumably under the influence of primary growth *(14)*. Winter stem contraction for basswood often exceeds stem expansion from the previous growing season. The amount of winter shrinkage in basswood stems was greater than that of yellow birch, sugar maple, or hemlock *(Tsuga canadensis) (49)*.

The period of shoot elongation for basswood in northern areas is shorter than that for other hardwoods-only red oak and sugar maple had shorter periods of terminal shoot elongation among seven species studied in northern Wisconsin. Based on an average of three growing seasons, shoot elongation for basswood began in May and was completed by the first of June *(10)*. Longer periods of shoot elongation have been noted for open-grown basswood in Illinois and basswood plantations in Ontario (mid-May to mid-August). Chlorophyll is found in xylem rays and primary xylem of basswood twigs (47). Although the photosynthetic contribution is not large, it may have seasonal significance when leaves are absent.

Rooting Habit-The initial taproot observed in basswood seedlings gives way in saplings to a system of lateral roots (5). This early root development is gradually obscured by the intensive development of

Figure 3—*Basswood stump sprouts.*

oblique roots in the central mass, and surface lateral roots extend out from this mass *(16)*. Adventitious roots have developed on the lower stem of basswood engulfed by dune sand (4).

Reaction to Competition-Although basswood is less shade tolerant than its common associate, sugar maple, vigorous sprouting and rapid sprout growth allow it to persist under the selection system. Overall, American basswood is most accurately classed as tolerant of shade. This great sprouting vigor also helps it compete with the abundant regrowth following clearcutting. On an excellent site in the central Appalachian hardwoods, basswood was second only to sugar maple in number of stems 7 years after clearcutting. On a good site and a fair site, however, basswood was not among the five most numerous species during the same period (39).

For reproduction from seed, the shelter-wood system should provide the partial shade necessary to control competing vegetation, and to create a microclimate suitable for germination. After basswood is established, the overstory should be removed.

Closely spaced, forest-grown trees develop straight, columnar trunks and narrow crowns, but open-grown trees have short stems and many large branches.

Damaging Agents-Basswood plantations established on weed-infested old-field sites are susceptible to girdling by mice and voles, and completely girdled trees die. In a southern Ontario plantation, 44 percent of the basswood stems were completely girdled and 39 percent were partially girdled *(41)*. The species responsible for the girdling, the meadow vole, does most of this damage feeding beneath the snow. Rabbits also feed heavily on seedlings and small saplings in both plantations and natural stands. Basswood seeds are eaten by mice, squirrels, and chipmunks, thus reducing the chances of seedling establishment.

Many different insects attack basswood, but few serious insect problems exist. The linden borer *(Saperda vestita)* makes long, irregular tunnels, particularly at the base of the tree, and may damage weak, very young, or overmature trees. Local infestations of defoliators may occur. The primary ones include the linden looper *(Erannis tiliaria),* basswood leafminer *(Baliosus nervosus)*, spring cankerworm *(Paleacrita vernata),* fall cankerworm *(Alsophila pometaria),* whitemarked tussock moth *(Orgyia leucostigma),* gypsy moth *(Lymantria dispar),* and forest tent caterpillar *(Malacosoma disstria) (1,22)*. In New England, American basswood is a highly preferred host for gypsy moth *(21)*, while in southern Quebec, it was classified as intermediate in susceptibility to gypsy moth defoliation (27).

The foliage is host to various diseases—anthracnose *(Gnomonia tiliae)*, black mold *(Fumago vagans)*, and leaf spot *(Cercospora microsora)*—but none seem to do serious damage. The wood of basswood decays easily and once exposed can be host to many of the common hardwood decay organisms such as the yellow cap fungi *(Pholiota limonella)* and *Collybia velutipes. Phellinus igniarius, Ustulina deusta,* and nectria canker *(Nectria galligena)* also are found on basswood.

Little defect is encountered in basswood when harvested before it reaches 120 years of age. Beyond this age, the chances of losses due to decay are greatly increased. Cull studies in the forests of Ontario indicate that yellow-brown stringy rot was the most common bole defect encountered; brown stain, some incipient yellow rot, and green stain were also found *(8)*.

The thin bark of this species is easily damaged by fire *(13)*. Basswood is one of the hardwoods least susceptible to late spring frosts *(40)*.

