Haplaxius crudus

Scientific Name
Haplaxius crudus (Van Duzee, 1907)

Synonyms:
Haplaxius pallidus (Caldwell)
Myndus crudus Van Duzee
Paramyndus cocois (Fennah)

Common Name
American palm cixiid, pallid cane leafhopper

Type of Pest
Planthopper

Taxonomic Position
Class: Insecta, **Order:** Hemiptera, **Family:** Cixiidae

Reason for Inclusion in Manual
Field suggestion

Figure 1. *Haplaxius crudus* adult (J. D. de Filippis, University of Florida, Bugwood.org)

Pest Description
Eggs: Eggs are white and spindle-shaped (Howard and Wilson, 2001). They are "0.5–0.6 mm in length and 0.15–0.20 mm in width with one blunt end" (Tsai and Kirsch, 1978).

Nymphs: "Tan to grey in color with a reddish blush on the head; legs are reddish grading to bright red distally; covered with a thin waxy bloom; tibiae of the forelegs are flattened" (Redford et al., 2010). "The eyes are dark maroon and do not appear to change in response to light conditions, as is the case with the imagos. There is a faint red blush on the front of the head and rostrum and around the eyes…There are numerous pits on the head, notum and abdomen, and a thin wax bloom over all surfaces. The foretibia are flattened and slightly dilated, possibly a modification for digging or shaping soil…There is a toothlike projection ventrally on each femur (Wilson and Tsai, 1982), the function of which is unknown." The length ranges from 0.64 mm (1st instar) to 2.68 mm (5th instar) (<$^1/_{16}$ to approx. $^1/_8$ in) (Howard and Wilson, 2001).

A detailed description of the immature stage (including drawings) can be found in Wilson and Tsai (1982) found here: http://ag.udel.edu/delpha/4777.pdf.

Adults: "Length 4.2 to 5.1 mm [approx. $^3/_{16}$ in]; head and thorax are pale-brown (straw-colored), abdomen light green; forewings are hyaline with pale or light-brown veins, not reticulate, membranous throughout" (Redford et al., 2010). At rest, forewings are

approximate (C. Bartlett, personal communication). “Hindwings membranous and smaller than forewings; antennae consists of a barrel-like basal segment” (Redford et al., 2010). This is the second of two segments, the first being very short in *Haplaxius*. The second segment is evident (C. Bartlett, personal communication) and bears “a seta-like flagellum, arising on sides of head beneath eyes, separated from front of head by vertical carina; spines occur in clusters on the ends of the hind leg segments; three parallel ridges divide the prothorax longitudinally; depending on light conditions, eyes may be straw colored (light eyes) or a deep maroon color (dark eyes)” (Redford et al., 2010). Females are slightly longer than males (Howard, 1987).

Male genitalia: “Median lobe of pygofer in ventral view…ovally produced with base narrow, apices of styles rounded; genital capsule in lateral view…with lower half of hind margin of pygofer strongly excavated, style capitate, anal flap simple but with pair of subtriangular projections originating between ventral margins in basal half; aedeagus in left lateral view…with broad and distally serrate apical appendage concealing most of apical process, flagellum small, ventral margin of shaft variably convex; aedeagus in left lateral view…with long process originating in distal half and directed ventrocephalad” (Kramer, 1979).

Biology and Ecology

Haplaxius crudus reproduces continually throughout the year (EPPO, n.d.). They have been observed mating on palms, but it is unknown whether they also mate on grasses or elsewhere (Howard and Wilson, 2001).

Females can lay eggs (either singly or in rows of up to five eggs) on the aboveground portions of grasses, approximately 1 to 2 cm (approx. $^{3}/_{8}$ to $^{13}/_{16}$ in) from the root collar (Howard and Wilson, 2001) or on moist soil adjacent to roots or grass stolons (Reinert, 1977). Eggs are often laid beneath the lower leaf sheaths. These leaves are often desiccated and beginning to deteriorate (Howard and Wilson, 2001).

