GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: ***Harmonia axyridis***

Harmonia axyridis **System:** Terrestrial

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Insecta	Coleoptera	Coccinellidae

Common name Harlequin ladybird (English), Japanese lady beetle (English), multivariate lady beetle (English), Harlequin lady beetle (English), multicolored Asian lady beetle (English), southern lady beetle (English), Asian lady beetle (English), Halloween lady beetle (English), Asiatischer Marienkafer (English), pumpkin lady beetle (English), veelkeurig aziatisch lieveheersbeestje (English), la coccinelle asiatique (English)

Synonym

Similar species *Hippodamia convergens*

Summary Harmonia axyridis (lady beetle) is native to Asia and has been used extensively around the world for biological control of various aphid species. While it is a popular control agent, it has also brought with it several negative effects. Its establishment appears to decrease the diversity of native Coccinellidae. Harmonia axyridis can also quickly become a human nuisance when it seeks shelter during the winter months and takes up residency in the walls and insulation of houses and other structures. Surprisingly, Harmonia axyridis has also attained status as a pest of fruit production; particularly in the vineyards of the Midwestern USA.

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Species Description
Harmonia axyridis adults are larger than most of other ladybird species and measure 5-8mm in length and 4-7 mm in width. They are oval in shape and convex. The elytron usually displays a wide transverse \"keel\" at the apex. They are a highly polymorphic with elytra ranging from pale yellow-orange to black bearing 0-19 spots. The head, antennae, and mouthparts are generally straw-yellow and sometimes tinged with black. The pronotum is also straw yellow with markings being five black spots, lateral spots that generally join to form two curved lines, an M-shaped mark, or a solid trapezoid. Larvae have tubercles and spines which are elongate and somewhat flattened. Mature larvae are distinctive in their coloring which is black to dark bluish-gray, with a prominent bright yellow-orange patch extending over the dorso-lateral lobes of abdominal segments 1-5 on each side (Adriaens *et al*, 2003; Koch, 2003; Soares *et al*, 2008).

Notes
Harmonia axyridis is believed to be an effective colonizer and strong competitor because it has a wide trophic niche, a high level of phenotypic plasticity for several of its life-history traits, is a voracious predator, and has strong dispersal capacities that allow it to undertake long range migrations to over-wintering sites (Adriaens *et al*, 2003).

Lifecycle Stages
Harmonia axyridis undergoes a holometabolous life cycle going through the egg, four larval instars, pupal, and adult stages. Studies show that temperature has an effect on the adult weight and the rate of development of the stages. The diet of the beetle is also known to have an effect on larval development (Koch, 2003). It has been demonstrated that at 26º C on a diet of the pea aphid *Acyrthosiphon pisum*, the mean duration of each stage of *H axyridis* is as follows: egg 2.8 days, first instar 2.5 days, second instar 1.5 days, third instar 1.8 days, fourth instar 4.4 days, pupa 4.5 days (LaMana and Miller, 1998). Adults typically live for one to three months, but may live up to three years (Koch, 2003).

Uses
Harmonia axyridis is widely used as a biocontrol agent for reducing pest aphid populations in greenhouses, orchards, and gardens in North America since 1916 and in Western Europe since 1982 (Adriaens *et al*, 2003; Brown *et al*, 2008a; Koch, 2003). In several cases, this coccinellid has proven to be an effective biocontrol agent, particularly in pecans groves in southern United States (Koch & Galvan, 2008).

Habitat Description
Harmonia axyridis is known to colonize a wide range of habitats. They are found in cropping areas, meadows, and semi-natural areas (Branquart, 2004). In North America they are found on a variety of nursery, ornamental, and field crops, including cotoneaster, rose, Christmas trees, apple, pecan, alfalfa, wheat, cotton, tobacco, and small grains (Cornell University, 2004). In Belgium *H. axyridis* was most commonly found on nettle (*Urtica dioica* L.) and deciduous such as maple (*Acer* sp.), willow (*Salix* sp.), lime (*Tilia* sp.), oak (*Quercus* sp.) and birch (*Betula* sp.) but the number of observations was also high on pine tree (*Pinus* sp.), hawthorn (*Crataegus* sp.), and on a number of herbs such as reed *Phragmites australis* (Adriaens *et al*, 2008). They tend to overwinter in buildings where they aggregate in secluded dark places (Branquart, 2004). Its lower limiting temperature has been found to be a round 10°C (Putsma *et al*, 2008).

