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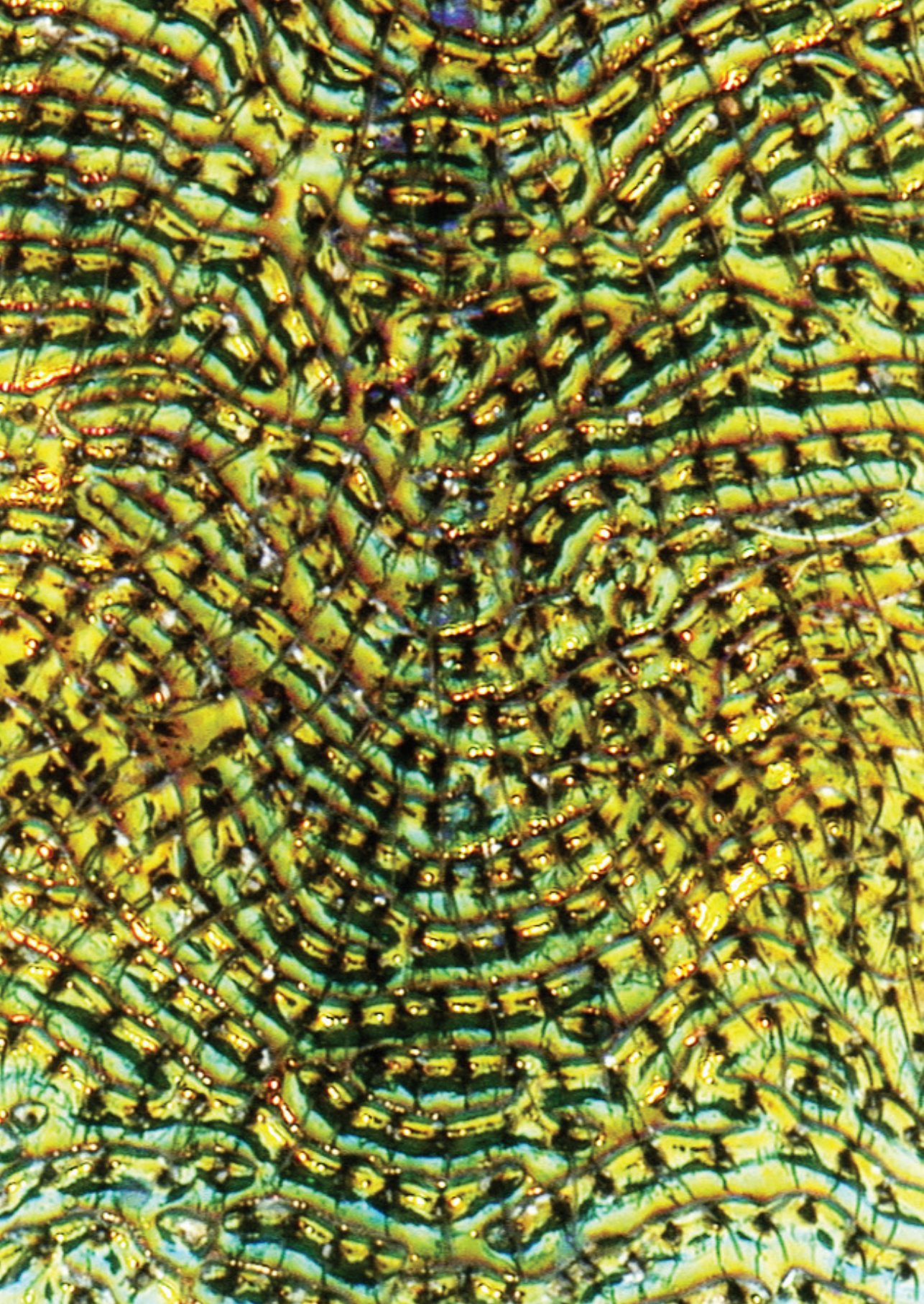

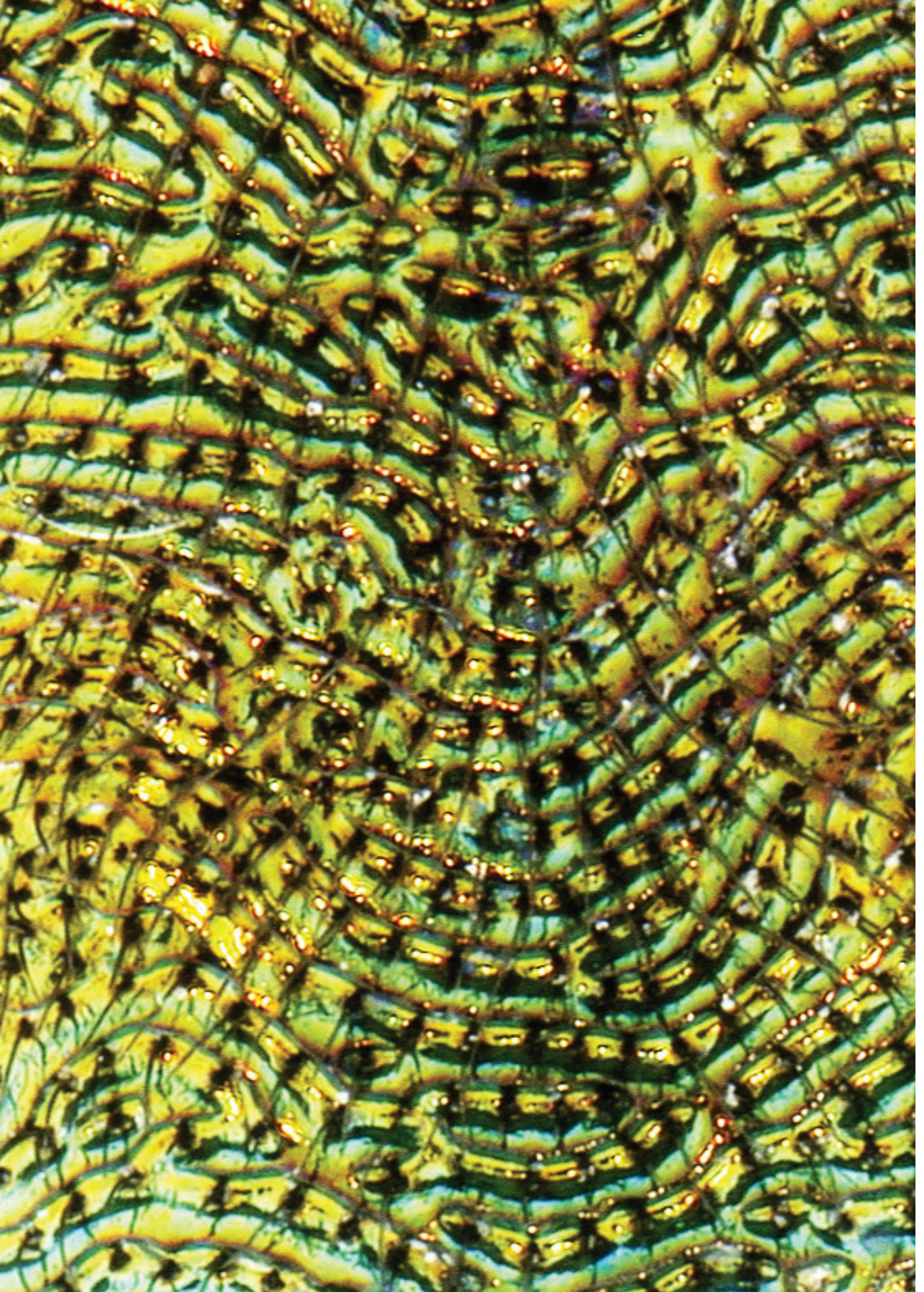

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Illustrated guide to the emerald ash borer *Agrilus planipennis* Fairmaire and related species (Coleoptera, Buprestidae)

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Contents

Introduction

The purpose of this guide is to aid in the identification of the invasive buprestid *Agrilus planipennis* Fairmaire, commonly known as the emerald ash borer (EAB), and related species to help mitigate future incursions of wood boring beetles into North America. EAB is one of the most destructive insect pest species in North America, killing an estimated tens of millions of healthy *Fraxinus* (ash) trees at a cost of billions of dollars since its unintentional introduction (Kovacs et al 2010). Since its discovery in 2002 in Michigan, USA and Ontario, Canada (Haack et al. 2002), EAB has spread to 23 US states and 2 Canadian provinces as of May 2014 (www.emeraldashborer.info).

EAB belongs to one of the largest genera in the animal Kingdom, *Agrilus* Curtis, including 3072 species (number from World *Agrilus* database maintained by E. Jendek as of May 2014). This guide focuses on EAB and 32 species we consider to be the most closely related or most similar to EAB. Species in groups 1–4 are hypothesized to be the most closely related to EAB. Some species included by Curletti (2001, 2003, 2006) in the subgenus *Pinagrilus* from the Australasian region may also be closely related to *A. planipennis*, as well as species in the *Agrilus purpurifrons*, *Agrilus cyanipennis*, *Agrilus ornatus*, *Agrilus acutus*, and *Agrilus quadripunctatus* species-groups. However, we chose to focus on a limited and manageable number of closely related species with one exception. Species in the *Agrilus sinensis* species-group (group 5) may or may not be closely related to EAB. One of the species in this group may be a root feeder, and the male genitalia of *A. sinensis* is considerably different from that of EAB and its relatives. Nevertheless, the *Agrilus sinensis* species-group is included in this guide for the following reasons: 1, phenotypic similarity with EAB, particularly in the shape of the pronotum, elytra, and head; 2, sympatry of *Agrilus sinensis* Thomson with EAB in its native range; 3, our preliminary phylogenetic study suggests *A. sinensis splendidicollis* shares a more recent common ancestor with EAB than with species of the *Agrilus hewitti* species-group; and 4, *A. sinensis* is relatively commonly collected and may be confused with EAB because of its superficial similarity. Furthermore, Jendek & Grebennikov (2011: 24) listed the *Agrilus sinensis* species-group as the relevant group for the *Agrilus cyaneoniger* species-group in their treatment of *Agrilus* of

East Asia. Many of the most recent and devastating invasive forest insect pests in North America have come from Asia, including EAB. In this guide we include not only a solid grouping of EAB's closest relatives, but provide the means to distinguish EAB from other potential invasive Asian *Agrilus* to quickly and accurately detect and identify potential threats to North American forest resources.

Acknowledgements

We thank the United States Forest Service International Programs and the Agricultural Research Service, without whose financial support this project would not have been possible. We are thankful to the curators and scientists who assisted us in our research, many of whom are listed in the materials and methods section, but also to Hans Mühle (Zoologische Staatssammlung München), Stephan Gottwald and Bernd Jaeger (Museum für Naturkunde, Berlin), Malcolm Kerley, Sharon Shute and Max Barclay (The Natural History Museum, London), James Hogan, Zoë Simmons and Darren Mann (Oxford University Museum of Natural History, Oxford), Vít Kubáň and Jiří Hájek (National Museum of Natural History, Prague); the late Charles Bellamy (California Department of Food and Agriculture); Satoshi Kamitani (Entomological Laboratory, Faculty of Agriculture, Kyushu University); Munetoshi Maruyama and fellow collectors from Oita Prefecture (Kyushu University Museum); Junsuke Yamasako (Ehime University); Nobuo Ohbayashi (Miura City, Japan); Hiraku Yoshitake, Yoshimatsu, N. Nakatani, Tanaka (National Institute for Agro-Environmental Sciences, Tsukuba, Japan); Shuhei Nomura (National Science Museum, Tsukuba, Japan); Hirokazu Fukutomi and colleagues (Ishikawa Insect Museum); Shigehiko Shiyake (Osaka Museum of Natural History); Si-Qin Ge, Hongxia Xu (Chinese Academy of Sciences, Beijing); Chen Hongyin, Wang Mengqing (Sino-American Biological Control Laboratory); Therese Poland (USDA Forest Service). We thank Kohichiroh Yasuda for permission to reproduce his images of *Agrilus cyaneoniger*, to Sarah King (http://www.sarahhhkay.com/) for designing the cover of this book, and K.V. Makarov (Moscow Pedagogical State University) for reproduction of his image of *Agrilus planipennis*. Finally, we thank Kevin Hackett (National Programs Staff, USDA ARS), Alma Solis (USDA ARS Systematic Entomology Laboratory), Dana Roth and Darcy Nelson (USDA Forest Service, International Programs) for their efforts to secure funding for this project. We thank the comments, suggestions and improvements provided by Aleš Smetana and Bruce Gill (CFIA-Canada) and 2 annonymous reviewers. USDA is an equal opportunity employer.

Material and methods

Terminology for male genitalia follows Jendek and Grebennikov (2011) and Kubáň et al. (2001). Paired structures are cited in the plural form. Square brackets "[ ]" are used for remarks and addenda. Distribution maps were created using Ortelius (Mapdiva). Shading in red indicates presence of that species in that area. Measurements for *Agrilus cuprifrons* and *A. maculiventris* were taken from the original description by Deyrolle (1864). Imaging: The following equipment was used for specimen observation and imaging: Leica (Wetzlar, Germany) MZ Apo stereomicroscope and Zeiss (Oberkochen, Germany) Discovery v20 stereomicroscope with AxioCam HRc, respectively. Red arrows in the species guide indicate key features.

Abbreviations for collections

BMNH The Natural History Museum, London, United Kingdom (Kerley, M.; Barclay, M.)
BPBM Bernice P. Bishop Museum, Honolulu, Hawaii, USA (Myers, S.; Samuelson, A.)
CAS California Academy of Sciences, San Francisco, California, USA (Kavanaugh, D.)
EJCB Jendek, E. personal collection, Bratislava, Slovak Republic [presently in Ottawa, Canada]
MCSN Museo Civico di Storia Naturale "Giacomo Doria", Genova, Italy (Poggi, R.)
MHNB Muséum d'Histoire Naturelle, Béziers, France (Albert, P.)
MNHN Muséum national d'Histoire naturelle, Paris, France (Menier, J.J.; Deuve, T.; Bruneau de Miré, I.)
NMPC National Museum (Natural History), Prague, Czech Republic (Bílý, S.; Kubáň V.)
NSMT National Science Museum (Natural History), Tsukuba, Japan (Nomura, S.)
USNM National Museum of Natural History, Washington D.C., USA (Furth, D.G.; Lingafelter, S.W.)

ZIN Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia (Volkovitsh, M.)
ZMHB Museum für Naturkunde der Humboldt-Universität, Berlin, Germany (Hieke, F.)
ZSMC Zoologische Staatssammlung, München, Germany (Baehr, M.)

Collecting and preserving adult *Agrilus*

Collecting species of *Agrilus* is generally similar to collecting many other species of adult buprestids. A brief summary of general collecting methods for buprestids is given by Paiero et al. (2013).

Collecting with a net is a general method that works well for *Agrilus*. If the specific host plant is known, it can be swept with a fairly large net, and if the adults are active usually numerous individuals can be collected. Smaller species are generally on smaller branches or twigs, sometimes even herbaceous plants, while larger species are generally associated with larger branches or trunks of trees. Use of a long net handle with a large net bag allows for collecting higher up in arboreal vegetation. A good method is to carefully get a leafy end of a branch inside the net and shake it a few times. The beetles will generally drop off the branch and into the net. Collecting along a forest edge where it is sunny is usually the most productive (Wellso et al. 1976). Often trees that are more mature and have some dead twigs and branches produce the most beetles.

Hand collecting, where specimens are collected singly with a net or by hand, can be productive at times. Walking slowly along a forest trail or forest edge and observing twigs, branches, and leaf surfaces for adults can be a productive collecting method, particularly when searching known host plants. Adults can sometimes be observed on branches or trunks of freshly cut trees, especially those that are exposed to direct sunlight, and can be collected individually. Sometimes, especially in tropical regions, sucker branches with new leaves sprout quickly from a freshly cut tree trunk or stump, and these can be quite attractive to *Agrilus*. It is always a good idea to search or sweep the lower vegetation under trees where you have swept at higher levels because sometimes adults will drop from the area first being swept into the lower vegetation. In mountainous regions, *Agrilus* can sometimes be concentrated on the tops of ridges where winds will carry many insects up the slopes. In such situations, adults that had been carried up during the day will congregate at the bases of herbaceous vegetation at night and later will crawl up the plant stems as the temperatures warm in the late morning and afternoon. These ridges or narrow mountain tops can be very productive as concentration sites for *Agrilus* and other buprestids.

Beating is another method that can be used to collect species of *Agrilus*. With this method branches and vegetation are struck with a "beating stick" over a cloth sheet

supported by a frame. Beetles fall off of the vegetation onto the sheet where they can be collected. This method works best when temperatures are cooler, given that during the heat of the day beetles can fly off the beating sheet before they can be captured.

Use of insect trapping methods, particularly use of Malaise traps, whether on the ground or elevated in the canopy, can be productive for *Agrilus* and other buprestids. Insects fly into the trap and land on the netting material used in construction of the traps and gradually work their way up into a collecting jar at the peak of the trap. Malaise trapping is usually most successful when the traps are placed near recently cut or fallen woody vegetation.

Another trapping method used for *Agrilus* and other buprestids is the use of sticky traps. These are generally colored pieces or strips of plastic which are coated with sticky adhesive. These traps are then placed on or near a host plant or tree. The beetles are either attracted to the color of the trap or randomly fly onto the trap. A disadvantage of using sticky traps is that the adhesive is quite strong, and a solvent is needed to remove the beetles from the trap and to clean them. Certain colors are more attractive to *Agrilus* than others. Purple and green sticky traps have been the most productive for trapping or monitoring for EAB as well as for some other *Agrilus* species (Francese et al. 2005, 2008, 2010, Crook et al. 2009, Petrice and Haack 2014, Petrice et al. 2013).

Rearing can be very productive for obtaining adult specimens from a specific host or for sampling potential hosts to determine if they are used by *Agrilus*. Twigs, branches, and wood from a potential host can be collected and put into rearing cages or sealed cardboard boxes. When using the latter, specimen collection can be facilitated by use of a clear vial or small jar to cover a hole in the box into which the newly emerged adults enter as a result of being attracted to the light. Otherwise rearing containers need to be checked regularly so that emerging beetles can be collected soon after emergence and before they become damaged or broken. Rearing is time consuming, sometimes taking months, and requires considerable space if numerous rearing containers are used. Also, it may be difficult to bring host material from distant collecting expeditions to a home base for rearing. Thus, it is most convenient to rear host material found close to where the collector resides. Rearing can be a very productive method for obtaining series of specimens or species that are otherwise rarely collected.

Several killing agents can be used for collected buprestid specimens. Ethyl acetate is probably the most commonly used. It kills beetles quickly and is easy to obtain. It evaporates quickly so collecting jars and vials need to be replenished at regular intervals. Specimens can be stored in containers with small amounts of ethyl acetate which keeps them pliable and suitable for mounting for extended periods. One disadvantage is that because it is a solvent, specimens stored in this way can become greasy and cannot be used for molecular sequence studies. A suitable replacement is ammonium carbonate, which preserves DNA, is inexpensive, readily available, keeps beetles "relaxed" (not brittle), and it is non-toxic.

