Ulmus rubra Muhl. Slippery Elm

Ulmaceae Elm family

John H. Cooley and J. W. Van Sambeek

Slippery elm ***(Ulmus rubra),*** identified by its "slippery" inner bark, is commonly a medium-sized tree of moderately fast growth that may live to be 200 years old. Sometimes called red elm, gray elm, or soft elm, this tree grows best and may reach 40 m (132 ft) on moist, rich soils of lower slopes and flood plains, although it may also grow on dry hillsides with limestone soils. It is abundant and associated with many other hardwood trees in its wide range. Slippery elm is not an important lumber tree; the hard strong wood is considered inferior to American elm even though they are often mixed and sold together as soft elm. The tree is browsed by wildlife and the seeds are a minor source of food. It has long been cultivated but succumbs to Dutch elm disease.

Habitat

Native Range

Slippery elm (fig. 1) extends from southwestern Maine west to New York, extreme southern Quebec, southern Ontario, northern Michigan, central Minnesota, and eastern North Dakota; south to eastern South Dakota, central Nebraska, southwestern Oklahoma, and central Texas; then east to northwestern Florida and Georgia. Slippery elm is uncommon in that part of its range lying south to Kentucky and is most abundant in the southern part of the Lake States and in the cornbelt of the Midwest (8).

Climate

Annual precipitation generally increases from northwest to southeast across the range of slippery elm *(11).* It averages about 530 mm (21 in) along the North Dakota-Minnesota boundary and about 2110 mm (83 in) at higher elevations in North Carolina. Warm season precipitation ranges from 410 to 1040 mm (16 to 41 in), and snowfall from very rare in the South to 254 cm (100 in) or more in the North. Average annual temperature ranges from 4" to 21" C (40° to 70" F), average January temperature from -15" to 12" C (5° to 54" F), and average July temperature from 16" to 27" C (60" to 80" F). The length of the frost-free period ranges from 90 to 280 days.

Soils and Topography

Slippery elm grows in soils common to the orders Mollisols and Alfisols. It grows best on moist, rich soils of lower slopes, streambanks, river terraces, and bottom land but it is often found on much drier sites, particularly those of limestone origin *(11).* Examples of sites on which it is, or has been, an important species are flood plains, terraces, and well-drained uplands in east-central Illinois; the northern Mississippi River flood plain; alluvial terraces in western Pennsylvania; and bottom land, lower ravine slopes, and upland in central New York. Slippery elm, along with black cherry *(Prunus serotina)* and red maple *(Acer rubrum)* are frequent invaders of tree plantings following surface-mining ***(12).***

Slippery elm can persist on poorly drained soils that are occasionally flooded for periods of 2 or 3 months but it does not reproduce or grow well if flooding is frequent or prolonged. In Illinois, on the flood plain of the Embarrass River, which is usually flooded at least once each year but not for more than 5 days at a time, slippery elm is most abundant along the river levee and at the edge of the flood plain where there is least chance of prolonged flooding. In another streamside forest, slippery elm was classified as an important subdominant in parts that were not flooded more than 1 percent of the time. In one prairie grove remnant, slippery elm was most important in terms of size and abundance on soils of the Argiudoll group, somewhat less important on Hapludalfs, and least important on Haplaquolls. On the northern Mississippi flood plain, slippery elm is found on the better drained sites; in the upland forest of southern Wisconsin, it is found on the moister sites.

Associated Forest Cover

Slippery elm grows over such a wide range of climatic, soil, and topographic conditions that its associates include more than 60 deciduous tree species. It is a common associate in the forest cover types Black Oak-American Elm-Red Maple (Society of American Foresters Type 39), Hawthorn (Type 109), White Oak-Black Oak- Northern Red Oak (Type 52), and River Birch-Sycamore (Type 61) (5). It probably also appears in Silver Maple-American Elm (Type

The authors are Principal Silviculturist (retired) and Research Plant Physiologist, North Central Forest Experiment Station, St. Paul, MN.