Special Uses

Basswood has relatively soft wood that works exceptionally well and is valued for hand carving. The inner bark, or bast, can be used as a source of fiber for making rope or for weaving such items as baskets and mats. Basswood flowers produce an abundance of nectar from which choice honey is made. In fact, in some parts of its range basswood is known as the bee-tree. Throughout the Eastern United States, basswood is frequently planted along city streets.

Genetics

The number of native taxa in the genus *Tilia* has been debated for some time. As many as 15 native species and 13 varieties are named in early taxonomic work. Only three species of *Tilia* are now recognized in the United States, *T. americana* L., *T. caroliniana* Mill., and *T. heterophylla* Vent. (24). Recent studies, however, suggest that the genus *Tilia* in eastern North America should be considered a single, but highly variable, species. In sampling *Tilia* from Quebec, Canada, to Lake County, FL, no apparent morphological discontinuities between populations were found to justify delimitation at the species level *(20)*.

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Tilia heterophylla Vent. White Basswood

Tiliaceae Basswood family

Timothy LaFarge

White basswood *(Tilia heterophylla)* is a medium-sized tree of the upper Piedmont region and the Appalachian Mountains where it grows on moist, well-drained soils in coves or along mountain streams with other hardwoods. Its growth is moderately fast and it produces commercially valuable lumber. The soft, lightweight wood is used for cabinetry, woodenware, and pulpwood, among its many uses. The name beetree linden is common because of the extensive use of this tree by bees for honey production. It is also an attractive landscape tree.

Habitat

Native Range

The range of white basswood (fig. 1) extends from southwestern Pennsylvania west in southern Ohio,

