

Agrilus planipennis

System: Terrestrial

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Insecta	Coleoptera	Buprestidae

Common name emerald ash borer (English)

Synonym

Similar species *Agrilus anxius*, *Agrilus bilineatus*, *Agrilus subcinctus*

Summary *Agrilus planipennis*, commonly known as the emerald ash borer (EAB), is an insect from a family of beetles generally referred to as metallic wood-boring beetles. *A. planipennis* is native to Asia and eastern Russia, and is only a minor pest in its native range. The beetle was discovered in Michigan and Ontario, Canada in 2002. Despite quarantine regulations and eradication attempts including burning of large numbers of infested trees, *A. planipennis* continues to spread. It is now present in Illinois, Indiana, Maryland, Michigan, Missouri, Ohio, Pennsylvania, Virginia, Wisconsin, West Virginia and parts of Canada. It colonizes and kills ash trees in the genus *Fraxinus* killing healthy ash trees in urban and forested areas. It now threatens more than eight billion ash trees in the continental United States. This has had significant ecological and economic effects. Similar damage is now occurring in the region of Moscow, Russia which causes serious concern for Europe if it continues to spread.



[view this species on IUCN Red List](#)

Species Description

The adult *A. planipennis* is 8.5 - 14.0 mm long and 3.1 - 3.4 mm. wide. The body which is narrow, elongate and cuniform is a metallic blue-green colour. It is commonly called the emerald ash borer. Mature larvae are 26 - 32 mm long and creamy white in color. The head of the larva is flat and the vertex is shield-shaped. The compound eyes are kidney shaped and somewhat bronze coloured. The prothorax is transversely rectangular and it is slightly wider than the head, but is the same width as the anterior margin of the elytra. The anterior margin of the elytra is raised forming a transverse ridge, the surface of which is covered with punctures. The posterior margins of the elytra are round and obtuse with small tooth-like knobby projections on the edge. The eggs of the emerald ash borer which are light yellow in colour turn brownish yellow just before hatching. The eggs which have a slightly convex centre are oval and 1 x 0.6 mm in size. The head is small and brown and it is retracted into the prothorax, exposing only the mouthparts. The prothorax is enlarged, whereas the meso- and meta-thorax are slightly narrower; the mesothorax bears spiracles. The abdomen is 10-segmented; the 1st to 8th segments with one pair of spiracles each and the last segment bears one pair of brownish serrated styles. Pupae are 10 -14 mm long and they are creamy white in color. The antennae stretch back to the base of the elytra and the last few segments of the abdomen bend slightly ventral (Nomura, 2002).

Lifecycle Stages

Initial observations led researchers to believe that *A. planipennis* had a one year life cycle in North America and other introduced locations (e.g. Scarr *et al.* 2002). However further observations caused Cappaert *et al.* (2005) to reevaluate the voltinism of *A. planipennis* and suggest that it actually has a semivoltine (two year) life cycle in North America. "It is not yet clear why delayed larval development occurs or what proportion of *A. planipennis* larvae require 2 yr for development. Although delayed development appears to be more common in low-density *A. planipennis* populations, we also have found that 2-yr development occurs occasionally in moderately to heavily infested trees in the core area of the infestation. It is possible that a second year of development is required when oviposition occurs late in the summer and larvae do not reach the prepupal stage before winter. Alternatively, a chemical or mechanical defensive response by newly infested trees may slow larval development, but other factors, such as cold temperatures or low nutrient levels, may also be involved. Additional studies are planned to address this phenomenon because it has important implications for survey activities and dynamics of *A. planipennis* population" (Cappaert *et al.* 2005).

Adult: Adults emerge from mid May to early June, depending on local conditions. According to Cappaert *et al.* (2005) "Adults live for around 3 to 6 weeks, with peak activity from late June to early July in southeastern Michigan. Adults feed on ash foliage for 5 to 7 days before mating, and females feed for another 5 to 7 days before oviposition."