After hatching, nymphs immediately move down to the soil surface. Nymphs develop in the root zones of grass species. Height of preferred host grasses can influence the number of nymphs of *H. crudus* (reviewed in Howard and Wilson, 2001), with longer grasses supporting greater nymph numbers than frequently mowed grass (Howard, 2012). Organic mulching also encourages nymph development (Howard and Oropeza, 1998). During the day, nymphs can usually be found on the soil surface under detritus. They may also be found in the soil up to 3 cm (approx. 1 $^{3}/_{16}$ in) in depth, sometimes more. When disturbed, nymphs can jump about 5 to 10 cm (approx. 2 to 4 in) (reviewed in Howard and Wilson, 2001). Nymphs can often be found in cavities of about 1 cm (approx. $^{3}/_{8}$ in) in diameter (Howard, 1987). There can be 2 to 10 nymphs per cavity (Tsai and Kirsch, 1978). Cavities are lined with the waxy excretions of the nymphs (Howard, 1987). The excretions often completely cover the nymphs as well (Reinert, 1977). There are a total of five instars (Howard and Wilson, 2001). In Florida, it is common to find 20 nymphs/ft^2 on turf, and as many as 49 nymphs/ft^2 have been found (Tsai and Kirsch, 1978).

The average development period for the nymph stage is 80.8 days at 24°C (75.2°F) and 52.6 days at 30°C (86°F) (Tsai and Kirsch, 1978). Nymph development is more favorable in moist sites versus dryer sites (Howard, 2012).

Once mature, adults will remain at the bases of the nymph host grasses for a few hours and then fly to palm foliage where they will feed and mate (Howard, 1987; Howard, 2012). Adults feed through a proboscis, piercing the host plant and extracting the phloem (Gitau et al., 2009). They feed on the undersides of the leaves or in partly concealed portions of host plants aboveground (Kramer, 1979) and are usually found on the underside of palm fronds (Howard and Mead, 1980). Adults can live for about 50 days on palms (Tsai and Kirsch, 1978).

Damage

There is no notable damage caused by *H. crudus* itself in either the nymph or adult form. Damage to palms is caused by the Lethal Yellows (LY) pathogen that *H. crudus* vectors.

Developing inflorescences dry up when infected with LY. In *Cocos nucifera* (coconut), the spathes enclosing the flowers become discolored and the tips become blackened. The youngest leaves next to the buds develop water soaked streaks which spread until a terminal rot of the growing point develops. A progressive leaf discoloration from light yellow to orange-yellow occurs, spreading from the older to the younger leaves. Leaf discoloration coincides with the death of the root tip. Mortality in *Cocos nucifera* (coconut) and other palms can occur about four months after the initial symptoms occur (Meyerdirk and Hart, 1982; EPPO, n.d.).

Detailed descriptions of LY can be found in Broschat et al. (2010) found here: http://itp.lucidcentral.org/id/palms/symptoms/Lethal_Yellowing.htm.

A key to the symptoms of palm diseases and disorders can be found here: http://itp.lucidcentral.org/id/palms/symptoms/symptom_key.html.

Pest Importance

Haplaxius crudus is not known to be damaging by itself and is not considered a major pest of palms. However, it does vector lethal yellowing (LY) disease of palms, which can cause mortality of many different palm species. By 1979, 4 million (estimated) *Cocos nucifera* (coconut) had been killed by LY in Jamaica (EPPO, n.d.). In Florida, 300,000 *Cocos nucifera* (coconut) had been killed by 1983.

During the 1970's, an epidemic of LY occurred in palms in the urban areas along the southeastern coast of Florida, as well as on some of the Florida Key islands (Howard, 1987). LY was found in the Rio Grande Valley of Texas around 1980 causing mortality of *Phoenix canariensis* (Canary Island date palm) and *P. dactylifera* (date palm) (McCoy et al., 1980).

LY seems to spread faster in areas with intense horticultural maintenance as opposed to sandy beaches. This is most likely due to the lack of grass which serves as host material for the nymphs (Howard, 2012).

This disease could potentially threaten ornamental palms and commercial dates in areas of the United States where it is not yet found, for example Arizona and California.

Known Hosts

Adults and nymphs have different host plants (Howard, 1987).