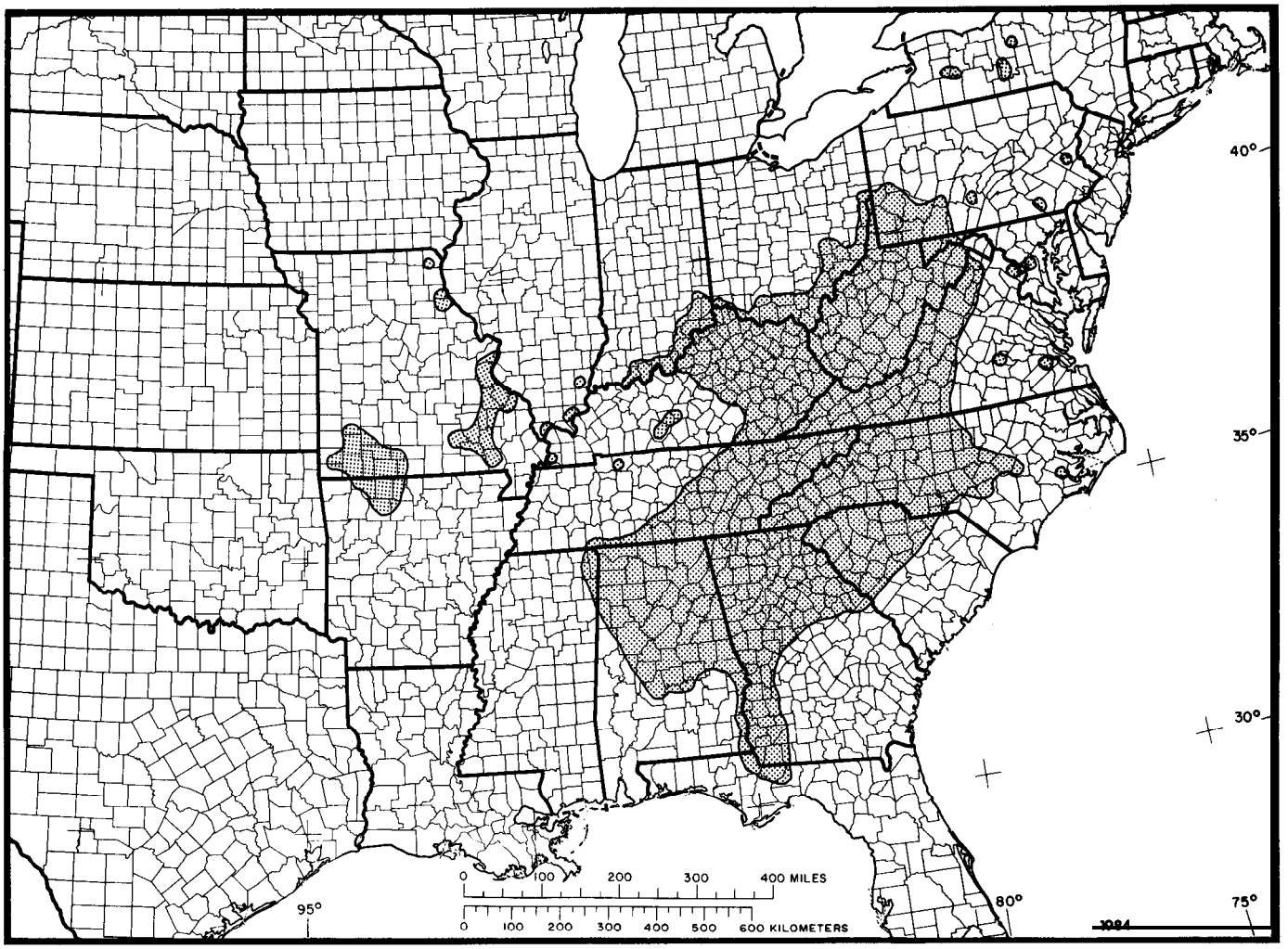

Figure *1-The native range of white basswood.*

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Indiana, and Illinois to Missouri; south to northern Arkansas; east to northeastern Mississippi, Alabama, northwestern Florida, and Georgia; and north to Maryland. Outlying populations occur in eastern Pennsylvania and western New York. It reaches its largest growth in the Appalachian Mountains, where it is often dominant. However, it is most common in the mixed mesophytic forests of the Cumberland Plateau, where it is second only to sugar maple *(Acer saccharum)* in frequency *(10,11)*.

Climate

Climatic conditions vary widely within the range of white basswood. In its southernmost range in northwest Florida, the mean annual number of days below freezing is 20; at the northernmost extremes in Pennsylvania and western New York, it is 150. These extremes occasionally include temperatures below -18" C (0° F) in the winter and some days in excess of 38" C (100° F) in the summer. Annual precipitation varies widely, ranging from more than 2030 mm (80 in) in some areas in the Southern Appalachians to about 910 mm (36 in) in some northern and western margins of its range *(14)*.

Soils and Topography

Quite particular in its soil and moisture requirements, white basswood cannot tolerate very wet or very dry conditions, and it almost always grows on moist but well-drained soils. This tree grows best along mountain streams or in mountain coves where the soils have an alluvial or a colluvial origin. These soils are deep, friable, and have considerable humus *(11)*.

White basswood is found on soils of five orders, Inceptisols, Ultisols, Alfisols, Entisols, and Mollisols. Of these, Inceptisols and Ultisols occupy by far the largest areas, and their common property is moisture availability for more than half the year or for more than 3 consecutive months during the warm season. Moisture availability during the warm season is also a property of Alfisols, which are present in the western portions of the range of white basswood, but it is not a property of Entisols and Mollisols. However, the latter orders occupy very small areas in the southern and western margins of the species range *(13)*.

Although rare at very low elevations, basswood is occasionally found on the Coastal Plain but appears with increasing frequency in the upper Piedmont. It is common in the Appalachian Mountains at elevations between 900 m (3,000 ft) and 1500 m (5,000 ft), where it usually grows on north and east exposures and on flood plains or in deep, moist coves *(11)*.

Associated Forest Cover

White basswood is a component of five forest cover types (5): White Oak-Black Oak-Northern Red Oak (Society of American Foresters Type 52), Yellow-Poplar (Type 57), Yellow-Poplar-Eastern Hemlock (Type 58), Yellow-Poplar-White Oak-Northern Red Oak (Type 59), and Silver Maple-American Elm (Type 62). However, it is not a major species in any of them. In the northern part of its range it grows with northern red oak *(Quercus rubra)*, white ash *(Fraxinus americana)*, black cherry *(Prunus serotina)*, white oak *(Q. alba)*, black oak *(Q. velutina)*, sweet birch *(Betula lenta)*, butternut *(Juglans cinerea)*, American elm *(Ulmus americana)*, American beech *(Fagus grandifolia)*, black walnut *(Juglans nigra)*, eastern hemlock *(Tsuga canadensis)*, and hickories *(Carya* spp.); farther south in the Appalachians it is more commonly found with yellow buckeye *(Aesculus octandra)*, yellow birch *(B. alZeghaniensis)*, sweet birch, sugar maple, black cherry, yellow-polar *(Liriodendron tulipifera)*, cucumbertree *(Magnolia acuminata)*, black locust *(Robinia pseudo-*acacia), loblolly pine *(Pinus taeda)*, and shortleaf pine *(P. echinata)*.

