United States Department of Agriculture

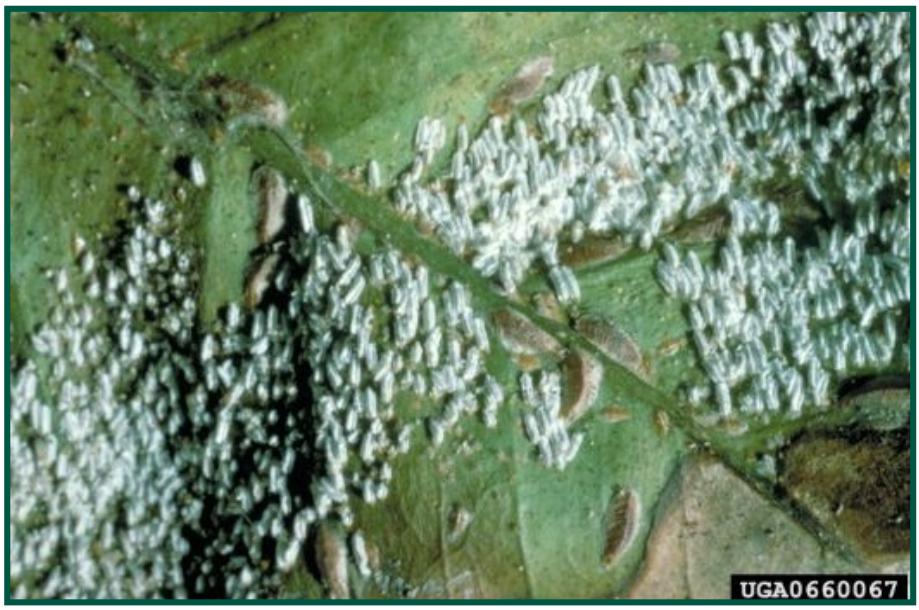
Animal and Plant Health Inspection Service

Plant Protection and Quarantine

New Pest Response Guidelines

Unaspis yanonensis (Kuwana) (Hemiptera: Diaspididae)

Arrowhead scale



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Cover Image

Citrus × *sinensis*, sweet orange (image courtesy of Lesley Ingram, Bugwood.org)

Unaspis yanonensis, arrowhead scale female (image courtesy of Charles Olsen, USDA–APHIS–PPQ, Bugwood.org)

Orange leaf infested with *Unaspis yanonensis*, arrowhead scale exhibiting aggregated white male and darker, larger female scales (image courtesy of F. Bertaux, GRISP, Antibes, Bugwood.org)

Chapter

1

Introduction

Unaspis yanonensis (Hemiptera: Diaspididae)—the arrowhead scale—was originally described from citrus in Japan as *Prontaspis yanonensis* by Kuwana (1923a), who considered it to be the most injurious scale insect of oranges in Japan at that time. Arrowhead scale remains a problem in Japan and elsewhere (Benassy *et al.*, 1976; Campolo *et al.*, 2013; Kim *et al.*, 2010). The scale propagates rapidly and feeds on twigs, leaves and fruit; in heavy infestations, trees may be killed, while lower pest densities can weaken trees and kill twigs. Foliar chlorotic spots produced by feeding can become necrotic and lead to leaf-drop and reduced photosynthetic activity. Feeding on the fruit can result in exocarp spots, irregular shape, premature ripening and can render plants more susceptible to attack by secondary organisms. Symptoms of infested citrus trees range from inhibition of growth to tree death (Campolo *et al.*, 2013). A preference for *Citrus* spp. highlights the potential of *U. yanonensis* as an economic pest in the U.S.

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

Chapter

2

Taxonomy

The armored scales, Diaspididae, are the largest family of scale insects with 2,400 species in 380 genera worldwide (Miller and Davidson, 2005). In North America, approximately 310 species are distributed among 86 genera (Triplehorn and Johnson, 2005). The Diaspididae host range includes approximately 1,400 genera in 180 plant families (USDA, 2007). The taxonomic classification of the arrowhead scale is presented in Table 2-1.

Table 2-1 Classification of *U. yanonensis*

Rank	Taxon
Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Hemiptera
Superfamily	Coccoidea
Family	Diaspididae
Genus	*Unaspis*
Species	*Unaspis yanonensis*

Synonyms

- *Chionaspis citri* Kuwana, 1907 (misidentification)
- *Prontaspis yanonensis* Kuwana, 1923
- *Unaspis yanonensis* Takahashi & Kanda, 1939
- *Unaspis janonensis* Ter-Grigorian, 1969
- *Unaspis yannonensis* Chou, 1982

(ScaleNet, 2015)

Common Names

English

- arrow-head scale
- arrowhead scale
- yanon scale
- yanone scale

Spanish

- escama de Yanon

(ScaleNet, 2015)

Chapter

3

Identification

Species Description/Morphology

Adult male (cover photo, Figure 4-1) armored scales are minute, short-lived, typically winged insects with either no or vestigial mouthparts. Adult females (cover photo, Figure 3-1 and Figure 4-1) are soft-bodied sessile parasites of perennial plants, protected beneath a durable scale cover of cemented wax elements and the exuviae of previous stages (Ben-Dov, 1990).

Kuwana (1923b) and Blackburn and Miller (1984) described and illustrated *U. yanonensis*, and Miller and Davidson (2005) provided a key to slide-mounted females that includes the congeneric and similar species *U. citri* (Comstock) and *U. euonymi* (Comstock), but not *U. yanonensis*.

Male and female armored scales are identical during the first instar, or “crawler” stage, but sexually dimorphic thereafter (Beardsley and Gonzalez, 1975). Third-stage females are sexually mature, but male development includes two additional nymphal instars, the propupa and pupa, prior to emergence as a sexually mature adult. All life stages are visible on the host except the eggs, which are concealed beneath the female scale cover until hatching (Kuwana, 1923b).

The armored scale is mobile during the first instar and adult male stages (Koteja, 1990). Male hindwings are reduced to club-shaped halteres, each bearing a long hooked apical seta (Giliomee, 1990) that renders dispersal via active flight poor and short-ranged. Females are sessile, legless and wingless (Takagi, 1990).

During the growing season, immatures of both sexes and female adults develop on host leaves, twigs and fruit (Kuwana, 1923b). *Unaspis yanonensis* adult females and second instars of either sex may overwinter on host plants (Campolo *et al.*, 2013; Murakami, 1970).

Except the wandering first instars, the developing insect is enclosed within a protective scale cover composed of wax filaments, non-wax material secreted by pygidial (abdominal) glands and products of internal glands secreted from the dorsally located anus (Miller and Davidson, 2005). The adult female dorsal scale cover of the arrowhead scale is smooth and blackish brown with a gray margin.

The pale yellow exuviae of the first and second stages are attached to the narrower anterior end (Kuwana, 1923b). As the wax and other components are secreted, a prominent longitudinal medial ridge (carina) becomes evident. The fully developed scale cover is an elongate sub-oval in general outline, but can vary from more elongated, to curved or lanceolate (see cover photo and Figure 3-1 and Figure 4-1). An adult female scale cover can range in length from 2.84–3.56 mm and 1.40–1.92 mm at maximum width (Kuwana, 1923b).