Cyanide, usually potassium cyanide, is also a favored killing agent for beetles and other insects. Collecting jars and vials charged with cyanide are effective for several years without replenishing. However, due to its extreme toxicity, it can be difficult to obtain. It also tends to make the muscles of specimens stiff which can make mounting or dissection a little more difficult. An advantage of cyanide is that it is not a solvent and specimens killed in this way rarely become greasy.

Ethyl alcohol can also be used as a killing and preserving agent. Beetles are simply collected into alcohol in the field. It is generally necessary to collect into 95% to 100% ethanol if the specimens are going to be used for DNA extraction. Ethanol does make the specimens stiff and difficult to prepare as dry, natural-looking specimens.

Larger specimens of *Agrilus* can be pinned directly. Smaller specimens are generally point-mounted by American collectors, which involves gluing the specimen to the sharp end of a small, white, narrow paper triangle. The tip of the point is bent and glued to the mesosternum of the specimen. European collectors prefer mounting all *Agrilus* specimens to card mounts. These mounts are flat pieces of thin, white cardboard on which the specimen is glued with small amounts of glue to the upper surface. A disadvantage of this method is that the underside of the specimen is difficult to observe without removal. One of the authors (EJ) uses a method in which part of the card is removed and half of the specimen placed over that area so its ventral surface can be seen.

Extracting the male genitalia is very important, as these structures are very diagnostic at the species level for *Agrilus* and other buprestids. The male genitalia are almost always strongly sclerotized, so they can easily be extracted from a relaxed or fresh specimen with fine forceps or with an insect pin or minuten with the extreme tip bent into a hook. Some workers extract the genitalia and leave them attached to the specimen at the end of the abdomen. Others completely extract the genitalia, clean off the membranous and soft connecting tissue with 10% KOH solution, rinse it with water and glue them to a point or mount them on slides in gelatin-glycerine gel (after A.V. Alexeev). The disadvantage to the later method is that the slides are generally kept separate from the specimen. Gluing the genitalia to the point at their base laterally results in both sides of the genitalia being easy to observe. The point is then pinned beneath the specimen. European workers glue the genitalia to the card mount with the specimen or follow the aforementioned slide preparation. Slide preparation of larvae for detailed study is described in detail by Chamorro et al. (2012).

Agrilus general biology

Of the nearly 15,000 buprestid species recognized worldwide (Bellamy and Nelson 2002), more than 3000 (20%) are species of *Agrilus.* Detailed life histories have only been completed for a few species (< 5%), and understandably those are primarily economically important species that infest and often kill urban and forest trees as well as certain agricultural and ornamental shrubs and vines. In the next few sections, we will first review the biology and ecology of *Agrilus* species at the genus level, and then present more details on *A. planipennis* and the other *Agrilus* species covered in this guide.

Agrilus species can be found in a variety of habitats from shorelines to mountain peaks, and they are native to all continents of the world with the exception of Antarctica (Bellamy 1995). Several species of *Agrilus* have also been recorded from islands such as Cuba, Hispaniola, Jamaica, and Trinidad in the Caribbean Sea; Fiji, Hawaii, New Guinea, and Tahiti in the Pacific Ocean; and Madagascar in the Indian Ocean (Bellamy 2002, 2006, 2013ab, Peck 2005). Interestingly, no *Agrilus* are native to New Zealand, although at least 54 species are found in Australia (Curletti 2001, Bellamy 2002, Leschen et al. 2003, Bellamy et al. 2013).

New species of *Agrilus* are described yearly from all parts of the world. This is reflected by the fact that the number of *Agrilus* species recognized worldwide grew from 2,265 in 1936 to 2,784 in 2008 (Obenberger 1936, Bellamy 2008). As for more recent evidence, consider that 74 of 278 taxa treated by Jendek and Grebennikov (2011) for East Asia were new taxa, and similarly 40 of the 64 *Agrilus* species listed by Curletti and Brûlé (2011) for French Guiana were new taxa. Elsewhere, Curletti and Sakalian (2009) recently described 16 new *Agrilus* species from Africa, Hespenheide (2012) described 11 new *Agrilus* from Mexico and Central America, and Jendek and Chamorro (2012) described 6 new species from the Oriental Region.

Of all the *Agrilus* species worldwide, *A. planipennis* (EAB) has been by far the most intensively studied species to date. Throughout its native range in East Asia, EAB rarely reaches outbreak levels (Liu et al. 2003, Wei et al. 2004, Zhao et al. 2005). However, in North America and western Russia, where established populations of EAB were first found in 2002 and 2003, respectively, widespread mortality of ash (*Fraxinus*) trees has been reported (Haack et al. 2002, Baranchikov et al. 2008, Izhevskii and Mozolevskaya 2010, Kovacs et al. 2010, McKenney et al. 2012). As further evidence of the intense

Table 1. *Agrilus* species that have become established in Canada and the continental United States.

Agrilus species	Range†		Likely mode of introduction	Principal host genera	Reference ‡
	Native	Introduced			
A. auroguttatus Schaeffer	AZ, MX	US-CA	Accidental	*Quercus*	4
A. cuprescens (Ménétriés)	Eurasia	NA	Accidental	*Rubus, Rosa*	14
A. cyanescens (Ratzeburg)	Eurasia	NA	Accidental	*Lonicera, Symphoricarpus*	5, 12
A. derasofasciatus Lacordaire	Europe, N AF	US	Accidental	*Vitis*	10, 13
A. hyperici (Creutzer)	Eurasia	NA, AU	Intentional	*Hypericum*	3
A. pilosovittatus Saunders	Asia	US	Accidental	*Wisteria*	9
A. planipennis Fairmaire	Asia	NA, RU	Accidental	*Fraxinus*	2, 7
A. prionurus Chevrolat	MX	US	Accidental	*Sapindus*	6, 15
A. sinuatus (Olivier)	Eurasia	US	Accidental	Rosaceae	1
A. subrobustus Saunders	Asia	US	Accidental	*Albizia*	11, 16
A. sulcicollis Lacordaire	Europe	NA	Accidental	*Quercus*	8, 12

† Abbreviations = AU = Australia, AZ = Arizona, MX = Mexico, NA = North America (US and Canada), N AF = North Africa, RU = Russia, US = United States, US-CA = California.

‡ References: 1 = Anonymous (1894), 2 = Baranchikov et al. (2008), 3 = Campbell and McCaffrey (1991), 4 = Coleman and Seybold (2011), 5 = Frost (1922), 6 = Haack (2006), 7 = Haack et al. (2002), 8 = Haack et al. (2009), 9 = Hespenheide (1968), 10 = Hoebeke (1980), 11 = Hoebeke and Wheeler (2011), 12 = Jendek and Grebennikov (2009), 13 = Malkin (1941), 14 = Weiss (1914), 15 = Wellso and Jackman (2006), and 16 = Westcott (2007).

research focus on EAB, consider that of the 13,065 DNA sequences in Genbank for all *Agrilus* as of June 2014, 12,019 entries were for EAB (92%, NCBI 2014).

In addition to EAB, at least 10 other exotic (= nonnative) *Agrilus* species have become established in the continental United States (Table 1). Of these 11 species, *Agrilus hyperici* (Creutzer) was intentionally introduced as a biological control agent of the perennial dicot common St. Johnswort, *Hypericum perforatum* (Campbell and McCaffrey 1991), and similarly it was successfully introduced into Australia (Briese 1991b) but failed to establish in South Africa (Gordon and Kluge 1991). The other 10 exotic *Agrilus* listed in Table 1 were all introduced inadvertently, most likely through international trade. EAB probably entered the United States in wood packaging material (e.g., crating, dunnage, and pallets) associated with imported goods from Asia (Haack 2006). International trade in firewood is suspected as the pathway by which *Agrilus prionurus* Chevrolat entered Texas from its native range in Mexico (Haack 2006). Similarly, firewood is the suspected pathway by which *Agrilus auroguttatus* Schaeffer was moved to California from its native range in either Arizona or northern Mexico (Coleman and Seybold 2011). The United States annually imports firewood worth millions of dollars from several countries worldwide, with Canada and Mexico ranking first and fourth, respectively, as the source of the firewood during the period

1996–2009 (Haack et al. 2010). The remaining exotic *Agrilus* listed in Table 1 were likely introduced with live plants given that the larval hosts for several of these exotic *Agrilus* are common ornamental shrubs, vines, and fruit trees.

Larval host plants. Species of *Agrilus* utilize primarily dicot angiosperms as larval hosts, including herbaceous perennials, vines, shrubs, and trees. Nevertheless, a few *Agrilus* species have occasionally been reared from gymnosperms (*Pinus* species, Jendek 2013b). By contrast, buprestid species in several other genera (e.g., *Acmaeodera, Anthaxia, Buprestis, Chrysobothris,* and *Dicerca*) routinely develop in both woody dicots and gymnosperms (Fisher 1928, Bílý 2002, Nelson et al. 2008). Overall, Jendek and Grebennikov (2011) list 68 plant genera that are utilized by *Agrilus* species as likely larval hosts in East Asia, Nelson et al. (2008) list 60 plant genera for North America as actual larval hosts, and Bílý (2002) lists 44 genera in Central Europe as actual larval hosts. Bílý (2002) was able to list actual larval hosts for all 44 European *Agrilus* species in his monograph, whereas Jendek and Grebennikov (2011) were able to list likely larval hosts for only 38% of 278 *Agrilus* treated for East Asia, and Nelson et al. (2008) provided actual larval hosts for 54% of 188 *Agrilus* species treated for North America. Considering these three world regions, *Quercus* was the most common larval host in each with 23 *Agrilus* species using *Quercus* in East Asia, 15 in North America, and 14 in Europe. The next top five plant genera used as larval hosts in these three world regions, listed in decreasing order, were *Ulmus, Salix, Zelkova, Caragana,* and *Carpinus* in East Asia (Jendek and Grebennikov 2011); *Celtis, Gleditsia, Diospyros, Salix,* and *Sapindus* in North America (Nelson et al. 2008); and *Salix, Castanea, Fagus, Populus,* and *Carpinus* in Central Europe (Bílý 2002). Again, these rankings would likely change for East Asia and North America as more is learned about the larval host plants in each region. Considering only those *Agrilus* species for which at least one larval host plant was reported, the vast majority of *Agrilus* species (75% for Central Europe, 85% for East Asia, and 86% for North America) were reported to use only one or two genera as larval hosts (Bílý 2002, Nelson et al. 2008, Jendek and Grebennikov 2011). Nevertheless, in each of these world regions there were a few species of *Agrilus* that were much more polyphagous such as *Agrilus viridis* (L.) from Europe to Eastern Asia (14 host genera, Jendek and Grebennikov 2011), *Agrilus obsoletoguttatus* Gory in North America (8 genera, Nelson et al. 2008), and *Agrilus roscidus* Kiesenwetter for Europe (13 genera, Bílý 2002).

Few details are available on larval hosts of *Agrilus* species in tropical and subtropical regions of the world. Nevertheless, some genera that have been documented as larval hosts include *Acacia* (Turner and Hawkeswood 1996, Braza 1997), *Alnus* (Jendek 2013a), *Citrus* (Baltazar and Salazar 1979, Hawkeswood and Turner 1994, Macabasco 1964, Jendek 2013a), *Eucalyptus* (Roberts 1987, Braza 1988), *Euodia* (Jendek 2013a), *Fagara* (Jendek 2013a), *Hibiscus* (Dutt 1969), *Sambucus* (Jendek 2013a), *Sorbaria* (Jendek 2013a), *Terminalia* (Mercer 1985, 1986, Roberts 1987), and *Zanthoxylum* (Jendek 2013a). Jendek and Poláková (2014) summarized the known host plants of World *Agrilus*.

Host plant relationships. *Agrilus* larvae typically develop in living or recently dead host plant tissues. Most *Agrilus* larvae tunnel in the cambial region, mining both the inner bark (phloem) and the outer sapwood (xylem). However, some species tunnel extensively in the xylem or pith, especially those that mine roots and small-diameter branches and suckers (e.g., *Agrilus horni* Kerremans, *Agrilus vittaticollis* (Randall), Carlson and Knight 1969, Solomon 1995).

Stressed plants are favored for oviposition by many *Agrilus* species that infest live plants. Apparently, larvae have higher survival when tunneling in stressed plants as compared with vigorous hosts, which may kill the larvae by "flooding" the gallery with exudates or by overgrowing the larvae with callus tissue (Anderson 1944, Carlson and Knight 1969). Environmental stresses such as severe drought or successive years of defoliation are known to trigger outbreaks of various *Agrilus* species (Heering 1956, Barter 1965, Nichols 1968, Dunbar and Stephens 1976, Wargo 1977, Ohgushi 1978, Mattson and Haack 1987, Hartman and Blank 1992, Jones et al. 1993, Evans et al. 2004, Vansteenkiste et al. 2004, Sever et al. 2012). Moreover, girdling trees to induce stress is known to increase attraction to many *Agrilus* (Anderson 1944, Barter 1957, Haack and Benjamin 1982, Dunn et al. 1986, McCullough et al. 2009). Although weakened hosts appear to be preferred for oviposition by many *Agrilus* that infest trunks and branches of trees, vigorous hosts are often selected by root-infesting *Agrilus* (Carlson and Knight 1969, Briese 1991a).

In situations where an *Agrilus* species encounters a naïve host plant (i.e., situations where the plant did not coevolve with the insect such as when either the insect or plant is introduced into a new world region), the host plant often lacks resistance and often can be easily infested and killed by the *Agrilus* species even when the host plant is healthy. This situation has been well-documented for the Asian species *A. planipennis* where it encountered North American and European *Fraxinus* species (Liu et al. 2003, Wei et al. 2004, Cappaert et al. 2005, Zhao et al. 2005, Baranchikov et al. 2008, Wang et al. 2010), as well as for the North American species *Agrilus anxius* Gory when it encountered European and Asian *Betula* species (Miller et al. 1991, Nielson et al. 2011). However this is not always the rule, given that apparently healthy North American *Quercus* species do not show susceptibility to *Agrilus sulcicollis* Lacordaire (Petrice and Haack 2014), which is a European *Agrilus* species that was recently discovered in North America (Haack et al. 2009, Jendek and Grebennikov 2009).

Voltinism. Species of *Agrilus* in temperate latitudes typically require 1–2 years to complete a single generation. In these species it appears that larvae must overwinter as last instars for pupation to be triggered the following spring. For species that tend to be univoltine (e.g., *A. anxius*, *Agrilus bilineatus* (Weber), *A. planipennis*), a second year may be needed when larvae develop in vigorous hosts or result from eggs laid in late summer and thus do not become final instars in their first year (Carlson and Knight 1969, Dunbar and Stephens 1976, Solomon 1995, Cappaert et al. 2005). By contrast, some temperate-zone *Agrilus* routinely require two years to complete one

generation, e.g., *Agrilus guerini* Lacordaire, *A. horni*, *Agrilus pensus* Horn, *A. torquatus* LeConte (Nelson and Hespenheide 1998, Brooks 1926, Carlson and Knight 1969, Solomon 1995, Bílý 2002).

Few life history studies have been conducted on *Agrilus* species in tropical or subtropical countries. However, for those reports that do exist, multivoltinism is suggested given that complete development has been reported in about 2 to 4 months (Macabasco 1964, Dutt 1969, Roberts 1987, Hawkeswood and Turner 1994). In these insects, host condition appears to strongly govern generation time given that development can occur in 2–4 months in susceptible hosts, but up to a year or more in vigorous hosts (Dutt 1969, Roberts 1987).

Adult seasonality and behavior. *Agrilus* adults are normally active throughout the summer months in temperate areas. Typically, the first adults emerge from their host plants beginning in late spring, peak in early to mid-summer, and end their flight season in late summer. For example, in the mid-latitudes of the Northern Hemisphere, adult emergence usually begins in May, peaks in June or July, and ends in August or September. By contrast, in warmer areas this schedule can be advanced by one to two months, or delayed by a month or more in colder areas (Svihra and Koehler 1993, Solomon 1995, Bílý 2002). *Agrilus* adults form a characteristic D-shaped exit hole when they emerge from their host plant, with the flat-side of the "D" corresponding to the dorsal side of the beetle (Wang et al. 2010). The sex ratio of most *Agrilus* species is close to 1:1 (Ohgushi 1966, Cote and Allen 1980, Haack and Benjamin 1982, Wei et al. 2007b, Haack et al. 2009, Lyons et al. 2009, Wang et al. 2010), however, Braza (1988) reported 1.75:1 (male:female) for *Agrilus sexsignatus* Fisher.

Agrilus are known as sun-loving beetles, being especially active on sun-exposed host plants such as those growing along a forest edge. Adults are capable of flying several kilometers during their lifetime (Taylor et al. 2010) but may not need to do so given that suitable hosts are usually nearby. Adults are most active from late morning through the afternoon hours, during which time they fly, walk, feed, mate, and lay eggs. Adults usually feed for 1–2 weeks before mating and laying eggs (Glasgow 1934, Barter 1957, Ohgushi 1963, Carlson and Knight 1969, Svihra and Koehler 1993, Wang et al. 2010), but maturation feeding can last 3–4 weeks in some species (Solomon 1995). Beetles feed on foliage throughout their entire adult life. They typically feed on the foliage of the same plant species that serve as their larval host plants, but some species may feed on non-hosts as well, e.g., *A. anxius* (Glasgow 1934, Akers and Nielson 1990). For this reason collection records that list the plant species on which the adult was taken are not always an accurate indication of actual larval hosts. In most studies, *Agrilus* adults have been reported to live an average of 2–5 weeks (Brooks 1914, Glasgow 1934, Balch and Prebble 1940, Barter 1957, Dunbar and Stephens 1976, Haack and Benjamin 1982, Wei et al. 2006, Wei et al. 2007b, Wang et al. 2010). However, average values of 7–9 weeks have been reported for EAB under favorable laboratory conditions, with some individual males living as long as 12 weeks and some females

as long as 17 weeks (EPPO 2013). Similarly, Nord et al. (1965) reported that some *A. horni* adults lived for over 11 weeks.

Agrilus adults appear to use a combination of visual and olfactory cues to locate hosts and mates (Lyons et al. 2009, Crook and Mastro 2010). Various shades of purple and green have been shown to be highly attractive to EAB adults, but other *Agrilus* species vary in their color preferences (Sakalian and Langourov 2004, Petrice et al. 2009, 2013, Crook and Mastro 2010, Domingue et al. 2013, Petrice and Haack 2014). In addition, several specific plant volatiles from bark and foliage enhance trapping of *Agrilus* adults, and some of these volatiles are known to increase in concentration during periods of environmental stress (Dunn et al. 1986, de Groot 2008, Crook and Mastro 2010). Although there has been evidence for several years to suggest that some *Agrilus* species produce short-range pheromones (Dunn and Potter 1988), only recently have some of these compounds been identified and field tested (Silk et al. 2009, 2011, Ryall et al. 2012). In addition, flying adult male *Agrilus* can visually detect potential mates on host plants (Chapman 1915, Hawkeswood and Turner 1994, Lelito et al. 2007, 2011, Domingue and Baker 2012).