Egg: Eggs are laid in bark crevices or under bark flaps (Bauer *et al.* 2004a in Cappaert *et al.* 2005) and hatch in seven to nine days (Nomura 2002).

Larva: Studies in southeastern Michigan revealed that larvae hatch in late June or early August (Cappaert *et al.* 2005). According to Scarr *et al.* (2002) "After hatching, first-instar larvae initially bore through the bark to feed on the phloem and eventually feed on the outer surface of the sapwood as they grow. Growing larvae as they feed form tunnels that are flat and wide, and zig-zag (S-shaped) throughout the bast and outer sapwood. Tunnels may be as long as 9 to 16 cm and they are filled with brownish sawdust and frass. In Michigan, U.S.A. tunnels are reported to be between 20 and 30 cm long. Most of the tunnels tend to occur in the basal portion of the tree trunk up to a height of 1.8 m." Cappaert *et al.* (2005) report that "As larvae feed they excise serpentine galleries through phloem, until cessation of feeding in October or November. Larvae then excavate a ~1cm deep cell in the sapwood or outer bark where they overwinter as prepupal larvae. Larvae pass through four instars".

Pupa: Cappaert *et al.* (2005) report that "Pupation begins in mid-April and continues into May. Adults emerge approximately 3 weeks later." Pupal development is variable according to humidity and temperature. After pupae transform into adults in the spring, the beetle takes 1 to 2 weeks before it emerges through D-shaped exit holes 3-4 mm wide (APHIS-USDA 2008).

Reproduction

Adults emerge from exit holes in tree trunks from mid-May onwards. Mating occurs seven to ten days after emergence and multiple matings often occur (Bauer *et al.* 2004a; Lyons *et al.* 2004 in Cappaert *et al.* 2005). Oviposition occurs seven to nine days after mating (Nomura 2002). In captivity most females lay 60-90 eggs, although up to 258 eggs has been recorded over a 6 week span (Lyons *et al.* 2004 in Cappaert *et al.* 2005). Eggs are laid in bark crevices or under bark flaps. Eggs are cream colored, but turn reddish brown after a few days (Bauer *et al.* 2004a in Cappaert *et al.* 2005).

General Impacts

Nomura (2002) states that, "During the early stage of an infestation, when *A. planipennis* population is low, the initial damage is low. However, after 2 to 3 years of continuous infestation, the population builds up, and eventually the tree's nutrient and water transport system is disrupted, culminating in wilting and eventual tree mortality. *A. planipennis* will kill apparently healthy trees during high beetle population levels which are probably triggered by a few years of hot and dry climatic conditions. *A. planipennis* can cause severe damage to ash stands over 8 years of age that are not crown-closed, with good sun light penetration, and that are comprised of trees with bark fractures. After 1 to 2 years of infestation, the bark often falls off in pieces from damaged trees thereby exposing the tunnel-ridden sapwood."

Nomura (2002) reports that damage consists of, "D-shaped exit holes along the lower bole surface are clear signs of buprestid beetle activity, however, careful examination is required as these are very cryptic. Frass filled, zigzagging tunnels about 6mm wide at the sapwood/bast interface are signs of *A. planipennis* feeding. Callus tissue produced by the tree in response to larval feeding may cause vertical splits 5 -10cm in length to occur in the bark above a gallery." MDNR (2004) states that, "Infested trees exhibit top-down dieback, with 1/3 to 1/2 of branches dying the first year and the remaining canopy dying the following year. This is often followed by a large number of shoots arising below the dead portions of the trunk. Borers make a small (1/16 inch diameter) "D"-shaped hole when entering the tree and several distinct "S"-shaped tunnels may be present under the bark. Trees may also exhibit 5-10cm vertical splits in the bark in response to larval feeding.