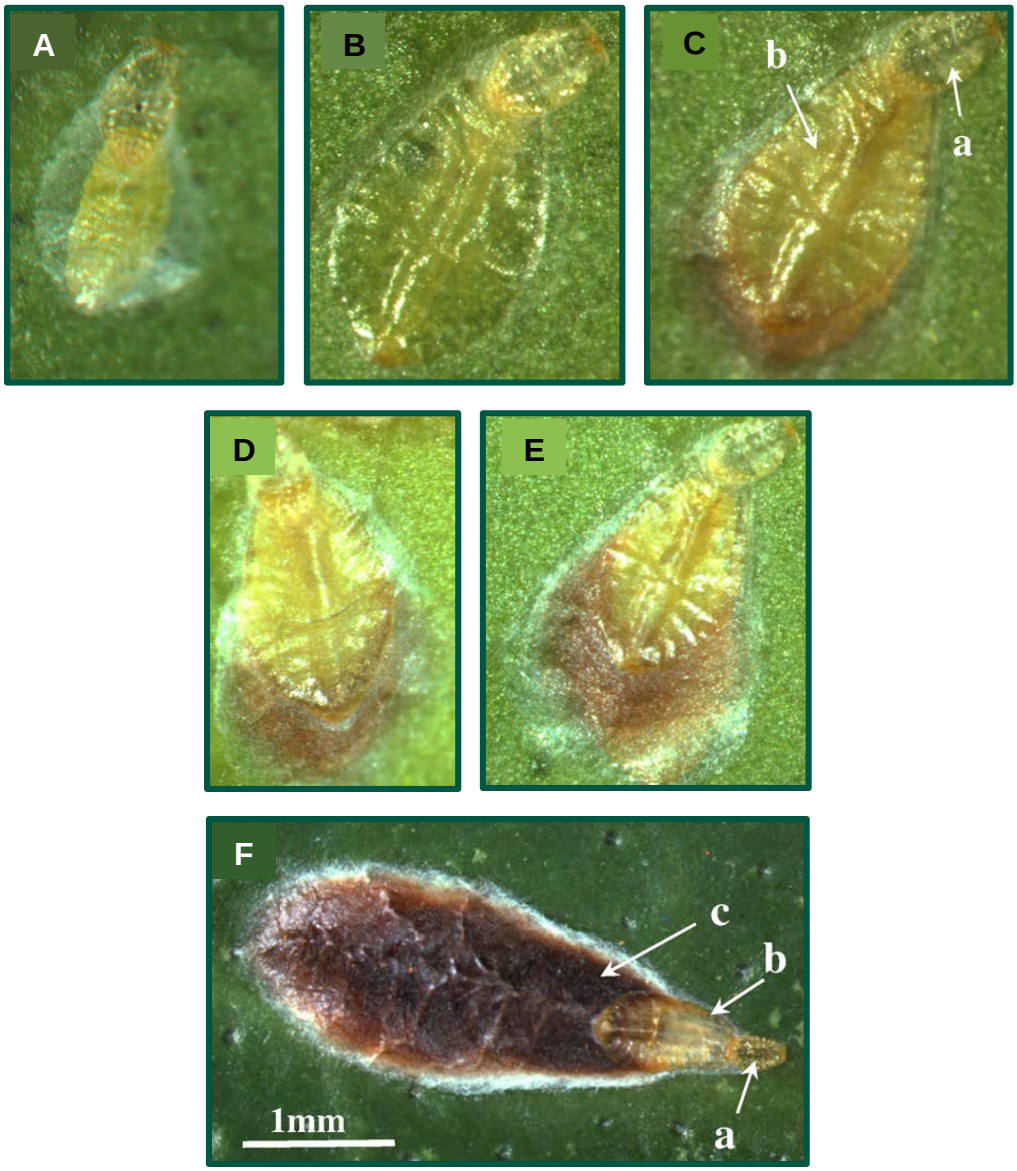

Figure 3-1 Larval (nymph) and adult stages of *U. yanonensis* females (Photos by Seo *et al.* (2008) published by Kim *et al.* (2010)): (A) early soft stage— soft, thin integument not yet hardened; (B) hardened stage—integument completely hardened; (C) late apolysis—old integument separates from the body for molting to next stage; (D–F) adult (3rd nymph): (D) early adult—female begins to grow permanent shield (protective scale cover); (E) middle—scale cover forms (~⅓ full size); (F) full-grown female—a: exuviae of first nymph, b: exuviae of second nymph and c: permanent scale cover (Kim *et al.*, 2010)

The pupal male scale is distinct from the female cover: The waxy material in the male scale cover is ‘felted’ in texture, and the cover is distinctly tricarinate, parallel sided and much smaller than the female scale, ranging from 1.25–1.56 mm long and 0.48–1.56 mm wide (Kuwana, 1923b). The exuvia of the male first instar is retained at the anterior of the cover, while later-stage male exuviae are hidden beneath the scale cover (Kuwana, 1923b; Miller and Davidson, 2005).

After the first instar settles, the antennae and legs retract, the mouthparts are inserted into the host tissue and the scale cover production commences (Miller and Davidson, 2005). The shape and color of the scale cover are similar in male and female first instars. However, the pygidial secretions of the male first instar are “coarse cottony threads” (Kuwana, 1923b), while those of the female are “felted white covers” (Miller and Davidson, 2005).

Sex-specific differences in the scale cover shape appear at the second instar (Miller and Davidson, 2005); for example, the narrower and more elongate body of male second and later instars is reflected in the scale cover. Soon after molting, the abdomen appears posterior to the cast exuvia of the previous instar, followed by the secretion of the new cover in which the pygidial secretions form three longitudinal processes resulting in an elongate “tricarinated mass” (Kuwana, 1923b). Additionally, the exuviae of the male second instar, pre-pupa and pupa are not incorporated into the scale cover (Miller and Davidson, 2005) but are pushed away from the body and beneath the cover (Kuwana, 1923b). After the pupal molt, the alate male backs out from beneath the posterior margin of the scale cover (Kuwana, 1923b). In all stages of both sexes, the body is detached from the cover (Miller and Davidson, 2005).

Armored scales are characterized by reduced body structures and segmentation. In females, the head and prothorax are fused into a composite region called the prosoma (Takagi, 1990). Adult females are legless with their antennae reduced to unsegmented tubercles (Miller and Davidson, 2005). Rostral mouthparts are located ventrally and distal to the anterior margin of the prosoma (Triplehorn and Johnson, 2005). The posterior segments of the abdomen partially coalesce into a composite structure called the pygidium, which is typically more sclerotized than the prosoma (Miller and Davidson, 2005). The anal and genital openings and a diversity of lobes, paired lobules, plates, gland spines and setae occur on the pygidium, and the size, shape and relative positions of these structures are used to identify armored scale species. Miller and Davidson (2005) provided a key to Diaspididae genera based on slide-mounted adult females. The morphological characteristics of *Unaspis yanonensis* adults and immatures are described by Kuwana (1923b) and presented in Table 3-1 to Table 3-6.

.

Table 3-1 Adult *U. yanonensis* morphological characteristics (Kuwana, 1923b)

Characteristic	Sex	Description
scale	female	dorsal ♦ length: 2.84–3.56 mm; maximum width: 1.40–1.92 mm ♦ blackish-brown with a gray margin ♦ shape: sides slope to margin from prominent central ridge ♦ accumulated exuviae pale yellow and elongate ventral ♦ white ♦ secreted from sides, does not reach midline
	male (late pupal stage)	♦ length = 1.25–1.56 mm; width = 0.48–1.56 mm ♦ white ♦ 1st instar exuviae retained at anterior end concealing pale yellowish brown accumulated exuviae of later instars ♦ elongate, distinctly carinate with longitudinal keels
dimensions	female	2.5 × 1.0 mm
	male	length: 0.45 mm (+ 0.36 mm style)
shape	female	elongate, distinctly segmented, constrictions at sutures
color	male	orange yellow with light-brown thoracic band
body	female	2 pairs spiracles (thoracic segments 1 and 3)
	male (alate adult)	♦ well-defined abdominal segments taper slightly posteriorly ♦ terminal segment bears sharp style ♦ fine hairs on all segments
antennae	female	consist of small tubercles, each with a single short hair
	male	♦ pale yellow ♦ average length = 0.54 mm ♦ 10 segments (3–10 have hairs longer than segment)
head	male	rounded, somewhat pointed at anterior apex
eyes	male	dark brownish-purple
mouthparts	female	well-developed rostral loop, long relative to overall dimensions
legs	male	♦ pale yellow ♦ total hind leg length = 0.39 mm: coxa = 0.04 mm, trochanter + femur = 0.15 mm, tibia = 0.11 mm, tarsus = 0.07 mm, tarsal claw = 0.02 mm
pygidium	female	♦ 12 glandular spines on penultimate abdominal segment arranged outside the median lobe, just outside outer lobule of 2nd lobe, one beyond outer lobule of 3rd lobe, approximately half way to pygidium base, 5 or 6 (sometimes more) immediately caudad of pygidium base ♦ anus circular with opening dorsally closer to posterior pygidial than anterior margin ♦ circumgenital gland orifices absent ♦ 6 marginal gland orifices 1. between 1st and 2nd lobes on slight prominence 2. on slight prominence between 2nd gland spine and inner lobule 3rd lobe 3. just beyond 2nd opening at outer angle of inner lobule of 3rd lobe 4. a little beyond, slightly inside margin and apparently opening into pocket 5. on slight protuberance beyond 4th gland spine 6. slightly beyond 5th ♦ dorsal micropores evenly distributed ♦ no circumvulvar wax pores
wings	male	♦ forewing expanse = 1.76 mm ♦ at rest, wings extend beyond style ♦ club-shaped halteres with hook-shaped seta extending beyond haltere apex

Table 3-2 Morphological characteristics of *U. yanonensis* eggs (Kuwana, 1923b)

Characteristic	Sex	Description
dimensions	both	length: 0.18 mm; width 0.09 mm
shape	both	ovoid
texture	both	smooth
color	both	orange yellow

Table 3-3 Morphological characteristics of *U. yanonensis* first instars (Kuwana, 1923b)

Characteristic	Sex	Description
scale	female	development of scale: 1. dorsal cottony thread-like wax secreted 2. thin, grayish waxy substance produced that progressively extends beyond dorsal midline and covers posterior half of body at 1st molt 3. with molting, 1st instar exuviae incorporated into scale cover
	male	coarse, white cottony texture of unincorporated wax filaments
dimensions	both	0.23 mm; width 0.14 mm
shape	both	flat oval lacking distinct segmentation
color	both	pale yellow with yellowish-brown posterior (male slightly darker)
antennae	both	5 segments ♦ 1–4 one hairs each ♦ 5 longest and distinctly annulate with several hairs
eyes	both	marginal, dorsal, posterior to antennae, purple
mouthparts	both	well-formed with long rostral loop
legs	both	3 similar pairs ♦ femurs well-developed with distinctly convex margins ♦ tibia less than half length of tarsus ♦ tarsal claw large and curved ♦ tarsal digitules prominent
glandular pores	both	large with distinctly cylindrical ducts ♦ 2 on anterior dorsum
marginal lobes	both	small ♦ posterior (6) with basal spines extending slightly beyond lobe apex ♦ lateral (4) consist of paired lobules ♦ medial (2) are longest
marginal hairs	both	approximately 30 ♦ 2 long extending from between median lobes

Table 3-4 Morphological characteristics of *U. yanonensis* second instars (Kuwana, 1923b)

Characteristic	Sex	Description
scale	female	♦ 1st instar scale cover expands laterally and posteriorly from fixed mouthparts ♦ with molting, 2nd instar exuviae incorporated into scale cover
	male	♦ white ♦ elongate ♦ tricarinate ♦ 1st instar exuviae located on anterior end
dimensions	female	length: 0.31 mm; width 0.2 mm
	male	length: 0.64 mm
shape	female	round or ovoid
	male	elongate
color	male	yellowish orange to orange
antennae	female	single segment
eyes	male	2 pairs: ♦ 1 marginal ♦ 1 dorsal purple
legs	female	absent
pygidium	female	♦ round ♦ median portion depressed ♦ lobes ❖ marginal (6) ❖ lateral (4) consist of paired lobules ❖ gland spines basal at lobes ♦ 4 marginal gland orifices proximal to lobes ♦ gland spines on each side
	male	♦ simpler than female ♦ unindented at median ♦ marginal lobes less distinct than in female ♦ marginal gland orifices: 6 pairs ♦ dorsal gland orifices present

Table 3-5 Morphological characteristics of *U. yanonensis* propupa males (Kuwana, 1923b)

