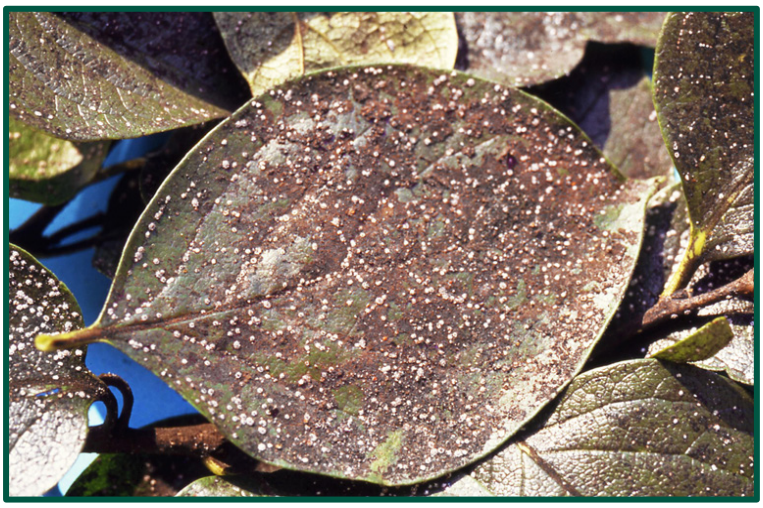
United States Department of Agriculture

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

New Pest Response Guidelines

Ceroplastes japonicus Green Japanese Wax Scale



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Acknowledgements

C. japonicus

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Cover Images

Male instars of *C. japonicus* (photo courtesy of Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy, Bugwood.org)

Adult female of *C. japonicus* on leaves (photo courtesy of Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy, Bugwood.org)

Sooty mold promoted by *C. japonicus* infestation on kaki leaves (photo courtesy of Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy)

Chapter

1

Introduction

The Japanese wax scale, *Ceroplastes japonicus* Green, is a major polyphagous pest of economically important ornamental, soft and hardwood trees, mulberry, tea, citrus, apple and stone fruits, some of which are high-value crops widely cultivated in the U.S. Soft scales such as *C. japonicus* can directly impact their hosts with heavy infestations leading to crop losses due to stunting, branch dieback and plant death (see *Damage* on page 5-1). Based on interception records and invasion plausibility, *C. japonicus* is among the four soft scale species most likely to be introduced (Miller and Miller, 2003).

For information regarding the use of this document, refer to *Appendix A: How to Use the Guidelines.*

Chapter

2

Taxonomy

Ceroplastes japonicus was originally described by Green (1921) in England as C*eroplastes floridensis japonicus* var. nov. using specimens collected from small branches of the Japanese maple, *Acer palmatum* Thunberg, imported from Japan to a nursery in St. Albans, Hertfordshire, England. Borchsenius (1949) described the morphological differences and elevated *C. japonicus* to species rank (Ben-Dov, 1993).

The accepted taxonomic classification of *C. japonicus* is presented in Table 2-1.

Table 2-1 Classification of *C. japonicus*

Rank	Taxon
Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Hemiptera
Suborder	Sternorrhyncha
Superfamily	Coccoidea
Family	Coccidae
Subfamily	Ceroplastinae
Tribe	Ceroplastini
Genus	*Ceroplastes*
Scientific name (accepted)	*Ceroplastes japonicus* Green

Synonyms

Ceroplastes japonicus Green is the accepted scientific name. Changes of status for *C. japonicus* as listed in the ScaleNet database (Ben-Dov *et al.*, 2014w) are presented below:

- *Ceroplastes floridensis japonicus* Green, 1921
- *Ceroplastes japonicus* [change of status] Borchsenius, 1949: 181c
- *Cerostegia japonica* [change of combination] De Lotto, 1969: 213b
- *Paracerostegia japonica* [change of combination] Tang, 1991: 308

- *Ceroplastes japonicus* [change of combination] Ben-Dov, 1993: 40

Common Names

Ceroplastes japonicus is commonly known as Japanese wax scale (Davis *et al.*, 2005). Additional common names noted in the literature (Davis *et al.*, 2005) are likely erroneous (Pellizzari, 2014).

Chapter

3

Identification

Species Description/Morphology

Any *C. japonicus* stage can occur on host plant leaves or stems, but only the first instar lacks the voluminous wax covering or 'test' characteristic of *Ceroplastes* spp. (Ben-Dov and Hodgson, 1997e). Morphometric parameters allow for identification, but sizes vary with age, stage, sex, ovarial development, host quality and feeding site (EPPO, 2003; Park *et al.*, 1992) as indicated in Table 3-1.

Table 3-1 *C. japonicus* measurements (Park *et al.*, 1992; Rainato and Pellizzari, 2008)

Developmental stage	Length (mm)	Width (mm)
egg	0.29 ± 0.01	0.15 ± 0.01
first instar	0.36 ± 0.02	0.17 ± 0.01
male, second instar	0.92–1.15	0.55–0.67
male, pre-pupa	0.78–1.13	0.40–0.57
male, pupa	0.82–0.98	0.34–0.42
male, test with waxy projections	1.76–2.01	1.04–1.64
male, test base	0.84–1.36	0.46–0.73
female, second instar	1.67 ± 0.12	1.05 ± 0.10
female, third instar	2.23 ± 0.14	1.44 ± 0.13
female, adult	3.05 ± 0.29	2.06 ± 0.21
female, developing ovary, late March	3.15 ± 0.33	2.11 ± 0.24
female, developing ovary, early April	3.22 ± 0.32	2.19 ± 0.23
female, developing ovary, mid April	3.37 ± 0.30	2.29 ± 0.26
female, developing ovary, late April	3.45 ± 0.71	2.49 ± 0.54
female, developing ovary, early May	3.66 ± 0.73	2.71 ± 0.56

Egg

Soft scale eggs are covered with filamentous wax to allow separation and prevent desiccation (Marotta, 1997). The *C. japonica* lays eggs in a 'brood chamber' on the ventral side of the female (Figure 3-1A).

Immature

Immatures are typically found atop young leaves (Figures 3-1B and C). The first instar or 'crawler' has well-developed antennae and legs, but lacks the waxy

cover, or test (EPPO, 2003; Marotta, 1997). The body is red, ovoid, slightly elongated and appears fused. The antenna is 6-segmented with sensory setae on segments 4–6 (Williams, 1997). Mouthparts are located on the venter between the prothoracic legs. Second instars develop wax scales and appear 'star-like' (EPPO, 2003). Sexual dimorphism appears at the second or third instar (EPPO, 2003; Williams, 1997). In females, the second and third instars are neotenic. In males, the postembryonic development resembles that of holometabolous insects. Before molting to the adult stage, *C. japonicus* males molt through first and second instars, a pre-pupa and the 'pupa,' a quiescent instar (Rainato and Pellizzari, 2008). The pre-pupa and pupa develop inside a wax covering from which the adult backs out. The test of the male pupa is oblong, white and opaque with prominent waxy projections giving it a white star-like appearance (Figure 3-1D). The median plate of the test is slightly broad and strongly elevated, particularly in the anterior region. The base of the test is distinct possessing a 'peripheral wax layer' along the margin (Rainato and Pellizzari, 2008). In the field, male tests primarily occur on the abaxial leaf surface (Gimpel *et al.*, 1974). For further description of immature males, refer to Rainato and Pellizzari (2008).

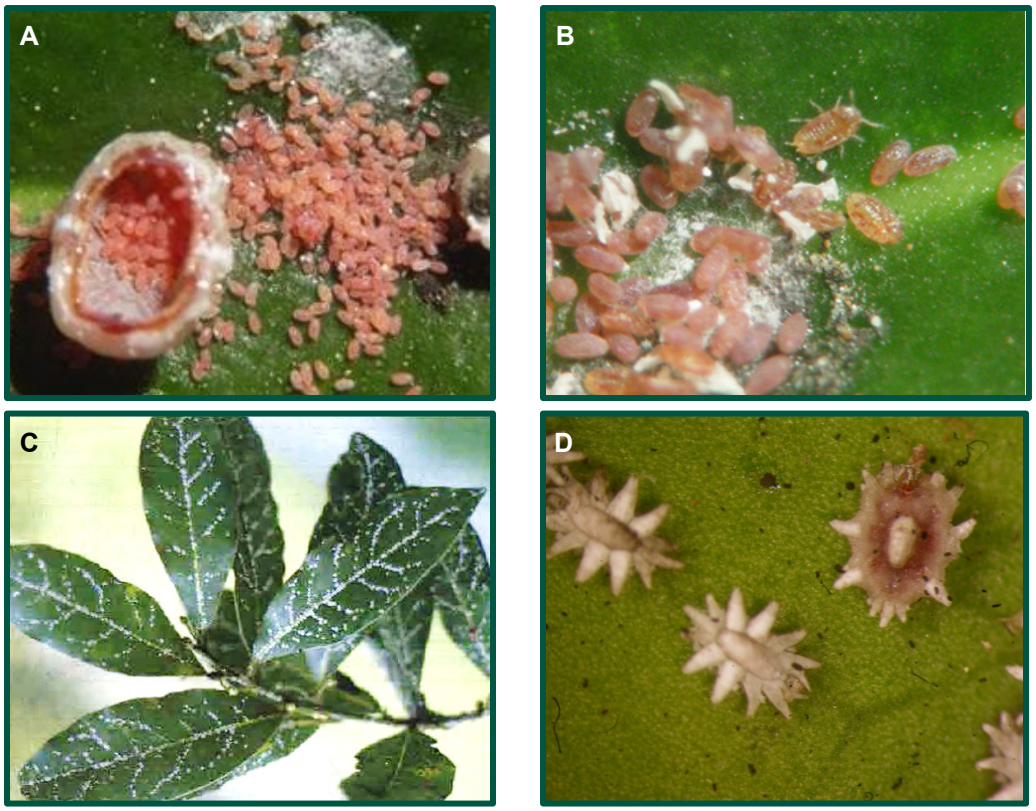

Figure 3-1 (A) *Ceroplastes floridensis* Bodenheimer eggs, which are morphologically similar to those of *C. japonicus*; (B) first instar and eggs of *C. floridensis;* (C) immatures of *C. japonicus* on laurel leaves, *Laurus* spp.; (D) male and female puparia (photos courtesy of: A–B Chazz Hesselein, Alabama Cooperative Extension System, Bugwood.org; C–D: Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy)

Adult Female

Adults feed on leaves and branches (Figure 3-2). An adult female is ovoid to rectangular, neotenic, sessile, apterous and has a reddish-brown body underneath a thick grayish to pinkish-white wax layer (Ben-Dov, 2014; EPPO, 2003). The head, thorax and abdomen appear fused. The development of soft scales in the females typically accompanies a gradual increase in length, a change in body color associated with dorsal sclerotization, dorsoventral swelling associated with ovary development and the formation of a brood chamber-like space on the venter for oviposition (Marotta, 1997).

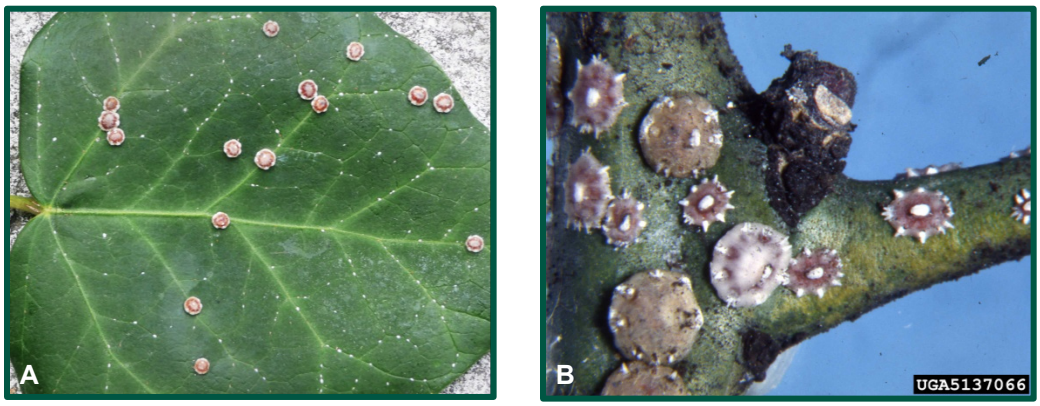

Figure 3-2 (A) Adult females and first instars of *C. japonicus* on ivy leaves; (B) adult females of *C. japonicus* on a stem (photos courtesy of Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy)

Adult Male

Males of *C. japonicus* are not reported in most introduced locations; the females reproduce through facultative parthenogenesis (Camporese and Pellizzari, 1998; Pellizzari and Camporese, 1994; Rainato and Pellizzari, 2008). Adult males resemble gnats, but can be distinguished by the absence of mouthparts and the presence of a protruding terminalia at the tip of the abdomen (Figure 3-3). Unlike females, males have a distinct head, thorax and abdomen. The head is bluntly triangular, and the antennae (~0.43 mm) are 10-segmented and filiform. The abdomen has 8 segments. The aedeagus (~0.23 mm) has a prominent basal rod within the penial sheath and is located posterior to the anus (Rainato and Pellizzari, 2008). Adult males are weak fliers and have a visible pair of hyaline, short, broad wings (~0.91 mm) (Rainato and Pellizzari, 2008). *Ceroplastes japonicus* lack hamulohalterae, which are present in some scale species (Rainato and Pellizzari, 2008). For further description of adult males, refer to Rainato and Pellizzari (2008). Broad morphological characteristics used to distinguish between the sexes are presented by Gullan and Kosztarab (1997).

Figure 3-3 Adult male *C. japonicus* inside the puparium (photo courtesy of Prof. G. Pellizzari, Dept. DAFNAE, University of Padova, Italy)

Diagnostics

Among the 162 coccid species in the Nearctic region, 105 are present in the U.S., of which 14 belong to the genus *Ceroplastes* (Ben-Dov *et al.*, 2014u). The current classification places two genera in Ceroplastinae—*Ceroplastes* with 135 species and *Waxiella* with 20 species (Rainato and Pellizzari, 2010). Most scale insects are small and require microscopy for accurate identification (Gullan and Kosztarab, 1997). All scale insects are identified using the morphological characteristics of slide-mounted young adult females (Ben-Dov, 1997; Hodgson, 1997). See ScaleNet for specific keys to scale insects.

Adult Female

Body Margins

Setae distributed along the lateral margins of the stigmatic furrows are referred to as the stigmatic setae (Figure 3-4) (Gimpel *et al.*, 1974). In some cases, the stigmatic setae extend beyond the furrows, but can still be identified based on structural similarity (Gimpel *et al.*, 1974). The stigmatic setae are lanceolate and have rounded or pointed apices (Ben-Dov, 2014; Pellizzari and Camporese, 1994). In *C. japonicus*, the stigmatic setae are continuous between the anterior and posterior furrows and are distributed in 3 irregular rows with from 97–148 setae along the body margin (Pellizzari and Camporese, 1994). The stigmatic furrow extends from the spiracles to the stigmatic setae and is lined by stigmatic pores with multiple (primarily 5) loculi (Gimpel *et al.*, 1974). In addition to the stigmatic setae, *C. japonicus* has a few (1–3) bristle-like flagellate setae located along the thoracic margin (*i.e.*, between the anterior and posterior distribution of stigmatic setae) (Fetykó and Kozár, 2012; Pellizzari and Camporese, 1994).

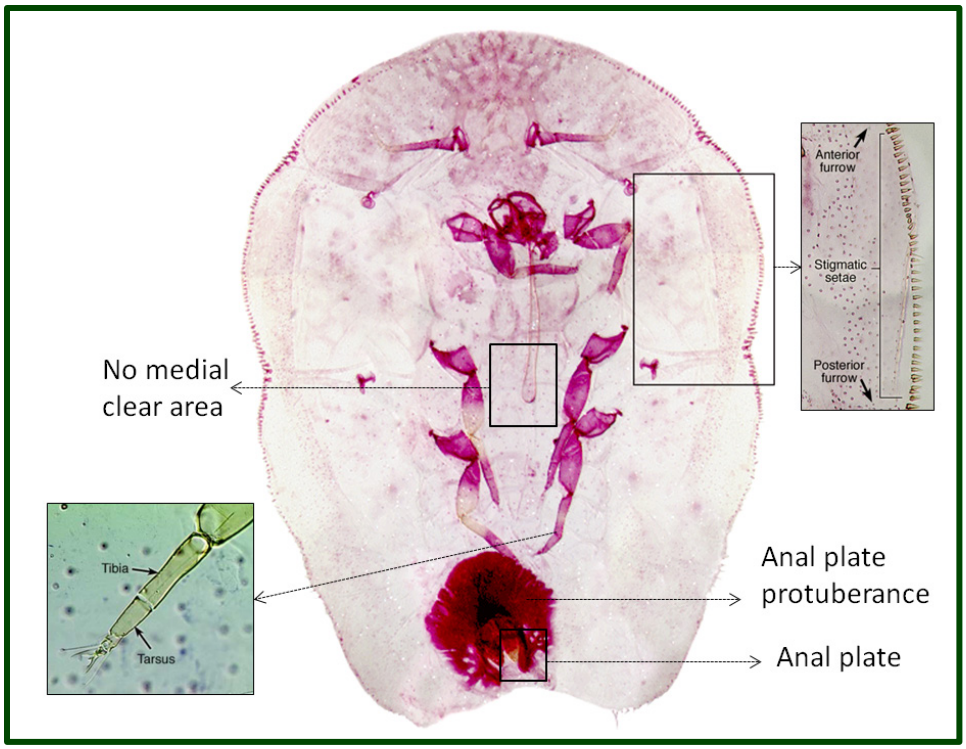

Figure 3-4 Slide-mounted *C. japonicus* female adult (photo courtesy of ScaleNet)

Dorsum

The dorsum is membranous and has arrangements of setae, pores and clear areas. The dorsal setae are cylindrical and have truncated or rounded apices (Ben-Dov, 2014). The dorsal pores are scattered with the oval trilocular pores most common in the species (Pellizzari and Camporese, 1994). However, the dorsal pores are not reliable for separating *Ceroplastes* species (Gimpel *et al.*, 1974). The dorsum also has 'clear' areas that lack large dorsal pores. *Ceroplastes japonicus* has 1 cephalic and 6 lateral clear areas, but lacks the mediodorsal clear area (Figure 3-4) (Pellizzari and Camporese, 1994). Adult females have a thick hemispherical wet wax test on the dorsum. If present, the marginal flange is small in young females and absent in older females. The apex of dry wax from the early instars appears as filaments on the dorsum—consisting of acute trifurcate cephalic, bifurcate posterolateral, simple anterolateral, mediolateral and weakly bifurcate caudal filaments. The dorsal dry wax cap from the early instars is not tilted and is located in the center of the wax cover without any surrounding nucleus (Ben-Dov, 2014). The anterior and posterior wax bands are present near the spiracles.

Venter

Antennae have 6 (rarely 7) segments with legs distinctly visible on the ventral side (Ben-Dov, 2014; Pellizzari and Camporese, 1994). Leg segments include

a short coxa, a short trochanter, a long femur and a long tibia followed by tarsus with no tibio-tarsal sclerosis or claw denticles. The tarsus tip has 2 equi-size digitules with expanded apices (Figure 3-4) (Ben-Dov, 2014; Gimpel *et al.*, 1974; Pellizzari and Camporese, 1994). The anal plates are rounded with a sclerotized surrounding area forming a prominent anal protuberance (Figure 3-4). Each anal plate has 3–4 apical and a pair of inconspicuous prevulvar setae, subapical (or ventral) setae and subdiscal setae. The discal, subdiscal and apical setae are sometimes referred to as dorsal setae (Gimpel *et al.*, 1974). Six fringe setae are located on the anal fold. The multilocular pores (~5 loculi) in the venter are distributed along the abdominal segments and are not restricted to the vulvar area. In some cases, the pores are present near the second and third pairs of legs and spiracles. The anterior and lateral pores associated with the anterior spiracles are similar in size (Ben-Dov, 2014). Small inconspicuous clusters of preopercular pores (6–14) occur near the anterior of the anal plates (Ben-Dov, 2014; Pellizzari and Camporese, 1994).

Wax Secretions

Members of the genus *Ceroplastes* have thick, soft, wet tests (Hodgson, 1997). The adult female secretes various waxes throughout its life cycle using tubular structures and pores. A narrow band of dry filamentous wax is secreted by the stigmatic pores; this wax is closely associated with the stigmatic setae. Immediately prior to oviposition, the multilocular pores near the vulva may secrete a powdery white wax that coats the chorion and may aid in the compact packing of eggs in the brood chamber. Wax secretions by the tubular ducts in the cephalic and vulvar areas occur immediately prior to or during oviposition; these secretions are filamentous and may be involved with the separation and protection of eggs in the venter. Wax secretions from the submarginal cruciform pores cover the ventral side and fix the scale to the host (Gimpel *et al.*, 1974).