Agrilus females deposit eggs on the outer tissues of host plants, such as in bark cracks and crevices along the trunks and major branches of trees and other woody hosts (Chapman 1915, Loerch and Cameron 1984, Solomon 1995). Some *Agrilus* eggs can be laid on smooth bark as well, especially when oviposition occurs on small-diameter twigs and suckers (Brooks 1914, Carlson and Knight 1969, Petrice et al. 2009). Eggs are deposited singly in many species or in clusters from a few to as many as 18 eggs (Barter 1965, Dutt 1969, Solomon 1995, Bílý 2002). Females of many *Agrilus* species deposit a semi-transparent substance over the eggs that helps cement the eggs to the host and protect them from desiccation (Brooks 1914, Hutchings 1923, Barter 1957). Egg hatch usually occurs in 1–2 weeks, but as many as 3–4 weeks has been reported for some species (Solomon 1995). Estimates of fecundity are difficult to obtain in nature given that *Agrilus* females usually oviposit in bark cracks and crevices. Under laboratory conditions in which *Agrilus* females were fed foliage and provided substrates for oviposition, mean lifetime fecundity averaged between 23–77 eggs per female (Brooks 1926, Akers et al. 1986, Yu 1992, Rutledge and Keena 2012a,b), with maximum values for individual females reported from 55 to 307 (Brooks 1926, Yu 1992, Huangfu et al. 2007, Lu et al. 2012, EPPO 2013)

Mating occurs on the host plant, often on the trunk, branches, and foliage. Carlson and Knight (1969) provide many details on the reproductive behavior and structures of male and female *Agrilus*. Typically males search for females when flying near host plants and then landing on likely mates, or while walking on the surface of the host. Mating is common during late morning and late afternoon, while oviposition peaks in early afternoon (Barter 1965, Carlson and Knight 1969).

Larvae and larval behavior. *Agrilus* larvae enter the host directly through the side of the egg that is in contact with the host tissue. In woody plants, larvae tunnel

through the outer bark for various distances until they reach the cambial region (which includes the inner bark, cambium, and outer sapwood) and there construct feeding galleries. Larvae construct galleries that are only slightly wider than their body and pack the frass tightly behind themselves in the galleries, using their terminal processes (Heering 1956, Carlson and Knight 1969). Larvae tunnel primarily in the inner bark (phloem) and also the outer sapwood (xylem). Larvae commonly depart the cambial region and enter the sapwood to molt or during periods of high host resistance (Balch and Prebble 1940, Anderson 1944, Carlson and Knight 1969). By contrast, in root borers such as *A. horni* and *A. vittaticollis*, larvae first tunnel in the cambial region and later tunnel in the xylem (Brooks 1914, Nord et al. 1965, Carlson and Knight 1969).

Agrilus larvae are usually reported to have four instars (Haack and Benjamin 1982, Loerch and Cameron 1983, Cappaert et al. 2005, Petrice et al. 2009, Haavik et al. 2013), or five (Barter 1957, Carlson and Knight 1969, Dutt 1969, Gul and Chaudhry 1983, Wei et al. 2006). In fact, in the case of *A. anxius*, both four and five instars have been reported (Barter 1957, Loerch and Cameron 1983). Often, authors that reported five instars included the prepupa in their measurements. Carlson and Knight (1969) state that larvae molt to fifth instars just prior to construction of the pupal chamber. The above authors measured various regions of the head and terminal processes when making these calculations. It is not clear if the number of instars is variable among or within *Agrilus* species, or if the variation reflects which characters were measured and what types of larvae were included in the sample (e.g., actively feeding larvae only, or also prepupae).

Agrilus larval galleries vary greatly in the total length and shape. Total gallery length (if measured as a straight line) is usually less than 1 m, but some individual galleries have measured over 2 m (Brooks 1914, Nord et al. 1965, Braza 1988). Total gallery length can also vary widely within the same *Agrilus* species, usually being longer and more sinuate (zig-zag) in high-vigor hosts, but shorter and straighter in low-vigor hosts (Anderson 1944, Barter 1957, Carlson and Knight 1969, Dunbar and Stephens 1976).

Most temperate *Agrilus* species have been reported to overwinter as last-instar larvae in pupal cells constructed in the sapwood, outer bark, pith, or roots, depending on the species (Solomon 1995, Campbell and McCaffrey 1991, Petrice et al. 2009). If larvae do not become last instars before the end of their first year of development then they will overwinter as early instar larvae in the cambial region and resume feeding the following spring. Interestingly, in the case of *Agrilus subcinctus* Gory, which develops in recently dead *Fraxinus* twigs, most individuals overwinter as pupae (Petrice et al. 2009). Many *Agrilus* larvae extend their gallery close to the host's outer surface just before or after construction of the pupal cell, and in so doing create a pathway that the new adult will later use to exit (Brooks 1914, Chapman 1915, Nord et al. 1965). A larva constructs a pupal cell that is about twice the thickness of its body by feeding so that its head remains close to the ventral side of its body until the head and anus nearly

touch (Brooks 1914, Carlson and Knight 1969). Mature larvae typically overwinter in this J- or U-shaped position.

Pupation. Pupation usually occurs in late spring and early summer. At first the pupa is white in color, but soon the eyes and mouthparts darken (Barter 1957, Chamorro et al. 2012). Pupation typically takes 1–4 weeks (Brooks 1914, Chapman 1915, Solomon 1995, Wang et al. 2010). Newly formed adults remain in the pupal cell from a few days to a week before chewing to the bark surface, constructing a D-shaped exit hole, and departing the host.

Within-tree infestation patterns. In many host genera, multiple species of *Agrilus* can infest the same tree concurrently (Hespenheide 1969, 1976, Moraal and Hilszczanski 2000). In these situations there is a tendency for the smaller species to colonize higher in the canopy or in smaller branches, while the larger species tend to colonize larger branches and lower on the trunk. For the trunk-infesting *Agrilus* species that can potentially kill their host, initial infestation tends to start in the upper trunk and branches, with subsequent infestation and associated dieback occurring lower on the trunk in succeeding years (Hutchings 1923, Balch and Prebble 1940, Barter 1957, Haack and Benjamin 1982, Moraal and Hilszczanski 2000, Cappaert et al. 2005). The tree-infesting *Agrilus* species that can kill their host are usually the first or among the first borers to colonize a susceptible host tree, and if successful then a succession of other borers, in a variety of insect families, will colonize in subsequent years (Cote and Allen 1980, Haack et al. 1983). By contrast, in root-feeding *Agrilus*, oviposition begins along the lower trunk or stem, near the ground (Brooks 1914, Solomon 1995).

Natural enemies. Several hymenopteran parasitoids have been reared from *Agrilus* eggs and larvae. For example, based on reviews of North American, Asian, and European literature (Solomon 1995, Wang et al. 2010, Trjapitzin and Volkovitsh 2011, Taylor et al. 2012), the families and genera of egg parasitoids included species of Aphelinidae (*Ablerus*), Encyrtidae (*Coccidencyrtus, Oobius, Ooencyrtus, Orianos*, and *Ptinobius*), and Signiphoridae (*Thysanus*). Similarly, the *Agrilus* larval parasitoids included species of Bethylidae (*Sclerodermus*), Braconidae (*Atanycolus, Doryctes, Ecphylus, Heterospilus, Iphiaulax, Leluthia, Microbracon, Monogonogastra, Pareucorystes, Spathius,* and *Wroughtonia,*), Chalcididae (*Phasgonophora*), Eulophidae (*Baryscapus, Entodon,* near *Hadrotrichodes,* and *Tetrastichus*), Eupelmidae (*Balcha, Calosota, Eupelmus, Metapelma,* and *Pentacladia*), Eurytomidae (*Bephratoides* and *Eurytoma*), Ichneumonidae (*Cunocephalus, Deuteroxorides, Dolichomitus, Ephialtes, Glypta, Labena, Olesicampe, Orthizema,* and *Pimploterus*), Pteromalidae (*Oodera* and *Zatropus*), and Stephanidae (*Foenatopus*).

Larvae of numerous predatory beetle species have been found to feed on *Agrilus* larvae (Dunbar and Stephens 1976, Cote and Allen 1980, Bauer et al. 2007, 2008). These species belong to the following families and genera: Cleridae (*Enoclerus* and *Phyllobaenus*), Elateridae (*Adelocera*), Passandridae (*Catogenus*), and Trogossitidae (*Tenebroides*). Several species of *Cerceris* wasps (Hymenoptera, Crabronidae) prey specifically on

Coleoptera, and some specialize on buprestid beetles, including *Agrilus* (Evans 1971, Evans and Hook 1986, Hook and Evans 1991, Marshall et al. 2005, Rutledge et al. 2013, Swink et al. 2013). Woodpeckers (Picidae) are also common predators of *Agrilus* larvae (Cote and Allen 1980, Cappaert et al. 2005, Lindell et al. 2008, Wang et al. 2010, Jennings et al. 2013).

General biology of *Agrilus planipennis*

The 2002 discovery of EAB in North America, along with recognition that it was highly lethal to North American ash trees, spurred great interest in the biology and ecology of this insect as well as other potential invasive *Agrilus* species worldwide (Haack et al. 2002, Cappaert et al. 2005, Poland and McCullough 2006, Chamorro et al. 2012). The native range of EAB is reported to include portions of China, Japan, Korea, Mongolia, Taiwan, and the Russian Far East (Yu 1992, Jendek 1994, Wei et al. 2004, Jendek and Grebennikov 2011). Since its discovery in 2002 in the vicinity of Detroit, Michigan, and nearby Windsor, Ontario, EAB has become established in 23 US states and 2 Canadian provinces as of May 2014. In European Russia, beetles that were later identified as EAB in 2005 were first collected in Moscow in 2003 (Mozolevskaya 2007, Baranchikov et al. 2008, Izhevskii and Mozolevskaya 2010, Volkovitsh and Mozolevskaya 2014). During the period 2006-2013, EAB spread several hundred kilometers to areas outside of Moscow and as December 2013 was found in 11 political regions (Oblasts), including regions near the borders of Belarus and Ukraine (Baranchikov 2013, EPPO 2013, Orlova-Bienkovskaya 2013a, 2013b, Straw et al. 2013, Volkovitsh and Mozolevskaya 2014). EAB is projected to have huge economic impacts in both North America and Europe given that the native *Fraxinus* species show little to no resistance to EAB infestation (Baranchikov et al. 2008, Rebek et al. 2008, Kovacs et al. 2010, McKenney et al. 2012, EPPO 2013, Volkovitsh and Mozolevskaya 2014).

When discussing the larval hosts of EAB it is important to recognize that based on adult morphology, Jendek (1994) synonymized *Agrilus feretrius* Obenberger (type from Taiwan), *Agrilus marcopoli* Obenberger (type from Mongolia), and *Agrilus marcopoli ulmi* Kurosawa (type from Japan) with *A. planipennis* (type from China). Only species of ash (*Fraxinus*) have been reported as hosts of EAB in China, Russia, and North America (Yu 1992, Haack et al. 2002, Liu et al. 2003, Zhao et al. 2005, Baranchikov et al. 2008, EPPO 2013, Volkovitsh and Mozolevskaya 2014). By contrast, species of *Juglans*, *Pterocarya*, and *Ulmus* have also been reported as EAB hosts in Korea and Japan (Ko 1969, Akiyama and Ohmomo 1997, Haack et al. 2002). However, in a recent pest risk assessment on EAB by the European and Mediterranean Plant Protection Organization (EPPO 2013), buprestid specialists from Japan now question the validity of the non-*Fraxinus* host records that were reported earlier for EAB. Given the above, it is clear

that EAB uses *Fraxinus* as a larval host; however, actual rearing records are needed to support *Juglans*, *Pterocarya*, and *Ulmus* as true larval hosts of EAB.

In North America and western Russia, where native *Fraxinus* species did not co-evolve with EAB, both healthy and stressed *Fraxinus* are highly susceptible to EAB. By contrast, in China and the Russian Far East, Asian *Fraxinus* are typically resistant to EAB infestation except during periods of severe environmental stress (Yu 1992, Zhao et al. 2005, Baranchikov et al. 2008, Volkovitsh and Mozolevskaya 2014). Moreover, North American *Fraxinus* species that have been planted in China and Russia have suffered high mortality as a result of EAB infestation (Liu et al. 2003, Zhao et al. 2005, Baranchikov et al. 2008, Volkovitsh and Mozolevskaya 2014).

The principal native hosts of EAB in China and the Russian Far East include *Fraxinus mandshurica* and *F. chinensis* (Yu 1992, Zhao et al. 2005, Wei et al. 2007b, Baranchikov et al. 2008, Izhevskii and Mozolevskaya 2010). In North America, EAB has been able to attack and kill all native *Fraxinus* species that it has so far encountered, including *F. americana, F. nigra*, *F. pennsylvanica*, *F. profunda*, and *F. quadrangulata* (Anulewicz et al. 2008, Pureswaran and Poland 2009, EPPO 2013). In European Russia, EAB has killed mostly plantings of the introduced North American species *F. pennsylvanica* and the native *F. excelsior* (Baranchikov et al. 2008, Izhevskii and Mozolevskaya 2010, Orlova–Bienkowskaja 2013a, Volkovitsh and Mozolevskaya 2014).

EAB oviposits preferentially on open-grown trees or trees growing along the forest edge but will attack interior trees later in the infestation (Poland and McCullough 2006, McCullough et al. 2009, Wang et al. 2010). EAB infests nearly all sizes of *Fraxinus* trees, from trees 2–3 cm in diameter to mature forest trees (Haack et al. 2002, Wei et al. 2007b).

EAB adults measure 7.5–15 mm in length (Yu 1992, Jendek and Grebennikov 2011) and typically complete one generation per year, but two years may be required in vigorous hosts, when eggs are laid late in the season, or in cooler climates (Cappaert et al. 2005, Wei et al. 2007b, Wang et al. 2010). Similarly, if infested host material becomes too dry, as can occur in cut firewood, development may take two years (Petrice and Haack 2007).

In the Great Lakes region of North America and at similar latitudes in China, adult flight usually begins in May, peaks in June or July, and ends by September (Cappaert et al. 2005, Wei et al. 2007b, Wang et al. 2010). Adults are most active on warm, sunny days when air temperatures are above 25°C (Wang et al. 2010). At night or during cool or rainy weather, adults rest on leaves or in bark crevices (Rodriguez-Saona et al. 2007). Under favorable laboratory conditions, adult males lived an average of 7 weeks (range 2–12) and females an average of 9 weeks (range 4–17, EPPO 2013). EAB feeds on foliage throughout their adult lifespan (Wei et al. 2010).

EAB adults appear to use a combination of visual and olfactory cues to locate host trees and mates. EAB adults are most attracted to various shades of purple and green (Francese et al. 2005, 2008, 2010, Crook et al. 2009). In addition, EAB have been found to be attracted to dead EAB adults when placed on foliage or on trap surfaces (Lelito

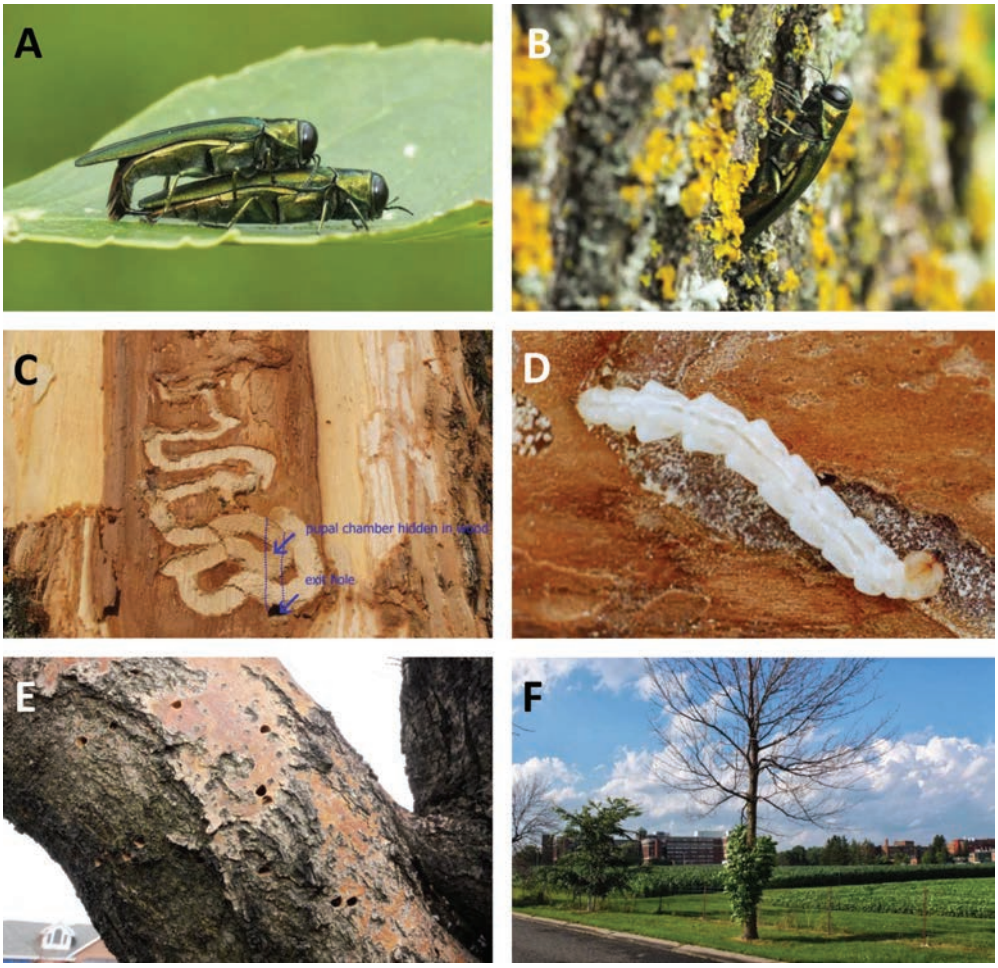


Figure 1. A, Male and female mating pair with sclerotized aedeagus visible; B, Female ovipositing in tree bark; C, Serpentine larval tunnel under the bark; mature larvae pupate in the pupal chamber and exit through a D-shaped hole; D, EAB larva, dorsal view; E, Trunk with numerous D-shaped exit holes, an obvious sign of EAB infestation; F, Ash tree attacked by EAB, with resultant epicormic branching along the lower trunk. (All photos by Eduard Jendek.)

et al. 2007, 2008, Petrice et al. 2012). In laboratory studies, EAB responds positively to certain *Fraxinus* volatiles, and these compounds have been shown to enhance attraction to EAB when added to purple or green traps (Rodriguez-Saona et al. 2006, Crook et al. 2008, de Groot 2008, Crook and Mastro 2010, Grant et al. 2011). Close range sex pheromones have also been identified for EAB (Lelito et al. 2009, Silk et al. 2011).