Life History

Reproduction and Early Growth

Flowering and Fruiting-White basswood flowers in the latter part of June and early July. Once flowering begins, flowers, pollen, and nectar are abundant. The perfect flowers are protandrous; the anthers usually open in the afternoon and release pollen for 24 hours, after which the stigmas become receptive and nectar production begins. There are 66 insect species known to pollinate basswood; bees and flies are the most common diurnal visitors and moths the principal nocturnal visitors. Nocturnal pollinators produce somewhat less fruit set than diurnal pollinators. Although insect pollination is predominant, wind pollination plays a minor role. White basswood is not self-compatible *(1)*.

The fruits are nutlike, leathery or woody, ellipsoidal, about 13 mm (0.5 in) long, and covered with rust-brown, woolly hairs. The fruits are borne in clusters of six or seven on bracts. The bracts, which are shaped like long, slender leaves, may serve as wings for the purpose of wind dispersal or may function primarily as flags to attract nocturnal pol-

linators. The light-colored bracts are distinct against the dark foliage at night *(1).*

Seed Production and Dissemination-White basswood seeds ripen in September and October following pollination and are dispersed in the winter and spring. Little information exists on fruit set and seed dispersal of this species. In general, these events seem to differ little from those of American basswood *(Tilia americana) (11).*

As with most tree seeds, natural germination is best on mineral soil. No specific information is available for white basswood, but in general, basswood seeds may remain dormant for as long as 2 or 3 years *(12).*

Seedling Development-Little is known about the early growth of white basswood. Immediate sowing after early collection of American basswood fruits (when they first turn slightly brown) has been found to give good germination success. Germination is epigeal. Basswood seedlings are usually planted as 1-O or 2-O stock *(12).*

Figure *2-A white basswood on Hitchiti Experimental Forest, Jones County, GA.*

Vegetative Reproduction-White basswood sprouts vigorously and commonly grows in clumps of three to six or more stems. Although clump growth is good, the trees are frequently defective and susceptible to sleet and wind damage. Hence, stands of sprouts are less desirable than those of seedling origin *(11).*

Sapling and Pole Stages to Maturity

Growth and Yield-Mature white basswood may exceed 27 m (90 ft) in height and 91 cm (36 in) in d.b.h. Typically, the bole is free of branches, smooth, and cylindrical (fig. 2). The growth rate of basswood is intermediate compared with other southern Appalachian species; it grows faster than most of the oaks and maples, but considerably slower than yellow-poplar and northern red oak. Economic maturity for sawtimber is estimated to be a d.b.h. of between 43 and 61 cm (17 and 24 in), depending on the vigor class of the tree *(11).*

Table l-Volume of standing basswood in the Southeast[1,2]

Location	Standing volume	Annual		
		Net growth	Removals	Mortality
			thousand m³	
Florida	664.4	18.4	11.2	10.6
Georgia	416.8	9.8	2.9	—
S. Carolina	44.9	4.0	—	3.8
N. Carolina	2227.2	63.8	5.6	6.0
Virginia	3760.5	108.3	16.7	23.2
Total	7113.8	204.3	36.4	43.6
			thousand ft³	
Florida	23,478	650	*397*	374
Georgia	14,729	348	103	—
S. Carolina	1,588	140	—	134
N. Carolina	78,699	2,253	198	213
Virginia	132,881	3,827	589	820
Total	251,375	7,218	1,287	1,541

[1] Volume of stemwood from a 0.3 m (1 ft) stump to a 10 cm (4 in) diameter top, outside bark
[2] Personal communication, Herbert A. Knight, resource analyst, Southeastern Forest Experiment Station, Asheville, NC.