Males and Immatures

Of the 144 species in the genus *Ceroplastes*, males of only 4 species have been described—*C. japonicus*, *C. ceriferus* (F.), *C. cirripediformis* Comstock and *C. rusci* (L.) (Rainato and Pellizzari, 2008, 2010).

A description of the first instar and other *C. japonicus* immature stages is reported by Camporese and Pellizzari (1994). Male and immature identification is not critical to this document and therefore not discussed in detail.

Similar Species

Fourteen species of *Ceroplastes* are currently reported in the U.S.: *C. brachyurus* Cockerell, *C. ceriferus, C. cirripediformis, C. cistudiformis* Cockerell, *C. dugesii* Lichtenstein, *C. feltyi* Hodges, *C. floridensis, C. irregularis* Cockerell, *C. nakaharai* Gimpel, *C. rubens* Maskell, *C. rusci, C. sinensis* Del Guercio, *C. stellifer* Lindinger and *C. utilis* Cockerell. Widely distributed species include *C. ceriferus* (19 states), *C. cirripediformis* (16 states) and *C. floridensis* (15 states) (Ben-Dov *et al.*, 2014u). The arrangement, shape and size of the setae may be used to identify various *Ceroplastes* spp. (Gimpel *et al.*, 1974).

Morphology

All identifying characteristics are based on adult female morphology. Identification keys are available to distinguish *C. japonicus* from *C. rubens, C. stellifer, C. sinensis, C. cirripediformis, C. cistudiformis, C. centroroseus* Chen, *C. floridensis, C. kunmingensis* (Tang *et* Xie), *C. xishuangensis* Tang *et* Xie, *C. hodgsoni* (Matile-Ferrero *et* Le Ruyet), *C. destructor* Newstead, *C. ceriferus* and *C. pseudoceriferus* Green (Fetykó and Kozár, 2012).

Of the 7 *Ceroplastes* spp. (*C. rubens*, *C. stellifer, C. sinensis, C. cirripediformis, C. cistudiformis, C. ceriferus* and *C. floridensis*) that occur in the U.S., *C. japonicus* is morphologically most like *C. floridensis*. However, the two congeners can be distinguished by the number and arrangement of stigmatic setae. In *C. japonicus*, the stigmatic setae form a continuous row between the anterior and posterior stigmatic furrows, but are interrupted by 7–12 marginal setae in *C. floridensis* (Pellizzari and Camporese, 1994). In *C. japonicus*, the stigmatic setae are arranged in three irregular rows along the margin with ~60 setae lateral to each furrow (Ben-Dov, 2014). Images of the morphological characteristics are available from ScaleNet for comparison (Figure 3-5).

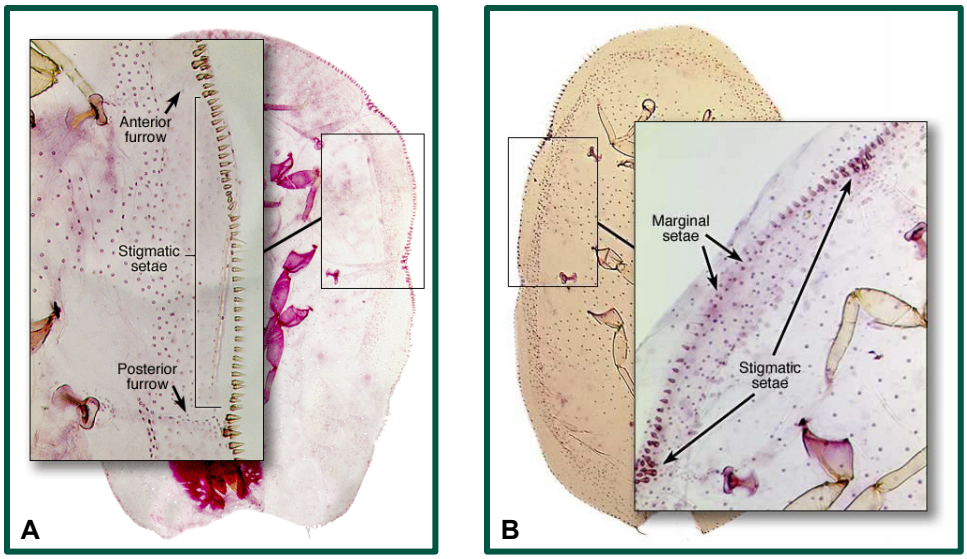

Figure 3-5 Slide-mounted female adults of (A) *C. japonicus* and (B) *C. floridensis* (photo courtesy of ScaleNet)

Bioinformatics

ScaleNet, a robust scale database, provides a simple user interface to run keys for 47 species belonging to the soft scale family. Using Lucid-based interactive identification keys, *C. japonicus* can be distinguished from adult females of *C. ceriferus*, *C. cirripediformis*, *C. floridensis, C. rubens, C. rusci, C. sinensis* and 40 other genera in the soft scale family (Ben-Dov *et al.*, 2014w).

Molecular Identification

Molecular identification does not require the proper specimen preparation and preservation of the cuticular features necessary for accurate morphological identification. *Ceroplastes japonicus* can be distinguished from its congenerics—*C. floridensis*, *C. ceriferus*, *C. pseudoceriferus*, *C. rubens* and *C. kunmingensis* (3 of 5 currently occur in the U.S.)—using DNA barcodes. Molecular identification was completed using the mitochondrial cytochrome c oxidase I sequence (COI) (GenBank Accessions JQ795609-JQ795722) according to the following method (Deng *et al.*, 2012):

1. Collect scales and preserve in 95% ethanol
2. Extract total DNA using a kit
3. Primers used:
   F (5′-CAGGAATAATAGGAACATCAATAAG-3′)
   R (5′- ATCAATGTCTAATCCGATAGTAAATA-3′)
4. Conduct PCR amplification and select PCR products
5. Sequence products bidirectionally
6. Use bioinformatic tools to align sequences

7. Calculate K2P sequence divergence and construct neighbor-joining (NJ) trees

Deng *et al.* (2012) noted that after aligning, the usable length of COI was 543 base pairs (bp). As observed in other scales, the *Ceroplastes* species had low GC content, and the NJ tree revealed that *C. japonicus* and *C. floridensis* formed distinct clusters with an interspecific divergence between 8.6 and 10.4%. Further studies are required to develop a comprehensive DNA barcode library to identify other Coccidae species.

Chapter 4

Biology

Life Cycle

Ceroplastes japonicus is univoltine in Italy and China with no generation information available from other regions (Jiang and Gu, 1988; Longo, 1985; Pellizzari and Camporese, 1994). The insect has 3 stages—egg, nymph and adult (Camporese and Pellizzari, 1998; Davis *et al.*, 2005). Seasonal variations in temperature and host phenology are critical to the development time of *C. japonicus* (Camporese and Pellizzari, 1998; Marotta and Tranfaglia, 1997).

Egg

Ovary development in female *C. japonicus* coincides with a dorsoventral increase in body size; convexity appears one month prior to oviposition (Marotta, 1997; Park *et al.*, 1992). Although a minimum threshold of 18 °C is required to initiate oviposition, the pre-ovipositional period is short at a high temperatures (EPPO, 2003). Park *et al.* (1992) observed that after 4 days at 25 °C, the overwintering females began oviposition, which continued for 10 days. On average, oviposition lasted for 7.5 days with 85% of the eggs laid in the first 4 days (Park *et al.*, 1992). Host quality and insect size significantly influence insect fecundity, but not oviposition phenology (Camporese and Pellizzari, 1998; Marotta, 1997). Longo (1985) observed up to 2,000 eggs on loquat, *Eriobotrya japonica* (Thunberg) Lindley. Camporese and Pellizzari (1998) noted higher fecundity on mulberry (*Morus alba* L.) than on bay (*Laurus nobilis* L.), citrus (*Citrus* spp.) or apple (*Malus* spp.). In most cases, oviposition occurs from mid-May to late June, with population peaks in late May. However, oviposition may also occur in early May or extend until late July (Camporese and Pellizzari, 1998; Jiang and Gu, 1988; Longo, 1985; Park *et al.*, 1992). During oviposition, the eggs are laid on the ventral side, pushing the body toward the dorsum. The abdomen completely shrinks after oviposition, and the venter meets the dorsum acting as a protective layer for the eggs (Marotta, 1997). Eventually the scale appears as a capsule filled with eggs (EPPO, 2003). After oviposition, egg development may depend on the accumulated degree days and host species. In general, egg development in *C. japonicus* requires at least 15.0 °C and at least 200 degree days; however, these

values can vary with the initial temperature and host plant (Park *et al.*, 1992; Yang *et al.*, 1996). At higher temperatures, the time required for egg development decreases, and the hatching rate increases. If the temperature is maintained at 24 °C, egg development is complete in 26–29 days (EPPO, 2003).

Instars

The first instars are highly mobile for the 1–2 days after emergence (EPPO, 2003; Marotta, 1997). After locating a suitable feeding site, such as the veins of young leaves, the first instar becomes immobile and molts to the second instar (EPPO, 2003). The wax layer develops after the instar settles. In the field, the first instar occurs from June to July with population peaks from late June to mid-July (Camporese and Pellizzari, 1998; Longo, 1985; Pellizzari and Camporese, 1994), but first instars can be found in the field as late as early August (Park *et al.*, 1992). Second instars are primarily found from mid-July to August (Camporese and Pellizzari, 1998; Pellizzari and Camporese, 1994) and rarely in late September (Park *et al.*, 1992). Third instars are observed in August and September (Camporese and Pellizzari, 1998; Longo, 1985; Pellizzari and Camporese, 1994) and occasionally October (Park *et al.*, 1992). In Russia, male immatures were recorded in August, but in Italy, they were observed in September–October (Longo, 1985; Rainato and Pellizzari, 2008). Temperature significantly influences the development of various instars. At a constant temperature of 24 °C, the first, second and third instars complete development in approximately 33, 15 and 22 days, respectively (EPPO, 2003).

Adult

Female adults typically occur from September to June (Camporese and Pellizzari, 1998; Jiang and Gu, 1988; Park *et al.*, 1992; Pellizzari and Camporese, 1994); the emergence of adult males peaks in mid-September (Longo, 1985). The type of *C. japonicus* reproduction depends on the availability of males at a location. If only females are present, the insect reproduces through facultative parthenogenesis (Rainato and Pellizzari, 2008). When both sexes are present, mating begins soon after adult emergence in September and can continue until late October. Both sexes are present in eastern Asia and the Republic of Georgia. In Italy, female *C. japonicus* was identified on hosts as early as 1983, but males were reported only recently (Camporese and Pellizzari, 1998; Pellizzari and Camporese, 1994; Rainato and Pellizzari, 2008). Mated females overwinter on host branches or on the upper side of leaves on evergreen plants and live for several months, whereas males are ephemeral and die in 3–4 days (Camporese and Pellizzari, 1998; EPPO, 2003; Gullan and Kosztarab, 1997; Jiang and Gu, 1988; Longo, 1985; Pellizzari and Camporese, 1994). The male-to-female ratio varies dramatically from male biased (apple, 4:1) to female biased (mulberry, 1:2.5) or unbiased (kaki

(*Diospyros kaki* L.) or tangerine (*Citrus reticulata* Blanco), 1:1). The sex ratio may also depend on the infested plant part. On laurel, the insect is unbiased on the leaves (1:1), but highly female biased on the branches (1:1,000) (EPPO, 2003).

Movement

Insect movement and distribution on a host may depend on the light source and intensity, gravity, temperature, humidity, plant phenology and quality (Marotta and Tranfaglia, 1997). The majority of population growth in *C. japonicus* occurs during flowering, fruiting, pre-emergence, seedling and the vegetative growth host stages (EPPO, 2003; Espinosa and Hodges, 2009). Immediately after hatching, first instars remain immobile under the female for a time depending on environmental conditions (Marotta, 1997).

After becoming active, the first instar migrates to feed on young leaves primarily located at the periphery or upper canopy of the host (EPPO, 2003; Greathead, 1997a; Marotta and Tranfaglia, 1997). The migration may be guided by innate behavior, the availability of feeding sites or environmental conditions. Although long-distance dispersal is possible, most instars settle within 1 m of the mother, typically on the venations on the upper side of leaves (Marotta, 1997; Pellizzari, 2014). For overwintering, young females migrate from the leaves of deciduous trees to the twigs; based on the host and abiotic factors, this migration may vary from September to early November (Camporese and Pellizzari, 1998).

Mortality Factors

Several abiotic and biotic factors limit the distribution of *C. japonicus* on its host plant. The first instar is active and does not settle immediately on the host. The first instar also lacks a waxy cover; therefore, it is exposed to important mortality factors such as temperature, humidity, wind and rainfall. The unsettled insect may desiccate under dry and warm conditions or be dispersed via wind (Greathead, 1997a; Marotta, 1997). The thick waxy cover deflects rain and protects adults from natural enemies and pesticides; however, early instars cannot avoid these mortality factors (Gullan and Kosztarab, 1997).

Hosts

Ceroplastes japonicus is a polyphagous soft scale predominantly found on perennial plants and occasionally on annual hosts. The scale is a pest of soft and hardwood trees, fruit trees, citrus and ornamentals in urban environments; *C. japonicus* also slightly impacts deciduous fruit trees in temperate zones (Espinosa and Hodges, 2009; Pellizzari and Germain, 2010; Pfeiffer, 1997; Rainato and Pellizzari, 2008). In Russia, *C. japonicus* is considered a ‘dangerous’ pest,

damaging orchards and urban plantations (Shiryaeva, 2000). *Ceroplastes japonicus* is reported on more than 100 plant species from 38 different families (Table 4-1).

Table 4-1 List of reported plant hosts of *C. japonicus*

Plant host	Common name	References
Aceraceae		
Acer spp.[1]	maple	Camporese and Pellizzari (1998)
Acer japonicum Thunb.	downy Japanese maple, full-moon maple, amur maple	Ben-Dov (1993)
Acer negundo L.	boxelder	Camporese and Pellizzari (1998)
Acer palmatum Thunb.	Japanese maple	Green (1921)
Acer pseudoplatanus L.	sycamore maple	Kozar *et al.* (1984), Camporese and Pellizzari (1998), Milek *et al.* (2007)
Acer saccharinum L.	silver maple	Camporese and Pellizzari (1998)
Actinidiaceae		
Actinidia spp.		Swirski *et al.* (1997h)
Actinidia chinensis Planch	Chinese gooseberry, kiwi	Swirski *et al.* (1997h), Seljak (2010)
Annonaceae		
Annona spp.	annona	Swirski *et al.* (1997h)
Annona cherimola Mill.	cherimoya	Swirski *et al.* (1997h)
Annona diversifolia Saff.	ilama	Swirski *et al.* (1997h)
Annona muricata L.	soursop	Swirski *et al.* (1997h)
Annona reticulata L.	custard apple	Swirski *et al.* (1997h)
Annona squamosa L.	sugar apple	Swirski *et al.* (1997h)
Apocynaceae		
Nerium oleander L.	Oleander	Ben-Dov (1993)
Trachelospermum asiaticum (Sieb. & Zucc.) Nakai	yellow star jasmine, Asiatic jasmine	Ben-Dov (1993)
Aquifoliaceae		
Ilex spp.		Longo (1985), Pellizzari and Camporese (1994)
Ilex aquifolium L.[1]	English holly	Camporese and Pellizzari (1998), Jancar *et al.* (1999), Seljak (2007), Japoshvili *et al.*(2008), Ben-Dov *et al.* (2014a)
Ilex colchica Pojark.	Black sea holly	Davis *et al.* (2005)
Ilex cornuta Lindl. & Paxton	Chinese holly	Camporese and Pellizzari (1998)
Ilex integra C.P. Thunberg ex A. Murray	mochi tree	Ben-Dov (1993)
Ilex latifolia C.P. Thunberg ex A. Murray	lusterleaf holly	Camporese and Pellizzari (1998)
Araliaceae		
Aralia spp.[1]	spikenard	Seljak (2007)
Fatsia japonica (Thunb.) Decne. & Planch.[1]	paperplant	Camporese and Pellizzari (1998)
Hedera spp.		Pellizzari and Camporese (1994)
Hedera colchica (K.Koch) K.Koch	colchis ivy	Davis *et al.* (2005)
Hedera helix L.[1]	English ivy	Longo (1985), Camporese and

		Pellizzari (1998), Milek *et al.* (2007), Seljak (2007), Japoshvili *et al.*(2008),Kaydan and Kondo (2008)
Asteraceae		
Artemisia spp.	sagebrush	Kozar (1998)
Berberidaceae		
Berberis spp.	barberry	Ben-Dov (1993)
Berberis aquifolium Pursh (= *Mahonia aquifolium*)	holly-leaved barberry	Ben-Dov (1993)
Epimedium colchicum (Boiss.) N. Busch	small eleven flower	Ben-Dov (1993), Jancar *et al.* (1999)
Boraginaceae		
Ehretia acuminata (DC.) R. Br.	koda	Ben-Dov (1993)
Buxaceae		
Buxus spp.		Ben-Dov (1993)
Buxus sempervirens L.	common box	Jancar *et al.* (1999)
Buxus sinica (Rehder & E.H. Wilson) M. Cheng[2]	Chinese box	Cave and Redlin (1996)
Celastraceae		
Euonymus spp.	spindletree	Ben-Dov (1993)
Euonymus japonicus Thunb.[1]	Japanese spindletree	Miyanoshita and Kawai (1992), Camporese and Pellizzari (1998), Jancar *et al.* (1999), Milek *et al.* (2007), Ben-Dov *et al.* (2014a)
Cornaceae		
Aucuba japonica Thunb.	Japanese laurel	Camporese and Pellizzari (1998)
Cornus mas L.	Cornelian cherry	Ben-Dov (1993)
Swida spp.	dogwood	Ben-Dov (1993), Ben-Dov *et al.* (2014a)
Cycadaceae		
Cycas revoluta Thunb.	sago palm	Ben-Dov (1993)
Ebenaceae		
Diospyros spp.[1]	persimmon	Dekanoidze (1971), Park *et al.* (1992), Pellizzari and Camporese (1994), Swirski *et al.* (1997b)
Diospyros kaki L. f.[1]	Japanese persimmon	Ben-Dov (1993), Swirski *et al.* (1997b), Camporese and Pellizzari (1998), Jancar *et al.* (1999), Milek *et al.* (2007), Seljak (2007), Japoshvili *et al.*(2008)
Diospyros lotus L.	Chinese persimmon	Swirski *et al.* (1997b)
Diospyros montana Roxb.	tandam	Swirski *et al.* (1997b)
Diospyros virginiana L.	common persimmon	Swirski *et al.* (1997b)
Elaeagnaceae		
Elaeagnus pungens C.P. Thunb. ex A. Murray	thorny olive	Ben-Dov (1993)
Elaeocarpaceae		
Elaeocarpus decipiens Hemsl.	Japanese blueberry tree	Ben-Dov (1993)
Euphorbiaceae		
Sapium spp.	milktree	Zheng (2004)
Hamamelidaceae		

Liquidambar styraciflua L.	sweetgum	Camporese and Pellizzari (1998)
Hydrangeaceae		
Deutzia crenata Siebold & Zucc.	crenate pride-of-Rochester	Camporese and Pellizzari (1998)
Hydrangea macrophylla (Thunb.) Seringe (= *Hydrangea hortensia*)		Jancar *et al.* (1999), Ben-Dov *et al.* (2014a)
Lauraceae		
Cinnamomum japonicum Sieb. ex Nakai	Japanese cinnamon	Jianqin (2007), Wu and Wei (2010)
Laurus spp.	laurel	Pellizzari and Camporese (1994)
Laurus nobilis L.[1]	sweet bay	Dekanoidze (1971), Longo (1985), Ben-Dov (1993), Camporese and Pellizzari (1998), Jancar *et al.* (1999), Beglaryan (2003), Milek *et al.* (2007), Seljak (2007), Japoshvili *et al.*(2008), Kaydan and Kondo (2008), Trencheva *et al.* (2010), Ben-Dov *et al.* (2014a)
Machilus thunbergii Hemsl. (= *Persea thunbergii*)	Japanese machilus, Japanese bay tree	Ben-Dov (1993)
Magnoliaceae		
Magnolia spp.	magnolia	Longo (1985), Seljak (2010)
Magnolia grandiflora L.[1]	southern magnolia	Longo (1985), Ben-Dov (1993), Camporese and Pellizzari (1998), Milek *et al.* (2007)
Meliaceae		
Melia spp.	melia	Zheng (2004)
Moraceae		
Ficus carica L.	edible fig	Jancar *et al.* (1999), Ben-Dov *et al.* (2014a)
Morus spp.[1]	mulberry	Dekanoidze (1971)
		Jancar *et al.* (1999), Ben-Dov (1993)
Morus nigra L.[1]	black mulberry	Seljak (2007)
Myrtus communis L.	myrtle	Ben-Dov (1993)
Myrsinaceae		
Myrsine africana L.	African boxwood	Camporese and Pellizzari (1998)
Myrtaceae		
Acca sellowiana (O. Berg) Burret (= *Feijoa sellowiana*)	feijoa, horn of plenty	Ben-Dov (1993)
Psidium guajava L. (= *P. pomiferum*, *P. pyriferum*)	guava	Swirski *et al.* (1997a)
Oleaceae		
Jasminum spp.	jasmine	Yang *et al.* (1996)
Osmanthus fragrans Lour.[1]	sweet osmanthus	Japoshvili *et al.*(2008)
Pittosporaceae		
Pittosporum tobira (Murray) Aiton fil.	Japanese cheesewood	Ben-Dov (1993)
Platanaceae		
Platanus spp.	sycamore	Pellizzari and Camporese (1994)
Platanus hybrida Brot. (= *Platanus acerifolia*)	London plane tree	Camporese and Pellizzari (1998)
Platanus orientalis L.	oriental plane tree	Pellizzari and Camporese (1994)