Characteristic	Description
scale	♦ white ♦ elongate ♦ tricarinate ♦ 1st instar exuviae located on anterior end
color	♦ orange yellow ♦ yellowish brown abdominal apex
antennae	♦ sheaths visible ♦ rudimentary and appressed to body
eyes	♦ dark purple brown ♦ dorsal pair posterior to the antennal sheaths ♦ ventral pair larger, closer together and more caudad than dorsal pair
legs	♦ sheaths visible ♦ rudimentary and appressed to body
wings	♦ sheaths visible ♦ rudimentary and appressed to body

Table 3-6 Morphological characteristics of *U. yanonensis* pupa males (Kuwana, 1923b)

Characteristic	Description
scale	♦ white ♦ elongate ♦ tricarinate ♦ 1st instar exuviae located on anterior end
dimensions	♦ length = 0.80 mm ♦ width = 0.30 mm ♦ style = 0.15 mm
color	♦ orange yellow ♦ yellowish brown abdominal apex
antennae	sheaths close to ventral margin
eyes	ventral larger than dorsal ♦ located near anterior margin dorsal farther apart ♦ closer to anterior margin
legs	sheaths close to ventral margin
wings	sheaths close to ventral margin

Diagnostics

Kuwana (1923b) and Blackburn and Miller (1984) presented morphological descriptions and illustrations of *U. yanonensis*. The morphological characteristics that distinguish *U. yanonensis* are presented in the previous section. The key in Miller and Davidson (2005) exclude *Unaspis yanonensis* but include the similar, congeneric species, *U. citri* (Comstock) and *U. euonymi* (Comstock), and provide slide-mounting instructions and a field-key based on the *U. citri* and *U. euonymi* hosts (Miller and Davidson, 2005).

Similar Species

The morphologically similar citrus snow scale, *U. citri*, also a pest of *Citrus* spp. (Blackburn and Miller, 1984; Kuwana, 1923b), occurs in California, Louisiana, Mississippi, Florida, Georgia and Virginia (Buckley and Hodges, 2013).

Kuwana (1923b) distinguished *U. yanonensis* from *U. citri* based on thoracic segmentation, the number of dorsal pygidial pores and the distance between pygidial median lobes (Table 3-7). Blackburn and Miller (1984) and Campolo *et al.* (2013) distinguished the two species based on the number and distribution of pygidial macroducts, gland spines and the condition of the median lobes (Table 3-8): *Unaspis yanonensis* has more than 100 macroducts and widely separated median lobes, while *U. citri* has fewer than 100 macroducts and closely spaced medial lobes.

Table 3-7 Morphological features distinguishing *U. yanonensis* and *U. citri* (Kuwana, 1923b)

Feature	U. yanonensis	U. citri
thoracic segmentation	distinct	indistinct
number of dorsal pygidial pores	numerous	few
distance between median pygidial lobes	distant	subadjacent

Table 3-8 Detailed morphological features distinguishing *U. yanonensis* and *U. citri* (Blackburn and Miller, 1984)

Feature	U. yanonensis	U. citri
macroducts on each side of pygidium	48–64	18–35
gland spines between the 2nd & 3rd and 3rd & 4th pygidial lobes	1	2
gland spines on each side of body anterior to segment 4	51–76	27–39
median lobes	strongly divergent	slightly divergent

Chapter

4

Biology

Life Cycle

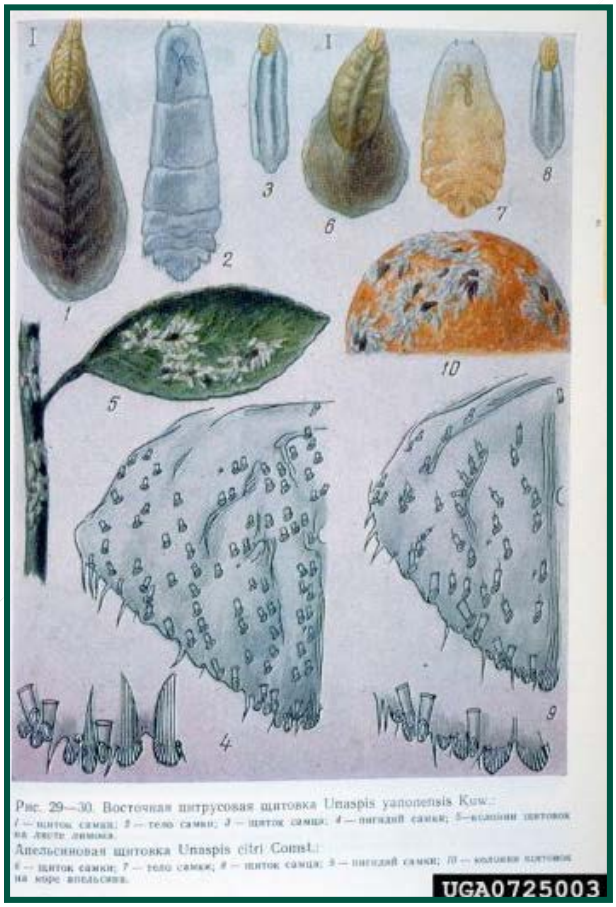

Figure 4-1 Select life stages and morphological characteristics of *U. yanonensis*: (1) female scale cover; (2) female; (3) male scale cover; (4) female pygidium; (5) scale colony on lemon leaf (image courtesy of Russian Federation Ministry of Agriculture and Food Production Archive, Ministry of Agriculture and Food Production, Bugwood.org)

Diaspididae developmental stages are sexually dimorphic beginning with the second instar. (Beardsley and Gonzalez, 1975). *Unaspis yanonensis* female development from egg to adult includes three instars (Kuwana, 1923b); male development includes additional propupal and pupal nymphal instars. All stages except the egg are visible on host plants (Kuwana, 1923b). Armored scales feed

during the first and second instar and adult female stages (Miller and Davidson, 2005). The only mobile stages are the first instar ("crawler") and adult male, which disperse to search for females (Koteja, 1990). The latter are ephemeral alates lacking mouthparts (Takagi, 1990). The identifying characteristics for each life stage are described in *Identification* on page 3-1.

Researchers in China, Japan and France reported 2–4 *U. yanonensis* generations per year (Davis *et al.*, 2005). Campolo *et al.* (2013) observed 2 complete generations in southern Italy (latitude 38° N) and an incipient third generation of first instars produced in October by second-generation females, but these did not molt and died during the winter. Temperature and humidity are the main constraints on the number of generations (Miller and Davidson, 2005).

Davis *et al.* (2005) documented three generations in Nagasaki (latitude 32° N) and Shizuoka (latitude 34° N) Prefectures, Japan. The first generation life cycle required 65 days in Nagasaki and approximately 75 days in Shizuoka. The second generation took 55–64 days in Nagasaki and the third (overwintering) generation 245 days.

The overwintering stage varies depending on the region and climate (Miller and Davidson, 2005). Most U.S. armored scale insect species overwinter as second-instar males, second-instar females or fertilized females. *Unaspis yanonensis* overwinters primarily as fertilized mature and immature females, and in lesser numbers as second instars in warmer regions (as summarized by Murakami (1970)). In Kanagawa Prefecture (latitude 35° N), hibernation occurs only in adult females, which overwinter on host leaves (Murakami, 1970). In southern Italy (Calabria, latitude 38° N), Campolo *et al.* (2013) discriminated between the pre-ovipositing and ovipositing female stages: pre-ovipositing females overwinter, whereas when the scale cover is removed from ovipositing females, which do not overwinter allowing eggs and chorions to be seen (Campolo *et al.*, 2013).

Studies in the prefectures of Kagoshima (latitude 31° N), Nagasaki (latitude 32° N) and Shizuoka (latitude 34° N) (Murakami, 1970) are summarized as follows: winter survival rates vary with developmental stage and environmental factors such that survival ranges from 34–90% in mature adults, 20–60% in immature adults and 2–30% in second instars.

The seasonal occurrence of *U. yanonensis* eggs and first instars on citrus in Korea (latitude 33° N), Japan (latitude 31–35° N) and southern Italy (latitude 38° N) is presented in Table 4-1.

Table 4-1 Seasonal occurrence of eggs or first instars from overwintered and growing-season *U. yanonensis* females in Korea, Japan and Italy

Location	Stage	Generation	Time	Reference
Jeju Island, Korea (latitude 33 °N)	first instar	1st (progeny of overwintered females)	appears mid-May; large population peaks late May to early June; small population peaks June	Kim *et al.* (2007)
	adult female	1st	late June, peaking in July	
	first instar	2nd	appears late July; large population peaks mid-August; small population peaks late September	
	adult female	2nd	mid-September, peaking in late September	
Japan (latitude 31–35 °N)	eggs	1st (progeny of overwintered 3rd generation females)	17 May–29 July	Kuwana (1923b)
		2nd (progeny of 1st generation females)	1 August–26 October	
		3rd (progeny of 2nd generation females)	21 September–2 November	
Italy (latitude 38 °N)	eggs	1st (progeny of overwintered females)	early April, peaking first half of May	Campolo *et al.* (2013)
	first instar	1st	appears mid-April; large population peaks May; small peaks late June	
	eggs	2nd (“summer generation”)	early June to mid-July	
	first instar	2nd	population peaks mid-August; small population peaks September	
	eggs	3rd (overwintering generation)	October	

Kuwana (1923b) provided life-cycle developmental times for three generations of *U. yanonensis* on citrus in Nagasaki, Japan (latitude 32° N). The development time from egg hatch to oviposition by females is presented in Table 4-2 and from egg hatch to the emergence of adult males from pupal cases in Table 4-3.