Redford et al. (2010) state that this species has been reported on some arborescent monocots like *Pandanus utilis* (common screw-pine) (Howard, 2012). It has also been collected from almost all palm species in Florida that are susceptible to lethal yellowing (Howard, 2012; Redford et al., 2010). Howard (2006) states that there is no conclusive data on host preferences among the different palm species. Some species that are attractive to *H. crudus* are not susceptible to LY. On these species, it is not clear which of the following scenarios is occurring: the insect does not actually feed on the palm; it feeds on the palm but does not transmit the pathogen; or it transmits the pathogen but does not induce the disease (Howard, 2012). Hosts include but are not limited to:

Major hosts

Cocos nucifera (coconut) (Redford et al., 2010; EPPO, 2012).

Minor hosts

Adonidia merrillii (manila palm), Arecaceae, *Dypsis lutescens* (=*Chrysalidocarpus lutescens*) (yellow cane palm), *Eragrostis curvula* (weeping lovegrass), *Heliconia bihai* (macawflower), *Pandanus utilis* (common screw-pine), *Phoenix canariensis* (Canary Island date palm), *Phoenix dactylifera* (date palm), *Pritchardia* spp., *Pritchardia thurstonii* (Thurston palm), *Saccharum* spp. (sugarcane), *Washingtonia* spp., *Washingtonia robusta* (fan palm) (Meyerdirk and Hart, 1982; Howard, 1987; Howard and Wilson, 2001; Redford et al., 2010; Wilson and Wheeler, 2010; EPPO, 2012).

Nymphal hosts

The nymphs feed on the stem bases and roots of several species of grasses, sedges, and palms (Wilson and Tsai, 1982). Hosts include but are not limited to:

Andropogon bicornis (West Indian foxtail grass), *Andropogon virginicus* (broomsedge), *Chloris barbata* (=*C. inflata*) (swollen fingergrass), *Cocos nucifera* (coconut), *Cynodon dactylon* (Bermudagrass), *Cynodon nlemfuensis* (African Bermudagrass), *Cynodon nlemfluensis* cv. ‘Puerto Rico Star Grass’, *Cyperus* spp., *Cyperus esculentus* (yellow nutsedge), *Digitaria eriantha* (digitgrass), *Distichlis spicata* (salt grass), *Eremochloa ophiuroides* (centipedegrass), *Eustachys petraea* (=*Chloris petraea*) (pinewoods fingergrass), *Fimbristylis cymosa* (=*F. spathacea*) (hurricane grass), *Megathyrsus maximus* (=*Panicum maximum*) (Guinea grass), *Panicum bartowense* (fall panicgrass), *Paspalum notatum* (bahiagrass), *Pennisetum ciliare* (=*Cenchrus ciliaris*) (bufflegrass), Poaceae, *Setaria* spp., *Stenotaphrum secundatum* (St. Augustine grass), *Urochloa*

mutica (=*Panicum purpurascens*) (paragrass), *Verbena scabra* (sandpaper vervain), and *Zoisia* sp. (Tsai and Kirsch, 1978; Wilson and Tsai, 1982; reviewed in Howard and Wilson, 2001; EPPO, 2012; EPPO, n.d.).

Nymphs feed primarily on the roots of turf grasses that grow in the vicinity of palms (EPPO, n.d.).

Lethal yellowing (LY) hosts
Adonidia merrillii (manila palm)*, Aiphanes lindeniana, Allagoptera* spp., *Allagoptera arenaria, Arenga* spp., *Arenga engleri* (Formosan sugar palm)*, Arikuryroba* spp., *Borassus* spp., *Borassus flabellifer* (toddy palm)*, Caryota* spp., *Caryota mitis* (Burmese fishtail palm)*, Caryota rumphiana* (Albert palm)*, Chelyocarpus chuco* (round leaf palm), *Chrysalidocarpus* spp., *Cocos nucifera* (coconut)*, Corypha* spp., *Corypha utan* (buri palm), *Cryosophila warscewiczii* (root spine palm)*, Cyphophoenix nucele* (Lifou palm), *Dictyosperma* spp., *Dictyosperma album* (hurricane palm)*, Dypsis cabadae* (cabada palm), *Gaussia* spp., *Gaussia attenuata* (llume palm)*, Howea belmoreana* (Belmore palm)*, Howea forsteriana* (Forster sentry palm)*, Hyophorbe* spp., *Hyophorbe verschaffeltii* (spindle palm)*, Latania* spp., *Latania lontaroides* (red latan palm)*, Livistona* spp., *Livistona chinensis* (fountain palm), *Livistona rotundifolia* (round leaf fountain palm)*, Mascarena* spp., *Nannorrhops* spp., *Nannorrhops ritchiana* (mazari palm), *Phoenix* spp., *Phoenix canariensis* (Canary Island date palm), *Phoenix dactylifera* (date palm), *Phoenix reclinata* (Senegal date palm), *Phoenix rupicola* (cliff date), *Phoenix sylvestris* (date sugar palm)*, Pritchardia* spp., *Pritchardia affinis* (Kona palm), *Pritchardia pacifica* (Fiji fan palm), *Pritchardia remota* (loulu), *Pritchardia thurstonii* (lau fan palm), *Ravenea hildebrandtii* (dwarf majesty palm), *Syagrus schizophylla* (arikury palm), *Trachycarpus* spp., *Trachycarpus fortunei* (Chinese windmill palm), *Veitchia* spp., and *Veitchia arecina* (Montgomery palm) (reviewed in EPPO, n.d.; Broschat et al., 2010).