Podocarpaceae		
Nageia nagi (Thunb.) Kuntze (= *Podocarpus nagi*)	broadleaf podocarpus	Ben-Dov (1993)
Punicaceae		
Punica granatum L.	pomegranate	Jancar *et al.* (1999), Le and HaiYan (2004), Ben-Dov *et al.* (2014a)
Rhamnaceae		
Ziziphus spp.[1]	jujube	Ben-Dov (1993), Camporese and Pellizzari (1998)
Ziziphus jujube Miller[1]	common jujube	Luo *et al.* (1994)
Rosaceae		
Chaenomeles spp.		Pfeiffer (1997)
Chaenomeles japonica (Thunb.) Lindl. ex Spach[1]	Maule's quince	Jancar *et al.* (1999), Seljak (2007), Ben-Dov *et al.* (2014a)
Crataegus spp.	hawthorn	Ben-Dov (1993)
Cydonia oblonga Mill. (= *Cydonia vulgaris*)	quince	Ben-Dov (1993), Camporese and Pellizzari (1998)
Eriobotrya japonica (Thunb.) Lindl.[1]	loquat	Longo (1985), Swirski *et al.* (1997h), Camporese and Pellizzari (1998), Jancar *et al.* (1999), Milek *et al.* (2007), Japoshvili *et al.*(2008)
Malus spp.	apple	Pfeiffer (1997)
Malus pumila Mill. (= *Malus domestica*)[1]	paradise apple	Ben-Dov (1993), Jancar *et al.* (1999), Milek *et al.* (2007), Ben-Dov *et al.* (2014a)
Prunus spp.[1]	stone fruit	Pellizzari and Camporese (1994)
Prunus armeniaca (= *Cerasus avium*)[1]	apricot	Camporese and Pellizzari (1998), Jancar *et al.* (1999), Ben-Dov *et al.* (2014a)
Prunus avium (L.) L. (= *Cerasus avium*) [1]	sweet cherry	Ben-Dov (1993), Jancar *et al.* (1999), Seljak (2007)
Prunus cerasus L. (= *Cerasus vulgaris*)	sour cherry	Ben-Dov (1993), Camporese and Pellizzari (1998)
Prunus domestica L.[1]	European plum	Camporese and Pellizzari (1998), Japoshvili *et al.*(2008)
Prunus laurocerasus L. (= *Laurocerasus officinalis*)[1]	cherry laurel	Ben-Dov (1993), Japoshvili *et al.*(2008)
Prunus mume Siebold & Zucc.	Japanese apricot	Ben-Dov (1993)
Prunus persica (L.) Batsch (= *Persica vulgaris*)	peach	Ben-Dov (1993), Jancar *et al.* (1999)
Prunus × *yedoensis* Matsum. (pro sp.)	Yoshino cherry	Ben-Dov (1993), Pfeiffer (1997)
Pyracantha coccinea M. Roem.	scarlet firethorn	Camporese and Pellizzari (1998), Seljak (2010)
Pyrus spp.	pear	Pfeiffer (1997)
Pyrus bretschneideri Rehd.	Yali pear	BA-AQIS (2003)
Pyrus communis L.[1]	common pear, European pear	Camporese and Pellizzari (1998), Jancar *et al.* (1999), Milek *et al.* (2007), Ben-Dov *et al.* (2014a)
Pyrus pyrifolia (Burm. f.) Nakai (= *Pyrus sinensis*)	Chinese pear	Ben-Dov (1993)
Rutaceae		

Citrus spp.[1]	citrus	Dekanoidze (1971), Longo (1985), Pellizzari and Camporese (1994), Greathead (1997f)
Citrus aurantium Ten. (= *Citrus deliciosa*)	Mediterranean mandarin	Milek and ŠImala (2011)
Citrus limon (L.) Burm. f.[1]	lemon	Jancar *et al.* (1999), Ben-Dov *et al.* (2014a), Milek *et al.* (2007)
Citrus reticulata Blanco (= *Citrus unshiu*) [1]	tangerine	Jancar *et al.* (1999), Ben-Dov *et al.* (2014a), Milek *et al.* (2007)
Poncirus trifoliata (L.) Raf. (= *Aegle sepiaria*, *Citrus trifoliata*)[1]	hardy orange	Ben-Dov (1993), Kozar *et al.* (1984), Camporese and Pellizzari (1998), Jancar *et al.* (1999)
Salicaceae		
Pleiarina glandulosa (Seemen) N. Chao & G.T. Gong (= *Salix glandulosa, S. chaenomeloides*)	king willow	Ben-Dov (1993), Davis *et al.* (2005), Ben-Dov *et al.* (2014a)
Populus spp.	cottonwood, poplar	Zheng (2004), Yongxiang (2008)
Salix alba L.[1]	white willow	Japoshvili *et al.*(2008)
Salix cinerea L. (= *Salix caprea*)	goat willow	Seljak (2010)
Salix babylonica L.	weeping willow	Camporese and Pellizzari (1998)
Salix saidaeana Seemen	willow	Ben-Dov (1993), Ben-Dov *et al.* (2014a)
Simmondsiaceae		
Simmondsia chinensis (Link) C.K. Schneid.	jojoba	Swirski *et al.* (1997b)
Taxaceae		
Taxus baccata L.[1]	English yew	Seljak (2007)
Theaceae		
Camellia japonica L.	Japanese camellia	Ben-Dov (1993)
Camellia oleifera Abel	oil tree	Sun (1989)
Camellia sinensis (L.) Kuntze (= *Thea sinensis*) [1]	tea	Ben-Dov (1993), Greathead (1997f), Ben-Dov *et al.* (2014a)
Cleyera japonica Thunb. (= *Eurya japonica*)	Japanese eurya	Ben-Dov (1993), Davis *et al.* (2005), Ben-Dov *et al.* (2014a)
Ulmaceae		
Ulmus spp.	elm	Zheng (2004)
Ulmus procera Salisb. (= *U. minor, U. campestris*)	English elm, European field elm	Pellizzari and Camporese (1994), Camporese and Pellizzari (1998)

[1] Preferred host; [2] unverified host

Natural Dispersal

Ceroplastes japonicus males have wings but are weak fliers and cannot actively disperse (EPPO, 2003; Greathead, 1997a). The first instars of *C. japonicus* are highly susceptible to natural dispersion via wind or phoresy via animals (Davis *et al.*, 2005). No evidence indicates phoresy via insects (Stouthamer and Morse, 2011). The form of *C. japonicus* dispersal relevant to quarantine occurs through the transport of host plant material during which any insect stage can be accidentally carried to a new location (EPPO, 2003).

Geographic Distribution

Ecological Distribution

The genus *Ceroplastes* includes 142 species, the majority of which are endemic to neotropical and Ethiopian zoogeographic regions (Fetykó and Kozár, 2012). *Ceroplastes japonicus* is distributed throughout China, Japan and Korea and is believed native to the eastern Palearctic region (EPPO, 2003; Pellizzari and Camporese, 1994). The insect was detected in 1933 in the former USSR on a *Chaenomeles* sp. seedling imported from Yokohama, Japan in 1927. An early introduction of *C. japonicus* is believed to have occurred in the western Republic of Georgia with subsequent spread and establishment to central Georgia, south Russia and Azerbaijan. *Ceroplastes japonicus* was reported in southern France on specimens collected from Antibes and Carqueiranne in 1930 (Pellizzari and Camporese, 1994) and in 1983 in north-eastern Italy on *Citrus trifoliata* with subsequent spread to central and northern Italy primarily in urban areas (Kozar *et al.*, 1984). *Ceroplastes japonicus* is the only *Ceroplastes* species that can survive the harsh winter in northern Italy where outbreaks are frequent and the pest thrives without competition from congeners (Pellizzari, 2014; Pellizzari and Camporese, 1994). *Ceroplastes japonicus* continues to increase its range to other European countries including Croatia, Bulgaria, Slovenia and Turkey (EPPO, 2003; Fetykó and Kozár, 2012). Green (1921) first described the insect in England from an imported host, but *C. japonicus* is not currently found there (Malumphy, 2010). The European and Mediterranean Plant Protection Organization (EPPO) added *C. japonicus* as a quarantine pest in several Asian and European countries (EPPO, 2014). The pest also has quarantine status in Australia (BA-AQIS, 2003).

The host suitability of the pest varies with location and may be correlated with its abiotic or biotic interactions and ability to disperse. In eastern Asia, *C. japonicus* damages persimmon, jujube, citrus and ornamentals; in the Republic of Georgia, it is established on fruit trees; and in Italy it is found on mulberry and citrus. In Croatia and Slovenia the most common hosts are laurel, kaki and ivy (Camporese and Pellizzari, 1998) with the pest restricted to citrus and subtropical fruits in southern Russia (CABI, 2012). The worldwide distribution of *C. japonicus* is presented in Table 4-2 and Figure 4-2.

Ceroplastes japonicus occurs in variable climatic zones—from low temperature, high humidity areas to warm, dry locations (Davis *et al.*, 2005). The optimum humidity for *C. japonicus* development is 75–80% with development favored at 24–27 °C (high and low thresholds of 12 °C and 35 °C, respectively) (EPPO, 2003). However, the pest can survive extremely low temperatures, tolerating

temperatures below −10 °C on mulberry and on citrus surviving frost better than its host (EPPO, 2003). Although low temperatures (sub-0 °C) in northern Italy are unfavorable for its congeneric species, the invasive *C. japonicus* occupies this niche and flourishes in the absence of its natural enemies (Pellizzari and Camporese, 1994). *Ceroplastes japonicus* is a pest in northern and central Italy impacting ornamentals in urban environments (Pellizzari and Camporese, 1994). Infestations become sporadic and scarce outside urban areas. Availability of suitable exotic ornamental hosts, nurseries, low numbers of natural enemies, high optimum temperatures and human activities that aid dispersal likely drive urban establishment (Camporese and Pellizzari, 1998).

Table 4-2 Worldwide distribution of *C. japonicus*

Location	Local distribution	References
Abkhazia[1]		Pellizzari and Camporese (1994), Davis *et al.* (2005), EPPO (2003)
Armenia[1]		Beglaryan (2003), EPPO (2014)
Azerbaijan		Davis *et al.* (2005), EPPO (2003)
Bulgaria[2]		Trencheva *et al.* (2010)
China	Hebei, Shanghai, Hubei, Shaanxi, Zhejiang, Hunan, Jiangsu, Henan, Shanxi, Sichuan, Baise	Pellizzari and Camporese (1994), Le and HaiYan (2004), Wang and Huang (2010), Ben-Dov *et al.* (2014a)
Croatia[1]	primarily Istria	Milek *et al.* (2007), Pellizzari *et al.* (2008), Ivic´ *et al.* (2012), EPPO (2014), Ben-Dov *et al.* (2014a)
France[1]	primarily southern France	Pellizzari and Camporese (1994), Pellizzari *et al.* (2008), Fetykó and Kozár (2012), Ben-Dov *et al.* (2014a)
Georgia[1]	western Georgia	Dekanoidze (1971), Kozar *et al.* (1982), Kozar *et al.* (1984), Ben-Dov (1993), Pellizzari and Camporese (1994), Yasnosh *et al.* (1995), Yasnosh and Japoshvili (1998), Ben-Dov and Hodgson (1997f), Japoshvili (2001)
Hungary		Fetykó and Kozár (2012), Klupács and Volent (2012)
Italy[1]		Kozar *et al.* (1984), Longo (1985), Ben-Dov (1993), Pellizzari and Camporese (1994), Camporese and Pellizzari (1998), Canovai and Raspi (1999), Rainato and Pellizzari (2008)
Japan[1]	Honshu, Shikoku, Kyushu, Kyoto and Ryukyu Archipelago	Takahashi and Tachikawa (1956), Noda *et al.* (1982), Ben-Dov (1993), Pellizzari and Camporese (1994), Ben-Dov and Hodgson (1997f), Yasnosh and Japoshvili (1998), Camporese and Pellizzari (1998), Fetykó and Kozár (2012)
Korea[1]	no differentiation between North and South Korea	Ben-Dov (1993), Pellizzari and Camporese (1994), Davis *et al.* (2005)
Nepal[3]		CABI (2003)
Russia		EPPO (2014), Fetykó and Kozár (2012)
Slovenia[1]		Jancar *et al.* (1999), Seljak (2007)
Turkey	Istanbul	Kaydan and Kondo (2008), Fetykó and Kozár (2012)

[1] Established; [2] restricted indoors; [3] unverified

Although unconfirmed reports cite *C. japonicus* in Lebanon, Jordan, Egypt (Sinai Peninsula), Syria, Iran, Iraq, Israel and on the Arabian peninsula (Burckhardt, 2004; CABI, 2003), these reports are likely misidentifications of other *Ceroplastes* spp. The fauna of Israel and Iran are well characterized, and *C. japonicus* is absent in these regions (Pellizzari, 2014).

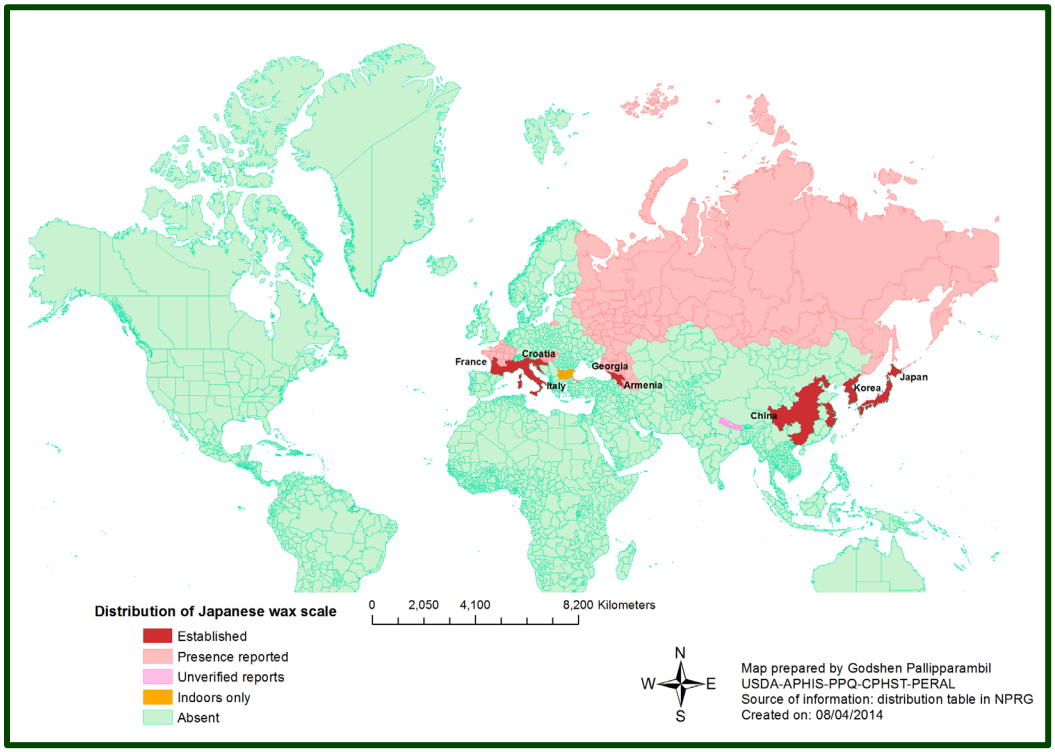

Figure 4-2 Worldwide distribution of *C. japonicus*; established locations are labelled

Potential Distribution

Based on the aforementioned ecological distribution, the Plant Hardiness Zones (PHZ) of *C. japonicus* established locations were determined to be 4–10 using ArcMap. Among these PHZ zones, 5–9 were most common at the established locations. Figure 4-3 indicates that most of the continental U.S. is suitable for *C. japonicus* establishment.

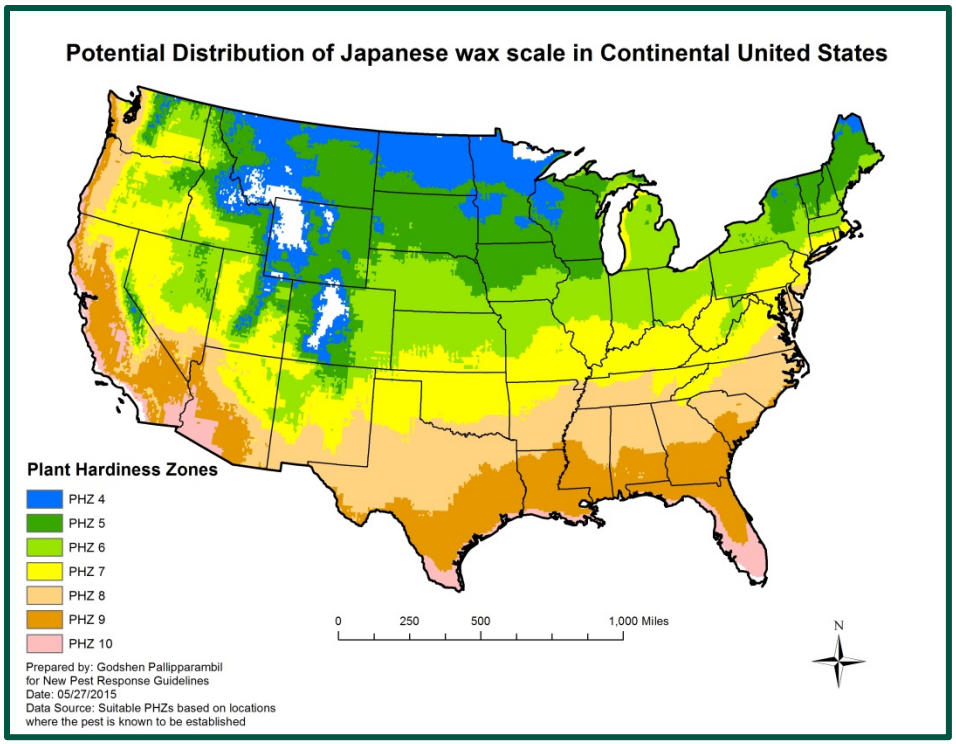

Figure 4-3 Potential distribution of *C. japonicus* based on known geographic associations

Ceroplastes japonicus is polyphagous and some of its hosts are widespread throughout the U.S. Table 4-3 lists the preferred hosts and their U.S. distribution.

Table 4-3 Distribution of preferred hosts of *C. japonicus* in the U.S.

Preferred plant hosts	Common name	US distribution (USDA Plants database, BONAP)
Acer spp.	maple	widespread
Ilex aquifolium	English holly	WA, OR, CA, VA, NJ
Aralia spp.	spikenard	Widespread
Fatsia japonica	paperplant	FL
Hedera helix	English ivy	widespread except northcentral region
Euonymus japonicus	Japanese spindletree	IN, VA, NC, LA, MS
Diospyros kaki	Japanese persimmon	absent
Laurus nobilis	sweet bay	CA
Magnolia grandiflora	southern magnolia	southern U.S.
Morus nigra	black mulberry	TX, LA, OH, KY, WV
Osmanthus fragrans	sweet osmanthus	absent
Ziziphus jujuba	Indian jujube	southern U.S.
Chaenomeles japonica	Maule's quince	MT, IL, PA, NY, VT, NJ, DE, MD
Eriobotrya japonica	loquat	CA, LA, FL, GA
Malus pumila	paradise apple	widespread
Prunus spp.	stone fruits	widespread

Pyrus communis	common pear	widespread
Citrus limon	lemon	FL, TX
Citrus reticulata	tangerine	FL
Poncirus trifoliata	hardy orange	southern and eastern U.S.
Salix alba	white willow	widespread
Taxus baccata	English yew	WA, PA, NY, MA, NJ
Camellia sinensis	tea	FL, GA, SC, NC

Chapter 5

Damage

Signs and Symptoms

There are no specific signs and symptoms to identify *C. japonicus*. However, typical scale feeding symptoms such as chlorosis, leaf fall, wilt, shoot and root stunt, stem dieback, presence of honey dew and sooty mold may indicate potential survey sites (Gill and Kosztarab, 1997; USDA-APHIS-PPQ-CPHST, 2005).