Table 4-2 Developmental life-cycle duration for female *U. yanonensis* observed on citrus in Nagasaki, Japan (Lat. 32 °N)

Generation (Kuwana’s nomenclature)	Egg hatch date	Oviposition date	Interval (days)
II	26 July 1916	19 September 1916	55
III	22 September 1916	26 May 1917	245
I	27 May 1917	31 July 1917	65
II	3 August 1917	6 October 1917	64
III	6 October 1917	6 June 1918	243
I	7 June 1918	11 August 1918	66

Table 4-3 Developmental life-cycle duration for male *U. yanonensis* observed on citrus in Nagasaki, Japan (Lat. 32 °N)

Generation (Kuwana's nomenclature)	Egg hatch date	Adult male emergence date	Interval (days)
II	26 July 1916	25 August 1916	29
III	22 September 1916	14 November 1916	43
I	27 May 1917	3 July 1917	38
II	3 August 1917	2 September 1917	31
III	6 October 1917	dead 25 November	—
I	7 June 1918	11 July 1918	35

Kim and Kim (2013) reported a minimum developmental threshold temperature of 8.7° C for *U. yanonensis* in citrus orchards on Jeju Island (33° N, 126° W), Korea. Overwintering females collected on citrus leaves on Jeju Island in January and maintained in a chamber at 2.0 ± 0.5° C terminated diapause.

Kim and Kim (2013) also performed laboratory studies to determine the effect of temperature on the pre-oviposition period, oviposition period, longevity and fecundity of overwintered females collected on citrus leaves on Jeju Island, Korea in January 2006. Longevity in the laboratory was measured as the sum of the pre-oviposition and oviposition periods with the pre-oviposition period beginning 7 March 2007. Fecundity was measured as the number of emerged first instars during 1–4 oviposition cycles. Kim and Kim's (2013) results are summarized in Table 4-4.

Table 4-4 Oviposition period, fecundity and longevity of overwintered *U. yanonensis* females collected from citrus on Jeju Island, Korea (33 °N) (Kim and Kim, 2013)

Temperature (°C)	16	20	24	28	32
pre-oviposition period (days)	49.0 ± 0.9	34.1 ± 0.4	21.0 ± 0.1	19.4 ± 0.2	19.7 ± 0.2
oviposition period (days)	37.8 ± 2.8	38.8 ± 2.9	45.6 ± 3.4	51.8 ± 3.2	29.6 ± 1.1
longevity (days)	87.3 ± 2.7	72.8 ± 3.0	66.7 ± 3.4	71.1 ± 3.2	48.9 ± 1.1
fecundity*	140.0 ± 5.0	166.2 ± 13.1	260.9 ± 24.4	252.4 ± 16.8	137.5 ± 10.8

* emerged first instars during 1–4 oviposition cycles

Unaspis yanonensis eggs remain in the ovary until embryonic development is nearly complete (Murakami, 1970). Eggs are laid beneath the scale cover and, in females overwintered on citrus, hatch in 35–70 minutes. Mobile first instars emerge from the maternal scale cover after approximately a day and wander for several hours before settling and feeding. An average of 140 first instars emerge per female (Murakami, 1970). The numbers of eggs and first instars emerging per female are presented in Table 4-5.

Table 4-5 Egg and first instar numbers observed by Kuwana (1923b) on citrus in Nagasaki, Japan (32 °N)

Generation	Oviposition dates	Eggs/female		Oviposition period (days)		Maximum first instars per female in 1 day
		Range	Avg.	Range	Avg.	
I (n = 12)	8/1–10/26 1917	105–287	177	19–80	45	45
II (n = 11)	9/21–11/2 1916	71–175	133	28–43	23	23
III (n = 16) (overwintered)	5/17–7/29 1918	113–303	196	31–72	28	28

In two laboratory incubation studies at 20° C with eggs collected in August 1916 and June 1917, Kuwana (1923b) observed that eggs hatched in 35–85 minutes.

Murakami (1970), in a summary of research in Japan, reported the emergence of first instars from overwintered females between May and July depending on the March–April temperatures. Emergence occurred in two first-instar density peaks with the first peak occurring 10–15 days after initial emergence, and a second smaller peak 30 days after the first peak.

First instars of the second generation appeared from July–November (Murakami, 1970), in early July in Kagoshima Prefecture (latitude 31° N) and early August in Kanagawa Prefecture (latitude 35° N).

First instars of the third, or overwintering, generation appeared south of Shizuoka Prefecture (latitude 34° N) from September–November (Murakami, 1970). At this latitude, the population was small relative to prior generations, but was as large as those of earlier generations in the more southerly Kagoshima Prefecture.

On citrus in southern Italy (Calabria, latitude 38 °N), Campolo *et al.* (2013) observed bimodal *U. yanonensis* first instar peak densities and peaks for females and male pupae (Table 4-6).

Table 4-6 Timing of peak *U. yanonensis* densities on citrus in southern Italy (Calabria, latitude 38 °N) (Campolo *et al.*, 2013)

	May	June	August	September	October	November
1st generation 1st instars/cm^2	6.5	1.7				
2nd generation 1st instars/cm^2			3.2	1.9		
3rd generation 1st instars/cm^2					1.4	1.3
ovipositing females/cm^2			0.6			
male pupae/cm^2				1.0	0.7	
pre-ovipositing females/cm^2					1.1	

Crawlers cease wandering when a suitable feeding site is found (Koteja, 1990). The first instar lasts 8–16 days regardless of sex (Davis *et al.*, 2005) and passes through four phases: torpidity (quiescence), dispersal, feeding/growth and morphogenesis (molting) (Koteja, 1990). During the torpid phase, neonates are quiescent beneath the cover of the maternal scale. The dispersal phase lasts from several hours to days, during which the first instars swarm over the host plant before settling. Settling often occurs within several dozen centimeters of the birth site, but distances up to150 m have been reported. Factors influencing the distance and duration of dispersal include availability of a suitable host site and environmental conditions such as temperature, light intensity, humidity, wind velocity and the nature of the substrate. Dispersal occurs between 13–43° C. Host chemical cues also influence the choice of settling site, which is made prior to piercing and feeding. Rough surfaces are preferred to smooth (Koteja, 1990).

After settling, the first instar begins feeding (Koteja, 1990); the legs are retracted, the body becomes more tightly adhered to the host surface, the stylets are inserted and feeding begins. The first instar oscillates about the axis formed from its mouthparts while secreting and cementing wax filaments (Miller and Davidson, 2005). The length of the cover increases distally and laterally during growth by adding wax and secreted fluids used as cement (Miller and Davidson, 2005).

The morphogenetic phase—during which the antennae and legs shrink, the integumental glands develop and the dorsal cuticle thickens—concludes when the cuticle is molted and reveals the second stage (Koteja, 1990). Molting encompasses splitting of the dorsal integument along the body margin (Miller and Davidson, 2005) and ecdysis, during which the dorsal integument is pushed up against the scale cover and the ventral portion pushed backward; the exuvia is incorporated into the scale cover when completely shed. The anterior portion of the second instar integument is located beneath the posterior end of the first instar exuvia. In females, this process is repeated when the second instar molts, with the second instar exuvia becoming incorporated into the scale cover beneath the posterior end of the first instar exuvia (Miller and Davidson, 2005).

Hosts

Armored scales are typically pests of host plants that live for more than one growing season (Miller and Davidson, 2005). Diaspididae feed on individual plant cells rather than the phloem sap upon which honeydew-producing scales (*e.g.*, soft scales and mealy bugs) feed. Males feed during the first and second instar stages; the pro-pupa, pupa and adult stages have vestigial or no mouthparts and do not feed. The piercing stylets are long and flexible with their direction controlled by muscles as they move through plant tissue. As the cells in a region are

punctured and drained, the mouthparts move to new regions. A meandering, yellow streak of chlorosis on the dorsal leaf surface often indicates feeding damage by armored scales (Miller and Davidson, 2005). When scale densities on a leaf become high, the chlorotic patches may merge, and the entire region become necrotic, leaving the leaf vulnerable to infection by bacterial and fungal pathogens.

Unaspis yanonensis is primarily a pest of citrus (Kuwana, 1923b), feeding on leaves, twigs and fruit (Murakami, 1970). Davis *et al.* (2005) summarized the known host species of *U. yanonensis* published from 1923–2004: *Unaspis yanonensis* feeds on the young stems, foliage and fruit of the Rutaceae genera *Citrus*, *Fortunella* and *Poncirus* and the Rubiaceae genus *Damnacanthus* (Davis *et al.*, 2005). Economic hosts grown in the U.S. are presented in Table 4-7.

Table 4-7 Reported plant hosts of *U. yanonensis* grown in the U.S. (Davis *et al.*, 2005)

Scientific name	Common name
(Citrus × paradisi [maxima × sinensis])	grapefruit
Fortunella spp.	kumquat
Citrus lemon	lemon
Citrus aurantifolia	lime
Citrus spp.	orange
Citrus reticulata	tangerine (honey and other)

Natural Dispersal

Dispersal occurs via active locomotion (wandering) and wind transport of first instars or via the passive transport of sessile fertilized females on transported plant material (Greathead, 1990). Only crawlers are capable of founding new populations either at different locations on the same host or different hosts.

First instar emergence from beneath the maternal scale-cover is influenced by temperature and light intensity (Greathead, 1990).

In citrus orchards on Jeju Island (latitude 33° N), first instar development required a minimum developmental threshold temperature of 8.7° C (Kim and Kim, 2013). Crawlers emerged and wandered at temperatures ranging from 13–20° C (Beardsley and Gonzalez, 1975), while for California red scale, *Aonidiella aurantii* (Hemiptera: Diaspididae), a threshold of 12° C with a light intensity threshold of 32 lux was required first instar emergence (Greathead, 1990). Emergence rate increased with increasing temperature and light intensity, consistent with observations of maximum emergence occurring shortly after dawn under typical field conditions. Greathead (1990) reasoned that *A. aurantii* emergence was unaffected by ambient relative humidity (RH) because the relative humidity under the maternal scale cover is close to 100% (Greathead, 1990).

The wandering time of *U. yanonensis* first instars on citrus twigs and leaves lasts from 71–180 minutes (Kuwana, 1923b). Host-plant species, substrate color, substrate texture, temperature and first instar density are the primary variables that influence the duration of the wandering phase (Greathead, 1990). Wandering time is longer on yellow substrates than on green; shorter on dusty surfaces; decreases as temperature rose from 15–30° C and increased with first instar density.