EAB males often hover from a distance of about 1 m from host trees when searching for potential mates, and when a female is located they land quickly on or near her (Lelito et al. 2007, Rodriguez-Saona et al. 2007). Mating occurs on the host plant, often on the trunk, branches, and foliage (Fig. 1A). After mating, females walk along the bark surface, stopping frequently to probe bark cracks and crevices in search of suitable oviposition sites (Fig. 1B, Wang et al. 2010).

EAB females initiate oviposition about 5–10 days after emergence, laying eggs individually or in small clusters in bark cracks and crevices along the trunks, major branches, and exposed roots of trees (Wei et al. 2007b, Wang et al. 2010). EAB prefers to oviposit on areas with rough bark (Wei et al. 2007b, Anulewicz et al. 2008, Wang et al. 2010). The eggs, larvae, and pupae of EAB are described in detail in Chamorro et al. (2012).

Larvae eclose in 7–10 days by chewing through the bottom of the egg and tunneling through the outer bark to the cambial region where they construct galleries in the inner bark and outer sapwood (Wei et al. 2007b, Wang et al. 2010). Galleries are typically constructed in a zig-zag pattern, especially in more vigorous hosts, but more meandering in shape in weakened hosts or when larval densities are high (Fig. 1C, Wei et al. 2007b, Wang et al. 2010).

EAB has four larval instars and in most localities are univoltine, overwintering as mature larvae or prepupae in pupal cells (Fig. 1D, Cappaert et al. 2005, Wang et al. 2010, Chamorro et al. 2012). Individuals that require two years to complete a single generation will overwinter in the cambial region as first through fourth instars. Mature EAB larvae construct individual pupal cells, usually in the outer sapwood, but also in the outer bark if sufficiently thick. No matter where pupation occurs, the larva will first construct a tunnel that extends nearly to the surface of the outer bark, which will later be used by the adult to exit the host (Wang et al. 2010). In the pupal cell the larva folds itself over in a J- or U-shape in preparation for overwintering. Some larvae remain in this doubled-over condition until the following spring, while others shrink in length, straighten, and develop into the prepupal stage prior to overwintering (Wang et al. 2010, Duan et al. 2012b).

Pupation typically occurs in late spring and early summer. Pupation lasts about 3–4 weeks. The newly eclosed adults remain in their pupal cells for about a week before starting to chew their way out by widening the exit tunnels previously constructed by the mature larvae (Wei et al. 2007b, Wang et al. 2010). Adults emerge through a D-shaped exit hole and begin walking or flying in search of host foliage (Fig. 1E, Wang et al. 2010).

Initial infestation of a host tree by EAB usually begins in the canopy, with subsequent years of attack occurring lower along the trunk (Cappaert et al. 2005, Foelker et al. 2013). In small diameter trees, initial infestation often starts along the main trunk (Timms et al. 2006, Wei et al. 2007b). Epicormic branching along the lower trunk of EAB-infested trees is common in many ash species (Fig. 1F, Cappaert et al. 2005, Wang et al. 2010).

Infested trees typically die after 1–3 years of successive EAB attack, with the timing depending largely on tree size and local EAB population density (Wang et al. 2010).

Recent surveys in China found several Asian hymenopteran parasitoids of EAB. These include the egg parasitoid *Oobius agrili* Zhang and Huang (Encyrtidae, Zhang et al. 2005); the larval parasitoids *Spathius agrili* Yang (Braconidae), *Tetrastichus planipennisi* Yang (Eulophidae, Yang et al. 2005, Liu et al. 2007), and *Deuteroxorides orientalis* (Uchida) (Ichneumonidae, Wang et al. 2010) and the larval and pupal parasitoid *Sclerodermus pupariae* Yang and Yao (Bethylidae, Yang et al. 2012). Of these, *O. agrili*, *S. agrili*, and *T. planipennisi* have been introduced and become established in the United States (Bauer et al. 2008, 2010, Duan et al. 2010, 2012a, 2013a). In addition, during recent surveys in the Russian Far East, two previously unreported braconid larval parasitoids of EAB were found: *Atanycolus nigriventris* Vojnovskaja-Krieger and *Spathius galinae* Belokobylskij and Strazanac (Belokobylskij et al. 2012, Duan et al. 2012b). Ants (Formicidae) and woodpeckers (Picidae) have also been reported as predators of EAB in China (Wang et al 2010) and European Russia (Volkovitsh and Mozolevskaya 2014).

Numerous native hymenopteran parasitoids have also been found to parasitize EAB in North America, including the braconids *Atanycolus cappaerti* Marsh and Strazanac, *Atanycolus disputabilis* (Cresson), *Atanycolus hicorie* Shenefelt, *Atanycolus nigropyga* Shenefelt, *Atanycolus simplex* (Cresson), *Atanycolus tranquebaricae* Shenefelt, *Leluthia astigma* (Ashmead), *Spathius floridanus* Ashmead, and *Spathius laflammei* Provancher; the chalcidid *Phasgonophora sulcata* Westwood; the eupelmid *Eupelmus pini* Taylor; and the ichneumonids *Dolichomitus vitticrus* Townes and *Cunocephalus* sp. (Cappaert and McCullough 2009, Duan et al. 2009, 2012a, 2013b, Kula et al. 2010, Taylor et al. 2012). In addition, the Asian eupelmid parasitoid *Balcha indica* Mani and Kaul, which has become established in North America, also attacks EAB larvae, prepupae, and pupae (Bauer et al. 2008, Duan et al. 2011). Parasitism of EAB by these species is generally low, with the exception of *A. cappaerti* (Duan et al. 2012).

In North America, species of predatory Coleoptera in the genera *Catogenus* (Passandridae), *Enoclerus* (Cleridae), and *Tenebroides* (Trogossitidae) have been reported to prey on EAB larvae (Bauer et al. 2007, 2008). In Canada, the stinkbug *Podisus maculiventris* Say (Hemiptera, Pentatomidae) was observed feeding on adult EAB by one of the authors (EJ). In eastern North America, the wasp *Cerceris fumipennis* Say (Hymenoptera, Crabronidae) preys almost exclusively on buprestid beetles, including EAB (Marshall et al. 2005, Rutledge et al. 2013, Swink et al. 2013). Woodpeckers (Picidae) readily feed on EAB larvae in North America, targeting primarily the overwintering life stages (Cappaert et al. 2005, Wang et al. 2010, Duan et al. 2012b, Jennings et al. 2013). Pathogenic fungi such as *Beauveria bassiana* (Balsamo) Vuillemin, *Paecilomyces farinosus* (Holm ex SF Gray) Brown and Smith, *Paecilomyces fumosoroseus* (Wize) Brown and Smith, *Verticillium lecanii* (Zimmerman) Viegas, and *Metarhizium anisopliae* (Metschnikoff) Sorokin were also recovered in North America from field-collected EAB larvae, pupae, and adults (Liu et al. 2003, Bauer et al. 2007).

Biology of the other treated *Agrilus*

Besides EAB, life-history studies have been published on only three additional species of the 33 *Agrilus* taxa treated in this guide, including *Agrilus cyaneoniger* Saunders, *Agrilus opulentus* Kerremans, and *Agrilus viridissimus* Cobos. These three species were likely studied in some detail because each had reached outbreak levels that resulted in localized tree mortality. For example, *A. cyaneoniger* was reported to kill *Quercus mongolica* in China (Gao et al. 2010, Yu et al. 2011), *A. opulentus* killed *Eucalyptus deglupta* in Papua New Guinea (Roberts 1987), and *A. viridissimus* killed *Terminalia brassii* and *T. catappa* in Papua New Guinea (Mercer 1985, 1986, Roberts 1987). In addition to the species listed above, *Agrilus agnatus* Kerremans, *Agrilus auristernum* Obenberger, and *Agrilus lafertei* Kerremans are associated with *Quercus* (Jendek 2000b, Jendek and Grebennikov 2011).

In Jilin Province, China, Gao et al. (2010) reported that most *A. cyaneoniger* required two years to complete one generation. Larvae generally overwintered as second instars in the cambial region during their first year of development and as fifth (final) instars in pupal cells in the outer bark during their second year. Pupation usually occurred over a 2-week period in May, with adult activity peaking in June. Adults fed on host foliage, mated on the bark surface, and laid eggs in bark cracks along the trunk and branches. Gao et al. (2010) also noted that eggs were most often laid singly and required about 10 days before larval eclosion. Working in the same outbreak area of China, Yu et al. (2011) noted that populations of *A. cyaneoniger* fell to endemic levels within five years of the initial outbreak, and that woodpecker predation and parasitism were likely responsible, in part, for this decline.

In Papua New Guinea, *A. opulentus* is reported to complete a generation in as little as 6–7 weeks (Roberts 1987) and *A. viridissimus* in about 3 months (Mercer 1985). These relatively short generation times typically occur when larvae develop in stressed, small diameter, or recently cut trees, whereas 9–12 months is usually required when larvae of these two species develop in living, larger-diameter trees (Roberts 1987). Adults of both *A. opulentus* and *A. viridissimus* feed on host foliage prior to mating and oviposition and then lay eggs, usually singly, in bark cracks (Roberts 1987). Larvae of both species develop in the cambial region and pupation occurs in the outer sapwood. In Papua New Guinea, *A. opulentus* is primarily a pest in young *Eucalyptus deglupta* plantations and also develops in native *Syzygium* trees, which are all members of the Myrtaceae (Roberts 1987). In Papua New Guinea, *A. viridissimus* is reported to develop in several species of *Terminalia* (Combretaceae) (Mercer 1986, Roberts 1987).

List of species and diagnosis of *Agrilus* species groups included in this guide

A combination of the following adult characters is shared by species related to EAB and included in this guide. That is, these characters will assist in determining whether the specimen in question was included in this guide.

BODY:
-Body size medium to large (6–17 mm).
-Body shape cuneiform (apical third of elytra markedly converging, elytral apex narrow.

HEAD:
-Head shape obviously flat.
-Medial impression deep to moderately shallow reaching frons and vertex.
-Epistoma with raised upper margin.
-Size of eyes moderate to large.
-Antennae moderate to long (reaching middle of pronotum and longer) and slender.

THORAX:
-Pronotum shape transverse.
-Anterior margin narrower than posterior or equal, rarely posterior narrower.
-Pronotal lateral margins straight, arcuate, or markedly arcuate.
-Pronotum widest medially or rarely subapically.
-Pronotum with obvious lateral depressions; disk (medially) weakly impressed or deep impression medially or antero- and posteromedially.
-Marginal and submarginal interspace narrow to moderate, rarely wide; subparallel or strongly convergent; junction present or absent.
-Anterior pronotal lobe moderate or obvious.
-Prehumeri carinal, filamentary, or absent.
-Prehumeral posterior end joining posterior pronotal angle.
-Humeral carina absent.
-Metasternal projection flat.

-Scutellar size ranges from very small to moderate.
-Length of scutellar projection shorter than scutellar disk height or equal to or slightly greater than scutellar disk height.
-Elytral apices separately arcuate, subangulate, spinose.

Group 1. *Agrilus ascanius* species-group

Agrilus ascanius Deyrolle, 1864
Agrilus cuprifrons Deyrolle, 1864
Agrilus maculiventris Deyrolle, 1864
Agrilus mcgregori Fisher, 1926
Agrilus opulentus Kerremans, 1900
Agrilus sapphirinus Jendek & Chamorro, 2012
Agrilus seramensis Jendek & Chamorro, 2012
Agrilus validus Deyrolle, 1864
Agrilus viridissimus Cobos, 1964
Agrilus woodlarkianus Kerremans, 1900

These species are recognized by the combined possession of the following traits: body size moderate (less than 10 mm); robust shape; head obviously large; eyes markedly protruding; pronotum weakly transverse or square, disk impression weak; prehumeri carinal; marginal and submarginal carinae subparallel (convergence absent), junction absent (except *A. sapphirinus*, which has obvious convergent carinae and junction) with interspace narrow or moderate; scutellum medium-sized, scutellar projection as long as or longer than scutellar disk length; elytra markedly tapering apically; elytral apices arcuate, subangulate, cuspidate or spinose; with tomentose pattern on pronotum, elytra or abdomen (except *A. sapphirinus*).

Group 2. *Agrilus cyaneoniger* species-group

Agrilus agnatus Kerremans, 1892
Agrilus auristernum Obenberger, 1924
Agrilus bifoveolatus Kerremans, 1895
Agrilus crepuscularis Jendek & Chamorro, 2012
Agrilus cyaneoniger Saunders, 1873
Agrilus lafertei Kerremans, 1892
Agrilus lubopetri Jendek, 2000
Agrilus planipennis Fairmaire, 1888
Agrilus pseudolubopetri Jendek & Chamorro, 2012

Agrilus qinling Jendek, 2000
Agrilus rubensteini Chamorro & Jendek, 2014
Agrilus tomentipennis Jendek & Chamorro, 2012

These species are characterized by the combined possession of the following traits: body size large (greater than 10 mm), elongate (elytra longer than 4 times pronotal length); eyes medium to large; head medially impressed; pronotal disk with deep medial impression (entire or anteromedial and posteromedial); marginal and submarginal carinae convergent with narrow interspace broadest medially or anteriorly; scutellum very small, usually impressed and with a reduced scutellar projection; elytra largely glabrous, feebly tapering at apical part; rarely with preapical perisutural tomentum or apical pubescence; elytral apices separately arcuate. Some species within this group possess bright, golden tomentum and/or sides of pronotum strongly arcuate. *Agrilus planipennis* and *A. tomentipennis* have defined prehumeri; *A. auristernum* has filamentary prehumeri; in all other species the prehumeri are absent.

Group 3. *Agrilus hewitti* species-group

Agrilus daillieri Baudon, 1965
Agrilus hewitti Kerremans, 1912

The combined possession of the following traits distinguishes this group: body size large (greater than 12 mm), robust shape; eyes medium to large; head characteristically deeply impressed medially; pronotum trapezoidal (widest at base); obviously transverse, with deep medial and lateral impressions; prehumeri carinal, markedly arcuate or bisinuate, with anterior end joining lateral carina or anterior pronotal angle; marginal and submarginal carinae convergent with narrow interspace; scutellum normal or large with scutellar projection moderately sized (approximately as long as scutellum is tall); elytra only feebly tapering apically; elytral apices widely separated, arcuate.

Group 4. *Agrilus piliventris* species-group

Agrilus ampliatus Kerremans, 1900
Agrilus maculipennis Kerremans, 1900
Agrilus ostrinus Kerremans, 1892
Agrilus piliventris Deyrolle, 1864
Agrilus pseudoostrinus Jendek, 2000
Agrilus spineus Jendek & Chamorro, 2012

These species are recognized by the combined possession of the following traits: body size moderate (less than 10 mm); robust shape; pronotum transverse or square, disk impression weak; prehumeri carinal; marginal and submarginal carina convergent with interspace narrow or moderate; scutellum medium-sized, scutellar projection as long as or longer than scutellar height; elytra markedly tapering apically; elytral apices subangulate, cuspidate or spinose; venter with bright, golden tomentum; pronotum, elytra or abdomen also with tomentum.

Group 5. *Agrilus sinensis* species-group

Agrilus coreanus Obenberger, 1935
Agrilus sinensis sinensis Thomson, 1879
Agrilus sinensis splendidicollis Fairmaire, 1889

The species in this group are easily distinguished from others treated in this guide by the following traits: body size moderate to large (8–12 mm); eyes medium to large; head medially impressed; pronotum shape transverse, trapezoidal with deep medial impression (anteromedial and posteromedial), marginal and submarginal carinae subparallel, not convergent, junction absent; interspace moderate, broadest anteriorly; prehumeri filamentary to carinal; scutellum rectangular, scutellar carina present, scutellar projection small (less than height of scutellum); elytra glabrous, apices widely separated, arcuate.

Adult and larval morphology

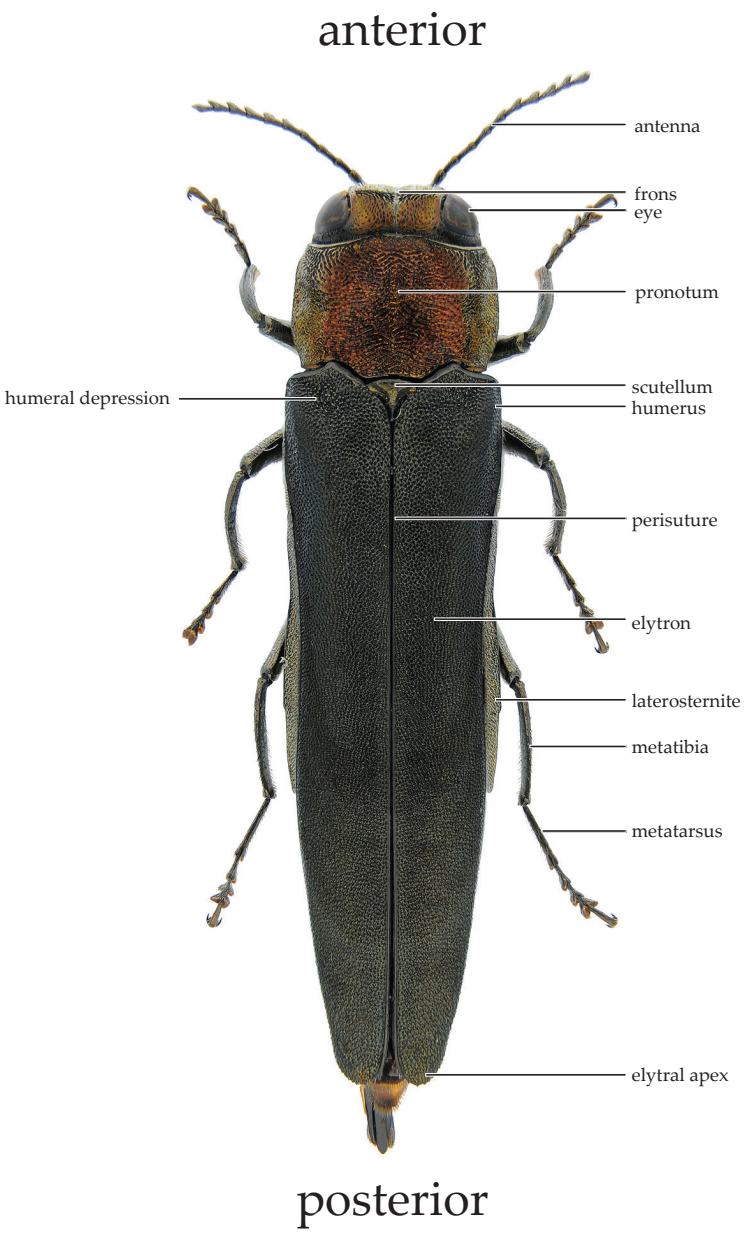


Figure 2. *Agrilus cyaneoniger*: dorsal view.