Impacts

Environmental

Approximately 4500 arthropod species have been introduced in the U.S., and annual losses from their environmental impact are estimated at ~2.137 billion U.S. dollars (Pimentel *et al.*, 2001). The environmental impact may result from direct impact on the native floral and faunal diversity, indirect impact on the ecosystem from complex food web interactions or pest management programs. A newly introduced insect can stimulate overuse of insecticides to eradicate the pest, preserve international trade and prevent loss in produce market value (Davis *et al.*, 2005). Organophosphates such as omethoate, monocrotophos, and methamidophos used to control *C. japonicus* in some locations are not registered in the U.S. due to potential environmental and health impacts (Kegley *et al.*, 2010); however, alternatives are available as discussed in *Chemical Control* on page 8-2.

Although impacts vary with arthropods, polyphagous species exert more influence than host-specific pests (Brockerhoff *et al.*, 2010; Wilson *et al.*, 2009). *Ceroplastes japonicus* has a wide host range and may impact protected flora. Several plant species protected in the U.S. are potential *C. japonicus* hosts. The potential hosts with federal protected status of endangered or threatened are listed in Table 5-1, 9 of which are congeneric species of known *C. japonicus* hosts. Although not included in the table, 82 host species have ‘endangered’ protected status in one or more states, and several have ‘threatened’ or ‘special concern’ status in multiple states (USDA-NRCS, 2014; USFWS, 2014).

Table 5-1 Protected plant species in the U.S. potentially impacted by *C. japonicus*; the list is restricted to species congeneric to the known *C. japonicus* hosts (USFWS, 2014)

Potential plant hosts	Common name	Federal protected status
Aquifoliaceae		
Ilex cookii Britton & P. Wilson	te	endangered
Ilex sintenisii (Urban) Britton	Sintenis' holly	endangered
Berberidaceae		
Mahonia nevinii (Gray) Fedde	Nevin's barberry	endangered
Mahonia pinnata subsp. *insularis* (Munz) J.B. Roof	island barberry	endangered
Buxaceae		
Buxus vahlii Baillon	Vahl's box	endangered
Myrsinaceae		
Myrsine juddii Hosaka	cloudswept colicwood	endangered
Myrsine linearifolia Hosaka	narrowleaf colicwood	threatened
Rhamnaceae		
Ziziphus celata W.S. Judd & D.W. Hall	Florida jujube	endangered
Rosaceae		
Prunus geniculata Harper	scrub plum	endangered

An introduced species may alter the composition, structure, processes and microenvironment of the ecosystem through direct or indirect interactions (Orwig, 2002). Scale insects including *C. japonicus* produce honeydew and are mutualistic with ants, influencing the abundance and behavior of both species. Ant–scale interactions can negatively influence the arthropod diversity of a region (Styrsky and Eubanks, 2007).

Economic

In the U.S., introduced arthropod pests annually cause ~18 billion dollars in economic losses (Pimentel *et al.*, 2001). Based on interception records and invasion plausibility, *C. japonicus* is among the four soft scale species most likely to invade (Miller and Miller, 2003). *Ceroplastes japonicus* has a high potential economic impact if introduced into the U.S. (Davis *et al.*, 2005; Miller and Miller, 2003).

Crop Loss

Plant susceptibility to scale insects varies, and host responses may depend on interactions with other biotic or abiotic factors in the ecosystem (Miller and Kosztarab, 1979); therefore, the potential impact of *C. japonicus* is difficult to estimate (Davis *et al.*, 2005). Soft scales can directly impact their hosts, and heavy infestations may lead to crop losses from stunting, branch dieback and plant death (EPPO, 2003; Gill and Kosztarab, 1997). Scale insects secrete honeydew that covers the entire leaf surface and indirectly impacts host plants by promoting sooty mold growth. In addition to reducing net photosynthesis,

sooty mold promoted by *C. japonicus* may reduce the commodity market value or aesthetic value of ornamentals (Camporese and Pellizzari, 1998; EPPO, 2003). Worldwide annual economic losses due to soft scale infestations are estimated in the billions in U.S. dollars (Gill and Kosztarab, 1997). Once introduced, complete eradication of *C. japonicus* could prove difficult.

Control Costs

Biological control is considered the best strategy to manage the insect, but insecticides are also effective especially prior to wax-scale development (EPPO, 2003). The repeated application of pesticides and the importation of biological control agents increase pest management costs.

Trade

Ceroplastes japonicus is a major polyphagous pest of economically important ornamentals, soft and hardwood trees, mulberry, tea, citrus, apple and stone fruits, some of which are high-value crops widely cultivated in the U.S. For example, in 2012 the value of total citrus production in the U.S. exceeded 3.7 billion dollars (USDA-NASS, 2014). However, the California citrus industry deemed *C. japonicus* a low risk because the insect is less likely to occur on the harvested fruit and therefore has a low impact on export trade (USDA-APHIS-PPQ-CPHST, 2011). At present, this pest is not included in the quarantine list by any of the Regional Plant Protection Organizations (RPPO), but is of quarantine significance in Australia and some Asian and European countries (BA-AQIS, 2003; EPPO, 2014). In Europe, *C. japonicus* is a quarantine pest in Belarus; in Asia, it is an A1 quarantine pest in Uzbekistan and Kazakhstan and an A2 in Azerbaijan (EPPO, 2014). International trade could be impacted if the pest is established in the U.S. (Davis *et al.*, 2005).

The wide host and ecological ranges, impact on high-value commodities, difficulty in eradication and potential to influence domestic and international trade suggest that *C. japonicus* could have a significant economic impact.

Chapter 6

Pathways

Natural Movement

Ceroplastes japonicus males are weak fliers with no reported long-distance flights (EPPO, 2003; Greathead, 1997a) and are ephemeral, dying in 3–4 days. No *C. japonicus* males are reported in most introduced locations.

The first instars are highly susceptible to natural dispersal via wind or phoresis by animals (Davis *et al.*, 2005). Although mortality is high during wind dispersal of soft scales, the insect can be dispersed up to a few hundred meters (Gullan and Kosztarab, 1997).

Human-Assisted Spread

From a quarantine perspective, the most important form of *C. japonicus* dispersal occurs through the transport of host plant material by which any insect stage can be accidentally carried to a new location (EPPO, 2003).

Between 1985 and 2012, 42 confirmed interceptions of *C. japonicus* occurred at U.S. ports, 57% of which occurred between 2001 and 2012 (USDA, 2014). Although all developmental stages were intercepted, the majority (80%) of the insects were adults. Interceptions were made at airports (93%), maritime and postal facilities; at these locations, more than 85% of the reports derived from international airline baggage. The insect was primarily detected on the leaves of *L. nobilis* (38%) or the stems and fruits of *Diospyros* sp. (29%) intended for consumption. *Ceroplastes japonicus* was also intercepted from *Hedera* sp., *Prunus* sp. and *Ulmus* sp. intended for propagation. Most interceptions were reported at international airports in Boston (26%), Chicago (24%), Los Angeles (17%) and New York (14%). In most cases, the infested baggage originated from Italy (36%) followed by Georgia (12%) and Armenia (7%); infested materials were occasionally reported from Croatia, France, Germany, Greece, Japan, Portugal, Russia, South Korea, Thailand, Turkey and Yugoslavia (USDA, 2014).

Chapter 7

Survey

Survey Types

Plant regulatory officials will conduct detection, delimiting and monitoring surveys for *C. japonicus*. A *Detection Survey* will be conducted to ascertain the presence or absence of *C. japonicus* in an area in which it is not known to occur. After a new detection in the United States, or when detection in a new area is confirmed, a *Delimiting Survey* should be conducted to define the extent and geographic location of the insect. In addition, when a control procedure is applied, its effectiveness should be measured via a *Monitoring Survey*.

Table 7-1 Decision table for selecting survey type

If you:	Use this type of survey:
are not sure whether the pest is present at a location	*Detection Survey* as described on page 7-1. Collect specimens and consult with the authorities listed in *Appendix D* to confirm identification.
know that the pest is present and need to define its geographic location	*Delimiting Survey* as described on page 7-4. Collect specimens and consult with the authorities listed in *Appendix D* to confirm identification.
have applied control measures and need to study their effect on the insect population	*Monitoring Survey* on page 7-10. Collect specimens and consult with the authorities listed in *Appendix D* to confirm identification.

Detection Survey

Detection surveys determine if a pest is present in a defined area and can be broad in scope to assess the presence of a pest or multiple pests over large areas or restricted to determine whether a specific pest or pests are present in a focused area.

Although negative results from a detection survey may not confirm the absence of a pest at a location, the surveys can provide reasonable confidence regarding pest occurrence.

Procedure

APHIS and state cooperators conduct pest detection surveys through the Cooperative Agriculture Pest Survey (CAPS) program, which is a part of the pest detection line item within USDA–APHIS–PPQ–PDEP. The state CAPS committee meets and develops the survey list for each state.

Visual inspection is the only survey method capable of identifying *C. japonicus* infestations. Most stages of this insect are sedentary, and no attractants or traps are available for detecting this soft scale. Typically, soft scales do not occur away from their host plants (Ben-Dov and Hodgson, 1997a); therefore, surveys should focus on known hosts.

If the CAPS program determines that the pest should be surveyed, use the following procedure to conduct a detection survey for *C. japonicus*:

1. Development stage of the surveyed insect: All scale insects are identified using the morphological characteristics of young adult females and therefore, surveys should be targeted to detect female adults.
2. Prior to surveying, consider the pest phenology to determine the time of survey. The majority of population growth in *C. japonicus* occurs during flowering, fruiting, pre-emergence, seedling and the vegetative growth host stages. In Italy, female adults typically occur from September to June.
3. Determine the potential survey sites: Focus the survey in locations where *C. japonicus* is more likely to occur.
   - Geographical areas suitable for pest occurrence as described in *Potential Distribution* on page 4-11.
   - The sampling universe should include orchards, nurseries, urban ornamentals and trees in urban and natural systems.
   - Within the potential distribution area, survey specific locations that have *Hosts* suitable for *C. japonicus*. The preferred hosts of the species and their distribution in the U.S. are listed in Table 4-3 on page 4-12.
   - Plant parts surveyed: For overwintering, young females migrate from the leaves of deciduous trees to the twigs. Females overwinter on host branches or on the upper side of leaves on evergreen plants.
4. Establish sentinel sites/targeted surveys
   - The aforementioned information may be used to establish sentinel sites or targeted surveys for *C. japonicus*

- Sentinel sites are regularly inspected locations along a surveyor's normal route, *e.g.,* a preferred host at a specific location can serve as a sentinel site to regularly monitor for *C. japonicus*
- Use GPS to record the sentinel site locations and draw a map of the immediate area that includes reference points to aid others in finding the area if necessary
- Flag the sampled site
- Once a sentinel site is established, the surveyor should re-inspect it on a regular basis (bimonthly or monthly) as permitted by their regular survey schedule

5. Examine feasibility and cost effectiveness

- Survey coordinators should determine if detection surveys for *C. japonicus* could be bundled with other ongoing or new surveys based on target habitat, seasonality, priority and/or pathway

6. Determine the survey technique(s)

- After determining the sites and design/bundling of the survey, conduct the survey using the CAPS-approved survey techniques for *C. japonicus*. Refer to the CAPS-Approved Survey Methodology for Negative Data Appendix M-1 for additional information

7. Procure survey supplies using the IPHIS Survey Supply Ordering System

8. Practice safety, sanitization and compliance during a survey

- Prior to beginning a survey, determine whether any pesticides have been recently applied rendering the inspection of preferred hosts of *C. japonicus* unsafe by contacting the property owner or manager and look for posted signs indicating recent pesticide applications, particularly in orchards and nurseries
- If pesticides have recently been applied, inspect the plant hosts after the re-entry period
- Determine and comply with all quarantine requirements that may be effective in the survey area

9. Collect survey data

- Data entry forms are available from the CAPS Website for specific pests

- Because information regarding *C. japonicus* is unavailable at present, refer to *Data Collection* on page 7-8

10. Preliminarily identify the survey samples

- Morphological characteristics that may aid in preliminary identification of *C. japonicus* are described in *Identification* on page 3-1

11. After a positive occurrence is suspected in the collected samples, submit the suspected *C. japonicus* specimen(s) to the proper authority to confirm the detection

- See *Sample Submission* on page E-1 and available *Taxonomic Support for Surveys* for further information.

12. Record data for each survey site

- Survey records and data recording formats should be consistent for standardizing the collected information
- If automated field collection services such as the Integrated Plant Health Information System (IPHIS) are used, ensure that all surveyors are trained in the technology prior to initiating the survey and use the appropriate IPHIS templates for *C. japonicus*
- To reduce the burden on field data collectors, enter any known contact or address information into the database and hand-held data recorders prior to initiating the survey
- After survey is completed, all data should be entered into the designated state or national pest database; for example, *C. japonicus* detection information is available from the Pest Tracker database

For additional information, refer to the CAPS survey guidelines (CAPS, 2014).

Delimiting Survey after Initial United States Detection

The objective of a delimitation survey is to determine the spatial extent of an exotic pest incursion following a detection. If *C. japonicus* is detected in the US, surveys will be conducted to determine the occurrence of an infestation and its spread. After the initial detection, a Technical Working Group (TWG) is formed to prepare a delimitation survey plan to investigate the spread of *C. japonicus*. The TWG may consider the following information to recommend a delimitation survey plan for the introduced species.

Prior to Delimitation

If the sampling used for initial detection of *C. japonicus* was sparse and non-intensive, a high-intensity broad detection survey should be conducted prior to establishing a more focused delimitation survey. This broad and intensive detection survey confirms that no *C. japonicus* is present outside the potential area of delimitation and allows for a more efficient utilization of the available survey resources. However, if this broad detection survey confirms the occurrence in the general area of first detection, the TWG should develop a delimitation survey plan to address the detection.

The trapping density in a high-intensity detection survey depends upon the available resources and logistics. Deployment should also consider the resources and the time required for regular sampling from the traps, servicing of the traps, sample processing and recording and analysis of the trap data.

Delimitation Area

The total delimitation area may depend on information from the *Trace-Back and Trace-Forward Investigations*, the nearby host distribution, *Pathways* including the extent of natural and artificial dispersal, agency resources and logistics. Information that directly assists in determining the delimitation area was unavailable in the literature. Refer to the *Visual Survey Plan* for the delimitation area and survey deployment specific to *C. japonicus*.

Survey Spots

After determining the total area and technique(s) for the delimitation survey, the specific survey sites should be determined within the delimitation area and may depend on the following:

1. Favorable microhabitats based on pest phenology, environmental conditions and topography. The sampling universe should include orchards, nurseries, urban ornamentals, and trees in urban and natural systems.
2. Hosts: If *C. japonicus* is detected in the U.S., the TWG should consider the preferred hosts/all hosts of the pest near the detected area, spatiotemporal distribution of these hosts and the host phenology suitable to the pest. The preferred hosts of the species and their distribution in the U.S. are listed in Table 4-3.
3. Plant parts surveyed should include leaves and twigs. For overwintering, young females migrate from the leaves of deciduous trees to the twigs. Females overwinter on host branches or on the upper side of leaves on evergreen plants.

Survey Techniques

The form of an insect survey is determined by the mobility of the pest species. For example, surveys of sessile female scale insects require visual inspection of host plants. Visual survey according to the following steps is the preferred method for surveying *C. japonicus*:

1. Determine the distribution of preferred hosts/all hosts near the first detection site. Lay out the host information using mapping software such as ArcMap and determine the sampling plan outline. An example is shown in the *Visual Survey Plan*.
2. Determine if similar native species are also reported from the detected site; refer to *Similar Species* in the *Identification* chapter. If similar species are reported from the site, determine the overlap of hosts between these congeners and *C. japonicus* along with their unique hosts. These initial steps will aid with targeted surveys.
3. Survey tools: 10–20× hand lens, pruner, zip lock bags for host samples, labels, forms, pencil and flags
4. Development stage of the surveyed insect: All scale insects are identified using the morphological characteristics of young adult females; therefore, surveys should be targeted to detect female adults
5. Visually inspect the preferred host plant for the following:
   - **A.** Sooty mold symptoms and honey dew on leaves, fruits or stems are typical signs that indicate plant feeding by hemipteran insects and should signal a need to survey for additional signs at the same location.
   - **B.** Greyish to pinkish-white wax scales dispersed on the host may be *C. japonicus*, but a few other species that occur in the U.S. also have similar signs; refer to *Similar Species* on page 3-7.
   - **C.** Morphological characteristics that may aid in preliminary identification of *C. japonicus* are described in *Identification* on page 3-1. Collect the sample scale with the host part. Label and keep in a cool dry location until the preliminary identification.
   - **D.** After a positive occurrence is suspected in the collected samples, submit the suspected *C. japonicus* specimen(s) to the proper authority to confirm the identification, especially if the location also has congeneric species. See *Sample Submission* on page E-1 and available *Taxonomic Support for Surveys* for further information.

Visual Survey Plan

The delimitation survey may also include multiple buffer zones with outer zones having relatively lower survey spot densities than the inner buffer zone(s); all

buffer zones have lower survey spot densities than the core infestation area. The survey spots in the core infestation area and the buffer zones will primarily depend upon the biology of the pest species, its dispersal capacity, availability of hosts, suitability of the host phenology at the trapping time and operational logistics.

The distance between survey spots within a delimitation area is estimated using the criteria necessary for determining the core delimitation area as follows:

- The delimitation area for *C. japonicus* cannot be determined by the movement of adult males as they are ephemeral and rarely reported from introduced locations.
- First instars are highly susceptible to wind and can be dispersed up to a few hundred meters. Although long-distance dispersal is possible, most instars settle within 1 m of the mother.
- *Ceroplastes japonicus* has aggregation behavior, and upon introduction, distribution is likely clustered. Therefore, after a positive detection, the core delimitation area should be small with additional visual survey spots adjacent to the original detection site

Based on these assumptions, multiple tiers of core delimitation areas with varying densities of visual survey spots are recommended. Table 7-2 provides a decision table to aid in determining delimitation areas for *C. japonicus* surveys.

Table 7-2 Core delimiting survey decision table for *C. japonicus*

If you detect:	Set the delimitation zone	THEN take this action in the zone:	AND supplement with this action in the zone:
≥ 1 insect any stage	core 1: within 100 m of the detection site	visual survey of all hosts	
	core 2: within 1 mi. radius of the detection site	visual survey sampling unit at every 100 m (10 hosts)*	visual survey sampling unit every 50 m (10 preferred hosts)*
	buffer: within 4 mi. radius of the detection site (*i.e.*, 3 mi. out from the core zone)	cross-transect visual survey sampling unit: all hosts along the transect if host density is high, sample preferred hosts or appropriate proportion of hosts	visual survey sampling unit every 200 m (10 preferred hosts)*

* At the sample location, inspect ≥ 10 plants from 3 adjoining rows (or equivalent distance)

Without targeted sampling, the probability of finding low populations of the pest outside the core may be extremely low. The following criteria are recommended for targeted sampling outside and near the core delimitation zone:

- Possibility of wind and human-assisted dispersal
- Female adults and most life stages are sessile, but human-assisted dispersion can occur through the transport of host plant material by which the pest is accidentally carried to a new location.
- Follow potential pathways from the core delimitation zone by which infested materials may have dispersed to target surveys in nurseries, host area borders, urban landscapes and preferred hosts as listed in Table 4-3. Consult TWG at the time of introduction.

Cross-transect sampling is completed by drawing two straight lines on the map (using mapping software such as ArcMap) that will intersect and run through the wind-blown path, host production/abundance area and other aforementioned pathways. The lines need not be perpendicular, but should pass through the areas suitable for pest spread.