Pathogen or Associated Organisms Vectored

The adult of *H. crudus* is the only confirmed vector of lethal yellowing (LY). This disease is highly destructive to palm species in both Florida and the Caribbean Basin (Redford et al., 2010). Although *H. crudus* is considered an inefficient vector of LY, its abundance is sufficient to spread the disease at very low transmission rates (EPPO, n.d.).

It is interesting to note that this species has not been recorded in some areas where LY is known to occur (Bahamas, Dominican Republic, Haiti), suggesting that either the leafhopper is more widespread than reported or that another vector exists for the disease (EPPO, n.d.).

This species has also been reported to transmit a disease called marchitez sorpresiva (sudden wilt) to *Elaeis guineensis* (African oil palm) (which is not known to be susceptible to LY) in Colombia (Mena Tascón and Martínez López, 1977; reviewed in Howard, 1987). Early symptoms of this pathogen are loss of fruit luster followed by fruit

rotting and cessation of flowering. Foliage discoloration and desiccation beginning at the tips and progressing to lower leaf bases also occurs (Thomas et al., 1979).

Known Distribution

Howard (1986) states that *H. crudus* is found through Mexico and Central America as well as parts of the Caribbean and the Eastern United States (specifically southern Florida and Texas).

Caribbean: Cayman Islands, Cuba, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago; **Central America:** Belize and Honduras; **North America:** Mexico; **South America:** Columbia and Venezuela (reviewed in Howard and Wilson, 2001; Ferreira et al., 2010; Redford et al., 2010; reviewed in Bourgoin, 2012).

Pathway

This species has been intercepted at U.S. ports of entry 2 times, once as an immature (originating from Australia which is not known to have this pest) and once as an adult (originating from Costa Rica). Both interceptions occurred on cut flowers. This suggests that this species can move through international travel as a hitchhiker pest (AQAS, 2012; queried May 25, 2012).

Natural spread of the LY pathogen occurs through movement of the vector (EPPO, n.d.). Lethal yellowing can be spread through international trade by infected vegetative plant material, including ornamentals. It is less likely to be carried in host palms (EPPO, n.d.).

Potential Distribution within the United States

Palms for landscaping are grown in 23 different states (USDA-NASS, 2010), while grass hosts of nymphs are grown throughout much of the United States (USDA-NRCS, 2012). Although host material is grown in many areas in the United States, *H. crudus* is not likely to establish in cooler climates as nymphs do not develop properly at or below 15°C (59°F). This insect does not occur above 30° north latitude (Tsai and Kirsch, 1978). *Haplaxius crudus* is currently found in Florida and Texas (Redford et al., 2010; EPPO, 2012) as well as Puerto Rico (Franqui-Rivera, 2011). Howard and Wilson (2001) state that the sparse populations of the insect in southern Texas may be seasonal migrants from more southern locations.

This species may serve as a threat to states and territories of the United States below the 30th parallel north, including Hawaii (Howard and Wilson, 2001).

Survey

CAPS-Approved Method*:

There are three approved survey methods for *Haplaxius crudus*: 1) sticky card traps, 2) visual inspection, and 3) sweep-netting around host material.