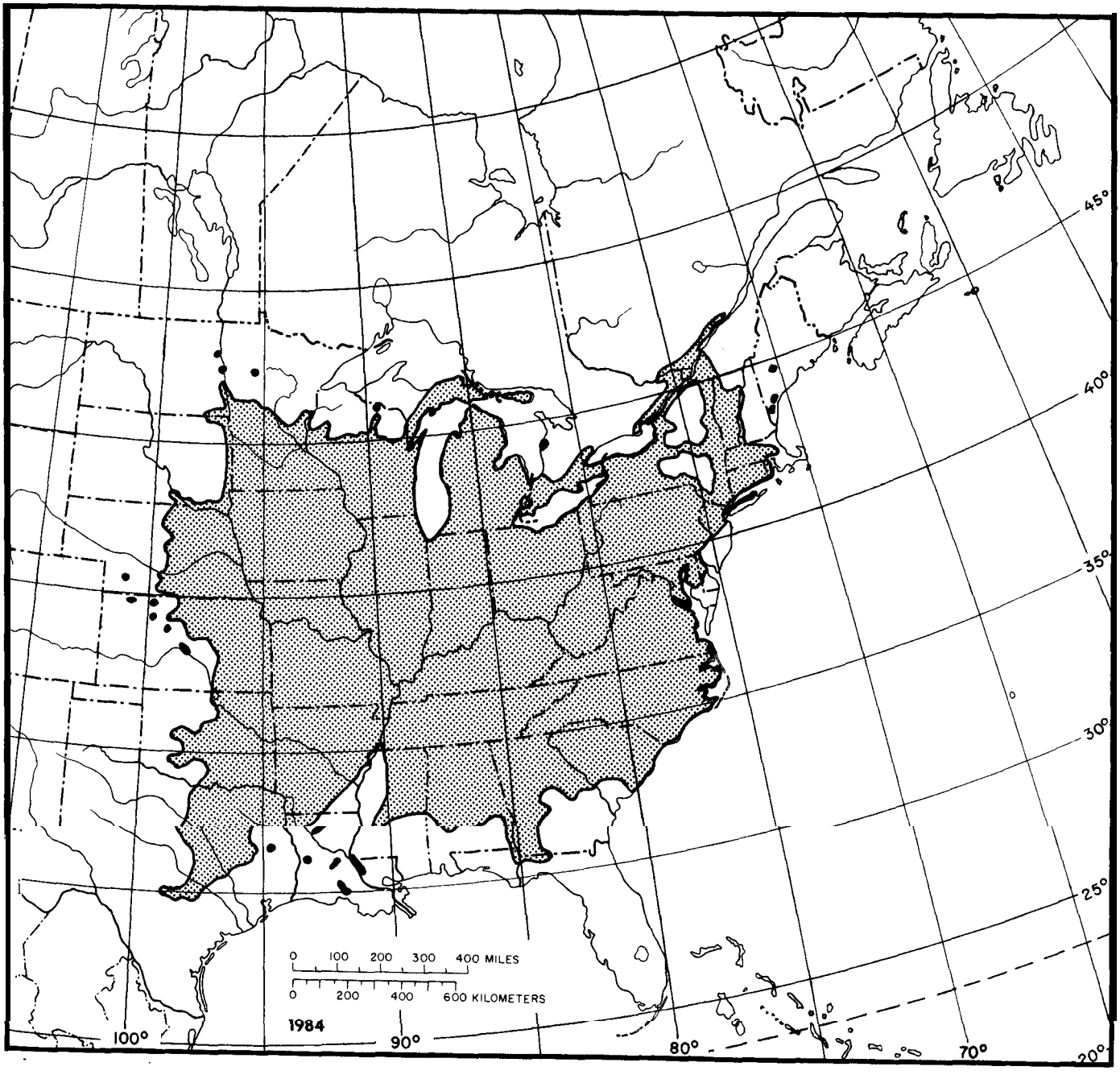

Figure 1—*The native range of slippery elm.*

62) and as an occasional tree in several other cover types. Common associates in uplands include bur, chinkapin, white, black, and northern red oaks ***(Quercus macrocarpa, Q. muehlenbergii, Q. alba, Q. velutina,*** and ***Q. rubra)***; shagbark, bitter-nut, mockernut, and pignut hickories *(Carya ovata,* ***C. cordiformis, C. tomentosu,*** and ***C. glabra)***; sugar, red, and silver maples *(****Acer saccharum, A.*** *rubrum,* and ***A. saccharinum);*** boxelder ***(A. negundo);*** white ash *(****Fraxinus americana);*** American elm *(****Ulmus americana);*** blackgum ***(Nyssa*** *sylvatica)*; basswood *(****Tilia americana);*** black cherry; black walnut *(****Juglans nigru);*** hackberry *(****Celtis occidentalis);*** and honeylocust *(Gleditsia triacanthos)*. On periodically

flooded lowlands slippery elm commonly occurs with silver and red maple, American elm, eastern cottonwood *(Populus deltoides)*, sycamore *(Platanus occidentalis)*, hackberry, blackgum, and honeylocust.