Safety, Sanitization and Compliance

Prior to beginning a survey, determine whether there have been recent pesticide applications that would render it unsafe to inspect the plant hosts and other substrates. Contact the property owner or manager and look for posted signs indicating recent pesticide applications, particularly in commercial fields or nurseries. If pesticides have been applied, surveys should be conducted after the re-entry period. When visiting the area to conduct surveys or take samples, survey personnel must take strict measures to prevent pest contamination between properties during inspections. Confirm that and the survey tools are clean. Determine and comply with all quarantine requirements that may be effective in the survey area.

Data Collection

Flag the plant, tree or sampled location whenever possible, and draw a map of the immediate area, indicating reference points so that the areas can be found in the future if necessary. **Do not** rely solely on the flagging or other markers to re-locate a site as they may be removed. Record the GPS coordinates for each sampled area so that the area or plant may be re-sampled if necessary. Survey task forces should consist of an experienced survey specialist or entomologist familiar with *C. japonicus* and the symptoms of its damage.

Surveyors visiting sites to place holds or obtain samples should collect the following information:

- Date of collection or observations
- Collector's name
- Grower's field identification numbers
- Full name of business, institution, or agency
- Full mailing address including country
- Type of property (commercial nursery, hotel, natural field, residence)
- GPS coordinates of the host plant and property
- Host plant species and specific crop plant variety, if applicable
- Presence or absence of the pest
- Observations of signs and symptoms
- General conditions or any other relevant information

In the absence of inspection officials, take the following actions immediately if symptoms are noted:

1. Mark the location
2. Take samples of infested plant parts and flag the location within the field
3. Notify the state or PPQ inspector
4. Place the samples from the infested plant inside two resealable plastic bags
5. Label the sealed bags with the following information:
   - **A.** Date
   - **B.** Name of person responsible
   - **C.** Location of sample collection
6. Keep bagged samples cool or refrigerated until the inspector arrives
7. **Do not** freeze the samples

Identification

Morphological characteristics that may aid in the preliminary identification of *C. japonicus* are described in *Identification* on page 3-1. See *Appendix D* for taxonomic support information for the surveys.

After a positive occurrence is suspected in the collected samples, submit the pest specimen(s) to the proper authority to confirm the detection; see *Sample Submission* on page E-1.

Survey Records

Data should be recorded for each survey site. Survey records and data recording formats should be consistent for standardizing the collection of information. If automated field collection services such as the Integrated Plant Health Information System (IPHIS) are used, ensure that all surveyors are trained in the technology prior to initiating the survey. Use the appropriate IPHIS templates for *C. japonicus*. To reduce the burden on field data collectors, enter any known contact or address information into the database and hand-held data recorders prior to initiating the survey. After the survey is completed, all data should be entered into the designated state or national pest database.

Duration of Delimitation Survey

Delimitation surveys are typically conducted until no target pest captures are detected for three generations of the pest species. *Ceroplastes japonicus* is univoltine in Italy and China with no generation information available from other regions. Therefore, delimitation surveys may be discontinued if this insect is not detected for 3 years.

Monitoring Survey

Conduct a monitoring survey if you have applied a control procedure and need to measure its effectiveness. If *C. japonicus* is detected in the United States, a TWG will be assembled to provide guidance on using a monitoring survey to measure the effectiveness of applied treatments. Refer to *Control Procedures* on page 8-1 for further information regarding control options.

Prior to Monitoring Survey

Prior to deploying pest eradication techniques and subsequent monitoring, the TWG consults with economists to develop an impact assessment for the introduced pest to determine if eradication is necessary or if a no-action plan is appropriate. Refer to *Damage* on page 5-1 for information useful for characterizing potential *C. japonicus* damage upon introduction to the US.

Procedure

All methods used in detection and delimitation surveys can extend to monitoring; however, monitoring surveys focus on movement and seasonal dynamics.

Because monitoring surveys investigate the density and spread of a pest, larger samples are required than in a detection survey.

A cross-transect sampling system can be used to monitor the pest. To assist with decision making, the cross-transect sampling can be supplemented with sequential sampling for low to moderate pest densities.

Trace-Back and Trace-Forward Investigations

Trace-back and trace-forward investigations aid in prioritizing delimiting survey activities after an initial detection. Trace-back investigations attempt to determine the source of the infestation. Trace-forward investigations attempt to define further potential dispersion through natural and artificial spread (commercial or private distribution of infested plant material). Once a positive detection is confirmed, efforts should be undertaken to determine the extent of the infestation or the potentially infested areas in which to conduct further investigations.

Homeowner Properties

For positive detections on homeowner properties, ask the owner of the infested material to determine its point of origin (nursery, neighbors, *etc.*) and any possible sites of further distribution.

Nursery Properties

For nursery hosts, a list of facilities associated with potentially infested stock from nurseries testing positive for *C. japonicus* will be compiled. These lists will be distributed by the state to the field offices and are not to be shared with individuals outside the USDA–APHIS–PPQ regulatory cooperators. Grower names and field locations on these lists are strictly confidential, and any distribution of lists beyond appropriate regulatory agency contacts is **prohibited**.

Each state is only authorized to see locations within their state, and sharing of confidential business information may be restricted between state and federal entities. Check the privacy laws with the State Plant Health Director for the state.

When notifying growers on the list, be sure to identify yourself as a USDA or state regulatory official conducting an investigation of facilities that may have received *C. japonicus*-infested material. Speak to the growers or farm managers and obtain proper permission prior to entering private property.

Several actions should occur immediately upon confirmation that a nursery host was infested with *C. japonicus*:

- Check nursery records to obtain names and addresses for all sales or distribution sites (if any sales or distribution has occurred from infested nursery during the previous 6 months).
- Evaluate the pest situation, including identification and inspection of the infested plant, the location within the nursery and the severity of infestation.
- Check nursery records to identify potential sources of the infestation inside or outside the nursery.

Analyzing Information

Use trace-back information gathered from the surveys and interactions to determine the origin of infestation. With timely submitted records from landowners and growers, prioritized lists for further surveys can be prepared.

Cooperation with Other Surveys

Other surveyors regularly sent to the field should be trained to recognize outbreaks that could be associated with *C. japonicus*.

Chapter 8

Control Procedures

Overview of Emergency Programs

Plant Protection and Quarantine (PPQ) develops and makes control measures available to involved states. Environmental Protection Agency (EPA)-approved treatments will be recommended when available. If selected treatments are not labeled for use against the organism or in a particular environment, PPQ's FIFRA (Federal Insecticide, Fungicide and Rodenticide Act) coordinator is available to explore the appropriateness in developing an emergency exemption under section 18, or a state special local need under section 24(c) of FIFRA, as amended. The PPQ FIFRA coordinator and pesticide-use coordinators are also available upon request to work with the EPA to expedite approval of a product that may not be registered in the United States, or to obtain labeling for a new use. Refer to *Resources* on page B-1 for information on contacting the coordinator.

Treatment Options

Treatments may include the following:

- *Cultural Control and Sanitary Measures* on page 8-1
- *Chemical Control* on page 8-2
- *Biological Control* on page 8-4
- *Host Resistance* on page 8-5

Cultural Control and Sanitary Measures

The following cultural and sanitary measures, some of which are specific to *C. japonicus,* may be used to manage scale infestations (Buss and Turner, 2006; Ciancio and Mukerji, 2010; Piper, 2011; Sadoff, 2010).

- Inspect new commodities and hosts for *C. japonicus* infestation prior to introduction into the property.

- Optimize irrigation: excessive irrigation increases humidity and promotes scale infestation, while a lack of water can stress the plants and increase infestation.
- Avoid over application of fertilizers: nitrogen in host plants can increase the fecundity and survival of scale insects. Optimizing the fertilizer application may allow rapid recovery from pruning.
- Prune branches to increase airflow, light penetration and reduce humidity to promote desiccation of scale insects. In China, Jianqin (2008) suggested annual pruning after observing a rapid decline in the *C. japonicus* population when its host *Cinnamomum japonicum* Sieb. ex Nakai was pruned. Pruning promotes scale parasitization and plant growth; 40–60% pruning is ideal for *C. japonicus*.
- Baojia *et al.* (2007) reported that orchard structures and landscapes that support high biodiversity significantly reduce *C. japonicus* outbreaks; however, this benefit remains unconfirmed at other locations (Pellizzari, 2014).
- Prune and remove infested plant material, destroy the debris and sanitize neighboring areas.

Chemical Control

Chemical control is most effective against susceptible *C. japonicus* first instars, *i.e.,* prior to their settling on the host plant and developing a wax layer (Greathead, 1997a; Gullan and Kosztarab, 1997; Marotta, 1997). Typically, the first instars are observed from June to July, with populations peaking from late June to mid-July (Camporese and Pellizzari, 1998; Longo, 1985; Pellizzari and Camporese, 1994). Application of oil is effective against the first instars and can be used in public areas without safety concerns (Pellizzari, 2014).

Darvas (1997) reviewed the importance of selective control using insecticides and indicated that insect growth regulators (IGR) such as buprofezin, kinoprene, fenoxycarb and pyriproxyfen are ideal for use against soft scales. Further, Darvas *et al.* (1994) demonstrated that the juvenile hormone mimic, fenoxycarb (0.025% active ingredient (a.i.)), was most effective against *C. japonicus*, preventing all first instars from developing into adults; buprofezin proved less effective against *C. japonicus*. Fenoxycarb is registered in the U.S. for outdoor container nurseries, landscapes and structural pest control (Kegley *et al.*, 2010).

In China, Guoyang *et al.* (1992) reported effective applications of a restricted-use organophosphate, methidathion 40 EC, against a *C. japonicus* infestation of *P. hybrid*, London plane trees. A previous study also reported the use of malathion and dimethoate sprays against *C. japonicus* infestations of mulberry (Dekanoidze, 1971). Huaiqing *et al.* (1994) and Luo *et al.* (1994) reported that systemic insecticides such as omethoate, monocrotophos, methamidophos and methidathion were effective against *C. japonicus* adults when used as a bark treatment, trunk injection or soil drench; treatment of branches using omethoate resulted in high adult mortality. Omethoate (40%) treatment of branches at 1.5–3.5 mL/tree was also effective against first instars (Luo *et al.*, 1994). Malathion, dimethoate and methidathion are registered for use in the U.S., whereas omethoate, monocrotophos and methamidophos are not (Kegley *et al.*, 2010).

Labeling

Although a proposed formulation may be approved for an effective eradication or control program, it may not be labeled, at the time of pest detection, for the specific use required. If a formulation is not labeled for the necessary use, one can request a federal crisis or quarantine exemption from the EPA under section 18 of FIFRA. For further information, refer to *Regulatory Procedures* on page 9-1. The prescribed formulation must be labeled for use on the site at which it is to be applied and must be registered for use in the state in which the eradication program is occurring. All applicable label directions must be followed, including requirements for personal protection equipment, maximum treatment rates, storage and disposal.

Biological Control

A number of predators and parasitoids reportedly attack *C. japonicus* (Table 8-1).

Table 8-1 Natural enemies of *C. japonicus*

Predators	Natural distribution	References
Coleoptera: Coccinellidae		
Chilocorus bipustulatus (L.)		Longo (1985)
Chilocorus kuwanae Silvestri[3]	Japan, northern China	Longo (1985), Ponsonby *et al.* (1997), Zhang *et al.* (2009), Jiang and Gu (1988)
Rhyzobius forestieri (Mulsant)	Australia	Canovai and Raspi (1999)
Rhyzobius lophanthae (Blaisdell) (= *Lindorus lophanthae*)		Longo (1985)
Neuroptera: Chrysopidae		
Mallada boninensis (Okamoto)[1]	Japan	Miyanoshita and Kawai (1992)
Parasitoids		
Hymenoptera: Aphelinidae		
Coccophagus hawaiiensis Timberlake		EPPO (2003)
Coccophagus lycimnia (Walker)	China	Jiang and Gu (1988)
Coccophagus yoshidae Nakayama	China	Jiang and Gu (1988)
Hymenoptera: Encyrtidae		
Anicetus aligarhensis Hayat, Alam *et* Agarwal	China	Zhang *et al.* (2011)
Anicetus beneficus Ishii *et* Yasumatsu	China	Jiang and Gu (1988)
Anicetus ceroplastis Ishii	China	Hui (1988)
Anicetus howardi Hayat, Alam & Agarwal	China	Zhang *et al.* (2011)
Anicetus ohgushii Tachikawa	China	Zhang *et al.* (2011)
Anicetus rarisetus Xu *et* He	China	Zhang *et al.* (2011)
Anicetus zhejiangensis Xu *et* Li	China	Zhang *et al.* (2011)
Microterys clauseni Compere	Japan	Kravchenko (1985), Orlinskii (1997), Japoshvili (2001)
Microterys ericeri Ishii		EPPO (2003)
Microterys pseudonietneri Xu	China	Zhi-hong and Han-lin (2000)
Hymenoptera: Eulophidae		
Tetrastichus murakamii Sugonjaev[2, 3]	Japan	Sugonjaev (1983)
Hymenoptera: Pteromalidae		
Scutellista caerulea (Fonscolombe) (= *S. cyanea*[1, 2*, 3])	France	Longo (1985), Orlinskii (1997), Badary and Abd-Rabou (2011)

Host stage attacked: [1] adult females; [2] pre-ovipositing adult females; [3] immatures; * preferred stage

In addition to the arthropods found in Table 8-1, entomopathogens such as *Lecanicillium lecanii* (Zimm.) Zare *et* W. Gams (Liu *et al.*, 2009), *Coniothyrium* spp., *Aschersonia* spp., *Paecilomyces* spp., *Fusarium* spp., *Beauveria* spp., *Pestalotia* spp., *Mucor* spp., *Entomophthora* spp., *Penicillium* spp. and *Myriangium* spp. readily infect *C. japonicus* (EPPO, 2003; Xie *et al.*, 2012; Zheng *et al.*, 1990).

Host Resistance

At the time of publication, no reports describe resistance against *C. japonicus* within a host species, but evidence indicates that the pest prefers some host species to others. Refer to *Hosts* on page 4-3 for details.

Chapter

9

Regulatory Procedures

Use *Chapter 9 Regulatory Procedures* as a guide to the procedures that must be followed by regulatory personnel when conducting pest survey and control programs against *C. japonicus*.

Instructions to Officials

Agricultural officials must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures is essential when explaining procedures to people interested in moving articles affected by the quarantine and regulations. Only authorized treatments can be used in line with labeling restrictions. During all field visits, ensure that proper sanitation procedures are followed.

Regulatory Actions and Authorities

After an initial suspect positive detection, an Emergency Action Notification may be issued to hold articles or facilities pending positive identification by a USDA–APHIS–PPQ-recognized authority and/or further instruction from the PPQ deputy administrator. If necessary, the deputy administrator will issue a letter directing PPQ field offices to initiate specific emergency action under the Plant Protection Act until emergency regulations can be published in the *Federal Register*.

The Plant Protection Act of 2000 (Statute 7 USC 7701-7758) provides the authority for emergency quarantine action. This provision is for interstate regulatory action only; intrastate regulatory action is provided under state authority.

State departments of agriculture normally work in conjunction with federal actions by issuing their own parallel hold orders and quarantines for intrastate movement. However, if the U.S. Secretary of Agriculture determines that an extraordinary emergency exists and that state measures are inadequate, intrastate regulatory action can be taken provided that the governor of the state has been

consulted and a notice has been published in the *Federal Register*. If intrastate action cannot or will not be taken by a state, PPQ may find it necessary to quarantine an entire state.

PPQ works in conjunction with state departments of agriculture to conduct surveys, enforce regulations and take control actions. PPQ employees must obtain permission of the property owner before entering private property. Under certain situations during a declared extraordinary emergency or if a warrant is obtained, PPQ can enter private property without owner permission. PPQ prefers to work with the state to facilitate access when permission is denied; however, each state government has varying authorities regarding entering private property.

A General Memorandum of Understanding (MOU) exists between PPQ and each state that specifies various areas in which PPQ and the state department of agriculture cooperate. For clarification, check with your State Plant Health Director (SPHD) or State Plant Regulatory Official (SPRO) in the affected state.

Tribal Governments

USDA–APHIS–PPQ also works with federally recognized Native American tribes to conduct surveys, enforce regulations and take control actions. Each tribe stands as a separate governmental entity (sovereign nation) with powers and authorities similar to state governments. Permission is required to enter and access tribal lands.

Executive Order 13175, Consultation and Coordination with Indian and Tribal Governments, states that agencies must consult with Native American tribal governments about actions that may have substantial direct effects on tribes. Whether an action is substantial and direct is determined by the tribes. Effects are not limited to tribal land boundaries (reservations) and may include effects on off-reservation land or resources which tribes customarily use or even effects on historic or sacred sites in states where tribes no longer exist.

Consultation is a specialized form of communication and coordination between the federal and tribal governments. Consultation must be conducted early in the development of a regulatory action to ensure that tribes have opportunity to identify resources that may be affected by the action and to recommend the best ways to take actions on tribal lands or affecting tribal resources. Communication with tribal leadership follows special communication protocols. For more information, contact PPQ's Tribal Liaison.

To determine if there are federally recognized tribes in a state, contact the State Plant Health Director (SPHD). To determine if there are sacred or historic sites in

an area, contact the State Historic Preservation Officer (SHPO). For clarification, check with your SPHD or State Plant Regulatory Official (SPRO) in the affected state.

Overview of Regulatory Program after Detection

Once an initial US detection is confirmed, holds will be placed on the property by the issuance of an Emergency Action Notification. Immediately put a hold on the property to prevent the removal of any host plants of the pest.

Trace-back and trace-forward investigations from the property will determine the need for subsequent holds for testing and/or further regulatory actions. Further delimiting surveys and testing will identify positive properties requiring holds and regulatory measures.

Record-Keeping

Record-keeping and documentation are important for any holds and subsequent actions taken. Rely on receipts, shipping records and information provided by the owners, researchers or manager for information on destination of shipped plant material, movement of plant material within the facility and any management (cultural or sanitation) practices employed.

Keep a detailed account of the numbers and types of plants held, destroyed and/or requiring treatments in control actions. Consult a master list of properties, distributed with the lists of suspect nurseries based on trace-back and trace-forward investigations, or facilities within a quarantine area. Draw maps of the facility layout to located suspect plants and/or other potentially infested areas. When appropriate, take photographs of the symptoms, property layout and document plant propagation methods, labeling and any other information that may be useful for further investigations and analysis.

Keep all written records filed with the Emergency Action Notification documents, including copies of sample submission forms, documentation of control activities and related state-issued documents if available.

Issuing an Emergency Action Notification

Issue an Emergency Action Notification to hold all host plant material at facilities that have plant material suspected of direct or indirect connection to positive confirmations. Once an investigation determines the plant material is not infested

or testing determines there is no risk, the material may be released and the release documented on the EAN.

Establishing a Federal Regulatory Area or Action

Regulatory actions undertaken using Emergency Action Notifications continue to be in effect until the prescribed action is carried out and documented by regulatory officials. These may be short-term destruction or disinfestation orders or longer term requirements for growers that include prohibiting the planting of host crops for a time. Over the long term, producers, shippers and processors may be placed under compliance agreements and permits issued to move regulated articles out of a quarantine area or property under an EAN.

Results analyzed from investigations, testing and risk assessment will determine the area to be designated for federal and parallel state regulatory actions. Risk factors will consider positive testing, positive associated and potentially infested exposed plants. Boundaries drawn may include a buffer area determined using risk factors and epidemiology.

Regulatory Records

Maintain standardized regulatory records and databases in sufficient detail to carry out an effective, efficient and responsible regulatory program.

Use of Chemicals

The PPQ *Treatment Manual* and these guidelines identify the authorized chemicals and describe the methods and rates of application and any special instructions. For further information refer to *Chemical Control* on page 8-2. Agreement by PPQ is necessary before using any chemical or procedure for regulatory purposes. No chemical can be recommended that is not specifically labeled for this pest. If a formulation is not labeled for the necessary use, one can request a federal crisis or quarantine exemption from the EPA under section 18 of FIFRA.

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Appendix

A

How to Use the Guidelines

Use *New Pest Response Guidelines: Ceroplastes japonicus Green: Japanese Wax Scale* when designing a program to detect, monitor, control, contain or eradicate an outbreak of this pest in the United States and collaborating territories.

The United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA–APHIS–PPQ) developed the guidelines through discussion, consultation or agreement with staff members at the USDA–Agricultural Research Service and advisors at universities.

Any new detection may require the establishment of an incident command system to facilitate emergency management. This document is meant to provide the information necessary to launch a response to a *C. japonicus* detection.

If *C. japonicus* is detected, a site-specific action plan will be based on the guidelines. As the program develops and new information becomes available, the guidelines will be updated.

