SECTION 4
ENTOMOLOGY

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Impact of Environmental Conditions on Arthropod Species Diversity in Dogwoods

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Nature of Work: In the last decade, the flowering dogwood, *Cornus florida*, has become threatened by a fungal disease, dogwood anthracnose, caused by *Discula destructiva* Redlin. Symptoms include leaf spots, twig blights, and limb/trunk cankers, which lead to the eventual death of the tree (1). Mortality of the flowering dogwood is extremely high in forested areas, such as the Great Smoky Mountains National Park, where dogwood density has declined in recent years. Little information about the transmission of this pathogen is available. Spores of the *Discula* sp. are often dispersed by wind or rain (3). In most cases, some type of mechanical injury often allows for the introduction of the pathogen. Researchers have suggested that insect species also may play an important role in epidemiology of dogwood anthracnose. Because of concern about the possible loss of dogwoods from the forest ecosystem and the potential impact on the arthropod community, a two-year research project was initiated to determine insect species associated with flowering dogwood in a forest habitat.

During 1993, insects were collected bimonthly from May to October from individual dogwood trees at three sites (Cades Cove, Mt. Sterling, and Rich Mountain) in the Great Smoky Mountains National Park in eastern Tennessee. These sites were selected based on the presence of anthracnose-infected (diseased) and non-infected (healthy) trees (Table 1). Three diseased and three healthy trees were randomly selected at each site. On each sampling date, plastic tarps were placed underneath the tree canopy. A selected insecticide, Pyrenone® (a pyrethrin [botanical]), was then applied, in a ratio of 10ml/3.8 liter of water, to the canopy of the tree using a hand-held sprayer. Fallen insects were removed from the tarps using a modified Dustbuster®, placed in plastic containers, and taken to the laboratory for processing and identification. All insects will be identified to species, where possible. This entire experiment will be repeated during 1994. At the conclusion of this two-year study, insect populations and communities will be compared between dogwood anthracnose-infected and non-infected trees. Species diversity indices will be calculated, and seasonal incidences of selected species will be evaluated.

Results and Discussion: Approximately 8,000 insects were collected from dogwoods in the Great Smoky Mountains National Park during 1993. Insect populations and communities were similar for both healthy and diseased trees at each location. The three most common orders represented were Coleoptera, Diptera, and Hymenoptera. Dipterans made up a lower percentage of the total number collected at Cades Cove (a low elevation site) than at Rich Mountain (a moderate elevation site). At Rich Mountain, dipterans comprised ca. 50% of all insects collected. Insect densities were lowest at the highest elevation (Mt. Sterling), where ca. twice as many insects were collected from healthy trees than diseased trees. Average insect densities/tree sample were greatest during May and June, peaking in mid- to late-June, at Cades Cove (Low Elevation) (Fig.

1) and Rich Mountain (Moderate Elevation). However, at the highest elevation (Mt. Sterling), insect densities were greatest during July. Seasonal fluctuations of insect densities were similar between healthy and diseased dogwood trees at all locations.

Significance to Industry: In previous studies conducted in the Great Smoky Mountains National Park, incidence of *Discula* conidia occurred in May and June. In our study, peak numbers of insects were also found during this time period. Previous greenhouse and laboratory studies, using the convergent lady beetle, *Hippodamia convergens*, as a model, have demonstrated that insects can disseminate viable conidia to healthy dogwood foliage and that the foliage can develop lesions symptomatic of dogwood anthracnose (2). Incidence of dogwood anthracnose and mortality of flowering dogwood are extremely great at the higher elevations. Researchers estimate that dogwoods may be lost as a component of the forest ecosystem from these areas. This research will provide a better understanding of insect species associated with flowering dogwood in a forest habitat. Future experiments will determine if insects collected in the Great Smoky Mountains National Park during May and June are carrying *Discula* spores on their bodies.

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Table 1. Elevational and disease comparisons among sampling sites within the Great Smoky Mountains National Park.

SITE	ELEVATION	DISEASE COMPARISON
Cades Cove	Low (603 m)	Low vs. Moderate (3.9%)a (36.1 %)
Rich Mountain	Moderate (835 m)	Low vs. Moderate (5.5%) (31-3%)
Mt. Sterling	High (1,219 m)	Moderate vs. Severe (46.7%) (88.3%)

[a]Number represents average percent infected foliage/tree.

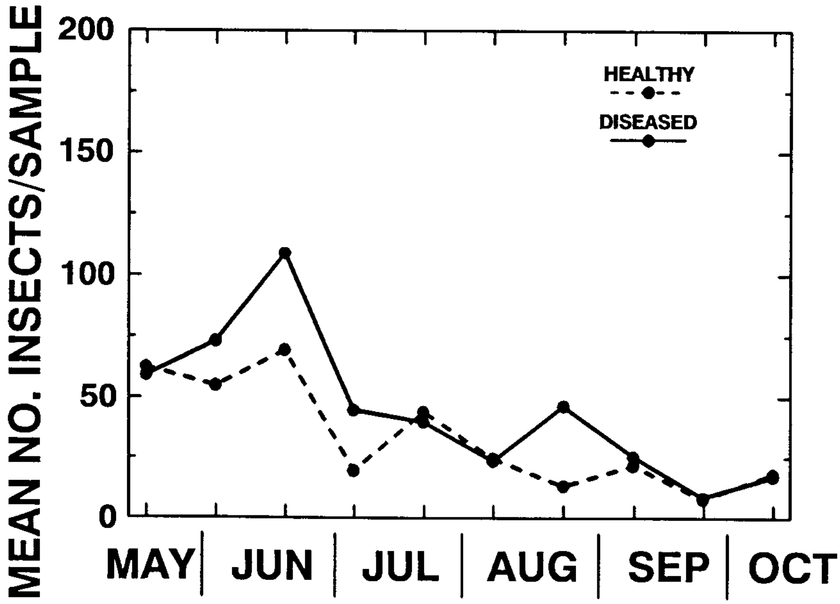

Figure 1. Average insect densities on anthracnose-infected (diseased) and non-infected (healthy) dogwoods at Cades Cove, 1993.

Tedders Trap: A Useful Tool for Monitoring Insect Pests in Shade Tree Farms

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Nature of Work: The larvae of many wood-boring beetles in the families Buprestidae and Cerambycidae are serious pests of shade trees (Johnson and Lyons). These larvae tunnel into conducting tissues of plants and cause additional damage by providing an entrance for fungi and other pests. Basic knowledge on the identification and biology of the various species of Buprestid and Cerambycid beetles damaging trees is lacking. The purpose of this study is to identify insects present in shade tree farms and to monitor the time of year pests are present and susceptible to control measures.

Traps designed by W. L. Tedders (Tedders and Wood 1994) were placed in four shade tree farms in Grady, Pickens, Meriweather and Morgan Counties, Georgia, for the purpose of monitoring insect populations within plantings of maple trees. Twenty-four traps were used per farm. Six traps were unbaited. Six traps were baited with ethanol, six with turpentine, and six with a 50-50 ethanol/turpentine mix. Traps were placed within the maple plantings in early March. Traps were examined weekly for the presence of insects. All insects were removed from the collection cups, placed in alcohol, and then taken to the laboratory where they were pinned, labelled and held for identification.