The wandering speed of sugarcane scale, *Aulacaspis tegalensis* (Zehntner), first instars is influenced by relative humidity—1.3 cm/min at 20% RH with a maximum of 2.1 cm/min at 40% RH and a minimum of 0.3 cm/min at 80% RH (Greathead, 1990).

In laboratory experiments on crawler survivorship as a function of temperature and humidity, Greathead (1990) found that 50% of *A. aurantii* first instars survived for 5.5 hours at 35° C and 25% RH, but the survival time increased to 17.25 hours when the temperature decreased to 15° C and the relative humidity increased to 70%. In field observations, 50% of *A. tegalensis* crawlers could survive 8 hours at 30° C and 30% RH, which increased to 28 hours when the temperature fell to 20° C and the relative humidity increased to 90%.

Distances traversed by first instars and the duration of wandering are largely determined by the character of the substrate surface—greater distances are traveled at higher speed over smooth surfaces, wandering across bare soil and sand is limited to short distances (Beardsley and Gonzalez, 1975).

Beardsley and Gonzalez (1975) summarized the work of others who found gender differences in the first instar wandering duration and distances among three diaspidid species. Female first instars of red pear scale, *Epidiaspis leperii* (Signoret), settled close to the mother scale, while males wandered farther. Conversely, the duration of wandering by white peach scale females, *Pseudaulacaspis pentagona* (Targioni), was greater than that of males; female pine needle scale, *Chionaspis pinifoliae* (Fitch), wandered longer and farther than males and settled on new growth, whereas *C. pinifoliae* males settled on old growth**.**

In general, most crawlers settle near their mother (Greathead, 1990). The maximum likely dispersal distance for crawlers of both purple scale, *Lepidosaphes beckii* (Newman), and California red scale, *Aonidiella aurantii*, was calculated at 444 feet (135 m), assuming a constant speed of 23 mm per minute, a temperature of 32.2° C and a maximum active lifetime of 4 days (Beardsley and Gonzalez, 1975). However, unless aided by wind, insects in nature rarely travel this distance prior to settling (Greathead, 1990).

First instars rarely move beyond the natal host (Beardsley and Gonzalez, 1975). Tree-to-tree movement of first instars is rare unless the trees are in contact. Short-distance dispersal within orchards on infested plant material has occurred via wind-blown infested leaves.

Long-distance dispersal by wind of diaspidid first instars is known, but not specifically documented for *U. yanonensis* (Beardsley and Gonzalez, 1975; Greathead, 1990). Horizontal wind transport of *A. aurantii* first instars was positively correlated with wind speed and temperature and negatively correlated with humidity (Greathead, 1990). Sticky trap captures at least 312 m downwind decreased above 2.7 m. However, vertical transport via updraft may explain both the appearance of *A. aurantii* first instars 80 km downwind from an identifiable source and *A. tegalensis* infestations in Kenya 150 and 260 km from an identifiable source (Greathead, 1990).

Interspecific differences among armored scales affect their potential for wind dispersal and may be related to ecological variables (Greathead, 1990)**.** *Aulacaspis tegalensis* is a high fecundity species that feeds on annual hosts such as sugarcane, and demonstrates a “take-off behavior” that enhances dispersal via wind. Conversely, *A. aurantii*, which has lower fecundity and feeds on citrus trees, flattens itself against the substrate during wind-tunnel experiments.

Passive dispersal of post-first instar stages occurs when infested plant material is moved and is enhanced because the insects are both small and sessile making detection difficult (Beardsley and Gonzalez, 1975). Short- and long-range dispersal occurs when both propagative plant material (nursery stock, seedlings) and non-propagative plant material (cut flowers, edible tubers and fruit) are moved. Other diaspidid dispersal modes include phoresy on insects, birds and humans (Beardsley and Gonzalez, 1975).

Geographic Distribution

Based on quarantine and interception data from the Imperial Quarantine Service stations at Moji and Nagasaki, Kuwana (1923b) inferred that *U. yanonensis*, native to China, was introduced into Japan and spread via infested orange stock.

Unaspis yanonensis is established in southern France, southern Italy, Armenia, Pakistan, India, China, Myanmar (Burma), Thailand, Malaysia, Indonesia, Vietnam, Hong Kong, South Korea, Japan, the Ryukyu Islands (Nansei Shoto), Taiwan, the Philippines, Australia and Fiji (ScaleNet, 2015).

Ecological Distribution

Based on the reported distribution, Davis *et al.* (2005) identified temperate broadleaf and mixed forests, Mediterranean scrub and tropical and subtropical broadleaf forests as biomes suitable for *U. yanonensis*.

Potential Distribution

Davis *et al.* (2005) estimated that approximately 30% of the continental U.S. is suitable for *U. yanonensis*. However, its preference for citrus hosts further restricts the likely distribution while highlighting its potential role as an economic pest.

Chapter 5

Damage

Signs and Symptoms

Large armored scale populations cause leaf mottling and branch dieback (Miller and Davidson, 2005). Feeding on individual cell contents removes only small quantities of water and solutes; thus, armored scales do not foul leaves with honeydew. Identification of trees infested by armored scales is hindered because sooty molds—highly visible signs of infestations by honey-dew-producing insects—do not proliferate near armored scale populations.

Kuwana (1923b) described *U. yanonensis* as the scale insect most injurious to orange growers in Japan. The insects propagate rapidly and feed on twigs, leaves and fruit. Entire trees are killed in heavy infestations, while lower pest densities weaken trees and kill twigs. Campolo *et al.* (2013), who studied *U. yanonensis* in southern Italy on blood orange, navel orange, lemon, mandarin and clementine, reported that foliar chlorotic spots produced via feeding can become necrotic and lead to leaf-drop and reduced photosynthetic activity. Fruit feeding can result in exocarp spots, irregular shape and premature ripening. Feeding can render plants more susceptible to attack by secondary organisms. Symptoms on infested citrus trees range from inhibited growth to tree death.

Impacts

Environmental

None of the known *U. yanonensis* hosts present in the U.S. (Table 4-5 on page 4-5) is listed as a species of concern or endangered (USFWS, 2014).

Environmental impacts have not been evaluated in controlled studies, but non-target impacts are possible if broad-spectrum insecticides such as organophosphates and carbamates are used during an emergency response (Table 8-1 on page 8-4).

Economic

No quantitative analysis of economic impact has been published. However, as stated previously, *Unaspis yanonensis* is the most injurious scale insect to orange production in Japan. Campolo *et al.* (2013) reported reduced quality and production of blood and navel oranges, lemons, mandarins and clementines in southern Italy. Ohkubo (1980), cited by Campolo *et al.* (2013), reported that a springtime threshold of eight females per leaf could result in tree death within a year. Campolo *et al.* (2013) observed that from the end of July 2010 to the beginning of August 2011, the scale density on leaves exceeded 14.69 ± 1.74. Laboratory studies demonstrated that bergamot foliage and fruit supported development.

Chapter 6

Pathways

Natural Movement

Dispersal occurs through active locomotion (wandering) and wind transport of first instars or via passive transport of sessile fertilized females on transported plant material (Greathead, 1990).

Dispersal to new feeding sites is limited to the first instar prior to settling and feeding (Beardsley and Gonzalez, 1975). Temperature and light intensity influence the first instar emergence from beneath the maternal cover (Greathead, 1990). Distances traversed by first instars and the duration of wandering are largely determined by the character of the substrate surface—greater distances are traveled at higher speed over smooth surfaces (Beardsley and Gonzalez, 1975); conversely bare soil and sand limit the distance travelled (Beardsley and Gonzalez, 1975).

Most diaspidid first instars settle near the mother (Greathead, 1990). Maximum hypothetical distances for first instars of the polyphagous purple scale, *Lepidosaphes beckii* (Newman), and California red scale, *Aonidiella aurantii* (Maskell), were calculated at 444 feet assuming a constant speed of 23 mm per minute, an optimum temperature of 32.2 °C and a maximum active life of 4 days (Beardsley and Gonzalez, 1975). However, except when dispersed by wind, armored scales seldom travel this distance to a settling site (Greathead, 1990).

First instars rarely move beyond the natal host (Beardsley and Gonzalez, 1975). Tree-to-tree movement of first instars is rare unless the trees are in contact. Short-distance dispersal within orchards on infested plant material has occurred via wind-blown infested leaves. Long-distance dispersal of first instars has occurred via wind (Beardsley and Gonzalez, 1975; Greathead, 1990), but no published reports describe wind dispersal of *U. yanonensis*.

Human-Assisted Spread

The likelihood of passive dispersal of post-crawler stages via infested plant material is increased because the insects are small and often attached to host material in hard-to-see locations (Beardsley and Gonzalez, 1975). Both short- and long-range dispersal occur via transported propagative plant material (nursery stock, seedlings) and non-propagative plant material, such as cut flowers, edible tubers and fruit. Other dispersal mechanisms include phoresy on insects, birds and humans (Beardsley and Gonzalez, 1975).

The U.S. *U. yanonensis* interceptions between 2 January 1984 and 15 October 2014 (Port Interception Network (PIN) 309 accessed 3 Dec. 2014 by Gary L. Cave) are summarized in Tables 6-1 to 6-4. This period saw 6,599 interceptions (Table 6-1) as delimited by the point-of-entry and report date. These interceptions included 6,672 *U. yanonensis* developmental life stages (Table 6-2), with live adults constituting 95.7%. Citrus species made up 99.64% of the host plants associated with the interceptions (Table 6-3), 89% of which were associated with fruit. Interceptions involving baggage accounted for 90.01%. Interceptions on baggage originating in countries in which the pest is neither native nor known to be introduced may signal a need for confirmation of *U. yanonensis* establishment (Evans and Dooley, 2013). Most interceptions originated in East Asian countries (Table 6-4), with Japan and China accounting for 77.39% and 7.73%, respectively. More than 95% of the interceptions occurred at points-of-entry in Hawaii (70.37%), Washington (15.67%), California (6.36%), Oregon (1.67%) and Alaska (1.53%).