Common understory species of slippery elm stands include blackberry *(Rubus allegheniensis);* black raspberry *(R. occidentalis);* prickly, hairystem, and Missouri gooseberries *(Ribes cynosbati, R. hirtellum,* and *R. missouriense);* roundleaf, alternate-leaf, red-osier, gray, and flowering dogwoods *(Cornus rugosa, C. alternifolia, C. stolonifera, C. racemosa,* and *C. florida);* beaked hazel *(Corylus cornuta);* American hazelnut *(C. americana);* Atlantic leatherwood *(Dirca palustris);* ninebark *(Physocarpus* spp.); climbing bittersweet *(Celastrus scandens);* Virginia creeper *(Parthenocissus quinquefolia);* grape *(Vitis* spp.); American and redberry elders *(Sambucus canadensis* and *S. pubens);* nannyberry *(Viburnum lentago);* blackhaw *(V. prunifolium);* witch-hazel *(Hamamelis virginiana);* poison-ivy *(Toxicodendron radicans);* American bladdernut *(Staphylea trifolia);* coralberry *(Symphoricarpos orbiculatus);* wild hydrangea *(Hydrangea arborescens);* eastern burningbush *(Euonymus atropurpureus);* and trailing wahoo *(E. obovatus) (4,11).*

Life History

Reproduction and Early Growth

Flowering and Fruiting-Slippery elm has inconspicuous, perfect flowers that appear in the spring before the leaves, from February to May, depending on weather and location. Seeds ripen from April to June and are dispersed by wind as soon as they are ripe. Large crops are borne every 2 to 4 years, beginning after age 15 *(2).*

Seed Production and Dissemination-Seeds of slippery elm are larger than many of the native elms. They range from 77,200 to 119,000/kg (35,000 to 54,000/lb) and average 90,400/kg (41,000/lb). Dispersal is by gravity and wind (2).

Seedling Development-Seeds sometimes show dormancy and seedlings are susceptible to damping off. Germination is epigeal *(2).* Seedlings become established under a wide variety of conditions. Mineral soil seedbeds are best but seeds germinate and survive in forest litter or among grasses and other herbaceous plants. In southeastern Minnesota woodlots the species reproduces more successfully than any other except aspen *(Populus* spp.) and paper birch *(Betula papyrifera).* In Ogle County, IL, it was the third most important tree species on abandoned pastureland. On gravel bars along the Jacks Fork and Current Rivers in Missouri, slippery elm does not become an important stand component until the bars have already been invaded by pioneer species such as water-willow *(Justica* spp.), Coastal Plain willow *(Salix caroliniana),* and eastern cottonwood.

Juvenile growth of slippery elm is rapid in the open or under light shade and slightly exceeds that of American elm. In southeastern Minnesota, trees 2.5 cm (1 in) in diameter were 7 to 18 years old, depending on severity of competition.

Vegetative Reproduction-Slippery elm sprouts readily from stumps. During its seedling stage it produces sprouts from rhizomes that sometimes form reproduction less than 0.6 m (2 ft) tall in patches 9.1 m (30 ft) or more in diameter. Roots can be formed in 1 year by layering. Rootstocks of slippery elm are often used to propagate hybrid elms.

Sapling and Pole Stages to Maturity

Growth and Yield-The height growth of slippery elm is most rapid in trees 20 cm (8 in) or less in d.b.h. In a streamside forest in Illinois, slippery elm increased 10 mm (0.4 in) in d.b.h. from 25 cm (9.7 in) to 26 cm (10.1 in) in 11 years. In a stand in Polk County, WI, suppressed and intermediate trees grew 11 mm (0.43 in) while codominant and dominant trees grew 2.9 cm (1.14 in) in 8 years.

On average sites, slippery elm reaches 18.3 to 21.3 m (60 to 70 ft) in height and 61 to 91 cm (24 to 36 in) in d.b.h. On the best sites individuals may reach 41.1 m (135 ft) in height and 122 cm (48 in) in d.b.h. The largest living specimen, located in Perry County, PA, is 27.4 m (90 ft) tall and 193 cm (76 in) in d.b.h.

Reaction to Competition-On sites to which it is well adapted, slippery elm is one of the more shade-tolerant species. It is much more tolerant than quaking aspen but slightly less tolerant than sugar maple. Reproduction is erratic under fully stocked stands. In a river terrace forest in east-central Illinois, slippery elm was present in most size classes but there were no seedlings, whereas a nearby upland coppice stand contained numerous slippery elm seedlings. It is most frequently a component of the subcanopy. Overall, it is classed as tolerant of shade.

Damaging Agents-Excluding insect species that feed only on American elm, more than 125 insect species feed on trees in the elm genus *(1).* Bark beetles and wood borers generally cause little damage to vigorous trees although some can ul-

timately kill weakened or diseased trees. They also introduce stain and rot organisms into dead trees and manufactured products. The spread of Dutch elm disease is the most detrimental effect of bark beetle feeding. The smaller European elm bark beetle *(Scolytus multistriatus)* is the primary vector of this disease in the United States, but the native elm bark beetle *(Hylurgopinus rufipes, Scolytus mali,* and *Xylosandrus germanus)* are also able to transmit it.

