Bacterial Leaf Scorch of Landscape Trees: What We Know and What We Do Not Know

James L. Sherald

Abstract. *Xylella fastidiosa* has been recognized as a pathogen of landscape trees for over 25 years. Collectively, these diseases are referred to as bacterial leaf scorch (BLS). Arborists, property owners, and communities are now beginning to recognize BLS as a serious threat to the urban forest. Although advances in symptom awareness and diagnostic techniques have enabled arborists to diagnose BLS, there are many questions regarding host range, transmission, pathogeneses, disease management, and individual tree therapy that remain unanswered.

Key Words. Alternative hosts; BLS; leafhoppers; Pierce's disease; *Xylella fastidiosa.*

Diseases caused by the fastidious, xylem-limited bacterium *Xylella fastidiosa* have been known for well over 100 years. Pierce's disease of grape, or the California vine disease, was reported in California, U.S. in 1892 (Pierce 1892) and phony disease of peach, a dwarfing disorder, was reported in Georgia in the late 1880s (Cochran and Hutchins 1974). At first, the relatedness of these disorders was not recognized; however, both diseases were thought to be viral in nature and transmissible by grafting and by leafhoppers. The first indication of a bacterial etiology occurred in 1971 when the antibiotic tetracycline was shown to suppress the symptoms of Pierce's disease (Hopkins and Mortensen 1971). Later, electron microscopy showed the presence of rippled-walled, rickettsia-like bacteria in xylem tissue of symptomatic grape and peach (Goheen et al. 1973; Hopkins and Mollenhauer 1973; Hopkins et al. 1973; Nyland et al. 1973). Successful isolation of the pathogen by Davis et al. (1978) led to the description of *X. fastidiosa* as a new species of plant pathogenic bacteria in 1987 (Wells et al. 1987). Since then, *X. fastidiosa* has been associated with several major diseases (Table 1).

Diseases caused by *X. fastidiosa* are confined primarily to the Americas, where they have significant economic importance for several major crops such as grape, alfalfa, peach, almond, citrus, and coffee. The recent arrival of the glassy-winged sharpshooter leafhopper in California in the 1990s has greatly increased the economic threat of Pierce's disease, almond leaf scorch, and oleander leaf scorch (Purcell and Saunders 1999a).

Xylella fastidiosa has been recognized as a pathogen of landscape trees since 1980 when xylem-limited bacteria serologically related to the Pierce's disease bacterium were found in leaf scorch-affected elms, sycamores, and oaks (Hearon et al. 1980). Over the last 25 years, *X. fastidiosa* has been found in over 40 species of landscape trees (Table 2). Leaf scorch diseases caused by *X. fastidiosa* are commonly referred to as bacterial leaf scorch (BLS). Today, BLS of elm, oak, and sycamore are recognized as major diseases of street and landscape trees in the mid-Atlantic and southeastern United States (Sherald 2001; Gould and Lashomb 2005).

BLS is a chronic disorder that affects trees over many years. Symptoms first appear in a single branch or segment of the crown and spread through the crown in subsequent years. Leaf symptoms develop in midsummer and progress in severity toward fall. Depending on the species, leaves develop various patterns of marginal and interveinal necrosis (Sherald 2001; Gould and Lashomb 2005). Elms develop a distinct undulating marginal necrosis bordered by a chlorotic halo; sycamores develop an irregular interveinal necrosis with zones of light and dark reddish brown tissue. In both elm and sycamore, symptoms usually progress in severity from the older to the younger leaves on the branch and affected leaves abscise early. Some oak species develop a marginal necrosis with a reddish band of tissue separating necrotic from green tissue. However, symptoms are not always distinct. In pin oak, BLS simply appears as early senescence with no distinct pattern of necrosis. Reductions in growth and seed set, as well as flower bud abortion, have all been reported in some hosts. Although BLS is a vascular disease, there is no vascular discoloration. Long-affected trees eventually develop dieback, which may be a consequence of BLS as well as other factors affecting the stressed tree. Infected trees are usually removed before they die because of their appearance or potential hazard.