Users

The guidelines are intended as a field reference for the following users who have been assigned responsibilities for a plant health emergency involving *C. japonicus*:

- PPQ personnel
- Emergency response coordinators
- State agriculture department personnel
- Others concerned with developing local survey or control programs

Contacts

When an emergency program for *C. japonicus* has been implemented, the success of the program depends on the cooperation, assistance and understanding of other involved groups. The appropriate liaison and information officers should distribute news of the program's progress and developments to interested groups including the following:

- Academic entities with agricultural interests
- Agricultural interests in other countries
- Commercial interests
- Grower groups such as specific commodity or industry groups
- Land-grant universities and cooperative extension services
- National, state and local news media
- Other federal, state, county and municipal agricultural officials
- Public health agencies
- The public
- State and local law enforcement officials
- Tribal governments

Initiating an Emergency Pest Response Program

An emergency pest response program consists of detection and delimitation and may be followed by programs in regulation, containment, eradication and control. The New Pest Advisory Group (NPAG) will evaluate the pest. After assessing the risk to U.S. plant health and consulting with experts and regulatory personnel, NPAG will recommend a course of action to PPQ management.

Follow this sequence when initiating an emergency pest response program:

1. A new or reintroduced pest is discovered and reported
2. The pest is examined and pre-identified by regional or area identifier
3. The pest's identity is confirmed by a national taxonomic authority recognized by the USDA–APHIS–PPQ National Identification System

4. Published New Pest Response Guidelines are consulted or a new NPAG is assembled to evaluate the pest
5. Depending on the urgency, official notifications are made to the National Plant Board, cooperators and trading partners
6. A delimiting survey is conducted at the site of detection
7. An incident assessment team may be sent to evaluate the site
8. A recommendation is made, based on the assessment of surveys, other data and recommendation of the incident assessment team or the NPAG as follows:
   - **A.** Take no action
   - **B.** Regulate the pest
   - **C.** Contain the pest
   - **D.** Suppress the pest
   - **E.** Eradicate the pest
9. State departments of agriculture are consulted
10. If appropriate, a control strategy is selected
11. A PPQ Deputy Administrator authorizes a response
12. A command post is selected and the incident command system is implemented
13. State departments of agriculture cooperate with parallel actions using a unified command structure
14. Trace-back and trace-forward investigations are conducted
15. Field identification procedures are standardized
16. Data reporting is standardized
17. Regulatory actions are taken
18. Environmental assessments are completed as necessary
19. Treatment is applied for required pest generational time
20. Environmental monitoring surveys are conducted to evaluate program success
21. Pest monitoring surveys are conducted to evaluate program success
22. Programs are designed for eradication, containment or long-term use

Preventing an Infestation

Federal and state regulatory officials must conduct inspections and apply prescribed measures to ensure that pests do not spread within or between properties.

Scope

The guidelines are divided into the following chapters:

1. *Introduction* on page 1-1
2. *Taxonomy* on page 2-1
3. *Identification* on page 3-1
4. *Biology* on page 4-1
5. *Damage* on page 5-1
6. *Pathways* on page 6-1
7. *Survey* on page 7-1
8. *Control Procedures* on page 8-1
9. *Regulatory Procedures* on page 9-1

The guidelines also include appendices and a list of literature cited.

Authorities

The regulatory authority for taking the actions listed in the guidelines is contained in the following authorities:

- Plant Protection Act of 2000 (Statute 7 USC 7701-7758)
- Executive Order 13175, Consultation and Coordination with Indian and Tribal Governments
- Fish and Wildlife Coordination Act
- National Historic Preservation Act of 1966
- Endangered Species Act
- Endangered and Threatened Plants (50 CFR 17.12)
- National Environmental Policy Act

Program Safety

The safety of the public and program personnel is a priority in pre-program planning and training and throughout program operations. Safety officers and supervisors must enforce on-the-job safety procedures.

Support for Program Decision Making

The USDA–APHIS–PPQ–Center for Plant Health, Science and Technology (CPHST) provides technical support to emergency pest response program directors concerning risk assessments, survey methods, control strategies, regulatory treatments and other aspects of the pest response programs. PPQ managers consult with state departments of agriculture in developing guidelines and policies for pest response programs.

How to Obtain the Guidelines

The guidelines are a portable electronic document that is updated periodically. Download the current version from its source and then use Adobe Reader® to view it on your computer screen. You can print the guidelines for convenience; however, links and navigational tools are only functional when the document is viewed in Adobe Reader®. Remember that printed copies of the guidelines are obsolete once a new version has been issued.

Conventions

Conventions are established by custom and are widely recognized and accepted. Conventions used in the guidelines are listed in this section.

Advisories

Advisories are used throughout the guidelines to bring important information to your attention. Please carefully review each advisory. The definitions have been updated to coincide with the American National Standards Institute (ANSI) and are formatted as follows:

Example — Example provides an example of the topic.

Important — Important indicates information that is helpful.

CAUTION

CAUTION indicates that people could possibly be endangered and slightly hurt.

DANGER

DANGEROUS indicates that people could easily be hurt or killed.

NOTICE

NOTICE indicates a possibly dangerous situation where goods might be damaged.

WARNING

WARNING indicates that people could possibly be hurt or killed.

Boldfacing

Boldfaced type is used to highlight negative or important words. These words are **never**, **not**, **do not**, **other than** and **prohibited**.

Lists

Bulleted lists indicate information listed in no particular order. Numbered lists indicate that information will be used in a particular order.

Disclaimers

All disclaimers are located on the page that follows the cover.

Control Data

Information placed at the top and bottom of each page helps users keep track of where they are in the guidelines. At the top of the page is the chapter. At the bottom of the page is the year, edition, title and page number. PPQ–Pest Detection and Emergency Programs (PDEP) is the unit responsible for the content of the guidelines.

Decision Tables

Decision tables are used throughout the guidelines. The first and middle columns in each table represent conditions, and the last column represents the action to take after considering all conditions listed for that row. Begin with the column headings and move left-to-right. If the condition does not apply, then continue one row at a time until you find the condition that does apply.

Table A-1 How to use decision tables

If you:	And if the condition applies:	Then:
read this column cell and row first	continue in this cell	TAKE the action listed in this cell
find the previous condition does not apply, then read this column cell	continue in this cell	TAKE the action listed in this cell

Footnotes

When space allows, figure and table footnotes are located directly below the

associated figure or table. However, for multi-page tables or tables that cover the length of a page, footnote numbers and footnote text cannot be listed on the same page. If a table or figure continues beyond one page, the associated footnotes will appear on the page following the end of the figure or table.

Heading Levels

Within each chapter and section there can be four heading levels; each heading is green and is located within the middle and right side of the page. The first-level heading is indicated by a horizontal line across the page with the heading following directly below. The second-, third- and fourth-level headings each have a font size smaller than the preceding heading level. The fourth-level heading runs in with the text that follows.

Hypertext Links

Figures and tables are cross-referenced in the body of the guidelines and are highlighted in blue hypertext type.

Italics

The following items are italicized throughout the guidelines:

- Cross-references to headings and titles
- Names of publications
- Scientific names

Numbering Scheme

A two-level numbering scheme is used in the guidelines for pages, tables and figures. The first number represents the chapter. The second number represents the page, table or figure. This numbering scheme allows for identification and updating. Dashes are used in the page numbering to differentiate page numbers from decimal points.

Transmittal Number

The transmittal number contains the month, year and a consecutively issued number (beginning with -01 for the first edition and increasing consecutively for each update to the edition). The transmittal number is only changed when the specific chapter sections, appendices, tables or index is updated. If no changes are made, then the transmittal number remains the unchanged. The transmittal number only changes when a new guidelines edition is issued or changes are made to the entire guidelines.

Acknowledgements

Writers, editors, reviewers, creators of cover images and other contributors to the guidelines are acknowledged in the acknowledgements section. Names, affiliations and Website addresses of the creators of photographic images, illustrations and diagrams are acknowledged in the caption accompanying the figure.

How to Cite the Guidelines

Cite the guidelines as follows:

U.S. Department of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine. 2014. New Pest Response Guidelines: *Ceroplastes japonicus* Green: Japanese Wax Scale. Washington, D.C.: Government Printing Office. http://www.aphis.usda.gov/import_export/plants/manuals/online_manuals.shtml

How to Find More Information

Contact USDA–APHIS–PPQ–PDEP–Emergency Management for more information regarding the guidelines. Refer to *Resources* on page B-1 for contact information.

Appendix

B

Resources

Use *Appendix B Resources* to find the Website addresses, street addresses and telephone numbers for the resources mentioned in the guidelines.

- Center for Plant Health, Science and Technology (USDA–APHIS–PPQ–CPHST)

- Pest Detection and Emergency Programs, Emergency Management (USDA–APHIS–PPQ–PDEP–EM)

- PPQ Treatment Manual

- Plant, Organism and Soil Permits (APHIS–PPQ)

- National Program Manager for Native American Program Delivery and Tribal Liaison (USDA–APHIS–PPQ)
  14082 S. Poston Place
  Tucson, AZ 85736
  Telephone: (520) 822-5440

- Biological Control Coordinator (USDA–APHIS–CPHST)

- FIFRA Coordinator (USDA-APHIS-PPQ-PDEP)
  4700 River Road
  Riverdale, MD 20737
  Telephone: (301) 851-2243

- Environmental Compliance Coordinator (USDA–APHIS–PPQ–PDEP)
  4700 River Road
  Riverdale, MD 20737
  Telephone: (301) 851-2345

- PPQ Forms
- List of State Plant Health Directors (SPHD)
- List of State Plant Regulatory Officials (SPRO)
- National Climatic Center, Database Administration
  Box 34
  Federal Building
  151 Patton Ave
  Asheville, NC 28801-5001
- CAPS Survey Manual
- GenBank®
- iPhyClassifier

Appendix

C

Forms

PPQ Form 391, Specimens for Determination **C-2**

PPQ Form 523, Emergency Action Notification **C-6**

PPQ Form 305, Insect Collection Worksheet for Genotype Analysis **C-8**

PPQ Form 391, Specimens for Determination

This report is authorized by law (7 U.S.C. 147a). While you ar not required to respond your cooperation is needed to make an accurate record of plant pest conditions. *See reverse for additional OMB information.*

FORM APPROVED
OMB NO. 0579-0010

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

SPECIMENS FOR DETERMINATION

Instructions: Type or print information requested. Press hard and print legibly when handwritten. Item 1 - assign number for each collection beginning with year, followed by collector's initials and collector's number. Example (collector, John J. Dingle): 83-JJD-001.
Pest Data Section – Complete Items 14, 15 and 16 or 19 or 20 and 21 as applicable. Complete Items 17 and 18 if a trap was used.

FOR IIBIII USE
LOT NO.
PRIORITY

1. COLLECTION NUMBER
2. DATE — MO | DA | YR
3. SUBMITTING AGENCY — ☐ State Cooperator ☐ PPQ ☐ Other _____

SENDER AND ORIGIN

4. NAME OF SENDER
6. ADDRESS OF SENDER
ZIP

INTERCEPTION SITE

5. TYPE OF PROPERTY *(Farm, Feedmill, Nursery, etc.)*
7. NAME AND ADDRESS OF PROPERTY OR OWNER
COUNTRY/ COUNTY

PURPOSE

8. REASON FOR IDENTIFICATION *("x" ALL Applicable Items)*

A. ☐ Biological Control (Target Pest Name)
B. ☐ Damaging Crops/Plants
C. ☐ Suspected Pest of Regulatory Concern *(Explain in* REMARKS*)*
D. ☐ Stored Product Pest
E. ☐ Livestock, Domestic Animal Pest
F. ☐ Possible Immigrant *(Explain in* REMARKS*)*
G. ☐ Survey *(Explain in* REMARKS*)*
H. ☐ Other *(Explain in* REMARKS*)*

9. IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE PROVIDE A BRIEF EXPLANATION UNDER "REMARKS".

HOST DATA

10. HOST INFORMATION
NAME OF HOST *(Scientific name when possible)*

11. QUANTITY OF HOST
NUMBER OF ACRES/PLANTS
PLANTS AFFECTED *(Insert figure and indicate* ☐ Number ☐ Percent*)*:

12. PLANT DISTRIBUTION
☐ LIMITED
☐ SCATTERED
☐ WIDESPREAD

13. PLANT PARTS AFFECTED
☐ Leaves, Upper Surface
☐ Leaves, Lower Surface
☐ Petiole
☐ Stem
☐ Trunk/Bark
☐ Branches
☐ Growing Tips
☐ Roots
☐ Bulbs, Tubers, Corms
☐ Buds
☐ Flowers
☐ Fruits or Nuts
☐ Seeds

PEST DATA

14. PEST DISTRIBUTION
☐ FEW
☐ COMMON
☐ ABUNDANT
☐ EXTREME

15. ☐ INSECTS ☐ NEMATODES ☐ MOLLUSKS

NUMBER SUBMITTED	LARVAE	PUPAE	ADULTS	CAST SKINS	EGGS	NYMPHS	JUVS.	CYSTS
ALIVE								
DEAD								

16. SAMPLING METHOD
17. TYPE OF TRAP AND LURE
18. TRAP NUMBER

19. PLANT PATHOLOGY – PLANT SYMPTOMS *("X" one and describe symptoms)*
☐ ISOLATED ☐ GENERAL

20. WEED DENSITY
☐ FEW ☐ SPOTTY ☐ GENERAL

21. WEED GROWTH STAGE
☐ SEEDLING ☐ VEGETATIVE ☐ FLOWERING/FRUITING ☐ MATURE

22. REMARKS

23. TENTATIVE DETERMINATION

24. DETERMINATION AND NOTES *(Not for Field Use)*

SIGNATURE
DATE

FOR IIBIII USE
DATE RECEIVED
NO.
LABEL
SORTED
PREPARED
DATE ACCEPTED
RR

PPQ FORM 391
(AUG 02)
Previous editions are obsolete.

This is a 6-Part form. Copies must be disseminated as follows:
☐ PART 1 – PPQ ☐ PART 2 – RETURN TO SUBMITTER AFTER IDENTIFICATION ☐ PART 3 – IIBIII OR FINAL IDENTIFIER
☐ PART 4 – INTERMEDIATE IDENTIFIER ☐ PART 5 – INTERMEDIATE IDENTIFIER ☐ PART 6 – RETAINED BY SUBMITTER

Figure C-1 Example of PPQ Form 391, Specimens for Determination, side 1

PPQ Form 391, Specimens for Determination (cont.)

OMB Information

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0010. The time required to complete this information collection is estimated to average .25 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Instructions

Use PPQ Form 391, Specimens for Determination, for domestic collections (warehouse inspections, local and individual collecting, special survey programs, export certification).

BLOCK	INSTRUCTIONS
1	1. Assign a number for each collection beginning the year, followed by the collector's initials and collector's number **EXAMPLE** In 2001, Brian K. Long collected his first specimen for determination of the year. His first collection number is 01-BLK-001 2. Enter the collection number
2	Enter date
3	Check block to indicate Agency submitting specimens for identification
4	Enter name of sender
5	Enter type of property specimen obtained from (farm, nursery, feedmill, etc.)
6	Enter address
7	Enter name and address of property owner
8A-8L	Check all appropriate blocks
9	Leave Blank
10	Enter scientific name of host, if possible
11	Enter quantity of host and plants affected
12	Check block to indicate distribution of plant
13	Check appropriate blocks to indicate plant parts affected
14	Check block to indicate pest distribution
15	• Check appropriate block to indicate type of specimen • Enter number specimens submitted under appropriate column
16	Enter sampling method
17	Enter type of trap and lure
18	Enter trap number
19	Enter X in block to indicate isolated or general plant symptoms
20	Enter X in appropriate block for weed density
21	Enter X in appropriate block for weed growth stage
22	Provide a brief explanation if Prompt or URGENT identification is requested
23	Enter a tentative determination if you made one
24	Leave blank

Distribution of PPQ Form 391

Distribute PPQ Form 391 as follows:

1. Send Original along with the sample to your Area Identifier.
2. Retain and file a copy for your records.

Figure C-2 Example of PPQ Form 391, Specimens for Determination, side 2

Purpose

Submit PPQ Form 391, Specimens for Determination, along with specimens for positive or negative identification.

Instructions

Follow the instructions in on page C-3. Inspectors must provide all relevant collection information with samples. This information should be shared within both the state and the regional office program contact. If a sample tracking database is available at the time of detection, please enter the collection information in the system as quickly as possible.

Distribution

Distribute PPQ Form 391 as follows:

1. Send the original with the sample to your area identifier.
2. Keep and file a copy for your records.

Table C-1 Instructions for completing PPQ Form 391, Specimens for Determination

Block	Description	Instructions
1	COLLECTION NUMBER	1. ASSIGN a collection number for each collection as follows: 2-letter state code-5-digit sample number (survey identification number in parentheses); example: PA-1234 (0402010001) 2. CONTINUE consecutive numbering for each subsequent collection 3. ENTER the collection number
2	DATE	ENTER the date of the collection
3	SUBMITTING AGENCY	PLACE an X in the PPQ block
4	NAME OF SENDER	ENTER the sender's or collector's name
5	TYPE OF PROPERTY	ENTER the type of property from which the specimen was collected (farm, feed mill, nursery, etc.)
6	ADDRESS OF SENDER	ENTER the sender's or collector's address
7	NAME AND ADDRESS OF PROPERTY OR OWNER	ENTER the name and address of the property from which the specimen was collected
8A–8H	REASONS FOR IDENTIFICATION	PLACE an X in the correct block
9	IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE GIVE A BRIEF EXPLANATION UNDER "REMARKS"	LEAVE BLANK; ENTER remarks in *Block 22*
10	HOST INFORMATION, NAME OF HOST	If known, ENTER the scientific name of the host
11	QUANTITY OF HOST	If applicable, ENTER the number of acres planted with the host
12	PLANT DISTRIBUTION	PLACE an X in the applicable box
13	PLANT PARTS AFFECTED	PLACE an X in the applicable box
14	PEST DISTRIBUTION: FEW/COMMON/ABUNDANT/ EXTREME	PLACE an X in the appropriate block
15	INSECTS/NEMATODES/ MOLLUSKS	PLACE an X in the applicable box to indicate type of specimen
	NUMBER SUBMITTED	ENTER the number of specimens submitted as ALIVE or DEAD under the appropriate stage
16	SAMPLING METHOD	ENTER the type of sample
17	TYPE OF TRAP AND LURE	ENTER the type of sample
18	TRAP NUMBER	ENTER the sample numbers
19	PLANT PATHOLOGY-PLANT SYMPTOMS	If applicable, check the appropriate box; otherwise LEAVE BLANK
20	WEED DENSITY	If applicable, check the appropriate box; otherwise LEAVE BLANK
21	WEED GROWTH STAGE	If applicable, check the appropriate box; otherwise LEAVE BLANK
22	REMARKS	ENTER the name of the office or diagnostic laboratory forwarding the sample; include a contact name, email address, phone number of the contact and the date forwarded to the state diagnostic laboratory or USDA-APHIS-NIS
23	TENTATIVE DETERMINATION	ENTER the preliminary diagnosis
24	DETERMINATION AND NOTES (**Not** for field use)	LEAVE BLANK; to be completed by the official identifier

PPQ 523 Emergency Action Notification

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information is 0579-0102. The time required to complete this information collection is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

FORM APPROVED - OMB NO. 0579-0102

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

EMERGENCY ACTION NOTIFICATION

SERIAL NO.

1. PPQ LOCATION
2. DATE ISSUED
3. NAME AND QUANTITY OF ARTICLE(S)
4. LOCATION OF ARTICLES
5. DESTINATION OF ARTICLES
6. SHIPPER
7. NAME OF CARRIER
8. SHIPMENT ID NO.(S)
9. OWNER/CONSIGNEE OF ARTICLES

Name:

Address:

PHONE NO. FAX NO.

SS NO. TAX ID NO.

10. PORT OF LADING
11. DATE OF ARRIVAL
12. ID OF PEST(S), NOXIOUS WEEDS, OR ARTICLE(S)
12a. PEST ID NO.
12b. DATE INTERCEPTED
13. COUNTRY OF ORIGIN
14. GROWER NO.
15. FOREIGN CERTIFICATE NO.
15a. PLACE ISSUED
15b. DATE

Under Sections 411, 412, and 414 of the Plant Protection Act (7 USC 7711, 7712, and 7714) and Sections 10404 through 10407 of the Animal Health Protection Act (7 USC 8303 through 8306), you are hereby notified, as owner or agent of the owner of said carrier, premises, and/or articles, to apply remedial measures for the pest(s), noxious weeds, and or article(s) specified in Item 12, in a manner satisfactory to and under the supervision of an Agriculture Officer. Remedial measures shall be in accordance with the action specified in Item 16 and shall be completed within the time specified in Item 17.