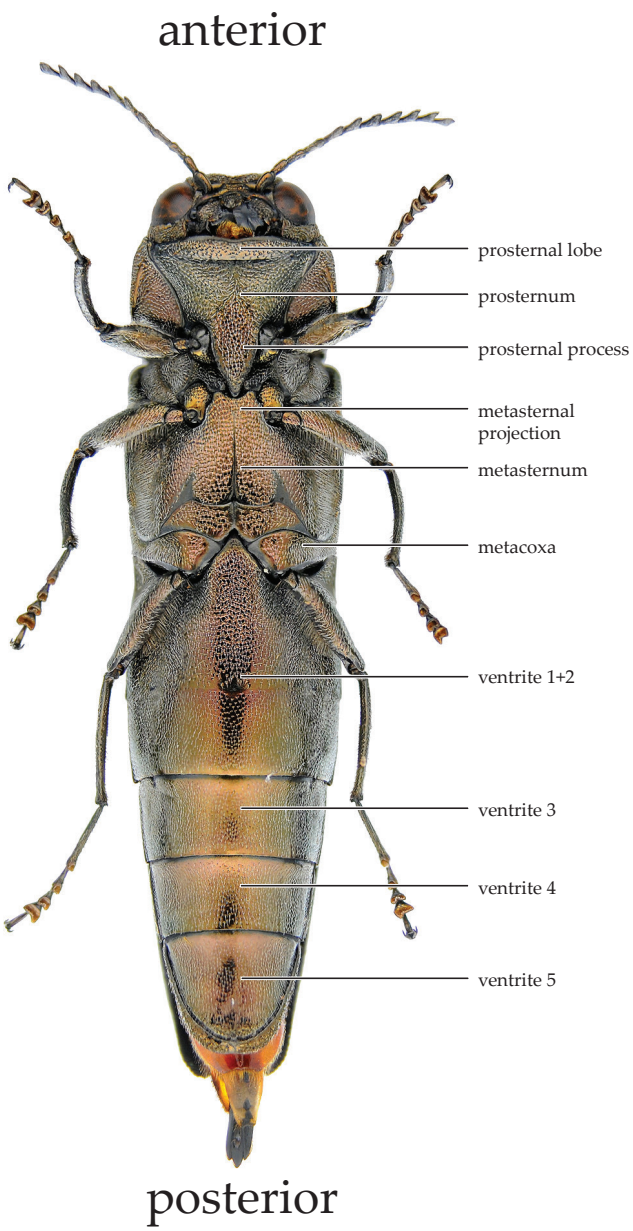


Figure 3. *Agrilus cyaneoniger*: ventral view.

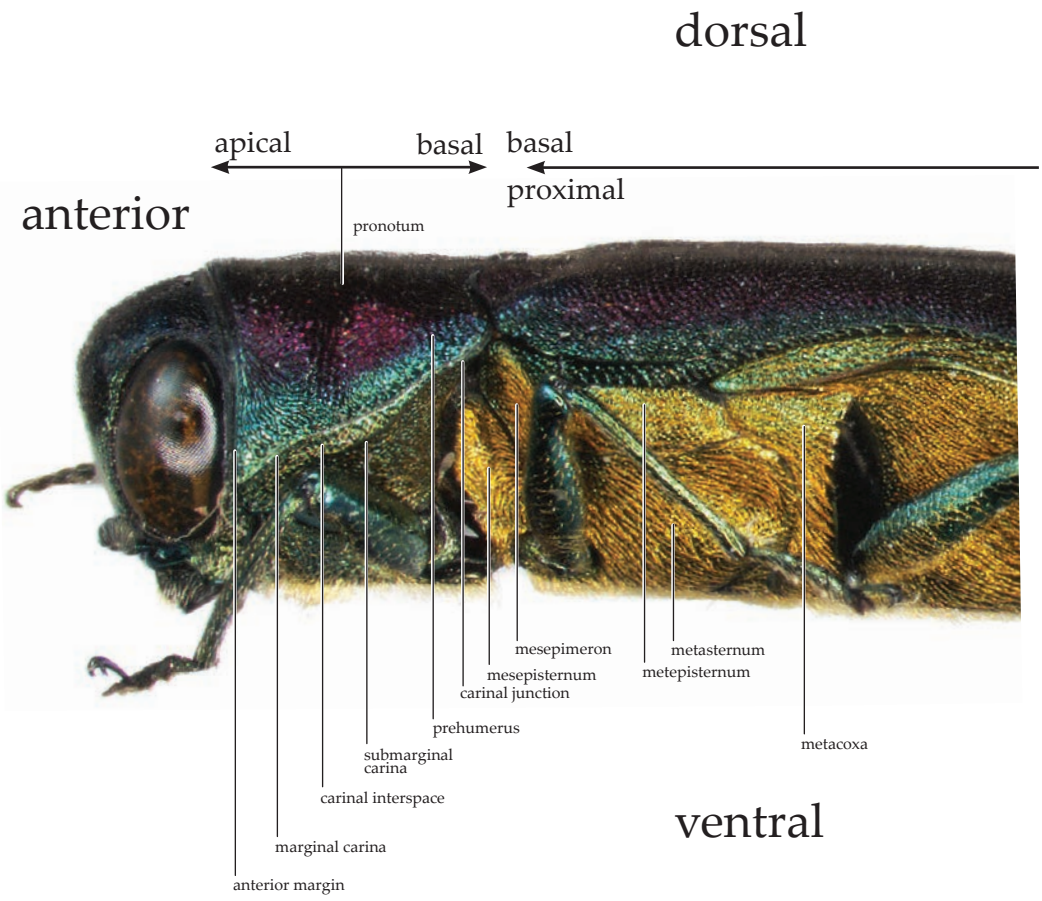


Figure 4. *Agrilus crepuscularis*: lateral view.

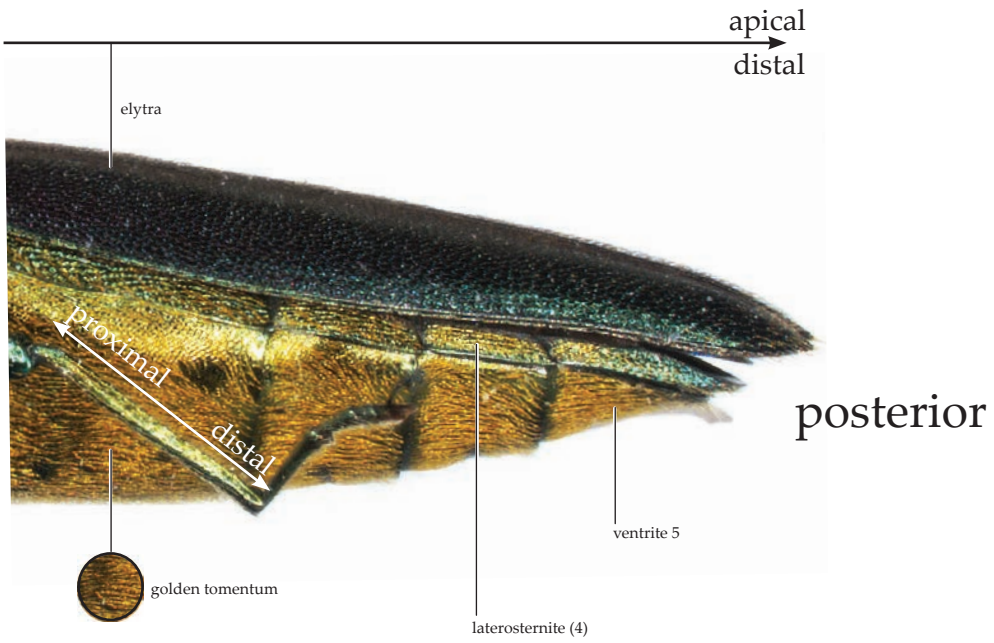
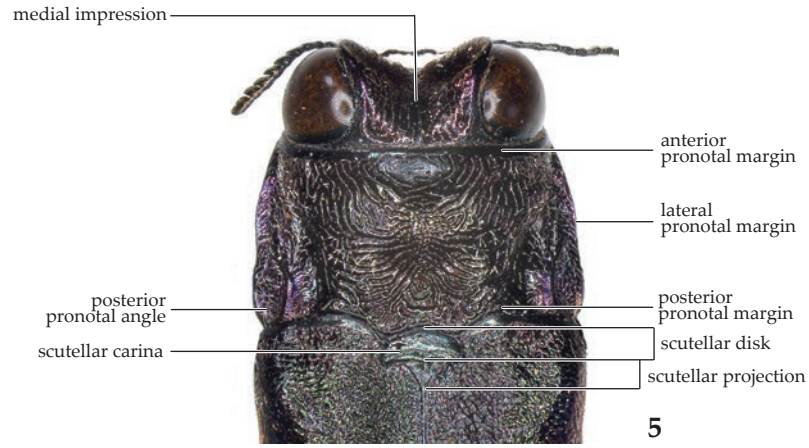
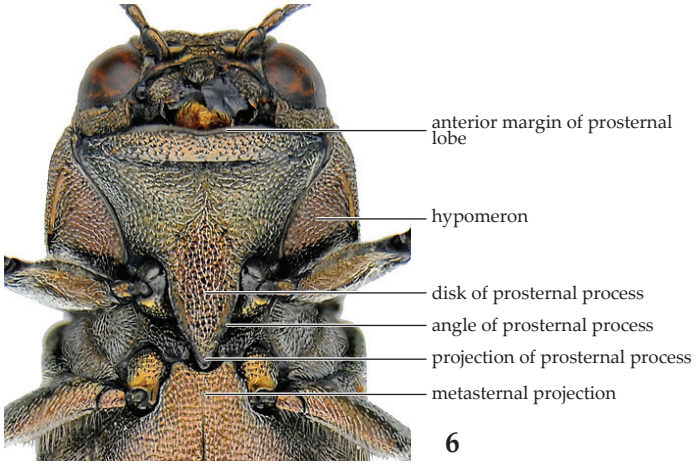


Figure 4. *Agrilus crepuscularis*: lateral view (continued).





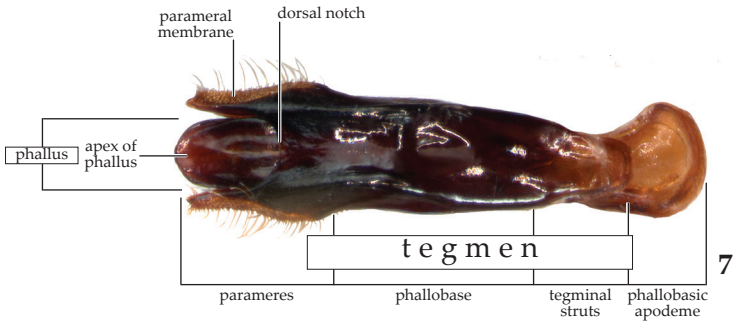
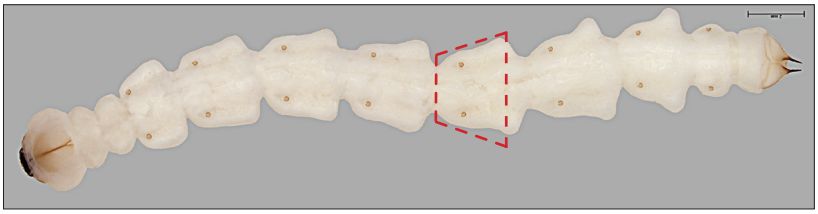


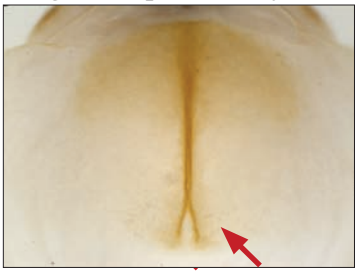
Figure 5. *Agrilus hewitti*: dorsal view of head pronotum, scutellum, and base of elytra; Figure 6. *Agrilus cyaneoniger*: ventral view; head, prosternum, meso- and metasternum; Figure 7. *Agrlius coreanus*, dorsal view of aedeagus.

Figure 8. *Agrilus planipennis* instar IV larva: dorsal view.

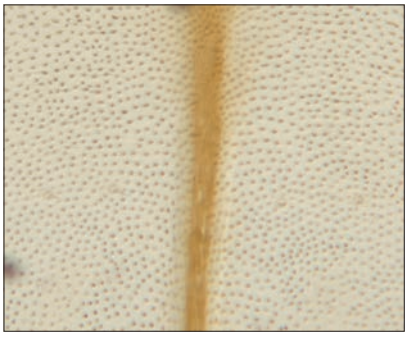
Abdominal segments trapezoidal



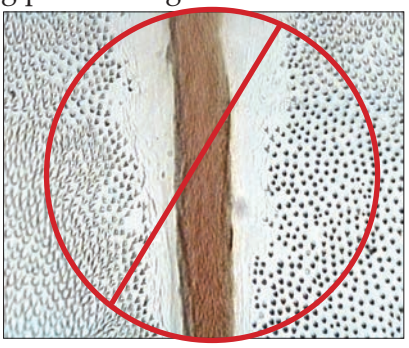
Pronotal groove posteriorly bifurcated



Smooth area not bordering prosternal groove



vs



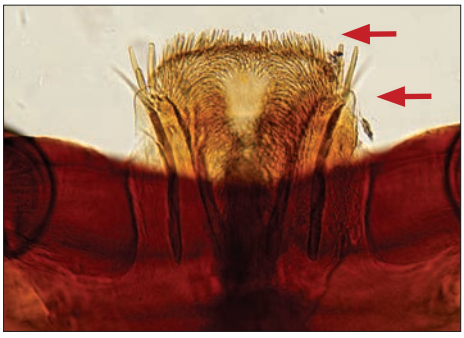
Prosternal groove entire, not bifurcated

Terminal processes long, cylindrical and narrow, with few setae & subdivisions (ledges) present on internal margin of terminal processes

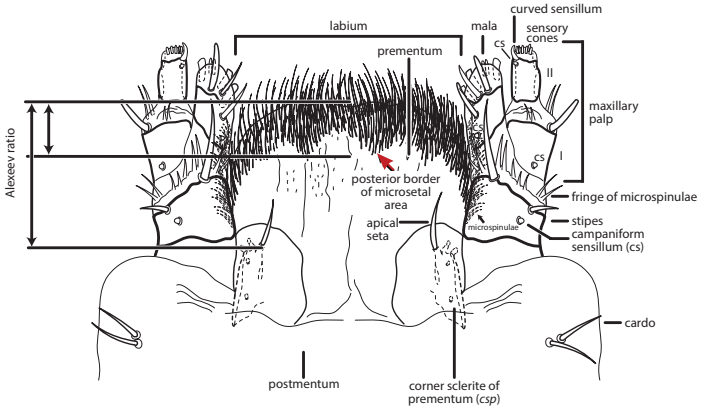
vs

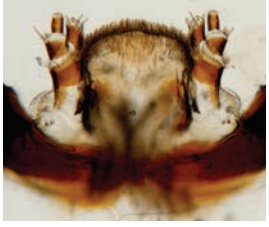
Labrum uniformly rounded & anterior margin of labrum glabrous

vs



Posterior contour of microsetal area of labium jagged (zigzag; Alexeev ratio 1/3; & presence of microspinulae subapically on the mala and internal surface of stipes and cardo



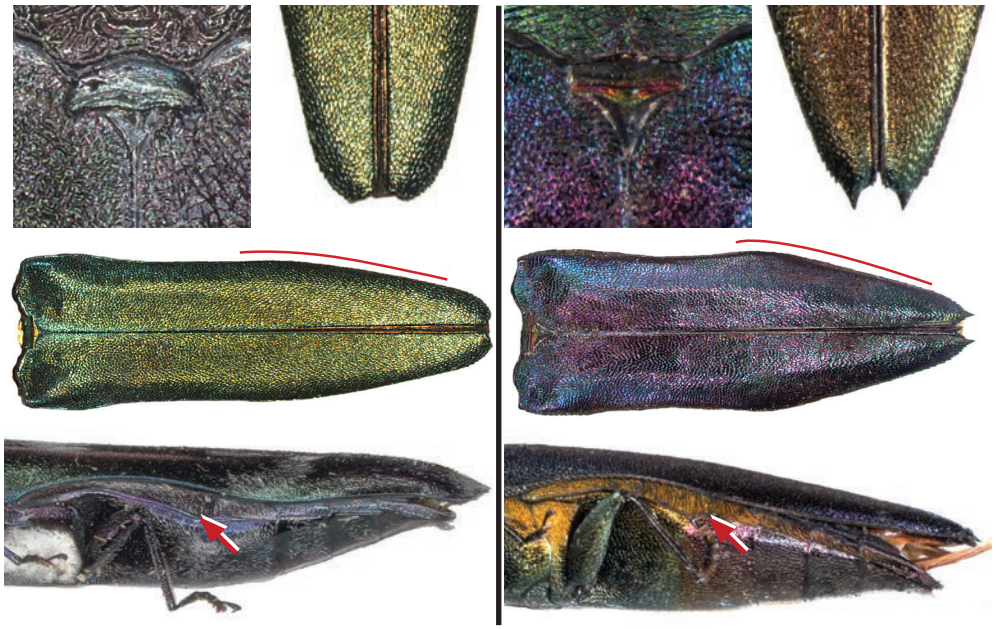


Key to species included in the identification guide

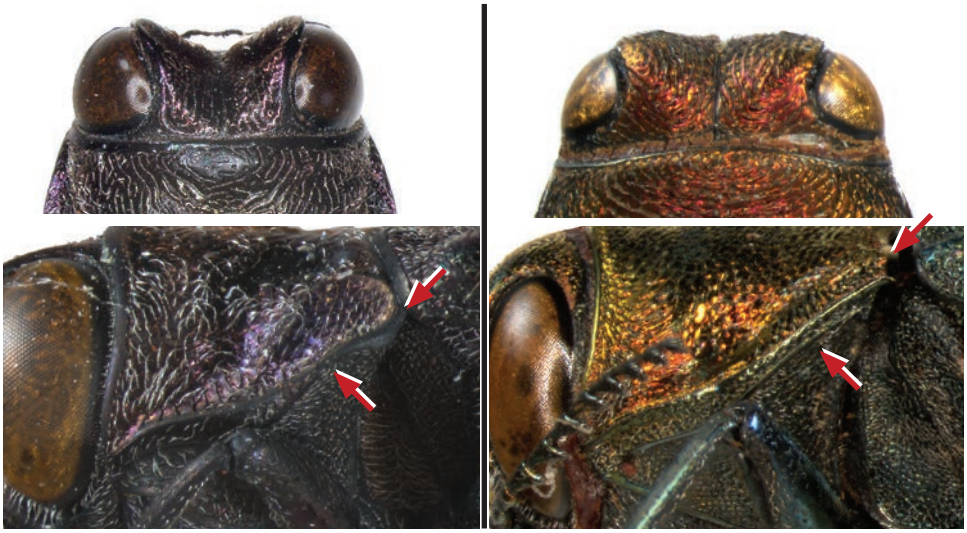
Key to species included in the identification guide