Recognition of *X. fastidiosa* as a pathogen of landscape trees has been an important advance, because many leaf scorch and decline symptoms in trees were previously attrib-

Table 1. Diseases caused by *Xylella fastidiosa*.

Disease	Reference
Alfalfa dwarf	Goheen et al. 1973
Almond leaf scorch	Mircetich et al.1976
Bacterial leaf scorch of landscape trees (BLS)	(Table 2)
Citrus variegated chlorosis	Chang et al. 1993; Lee et al. 1993
Coffee leaf scorch	deLima 1998
Oleander leaf scorch	Purcell et al. 1999c
Peach phony disease	Hopkins et al. 1973
Pear leaf scorch	Leu and Seu 1993
Pecan leaf scorch	Sanderlin and Heyderich-Alger 2000
Periwinkle wilt	McCoy et al. 1978
Pierce's disease of grape	Goheen et al. 1973; Hopkins and Mollenhauer 1973
Plum leaf scald	Kitajima et al. 1975

uted, and sometimes treated, for various other biotic and abiotic disorders. Although recognition of the pathogen is an important first step, there are many unanswered questions about *X. fastidiosa* and the diseases it causes in landscape tress.

The economic consequences of *X. fastidiosa* in agronomic commodities such as grape, almond, citrus, and coffee are well recognized and provide significant impetus and support for research that indirectly benefits our understanding of BLS. Although some local and statewide surveys of BLS have been performed (Sherald et al. 1994; Sherald 2001; Lashomb et al. 2002), the compensatory and ecological losses caused by *X. fastidiosa* in the urban forest are only barely appreciated. A survey of oaks in several New Jersey communities found 30% to 35% of the highly susceptible oak species exhibiting symptoms. The economic impact of the disease was estimated to be between $0.7 and $1.6 million over the next 10 years (Gould et al. 2004). Hopefully, further studies like this will heighten the awareness of the significance of these diseases and encourage support for the research needed to answer the questions presented in this article.

HOST RANGE

Xylella fastidiosa has a wide host range, including over 150 species in 30 families of dicotyledonous and monocotyledonous plants (Freitag 1951; Raju et al. 1980; Raju et al. 1983; Hopkins and Adlerz 1988; Hill and Purcell 1995; McElrone et al. 1999; Hartman et al. 2001; Costa et al. 2004; Wistrom and Purcell, 2005; Shapland et al. 2006; XYLELLA FASTIDIOSA 2006). Currently, more than 40 tree species have been identified as hosts (Table 2). Although *X. fastidiosa* is difficult to isolate and grow in culture, diagnostic tools such as enzyme-linked immunosorbent assay (Sherald and Lei 1991), polymerase chain reaction (PCR) (Pooler and Hartung 1995), and immunomagnetic separation followed by PCR (Pooler et al. 1997) can detect *X. fastidiosa* in tissue extracts.

Undoubtedly, additional hosts, including trees and other landscape plants, will continue to be discovered using these and possibly other tools. Although many hosts are asymptomatic, they may still provide an alternative source of inoculum for tree infections. The high incidence of Pierce's disease along the edges of vineyards has demonstrated that alternative hosts inhabiting the riparian edges are the primary source of inoculum (Hewitt et al. 1949; Goodwin and Purcell 1992). Hosts such as porcelain berry (*Ampelopsis brevipedunculata*), Asiatic bittersweet (*Celastrus orbiculatus*), mugwort (*Artemisia* spp.), goldenrod (*Solidago fistulosa*), English ivy (*Hedera helix*), Virginia creeper (*Parthenocissus quinquefolia*), periwinkle (*Vinca major*), blackberry (*Rubus* spp.), Bermuda grass (*Cynodon dactylon*), annual bluegrass (*Poa annua*), perennial ryegrass (*Lolium perenne*), elderberry (*Sambucus* spp.), and wild grape (*Vitis* spp.) (Freitag 1951; Hopkins and Adlerz 1988; Sherald and Kostka 1992; McElrone et al. 1999; Hartman et al. 2001; XYLELLA FASTIDIOSA 2006) are common cultivated or wild-edge inhabitants in suburban and urban landscapes. These hosts may be significant factors in BLS epidemiology and may account for the prevalence of BLS in landscape settings rather than in forests. However, although *X. fastidiosa* may multiply in many hosts, not all hosts will support large bacterial populations nor will all hosts experience systemic spread of the pathogen (Hill and Purcell 1995; Purcell and Saunders 1999b; XYLELLA FASTIDIOSA 2006). Furthermore, their importance as alternative hosts also depends on their attractiveness to leafhoppers or other insect vectors. Therefore, it is unlikely that all alternative hosts pose equal threats to tree populations. Unraveling the relationships among tree hosts, alternative host reservoirs, and insect vectors is a major challenge with significant bearing on BLS management.