AFTER RECEIPT OF THIS NOTIFICATION, ARTICLES AND/OR CARRIERS HEREIN DESIGNATED MUST NOT BE MOVED EXCEPT AS DIRECTED BY AN AGRICULTURE OFFICER. THE LOCAL OFFICER MAY BE CONTACTED AT:

16. ACTION REQUIRED

☐ TREATMENT:

☐ RE-EXPORTATION:

☐ DESTRUCTION:

☐ OTHER:

Should the owner or owner's agent fail to comply with this order within the time specified below, USDA is authorized to recover from the owner or agent cost of any care, handling, application of remedial measures, disposal, or other action incurred in connection with the remedial action, destruction, or removal.

17. AFTER RECEIPT OF THIS NOTIFICATION COMPLETE SPECIFIED ACTION WITHIN (Specify No. Hours or No. Days):
18. SIGNATURE OF OFFICER:

ACKNOWLEDGMENT OF RECEIPT OF EMERGENCY ACTION NOTIFICATION

I hereby acknowledge receipt of the foregoing notification.

SIGNATURE AND TITLE:

DATE AND TIME:

19. REVOCATION OF NOTIFICATION

ACTION TAKEN:

SIGNATURE OF OFFICER:

DATE:

PPQ FORM 523 (JULY 2002) Previous editions are obsolete.

Figure C-3 Example of PPQ 523 Emergency Action Notification

Purpose

Issue a PPQ 523 Emergency Action Notification (EAN) to hold all host plant material at facilities that house the suspected plant material directly or indirectly connected to positive confirmations. Once an investigation determines that the plant material is not infested or testing determines there is no risk, the material may be released and the release documented on the EAN.

The EAN may also be issued to hold plant material in fields pending positive identification of suspect samples. When a decision is made to destroy plants, or in the case of submitted samples, once positive confirmation is received, the same EAN that placed plants on hold also documents any actions taken, such as destruction and disinfestation. More action may be warranted if other fields test positive for this pest.

Instructions

If plant lots or shipments are held as separate units, issue separate EANs for each unit of suspected and associated plant material. The EANs are issued under the authority of the Plant Protection Act of 2000 (state 7 USC 7701-7758). States are advised to issue their own hold orders parallel to the EAN to prevent intrastate movement of plant material.

When using an EAN to hold articles, the EAN language must clearly specify actions to be taken. An EAN issued for positive testing and positive associated plant material must clearly state that the material must be disposed of, or destroyed, and the areas disinfested. Include language that these actions will occur at the owner's expense and will be supervised by a regulatory official. If the EAN is used to issue a hold order for further investigations and testing of potentially infested material, use the same EAN to document any disposal, destruction and disinfestation orders resulting from the investigations or testing.

PPQ Form 305, Insect Collection Worksheet for Genotype Analysis

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0104. The time required to complete this information collection is estimated to average .17 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

OMB APPROVED
0579-0104
EXP: XX/XXXX

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

INSECT COLLECTION WORKSHEET FOR GENEOTYPE ANALYSIS

COMPLETE FOR EACH TRAP CONTAINING SPECIMENS

1. INSECT NAME

2. SUBMITTER'S NAME

3. SUBMITTER'S ADDRESS *(Include ZIP Code)*

4. SUBMITTER'S EMAIL ADDRESS

5. SUBMITTING AGENCY

☐ STATE ☐ USDA ☐ OTHER ORGANIZATION

TELEPHONE NUMBER

FAX NUMBER

TRAP DATA

6. DATE COLLECTED

7. DATE OF LAST TRAP CHECK

8. TRAP NUMBER

9. NEAREST PORT OF ENTRY *(Including Military Bases)*

10. TRAP TYPE

☐ Delta ☐ Milk Carton ☐ Light Trap ☐ Other _____

11. TRAP LOCATION
Address

Town or City *(or nearest one)*

State

County

ZIP code

Longitude *(if available)*

Latitude *(if available)*

Other Coordinates

12. APPROXIMATE NUMBER OF SPECIMENS IN TRAP

13. OTHER LIFE STAGES COLLECTED *(If submitted check appropriate box and indicate approximate quantity)*

☐ Eggs _____ *(IMPORTANT: One egg mass per specimen bag. DO NOT mix egg masses)*

☐ Larvae _____

☐ Pupae _____

☐ Female Adult _____

14. SPECIAL TREATMENTS OF SPECIMENS *(e.g., freezing conditions, use of alcohol, prolonged storage conditions, host if no trap used, etc.)*

15. SEND TO

MOLECULAR DIAGNOSTICS
USDA, APHIS, PPQ
OTIS CPHST LABORATORY
1398 WEST TRUCK ROAD
BUZZARDS BAY, MA 02542

Telephone Number:
508-563-0900

Fax Number:
508-563-0903

16. DATE SENT

FOR LABORATORY USE ONLY

DATE RECEIVED

OTIS ID NUMBER

PPQ FORM 305
AUG 2014

Previous edition is obsolete.

Figure C-4 Example of PPQ 305, Insect Collection Worksheet for Genotype Analysis

Appendix

D

Taxonomic Support for Surveys

Background

The National Identification Services (NIS) coordinates the identification of plant pests in support of the USDA's regulatory programs. Accurate and timely identifications are the foundation of quarantine action decisions and are essential in the effort to safeguard the nation's agricultural and natural resources.

The NIS employs and collaborates with scientists who specialize in various plant pest groups, including weeds, insects, mites, mollusks and plant diseases. These scientists are stationed at a variety of institutions around the country, including federal research laboratories, plant inspection stations, land-grant universities and natural history museums. Additionally, the NIS Molecular Diagnostics Laboratory is responsible for providing biochemical testing to support the agency's pest monitoring programs.

On 13 June 2007, the PPQ Deputy Administrator issued PPQ Policy No. PPQ-DA-2007-02, which established the role of PPQ NIS as the point of contact for all domestically detected confirmations and communications regarding introduced plant pests. The position of Domestic Diagnostics Coordinator (DDS) was established to administer the policy and coordinate domestic diagnostics for the NIS. Any questions regarding sample routing or communication of results can be directed to the PPQ Survey Field Operations Manager (Brian Kopper: phone (919) 855-7318; e-mail, brian.j.kopper@aphis.usda.gov) or the Domestic Diagnostics Coordinator

Taxonomic Support and Survey Activity

Taxonomic support for pest surveillance is fundamental to conducting quality surveys. A misidentification or incorrectly screened target pest can yield a missed opportunity for early detection when control strategies are more viable and cost effective. The importance of good sorting, screening and identification during domestic survey activity cannot be overemphasized.

Fortunately most states have, or have access to, good taxonomic support. Taxonomic support should be considered in cooperative agreements as another cost of conducting surveys. Taxonomists and laboratories within the state often

require supplies, develop training materials or hire technicians to meet their screening and identification needs. When considering whether to survey for a particular pest during a given year, consider the challenges of taxonomic support.

Sorting and Screening

For survey activities, the proper sorting and screening of samples prior to examination by an identifier will result in improved turn-around times for identification.

Sorting

Sorting is the first level of activity to ensure samples submitted are of the correct target group for the pests being surveyed. Select those plant samples that are symptomatic if appropriate. A minimum level of sorting is expected of surveyors depending on the target group, training, experience or demonstrated ability.

Screening

Screening involves a higher level of sample discrimination such that the suspect target pests are separated from the known non-target or native species of similar taxa. For example, only the suspect target species or those that appear similar to the target species are forwarded to an identifier for confirmation. This process can involve a first and second level of screening depending on the difficulty and complexity of the group. Again, the appropriate degree of screening depends on the target group, training, experience and demonstrated ability of the screener.

Check individual survey protocols to determine if samples should be sorted, screened or sent in their entirety (raw) before submitting for identification. If not specified in the protocol, assume that samples should be sorted to some degree.

Resources for Sorting, Screening and Identification

Sorting, screening and identification resources and aids useful to CAPS and PPQ surveys are best developed by taxonomists knowledgeable in the taxa that include the target pests and the established or native organisms in the same group that are likely in the samples and can be confused with the target. These aids are often regionally based and can be in the form of dichotomous keys, picture guides or reference collections. The NIS encourages the development of these resources, and when aids are complete, posts them in the CAPS Website for the benefit of others. Please see the following Website for some available screening aids: https://caps.ceris.purdue.edu/node/34.

Other Entities for Taxonomic Assistance in Surveys

When taxonomic support within a state is inadequate for a particular survey, other entities may assist including PPQ identifiers, universities and state departments of agriculture from other states and independent institutions. Check with the PPQ regional CAPS coordinators regarding the availability of taxonomic assistance.

Universities and State Departments of Agriculture

Depending on the taxonomic group, a few cases involve two entities that are interested in receiving samples from other states. Arrangements for payment, if required for these taxonomic services, can be made through cooperative agreements. The National Plant Diagnostic Network (NPDN) also has several regional hub laboratories that can provide service identifications of plant pests in their respective regions. PPQ currently has arrangements with to state departments of agriculture (Oregon and Washington) and one university (Mississippi State University) through Farm Bill funding to provide taxonomic services to other states should they desire it. Contact your CAPS NOM for more information.

Independent Institutions

The Raleigh PPQ Field Operations office has set up multi-state arrangements for the Carnegie Museum of Natural History to identify insects from trap samples. They prefer to receive unscreened material and work on a fee basis per sample.

PPQ Port Identifiers

There are over 70 identifiers in PPQ that are stationed at ports of entry to primarily identify pests encountered in international commerce including conveyances, imported cargo, passenger baggage and propagative material. In some cases, these identifiers process survey samples generated during PPQ-conducted surveys and occasionally those from CAPS surveys. They can also enter the PPQ form 391 for a suspect CAPS target or other suspect new pests into our PestID database prior to their being forwarded for confirmation by an NIS-recognized authority. The list of PPQ port identifiers and their areas of coverage can be found on the following Website: http://inside.aphis.usda.gov/ppq/php/manual/mac/identifiers_co-lat_natl_spec.pdf.

PPQ Domestic Identifiers

PPQ has a limited number of domestic identifiers normally stationed at universities who are primarily responsible for survey samples. Domestic

identifiers can handle unscreened or partially screened samples with prior arrangement through the PPQ CAPS NOM. They can also act as an intermediary alternative to sending an unknown suspect to, for example, the ARS Systematic Entomology Lab (SEL) depending on their specialty and area of coverage. In addition, these identifiers can enter the PPQ form 391 for a suspect CAPS target or other suspect new pests into our PestID database prior to forwarding the sample for confirmation by an NIS-recognized authority.

Bobby Brown
Domestic Entomology Identifier
USDA–APHIS–PPQ
901 W. State Street
Smith Hall, Purdue University
West Lafayette, IN 47907-2089
Phone: (765) 496-9673
Fax: (765) 494-0420
e-mail: robert.c.brown@aphis.usda.gov

Specialty: Forest pests (Coleoptera, Hymenoptera)

Area of coverage: Primarily northeast and Midwest U.S.

Julieta Brambila
Domestic Entomology Identifier
USDA–APHIS–PPQ
P.O. Box 147100
Gainesville, FL 32614-7100
Phone: (352) 395-4792
e-mail: julieta.brambila@aphis.usda.gov

Specialty: Adult Lepidoptera, Heteroptera

Area of coverage: Primarily eastern U.S.

Kira Metz
Domestic Entomology Identifier
USDA–APHIS–PPQ
Minnie Belle Heep 216D
2475 TAMU
College Station, TX 77843
Phone: (979) 450-5492
e-mail: kira.zhaurova@aphis.usda.gov

Specialty: Lepidoptera, Coleoptera

Area of coverage: Primarily western/southern U.S.

ATTENTION SAMPLE SUBMITTERS: When sending domestic samples to domestic identifiers, you must notify them first by e-mail or phone that you plan to send samples, describing what type and how many. Once notification has been sent, forward an e-mail to them with a tracking number for the express carrier through whom the samples were forwarded. If you plan to send a domestic sample to a national specialist, notify the Coordinated Agricultural Project National Operations Manager (CAPS NOM) or the National Domestic Diagnostics Coordinator prior to sending the sample.

Final Confirmations

If identifiers or laboratories at the state, university or institution level suspect the detection of a CAPS target, a plant pest new to the United States or a quarantine pest of limited distribution in a new state, the specimens should be forwarded to an NIS-recognized taxonomic authority for final confirmation. State cooperator and university taxonomists can go through a PPQ area identifier or the appropriate domestic identifier that covers their area to place the specimen into the PPQ system. They will then send the specimen to the NIS-recognized authority for that taxonomic group. In some cases, domestic identifiers can make final confirmation depending on their ID authority, accreditation and proficiency testing.

State-level taxonomists, who are reasonably certain that they have a new United States record, CAPS target or federal quarantine pest, can send the specimen directly to the NIS-recognized authority, but must notify their State Survey Coordinator (SSC), PPQ Pest Survey Specialist (PSS), State Plant Health Director (SPHD) and State Plant Regulatory Official (SPRO).

Before forwarding these suspect specimens to identifiers or to the NIS-recognized authority for confirmation, please complete a PPQ form 391 with the tentative determination. In addition, fax a copy of the completed PPQ Form 391 to 'Attention: Domestic Diagnostics Coordinator' at (301) 851-2115, or send a PDF file in an e-mail to aphis-ppq.nis.urgents@aphis.usda.gov with the overnight carrier tracking number.

The addresses of the NIS-recognized authorities to which suspect specimens are to be sent can be found at the following Website: http://inside.aphis.usda.gov/ppq/php/manual/mac/identifiers_co-lat_natl_spec.pdf.

Only use the 'Urgent' listings for suspected new United States or state records of a significant pest, and the 'Prompt' listings for all others.

When the specimen is forwarded to a specialist for final confirmation, use an overnight carrier, insure proper and secure packaging and include a hard copy of the PPQ form 391 marked 'Urgent' or 'Prompt' as previously described.

Please contact the National Operations Manager assigned to this new pest response by calling (919) 855-7335.

Digital Images for Confirmation of Domestic Detections

For the aforementioned confirmations, send specimens, not digital images. For entry into the National Agricultural Pest Information System (NAPIS), digital

imaging confirmations can be used for new county records of widespread pests by state taxonomists or identifiers with their prior approval. These scientists always have the prerogative to request that the specimens be sent. Pests with PPQ regulatory programs may require specimens to be sent to SEL for new county records depending on the species.

Communication of Results

If no suspect CAPS target, program pests or new detections are found, communication of these identification results can be sent by the domestic identifiers or taxonomists at other institutions directly back to the submitter. The information can be presented in a spreadsheet, in a hardcopy of PPQ form 391 or other informal means labelled with the species or 'no CAPS target or new suspect pest species found.' Good record keeping by the intermediate taxonomists performing these identifications is essential.

All confirmations received from the NIS-recognized authorities, positive or negative, are communicated by the NIS to the PPQ Pest Detection and Emergency Programs (PDEP) staff at PPQ headquarters. The PDEP then notifies the appropriate PPQ program managers and the SPHD and SPRO simultaneously. One of these contacts should forward the results to the originating laboratory, diagnostician, identifier and/or submitter of the specimen or sample.

Data Entry in NAPIS

For survey data entered into NAPIS, new country and state records should be confirmed by an NIS-recognized authority, while for others that are more widespread, use the identifications from PPQ identifiers or state taxonomists. When in doubt, contact the PPQ Domestic Survey Coordinator.

Appendix

E

Sample Submission

Taxonomic support for insect surveys requires that samples be competently and consistently sorted, stored, screened (in most cases) and submitted to the identifier. Refer to *Molecular Identification* on page 3-8 for additional information.

Sorting Trap Samples

When a trap is serviced, sorting is critical. Debris and non-target insect orders must be sorted from the trap material. The taxonomic level of sorting will depend on the expertise available and can be confirmed with the identifier.

Screening Trap Samples

Screening is a process of eliminating non-target families, genera or 'look-a-likes' of the surveyed species. Consult the CAPS website for screening aids for particular groups. When in doubt, however, forward the specimens to the identifier/taxonomist. The use of these aids should be coupled with training from identifiers and/or experienced screeners prior to their use. These aids can be found at the following Website: https://caps.ceris.purdue.edu/node/34.

Storage

Where appropriate, samples may be stored indefinitely in alcohol. However, samples of dried insects, such as those in sticky traps, may decompose over time if not maintained in a cool location such as a refrigerator or freezer. If insect samples have decomposed, do not submit them for identification.

Samples for Genotype Analysis

Samples collected for genotype analysis should be taken from traps every two weeks, or more frequently if high humidity or high temperatures threaten the quality of specimen DNA. Collected specimens should be placed in containers

that promote drying, such as paper bags or cardboard boxes, and maintained in a cool dry place until stored in a freezer or shipped. Samples that are not immediately shipped for analysis should be stored frozen and dry.

Packaging and Shipping

Ensure specimens are dead prior to shipping by either placing them in a vial of alcohol or placing dry specimens in the freezer for at least 1 day. The following are a few tips on sorting, packaging and shipping liquids, sticky traps and dry samples:

Liquids

Factors such as arthropod group, their life stage and the method of collection determine how the specimens are handled, preserved and shipped to the identifier. In general, mites, insect larvae, soft- and hard-bodied adult insects can be transferred to vials of 75–90% ethanol (EtOH) or an equivalent such as isopropyl alcohol. At times, Lindgren funnel trap samples containing bark beetles may also contain rainwater. To prevent later decay, drain off all liquid and replace with alcohol.

Vials should contain samples from a single trap and a printed or hand-written label with the associated collection number that can be found in the top right corner of form 391. Please use a writing utensil that is not alcohol soluble such as a Micron® pen or a pencil. Samples from multiple traps **must not** be combined in a single vial to preserve the locality-associated data. Vials can be returned to field personnel upon request.

If the mail or freight forwarder takes issue with sending specimens in alcohol, the majority of the liquid can be decanted from the vial, which should then be sealed tightly in the container immediately prior to shipping. Notify the identifier that the vials will require the alcohol be replaced as soon as they are received. If shipped quickly, the specimens should not dry out if the vial is properly sealed.

Samples for Genotype Analysis

When submitting insect samples for genotype analysis, include a copy of PPQ Form 305, Insect Collection Worksheet for Genotype Analysis with each sample in the shipping container.

For specimens caught in sticky traps, package to avoid crushing during storage and shipment. Leave traps intact with specimens inside. Label traps with trap numbers that match accompanying PPQ form 305. Do not include Styrofoam peanuts in the packaging of sticky traps.

For insects caught in non-sticky traps, place the loose specimens from each trap in a paper bag with moisture-absorbing paper tows or tissue. Label the bag with the trap ID and seal with tape or staples.

Documentation

Each sample/vial should be documented in and accompanied by its own completed PPQ form 319, *Specimens for Determination*. You should maintain a partially pre-filled electronic copy of this form on your computer with your address and other information to save time. Indicate the name of the person making any tentative identification prior to sending to an identifier. Please ensure all applicable fields are completed and that the bottom field (block 24, *Determination and Notes*) is left blank for completion by the identifier. Include the phone number and/or e-mail address of the submitter. Other documentation in the form of notes, images, *etc.* can be included if useful to the determination. A method for cross-referencing the sample/vial with the accompanying form is critical. For example, write the collection number on both Form 391 and the envelope containing the sample.

Appendix

F

Environmental Compliance

Overview

Program managers of federal emergency response or domestic pest control programs must ensure that their programs comply with all federal acts and executive orders pertaining to the environment as applicable. Two primary federal acts, the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), often require the development of significant documentation before program actions may begin.

Program managers should also seek guidance and advice as needed from Environmental and Risk Analysis Services (ERAS), a unit of APHIS' Policy and Program Development (PPD) staff. ERAS is available to provide guidance to program managers and prepare drafts of applicable environmental documentation.

In preparing draft NEPA documentation, ERAS may also perform and incorporate assessments that pertain to other acts and executive orders described below as part of the NEPA process. The Environmental Compliance Team (ECT), a part of PPQ's Emergency Domestic Programs (EDP), will assess ERAS in the development of documents and will implement any environmental monitoring.

Leaders of the programs are strongly advised to meet with ERA and/or ECT early in the development of a program to conduct a preliminary review of applicable environmental statutes as requested by program managers or as suggested to address concerns over controversial activities. Monitoring may be conducted with regards to worker exposure, pesticide quality assurance and control, off-site chemical deposition or program efficacy. Different tools and techniques are used depending on the monitoring goals and control techniques used in the program. Staff from the ECT will work with the program manager to develop an environmental monitoring plan, conduct training to carry out the plan, provide day-to-day guidance on monitoring and provide an interpretive report of monitoring activities.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires all federal agencies to examine whether their actions may significantly affect the quality of the human environment. The purpose of NEPA is to inform the decision maker before taking action and to tell the public of the decision. Actions that are excluded from this examination, that normally require an environmental assessment and environmental impact statements, are codified in APHIS' NEPA implementing procedures located in 7 CFR 372.5.

