HISTORY AND RANGE OF NORWAY MAPLE

by David J. Nowak[1] and Rowan A. Rowntree[1]

Abstract. The Norway maple, *Acer platanoides,* was introduced into the United States about 1756 after being cultivated in England since 1683. This species remained in relative obscurity in the U.S. until the mid- to late-1800's, but is now one of the most popular urban trees. In certain regions of the United States, Norway maples dominate street tree populations and commonly escape to compete with native species. The extensive use of this species in North America has led to various problems across its new range. Some of these problems may be overcome by future introductions from its native range in Eurasia.

L'érable de Norvège, *Acer platanoides*, était introduit aux Etats-Unis vers 1756 après avoir été cultivé en Angleterre depuis 1683. Cette espèce restait dans une relative obscurité aux Etats-Unis jusque vers la mi à la fin du 18e siècle, mais est maintenant une des plus populaires parmi les arbres urbains. Dans certaines régions des Etats-Unis, les érables de Norvège dominent les populations d'arbres de rues et s'échappent couramment pour compétionner avec les espèces indigènes. L'utilisation considérable de cette espèce en Amérique du Nord a entrainé des problèmes variés au travers de sa nouvelle aire de distribution. Certains de ces problèmes peuvent être surmontés par de nouvelles introductions provenant de son aire de distribution indigène en Eurasie.

Although Norway maple *(Acer platanoides)* is native to Europe, this species has been estimated as the most frequently planted and occurring street tree in the United States, with the majority of its use in the eastern and north central United States (11, 15, 20).

The reason for Norway maple's popularity as a street tree is that it has many desirable characteristics, including a vigorous early growth rate, desirable form and size, the capacity to withstand many urban impacts (e.g., pavement, moderate levels of pollution, dusts, and dry soils), and the abilities to transplant well, grow on a wide variety of soils, and withstand ice and snow damage better than other maples (14).

After the high losses in street trees due to Dutch elm disease, Norway maple was one of few species available in large enough quantities to meet replanting needs (Skiera, pers. comm., 1985). This fact, along with Norway maple's large diversity in cultivar color and form, are other reasons for this species' popularity. There are presently 89 "valid" cultivars of Norway maple (33).

The widespread use of this exotic tree species has led to various problems within its introduced North American range. This paper will review Norway maple's native Eurasian habitat and range, its introduction and early history in the United States and the environmental constraints of its range in North America.

Native Eurasian Range and Habitat

Norway maple is the most widespread native maple in Europe (33) ranging from southern Scandinavia and the Ural Mountains southwards over the greater part of Europe (except western France) to northern Spain, northern Italy, and Greece, extending into the Caucasus Mountains, Asia Minor and northern Iran (Figure 1) (12, 38). In Sweden, Norway maples grow wild as far north as latitude 63° 10' on the east coast and have been planted and exist as a shrub as far north as latitude 69° 40' on the west coast of Norway (8).

In central Germany, Norway maples are found up to an elevation of 1,650 feet; in the Vosges mountains of France, up to 2,350 feet; and as high as 4,000 feet in the Bavarian Alps (27). In the Caucasus mountains, they occur at elevations between 2,000 and 6,000 feet (8).

In Europe, Norway maple is principally a species of lowlands, wide river valleys and low mountain areas (18). The species does not form pure stands over large areas, and is generally found in small groups or as individuals in mixed forests (27).

The two most important European maple species, Norway maple and sycamore maple *(Acer pseudoplatanus),* are insect-pollinated; Norway maple flowers early, sometimes as early as the middle of April while sycamore maple flowers 3 to 4 weeks later when conditions for insect-pollination are better. This phenological difference results in sycamore maple being very common in

1. Current Address: c/o Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, 1960 Addison St. Box 245, Berkeley, CA 94701.

European mixed hardwood stands, whereas Norway maple makes up only 5 to 15 percent of the total maple reproduction (16).

In its native range, Norway maples grow best where there are high amounts of precipitation and/or an underground supply of water. They tend to be located at the base of hills where they receive surface runoff and subsurface soil water flow. They also thrive at higher elevations with sufficient precipitation (26).