A. planipennis attacks ash trees in the genus *Fraxinus*. All North American ash species that occur within the current EAB range have been killed by EAB, including white ash (*F. Americana*), green ash (*F. pennsylvanica*), black ash (*F. nigra*), blue ash (*F. quadrangulara*) and pumpkin ash (*F. profunda*) (Lindell et al. 2008). Attacks on non-ash species have not been observed in North America to date, but there is concern that other species could be vulnerable. If *A. planipennis* host range extends beyond *Fraxinus* spp., the impacts of this invasive pest in North American forests would increase dramatically. Anulewicz et al. (2008) assessed *A. planipennis* landing rates, oviposition and larval development in a number of North American tree species. They found that "although *A. planipennis* adults will occasionally land on and oviposit on logs and trees of non-ash species, *A. planipennis* larvae did not successfully develop on anything other than *Fraxinus* species" (Anulewicz et al. 2008).

The three main ash species in Europe are *F. excelsior*, the most widespread species, and *F. ornus* and *F. angustifolia*. Nothing is known of the susceptibility of these to *A. planipennis*, so evaluating the resistance of these European species should be a research priority. *F. excelsior* is a common forest and urban tree used for timber, flooring, tool making and for its medicinal properties (FRAXIGEN 2005 in Baranchikov et al. 2008). All three species are important components of forest ecosystems in Europe and "their disappearance would have serious consequences for native biodiversity and ecosystem services" (Baranchikov et al. 2008).

Pathway

Although *Agrilus planipennis* is a good flier, human activities are the primary cause of long distance spread. This includes moving infested trees, logs, and firewood (MDNR, 2004). Movement of infected nursery stock (Herms et al. 2003).

Principal source: [Smitley and McCullough, 2004](#) How Homeowners Can Protect Ash Trees From the Emerald Ash Borer in Southeastern Michigan.

Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Dr. Deborah G. McCullough Associate Professor Dept. of Entomology and Dept. of Forestry Michigan State University USA

Publication date: 2006-08-14

ALIEN RANGE

Global Invasive Species Database (GISD) 2025. Species profile *Agrilus planipennis*. Available from: <https://www.iucngisd.org/gisd/species.php?sc=722> [Accessed 12 July 2025]

[2] CANADA
[17] UNITED STATES

[2] RUSSIAN FEDERATION

BIBLIOGRAPHY

51 references found for *Agrilus planipennis*

Management information

[Animal and Plant Health Inspection Service \(APHIS\), 2006. The U. S. Department of Agriculture's News Release USDA Expands emerald ash borer Quarantine in Illinois, Indiana and Ohio.](#)

Summary: Quarantine regulation APHIS November 2006

Available from: http://www.aphis.usda.gov/newsroom/content/2006/11/eab_fed_order.shtml [Accessed 27 November 2006]

[APHIS, 2006. Questions and Answers: Emerald Ash Borer Quarantine](#) [Retrieved 2 February, 2009]

Summary: A factsheet produced by APHIS with common questions and answers about the emerald ash borer quarantine restrictions in the United States. Available from http://www.aphis.usda.gov/publications/plant_health/content/printable_version/emerald_ash_borer_faqs.pdf
Bauer, L.S., Liu, H. & Gould, J. 2007. Progress on biological control of emerald ash borer. *Emerald Ash Borer Research and Development Review Meeting* ♦ 2007: 56-58.

[Canadian Food Inspection Agency, 2004. Emerald Ash Borer.](#)

Summary: Available from: <http://www.inspection.gc.ca/english/plaveg/protect/pestrava/ashfre/agrplae.shtml> [Accessed 30 November 2004]

Chen, Z., White, M.S., Keena, M.A., Poland, T.M. & Clark, E.L. 2008. Evaluation of vacuum technology to kill larvae of the Asian longhorned beetle, *Anoplophora glabripennis* (Coleoptera: Cerambycidae), and the emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae), in wood. *Forest Products Journal* 58(11): 87-93.