Results and Discussion: Results are presented from collections taken March through June, 1994, from collection sites in Meriweather and Morgan Counties. Table 1 presents identification on major insect orders and families collected. Major orders of insects collected in the Tedders traps include Coleoptera, Diptera, Hymenoptera, Hemiptera, Orthoptera, Homoptera and Lepidoptera. The most frequently collected beetles were weevils (Curculionidae), lady beetles (Coccinellidae), longhorned beetles (Cerambycidae), metallic wood borers (Buprestidae), and click beetles (Elateridae). Blow flies (Calliphoridae) and robber flies (Asilidae) were the most frequently collected dipterans. Alates of various species of ants (Formicidae), bees (Apidae), paper wasps (Vespidae), and ichneumon wasps (Ichneumonidae) were the most frequently encountered hymemopterans in the traps. Other groups frequently collected included stink bugs (Pentatomidae), assassin bugs (Reduviidae), grasshoppers (Acrididae), leafhoppers (Cicadellidae), treehoppers (Membracidae) and several species of moths.

Several species of beetles collected are of interest due to the potential damage they can cause to ornamental trees and shrubs. Table 2 presents the species of Buprestid and Cerambycid beetles that were recovered from the traps March through June, 1994.

Significance to Industry: Preliminary results indicate that the Tedders trap is very useful in monitoring damaging species of insects in shade tree production areas. Beetles in the families Curculionidae, Buprestidae and Cerambycidae were recovered from the traps. Data on damaging species collected and trapping dates will be used to develop insect pest management programs for shade tree production areas in Georgia.

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Table 1. Insect groups collected in Tedders traps in shade tree farms in Morgan and Meriweather Counties, Georgia, 1994.

Order	Families	
Coleoptera	Curculionidae	Coccinellidae
	Cerambycidae	Buprestidae
	Elateridae	
Diptera	Asilidae	Calliphoridae
Hemiptera	Pentatomidae	Reduviidae
Hymenoptera	Formicidae	Ichneumonidae
	Apidae	
Orthoptera	Acrididae	
Homoptera	Cicadellidae	Membracidae
	Cicadidae	
Lepidoptera	unidentified	

Table 2. Buprestidae and Cerambycidae beetles collected from Tedders traps in shade tree farms in Morgan and Meriweather Counties, Georgia, March through June, 1994.

Family	Genus and species	
Buprestidae	*Buprestis rutipes*	*Buprestis lineata*
	Chrysobothris dentipes	*Chrysobothris sp.*
Cerambycidae	*Ancylocera bicolor*	*Anelaphus parallelus*
	Asemum striatum	*AstyleXopus variegatus*
	Aegomorphus modestus	*Ataxia crypta*
	Clytus ruricola	*Ecyrus dasycerus*
	Eucleices picipes	*Knulliana cincta**
	Leptostylus albescens	*Monochamus carolinensis*
	*Neoclytus acuminatus***	*Neoclytus caprea*
	Phymatodes amoenus	*Rhagium inquisitor*
	Stenosphenus notatus	*Typocorus zebra*
	Xylotrechus colonus	

*Banded hickory borer
* * Redheaded ash borer

Assessment of Insect Pests on Improved Maple Cultivars in South Carolina Tree Nurseries: the First Two Years

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Nature of Work: The insect threats to nursery tree production in South Carolina are relatively few in number but potentially severe in impact. Experience reveals that the most damaging insect pests of nursery trees grown for the landscape industry are flatheaded borers (Coleoptera: Buprestidae), which weaken trees and distort growth in such a way as to render the trees unmarketable. This is particularly true for the popular maples, a staple of the industry. On occasion, less well-known pests may manifest their damage potential, as the potato leafhopper affected maples in 1990-91 (Alverson and Allen 1991). Currently, the only control measure utilized to counteract these threats to maples and other nursery trees consists of regular schedules of spray applications using residual pesticides. Little data is available to determine whether prophylactic treatments are justified, but the need for this research is mandated by the imminent loss of pesticides or limitations to their use.

Our research evaluates the potential for insect damage to nursery trees in the absence of pesticides. This paper presents the results of the first two years of observation and measurement in four maple varieties established in early spring, 1992. Five Latin Square experimental design plots were set out as liners in adjacent areas, resulting in 20 replicates of each of the four maple varieties, *Acer rubrum*, 'Red Sunset', 'October Glory', and *A. saccharum*, 'Legacy' and 'Green Mountain'. One-fourth of these were treated systematically every two weeks with Ambush (permethrin) at the rate of 5 ml/gal. Caliper measurements were made monthly at a height of 4 inches above soil level using an electronic caliper. Observations for insect pests were made visually. Borer infestations were monitored by inspecting trunks for signs in the fall. Potato leafhopper pressures were determined using yellow sticky cards replaced weekly in the field. A damage rating (Alverson and Allen 1991) was made for each tree in July, 1993.

Results and Discussion: In June, 1993 and 1994, defoliation by the gregarious greenstriped mapleworm (GSM) was evidenced (Table 1). There was a significant difference in the infestation of maple species, with a distinct preference for red maples. (Larvae were removed and the percentage defoliation recorded for long-term evaluations to be reported at the end of the study.) Single larval cohorts on branches defoliated 5% to 90% of leaves, with an average defoliation rate of 40%/infested tree. No GSM were observed in the first year (1992). Defoliated trees refoliated after larvae were removed, and no measurable impact on tree growth, shape, or calipering was evidenced. Half of the 1993infested trees were subsequently infested by borers. GSM is a univoltine species which infests for a short period early in the season. Because trees refoliate rapidly, GSM probably does not represent a serious economic threat to maple production, even when unchecked. Infestations may cause stress which renders the trees susceptible to successful borer attack.

Flatheaded appletree borers (buprestids) appear to be the greatest threat to maple production. Nearly 30% of all red maples were infested by the end of the second year. Infestation renders the trees unhealthy and unmarketable, representing a significant economic loss to growers. No sugar maples were infested in our studies.

Potato leafhopper (PH) densities were generally low in 1992, but increased in the subsequent early summer seasons (Fig. 1). The damage index taken in mid-summer, 1993, accounts for both number of terminals damaged and the severity of damage. Moderate damage was observed in trees untreated with permethrin compared to the light damage measured in treated trees (Fig. 2). Again, red maple varieties appeared more susceptible to leafhopper damage. In spite of the significant leaf damage differences, the effect of PLH on calipering was no evident in any variety (Fig. 3).

Significance to Industry: Growers should recognize that flatheaded borers are the most significant threat in that they cause the economic mortality of infested trees, and infestation rates may reach high levels quickly. Potato leafhopper damage, though noticeable, may not have significant long term effects on calipering. Greenstriped mapleworms may cause high levels of defoliation, but recovery occurs quickly and is sustained over a long season. Red maples, in general, are more susceptible to the indigenous insect pests in South Carolina than sugar maples in the first few years of nursery production.