TRANSMISSION

Xylem-feeding, sharpshooter leafhoppers in the subfamily Cicadellinae were known vectors of the causal agents responsible for Pierce's disease, alfalfa dwarf, and phony peach disease long before *X. fastidiosa* was identified as the pathogen (Hewitt et al. 1942; Houston et al. 1947; Turner 1949; Turner and Pollard 1959). Today, at least 24 species of leafhoppers are known vectors of Pierce's disease (Frazier 1965) and 19 leafhopper species are vectors of alfalfa dwarf (Frazier 1944; Frazier and Freitag 1946). Four species of spittlebug, family Cercopidae, were found to be capable of transmitting *X. fastidiosa* in Pierce's disease and alfalfa dwarf (Severin 1950). The glassy-winged sharpshooter (*Homalodisca coagulata*), GWSS, is one of the most important vectors. GWSS is endemic to the southeastern United States, where it is a major vector of *X. fastidiosa* in peach and grape. Since its arrival in California in the 1990s, it has become a serious threat to the California grape and almond industry and may become a threat to the citrus industry if the *X. fastidiosa* strains respon-

Table 2. Tree Hosts of *Xylella fastidiosa*.

Scientific name	Common name	Reference[z]
Albizia julibrissin	Silk tree	Wong et al. 2004
Acer negundo	Boxelder	McElrone et al. 1999
A. rubrum	Red maple	Sherald et al. 1987; Blake 1993; Hartman et al. 1996
A. saccharinum	Silver maple	Hartman 2002
A. saccharum	Sugar maple	Hartman et al. 1996
Cercis occidentalis	Western redbud	Wong et al. 2004
Chitalpa tashkinensis	Chitalpa	Randall et al. 2007
Cornus florida	Flowering dogwood	McElrone et al. 1999
Celtis occidentalis	Hackberry	Beale et al. 2002
Fagus crenata	Japanese beech (bonsai)	Huang et al. 2003
Ginkgo biloba	Maidenhair tree	Wong et al. 2004
Jacaranda mimosifolia	Jacaranda	Wong et al. 2004
Juglans	Walnut	Wong et al. 2004
Liquidambar stryaciflua	Sweetgum	Long 1994; Hartman et al. 1996; Wong et al. 2004
Magnolia grandiflora	Southern magnolia	Wong et al. 2004
Morus alba	White mulberry	Kostka et al. 1986b; Wong et al. 2004
Platanus occidentalis	American sycamore	Sherald et al. 1983; Haygood et al. 1988; Hopkins and Adlerz 1988; Blake 1993; Hartman et al. 1996
P. × acerifolia	London Plane	Sherald 2001
P. mexicana	Mexican sycamore	Sherald 2001
Olea europea	Olive	Wong et al. 2004
Phoenix reclinata	Senegal date palm	Wong et al. 2004
Prunus cerasifera	Ornamental palm	Wong et al. 2004
Quercus alba	White oak	Long 1994
Q. bicolor	Swamp oak	Long 1994
Q. coccinea	Scarlet oak	Hearon et al. 1980; Kostka et al. 1984; Long 1994
Q. falcata	Southern red oak	Hopkins and Adlerz 1988
Q. imbricaria	Shingle oak	Hartman et al. 1995; LG[z]
Q. incna	Bluejack oak	Barnard et al. 1998
Q. laevis	Turkey oak	Barnard et al. 1998
Q. laurifolia	Laurel oak	Hopkins and Adlerz 1988
Q. macrocarpa	Bur oak	Hartman et al. 1995
Q. nigra	Water oak	Long 1994; Hartman et al. 1995
Q. paulustris	Pin oak	Kostka et al. 1984; Long 1994; Hartman et al. 1995
Q. phellos	Willow oak	Long 1994
Q. prinus	Chestnut oak	Long 1994
Q. rubra	Northern red oak	Long 1994; Hartman et al. 1995; Hearon et al. 1980
Q. shumardii	Shumard oak	Mullen 1993; LG
Q. stellata	Post oak	Long 1994
Q. velutina	Black oak	Huang 2003
Q. virginiana	Live oak	Mullen 1993
Ulmus americana	American elm	Wester and Jylka 1959; Sherald 1993
U. glabra	Wych elm	Kostka et al. 1982
U. pumila	Siberian elm	Kostka et al. 1982