Crook, D.J., Khimian, A., Francese, J.A., Fraser, I., Poland, T.M., Sawyer, A.J. & Mastro, V.C. 2008. Development of a host-based semiochemical lure for trapping emerald ash borer *Agrilus planipennis* (Coleoptera: Buprestidae). *Environmental Entomology* 37(2): 356-365.

de Groot, P., Grant, G.G., Poland, T.M., Scharbach, R., Buchan, L., Nott, R.W., Macdonald, L. & Pitt, D. 2008. Electrophysiological response and attraction of emerald ash borer to green leaf volatiles (GLVs) emitted by host foliage. *Journal of Chemical Ecology* 34: 1170-1179.

emeraldashborer.com

Summary: This Web site is part of a multinational effort in Michigan, Connecticut, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, Ontario and Quebec to bring you the latest information about emerald ash borer.

Available from: <http://www.emeraldashborer.info/index.cfm> [Accessed 21 November 2012]

[European and Mediterranean Plant Protection Organization \(EPPO\), 2005. Data Sheet on Agrilus planipennis \(Coleoptera: Buprestidae\) Emerald Ash Borer. OEPP/EPPO, Bulletin OEPP/EPPO Bulletin 35, 436-438](#)

Summary: Available from: http://www.eppo.org/QUARANTINE/insects/Agrilus_planipennis/DS_Agrilus_planipennis.pdf [Accessed 5 March 2008]

Francese, J.A., Oliver, J.B., Fraser, I., Lance, D.R., Youssef, N., Sawyer, A.J. & Mastro, V.C. 2008. Influence of trap placement and design on capture of emerald ash borer (Coleoptera: Buprestidae). *Journal of Economic Entomology* 101(6): 1831-1837.

[Haack, R. A., E. Jendek, H. Liu, K. R. Marchant, T. R. Petrice, T. M. Poland, and H. Ye. 2002. The Emerald Ash Borer: A New Exotic Pest in North America. Newsletter of the Michigan Entomological Society.](#)

Summary: Available from: <http://www.ncrs.fs.fed.us/4501/eab/downloads/MichEntSocEABarticle.pdf> [Accessed 30 November 2004]

[Hermes, A.A; Stone, A.K; and Chatfield, J.A., 2003. Emerald Ash Borer: the beginning of the end of ash in North America.](#)

Summary: Available from: <http://hancock.osu.edu/hort/mgpdf/hermsbeginofend.pdf> [Accessed 30 November 2004]

[Illinois Dept of Agriculture., June 13 2006. Emerald ash borer confirmed in Illinois.](#)

Summary: Available from: <http://www.agr.state.il.us/newsrels/r0613061.html> [Accessed July 2006]

[International Plant Protection Convention \(IPPC\), 2002. International Standards for Phytosanitary Measures \(ISPM\) No. 15 \(2002\) with modifications to Annex I \(2006\) Guidelines for regulating wood packaging material in international trade \(PUBLICATION \)](#)

Summary: Available from:

https://www.ippc.int/servlet/BinaryDownloaderServlet/133703_ISPM15_2002_with_Ann.pdf?filename=1152091663986_ISPM_15_2002_with_Annex1_2006_E.pdf&refID=133703 [Accessed November 20]

Keiran, Monique., 2004. Battling the beetle In Nature Canada.

Summary: Available from: <http://www.cnf.ca/naturecanada/summer04/battle.html> [Accessed 30 November 2004]

Lelito, J.P., Fraser, I., Mastro, V.C., Tumlinson, J.H. & Baker, T.C. 2008. Novel visual-cue-based sticky traps for monitoring of emerald ash borers, *Agrilus planipennis* (Col., Buprestidae). *Journal of Applied Entomology* 132: 668-674.

Lindell, C.A., McCullough, D.G., Cappaert, D., Apostolou, N.M., Roth, M.B. 2008. Factors influencing woodpecker predation on emerald ash borer. *The American Midland Naturalist* 159: 434-444.

Liu, H. & Bauer, L.S. 2008-a. Microbial control of emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae) with *Beauveria bassiana* strain GH4: field applications. *Biocontrol Science and Technology* 18(6): 557-571.