1. Scutellum small (obsolete), usually without transverse carina, disk impressed ...22
- Scutellum medium to large, with transverse carina, disk not impressed 2

2. Scutellar projection equal to or shorter than length of scutellum; elytra feeble tapering apically, apices without spines; ventrites and/or laterosternites without bright, golden tomentum.....3
- Scutellar projection large, approximately as long as scutellar length or larger; elytra markedly tapering apically, apices with or without spine; ventrites and/or laterosternites usually with bright, golden tomentum 7



3. Body large and robust; eyes large; frons deeply impressed medially; marginal and submarginal carina convergent, junction present; posterior end of prehumeri joining posterior pronotal angle.....4 (*Agrilus hewitti* group)
- Body large; eyes moderate to large; head and pronotum metallic red to cupreous-red; frons medially weakly to moderately impressed; marginal and submarginal carina subparallel, convergence absent, junction absent; posterior end of prehumeri joining posterior pronotal margin.....5 (*Agrilus sinensis* group)



4. Body color metallic purple; white tomentum present on pronotum, elytra proximally and distally, on laterosternites, and pro-, meso-, and metasternum; aedeagus produced laterally .....*Agrilus hewitti* Kerremans
- Body color metallic blue turning purple apically; narrow strip of white tomentum on elytra directly opposite scutellum, on laterosternites, and patches ventrally; tegmen of aedeagus weakly produced laterad, phallus wide, apex pointed .....*Agrilus daillieri* Baudon

5. Anterior pronotal lobe obvious, subangulate (almost triangular); elytra black; aedeagus moderately sized, apex of phallus pointed.....*Agrilus coreanus* Obenberger
- Anterior pronotal lobe moderate, rounded; elytra bluish-green or black; aedeagus robust, dorsally enlarged, apex of phallus concave.....6

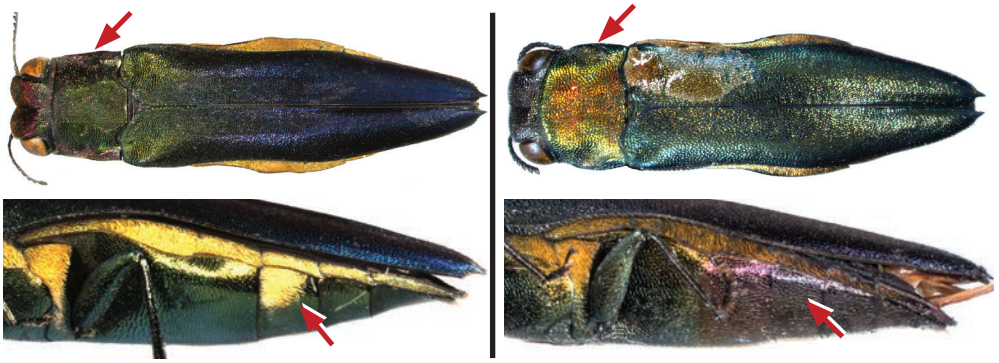
6. Elytra bluish-green.....*Agrilus sinensis splendidicollis* Fairmaire
- Elytra black.....*Agrilus sinensis sinensis* Thomson

7. Abdominal ventrites with bright, golden tomentum; eyes not markedly protruding.....17 (*Agrilus piliventris* group)
- Abdominal ventrites with or without tomentose patches; eyes markedly protruding.....8 (*Agrilus ascanius* group)

8. Abdominal ventrites completely or partially covered with golden tomentum; body variously colored.....9
- Abdominal ventrites without golden tomentum; body color metallic blue .... *Agrilus sapphirinus* Jendek & Chamorro

9. Laterosternites completely covered with golden tomentum.....10
- Laterosternites with patches of golden tomentum 13

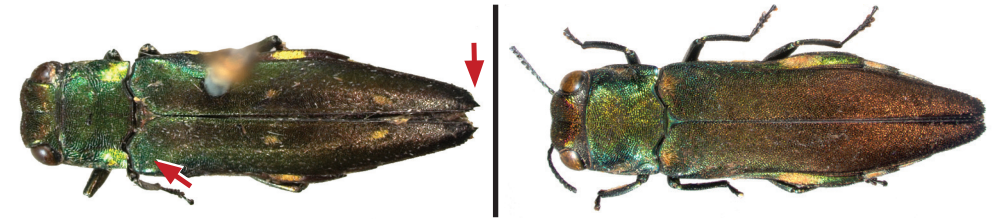
10. Frons red, pronotum and elytral bases metallic green becoming blue apically; pronotal margins straight; scutellum entirely black; ventrite 3 with golden tomentum laterally ..... *Agrilus seramensis* Jendek & Chamorro
- Dorsally not tricolored as above (red, green, blue); pronotal margins arcuate; scutellum not entirely black; ventrite 3 without golden tomentum laterally.....11



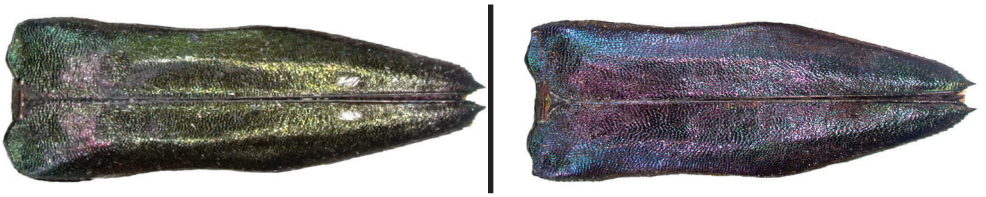
11. Pronotal disk metallic green; scutellar projection not impressed .... *Agrilus cuprifrons* Deyrolle
- Pronotal disk metallic red or reddish-orange; scutellar projection impressed.....12

12. Elytra metallic green; small to medium-sized (approximately 7 mm); abdomen unicolored ..... *Agrilus mcgregori* Fisher
- Elytra black with metallic purple luster apically; medium-sized; abdomen metallic green proximally, metallic purple distally ..... *Agrilus ascanius* Deyrolle

13. Medium-sized; elytral apices unispinose 14
- Small to medium-sized (approximately 7 mm); elytral apices lacking spines, golden tomentum on humeral depressions..... *Agrilus validus* Deyrolle

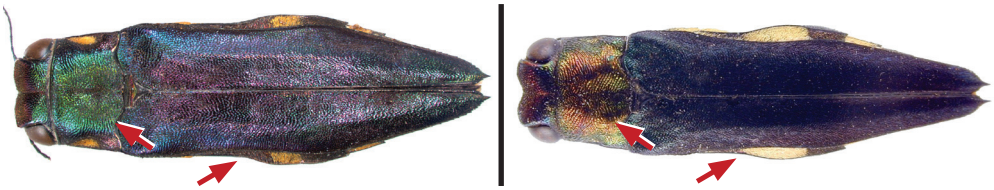


14. Tomentose spots on elytra (spots rarely rubbed off) 15
- Tomentose spots absent from elytra 16



15. One pair of tomentose spots on each elytron: medially and subapically (4 in total on elytra); pronotum lacking lateral golden tomentum.....*Agrilus viridissimus* Cobos
- One pair or a single tomentose spot on each elytron: (2 or 4 in total on elytra); pronotum with lateral golden tomentum.....*Agrilus opulentus* Kerremans

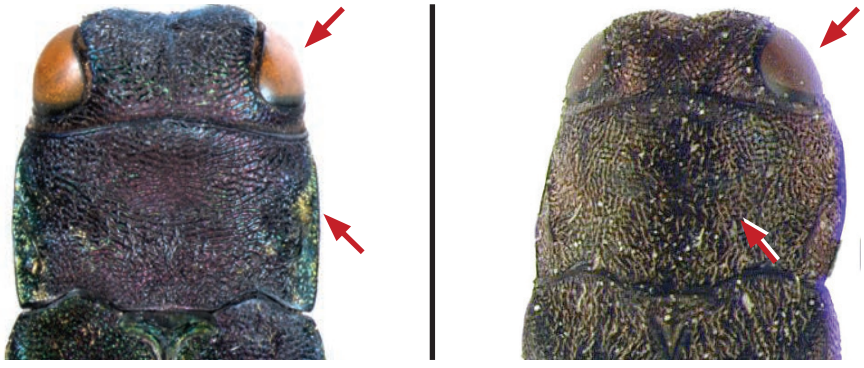
16. Pronotal disk metallic green; elytra metallic blue; proximal golden tomentum on laterosternites reduced ..... *Agrilus woodlarkianus* Kerremans
- Pronotal disk metallic reddish-orange; elytra black becoming purple apically; proximal golden tomentum on laterosternites large, reaching anterior narrowed section... .....*Agrilus maculiventris* Deyrolle



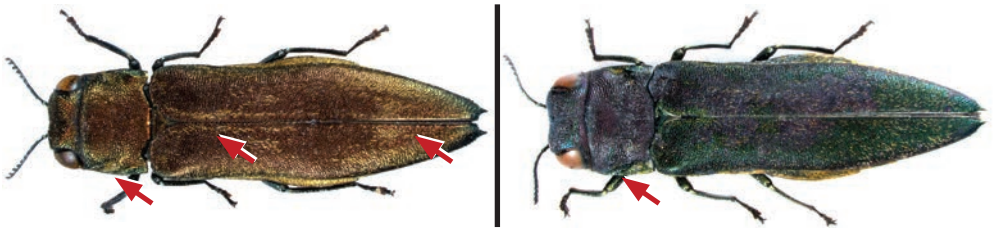
17. Pronotum metallic violet-red 18
- Pronotum variously colored: metallic copper, olive green with blue or gold, black...19

18. Elytra not same color as pronotum, instead black with metallic greenish-yellow apex; pronotal margins arcuate ..... *Agrilus piliventris* Deyrolle
- Elytra same color as pronotum, metallic violet-red; pronotal margins entire.....
..... *Agrilus ostrinus* Kerremans

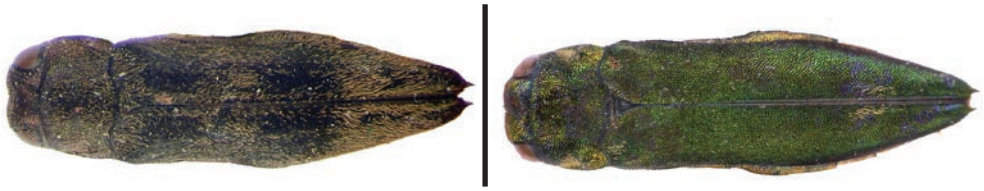
19. Size small to moderate (less than 9 mm); eyes slightly bulging beyond head margin; tomentum on pronotum absent or if present located mesolaterally 20
- Size moderate (greater than 10 mm); eyes not bulging beyond head margin; tomentum on pronotum present.....21



20. Color dorsally and ventrally metallic copper; pronotal lateral margin weakly arcuate; elytra with proximal and distal perisutural golden tomentum .....
.....*Agrilus pseudoostrinus* Jendek
- Color dorsally metallic olive green-blue, ventrally metallic green; pronotal lateral margin arcuate; elytra with scattered pubescence .....*Agrilus spineus* Jendek & Chamorro

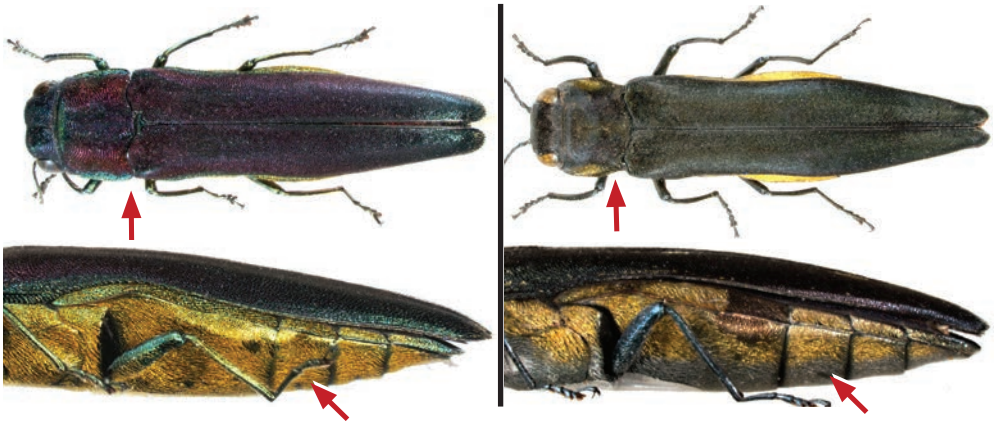


21. Color black; elytra with proximal and distal golden tomentum .....
.....*Agrilus ampliatus* Kerremans
- Color dorsally metallic olive green; elytra with golden tomentum in humeral depression and as a pair of tomentose patches on elytral sutural margin approximately ¼ from apex.....*Agrilus maculipennis* Kerremans



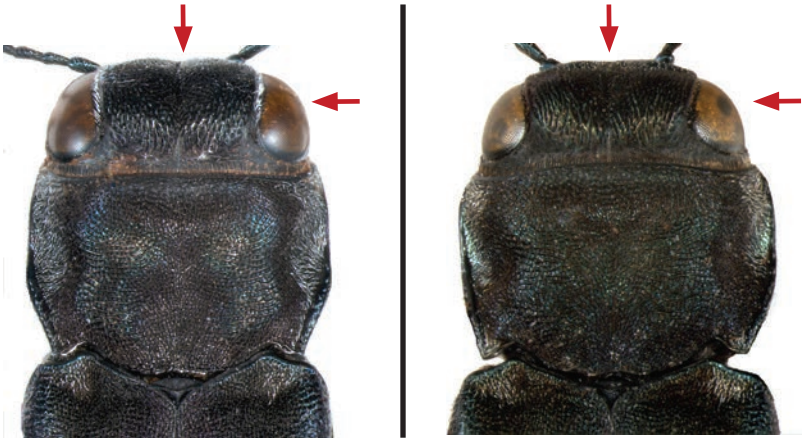
22. Abdominal ventrites with bright, golden tomentum, may also be present on laterosternites 23
- Abdominal ventrites without bright, golden tomentum 29

23. Color dorsally mostly metallic violet-red; abdominal ventrites covered entirely with golden tomentum; pronotum transverse, posterior pronotal and elytral humeral angles continuous (i.e. pronotal sides not markedly arcuate).....
.....*Agrilus crepuscularis* Jendek & Chamorro
- Color dorsally generally black or blue; abdominal ventrites with golden tomentum laterad; posterior pronotal and elytral humeral angles not continuous (i.e. pronotal sides arcuate to markedly arcuate).....24



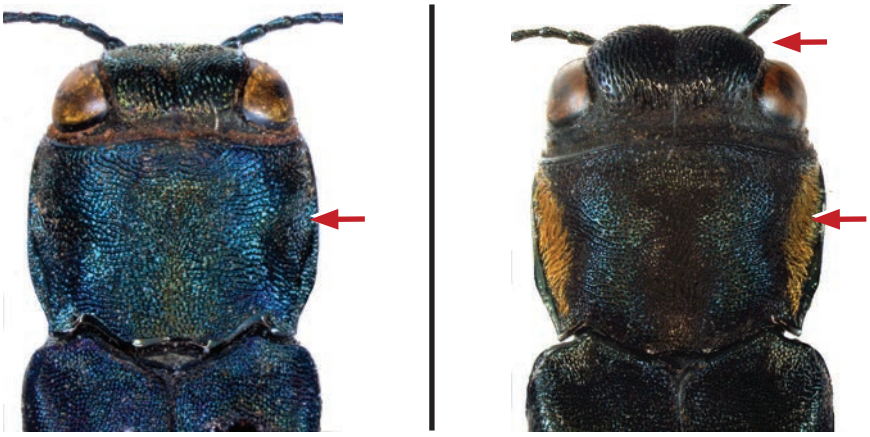
24. Color dorsally black to dark blue; elytra lacking golden tomentose spots 25
- Color dorsally blue, violet, or black; if black, elytra with 4 golden tomentose spots (2 on each elytron).....27

25. Frons with pronounced medial impression; eyes protruding beyond head outline; sides of pronotum with or without golden tomentose patches 26
- Frons with weak medial impression; eyes not protruding beyond head outline; sides of pronotum with white tomentose patches; apex of phallus cuspidate .... *Agrilus lafertei* Kerremans



26. Sides of pronotum with golden tomentose patches..... *Agrilus qinling* Jendek
-Sides of pronotum with white tomentose patches .....*Agrilus agnatus* Kerremans

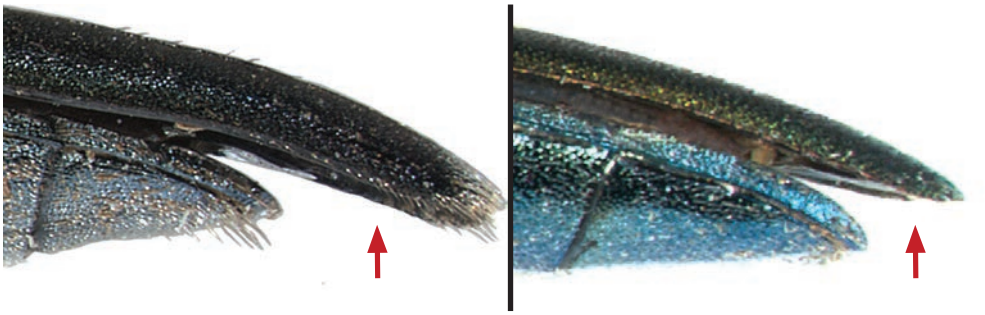
27. Frons not greatly protruding beyond head outline (or eye margin); elytra without golden tomentose spots, apically with or without white tomentum 28
- Frons greatly protruding beyond head outline (or eye margin); elytra with 4 golden tomentose spots (2 on each elytron), perisuture apically with patches of white tomentum ..... *Agrilus bifoveolatus* Kerremans

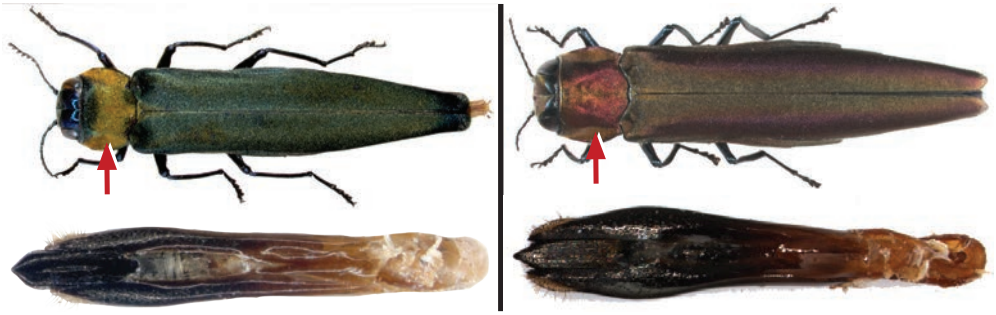


28. Body metallic blue; sides of pronotum without bright, golden tomentum, prehumeri filamentary; elytra subapically with white perisutural tomentum .....
.....*Agrilus auristernum* Obenberger
- Body black; sides of pronotum with bright, golden tomentum (female), prehumeri absent; elytra subapically without white perisutural tomentum .....
..... *Agrilus rubensteini* Chamorro & Jendek