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Table 1. Infestation levels by greenstripe mapleworm and appletree borer in maples, Clemson, SC

	% of Trees Infested		
	Greenstriped Mapleworm		Flatheaded Appletree Borer
Variety	1993	1994	1993
October Glory	10	20	30
Red Sunset	15	35	25
Green Mountain	5	0	0
Legacy	0	0	0

Fig. 1. Potato leafhopper (PLH) captures on yellow sticky cards, June 1992 through June 1994. Arrow indicates date that PLH damage index (Alverson and Allen 1991) was calculated.

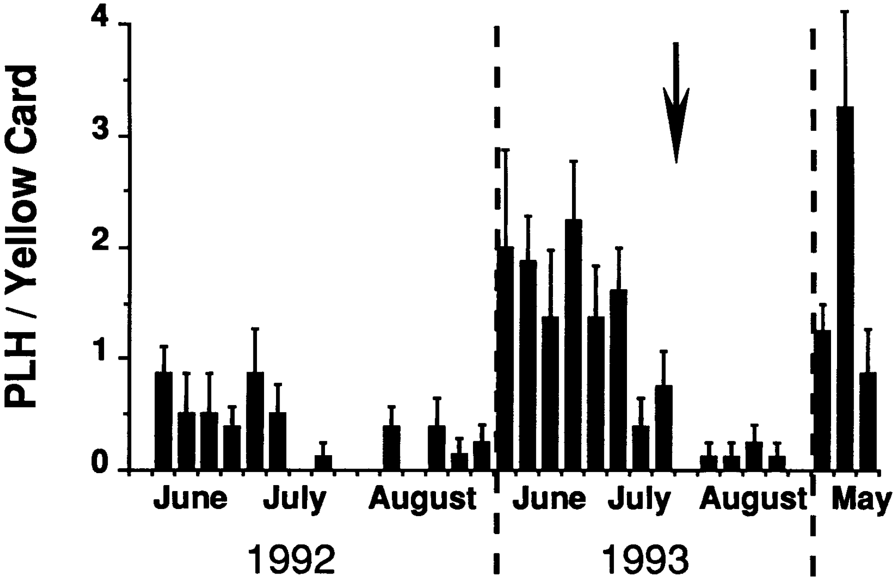


Fig. 2. Potato leafhopper damage index for each of four maple varieties, Clemson, SC, July, 1993.

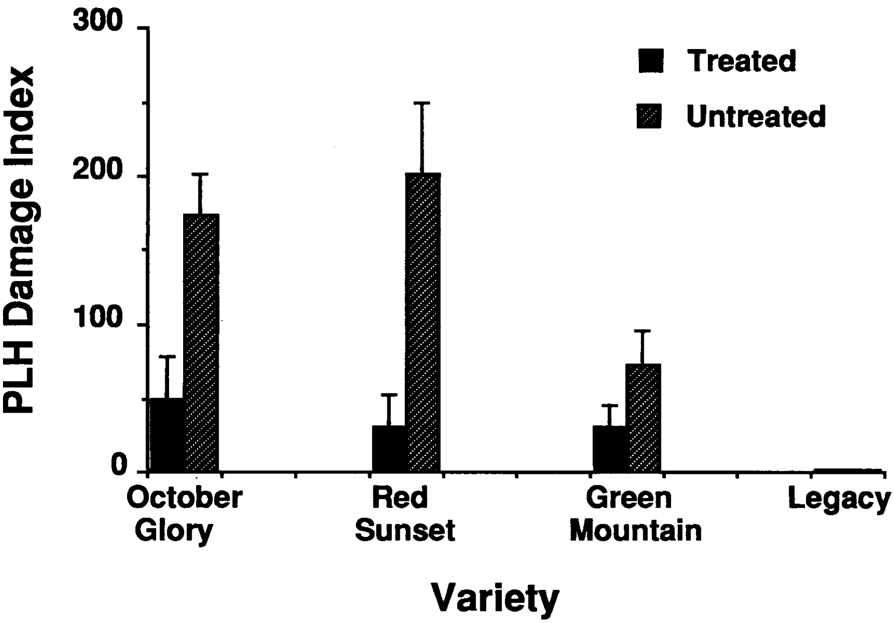
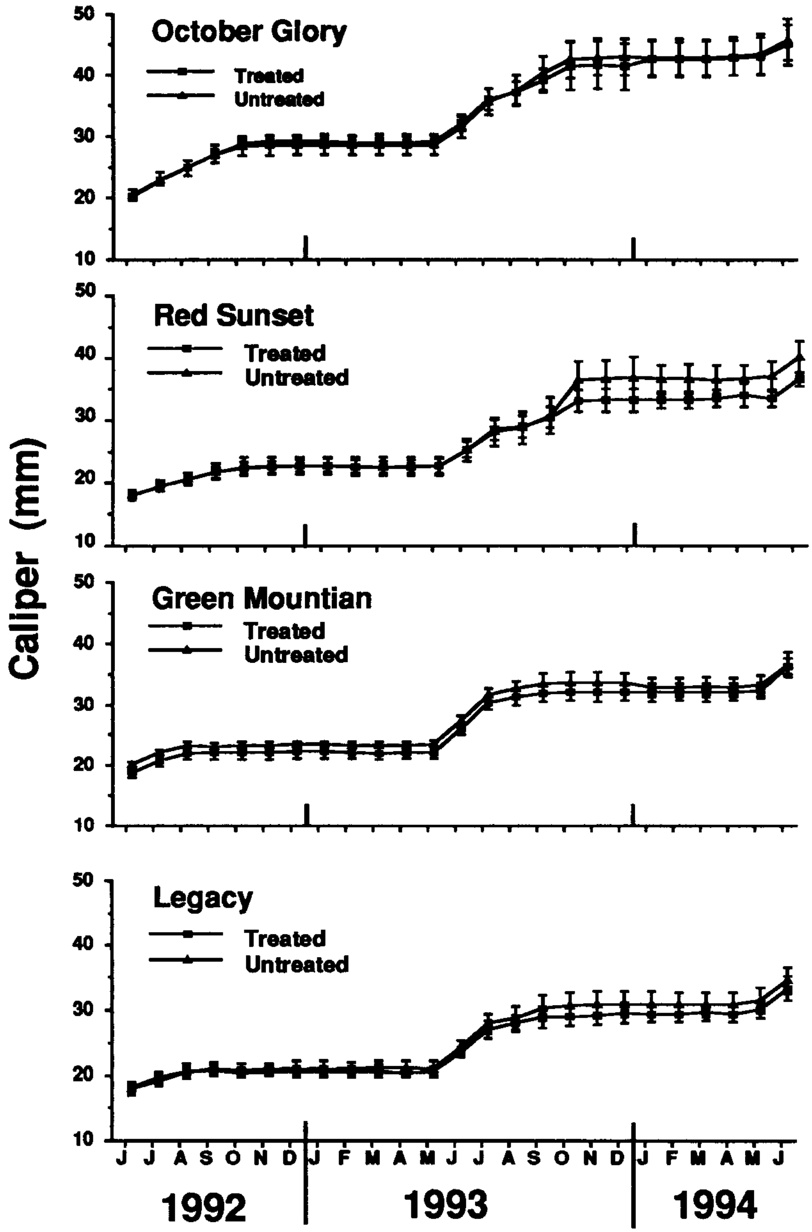


Fig. 3. Mean caliper comparisons for maple varieties treated and untreated for potato leafhopper, 1992-1994.