Sticky Card Traps
Adults are normally found on the underside of palm fronds (Howard and Mead, 1980). To increase the chance of trapping adults, sticky traps should be hung by wire on the frond midrib near the base of the frond. Surveyors should ensure that the sticky trap is placed in such a way that it will not easily come in contact with plant parts.

IPHIS Survey Supply Ordering System Product Names:
Sticky Card, Blue

When removing suspect samples from sticky traps, follow the instructions found in Miller et al. (2003): http://caps.ceris.purdue.edu/webfm_send/727.

Visual survey
Adults move to palm foliage to feed and mate (Howard, 2012). Adults of *H. crudus* are usually found on the underside of palm fronds (Howard and Mead, 1980) and are active diurnally and nocturnally (Howard, 2012). Relatively high numbers of adults are consistently observed on certain palm species including coconut palm (*Cocos nucifera)*, Manila palm (*Andonidia merrillii*), and Mexican fan palm (*Washingtonia robusta*). Adults are rarely observed on certain other palm species, including Cuban royal palm (*Roystonea regia*) and yellow-cane palm (*Dypsis lutescens*) (Howard, 2012). Although this species does not cause notable damage, it does vector the Lethal Yellows (LY) pathogen. Adults may be found on host plants exhibiting symptoms of LY.

Sweep netting
1.1. Sampling
When sweeping for *Haplaxius crudus*, surveyors should focus on areas near palms with potential nymphal hosts, like grasses and sedges. Adults feed on palms but move to aboveground portions of grasses or on moist soil adjacent to roots or grass stolons for oviposition (Reinert, 1977). If adults are suspected in small palm trees, surveyors may place the sweep net underneath the suspect tree and tap the palm to dislodge and collect any suspect insects.

For general guidance on how to conduct sweep netting, consult the **Sweep Netting** section in the **Palm Commodity-based Survey Reference Introduction.**

Surveyors should complete twenty sweeps at each sampling site. All insects collected during a set of sweeps constitute one sample. Once 20 sweeps have been completed at the sampling site, the bag of the net should be flipped over or quickly closed. The net bag should be inverted into a gallon-sized re-sealable bag or other container for transportation back to the lab. All arthropods in the net should be emptied into the plastic bag or other container. The bag/container should be placed in a cooler for transportation.

1.2 Sample Processing, Sorting, and Screening

At the lab, the entire re-sealable bag or container should be placed in the freezer for a minimum of 24 hours. After this time, the bag contents should be dumped into a sorting pan.

Sort the samples: remove debris and non-target species. The taxonomic level of sorting will depend on the expertise available on hand and can be confirmed with the identifier. Some states may have taxonomic support, access to local training aids, or identification guides.

If possible, screen for the target pest. Screening is a process of eliminating non-target families, genera, or "look-a-like" species in the sample. When in doubt, forward the specimens to the identifier.

1.3 Submitting the Sample

Once sorting and screening (if possible) have been completed, place specimens into vials of 75-90% ethanol and submit for identification. Follow the instructions in **Procedures for Submitting Survey Samples to Domestic and Other Identifiers** for additional guidance on sample submission.

Survey Site Selection:

Adults can be surveyed for in areas where host plants are present. This can include nurseries with ornamental palms as well as areas where palms are used in landscaping, including golf courses and public areas.

Time of year to survey:

This species is found throughout the year in Florida. According to Woodiel and Tsai (1978), flight activity for this species was highest in March, May, September, and November when surveying in *Cocos nucifera* (coconut) groves.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Literature-Based Methods:

Trapping:

No pheromones have been discovered for this species. Work by Cherry and Howard (1984) found that blue sticky traps caught more *H. crudus* adults than any other color traps, catching both sexes during both day and night. Blue traps caught significantly more adults during the day (Cherry and Howard, 1984). Later it was found that the more attractive colors (blue and white) had higher concentrations of titanium dioxide than the other paints tested; which made them more reflective of ultraviolet light. Therefore, the concentration of titanium dioxide, rather than the actual color, may be the more important factor in attracting the insect (Howard and Wilson, 2001).

Traps consisted of 15.7 cm (approx. 6 $^{3}/_{16}$ in) diameter plastic discs covered in tree tanglefoot® hung by wires under the fronds of *Cocos nucifera* (coconut). Traps were replaced every two weeks (Cherry and Howard, 1984).