Optimal growth is found on deep, fertile, moist soils that are adequately drained and have a pH of 5.5 - 6.5. The tree is rare in areas that are too wet, too dry or acidic (pH near 4) (21, 26). Its best development is on either light loamy soils, on soils moderate in clay and lime content not liable to be dried, or on rather "limy", moderately fresh, silty soils (18, 27). Sandy soils, or soils high in lime or clay content are not suitable for optimum growth (27). Rubner (32) believes that optimum conditions are found in the eastern part of the Balkan Peninsula.

Norway maple is shade tolerant when young and growing in a nutrient-sufficient soil, but is considered intermediate in shade tolerance. As the tree matures, more light is required for optimal growth (27). It is sensitive to excessive heat and late spring frosts, but is generally regarded as winter hardy. The species is adapted for cultivation by the seaside (37). Some problems in Europe are sunscald, deer browse, and water inundation (27). The tree's normal longevity is between 100 and 150 years, but in the Balkan Peninsula, they live up to 200 years (26).

In the Ukraine, moisture is the limiting factor in the southern extension of its range (17). In this region, a growing season moisture deficiency is found, however, this deficiency is believed to be partially offset by water reserves in the soil as a result of winter precipitation and by lower than average transpiration. Soil fertility and air temperature do not limit the southward expansion of Norway maple in the Ukraine (17). The Ukraine average temperature in July is close to 70°F; the maximum temperature ranges between 97°F and 102°F.

Besides being used as a street tree throughout much of Europe (22), Norway maples are also used sparingly as a lumber species with certain trees being used for veneer and/or speciality items such as tool handles, gun-stocks and violins (1, 31).

Introduction and Early History in the United States

The earliest cultivation of Norway maple in Great Britain probably occurred at the Edinburgh Botanic Garden, where James Sutherland included Norway maple 'Laciniatum' in his *Hortus Medicus Edinburgensis* of 1683 (12, 21, 33). In the United States, the first documented introduction of Norway maple was by John Bartram of Philadelphia. In 1756, Bartram corresponded with Philip Miller in England who sent him seedlings, and soon afterwards Bartram was offering Norway maples in the United States (19).

The date 1762 also has been cited for the American introduction of Norway maple (25). This date was most likely obtained by searching through early seed catalogs (McGourty, pers. comm., 1985). The only two known nurseries operating in the United States in 1762 were Bartram's Garden in Philadelphia, PA. and Prince's

Figure 1. Native range of *Acer platanoides* L. (from citation no. 38).

Nursery in Flushing, NY (24). No verification of this catalog date could be made, but it seems reasonable that 1762 is the earliest catalog date of Norway maple (most likely from Bartram's Garden).

Another introduction of Norwav maple was made by William Hamilton circa 1784 (9, 13, 24). In 1792, George Washington ordered two Norway maples from John Bartram (19). The earliest documentation of Norway maple being offered in California was by Suscol Nurseries in Napa, in 1861 (2).

In the American botanical literature of the early- to mid-1800's, there are only a few references to Norway maple. Prince (29) considered it as "one of the finest ornamental trees". Sargent (36) listed it as "Among the rarer Maples" and as the finest of all maples.

From the 1870's onward, the growing popularity of Norway maple is attested to by its increasingly frequent mention in the literature. Problems (i.e., damaged foliage and crooked growth) were already being confronted (35, 40), yet recommendations were continually made for its use as an ornamental tree (5, 7, 39). Norway maple was considered "well adapted" for streets and park avenues (43) and was regarded as sufficiently tested in America by 1883 (44). Even so, complaints were registered about the selection of Norway maple over native species (34).

The exact geographic origins of early introductions planted in the United States are difficult to determine due to a lack of records from the 1700's, and the fact that the only verified introductions were from Great Britain. It is known, however, that some early introductions into the United States were also made from southern Europe (3).

Many of the early producers of Norway maple cultivars were located in Germanv, France and Belgium (33). Therefore, it is reasonable to assume that many early importations of Norway maple seed were made from these areas of Europe. Santamour and McArdle (33) reported that it is unlikely that any significant introductions came from southern Europe.