Shoot Boring Caterpillars, Proteoteras spp. (Lepidoptera: Tortricidae) Major Pests of Red Maple in Tennessee Nurseries

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Tennessee

Nature of Work: Red maple, Acer rubrum, is a major nursery crop in Tennessee. A suspected complex of shoot boring caterpillars which include Proteoteras aesculana Riley cause damage to the terminal buds and elongating shoots of red maple and to a lesser extent, sugar maple, Acer saccharum. The destruction of the terminal bud or shoot produces an undesirable forked double leader at the terminal instead of the desired central leader. Training a new central leader requires extensive time and labor. Even after corrective measures are taken, a noticeable crook in the trunk usually occurs which can lessen the value of the crop.

P. aesculana larvae attack maples, horsechestnuts and buckeyes (Johnson & Lyon 1991). They have one generation per year. Moths collected from Giles County in southern Middle Tennessee had emerged by June 14, 1993. The resulting larvae feed on leaves which are webbed together to form a sturdy roof that cups over the terminal. They bore into new shoot growth during mid-summer. They are suspected to overwinter as larvae by excavating terminal buds as does Proteoteras moffatiana Fernald (Simmons and Knight 1973). The overwintered larvae of the boxelder twig borer, Proteoteras willingana (Kearfott) may only leave the hibernation cell in the bud for a short time to feed on nearby buds or may feed on buds before burrowing into the new shoot growth (Peterson 1958). Early season control is difficult because the larvae may only be in an exposed position on the outer surface of the small and expanding shoots and foliage for a short period of time. Proper timing of insecticide sprays is difficult and systemic insecticides may be the best approach. Pest control in nurseries has been unsatisfactory in many cases. The life cycle of the pest or pest complex is not generally understood by nurserymen. Spraying of pesticides commonly occurs after the first signs of damage when the caterpillars are inside of the shoots. Significant damage has often already occurred by the time the application is made. A test was designed to see if control could be achieved by applying a carefully timed spray in the early spring before the first signs of borer damage to new growth occur.

A block of “October Glory” red maple were inspected on April 20, 1994 at Hills’ Creek Nursery in Warren County, Tennessee. Leaves were emerging from the buds with the second pair of leaves visible in the most advanced shoots. No signs of tunneling by shoot borers were seen at this time. Six insecticide treatments (Cygon 2E (5 ml./gal.), Astro T & O 3.2 EC (2.4 ml./gal.), Dursban Turf 4 EC (9.9 ml./gal.), Pageant DF 50% DF (9.44 gm./ gal.), Orthene Turf, Tree and Ornamental Spray 75% SP (4.54 gm./gal.), and Talstar T & O 10 WP (1 tsp./gal.) on 30 feet of row replicated 4 times were applied on April 20. The applicator used a CO_2 compression sprayer operating at 40 pounds per square inch, equipped with two TXVS-18 hollow cone nozzles. A thorough inspection of all trees in each 30 feet of row section was made on April 29 for borer damage. There were 4 to 6 inches of new growth on the terminals with the fourth pair of leaves visible on April 29. Infested shoots were beginning to wilt and the leaves were turning dark brown. A small ball of insect frass and silk was usually found extruding from a small hole in the shoot. The damaged shoots were not dissected to reveal the presence or viability of the larvae.

Results and Discussion: The distribution of borer damaged trees are very clumped with some individual trees having as many as 12 damaged shoots. Only 53% of 19 unsprayed controls had borer damage. There was an average of 3.1 borer damaged shoots in each control (N= 19). Half of the 24 treatments had borer damage. The borer damaged shoots averaged 1.75 in each treatment (N=24). Means were not significantly different at the 5% level (Pr>F=0.21228) Type I, (Pr>F=0.24509) Type III according to the General Linear Models Procedure (SAS 1981). If additional sampling had been performed one or two weeks later subsequent damage may have been revealed. Since some damaged buds and shoots break off, it is difficult to detect this type damage at a later sampling date. Damaged shoots would need to be marked and trees numbered to compare damage from two sampling dates. The use of a sex attractant lure may aid in the timing of mid-summer sprays for control of early instar larvae (Wong, Drouin, Szlabey and Dang 1983).

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Update on Management of the Top Seven Landscape Pest Groups

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Nature of Work: There are literally hundreds of insects and mites associated with ornamental plant species. Fortunately most of these rarely achieve significant pest status. Here we review aspects of the biology and control of the most important pest groups likely to be encountered in the southeast.

Results and Discussion: Seven groups of insects and mites consistently inflict the most serious damage on woody ornamentals. Their feeding may be confined to a particular type of plant (specialists) or a variety of plant materials (generalists). For many groups, avoiding susceptible plant materials or certain growing conditions may alleviate pest problems. The common pesticides that are effective against each pest group and some alternative management solutions are also provided.

Mites: Twospotted spider mite, *Tetranychus urticae* Koch, is the number one pest of ornamental plants in the Southeast and usually prefers hot, dry conditions. It attacks a wide range of ornamental species, agronomic crops, and weeds. Holly cultivars with cupshaped leaves *(Ilex crenata* cultivars) and *Pittosporum* are preferred hosts. Twospotted spider mites have a high reproductive rate and can complete a generation in 7-10 days under optimum hot conditions. Mites feed on plant leaves, usually on the under side, but on all plant parts during heavy infestations. Damage appears as an off-color, stippled or scorched appearance. Webbing is constructed on most plants as the mites feed. To detect mites, hold a white sheet of paper under a branch and strike the foliage. Mites will fall on the paper if present. Several applications of an acaricide may be necessary to control the mite. Many natural enemies feed on spider mites, but most are affected by pesticides.

Southern red mite, *Oligonychus ilicis* (McGregor), is a cool weather pest that can be found on azalea, elaeagnus, camellia, pyracantha and photinia. This mite feeds on both sides of the leaves and causes a bronzed or scorched appearance. The southern red mite reproduces slowly and probably does not need to be controlled except on saleable stock. Populations can be found yearround on shaded or stressed landscape pyracantha, but nursery populations usually disappear with the development of new spring growth. This mite may also be detected using the paper technique. Natural enemies are the same as for twospotted spider mites.