[z]LG = Longwood Gardens, Kennett Square, PA (pers. comm.).

sible for citrus variegated chlorosis are introduced (Purcell and Saunders 1999a; XYLELLA FASTIDIOSA 2006).

Currently, no insects have been proven to be vectors of *X. fastidiosa* in landscape trees. However, *X. fastidiosa* has been found in seven leafhopper species captured on elm and oak and some of these are recognized vectors of *X. fastidiosa* in other diseases (Bentz and Sherald 2001). In addition to

known sharpshooter leafhopper vectors, three species of tree-hopper, which are abundant in oak, were also been found carrying *X. fastidiosa* (Bentz and Sherald 2001). Treehoppers could be a new group of vectors that play a significant role in the transmission of *X. fastidiosa* in trees.

It should be recognized that although many leafhoppers may carry *X. fastidiosa*, they are not equally efficient in trans-

mission. Successful transmission is driven by several factors, including their affinity for the host, seasonal host susceptibility, and the vector's feeding habits (Day and Bennetts 1954; Turner and Pollard 1955; Purcell 1979). Determining the vectors is essential in understanding the epidemiology of BLS. Once vectors have been identified, factors such as their preferred habitat, alternative host preferences, and seasonal periods of transmission can be examined. Knowing the vectors and understanding their biology is fundamental in devising disease management strategies.

Xylella fastidiosa is a graft-transmissible, systemic pathogen and caution should be exercised in the vegetative propagation of susceptible hosts. There is potential for root graft transmission; however, there is no epidemiological or direct evidence that root graft transmission of *X. fastidiosa* occurs in landscape trees. Root graft transmission should be investigated because the opportunities for root grafts are common in landscape settings. Natural root graft transmission of citrus variegated chlorosis has been demonstrated in potted sweet oranges (He et al. 2000).

Because *X. fastidiosa* has been notoriously difficult to isolate and grow in culture, it is assumed that there is little likelihood of it being mechanically transmitted in the course of routine pruning. However, until this avenue of transmission is experimentally proven to be ineffective, caution is still warranted and pruning tools should be disinfected.

PATHOGEN

Xylella fastidiosa is a Gram-negative, rod-shaped bacterium that has specific nutritional requirements. Based on an analysis of 25 strains isolated from ten hosts, *X. fastidiosa* was described as a single species (Wells et al. 1987). However, genetic and phenotypic variation within the species has long been recognized and host-specific pathotypes have been identified. For example, strains shown to cause Pierce's disease of grape also cause almond leaf scorch and alfalfa dwarf (Mircetich et al. 1976; Davis et al. 1980). Similarly, the strain or strains responsible for phony peach disease are also responsible for plum leaf scald (Wells et al. 1981). Strains causing citrus variegated chlorosis (CVC) are closely related to strains responsible for coffee leaf scorch (CLS) and can cause CLS symptoms when inoculated into coffee (Li et al. 2001). Strain relationships become more complex when genetically distinct strains cause similar symptoms in the same host. Strains responsible for CVC and CLS are readily distinguishable from Pierce's disease strains yet can cause Pierce's disease symptoms in grape, whereas Pierce's disease strains do not cause symptoms in citrus (Li et al. 2002). Reciprocal transmission studies involving shade trees have only been performed with isolates from elm and sycamore and in this study, symptoms could only be produced in the species from which the isolate was obtained (Sherald 1993).