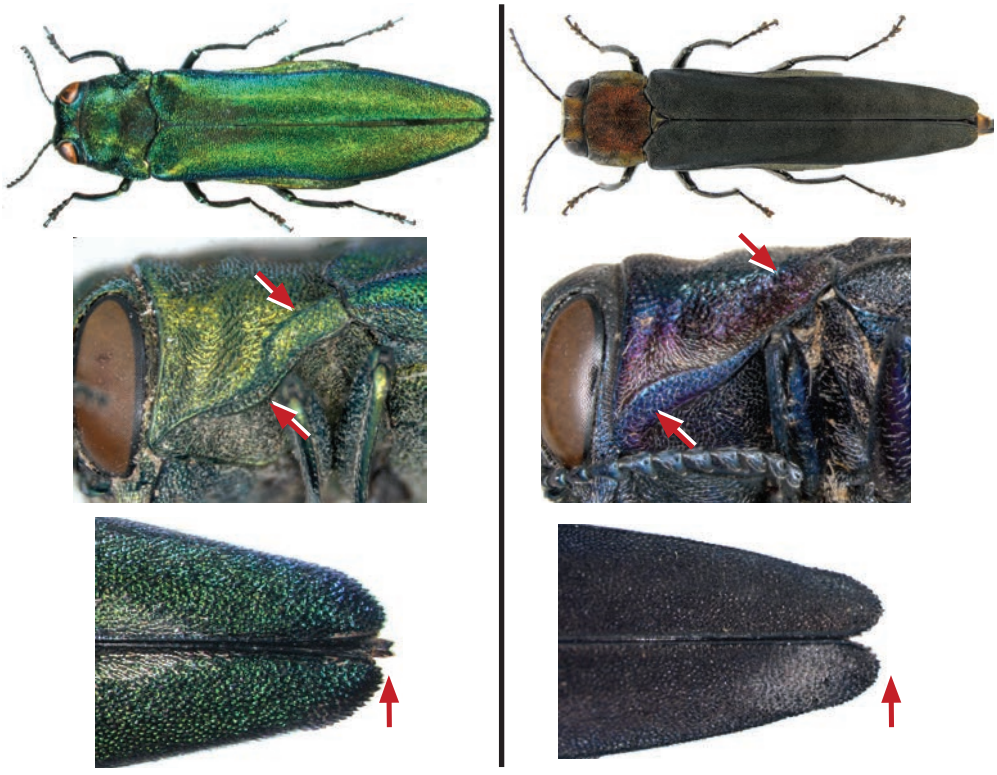
29. Body slender and elongate (pronotal:elytral ratio greater than 4.5:1); color of males metallic blue-green to cupreous, females may or may not be metallic violet; pronotal marginal carina terminating before anterior (pronotal) angle; females with golden tomentum on pronotum.....30
- Body broad, not greatly elongate (pronotal:elytral ration less than 4:1); color of elytra metallic green or black; pronotal marginal carina terminating at anterior (pronotal) angle; females without golden pronotal tomentum 31

30. Elytral apices greatly extending beyond the abdomen, approximately by length of last ventrite; tegmina of aedeagus with sides before apex weakly produced laterad, apex of phallus deltoid; females with orange tomentum on almost entire dorsum of pronotum..... *Agrilus lubopetri* Jendek
- Elytral apices extending slightly beyond the abdomen, less than length of ventrite 5; tegmina of aedeagus with sides subapically widened; apex of phallus deltoid; females metallic violet with orange setae on the sides of the pronotum, not covering entire dorsum of pronotum .....*Agrilus pseudolubopetri* Jendek & Chamorro

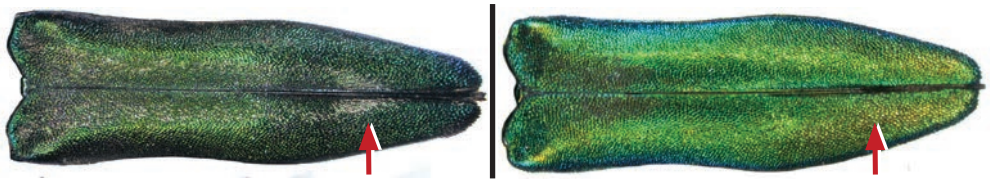




31. Color of elytra metallic green rarely violet or cupreous; pronotum transverse and trapezoidal; prehumerus well developed; pronotal intercarinal space broadest medially; pygidium bearing apical spine.....32
- Color of elytra black to bluish-black; pronotum transverse with lateral margins arcuate; prehumeral carina absent; pronotal carinal interspace broadest anteriorly; pygidium without apical spine..... *Agrilus cyaneoniger* Saunders



32. Subapex of elytra with a pair of white tomentose spots near perisuture .... *Agrilus tomentipennis* Jendek & Chamorro
- Elytra lacking pair of white tomentose spots .....*Agrilus planipennis* Fairmaire



Agrilus ascanius group

Agrilus ascanius Deyrolle, 1864

Diagnosis
Body broad, size medium. Color of pronotal disk metallic red with yellow-orange sides; elytra black turning metallic purple apically; golden tomentum covering laterosternites, metepisternites, and metacoxae laterally. Eyes markedly protruding beyond head outline. Frons metallic red with medial vertical impression and produced anterad. Anterior margin of pronotum slightly narrower than posterior, lateral margin arcuate. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum rectangular, size roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection equal to or longer than disk length, impressed. Elytral apices unispinate. Ventrites without golden tomentose patches.
Similar species: *Agrilus seramensis* has head and pronotal sides metallic red, green pronotal disk and elytral bases apically becoming blue; scutellum black; ventrite 3 and laterosternites with lateral golden tomentose spots; pronotal lateral margin straight. *Agrilus cuprifrons* has a metallic green pronotum and golden tomentum mesolaterally.

Size: 9.8 mm
Distribution: Indonesia: Maluku.
Altitude range: Unknown.
Host plants: Unknown.
Similar species: *Agrilus seramensis* Jendek & Chamorro; *A. cuprifrons* Deyrolle.

Agrilus cuprifrons Deyrolle, 1864

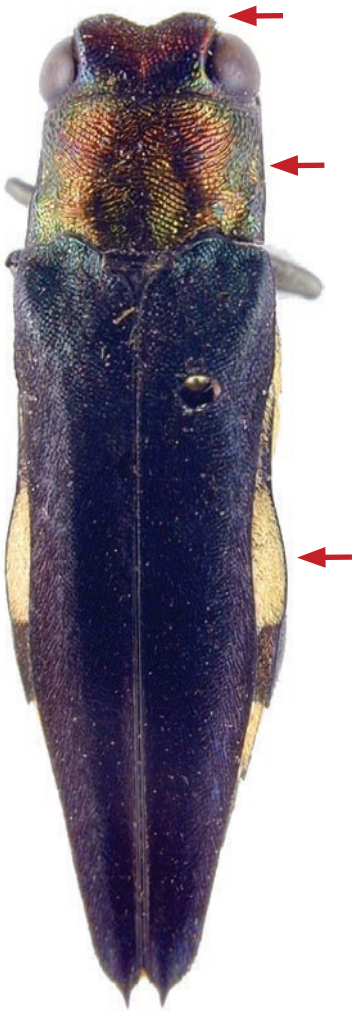
Diagnosis

Body broad, size medium. Pronotum metallic green and black elytra becoming metallic reddish-purple apically, golden tomentum mesolaterally on pronotum and competely covering laterosternites. Eyes markedly protruding beyond head outline. Frons with medial vertical impression and produced anterad. Anterior margin of pronotum slighly narrower than posterior, anterior pronotal lobe obvious. Prehumeri carinal, anterior end close to paired pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection equal to or longer than disk length. Elytral apices acutely unispinate.

Similar species: *Agrilus ascanius* has a metallic red pronotum with yellow-orange sides and black elytra; frons is less produced anterad. *Agrilus seramensis* has frons and pronotal sides metallic red, green pronotal disk and elytral bases turning metallic blue apically; lacks golden tomentum on pronotum; scutellum black, impressed distal from carina; pronotal lateral margins straight; laterosternite margins bisinuate. *Agrilus mcgregori* is small to medium-sized; has metallic red pronotum with yellow-green sides and elytra metallic dark green; prehumeri are narrower; scutellum beyond carina is slightly impressed.

Size: 10 mm
Distribution: Indonesia: Sulawesi.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ascanius Deyrolle; *A. seramensis* Jendek & Chamorro; *A. mcgregori* Fisher.

Agrilus maculiventris Deyrolle, 1864



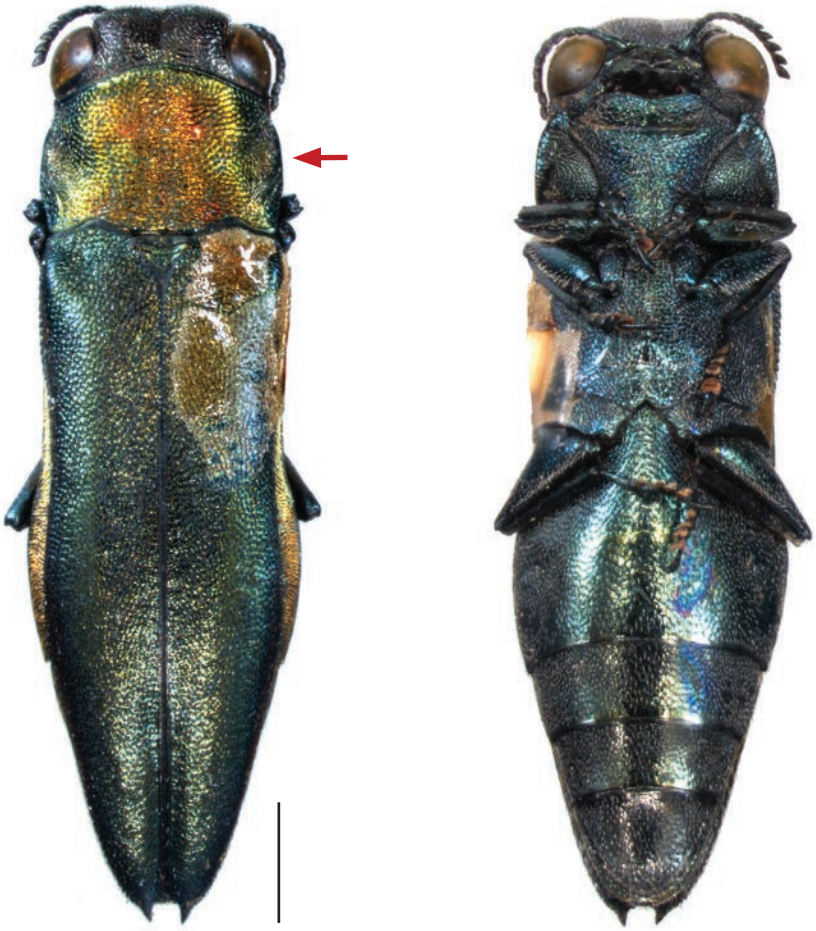
Diagnosis

Body robust, size medium. Pronotum metallic reddish-orange and elytra black with purple luster, golden tomentose patches on laterosternites. Eyes markedly protruding beyond head outline. Frons metallic red with medial vertical impression and produced anterad. Anterior margin of pronotum narrower than posterior, lateral margins straight. Prehumeri narrow, carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection large, equal to or longer than disk length, impressed. Elytral apices unispinate.

Similar species: *Agrilus woodlarkianus* has smaller proximal tomentose patches on laterosternites; has metallic green pronotal disk and blue elytra turning violet apically. *Agrilus opulentus* has a pair of subapical tomentose spots on the elytra. *Agrilus viridissimus* has a green pronotum and each elytron usually with medial and subapical tomentose spots (4 total on elytra).

Size: 11 mm
Distribution: Indonesia: Maluku; Malaysia: Sarawak.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus opulentus Kerremans;
A. woodlarkianus Kerremans;
A. viridissimus Cobos.

Agrilus mcgregori Fisher, 1926



Diagnosis

Body broad, size small to medium. Color of pronotal disk metallic cupreous-red, sides yellowish-green, elytra metallic dark green; golden tomentum on paired pronotal lateral depressions, laterosternites, metepisternites, and metacoxae laterally. Eyes markedly protruding beyond head outline. Frons produced anterad. Anterior margin of pronotum slighly narrower than posterior, lateral margins markedly arcuate, anterior lobe obvious. Prehumeri narrow, carinal, anterior end near paired pronotal marginal carinae and terminating distally beyond middle of pronotum, carinal interspaces broadening anteriorly. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection shorter than disk length, impressed. Elytral apices unispinate.

Similar species: *Agrilus ascanius* has a metallic red pronotum with yellow-orange sides and black elytra. *Agrilus cuprifrons* has a metallic green pronotum and black elytra becoming metallic reddish-violet apically. Both these species are larger, elytra ~3.5 times pronotal height.

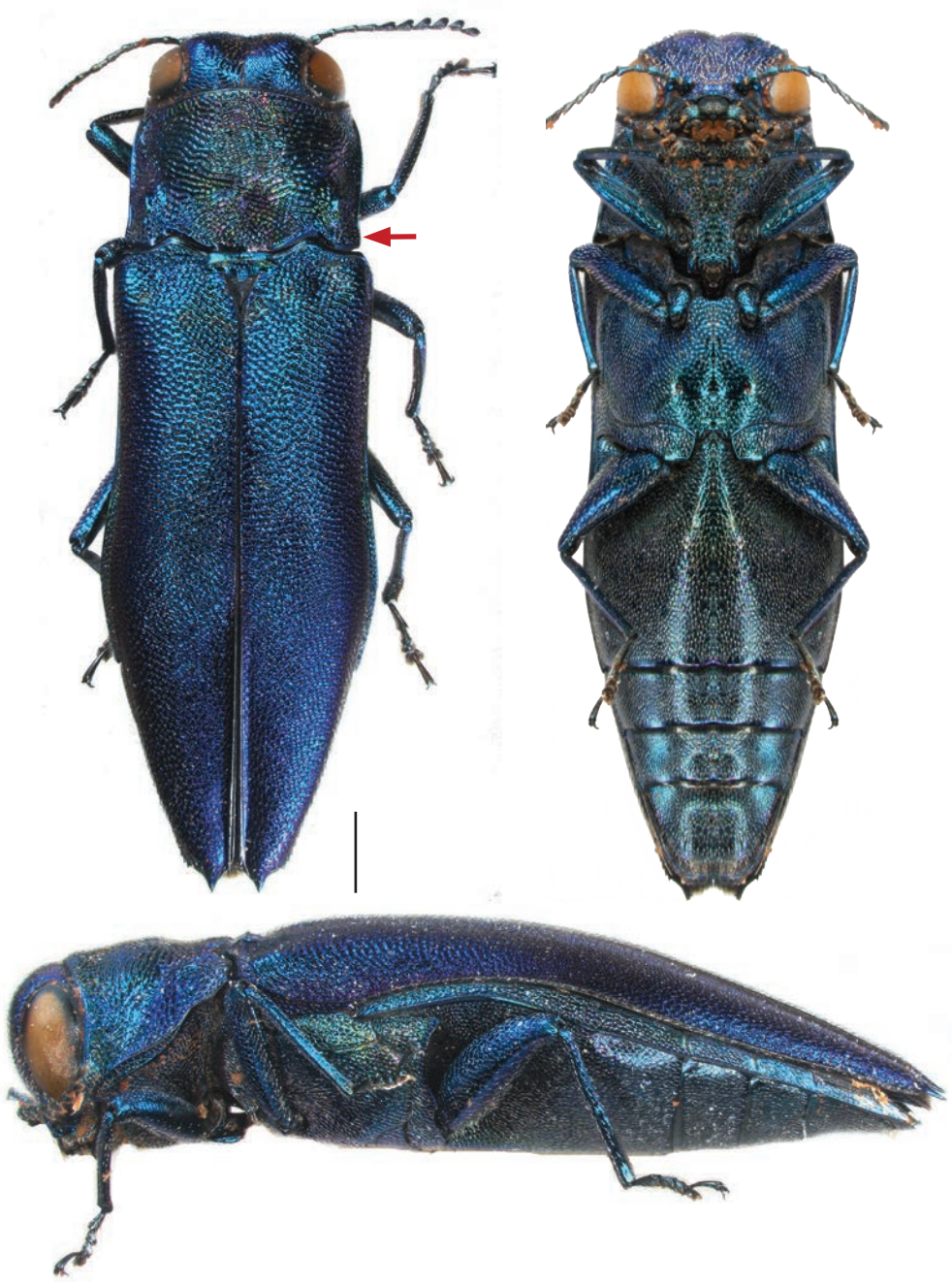
Size: 7–7.5 mm
Distribution: Philippines: Visayas islands.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ascanius Deyrolle;
Agrilus cuprifrons Deyrolle.

Agrilus opulentus Kerremans, 1900

Diagnosis
Body robust, size medium. Frons metallic red, metallic green pronotum and elytra with purple luster, golden tomentose patches on laterosternites, laterally on pronotum, on mes- and metepisternites, mesepimera, and laterally on metacoxae. Eyes markedly protruding beyond head outline. Frons with medial vertical impression and produced anterad. Anterior margin of pronotum narrower than posterior, lateral margins straight, anterior lobe moderate. Prehumeri narrow, carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection broad, equal to or longer than disk length, impressed. Elytral apices unispinate.
Similar species: *Agrilus maculiventris* has larger proximal tomentose patches on laterosternites; pronotal disk metallic red and elytra black. *Agrilus opulentus* has a pair of subapical tomentose spots on the elytra. *Agrilus viridissimus* has a medial and a subapical pair of tomentose spots on the elytra.

Size: 10–11.5 mm
Distribution: Papua New Guinea. Solomon Islands.
Altitude range: 10.0–1400 m.
Host plants: *Eucalyptus deglupta*; *Terminalia brassii*; *Elaeocarpus*: CURLETTI, 2006.
Similar species:
Agrilus maculiventris Deyrolle; *A. woodlarkianus* Kerremans.