Spruce spider mite, *O. ununguis* (Jacobi), is an ubiquitous pest of juniper and other conifer species on the east and west coasts of the United States and Canada. ‘san Jose’ juniper and other cultivars with similar growth habits seem to be preferred hosts. Feeding damage makes the plants appear off color and eventually completely brown. Detect this mite with the paper technique. Several applications of an acaricide may be necessary to control the mite. Effective pesticides for mite control include horticultural oil, insecticidal soap, Kelthane, Isotox, Orthene, and Diazinon.

Sixspotted mite, *Eotetranychus sexmaculatus* (Riley), is found during the winter and spring on azalea. It is yellow in appearance and, although smaller, may be mistaken for the twospotted spider mite. It causes little damage and may be important as an alternate host for predatory mites.

Many species of eriophyid mites are known from ornamental plants but no particular species are considered major pests of ornamentals. These occasional pests usually cause distorted leaves as a result of feeding on developing buds.

Scales: Scale insects which continue to be major pests in the landscape include the following armored scales: euonymus scale, *Unaspis euonymi (Comstock);* false oleander scale, *Pseudaulacaspis cockerelli* (Cooley); obscure scale, *Melanaspis obscura* (Comstock); tea scale, *Fiorinia theae* Green; and white peach scale, *Pseudaulacaspis pentagona* (TargioniTozzetti). Common non-armored scale insects frequently encountered include: cottony camellia scale, *Pulvinaria floccifera* (Westwood); cottony cushion scale, *Icerya purchasi* Maskell; and Florida wax scale, *Ceroplastes floridensis* Comstock.

While some scale species, such as euonymus scale and tea scale, have limited host ranges, many others are polyphagous and can damage a wide variety of plants commonly used in the landscape. Many times scale insects are overlooked as the causative agent of landscape plant damage because they do not look like insects. The females, which are the most injurious, lack visible insect characteristics like antennae, legs, and wings. Therefore, large populations of scale insects often build up and cause plant damage before they are detected. Learning to recognize scale insects and their damage symptoms is the first step in developing pest management programs for preventing scale populations from reaching aesthetic or economic injury levels.

Pesticides are still the mainstay for managing scale insect pests in the landscape, but other approaches are available and can be combined with chemical applications to manage scale insects.

The use of resistant or tolerant varieties of host plants and biological control have worked well against euonymus scale. The Korean ladybeetle, *Chelocorus kuwanae* (Silvestri), has proven to be a very effective predator of euonymus scale, and has been released in about 25 states in the eastern U.S.. It will feed on other armored scale insects as well. Another coccinellid beetle, the vedalia beetle, *Rodalia cardinalis* (Mulsant), is a good biological control agent of cottony cushion scale.
Horticultural oils and soaps are effective on many species of scale insects, particularly against the younger stages. These materials also have less effect on natural enemies than more conventional pesticides.

Effective pesticides in combating scale insects in the landscape include: Cygon, Dursban, Malathion, Orthene, and Sunspray Ultrafine Oil. A relatively new material, Merit 75WSP, a systemic insecticide, offers great promise in controlling many scale insect pests on landscape ornamentals. The crawler stage is most easily killed and spray applications should, therefore, be applied against this stage for best results.

Aphids: Aphids are small, soft-bodied insects with sucking mouthparts that feed on plant fluids. In addition to direct feeding damage, which may cause wilting, stunting and plant death, they excrete a sweet, sticky fluid called honeydew that supports the growth of sooty mold fungus. This is often the most detrimental impact of an aphid infestation, as the mold forms a black coating on the leaves that detracts from the appearance of the plant and interferes with photosynthesis. Some species of aphids can also serve as vectors for plant diseases.

Tactics used to control aphids in the landscape depend on the host range and life cycle of the individual species. For those aphids with a single host, such as crape myrtle aphid, there may be resistant varieties available or the plant can be avoided altogether. Other more polyphagous species often reach population levels that require control measures. This is sometimes difficult, as some of our more serious pest species, such as the green peach aphid, are notorious for developing populations resistant to chemical insecticides. A wide variety of alternative controls are available for aphids, including the use of soaps and/or oils, aphid-specific parasitic wasps, and predators such as lady beetles and lace wings.

Borers: Insect borers are of particular importance because the end result of an infestation is often the death of the landscape plant. Borers include clearwing moths (dogwood borers, rhododendron borers, peachtree borer, and lilac borer [=ash borer]; flatheaded borers (flatheaded apple tree borer, two lined chestnut borer); bark beetles including ambrosia beetles and shothole borers; and roundheaded borers (azalea or rhododendron stem borer). Borers are opportunists in that they are often better able to infest a stressed or weakened plant. Cultural management practices used to maintain a healthy, vigorous plant include proper fertilization, timely irrigation, good drainage, and using the right amount of mulch.

Care should be taken not to damage the bark of dogwood trees since dogwood borers lay their eggs near wounds in the bark. Also dogwood trees planted in open sunny areas are more likely to be attacked by dogwood borer than dogwoods found in the shaded forest understory.

Insecticide sprays of Dursban, Lindane or Thiodan applied to the trunk help prevent borer infestation. Proper timing of insecticide sprays for the presence of adult oviposition periods is necessary to prevent borer injury.

Caterpillars: In the southeast, several species of caterpillars are persistent problems in landscape situations. Their damage is primarily cosmetic, however when populations are high the caterpillars can completely defoliate their host and cause great plant stress. Several species of caterpillars cause additional aesthetic damage due to the construction of unsightly silken webs or tents within the foliage of their host plant. The fall webworm, orange stripped oakworm, tent caterpillars, bagworms and several species of leafrollers/leaftiers are the most persistent caterpillar pests. Control options include hand removal, pruning, or use of Bt or sevin.

Lace bugs: Several species of lace bugs attack woody ornamentals. Three species in the genus *Stephanitis* attack ericaceous evergreens, primarily azaleas and rhododendrons. At least 27 species in the genus *Corythucha* injure deciduous trees or shrubs. Azalea lace bug has been a serious pest from New York and Massachusetts south to Florida since the early 1900s. This insect, introduced from Japan, is small (1/4 inch long). Adults are easily recognized by the lacelike like pattern of the wings. Nymphs have a spiny appearance.

Four generations of this pest occur in Georgia; fewer occur farther north, and generations are probably continuous farther south. The insect overwinters as an egg inserted in the underside of a leaf along the midrib. Adults can survive mild winters. Nymphs emerge in March in Georgia and complete growth through five nymphal instars by April.

Small, chlorotic spots initially mark the feeding site. Severely injured plants appear bleached or bronzed. Dark, lacquerlike fecal material is also present on the undersides of leaves. Azalea lace bug is best controlled during the first generation, after eggs have hatched but before nymphs have become winged adults (ca. 540 degree days above a 50° F). Early season control will reduce the need to apply pesticides later in the summer. Apply pesticides to the underside of the leaves where insects feed.

Horticultural oil, insecticidal soap, Orthene, and products containing azadirachtin (e.g., Bioneem) have been effective in controlling azalea lace bugs. Predaceous plant bugs and tiny parasitic wasps are important natural enemies of azalea lace bug that help to keep populations in check.