No volume or yield tables are available for white basswood. A standing inventory of basswood-including net annual growth, removals, and mortality-is available for five Southeastern States (table 1). Although white basswood is not distinguished from American basswood in this survey, the latter species grows only in the northern and westernmost portions of Virginia and North Carolina. White basswood grows in all five States.

Rooting Habit-White basswood roots have been found to have ectotrophic mycorrhizae; a fungus grows on the outside of the short root to form a mantle, and two rows of spherical cells are present in the cortex to form a Hartig net *(8)*.

Reaction to Competition-Basswood is classed as shade tolerant, and variations between American basswood and white basswood are not noted *(11)*.

Damaging Agents-White basswood is relatively free of serious diseases, although it is attacked by cankers, rots, stains, leaf spots, and wilt. Discolorations of the wood are common following wounding of any type, but they are not considered serious defects unless decay enters before the wound heals. Decay fungi attacking white basswood include species of ***Daedalea, Fomes, Hydnum, Pholiota, Pleurotus, Polyporus, Irpex,*** and ***Stereum.*** Basswoods of stem sprout origin or seedlings that have been wounded are likely to become highly defective; often the main bole of such trees will be almost entirely hollow *(6,11)*.

Cankers caused by ***Nectria galligena*** are common on basswood but are not considered serious problems. Other stem diseases of minor importance are ***Nectria cinnabarina, Botryosphaeria ribis,*** and ***Strumella coryneoidea.***

Leaf spots are common but do not cause excessive damage. The common leaf spots are caused by species of ***Cercospora, Phyllosticta, Gnomonia, Phlyctaena,*** and ***Asteroma.*** Wilt caused by species of ***Verticillium*** is known to occur in white basswood but so far has been of no consequence in forest stands *(6,11)*.

White basswood is also comparatively free of serious insect enemies, but it is the host of many defoliators, several borers, aphids, and gall midges. Common defoliators include the basswood leafroller ***(Pantographa limata),*** elm spanworm ***(Ennomos subsignaria),*** linden looper ***(Erannis tiliaria),*** whitemarked tussock moth ***(Orgyia leucostigma),*** variable oakleaf caterpillar ***(Heterocampa manteo),*** basswood leafminer ***(Baliosus nervosus)***, bagworm ***(Thyridopteryx ephemeraeformis),*** and the Japanese beetle ***(Popillia japonica).***

Important borers include the linden borer ***(Saperda vestita), Chrysobothris azurea***, flatheaded sycamore-heartwood borer ***(Chalcophorella campestris),*** which enters the wood at wounds, ***Dicerca lurida***, ambrosia beetles ***(Platypus compositus)***, and the twig girdler *(Oncideres cingulata) (3)*.

Like those of yellow-poplar, the tender twigs and smaller branches of basswood are readily browsed by livestock and white-tailed deer.

Because of its thin bark, basswood is very susceptible to fire damage, especially at the seedling and sapling size. Consequently, butt rot is very common and a serious problem in burned stands.

Special Uses

Because of its soft texture, light weight, and dimensional stability, basswood lumber (including that of white basswood) is a choice wood. In addition to lumber uses, it is highly desirable for veneer, slack cooperage, excelsior, drawing boards, and particleboard; other values include bee pasture, yielding a fragrant honey, and shade and ornamental plantings ***(12).***

Genetics

Currently three species of ***Tilia*** in North America are recognized: ***T. americana, T. heterophylla,*** and ***T. caroliniana*** *(9,10)*, although there are no known races or varieties within them. Recent studies of field specimens, field plots, and nursery plantings indicate that the variation in *Tilia* is essentially clinal. Pubescence and stellate hairs tend to be absent in the northwest portions of the ranges of basswoods but abundant in South Carolina (2). Flavonoid variation patterns indicate definite differences between northern and southern populations and show an intermediate zone in the southern Appalachians (7). These patterns suggest that there is only one species, *Tilia americana* L., in the range from Massachusetts to North Carolina. The population occupying the remaining southeastern portion of the range could be named *T. americana* var. ***heterophylla.***

Hybrid swarms between white basswood and other species have been observed outside the glaciated area in southern Ohio (4). It has also been suggested that the absence of distinct morphological differences between species of basswood leads to inconstancy of insect pollinators and hence to hybridization *(1)*.

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