Liu, H. & Bauer, L.S. 2008-b. Microbial control of emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae) with *Beauveria bassiana* strain GH4: greenhouse and field trials. *Biological Control* 45: 124-132.

[McCullough, D.G., D.A. Cappaert, T.M. Poland, P. Lewis, and J. Molongoski. 2007. Evaluation of neo-nicotinoid insecticides applied as non-invasive trunk sprays. Pp. 52-54 in: V. Mastro, D. Lance, R. Reardon, and G. Parra \(compilers\), Proceedings of the Emerald Ash Borer Research and Technology Development Meeting, October 31-November 1, 2006. Cincinnati, Ohio. USDA Forest Service, FHTET Publ. 2007-04.](#)

McCullough, D.G & Roberts, D.L., 2003. Pest Alert. (Draft) Emerald Ash Borer

McCullough, D.G. & Siegert, N.W. 2007. Estimating potential emerald ash borer (Coleoptera: Buprestidae) populations using ash inventory data. *Journal of Economic Entomology* 100(5): 1577-1586.

[MDNR \(Michigan Department of Natural Resources\). 2004. Emerald Ash Borer \(*Agrilus planipennis*\). Wildlife Species & Habitat.](#)

Summary: Available from: http://www.michigan.gov/dnr/0,1607,7-153-10370_12145_12204-69875--,00.html [Accessed 30 November 2004]

[Michigan Department of Agriculture. 2003. Emerald Ash Borer Michigan Eradication Strategy.](#)

Summary: Available from: http://www.michigan.gov/documents/MDA_EAB_Strategy_86341_7.pdf [Accessed 30 November 2004]

[MNR. 2003. Ministry of Natural Resources. Ontario . Emerald Ash Borer \(*Agrilus planipennis*\) Forest Health Alert - 3](#)

Summary: Available from:

<http://ontariosforests.mnr.gov.on.ca/spectrasites/viewers/showArticle.cfm?objectId=8C3E31C3-EFA8-4C0E-990E546CBA97ED3B&method=DISPLAYFULLNOBARNOTITLEWITHRELATED&id=8C3E31C3-EFA8-4C0E-990E546CBA97ED3B&siteid=4955403F-D8E4-4346-8F11DB6760C4B847> [Accessed 30 November 2004]

[Nixon, P. 2008. Entomology Fact Sheet, NHE-16: Emerald ash borer insecticidal management. Department of Natural Resources and Environmental Sciences, University of Illinois.](#)

Nzokou, P., Petrice, T.R., Haack, R.A. & Kamdem, D.P. 2006. Borate and imidacloprid treatment of ash logs infested with the emerald ash borer. *Forest Products Journal* 56(5): 78-81.

Nzokou, P., Tourtellot, S. & Kamdem, D.P. 2008-A. Kiln and microwave heat treatment of logs infested by the emerald ash borer (*Agrilus planipennis* Fairmaire) (Coleoptera: Buprestidae). *Forest Products Journal* 58(7-8): 68-72.

Nzokou, P., Tourtellot, S. & Kamdem, D.P. 2008-B. Impact of pesticides borate and imidacloprid on insect emergence from logs infested by the emerald ash borer. *Arboriculture and Urban Forestry* 34(3): 173-178.

Nzokou, P., Tourtellot, S. & Kamdem, D.P. 2008-C. Sanitization of logs infested by exotic pests: case study of the emerald ash borer (*Agrilus planipennis* Fairmaire) treatments using conventional heat and microwave. USDA

Pontius, J., Martin, M., Plourde, L. & Hallett. 2007. Ash decline assessment in emerald ash borer-infested regions: A test of tree-level, hyperspectral technologies. *Remote Sensing of Environment* 112: 2665-2676.