Reproduction
Harmonia axyridis may produce up to 1,642 to 3,819 eggs per female over their entire life span, at a rate of about 25 eggs per day. Eggs are typically laid in clusters of 20 to 30 eggs (Koch, 2003; Roy & Roy, 2008).

Nutrition
Harmonia axyridis preys mostly on tree-dwelling hemipteran insects such as aphids, psyllids, and scale insects. It also feeds on immature stages of other Coleoptera and Lepidoptera and plant material such as pollen and injured fruits (Koch, 2003).

General Impacts

Harmonia axyridis preys on and displaces native coccinellids, is a pest to fruit production, and is a household nuisance capable of major infestations. It has strong dispersal capabilities that allow it to rapidly colonize new locations. Expansion rates have been estimated at around 50 to over 100 km/yr (Brown *et al*, 2008b; Van Lenteren *et al*, 2008). *H. axyridis* has become a problematic invasive in many parts of North America, South American, and Europe.

Intraguild predation by *H. axyridis*, as well as competition, dramatically reduce native coccinellid populations throughout its introduced range (Adriens *et al*, 2008; Alyokhin & Sewell, 2004; Foley *et al*, 2009; Hautier *et al*, 2008; Koch, 2003; Koch & Galvan, 2008; Noia *et al*, 2008; Ware & Majerus, 2008). The intensity of intraguild predation appears to be inversely related to aphid prey availability (Burgio *et al*, 2002). It has reduced native ladybird populations and become the dominant aphidophagus species in many parts of the United States, Canada, and Europe (Adriaens *et al*, 2008; Gardiner *et al*, 2009; Harmon *et al*, 2007; Kenis *et al*, 2008). Impacted species include *Adalia bipunctata*, *Adalia decempunctata*, *Coccinella transversoguttata*, *Hippodamia tredecimpunctata*, *Coccinella septempunctata*, and *Propylea quatordecimpunctata Aphis monardae*, *Monarda fistulosa*, *Aphis asclepiadis*, *Asclepias syriaca* (Adriaens *et al*, 2008; Alyokhin & Sewell, 2004; Koch & Galvan, 2008). It exhibits a high tolerance for the species-specific alkaloid defenses found in coccinellids and preys on native ladybird eggs and larvae while at the same time the defensive chemistry found in its eggs allows them to avoid intraguild predation (Sloggett & Davis, 2010; Pell *et al*, 2008). Similar alkenes to those that provide defense for its eggs are deposited within its larval tracks and act as oviposition deterring semiochemicals to other ladybirds (Pell *et al*, 2008). Additionally, it predates on and reduces aphid populations thereby directly competing with native aphidophagus species (Alyokhin & Sewell, 2004; Hautier *et al*, 2008; Kenis *et al*, 2008). *H. axyridis* may also impact and prey on other species such the monarch butterfly (*Danaus plexippus*) and chrysomelid *Galerucella calmariensis* (Koch *et al*, 2003; Sebolt & Landis, 2004 in Koch & Galvan, 2008).

H. axyridis is a significant pest to fruit production and processing. It is a contaminant and cause of damage to wine grapes. It inhabits wine grape orchards and damages and consumes the sugar rich grapes. *H. axyridis* is harvested along with the grapes and contaminates them by releasing hemolymph when disturbed or killed which causes an unpleasant odor and taste in the resultant wine (EPPO, 2009; Foley *et al*, 2009; Galvan *et al*, 2006; Roy & Roy, 2008). Economic consequences are included as a result of losses on the contaminated wine and/or additional costs of time and labor to control its populations (Galvan *et al*, 2006). Studies have found *H. axyridis* problematic to wineries in Switzerland and the Great Lakes and eastern regions of the United States (EPPO, 2009; Galvan *et al*, 2006). It establishment in other major winery regions in Western Europe, South Africa, and California pose a significant threat to the industry (Galvan *et al*, 2006). *H. axyridis* is also reported to be a pest to apple, pear, raspberry, citrus, and potato agriculture (EPPO, 2009; Koch & Galvan, 2008; Roy & Roy, 2008).