The three types of NEPA documentation are categorical exclusions, environmental assessments and environmental impact statements.

Categorical Exclusion

Categorical exclusions (CEs) are classes of actions that do not significantly affect the quality of the human environment and for which neither an environmental assessment (EA) nor an environmental impact statement (EIS) is required. Generally, the means through which adverse environmental impacts may be avoided or minimized have been built into the actions themselves (7CFR 372.5(c)).

Environmental Assessment

An environmental assessment (EA) is a public document that succinctly presents information and analysis for the decision maker of the proposed action. An EA can lead to the preparation of an environmental impact statement, a finding of no significant impact (FONSI), or the abandonment of a proposed action.

Environmental Impact Statement

If a major federal action may significantly affect the quality of the human environment (adverse or beneficial) or the proposed action may result in public controversy, then prepare an environmental impact statement (EIS).

Endangered Species Act

The Endangered Species Act (ESA) is a statute requiring that programs consider their potential effects on federally protected species. The ESA requires programs to identify protected species and their habitats in or near program areas and to document how adverse effects to these species will be avoided. The documentation may require review and approval by the U.S. Fish and Wildlife

Service and the National Marine Fisheries Service before program activities can begin. Knowingly violating this law can lead to criminal charges against individual staff members and program managers.

Migratory Bird Treaty Act

The statute requires that programs avoid harm to over 800 endemic bird species, eggs and their nests. In some cases, permits may be available to capture birds, which require coordination with the U.S. Fish and Wildlife Service.

Clean Water Act

The statute requires various permits for work in wetlands and for potential discharge of program chemicals into water, which may require coordination with the Environmental Protection Agency, individual states and the Army Corps of Engineers. Such permits would be needed even if the pesticide label allows for direct application to water.

Tribal Consultation

The executive order requires formal government-to-government communication and interaction if a program might have substantial direct effects on any federally recognized Indian Nation. This process is often incorrectly included as part of the NEPA process, but must be completed before public involvement under NEPA. Staff should be cognizant of the conflict that could arise when proposed federal actions intersect with tribal sovereignty. Tribal consultation is designed to identify and avoid such potential conflict.

National Historic Preservation Act

The statute requires that programs consider potential impacts on historic properties (such as buildings and archaeological sites) and requires coordination with local state historic preservation offices. Documentation under this act involves preparing an inventory of the project area for historic properties and determining what effects, if any, the project may have on historic properties. This process may need public involvement and comment before the start of program activities.

Coastal Zone Management Act

The statute requires coordination with states in which programs may impact coastal zone management plans. Federal activities that may affect coastal resources are evaluated through a process called federal consistency. This process affords the public, local governments, tribes and state agencies an opportunity to review the federal action. The federal consistency process is administered individually by states with coastal zone management plans.

Environmental Justice

The executive order requires consideration of program impacts on minority and economically disadvantaged populations. Compliance is usually achieved within the NEPA documentation for a project. Programs are required to consider if the actions might impact minority or economically disadvantaged populations and if so, how such impact will be avoided.

Protection of Children

The executive order requires federal agencies to identify, assess and address environmental health and safety risks that may affect children. If such a risk is identified, measures must be described and carried out to minimize such risks.

Glossary

C. japonicus

abiotic. pertaining to the absence of life; diseases not caused by living organisms

acute. pointed or triangular

adventitious roots. roots that arise from an atypical place, from a stem rather than as branches of a root

AFLP. Amplified Fragment Length Polymorphism; technique that uses PCR to amplify genomic DNA, cleaved by restriction enzymes to generate DNA fingerprints; a combination of RFLP and arbitrary primer PCR and does not require prior sequence knowledge

amplicon. Piece of DNA synthesized using amplification techniques such as PCR

APA. American Phytopathological Society

aperture. mouth or principal opening of the shell through which the body of the gastropod passes out of the shell

apex. tip of the spire of a snail shell at the opposite end from the aperture

APHIS. USDA–Animal and Plant Health Inspection Service

appressed. pressed close to or lying flat

approved landfill. state-licensed municipal or private landfill managed under state regulation to prevent leaching of potential pollutants into groundwater

AQAS. Agricultural Quarantine Activity System, a web database accessible from any USDA–APHIS computer

aerial treatment. application of insecticide to a treatment area via aircraft

array. arrangement of traps within one square mile

array sequence. layout of traps (array) from the core area outward to the perimeter (buffer area)

ARS. USDA–Agricultural Research Service

attract and kill. IPM technique in which both pheromones and insecticides are applied to the upper canopy of an orchard, attracting male insects to the orchard where they are killed by the insecticide

augmentation. intentional addition of natural enemies via mass release in areas in which these enemies are absent, occur too late in the season or pest life cycle or are present in ineffective numbers

barrier. natural or artificial obstacle to movement

biological control. development and use of natural means of control through parasites, predators, pathogens and biological tactics to suppress a pest population density below a level that would not occur in their absence, either for a given period or permanently

biological tactics. use of any natural or derived product or technique utilizing biological applications such as gene transfer, genetic manipulation, pheromone attractants, host substitution or other biological means to suppress a pest population density below a level that would not occur in their absence, either for a given period or permanently

biometric survey. survey succeeding the delimiting survey in which properties are number and letter coded for survey purposes on a rotational basis

black-light trap. trap with a special bulb radiating ultraviolet lights that can attract insects

blastokinesis. movement of the developing embryo into the yolks of insect eggs

block. units (*e.g.,* 1 square mile) of a detection survey in which all survey activities are conducted

brachyblasts. short lateral branch

breeding attack. attack by an insect on a host plant to successfully breed

buffer area. survey area that is beyond the core block

bullate. appearing puckered as if blistered

calling. emission of sex pheromones by a female to attract mates

callow. condition of the adult shortly after eclosion when its cuticle is not fully sclerotized or fully mature in color

cambium. meristematic tissue in woody plants that exists between the wood

(xylem) and the inner most bark (phloem)

CAPS. Cooperative Agricultural Pest Survey program, partnership between all 50 states and the USDA to detect and monitor exotic pests of economic impact

cast needles. premature drop of needles from a tree

catenulate. arranged in a series of rings or chains

CFR. Code of Federal Regulations

chemical integration. direct application of selected chemicals on the host that are nontoxic or relatively nontoxic to selected parasites or predators

chimeric. composed of parts of different origin

chlorosis. yellowing of normally green tissue due to chlorophyll destruction as a result of pest damage

classical biological control. introduction of exotic natural enemies from the region of origin to provide a permanent, self-sustaining suppression of a pest population density below a level that would not occur in their absence

clavate. resembling a club, becoming increasingly wide from the base to the distal end

cold treatment. exposure of a host product to cold temperatures lethal to a target pest; may be used alone or with fumigants

commercial production area. area in which host material is grown for sale

confirmation detection. positive identification of a submitted specimen

containment. application of phytosanitary measures in and around an infested area to prevent spread of a pest

control. application of phytosanitary measures in and around an infested area to prevent spread of a pest

conterminous. having a boundary in common

core area. area of 1 square mile surrounding a confirmed detection

corm. solid swollen underground bulb-shaped stem or stem base that serves as a reproductive structure

cotyledons. embryonic leaf in seed-bearing plants

CPB. United States Department of Homeland Security–Customs and Border

Protection

CPHST. PPQ–Center for Plant Health Science and Technology

crepuscular. active during twilight hours

cross transect survey. survey designed to detect the infestation in the shortest time possible; strung out along the two lines of an axis and run through the most likely host areas; the survey may eventually be replaced by one based on a grid system for improved coverage

crown. portion of a plant, typically at ground level, at which the stem and roots merge

cultural control. intentional use of simple practices or mechanical measures that may be available to control a pest population

day degree. measure of physiological time using the accumulation of heat units (degrees) above an insect's developmental threshold for a 24-hour period

DBH. Diameter at Breast Height

delimiting survey. survey conducted in a susceptible area not known to be infested with the target pest

delta trap. five-sided insect trap, configured with three lateral sides arranged triangularly, equipped with a lure (*i.e.,* pheromone), a baffled edge and an adhesive surface inside to capture and secure attracted insects

dendroid. resembling a tree in form with a branching structure

denticulate. having a fine-toothed margin

destructive sampling. method of observing signs and symptoms of the presence or absence of a pest by destruction of the living sample unit; for example, removal of bark to look for larvae

detection. collection of any life stage of the target pest

detection survey. survey conducted in an environmentally favorable area in which the pest is not known to occur

developmental thresholds. minimum and/or maximum temperatures that support physiological development of a species

DHS. United Stated Department of Homeland Security

dieback. death of branches on woody plants, shrubs or trees; typically young

shoots, twigs and distal portions of branches dies progressively toward older plant parts

disposal. method used to eliminate infested plant material or associated materials, usually at an approved landfill

diurnal. active during the day

EAN. Emergency Action Notification

eclosion. molting and escape of the adult insect from the cuticle/cocoon of the pupa, or, from the final immature instar

EDP. PPQ–Emergency and Domestic Programs

elicitins. small cysteine-rich lipid-binding proteins

ELISA. Enzyme-Linked Immunosorbent Assay, a molecular diagnostic technique

ellipsoid. surface whose plane sections are all ellipses or circles

EM. PPQ–Emergency Management

endophytes. endosymbiont, often a bacterium or fungus, that lives within a plant for at least part of its life without causing apparent disease

entomopathogen. pathogen that induces illness in insects

EPA. United States Environmental Protection Agency

epicenter. original location/point of infestation

epicormic shoots. new shoots arising near the base of the plant

epistoma. oral margin or sclerite directly behind the labrum

EPPO. European and Mediterranean Plant Protection Organization

eradication. application of phytosanitary measures to eliminate a pest from an area before it becomes too large in area or number for current technology

exotic species. pest species not native to or historically resident in North America

exudate. liquid excreted or discharged from injured plant tissues

fascicles. dense cluster or bundle

FIFRA. Federal Insecticide, Fungicide and Rodenticide Act

FONSI. Finding Of No Significant Impact

fructification. fruit bearing

fumigation. application of an approved fumigant as a treatment

funicle. part of the flagellum of the antenna proximal to the club

fusiform. spindle shaped; tapering at each end

generation. period during which a pest completes all stages of development predicted using biological information

geniculate. bent at a sharp angle

girdle. to circle and cut through a stem or the bark and outer few rings of wood, disrupting the phloem and xylem

GIS. geographic information systems; a computer system capable of capturing, storing, analyzing and displaying geographically referenced information

globose. ball shaped

ground spray. using ground spray equipment to apply pesticide to the ground, selected resting places, or host vegetation in a target infested area

hastiseta. larval body hair in which the shaft is constricted at regular intervals; apex consists of a barbed head; barbed hairs are found in pairs of tufts, borne on certain abdominal segments

haustoria. specialized branch of a parasite formed inside host cells to absorb nutrients

heteroecious. parasite that develops different stages of the life cycle on different host species

hibernaculum. larval overwintering refuge constructed with silk

host. plant that provides nutrients and is suitable for the survival and development of a pest species; a true host supports reproduction of the pest species

host collecting. collection and retention of infested host material for the purposes of determining characteristics of a pest's use of the host; also known as holding

hot-zone survey. choosing an area, typically residential, on which to concentrate surveys based on known pathway information with ZIP code-based demographic information or other scientific information; also known as a targeted survey or demographic survey

hyaline. transparent or nearly so; translucent; often used in the sense of colorless

hyphae. single, tubular filament of a fungal thallus of mycelium; the basic structural unit of a fungus

ICS. Incident Command System

identification authority. authority to confirm the presence of a particular pest contractible issued by the APHIS–National Identification Services to diagnosticians that have demonstrated proficiency in identification

incineration. burning of plant hosts and associated soil or media resulting in their complete destruction

infection. establishment of a parasite on or within a host plant

infestation. collection of one or more target pests from an area/host

infested area. area surrounding a single detection site or a group of sites; the standard designated area of 2.5 square miles is used, unless biotic or abiotic factors dictate adjustment of this area

inoculative augmentation. flooding a chosen area with large numbers of one or more natural enemies at the time a pest occurs or is expected to occur in an area with the intention of having established populations of these natural enemies through subsequent generations for pest control

inundative augmentation. flooding a chosen area with large numbers of one or more natural enemies to exert rapid control of a pest in the present generation to prevent or decrease possible damaging host losses

intercalary. inserted between

ISIS. Integrated Survey Information System

isozyme. enzymes that differ in amino acid sequence but catalyze the same chemical reaction

labrum. upper lip abutting the clypeus in front of the mouth

limoniform. shaped like a lemon

management. application of selected phytosanitary measures in and around an infested area to keep an invading population in check when other means of population eradication would fail

maturation feeding. feeding required by an individual organism before it can successfully reproduce

mesonotum. notum of mesothorax

mesothorax. second or middle thoracic segment bearing the middle legs and the forewings

metathorax. third or posterior thoracic segment bearing the hind legs and hind wings

migratory species. species in which individuals habitually move from place to place especially in search of mates or egg-laying sites

MOA. Mode Of Action

monitoring survey. survey conducted at a site at which a pest was detected and an eradication program is being performed; also known as an *evaluation survey*

monophagous. pest species that feeds on only one host plant species

mycelium. mass of hyphae constituting the body (thallus) of a fungus

NAPIS. National Agricultural Pest Information System

NASS. National Agricultural Statistics Service

natural enemies. living organisms found in a natural community that kill, weaken or inhibit the biological potential of a pest species

necrosis. death or discoloration of plant tissue

NEPA. National Environmental Policy Act

NIS. PPQ–National Identification Service

nocturnal. active at night

non-migratory. species in which the individuals typically do not move far from the area of their birth

non-native. immigrant

NPAG. PPQ–New Pest Advisory Group

NPRG. New Pest Response Guidelines

obpyriform. resembling a pear and ;attached at the narrower end

oogonia. female gametangium of oomycetes, containing one or more gametes

oospore. thick-walled, sexually derived resting spore of oomycetes

parasite. organism living on the host at one or multiple life stages that may kill or

debilitate the host

parasite/predator conservation. conservation of natural enemies through integrated procedures using highly selective predator/parasite friendly insecticides or techniques, biological insecticides or cultural practices favoring parasites/predators

parasitoid. organism that lives on a host (often an immature stage) when immature, but are free-living as adults; parasitoids always kill the host; like parasites, these organisms are typically host specific, and some are obligate on certain hosts, effectively finding hosts even when host populations are small

parthenogenesis. development of an unfertilized egg into an adult female; asexual reproduction; occurs in many different invertebrates

PASS. Potentially Actionable Suspect Sample; a presumptive positive sample diagnosed or identified by provisionally approved laboratory or diagnostician with identification authority that would require confirmatory testing by an official APHIS laboratory due to the nature of the plant sampled and the necessity for federal confirmation

pathogen. infectious agent that causes disease to its host

pathway. means by which exotic plant pests are introduced in the US

PCR. Polymerase Chain Reaction, a laboratory technique that amplifies DNA sequences; useful tool for molecular identification of a pest species

PCR primers. short fragments of single-stranded DNA (15–30 nucleotides long), complementary to DNA sequences that flank the target region of interest; necessary components for the polymerase chain reaction

peduncle. stalk of an inflorescence or a stalk bearing a solitary flower in a one-flowered inflorescence

PERAL. Plant Epidemiology and Risk Analysis Laboratory

pest. insects, weeds, plant disease agents and microorganisms

PestID. database containing all the information recorded from the PPQ form 309 Pest Interception Record

phenology. study of periodic recurrent biological events of the organism

phloem. tissue that conducts synthesized food substances (*e.g.,* from leaves) to parts needed; consists primarily of sieve tubes

phyllody. development of leaf-like growths in place of normal flower parts

PIB. polyisobutylene

pitch tube. tubular mass of resin mixed with bark, wood borings and insect excrement that forms on the surface of the bark at beetle entrance holes

plant hardiness zones. zones defined in the USDA Plant Hardiness Zone Map that determine the plant species likely to thrive at a particular location; the maps are based on the mean annual minimum winter temperature divided into 10 °F zones.

pleomorphic. capable of assuming different shapes

polyphagus. organism that feeds on a wide range of plant host species

positive point. site at which the target pest species was detected

PPQ. APHIS–Plant Protection and Quarantine

predator. organism that consumes substantial numbers of prey

pronotum. upper and dorsal part of the prothorax

prosternum. sternum of the prothorax

prothorax. first thoracic ring or segment bearing the anterior legs, but no wings

protuberance. something that protrudes such as a bulge, knob or swelling

pyriform. pear shaped

regulated area. area that extends to a given distance in any direction from the epicenter of an infestation

regulated articles. all known/suspected hosts or substrates of a confirmed infestation of an exotic pest species

regulatory inspection. visual examination of host material, containers and transport

reniform. kidney shaped

rhizosphere. microenvironment in the soil, immediate around the plant root

riparian. relating to or located on the banks of a river or stream

sanitation. destruction or removal of infested plants or plant parts; decontamination of tools, equipment, containers, work space, hands, *etc.*

saprophyte. organism that obtains nourishment from non-living organic matter

satellite site. potentially infested property that is beyond a given distance from the confirmed infestation site

sclerite. hardened plate of the body wall bounded by membrane or sutures

sclerotization. hardening of the cuticle involving the development of crosslinks between protein chains

SEL. USDA–ARS–Systematic Entomology Laboratory

septate. with cross walls; having septa

seta (plural setae). sclerotized hair-like projection of cuticula arising from a single trichogen cell and surrounded at the base by a small cuticular ring

sex pheromone. semiochemical secreted by an insect to attract or advertise reproductive competence to the opposite sex of the same species; these pheromones can be artificially produced and embedded in lures to trap the opposite sex

sinuate. curved or curving in and out

SL. soluble concentrate

soil treatment. application of an approved pesticide to the soil of nursery stock or within the drip line of host plants

SPHD. State Plant Health Director

SPRO. State Plant Regulatory Official

steam sterilization. use of live steam as a treatment on selected regulated items

stellate. arranged in rays or radii

sternum. entire ventral division of any segment

stunting. overall reduction on plant height due to shortening of internodes

subglobose. nearly globose

suppression. application of phytosanitary measures in an infected area to reduce pest populations

sweep net. survey method in which a mesh net suspended around a hoop is swept through the air or around vegetation to collect insects

symbiotic. mutually beneficial association of two different organisms

symptom. external and internal reactions or alterations of a plant as the result of pest feeding

teleomorph. sexual form of a fungus

TESS. Threatened and Endangered Species System

tergum. upper or dorsal surface of an insect body segment, whether consisting of one or more sclerites

thorax. middle body segment between the head and abdomen of an insect; consists of three segments (prothorax, mesothorax and metathorax) each of which typically bears a pair of articulated legs

trace-back. to investigate the origin of infested plants through intermediate steps in commercial distribution channels to the origin

trace-forward. to investigate the potential distribution of infected plants from a source through steps in commercial distribution channels

trap survey. determining the occurrence and/or density of a pest species using traps placed in a predetermined pattern and serviced on a given schedule

true host. host capable of sustaining reproduction

tuberculate. covered with tubercles (wart-like projections)

TWG. Technical Working Group

tyloses. bladder-like outgrowth from certain cells in woody tissue that extends into and blocks adjacent conducting xylem cells

umbricate. shingle-like; having regularly arranged overlapping edges as in roof tiles

uninucleate. cell having one nucleus

univoltine. one generation per year

USDA. United States Department of Agriculture

USFWS. United States Fish and Wildlife Service

vacuole. generally spherical organelle within a plant cell bound by a membrane and containing dissolved materials such as metabolic precursors, storage materials or waste products

vector. carrier (*e.g.,* insect) of an infectious agent (*e.g.,* plant virus) capable of transmitting infection from one host plant to another

verrucose. covered with warts or projections that resemble warts

viresence. development of green color in place of normal flower color

visual survey. examining plant hosts, substrates or hiding places for eggs, larvae, pupae, adults of a pest or visible characteristic damage on the host by the pest

white resin streaks. viscous secretion from the plant as a result of pest attack

wing trap. disposable adhesive-coated capture devise used primarily for surveying moths

witches broom. abnormal excessive proliferation of axillary shoots resulting in a broom-like growth

xylem. woody part of plants; the supporting and water-conducting tissue consisting primarily of tracheids and vessels

zonate. marked with zones or bands; belted; striped

zonobiome. ecosystem with the same average temperature and the same volume of rainfall