Hawthorn lace bug appears similar to azalea lace bug but attacks members of the rose family especially *Cotoneaster* and *Pyracantha.* This species overwinters as an adult and becomes active in the spring. Damage is often most apparent during midlate summer during dry years.

Miscellaneous: Japanese beetle, *Popillia japonica* Newman are included because of their damage potential. Adults feed on over 300 host plants. Adults are skeletonizing defoliators that can cause extensive damage to preferred hosts which are abundantly used in the Southeast (roses, flowering crabapple, flowering cherry, crape myrtle, Japanese maple, Virginia creeper, and others). Grubs feed on roots of turfgrasses. The range of the beetle is expanding, including most eastern states, and now extending south to central Georgia. Practical current control tactics for the grubs are primarily chemical control. Control of adults is also principally chemical; trapping devices such as ‘Bag-a-bug’ have uncertain impact.

Two-lined spittlebug adults, *Prosapia bicincta* (Say) damages holly, an extensively used host plant in the Southeast, causing leaf distortions and blotching of leaves. Nymphs develop in warm season turfgrasses and landscape lawns. Most practical controls would be directed at the developing nymphs (where infestations are severe) by spot treatment of spittle masses in grasses. Removal of weedy grass hosts may be of some help.

Citrus whitefly, *Dialeurodes citri* (Ashmead) is a persistent and predictable pest of Gardenia and Ligustrum in the Southeast, and sometimes occurs on other hosts as well. They remove considerable sap from hosts and deposit quantities of honeydew excretions which provides an excellent medium for the growth of sooty mold fungi. Practical control methods include avoiding the use of gardenia or Ligustrum in the landscape; otherwise chemical control is likely necessary in late spring/summer.

Managment of Aphids on River Birch

P.B. Schultz
Virginia

Nature of Work: *Hamamelistes spinosus* Shimer has no accepted common name, but reaches pest levels on river birch in Virginia nurseries and landscapes. It has an interesting life cycle involving both witch hazel and birch (1). The aphid survives the winter as an egg on witch hazel or as a hibernating female on birch. In the spring after winter dormancy, the egg hatches. On birch, the female becomes active at the time of budbreak. It moves from the bark to the new leaves where it gives birth to young aphids. They grow and reproduce rapidly and the leaves of an infested host soon acquire characteristic corrugations and a reddish color. The undersides of the leaves within the folds fill with aphids and white cottony material. Winged migrants develop on the leaves and seek witch hazel on which to lay their eggs and complete their life cycle. This is completed by late spring.

River birch, *Betula nigra* L., infested with heavy populations of *Hamamelistes spinosus* were used in the study. Trees were planted in spring, 1993, in 3 gallon containers in a 4:1 ratio of bark to sand, and fertilized with Osmocote 17-7-12 at the recommended rate. In April, 1994, trees were approximately 2 meters high, and had overwintered in a plastic-covered greenhouse. Population increases of the aphid began with the onset of warm temperatures. Trees remained in the overwintering structure until the conclusion of the study. Suppression of the aphid with granular acephate (Orthene 15G) was evaluated using three rates of application and an untreated check with four replications per treatment. Treatments were applied to the media surface on April 6, 1994 using a measuring spoon. Rates were 1, 2, and 4 teaspoons per container (X, 2X, and 4X) that equaled 3.1, 6.2, and 12.4 grams per container.

Results and Discussion: Pre-treatment counts on April 6, 1994 had no signficiant differences between treatments. By 7 days posttreatment all rates of Orthene 15G had significantly reduced aphid populations. The trees treated with Orthene 15G continued to have lower aphid populations than the untreated trees through the sampling dates (20 days post-treatment). Aphid levels in the untreated trees declined and reached levels not significantly greater than the treated trees. This decrease is consistent with their life history in that they leave the birch foliage and migrate to witch hazel on which they oviposit and complete their life cycle.

Significance to Industry: The use of granular systemic insecticides offers the industry an alternative to spray applications. Orthene in a granular formulation shows effectiveness against this aphid on river birch and would likely be effective against other species. Its residual activity was not determined due to the migratory habits of this species, but may well exceed the 20 days in this study.

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Aphid counts on river birch foliage, 1994

	Apr 6	Apr 13	Apr 15	Apr 20	Apr 26
Orthene 15G X	555.5	99.1a*	58.3a	60.1a	29.4a
Orthene 15G 2X	553.3	101.5a	89.1a	79.3ab	22.0a
Orthene 15G 4X	344.3	76.3a	67.0a	53.0a	35.9a
Check	512.0	494.6b	237.5b	135.6b	145.6b

*Means followed by the same letter are not significantly different (Duncan's multiple range test, p= 0.05)

Evaluation of Pyrethroid Insecticides for Control of Nursery Pests

Mark A. Coffelt
New Jersey

Nature of Work: Pyrethroids are synthetically produced pyrethrin-like compounds. Pyrethrins are collective names for compounds derived from pyrethrum flowers *(Chrysanthemum cinerariaefolium).* East Africa is the primary growing region for pyrethrum, and the formulated products from pyrethrum have been used for insect control for over one thousand years. Fast knockdown of key insect pests is one distinguishing feature of pyrethrins, and when synergists such as piperonyl butoxide are added, activity is increased. Providing broad spectrum insect control, pyrethrins are used to control insect pests of animals, humans, stored products, field crops, forest and ornamental plants. One such product available to nurserymen is Pyrenone® Crop Spray (Table 1). Natural pyrethrins degrade in sunlight and are short-lived on plants. Early synthetic pyrethroids degraded in sunlight; however, synthetic pyrethroids were developed in the 1970's that were photostable. These compounds are are used at low rates to control a broad spectrum of insect pests, including insects infesting ornamental plants (Table 1). Deltamethrin and Tralomethrin are two synthetic pyrethroids developed by Roussel Uclaf Corporation (RUC). Deltamethrin has been described as one of the most potent insecticidal pyrethroids ever developed (2), and ornamental pest control uses are pending with the EPA. Tralomethrin is sold as Saga® 40WP and ornamental use patterns are expected to be registered in August of 1994. Both deltamethrin and tralomethrin are used at the lowest concentrations of active ingredient (0.0015%) than any other registered pyrethroid (Table 1), yet provide very effective control (Tables 2 & 3).

The objective of this research was to document the activity of several synthetic pyrethroids and biologicals against chewing and sucking insect pests of ornamentals plants. A serious defoliator of oak species in the southeastern USA is the orangestriped oakworm, *Anisota senatoria* (Smith). Studies was conducted at the Hampton Roads Agricultural Experiment Station in Virginia Beach, VA. Seven treatments and a water control were applied to 15-25 foot pin oaks *(Quercus palustris)* on 13 August, 1993, to control late instar (fourth and fifth) *A. senatoria* larvae (3 single tree replicates/treatment). Pretreatment counts of late instars were conducted before treatment application and trees were sprayed to runoff (CO_2 sprayer at 30 psi). The number of live caterpillars were determined three days after treatment (DAT). Temperature at time of treatment was 82°F and rainfall was 0.0 inches between 13 and 16 August.