Recently, three subspecies of *X. fastidiosa* have been described: two North American subspecies, *X. fastidiosa* subsp. *piercei* and *X. fastidiosa* subsp. *multiplex,* and a South American subspecies, *X. fastidiosa* subsp. *pauca* (Schaad et al. 2004). A fourth subspecies, *X. fastidiosa* subsp. *sandyi,* has also been proposed for oleander leaf scorch isolates (Schuenzel et al. 2005). Subspecies classification of *X. fastidiosa* strains responsible for BLS is far from resolved. Oak leaf scorch strains have been placed in *X. fastidiosa* subsp. *multiplex* (Schuenzel et al. 2005). Schaad et al. (2004) have placed a maple strain in *X. fastidiosa* subsp. *piercei* and sycamore and elm strains in *X. fastidiosa* subsp. *multiplex.* Although strains may be readily distinguished by molecular and genetic techniques, host response is the most meaningful test of strain significance and the hardest to demonstrate. The relationships of strains to hosts, both primary and alternative, as well as to insect vectors are numerous, complex, and very difficult to unravel. Understanding these relationships may have important disease management implications.

Survival and growth of *X. fastidiosa* are likely dependent on several factors, including temperature. Studies of Pierce's disease strains have shown that rapid growth occurs between 25 and 32°C (77°F and 89.6°F). Temperatures below 12°C to 17°C (53.6°F to 62.6°F) and above 34°C (93.2°F) adversely affect survival of the pathogen (Feil and Purcell 2001). The significance of warm temperatures is demonstrated by the fact that symptoms of Pierce's disease appear earlier in warmer areas and expand beyond their normal range after mild winters (Feil and Purcell 2001). Temperature optimums have not been determined for strains associated with landscape trees. Occurrences of BLS in Kentucky, Pennsylvania, New Jersey, New York, and southern Ontario suggest a greater tolerance of colder temperatures. However, like Pierce's disease and the other diseases caused by *X. fastidiosa,* BLS occurs predominantly in the southern and mid-Atlantic states where winters are mild. As global warming increases, BLS may expand further north and the incidence and severity of these diseases could increase throughout their range. This would be a consequence of several factors, including an increase in the survival and growth of the pathogen, an increase in the growing season and period of susceptibility of the host, and an increase in heat and moisture stress.

PATHOGENESIS

The process by which *X. fastidiosa* causes disease is not completely understood. Phytotoxins, growth regulator imbalance, and water stress have all been considered possible mechanisms of pathogenesis (Hopkins 1989). Physiological studies have shown a relationship between occluded vessels and symptom development in grape (Hopkins et al. 1977, 1981). In elm, Kostka et al. (1986a) showed a reduction in stem hydraulic conductivity and stem water potential in infected elms. Numerous observations of *X. fastidiosa in planta*

have shown that bacteria occur in a slime-like matrix, or biofilm glycocalyx, which likely occludes tracheary elements (Mollenhauer and Hopkins 1974; Hearon et al. 1980; Chagas et al. 1992). *Xylella fastidiosa* is the first plant pathogen for which the complete genome has been sequenced, providing insight into the organism's pathogenic potential (Simpson et al. 2000). Examination of the genome found that *X. fastidiosa* has the capacity to produce biofilm extracellular polysaccharides (EPSs). Biofilms are significant in the pathogenesis of many plant and mammalian pathogens enabling bacteria to attach to the host, colonize, and share enzymatic functions. Mutants lacking the ability to produce EPSs are usually nonpathogenic. Marques et al. (2002) have proposed that the biofilm is a likely virulence factor in *X. fastidiosa*.

Intraplant movement is critical for pathogenicity. The genome showed evidence of pectolytic enzymes capable of breaching the pit membranes between vessels. Genes were also found for encoding proteins necessary for the development of fimbriae or pili that are commonly observed on the polar ends of *X. fastidiosa*. Pili play an important role in bacterial colonization, enabling bacteria to attach to each other as well as to insect and plant hosts. Pili also provide twitching motility, which enables *X. fastidiosa* to move upstream from the point of inoculation against acropetal sap flow (Meng et al. 2005).