North American Range

Norway maple performance varies across the United States and Canada due to differing environmental conditions. To determine in which geographical areas Norway maples are grown and the problems associated with those areas, a North American "urban" range map was compiled for Norway maple (Figure 2).

The boundaries of this range map were based on USDA plant hardiness zones (41), estimated average annual precipitation/evapotranspiration index (10), western climate zones (4), extrapolations of these factors and by compiling the experiences of many authorities throughout the United States and Canada (28). The boundaries on the map are approximate, delimiting general areas with different climatic conditions affecting Norway maple performance.

The map is divided into four classifications: optimal range; sub-optimal ranqe—irrigation necessary; marginal range; and sub-marginal range—not recommended. These ranges delimit only broad climatic conditions that affect Norway maples; local environmental conditions should also be considered when planting this species.

Norway maples are generally heavily utilized throughout the optimal and sub-optimal ranges, used more sparingly in the marginal range, and rarely planted in the sub-marginal range (e.g., only approximately 7 publicly planted Norway maples exist in the Los Angeles basin, CA).

Optimal climatic range. The optimal range denotes areas where Norway maples can be grown with few environmental constraints. Average rainfall and seasonal temperatures within this range generally do not limit the performance of this species as an urban tree.

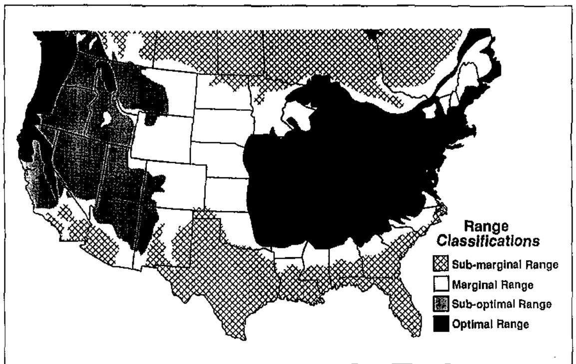

Figure 2. North American climatic range classifications of *Acer platanoides* L.

In the West, the optimal range for Norway maple growth is delimited by areas with sufficient natural precipitation (as defined by average annual precipitation/evapotranspiration index greater than one) and an average annual minimum temperature greater than -25°F (hardiness zones 4b-10a).

In the East and Midwest, the optimal range is delimited by areas within hardiness zones 4b-7b with sufficient natural precipitation. Norway maples perform well in this region, especially in the Mid-Atlantic and New England States where they have become acclimated and are seeding in naturally. Some of the major problems associated with Norway maples in the Northeast and Midwest are maple decline, Verticillium wilt, and aphids (honeydew). Although this region is noted by many authorities to be optimal habitat, irrigation may be required in relatively dry years or to enhance Norway maple performance.

Local extremes in temperature (e.g., late spring and early fall frosts) can occur in the colder areas of the optimal range. Late spring frosts are known to have killed or damaged many Norway maples in Montreal (optimal range—hardiness zone 5a) (6). Therefore, local conditions of colder "optimal" areas should be considered before planting Norway maples.

Sub-optimal climatic range—irrigation required. The sub-optimal range is found in the west and the only major limiting factor to optimal Norway maple growth in this range is insufficient moisture (average annual precipitation/evapotranspiration index less than one). Although Norway maples planted throughout much of the western U.S. (west of eastern Oklahoma, Kansas, Nebraska and South Dakota) require some irrigation, much of this area was classified as marginal range due to other problems that limit optimal growth.

Norway maples are common and perform well in the optimal and sub-optimal areas of Idaho, Oregon and Washington, and are becoming naturalized in these states in areas with sufficient moisture (e.g., along streams). They are relatively problem free in these states with the possible exception of aphids.

Marginal and sub-marginal ranges. Marginal range delimits areas where microclimate becomes very important for the successful growth of Norway maples due to detrimental environmental conditions. The sub-marginal range delimits areas where the environmental conditions are considered too severe to warrant the growth of Norway maples. These detrimental environmental conditions vary with geographic region across the United States and Canada as follows:

Central Rocky Mountains, northern United States and southern Canada. These areas are delimited as marginal range because they have an annual minimum temperature between -35°F and -25°F (hardiness zones 3b and 4a). These cold winter temperatures lead to high incidences of frost cracks and sun scald. Norway maples are not recommended for the sub-marginal range that exists throughout much of Canada and the northern plains states due to an average minimum temperature less than -35°F (hardiness zones 1 -3a).