[Purdue Entomology Extension, 2006. National Map. Emerald ash borer Information, Purdue University](#)

Summary: National map

Available from: <http://www.entm.purdue.edu/EAB/images/maps/fullSize/nationalMap.gif> [Accessed 27 November 2006]

[Smitley, D., and D. McCullough. 2004. How Homeowners Can Protect Ash Trees From the Emerald Ash Borer in Southeastern Michigan](#)

Summary: Available from: <http://www.emeraldashborer.info/files/Howtoprotectashtrees3-04.pdf> [Accessed 30 November 2004]

[United States Government Accountability Office \(GAO\) GAO-06-353 Report, April 21, 2006. Invasive Forest Pests: Lessons Learned from Three Recent Infestations May Aid in Managing Future Efforts.](#)

Summary: Invasive forest pests have seriously harmed our environment and imposed significant costs upon our economy. The U.S. Department of Agriculture (USDA) is the lead agency for responding to forest pests. This report evaluates the federal response to three invasive forest pests—the Asian longhorned beetle, the emerald ash borer, and the pathogen *Phytophthora ramorum* (P. ramorum). Specifically, GAO describes (1) the status of efforts to eradicate these species, (2) the factors affecting the success of those efforts, (3) overall forest health monitoring programs, (4) coordination and communication of the three pest response efforts, and (5) USDA's use of panels of scientific experts to aid in the response efforts.

Available from: <http://www.gao.gov/new.items/d06353.pdf> [Accessed 20 May 2006]

[USDA. 2009. Emerald ash borer. \[Retrieved 29 January, 2009\]](#)

Summary: An excellent website with detailed and up to date information about emerald ash borer distribution in the United States, ecology and management. Also has detailed information for public about identification, quarantine restriction information, FAQs and what to do if infestation suspected. Available from <http://www.emeraldashborer.info/>

[Walker, K. 2006. Emerald ash borer \(*Agrilus planipennis*\) Pest and Diseases Image Library. Updated on 24/09/2006 8:07:11 AM.](#)

Summary: PaDIL (Pests and Diseases Image Library) is a Commonwealth Government initiative, developed and built by Museum Victoria's Online Publishing Team, with support provided by DAFF (Department of Agriculture, Fisheries and Forestry) and PHA (Plant Health Australia), a non-profit public company. Project partners also include Museum Victoria, the Western Australian Department of Agriculture and the Queensland University of Technology. The aim of the project is: 1) Production of high quality images showing primarily exotic targeted organisms of plant health concern to Australia. 2) Assist with plant health diagnostics in all areas, from initial to high level. 3) Capacity building for diagnostics in plant health, including linkage developments between training and research organisations. 4) Create and use educational tools for training undergraduates/postgraduates. 5) Engender public awareness about plant health concerns in Australia. PaDIL is available from : <http://www.padil.gov.au/aboutOverview.aspx>, this page is available from:

<http://www.padil.gov.au/viewPestDiagnosticImages.aspx?id=307> [Accessed 6 October 2006]

[Zablotsny, J. E., Undated. USDA APHIS PPQ *Agrilus planipennis* Fairmaire Screening Aid](#)

Summary: Available from: <http://www.emeraldashborer.info/files/agriscrn.pdf> [Accessed 30 November 2004]

General information

Anulewicz, A.C., McCullough, D.G., Cappaert, D.L. & Poland, T.M. 2008. Host range of the emerald ash borer (*Agrilus planipennis* Fairmaire) (Coleoptera: Buprestidae) in North America: results of multiple-choice field experiments. *Environmental Entomology* 37(1): 230-241.

[APHIS-USDA. 2008. Emerald ash borer.](#)

Baranchikov, Y., Mozolevskaya, E., Yurchenko, G. & Kenis, M. 2008. Occurrence of the emerald ash borer, *Agrilus planipennis* in Russia and its potential impact on European forestry. *OEPP/EPPO Bulletin* 38: 233-238.

Cappaert, D., McCullough, D.G., Poland, T.M. & Siegert, N.W. 2005. Emerald ash borer in North America: a research and regulatory challenge. *American Entomologist* 51(3): 152-165.