Another study in Virginia Beach, VA, examined control of a major sucking insect pest of azaleas, the azalea lace bug *(Stephanitis pyrioides* Scott). Four treatments and a water control were applied to azaleas *(Rhododendron cv.* George Tabor) planted in 3 gallon pots. Potted plants were placed on an outdoor pad in full sun and received daily overhead irrigation. Pretreatment counts were made on each plant on May 17, 1993, by counting the number of late instar nymphs and adults during a 30 second period. Sprays were applied to runoff using a $C0_2$ sprayer at 30 psi. Mortality was determined at

1 week after treatment (WAT) by using 30 second counts. Rates of formulated product per 100 gallons for both studies were: DTM =Deltamethrin 5SC Roussel Uclaf @ 4 oz; SAGA=Saga 40WP (Tralomethrin- Roussel Uclaf) @ 0.03 lb; TEMPO=Tempo® 2EC (Cyfluthrin- Miles) @ 1.5 oz; MARGO.=Margosan-O® 0.3% (azadirachtin-Grace/Sierra) @ 80 oz; DIPEL=Dipel® 2X (6.4% *Bacillus thuringiensis kurstaki* Abbott Laboratories) @ 0.75 lbs; FORAY=Foray(X3 48B (2.1 % *Bacillus thuringiensis kurstaki* - Novo Nordisk) @ 48 oz.

Results and Discussion: The three synthetic pyrethroids compounds (DTM, Saga and Tempo) all provided 95% control of late instar orangestriped oakworm larvae (Table 2). The three biological compounds (Dipel, Foray and Margosan-O) provided reduced control, with 5.3%, 5.2% and 16.5% control, respectively. Late instar oakworm are large (2 inches in length) and more difficult to control than the early instars (1). Control of adult azalea lace bug after 1 week indicated that the three synthetic pyrethroid compounds gave similar levels of control, and Margosan-O gave significantly less control (40%) than DTM (100%) and Tempo (93%).

Significance to Industry: Natural pyrethrins and synthetic pyrethroid insecticides are effective for controlling pests of ornamental plants. Data for synthetic pyrethroids indicated that DTM, Saga and Tempo gave excellent control of chewing and sucking insects. Nurserymen should be aware of the potential of synthetic pyrethroids, such as the new products DTM and Saga, which have the advanages of lower rates and increased efficacy.

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Acknowledgments

I would like to thank Dr. Don Maciver, senior scientist at RUC for assistance, and Dr. Peter Schultz for assistance in data collection.

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Margosan-O is a registered trademark of Grace-Sierra Crop Protection Company.
Dipel is a registered trademark of Abbott Laboratories.
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Table 1. Natural pyrethrins and synthetic pyrethroids used to control pests attacking ornamental plants.

COMPANY NAME	NATURAL PYRETHRIN	BRAND & FORMULA.	RATE OF FORMULA PRODUCT/100 GAL.	CONCENTRATION OF AI %
		NATURAL PYRETHRIN		
RUC	Pyrethrin 6.0% PBO 60%	Pyrenone® Crop Spray	350ml - 11.8 oz	0.005
		SYNTHETIC PYRETHROIDS		
RUC	Deltamethrin	DTM 5SC	115 ml - 4 oz	0.0015
RUC	Tralomethrin	Saga® 40WP	15 g - 0.03 lb	0.0015
Miles	Cyfluthrin	Tempo® 2EC	45 ml - 1.5 oz	0.003
Miles	Cyfluthrin	Tempo® 20WP	53 g - 0.1 lb	0.003
FMC	Bifenthrin	Talstar® T&O 7.9F	236 ml - 8 oz	0.005
FMC	Permethrin	Astro ™ T&O 36.8EC	118 ml - 4 oz	0.012
Sandoz	Fluvalinate	Mavrik Aquaflow® 22.3F	118 ml - 4 oz	0.0075
Valent	Fenopropathrin	Tame® 2.4EC	315 ml - 10.6 oz	0.024
MGK	Fenvalerate	Evercide® Conc. 2.6	5910 ml - 1.5 gal.	0.040

Table 2. Mean mortality of late instar orangestriped oakworm 3 DAT (1993)

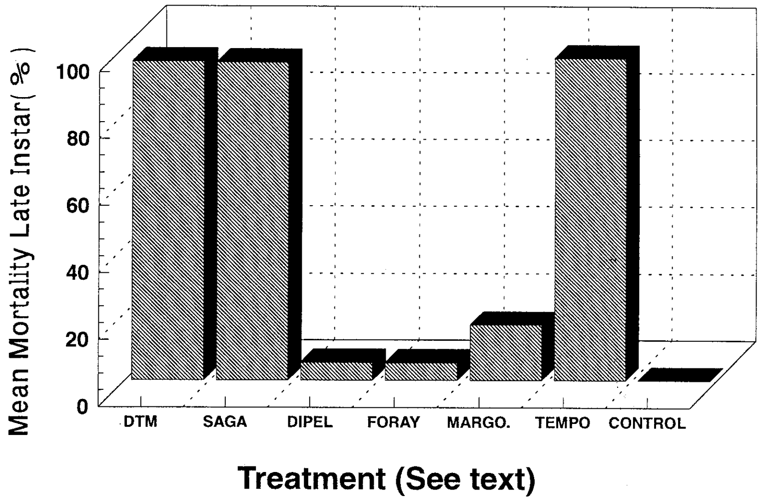
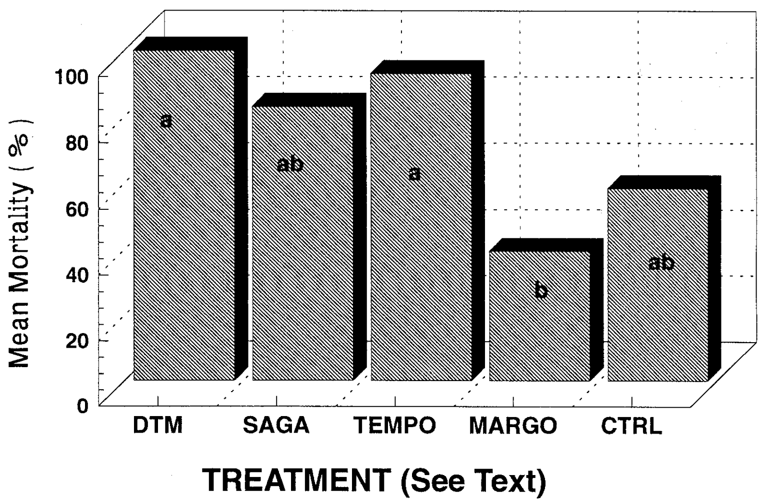


Table 3 Mean mortality of azalea lace bug , 1 WAT (1993)



Means within bars followed by the same letter are not significantly different (Tukey's test).