Western Midwest. Midwestern areas with insufficient moisture and where cold winter temperatures are not a limiting factor (western Oklahoma, Kansas, and Nebraska, southern South Dakota, and eastern Wyoming and Colorado), are marginal habitat due to low moisture and humidity, high summer temperatures and strong winds which create desiccating conditions. These factors lead to high incidences of leaf scorch and slow growth. Norway maples perform better in this region when planted in areas protected from winds or in stream bank areas which offer protection and moisture.

Southeastern United States. The marginal range in the Southeast corresponds predominantly to hardiness zone 8a. Areas of the Southeast are considered marginal and sub-marginal mainly due to excessive heat and high summer evapotranspiration. These conditions lead to severe foliar problems, especially leaf scorch and slow growth. Although heat was not a limiting factor in the southern range of Norway maple in the Ukraine (17), the sources of Norway maples in the United States are most likely from cooler provenances of Western Europe.

Southwestern United States. Norway maples are not recommended for use in areas of southern California and southwestern deserts due to intense sun, heat and dryness. Although Norway maple is moderately tolerant of alkaline soils, the soils of the Southwest can cause problems, such as leaf burn, where soil pH is too high. Other problems associated with Norway maples in the Southwest are aphids, leaf scorch (due to low humidity and high summer temperatures) and slow growth.

Part of the problem of slow growth of Norway maples across the southern United States may be related to photoperiod. The southern United States is well below the species' natural southern range in Eurasia: 37°N latitude. Compounding this southern range extension is the likelihood that many of the early introductions were from Western Europe, approximately 43°N to 55°N latitude. Norway maple is considered a long day plant and short day conditions, like those of the southern United States, can reduce growth in long day plants (42).

Lack of chilling requirement does not appear to be a problem in warmer areas because Norway maples grow within hardiness zone 10a in Los Angeles County, with an average annual minimum temperature of 30°F to 35°F.

Cultivar selection can also influence Norway maple performance. Red-leaved and variegated varieties tend to exhibit more problems than green-leaved varieties in areas with hot summers (Warren, pers. comm., 1985).

Conclusions

The best regions for growth of Norway maples in the United States are the Northeast, eastern Midwest and the Northwest. Although moisture can be limiting in the Northwest, moisture problems can be overcome with irrigation.

The major limitations to optimal growth in North America appear to be cold temperatures, excessive heat, high soil pH and excessive evapotranspiration. Some of these limitations may be overcome by proper site selection.

Certain of these problems may also be overcome by the introduction and testing of new Norway maple stock from Europe. Future introductions promise to improve Norway maple performance in the North. Improvements in cold hardiness could most likely be made by introductions of Norway maples from the central U.S.S.R. (the easternmost portion of its native range) where average annual absolute minimum temperatures are below -40°F (23).

It is unlikely, however, that future introductions will overcome the limitations to optimal growth that occur in the Southeast and Southwest because of a combination of three geographical differences between these regions and Norway maple's native range: climate, elevation and latitude.

Climate. The Southeast has a humid subtropical climate while much of the Southwest has an arid mid-latitude climate. These climatic types are not found within Norway maple's native range (30).

Elevation. All of the southern range extensions (below approximately 45°N latitude) in Europe occur in mountainous regions (30). These mountainous regions will generally have delayed phenological events and a cooler climate (similar to farther north in its range) than lower elevational areas of equal latitude. Most of the "problem" areas of the Southeast and Southwest occur at relatively low elevations.

Latitude. Southern United States latitudes are below the natural southern range of Norway maple in Europe. Planting this species farther south than its native range will likely lead to photoperiod problems.

Acknowledgments. We would like to thank Dr. Norman Richards for his assistance throughout this study and Russell Beatty for his review and comments on an earlier draft of this paper.

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USDA Forest Service
Northeastern Forest Experiment Station
Syracuse, NY 13210