Table 6-1 Summary of *U. yanonensis* interceptions by point-of-entry (PIN 309 data 2 Jan. 1984–15 Oct. 2014)

Point-of-entry	Number of interceptions
airport	5,528
land border	733
maritime	331
pre-departure	3
inspection station	2
foreign	1
mail	1
Total	**6,599**

Table 6-2 Summary of *U. yanonensis* interceptions by life stage (PIN 309 data 2 Jan. 1984–15 Oct. 2014)

Life stage	Number of interceptions
alive adult	6,388
alive immature	208
dead adult	37
alive pupa	29
dead immature	7
alive egg	3
Total	**6,672**

Table 6-3 Summary of *U. yanonensis* interceptions by host species (PIN 309 data 2 Jan. 1984–15 Oct. 2014)

Inspected hosts	Number of interceptions
Citrus spp.	3,897
Citrus reticulata	2,259
Citrus sinensis	315
Citrus maxima	26
Citrus aurantiifolia	25
Citrus limon	20
Citrus paradisi	12
Citrus nobilis	10
Citrullus spp.	5
Citrus unshiu	4
Fortunella sp.	4
Citrus madurensis	3
Cycadaceae	2
Fortunella japonica	2
Unknown Fruit	2
Alyxia sp.	1
Annona sp.	1
Araceae	1
Baggage	1
Citrus aurantium	1
Citrus hystrix	1
Citrus tangelo	1
Ficus sp.	1
Mangifera indica	1
Plant	1
Pouteria sp.	1
Stores	1
Total	**6,599**

Table 6-4 Summary of *U. yanonensis* interceptions by origin (PIN 309 data 2 Jan. 1984–15 Oct. 2014)

Origin	Number of interceptions
Japan	5,107
China	510
unknown	335
Asia (country unknown)	325
Taiwan	101
South Korea	62
Hong Kong	55
the Philippines	22
Thailand	14
Hawaii	10
Vietnam	10
Singapore	8
Indonesia	7
Australia	6
Canada	3
Panama	3
Congo	2
India	2
Cambodia	1
Cook Islands	1
Egypt	1
El Salvador	1
France	1
Greece	1
Iran	1
Italy	1
Lithuania	1
Malaysia	1
Mexico	1
Mongolia	1
Nicaragua	1
Nigeria	1
South America (country unknown)	1
Soviet Union	1
Spain	1
Total	**6,599**

Chapter 7

Survey

Surveys require visual inspection of asymptomatic and symptomatic citrus. Symptoms of infestation are discussed in *Impacts* on page 5-1.

Sticky traps have been used to measure the downwind displacement of *Aonidiella aurantii* crawlers (Greathead, 1990), but no reports of wind dispersal of *U. yanonensis* have been published.

Survey Types

Plant regulatory officials organize detection, delimiting and monitoring surveys for *U. yanonensis*. A *Detection Survey* is designed to determine whether a pest is present in an area in which it was not previously known. Subsequent to either a new detection, or confirmation of a new detection, a *Delimiting Survey* after Initial United States Detection will be conducted to determine the extent of the infestation. In addition, when a control procedure is applied, a *Monitoring Survey* is implemented to evaluate effectiveness.

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 7-2. 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* after Initial United States Detection as described on page 7-5. 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 7-9. 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. The geographic scope of a survey can vary from narrow to broad and address one or multiple target species. Although a detection survey may fail to confirm the presence of a pest, surveys nonetheless provide valuable date on pest occurrence.

Campolo *et al.* (2013) measured the regional distribution of *U. yanonensis* in citrus orchards (bergamot, sweet orange and clementine), in Calabria, Italy. Four branches per tree on 100–200 trees per location were inspected. The seasonal development and population structure on infested trees in each of the four cardinal directions (N, S, E, W) were also examined. Single 40-cm 1–2-year-old leaf-bearing twigs were collected and transferred into paper bags that were subsequently sealed in vinyl bags for storage for 24 hours at 4 °C. The abundance of instars was determined through examination under a stereo microscope the ventral surface of 10 randomly selected leaves per twig. The densities of the combined first instars, second instars, male pupae, pre-ovipositing females and ovipositing females ranged from 2.74 ± 0.19 to 7.24 ± 0.25 scales per cm^2 of leaf area. The density was highest on the north side of the trees, lowest on the south and west and intermediate on the east (Campolo *et al.*, 2013).

To study seasonal development and population fluctuation, Kim *et al.* (2007) sampled 15-year-old trees in unsprayed abandoned citrus orchards on Jeju Island, Korea by taking leaf samples weekly from 6 randomly selected trees per orchard. Each sample consisted of 5–10 leaves per tree that were stored at 4 °C, until examination. Counts of males per leaf were taken for first instars, second instars and the stages beyond second instar. To quantify male density on the leaves, the authors used a scale from 0–7, with 1 equal to less than 10 males per leaf and 7 greater than 500 males per leaf. The females were counted as numbers of first instars, second instars or mature adults per leaf. The first generation, or progeny from overwintered females, was counted on overwintered leaves collected from April–July. The second generation was counted on “spring-emerged new leaves” bearing first-generation females. The seasonal occurrence of females and first instars is presented in Table 4-1 on page 4-3.

Murakami (1970) reported large variances in both the inter-orchard and inter-tree distribution of *U. yanonensis.* In an orchard, density was concentrated on the “relatively sunny side,” although the insects favored dark, warm locations. A higher population density was found in the upper region, versus the lower and inner portions of the tree.

Emergence and dispersal of first instars can be detected by wrapping two-sided sticky tape around twigs and branches near sessile females. Sticky card traps placed in the tree canopy can be monitored for wind-blown crawlers (Miller and Davidson, 2005).

Procedure

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

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

1. Determine the potential survey sites: Focus the survey in locations where *U. yanonensis* is more likely to occur.

- **A.** Based on the reported distribution, Davis *et al.* (2005) identified temperate broadleaf and mixed forests, Mediterranean scrub and tropical and subtropical broadleaf forests as biomes suitable for *U. yanonensis*
- **B.** *Potential Distribution* on page 4-10 provides broad information on the geographical areas suitable for pest occurrence and is typically based on favorable environmental conditions and the presence of specific plant hosts as reported in states/counties.
- **C.** Within the potential distribution area, survey specific locations that have *Hosts* suitable for the pest species.
- **D.** Prior to surveying, consider the pest phenology, as presented in *Biology*, to determine the time of survey.
- **E.** Survey locations of previous detection, as presented in *Pathways*.

2. Sentinel sites/targeted surveys: The aforementioned information may be used to establish sentinel sites or targeted surveys for *U. yanonensis*. Sentinel sites are locations regularly inspected along a surveyor's normal route. If sentinel sites are established for the pest species, use GPS to record the host plant locations and draw a map of the immediate area that includes reference points to aid others in finding the area if necessary. 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. GIS can be used to map the sentinel site locations to promote even coverage, particularly in high-risk areas. Targeted surveys can be regularly conducted at nurseries and in areas of regular traffic from countries with known infestations.

3. Feasibility and cost effectiveness: both may be enhanced if *U. yanonensis* can be included in ongoing surveys for other pest insects.

4. 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 *U. yanonensis*. Refer to the CAPS-Approved Survey Methodology for Negative Data Appendix M-1 for additional information. However, **if no approved survey methods are available for *U. yanonensis*, use the techniques described in *Literature-Based Survey Techniques* on page 7-9**; this section may be used to develop the approved and standardized methods.
5. Procure survey supplies using the IPHIS Survey Supply Ordering System.
6. Safety, sanitization and compliance during a survey: Prior to beginning a survey, determine whether any pesticides have been recently applied rendering 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, pest inspection should occur 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 clothing and footwear are free of pests, soil and litter to avoid moving soil-borne pests and arthropods from one property to another and that survey tools are clean. Determine and comply with all quarantine requirements that may be effective in the survey area.
7. Data collection during the survey: Data entry forms are available from the CAPS Website for specific pests. If no information on *U. yanonensis* is available, use information from congeneric species or refer to *Data Collection* on page 7-7.
8. Preliminary identification of the survey samples: Morphological characteristics that may aid in preliminary identification of *U. yanonensis* are described in *Identification* on page 3-1.
9. 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 and available *Taxonomic Support for Surveys* for further information.
10. 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. Surveyors should be instructed in the technology prior to initiating the survey, including how to properly complete the appropriate survey forms. 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. For example, the detection data may be entered in the National Agricultural Pest Information System (NAPIS) and publicly viewable from the Pest Tracker interface.

For additional information, refer to the CAPS survey guidelines (CAPS, 2014). For information regarding surveys based upon scientific literature, refer to *Literature-Based Survey Techniques*.

Delimiting Survey after Initial United States Detection

Following a *U. yanonensis* detection, a Technical Working Group (TWG) prepares a delimiting survey to determine the spatial distribution of the infestation. The TWG may consider the following information in devising a delimitation survey plan.

Prior to Delimitation

If the sampling protocol used in the initial *U. yanonensis* detection was non-intensive, a high-intensity broad detection survey should be conducted prior to establishing a more focused delimitation survey. A broad and intensive detection survey aids in establishing that a target species is absent outside the potential area of delimitation and allows for more efficient use of survey resources. However, if a broad detection survey confirms the occurrence in the general area of the first detection, the TWG should develop a delimitation survey plan.

The number of traps deployed in an area 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 visits to the traps for sample recovery and servicing, sample processing and recording and analysis of trap data.

Delimitation Area

The total delimitation area may depend on information from the *Trace-Back and Trace-Forward Investigations*; distribution of host in the nearby area; *Pathways*, including the extent of natural and artificial dispersal; and agency resources and logistics.

All specimens and species of *Citrus, Fortunella, Poncirus and Damnacanthus*

within a circle of radius 1,025 feet (312 m) of the detection site should be examined. Stems, foliage and fruit should be visually inspected for all life stages and locality data of the specimens recorded. If *U. yanonensis* is detected at a second site within the initial delimitation area, that site becomes the center of a new survey area, and all hosts examined previously described. A delimitation survey for that area ends when no additional *U. yanonensis* are found within 1,025 feet of a prior detection.