[CONABIO. 2008. Sistema de información sobre especies invasoras en México. Especies invasoras - Insectos. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Fecha de acceso.](#)

Summary: English:

The species list sheet for the Mexican information system on invasive species currently provides information related to Scientific names, family, group and common names, as well as habitat, status of invasion in Mexico, pathways of introduction and links to other specialised websites. Some of the higher risk species already have a direct link to the alert page. It is important to notice that these lists are constantly being updated, please refer to the main page (<http://www.conabio.gob.mx/invasoras/index.php/Portada>), under the section Novedades for information on updates.

Invasive species - insects is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Insectos [Accessed 30 July 2008]

Spanish:

La lista de especies del Sistema de información sobre especies invasoras de México cuenta actualmente con información acerca de nombre científico, familia, grupo y nombre común, así como como hábitat, estado de la invasión en México, rutas de introducción y ligas a otros sitios especializados. Algunas de las especies de mayor riesgo ya tienen una liga directa a la página de alertas. Es importante resaltar que estas listas se encuentran en constante proceso de actualización, por favor consulte la portada (<http://www.conabio.gob.mx/invasoras/index.php/Portada>), en la sección novedades, para conocer los cambios.

Especies invasoras - Insectos is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Insectos [Accessed 30 July 2008]

Government Accountability Office (GAO). 2006. Invasive forest pests: lessons learned from three recent infestations may aid in managing future efforts (GAO-06-353). United States Government Accountability Office Washington, D.C. 20548.

Summary: Available from <http://www.gao.gov/new.items/d06353.pdf>

[ITIS \(Integrated Taxonomic Information System\). 2004. Online Database *Agrilus*](#)

Summary: An online database that provides taxonomic information, common names, synonyms and geographical jurisdiction of a species. In addition links are provided to retrieve biological records and collection information from the Global Biodiversity Information Facility (GBIF) Data Portal and bioscience articles from BioOne journals.

Available from: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=188437 [Accessed 30 November 2004]

[Maryland Department of Agriculture. 2009. Emerald Ash Borer in Maryland.](#) [Accessed 29 January, 2009]

Summary: Available from <http://www.mda.state.md.us/plants-pests/eab/>

[Massachusetts Introduced Pests Outreach Project. UNDATED. Emerald Ash Borer. Massachusetts Dept. of Agricultural Resources and the UMass Extension Agriculture and Landscape Program.](#)

Summary: Available from: <http://www.massnrc.org/pests/pestFAQsheets/emeraldashborer.html> [Accessed 30 November 2004]

[Nomura, S. 2002. *Agrilus planipennis*. Canadian Food Inspection Agency Science Branch.](#)

Summary: Available from: <http://www.inspection.gc.ca/english/sci/surv/data/agrplae.shtml> [Accessed 30 November 2004]

Rebek, E.J., Herms, D.A. & Smitley, D.R. 2008. Interspecific variation in resistance to emerald ash borer (Coleoptera: Buprestidae) among North American and Asian ash (*Fraxinus* spp.). *Environmental Entomology* 37(1): 242-246.

Syndor, T.D., Bumgardner, M. & Todd, A. 2007. The potential economic impacts of emerald ash borer (*Agrilus planipennis*) on Ohio, U.S., communities. *Arboriculture and Urban Forestry* 33(1): 48-54.

Wang, X.Y., Yang, Z.Q., Wu, H. & Gould, J.R. 2008. Effects of host size on the sex ration, clutch size and size of adult *Spathius agrili*, an ectoparasitoid of emerald ash borer. *Biological Control* 44: 7-12

Yang, Z.Q., Wang, X.Y., Gould, J.R. & Wu, H. 2008. Host specificity of *Spathius agrili* Yang (Hymenoptera: Braconidae), an important parasitoid of the emerald ash borer. *Biological Control* 47: 216-221.