Outbreak of the Asian Ambrosia Beetle, Xylosandrus crassiusculus (Motschulsky), Is Cause For Concern

R. Mizell, S. K. Braman, B. Sparks, W. Hudson
Florida and Georgia

Nature of the Work: Many species of ambrosia beetles or “shot hole borers” are widely distributed throughout the world. Native species that are well known pests of trees and shrubs in the southeastern U.S include members of several genera (*Xyleborus, Xyleborinus, Ambrosiodmus, Monarthrum, Phleotribus* and many others). The Asian ambrosia or shot hole beetle, *Xylosandrus crassiusculus*, was first detected in the U.S. around Charleston, S.C. about 1972. Since that time it has spread across the lower Piedmont and coastal plain of the southern U.S (Atkinson et al. 1988).

During the past year severe infestations of landscape and nursery trees have been observed in Georgia and Florida and apparently are increasing in number. This beetle is very aggressive, has a broad host range and kills most trees it attacks by innoculating them with a fungus (the ambrosia) on which it feeds. Nurserymen, landscapers and homeowners should be aware of this destructive insect species and its relatives and implement an aggressive control program when infestations are found.

Results and Discussion: Thousands of species of boring beetles are known that attack trees and shrubs. Some well known species include the southern pine beetles (*Dendroctonus* and *Ip*s spp.) that attack pines and the Scolytus spp. beetles that spread Dutch elm’s disease. These beetles often attack stressed, injured dying or cut trees, but can also readily attack healthy trees. Ambrosia beetles are a related and destructive group of beetles that attack many species of hardwood trees. As with other Scolytids, most of the native species primarily attack injured, stressed or dying trees. However, several species introduced to the U.S. from Asia or elsewhere are much more aggressive and attack many nursery and landscape trees that otherwise appear healthy.

Xylosandrus crassiusculus usually kills the trees it infests. Reported host trees include: crape myrtle, dogwood, Bradford pear, Shumard oak, Drake elm, sweet gum, cherry, magnolia, peach, plum, golden rain tree, Australian pine, and camphor tree. In the tropics the beetle attacks over 100 plant species (Atkinson et al. 1988). *X. compactus*, a close relative and a twig feeder, is also a pest of dogwood, redbud and red maple (Mangold et al. 1977).

Like other beetles in this group, the red brown *X. crassiusculus* is small (2.1-2.9 mm) with the head hidden from view when looking down from above. Females bore into trees of 1-30 cm in diameter usually within 1-3 m of the ground but may limit their attacks to healthy limbs as reported by Kovach and Gorsuch (1985) on peach. As the galleries are constructed in the wood, long narrow strands of frass (sawdust and excreta) are pushed out of the gallery entrance. These frass strands are often the first sign that the beetles are present. When a tree is heavily infested, these frass strands will stick out marking the galleries at a density of near 0.5 per cm^2. Most heavily infested trees will die after showing symptoms of stress.Ambrosia beetles construct gallery chambers in the wood or pith and innoculate the plant with a fungus on which they feed. We have observed females attacking dogwood to be "pitched out" i.e. drown while attempting to construct galleries. The female lays her eggs in the gallery chamber and stays with the brood until they emerge. All beetle life stages can be found in the chamber. An ambrosia beetle generation may take as few as 20 days or up to 4 months depending on location (Kovach 1986). Brood production appears to vary with the host plant. Kovach (1986) reported an average of 8 beetles per gallery emerging from peach. The senior author observed as many as 27 adults in galleries in Bradford pear and Kwanzan cherry in Florida. Kovach (1986) reported only one generation per year for *X. crassiusculus* in South Carolina based on trap data. The peak emergence was observed in February and March, but low numbers were trapped throughout the growing season. A similar pattern was observed in Florida in 1994. However, field growing crape myrtles of ca. 5-8 cm in diameter were observed under active attack on June 6, 1994 in Monticello, FL.

We do not have an explanation of why this sudden outbreak of ambrosia beetles is occurring. Unfortunately, we have not identified an effective insecticide (or possibly rate) to control these beetles either to prevent attack or as a remedial to kill the beetles after they enter trees. The senior author tested chlorpyrifos (Dursdan Turf, 0.8%), Lindane Borer & Leafminer Spray (2.5%) and carbaryl (Sevin SL, 4%) on 3 gal. dogwood and Kwanzan cherry as a preventative application. Three dogwoods and three cherries were each sprayed to runoff with either carbaryl, lindane or chlorpyrifos. Three untreated trees of each species, and treated trees were placed in a large outdoor screen cage with trees that were previously and naturally infested with X. crassiusculus. Of the 24 test trees, 14 were killed by the beetle. Two untreated dogwood trees and one sprayed with lindane survived in the cage. Apparently they were not attacked. Two cherry trees treated with carbaryl survived along with one cherry in each of the other treatments. These results suggest the need for additional insecticide screening trials. Lindane, chlorpyrifos and carbaryl are the insecticides most often effective against many other wood boring beetles. Thiodan should also be tested as it is labeled against boring insects.

In a remedial test the senior author sprayed infested Bradford pear, dogwood and Kwanzan cherry with either chlorpyrifos, lindane or carbaryl. When treatments were evaluated the controls and carbaryl treatments were similar and contained live beetles in the galleries. Trees treated with lindane or chlorpyrifos had very few beetles in the galleries but the evaluation was unclear as to whether the beetles were killed, had emerged or did not complete development. Unfortunately, this was our first experience with these beetles, and we apparently waited too long after the treatments to correctly evaluate the effects. The strongest statement that can be made from this limited test is that chlorpyrifos and lindane as remedial sprays did appear to reduce the brood production in the pear and cherry. More tests need to be conducted. Even with a remote promise of some insecticidal control, we suggest that nursery trees that are under moderate to heavy attack by ambrosia beetles be destroyed immediately.

Beetles will continue to develop and emerge from uprooted and dead trees, so removed plants should be burned. These beetles are very destructive and will quickly destroy nursery and landscape stock in large numbers. In other situations where small numbers are observed attacking large plants in a landscape, it may be prudent to wait before deciding the course of action. While most attacked trees do die, some are able to survive attack.

Finally, Kovach and Gorsuch (1985) described and used a plexiglass trap baited with ethyl alcohol to trap and determine the flight period of several species of ambrosia beetles. They also provide a key to identify several species (including *X. crassiusculus*) common to peach in South Carolina.

Significance to Industry: Ambrosia beetles represent a real threat to nursery and landscape trees. They have a broad host range and the Asiatic ambrosia beetle aggressively attacks many species of ostensibly healthy trees. Continued infestations of crape myrtle could be particularly devastating since crape myrtle is one of the most important woody landscape plants in the southern U.S. Insecticides that can protect trees by preventing beetle attack have not been identified. Therefore, infested trees should be destroyed before the beetles emerge. Personnel from all segments of the industry should be alert to this difficult pest problem and communicate with each other the species, host plants, timing and degree of infestations. The population dynamics of these ambrosia beetles remains unpredictable and everyone with trees in the south-eastern U.S. is probably at risk.

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