Survey Techniques for Delimitation

Visual inspection of host plants is the appropriate survey technique for insects that do not disperse widely or are sessile.

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:

- Favorable microhabitats based on pest phenology, environmental conditions and topography (see *Detection Survey* on page 7-2).
- If *U. yanonensis* is detected in the U.S., the technical working group (TWG) should consider the preferred pest hosts near the detected area, the spatiotemporal distribution of these hosts and the host phenology suitable to the pest. This information for *U. yanonensis* has been presented in *Biology* on page 4-1.
- Information on the natural and human-assisted dispersal of *U. yanonensis* is presented in *Pathways* on page 6-1.
- The logistics and available resources can vary based on the time and location of detection and the pest species.

Previous detections of *U. yanonensis* are presented in *Pathways* on page 6-1.

Trap Deployment Plan

Survey and monitoring of *U. yanonensis* is currently performed by visual inspection of host plants. First instar emergence is monitored by wrapping two-sided sticky tape around stems and branches of the host tree and near sessile females.

Safety, Sanitization and Compliance

Prior to beginning a survey, determine whether recent pesticide applications make it unsafe to inspect 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 clothing and footwear are free of pests, soil and litter to avoid moving soil-borne pests and arthropods from one property to another and that 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 relocated. **Do not** rely solely on the flagging or other markers to re-locate a site. 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 *U. yanonensis* and the symptoms of its damage.

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

- Date of collection and observations
- Collector's name
- Grower's field identification numbers and physical address of survey location
- Full name of owner business, institution, or agency
- Full mailing address of owner business, institution, or agency, 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 collection site
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 *U. yanonensis* are described in *Identification* on page 3-1. See *Appendix D* for taxonomic support information for the surveys.

If it is suspected that the target pest is in a sample, submit the pest specimen(s) to the proper authority for confirmation; see *Sample Submission* on page E-1.

Survey Records

Record the above data for each survey site. Survey records and data recording formats should be standardized and consistent. If automated field collection services, such as the Integrated Plant Health Information System (IPHIS) are used, ensure that all surveyors are properly trained and the appropriate IPHIS template chosen. 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 complete, all data should be entered into the designated state or national pest database.

Literature-Based Survey Techniques

Visual survey of Host Damage

For characteristic damage caused by *U. yanonensis*, refer to *Signs and Symptoms* on page 5-1.

Visual survey for pest stages

Information relevant to a visual survey for *U. yanonensis* life stages is presented in *Biology* on page 4-1 and *Detection Survey* on page 7-2.

Trapping

Pheromone Traps: Pheromone traps have not been used for *U. yanonensis*.

Other Trapping Techniques: Survey and monitoring for *U. yanonensis* occurs through visual inspection of host plants as previously described. Two-sided sticky tape wrapped around stems and branches of the host tree and nearby sessile females will trap mobile first instars. Long-distance dispersal of diaspidid first instars by wind can also be monitored with sticky traps (Beardsley and Gonzalez, 1975; Greathead, 1990), but there is no report in the literature of *U. yanonensis* dispersal via wind.

Other Sampling Techniques

No additional sampling techniques for *U. yanonensis*, have been described in the literature.

Duration of Delimitation Survey

Typically, a delimitation survey is concluded when time for three generations of the pest has passed with no detections *Unaspis yanonensis* phenology is described in *Biology* on page 4-1.

Monitoring Survey

Conduct a monitoring survey after control procedures are initiated to measure their effectiveness. If *U. yanonensis* is detected in the United States, a TWG will be assembled to provide guidance on monitoring surveys to measure the effectiveness of applied treatments. Refer to *Control Procedures* on page 8-1 for information on control options.

Prior to a Monitoring Survey

Prior to deploying pest eradication techniques, the TWG will consult with economists to develop an impact assessment and determine whether eradication is necessary or if a no-action plan is appropriate. Refer to *Damage* on page 5-1 for information on evaluating the potential for damage by *U. yanonensis* if introduced into the U.S.

Procedure

Monitoring procedures were described in *Detection Survey* on page 7-2. Assessing the efficacy of control measures by evaluating color and degree of desiccation beneath the scale cover can take 2–6 weeks (Ishaaya and Swirski, 1990). Ishaaya and Swirski (1990) described an iodine test to speed this assessment, but it may yield false negatives (*i.e.*, dead scales identified as alive) due to the reaction of the iodine with live parasitoids inside armored scale cadavers.

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). If a detection is confirmed, the potential extent of the infestation should be re-evaluated and inform the choice of additional survey sites.

Homeowner Properties

When a detection occurs on homeowner property, ask the owner for point-of-origin information, (*e.g.*, nursery, neighbors) and if any parts from infested material have been moved elsewhere.

Nursery Properties

When an infested host is confirmed in a nursery, a list of facilities that may have received infested stock will be compiled. These lists will be distributed by the state to the field offices and cannot be shared with individuals outside the USDA–APHIS–PPQ regulatory cooperators. Grower names and field locations on these lists are strictly confidential, and distribution of the information beyond appropriate regulatory agency contacts is **prohibited**.

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

Identify yourself as a USDA or state regulatory official to the grower or facility manager prior to investigating a facility that may have received *U. yanonensis*-infested material, and obtain permission prior to entering private property.

Upon confirmation that a nursery host is infested with *U. yanonensis*, the following action are taken immediately:

- Check nursery records for names and addresses for all sales or distribution sites for the previous 6 months for potentially infested stock.
- Evaluate the severity of infestation and identify and document the location within the nursery of the infested plant.
- Check nursery records to identify potential sources of the infestation either from within the nursery or from outside sources.

Analyzing Information

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

Cooperation with Other Surveys

Other surveyors who are routinely in the field should be trained to recognize outbreaks of *U. yanonensis*.

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 certain treatments are not labeled for use against the organism or in a particular environment, PPQ's FIFRA (Federal Insecticide, Fungicide and Rodenticide Act) coordinator can petition for 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 can request that the EPA 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 further information.

Treatment Options

Diaspididae populations can be maintained below damaging levels by properly monitoring and regulating the interaction among insecticides, parasites, predators, plant genetics, plant defenses and growing conditions (Miller and Davidson, 2005). The following sections present insecticide options and the roles of natural enemies and host resistance.

Assessing the efficacy of control measures by evaluating the color and degree of desiccation beneath the scale cover can take 2–6 weeks (Ishaaya and Swirski, 1990). Ishaaya and Swirski (1990) described an iodine test to speed this assessment, but it may yield false negatives (*i.e.*, dead scales identified as alive) due to the reaction of the iodine with live parasitoids inside armored scale cadavers.

Treatments may include the following:

- *Cultural Control and Sanitary Measures* on page 8-2
- *Chemical Control* on page 8-2

- *Biological Control* on page 8-4
- *Host Resistance* on page 8-5
- *Integrated Pest Management* on page 8-5

Cultural Control and Sanitary Measures

No instances of cultural control specific to *U. yanonensis* have been reported in the literature. Cultural controls and sanitary measures for control of *U. citri* and other insect pests in Florida orange and grapefruit groves include the management of irrigation and fertilization to enhance host resistance; the removal of infested trees; maintaining buffers between infested and pest-free blocks; and planting resistant rootstocks and certified pest-free trees in pest-free sites (Mossler, 2011).

Chemical Control

The sprayable chemicals, oils, soap and lime sulfur insecticides listed for control of *Unaspis* species is presented in Table 8-1 on page 8-4. Organophosphates and carbamates are broad-spectrum insecticides that may negatively impact natural enemies. Benassy *et al.* (1976) reported that oil used against *U. yanonensis* on citrus in southern France provided inadequate control relative to methidathion. The neonicotinoids and juvenile hormone analog recommended by Frank (2009) for use against *U. euonymi* are compatible with natural enemies of that species.

The efficacy of insecticidal sprays decreases when applied to developmental stages protected by a scale cover (Kim *et al.*, 2010). In a laboratory study, Kim *et al.* (2010) applied several concentrations of commercially formulated petroleum oil and lime sulfur in distilled water to first instars, second instars and adult females. The second instars belonged to three categories based on integument condition: early soft thin integument; hardened integument; and apolytic integument separated from body immediately prior to molting. Two categories of females were treated, distinguished by the extent of scale-cover development: early in scale-cover development and middle—with a scale-cover approximately one-third full size.

The highest mortality rate (exceeding 94%) among first instars was observed 4 and 10 days after application of 1% petroleum oil spray and 1.25% lime sulfur spray. Second instar mortality in all three categories was 100% after treatment with 2% petroleum oil. The mortality of early second instars exceeded 90% when sprayed with 2% lime sulfur.

Mortality rates of both early and middle adult females treated with the highest concentrations of petroleum oil and lime sulfur were equal to or less than 22%, but the authors expected that morphological abnormalities in the scale cover developed after applications would reduce fitness of females by increasing vulnerability to predators and abiotic factors (Kim *et al.*, 2010).

The female scale cover protects females and conceals first instars from insecticidal sprays; thus, insecticide efficacy is stage-specific and maximized when application coincides with the emergence and wandering of first instars (Kim and Kim, 2013). Observations of blastoderm development and yolk formation can be used to predict first instar appearance (Beardsley and Gonzalez, 1975). Kuwana (1923b) reported that *U. yanonensis* eggs develop a reddish-brown spot visible through the egg shell near one end when close to hatching. Kim and Kim (2013) used degree-days to predict first instar emergence. Trees can be monitored for first instar emergence by wrapping two-sided sticky tape around twigs and branches near sessile females, and wind-blown first instars can be monitored via sticky card traps placed in tree canopies (Miller and Davidson, 2005).

In most cases, armored scales become pests when transported from indigenous habitats (*i.e.*, precinctive *sensu* Frank, 1995) to areas that typically lack the natural enemies with which they had co-evolved (Beardsley and Gonzalez, 1975). Sprays that target first instars should not be used in areas in which natural enemies may be effective in controlling armored scale population (Miller and Davidson, 2005).