Finally, *H. axyridis* is a nuisance that infests homes and other buildings in large numbers searching for overwintering sites (EPPO, 2009; Foley *et al*, 2009; Koch & Galvan, 2008). High densities, as many as thousands in a single home, aggregate inside buildings and cause cosmetic damage, and sometimes bite or cause allergic reactions (Kenis *et al*, 2009; Koch & Galvan *et al*, 2008; Roy & Wajnberg, 2008). Their hemolymph has a foul odor and may stain or cause damage to carpets, curtains, furniture, and walls. They may also act as a contaminant pest to food service, industry, and research institutions (Koch & Galvan, 2008). Some studies state that it has become an important seasonal allergen in the United States indicating that it can cause symptoms including chronic cough, conjunctivitis, and even asthma (Foley *et al*, 2009; Koch & Galvan *et al*, 2008; Pervez & Omkar, 2006).

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Management Info
Physical: Household infestation by *Harmonia axyridis* may be prevented by sealing or screening entrance points such as window seams, weather stripping, cracks and small holes, exhaust vents, etc. The use of a broom or vacuum is recommended to remove large aggregations from homes. Various traps, including black light and other light traps specifically for capturing beetles are also available (Kenis *et al*, 2008; Koch & Hutchison, 2003a).
Chemical: Traps utilizing pheromone and semiochemical lures are being investigated (Kenis *et al*, 2008). Exterior application of insecticides focused around windows, doors, foundations, and eves may be prevent infestation by *H axyridis* (Koch, 2003; Koch & Hutchison, 2003b). Most insecticides commonly used in agricultural environments are toxic to *H. axyridis* (Kenis *et al*, 2008). DEET (N,N-diethyl-3-methylbenzamide) and repellents camphor and menthol have also been found to be effective (Koch & Galvan, 2008).
Insecticide treatment of *H. axyridis* in vineyards should not be done preventively but an integrated pest management program should be based on the timing of infestation, estimated levels of infestation and resulting taint, and control methods. *H. axyridis* adults begin to move to grape clusters between 2 and 3 weeks prior to harvest. Even though fluctuate during the growing season, grape growers should not act until 2 or 3 weeks before harvest when the proportion of injured berries increases, which then attracts and provides opportunity for *H. axyridis* to feed on the grapes. Grape growers can follow *H. axyridis* population fluctuation in vineyards using yellow sticky traps, which can be used as an early warning. Control measures to manage *H. axyridis* before it can become a wine contaminant are essential for reducing the economic impact of this pest on the wine industry. In field and laboratory studies, carbaryl, bifenthrin, zeta-cypermethrin, thiamethoxam, and imidacloprid showed either toxic and/or repellent effects. However, of these insecticides, only carbaryl, thiamethoxam and imidacloprid are currently labeled in the United States for use on wine grapes within 7 days of harvest, which is when *H. axyridis* typically reaches high densities (Koch & Galvan, 2008). Some discourage against the use of insecticides in vineyards and orchards because of their effect on native aphidophages and beneficial insects (Roy & Roy, 2008).
Biological control:Several parasitoids attack *H. attack* including phorids *Phalacrotophora philaxyridis* and other *Phalacrotophora* spp., tachinids *Degeria lutuosa* and *Stronygaster trianulifera*, and braconid *Dinocampus coccinellae* but have not been investigated as potential biological controls (Koch, 2003). The entomopathogenic fungus *Beauveria bassiana* infects *H. axyridis* and has been found to reduce egg production and cause winter mortality in studies and may hold potential as a biological control (Roy *et al*, 2008b; Steenberg & Harding, 2009).

Pathway
The argument has been made that the current populations of *H. axyridis* in North America may have stemmed from accidental sea-port introductions (Koch, 2003).

Principal source: Koch, Robert L.; Galvan, Tederson L., 2008. Bad side of a good beetle: the North American experience with *Harmonia axyridis* BioControl (Dordrecht). 53(1). FEB 2008. 23-35.
Adriaens, Tim; Gomez, Gilles San Martin y; Maes, Dirk, 2008. Invasion history, habitat preferences and phenology of the invasive ladybird *Harmonia axyridis* in Belgium. BioControl (Dordrecht). 53(1). FEB 2008. 69-88.
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