The mechanisms of pathogenesis may vary among hosts. The presence of genes encoding for the metabolism of iron and other metals suggests that some symptoms such as leaf variegation in CVC may be a consequence of the reduction of essential micronutrients in xylem fluid (Simpson et al. 2000). It is interesting that in phony peach disease, alfalfa dwarf, and ragweed stunt, *X. fastidiosa* simply causes a reduction in growth. It remains to be seen whether this response is solely a consequence of a reduction in water transport or some other mechanism.

MANAGEMENT

Currently, we do not know how to limit the spread of BLS or how to cure a BLS-infected tree. Typically, the first line of defense in plant disease management is sanitation, the removal of infected hosts. However, the chronic nature of BLS means that infected trees can remain aesthetically acceptable in the landscape for a long time before they must be removed. Because we do not even know if direct spread from tree to tree is a common occurrence, it is probably not advisable to engage in an aggressive sanitation program to remove infected trees when their removal may have little value in limiting disease spread. In Pierce's disease, removal of infected grapes did not reduce spread (Hewitt et al. 1949).

The host range for *X. fastidiosa* is extensive and far from completely known. Identification and removal of alternative host reservoirs may be an effective approach in reducing the incidence of BLS. However, the significance of alternative

reservoirs must first be confirmed. Some alternative hosts such as the invasive exotic species porcelain berry and Asiatic bittersweet are extremely pervasive and some leafhoppers can fly for long distances. Consequently, aggressive removal of these hosts over large areas will be difficult.

An important research priority is to determine the significant insect BLS vectors. Understanding their life histories, including range of flight, preferred habitats, and hosts, is essential to prescribe management strategies. Because leafhoppers are generally active for long periods and *X. fastidiosa* persists in the adults, long-term canopy protection with insecticides would be necessary. In the landscape, particularly in large municipal plantings, routine insecticide treatments are not an attractive or practical management approach. Management of vector habitats and alternative hosts may be useful. Pierce's disease occurs most commonly near riparian and other edge areas where leafhoppers overwinter and where alternative hosts occur (Hewitt et al. 1949; Purcell 1975; Goodwin and Purcell 1992). Recently, riparian vegetation management practices for Pierce's disease have been developed (Pierce's Disease/Riparian Habitat Workgroup 2000). These practices prescribe the removal of host plants preferred by the blue–green sharpshooter for reproduction as well as the removal of systemic alternative hosts of *X. fastidiosa*, particularly invasive exotics. These species are replaced with native riparian plants that are not preferred by leafhopper or *X. fastidiosa* hosts.

When symptoms first appear, if they are localized on a single branch, an attempt should be made to prune out the infection. The disease is chronic and in some hosts and individual trees, it may spread slowly, providing the opportunity to remove the infection before it becomes systemic throughout the tree. Because there is no way to know how far beyond the obvious symptoms the bacteria have gone, it is advisable to prune the branch as far beyond the visible symptoms as possible without destroying the aesthetic value of the tree. Studies to determine the spread of *X. fastidiosa* beyond obvious symptoms and the development of rapid techniques for tracing infections would be very helpful in directing therapeutic pruning. Pruning is being used to manage CVC in Brazil.

It has long been suspected that abiotic drought stress would exacerbate the effect of *X. fastidiosa*. McElrone et al. (2001) demonstrated that drought stress enhanced symptom progression and severity in Virginia creeper (*Parthenocissus quinquefolia*) artificially inoculated with *X. fastidiosa*. Horticultural practices that enhance root growth and minimize moisture stress may reduce symptom severity and prolong the life of infected trees.