Apart from their efficacy as non-residual contact insecticides, the advantages of horticultural oils over chemical insecticides with residual activity include the following: no resistance concerns; ease and safety of use, reduced cost and reduced impact on beneficial insects. Challenges to their use include correct timing as they must be applied when first instars are active; limited mode-of-action (suffocation while wet) ensuring thorough coverage of the target population; application only when suitable conditions are present and when the plant is not overly stressed due high pest load, heat or drought (Miller and Davidson, 2005).

Table 8-1 Spray-application insecticides active against *Unaspis* spp.

Targeted species	Insecticide	Chemical class	IRAC MOA[1]	Reference
U. yanonensis	petroleum oil 95%	oil	na	Kim et al. (2010)
	lime sulfur 22%	fungicide and fertilizer	na	
	methidathion	organophosphate	1B	Bénassy *et al.* (1976)
U. citri	chlorpyrifos 4 EC	organophosphate	1B	Stansly and Rogers (2013)
	chlorpyrifos 50 W	organophosphate	1B	
	carbaryl 80 S	Carbamate	1A	
	carbaryl 4 F	carbamate	1A	
	Sevin XLR	carbamate	1A	
	petroleum oil ≥ 97% (FC 435-66, FC 455-88, or 470 oil)	oil	na	
U. euonymi	acetamiprid	neonicotinoid	4A	Frank (2009)
	dinotefuran	neonicotinoid	4A	
	horticultural oil	horticultural oil	na	
	insecticidal soap	insecticidal soap	na	
	pyriproxyfen	juvenile hormone analog	7C	

[1] Insecticide Resistance Action Committee mode of action classification

[2] Emulsifiable concentrate

Labeling

Although a proposed formulation may be approved for an eradication or control program, it may not have been labeled for use at the time of detection. If a formulation is not labeled for use when needed, a federal crisis or quarantine exemption from the EPA can be granted 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—Natural Enemies

In most cases, armored scales become pests s when transported from indigenous habitats (i.e., precinctive *sensu* Frank, 1995) to areas that typically lack the natural enemies with which they had co-evolved (Beardsley and Gonzalez, 1975). Sprays that target first instars should not be used in areas in which natural enemies may be effective in controlling armored scale population (Miller and Davidson, 2005). Campolo *et al.* (2013) concluded that the high densities of *U. yanonensis* observed in southern Italy citrus orchards could be attributed to an absence of the

parasitoids that keep populations low in eastern Asia. Kim *et al.* (2007) described significant reductions in *U. yanonensis* populations in citrus on Jeju Island, Korea due to the ladybug, *Chilocorus kuwanae* Silvestri (Coleoptera: Coccinellidae). However, Campolo *et al.* (2013) reported that *C. kuwanae* and *Chilocorus bipustulatus* (L.) have no impact on *U. yanonensis* populations in southern Italy.

In an eight-year study in Japan, Itioka *et al.* (1997) confirmed previous results that stable biological control of *U. yanonensis* could be maintained by *Aphytis yanonensis* DeBach *et* Rosen and *Coccobius fulvus* (Compere *et* Annecke) (Hymenoptera: Aphelinidae) imported from China in 1980.

Host Resistance

Several species or varieties of citrus are either significantly or substantially resistant to *U. yanonensis* infestation. Kuwana (1923b) reported the following citrus varieties in Japan with minor infestations: *Citrus medica* var. *sarcodactylis*, *Citrus grandis*, *Fortunella japonica* and the Japanese citrus hybrid, natsudaidai. However, Murakami (1970) later reported higher densities on natsudaidai growing in three Japanese districts. In addition to natsudaidai, Murakami (1970) reviewed the work of others and reported that *Citrus junos* and *C. hanajuzu* were resistant to *U. yanonensis*.

Japanese studies indicated that high levels of coumarin derivatives and organic acid and lower levels of assimilable nitrogen compounds contributed to natsudaidai resistance to *U. yanonensis* (Murakami, 1970). High *U. yanonensis* densities on natsudaidai were associated with high foliar levels of nitrogen, phosphorus, calcium, magnesium and manganese; lower densities were associated with high foliar levels of potassium. A component of *C. junos* was reportedly lethal to first instars.

Integrated Pest Management (IPM)

There are no published economic threshold data for *U. yanonensis* in citrus. The roles of natural enemies, insecticide choice, timing of insecticide application and other elements of IPM programs for *U. yanonensis* are summarized in the preceding sections.

Chapter 9

Regulatory Procedures

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.

Treatments of infested host material include methyl bromide, malathion, and carbaryl applications (USDA–PPQ Treatment Manual, online at http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf, accessed 28 May 2015).

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 application methods and rates with 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.

Chapter

10

Research Needs

Morphology-based diagnostics are needed to enable surveyors to distinguish incursive *U. yanonensis* from native and established Diaspididae. Additionally, the prospect that *U. yanonensis* first instars may be wind dispersed has not been addressed; this information could aid in optimizing the economic and biological efficiency of delimitation survey design and implementation. Available published research does not include information essential to developing IPM programs for *U. yanonensis*.

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Appendix

A

How to Use the Guidelines

Use *New Pest Response Guidelines: Unaspis yanonensis (Hemiptera: Diaspididae), Arrowhead 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 *U. yanonensis* detection.

If *U. yanonensis* 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 *U. yanonensis*:

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

Contacts

When an emergency program for *U. yanonensis* 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
10. *Research Needs* on page 10-1

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. 2015. New Pest Response Guidelines: *Unaspis yanonensis* (Hemiptera: Diaspididae), Arrowhead 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	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) CONTINUE consecutive numbering for each subsequent collection 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 CAPS Website for some available screening aids.

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.

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 CAPS Website.

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.

Sticky Trap Samples

Due to their fragile appendages, scales on wings, *etc.*, adult Lepidoptera, require special handling and shipping techniques. Lepidoptera specimens in traps should not be manipulated or removed for preliminary screening unless expertise is available. Traps can be folded with Stickum™ glue on the inside without the sticky surfaces touching and secured loosely with a rubber band for shipping. Inserting a few Styrofoam peanuts on trap surfaces away from insects will cushion and prevent the sticky surfaces from adhering during shipment to taxonomists (see Figure E-1). **Do not** simply fold traps flat or cover traps with

transparent wrap (or other material) to avoid seriously damaging or pulling apart specimens rendering identification difficult or impossible.

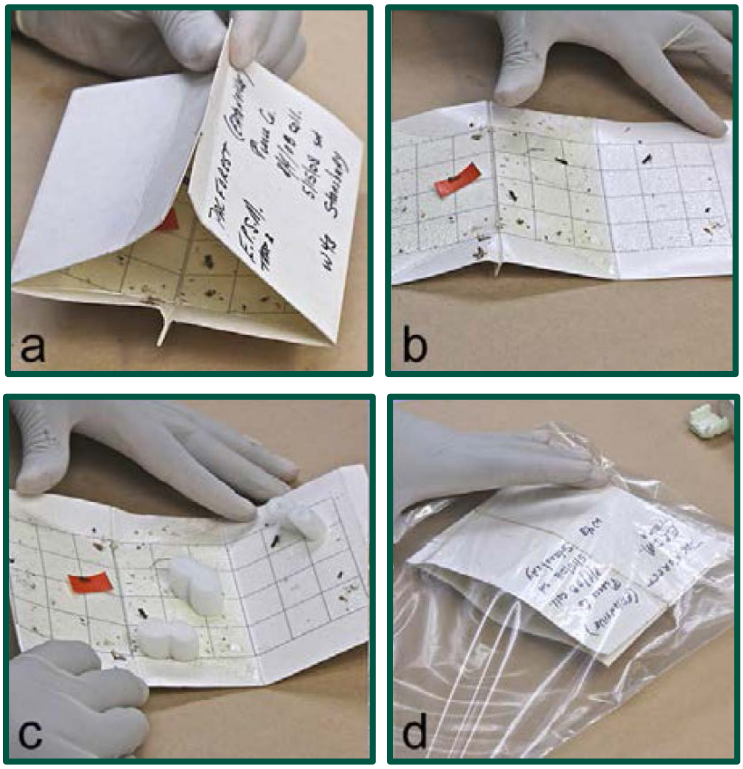

Figure E-1 Recommended method for packing sticky traps: (a) open and (b) unfold trap; (c) place 2–4 packing peanuts in areas of trap with no moths; (d) fold trap, secure with rubber band and place in a plastic bag

An alternative to this method is to cut out the area of the trap with the suspect pest and pin it securely to the foam bottom of a tray with a lid. Maintain space around the specimen for pinning and future manipulation. For multiple traps, place several foam peanuts between sticky surfaces (arranged around suspect specimens) to prevent surfaces from sticking to one another. **Do not** simply fold traps flat or cover traps with transparent wrap (or other material) as this will seriously damage or pull apart the specimens rendering identification difficult or impossible.

Dry Specimens

Some collection methods produce dry material that is **fragile** (**Note:** bark beetle/wood borer samples collected in Lindgren funnel traps should not be sent dry. Follow the guidelines listed in the specific protocol described in *Liquids*). Dry samples can be shipped in vials or glassine envelopes. As with the alcohol samples, make sure the collection label is associated with the sample at all times. This method is typically used for larger insects, but has a greater risk of breakage during shipping. Additionally, dry samples are often covered with debris and

sometimes difficult to identify.

Ensure that samples are adequately packed to ensure safe transit to the identifier. If a soft envelope is used, it should be wrapped in shipping bubble sheets; if a rigid cardboard box is used, samples should be packed so that movement within the container is restricted. Please include the accompanying documentation and notify the identifier prior to shipping. Remember to inform the identifier that samples are on the way, providing the approximate number and your contact information.

Samples for Genotype Analysis

When submitting insect samples for genotype analysis, include a copy of PPQ 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 trap 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

U. yanonensis

Definitions, Terms and Abbreviations

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

blacklight 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

virescence. 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