Only a few defoliators feed exclusively on elms and even fewer feed exclusively on slippery elm. The elm calligrapha *(Calligrapha scalaris),* the elm leaf beetle *(Pyrrhalta luteola),* the larger elm leaf beetle *(Monocesta coryli), Canarsia ulmiarrosorella,* an elm casebearer *(Coleophora ulmifoliella), Nerice bidentata,* and one species of the genus *Macroxyela* usually feed only on elms. Slippery elm is especially favored by the larger elm leaf beetle. Elms are preferred hosts for *Dasychira basiflava,* fall cankerworm *(Alsophila pometaria),* spring cankerworm *(Paleacrita vernata),* whitemarked tussock moth *(Orgyia leucostigma),* the yellownecked caterpillar *(Datana ministra),* and the elm sawfly *(Cimbex americana).* Although larvae of the gypsy moth *(Lymantria dispar)* will feed on leaves of slippery elm, it is not a preferred host.

Sucking insects that feed exclusively on elm or prefer elm to most other species include elm cockscombgall aphid *(Colopha ulmicola), Tetraneura ulmi,* European elm scale *(Gossyparia spuria),* elm scurfy scale *(Chionaspis americana),* elm leaf aphid *(Tinocallis ulmifolii),* woolly apple aphid *(Eriosoma lanigerum),* and woolly elm bark aphid *(E. rileyi).* The gall aphid *(Kaltenbachiella ulmifusa)* is limited to slippery elm. The whitebanded elm leafhopper *(Scaphoideus luteolus)* is the principal vector of elm phloem necrosis,

Slippery elm has many of the same diseases as American elm (6). It is attacked and killed by Dutch elm disease caused by the fungus *Ceratocystis ulmi.* It is also killed by elm yellows or elm phloem necrosis (a mycoplasma-like organism) throughout much of its range. These two diseases are so virulent and widespread that slippery elm seldom reaches commercial size and volume as a forest tree and it is being replaced as a street tree in many localities. A dieback caused by *Dothiorella ulmi* is widespread from New England to Mississippi and has often been confused with Dutch elm disease. A leaf spot caused by *Gnomonia ulmea,* brown wood rot caused by *Pleurotus ulmarius,* white flakey rot caused by *P. ostreatus,* ustulina butt rot caused by *Ustulina vulgaris,* slimeflux and wetwood caused by *Erwinia nimipressuralis,* and nectria canker caused by *Nectria galligena* all attack slippery elm. In a survey in Davidson County, TN, infestations of mistletoe *(Phoradendron flavescens)* were more numerous on slippery elm than on any other species except American elm and white ash.

Slippery elm is also damaged by several other agents. In mixed hardwood stands, bark stripping by deer is more frequent on slippery elm than on other species. Bark stripping occurred most frequently on stems of saplings and on roots of pole-sized trees *(9).* Slippery elm also suffers crown breakage following severe ice storms in Wisconsin (3).

Special Uses

Slippery elm wood, although considered inferior to American elm, is used commercially for the same products: furniture, paneling, and containers. The seeds are eaten by birds and small animals. Deer and rabbits browse the twigs.

Genetics

Morphological observations that the *Ulmus* genera is composed of two distinct groups were confirmed with analyses of leaf flavonoids *(13).* Slippery and American elm, the unwinged species, produce kaempferol and quercetin, while the winged species produce myrictein. No studies of genetic diversity have been reported for slippery elm.

Because this species is so widely distributed, ecotypes and races probably exist. Like those of most elm species, vegetative cells of naturally growing slippery elm contain 28 chromosomes (14 pairs) and there are no genetic barriers to gene exchange among diploid elm species *(10).* Slippery elm is commonly crossed with Siberian elm *(Ulmus pumila).* The F_1 hybrids tend to have morphological characteristics intermediate between parents and grow faster than Siberian elm but the susceptibility of these hybrids, as well as three species combined with Japanese elm *(U. japonica),* to Dutch elm disease is a function of the proportion of slippery elm genes present (7). Pollination of Chinese elm *(U. parvifolia)* and September elm *(U. serotina)* with slippery elm pollen have produced hybrid seedlings.

Natural hybrids of rock elm and slippery elm have been observed in Sawyer County, WI, and along streets in Columbia, MO. Ecological isolation probably accounts for the limited occurrence of natural hybrids of these two species *(11).*

A triploid elm has been reported that was determined to be an F_1 seedling of Siberian elm x slippery elm.

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