Chemotherapy with injected oxytetracycline has caused symptom remission but has not been effective in curing infected trees (Kostka et al. 1985; Chang and Walker 1988). The growth regulator paclobutrazole (PBZ) has been found to

reduce leaf scorch symptoms in oak (The Bartlett Tree Research Laboratories, pers. comm.). PBZ's growth regulator capacity may enhance the water efficiency of the plant, thus reducing symptom expression and the effect on the tree. Recent studies have also shown that PBZ at a rate of 20 μg/mL^{-1}, ten times higher than the labeled rate, reduced *in vitro* growth of *X. fastidiosa* (DeStephano 2005). The effect on *in vitro* growth may be a consequence of the disruption of sterol biosynthesis (Sugavanam 1984; Burden et al. 1987; Radenmacher 1987). These studies have been largely exploratory so there is still considerable research that should be done involving a range of host and pathogen-affecting compounds and methods of application, including integrated and repeated treatments. The chronic nature of BLS provides an expanded window for a series of therapies that may ultimately be necessary to cure infected trees. Novel approaches such as biological control may also hold promise. Recently, a benign strain of *X. fastidiosa* was found to be effective in providing induced resistance to Pierce's disease (Hopkins 2005).

The most lasting and practical approach to BLS management in landscape trees would be to find disease-tolerant selections. Tolerance has been found in grape, plum, and alfalfa and tolerance may exist in other hosts as well (Purcell 1979). Unfortunately, screening for tolerance is difficult because of the fastidious nature of the pathogen, the slow and erratic nature of symptom development, and the difficulties associated with working with woody plants. Genetic engineering is being considered in the development of Pierce's disease resistance and may also offer promise for landscape trees.

The recognition of *X. fastidiosa* as a pathogen of landscape trees has been a significant advance over the last 25 years. Previously, leaf scorch and decline symptoms have been incorrectly attributed to a wide range of abiotic stressors and pathogens. Now that we are able to diagnose BLS with confidence, we must focus research on the difficult questions presented here, which are pertinent to controlling the spread and treatment of BLS.

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James L. Sherald
Chief, Natural Resources and Science
Center for Urban Ecology
National Capital Region
National Park Service
4598 MacArthur Boulevard, N.W.
Washington, DC 20007-4227, U.S.
jim_sherald@nps.gov

Résumé. *Xylella fastidiosa* a été reconnu comme étant un pathogène des arbres ornementaux depuis plus de 25 ans. Collectivement, ces maladies sont référencées sous le terme de roussissure bactérienne. Les arboriculteurs, les propriétaires et les municipalités commencent maintenant à reconnaître la roussissure bactérienne comme une menace sérieuse à la forêt urbaine. Alors que les avancées dans la surveillance des symptômes les techniques de diagnostic ont donné des moyens aux arboriculteurs pour diagnostiquer la roussissure bactérienne, il subsiste de nombreuses questions toujours non résolues en regard du champ de l'hôte, de la transmission, de la pathogénèse, de la gestion de la maladie et de la thérapie pour les arbres.

Zusammenfassung. Xylella fastidiosa ist seit über 25 Jahren als Pathogen bei Landschaftsgehölzen bekannt. Zusammenfassend spricht man bei diesem Erregerbild von Bakterieller Blattwelke oder BLS. Arboristen, Landeigentümer und Kommunen beginnen nun, diese Krankheit als eine ernsthafte Bedrohung für urbanes Grün zu sehen. Während Fortschritte in der Symptomerkennung und Diagnose-Techniken den Arboristen helfen, BLS zu diagnostizieren, so bleiben doch viele Fragen bezüglich des Wirtsspektrums, Übertragung, Pathogenese, Krankheits-Management und individuelle Baumtherapie offen.

Resumen. *Xylella fastidiosa* ha sido reconocido por 25 años como un patógeno de los árboles urbanos. Colectivamente esta enfermedad es referida como Quemadura Foliar Bacterial (BLS, por sus siglas en inglés). Los Arboristas, los propietarios y las comunidades están ahora empezando a reconocer BLS como una amenaza seria para los bosques urbanos. Mientras los avances en las técnicas de diagnóstico han habilitado a los Arboristas para diagnosticar BLS, hay muchas interrogantes que aún permanecen sin respuesta con relación a rango del hospedero, transmisión, patogénesis, manejo de la enfermedad y terapia de los árboles individuales.