Previously, trapping of adults was achieved by applying tanglefoot® directly to the host plant (Howard and Hutchinson, 1977; Cherry and Howard, 1984). An electric run netting machine has also been used to survey for *H. crudus*. The machine consisted of a boom and net assembly powered by an electric motor and supported by a tripod (Woodiel and Tsai, 1978; Tsai and Mead, 1982) as well as sweep netting of nymphal host grasses (Howard, 1987).

Key Diagnostics/Identification

CAPS-Approved Method*:

Morphological. There are many described species of *Haplaxius* and Kramer (1979) himself suggested that there are probably a great number of undescribed species as well. For this reason, at least a simple dissection of the male is needed, focusing on the anal flap of the first, long anal segment, and the heavily sclerotized, digitate process on the aedeagus directed ventrocephalad (Redford et al., 2010). A screening aid to adult pests and diseases of cultivated palms (including *H. crudus*) can be found in Redford et al. (2010) found here: http://itp.lucidcentral.org/id/palms/sap/American_Palm_Cixiid.htm.

Male genitalia of *H. crudus* (Fig. 2, courtesy of S. McKamey, USDA-ARS Systematic Entomology Lab), showing digitate aedeagal process, partially hidden when viewed from the right but clearly visible when viewed from the left. On both images the anal flap, represented by a small triangle, is visible at the base of the first anal segment.

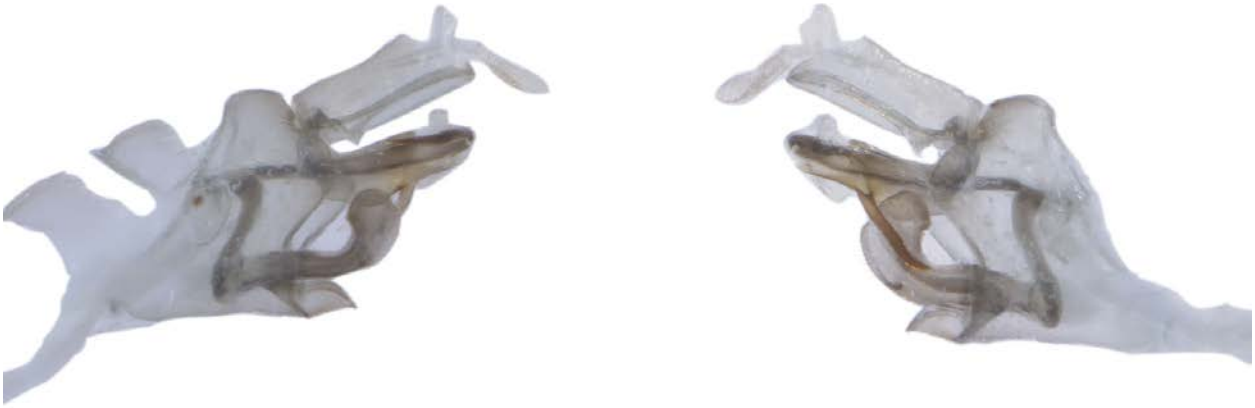

Figure 2. Male genitalia of *Haplaxius crudus* (S. McKamey, USDA-ARS Systematic Entomology Lab).

A key to male species of *Haplaxius* in the Western Hemisphere (including *H. crudus*) is found in Kramer (1979) found here: http://ag.udel.edu/delpha/2618.pdf.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Pests

A pictorial key to genera (including *Haplaxius*) of Cixiidae in Florida can be found in Mead (1979). *Haplaxius crudus* is the only species in the family Cixiidae found on palm foliage in both Florida and the Caribbean (Redford et al., 2010).

This species may be confused with *Cedusa inflata* or *Omolicna cubana* (Derbidae). Unlike *H. crudus*, these two species have a short apical segment (only as long as wide, rather than longer than wide) present on the rostrum (Redford et al., 2010). *Haplaxius crudus* may easily be confused with other species in the genus (e.g., *H. fulvus*, *H. ovatus*, and *H. pusillus*) from which it is best separated based on male genitalia.

Information and images of similar species can be found in Bartlett (2012) found here: http://ag.udel.edu/enwc/research/planthoppers/families/species/Haplaxius.htm. Bartlett (2011) provides a key to the Cixiidae genera found in Delaware, including *Haplaxius*.

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