Agrilus sapphirinus Jendek & Chamorro, 2012

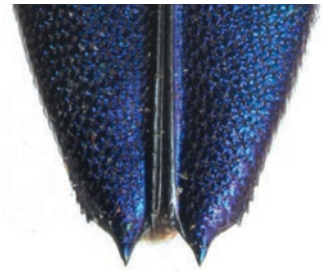


Diagnosis

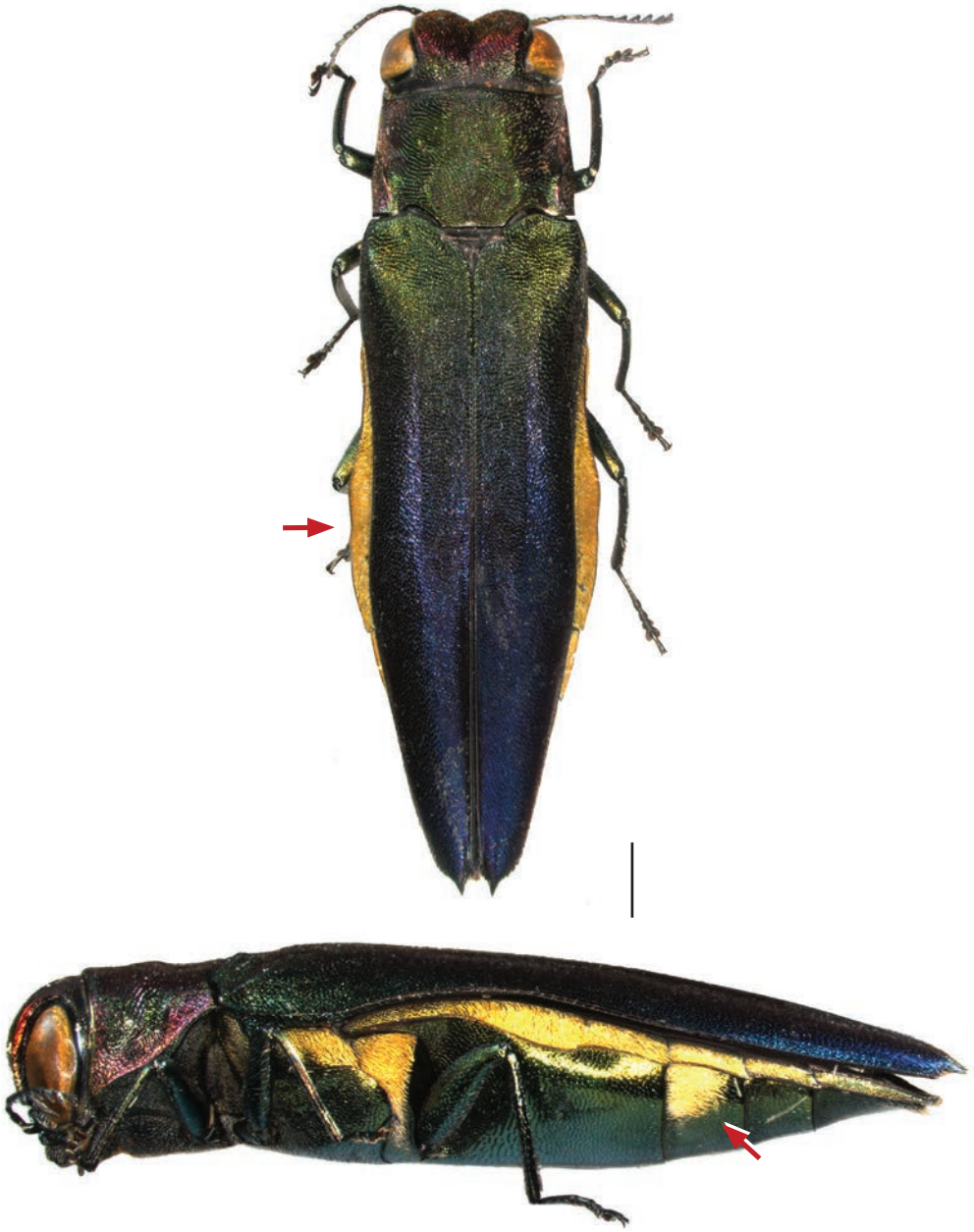
Body broad, size medium. Body color entirely metallic blue, golden tomenta absent. Eyes markedly protruding beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum slighly narrower than posterior, lateral margin slightly sinuate; marginal and submarginal interspace narrow; junction strongly convergent. Prosternal process dilated, angles acute. Prehumeri filamentary, anterior end distant from pronotal marginal carinae. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection almost as long as disk length, black, impressed. Elytral apices unispinate.

Similar species: This species is distinct due to its bright metallic blue color, lack of golden tomentum, more or less sinuate pronotal margin and rectangular posterior angle, and dilated prosternal process with acute angles. It is similar to *Agrilus ascanius* and other related species based on the presence of elytral apical spines, bulging eyes and overall appearance.

Size: 10.5 mm
Distribution: Laos.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ascanius Deyrolle.



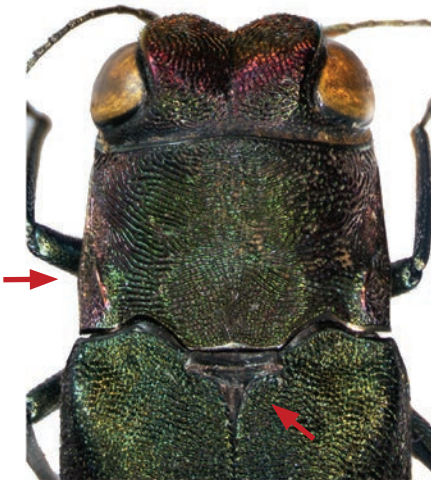
Agrilus seramensis Jendek & Chamorro, 2012



Diagnosis

Body broad, size medium to large. Frons and pronotal sides metallic red, green pronotal disk and elytral bases becoming metallic blue apically, golden tomentum on laterosternites, metepisternites, metacoxae, and laterally on ventrite 3. Eyes markedly protruding beyond head outline. Frons with medial vertical impression and produced anterad. Anterior margin of pronotum slightly narrower than posterior. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Laterosternite margins sinuate. Scutellum black, width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection as long as disk length, impressed. Elytral apices strongly unispinate. **Similar species**: *Agrilus ascanius* has a metallic red pronotum with yellow-orange sides and black elytra; frons is weakly produced anterad; pronotal margin arcuate. *Agrilus cuprifrons* has a metallic green pronotum and black elytra becoming metallic reddish-purple apically, golden tomentum present mesolaterally on pronotum.

Size: 8.0–11.5mm
Distribution: Indonesia: Maluku.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ascanius Deyrolle; *A. cuprifrons* Deyrolle.

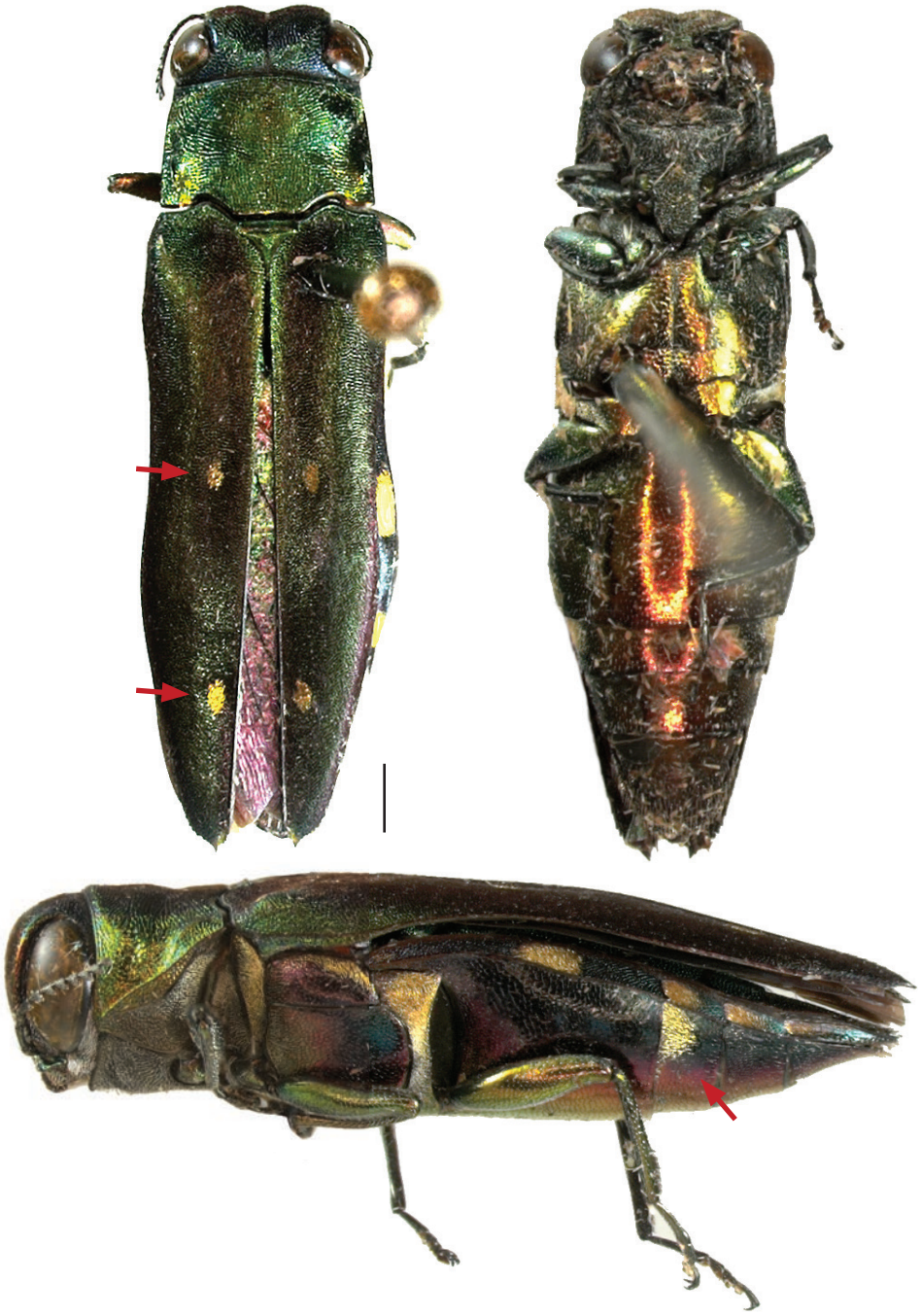


Agrilus validus Deyrolle, 1864

Diagnosis
Body slender, size small to medium. Pronotal disk and elytra metallic cupreous-green, pronotal sides yellowish-green, patches of golden tomentum on laterosternites, laterally on pronotum, humeral depressions, pair of spots on mesosternites, and metacoxae laterally. Eyes markedly protruding beyond head outline. Frons metallic red with medial vertical impression and produced anterad. Anterior margin of pronotum slightly narrower than posterior, lateral margins arcuate. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection narrow, shorter than disk length. Elytral apices separately arcuate, without spines.
Similar species: *Agrilus woodlarkianus* is usually larger, has unispinate elytral apices; metallic green-blue pronotal disk; purple-blue elytra; straight pronotal margins; broad, impressed scutellar projection; and ventrite 3 with golden tomentose patches laterally.

Size: 8–8.4 mm
Distribution: Indonesia: Sulawesi.
Altitude range: Unknown.
Host plants: Unknown.
Similar species: *Agrilus woodlarkianus* Kerremans.

Agrilus viridissimus Cobos, 1964



Diagnosis

Body robust, size medium. Pronotum metallic green and elytra cupreous-green, golden tomentose patches on laterosternites and a medial and subapical pair of tomentose spots on elytra (total of 4 spots). Eyes markedly protruding beyond head outline. Frons metallic red with medial vertical impression and produced anterad. Anterior margin of pronotum narrower than posterior, lateral margins straight. Prehumeri narrow, carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum length roughly 1/3 length of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection broad, as long as disk length, impressed. Elytral apices unispinate.

Similar species: *Agrilus woodlarkianus* has smaller proximal tomentose patches on laterosternites; has a metallic green pronotal disk and blue elytra. *Agrilus opulentus* has a pair of subapical tomentose spots on the elytra. *Agrilus maculiventris* lacks elytral tomentose spots and has a reddish-orange pronotal disk.

Size: 9–12 mm
Distribution: Papua New Guinea.
Host plants: *Terminalia catappa*: Curletti, 2006.
Similar species: *Agrilus maculiventris* Deyrolle; *A. opulentus* Kerremans; *A. woodlarkianus* Kerremans.

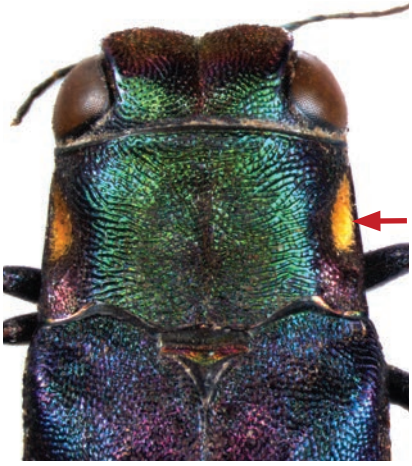
Agrilus woodlarkianus Kerremans, 1900

Diagnosis

Body robust, size medium. Pronotal disk metallic green, reddish-purple-blue pronotal sides and elytra, golden tomentose patches on laterosternites, mesepisternites, mesepimera, metepisternites, and laterally on pronotum, metacoxae and ventrite 3. Eyes markedly protruding beyond head outline. Frons metallic red with medial vertical impression and produced anterad. Anterior margin of pronotum narrower than posterior, lateral margins straight. Prehumeri narrow, carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection as long as disk length, impressed. Elytral apices unispinate. Laterosternite margins sinuate.

Similar species: *Agrilus maculiventris* has larger proximal tomentose patches on laterosternites; metallic reddish pronotal disk and black elytra. *Agrilus opulentus* has a pair of subapical tomentose spots on the elytra. *Agrilus viridissimus* has a medial and a subapical pair of tomentose spots on the elytra.

Size: 10.2–11 mm
Distribution: Papua New Guinea; Australia: Queensland.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus maculiventris Deyrolle; *A. opulentus* Kerremans; *A. viridissimus* Cobos.



Agrilus cyaneoniger group

Agrilus agnatus Kerremans, 1892

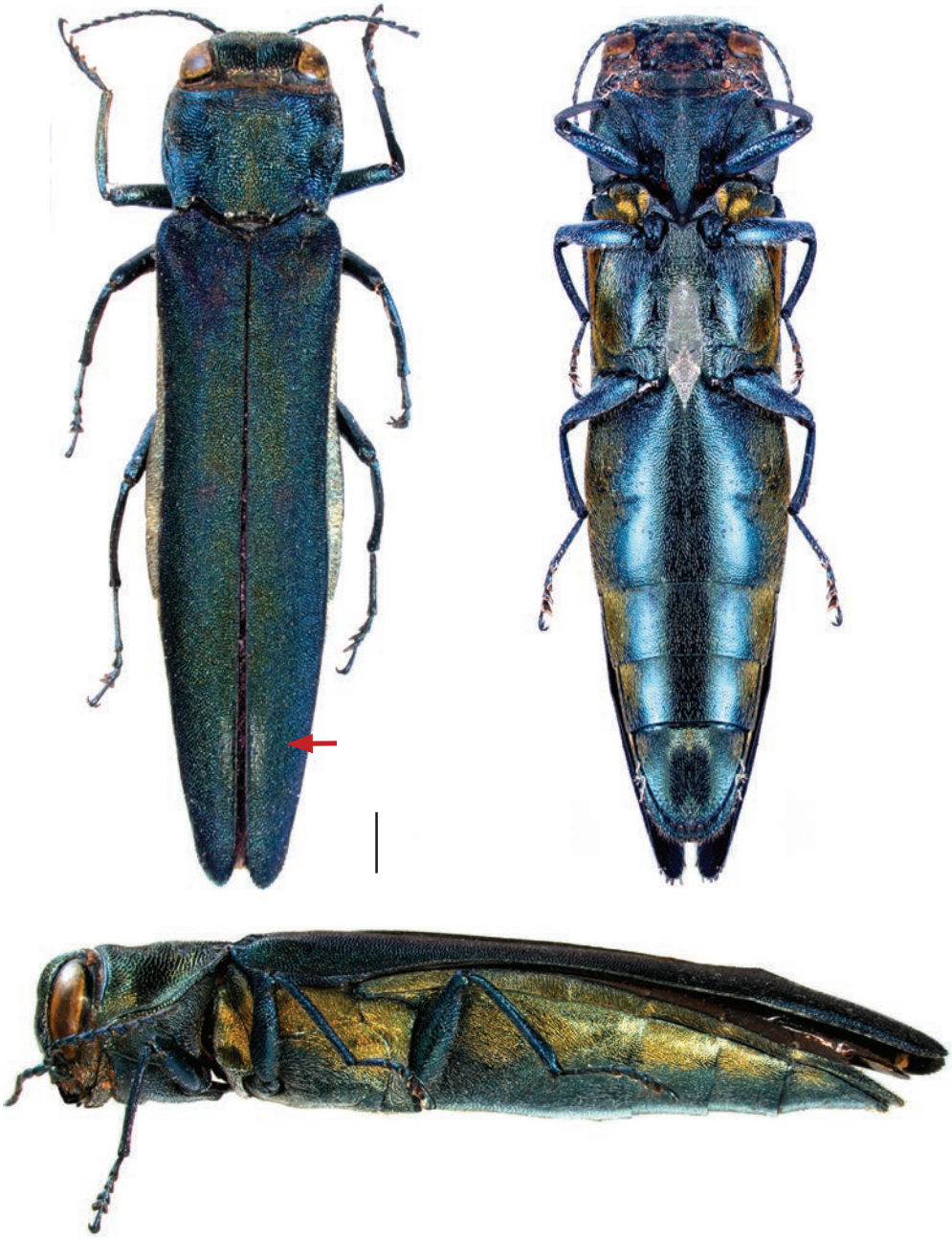
Diagnosis

Body slender, size large. Dorsally metallic dark-blue; laterosternites and ventral sides of abdomen with golden tomentum. Frons with well-developed medial impression (medial carina distinct). Eyes protruding beyond head outline. Pronotum widest medially, lateral impressions with narrow patches of whitish pubescence; lateral margins evenly rounded anteriorly and posteriorly; marginal and submarginal carinae convergent; interspace broadening anteriorly (towards head); prehumeri absent. Scutellum very small, triangular. Elytral apices narrowly arcuately-acuminate with patches of white setae near midline. Aedeagus: tegmen widest proximal to dorsal notch; phallus narrow, apex acuminate.

Similar species: *Agrilus lafertei* has a weak medial frontal impression and the eyes do not protrude beyond the head outline. *Agrilus qinling* has elytral apices widely subarcuate and pronotal lateral impressions have golden tomentose setal patches. Aedeagi are distinct.

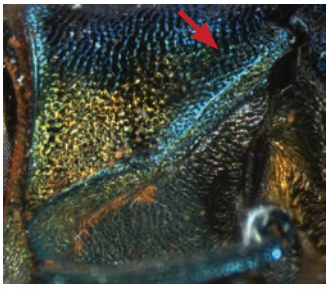
Size: 10–13 mm
Distribution: China: Guizhou, Yunnan; Laos; Myanmar; Thailand; Vietnam.
Altitude range: 800–2500m.
Host plants: Unknown.
Similar species: *Agrilus lafertei* Kerremans; *A. qinling* Jendek.

Agrilus auristernum Obenberger, 1924

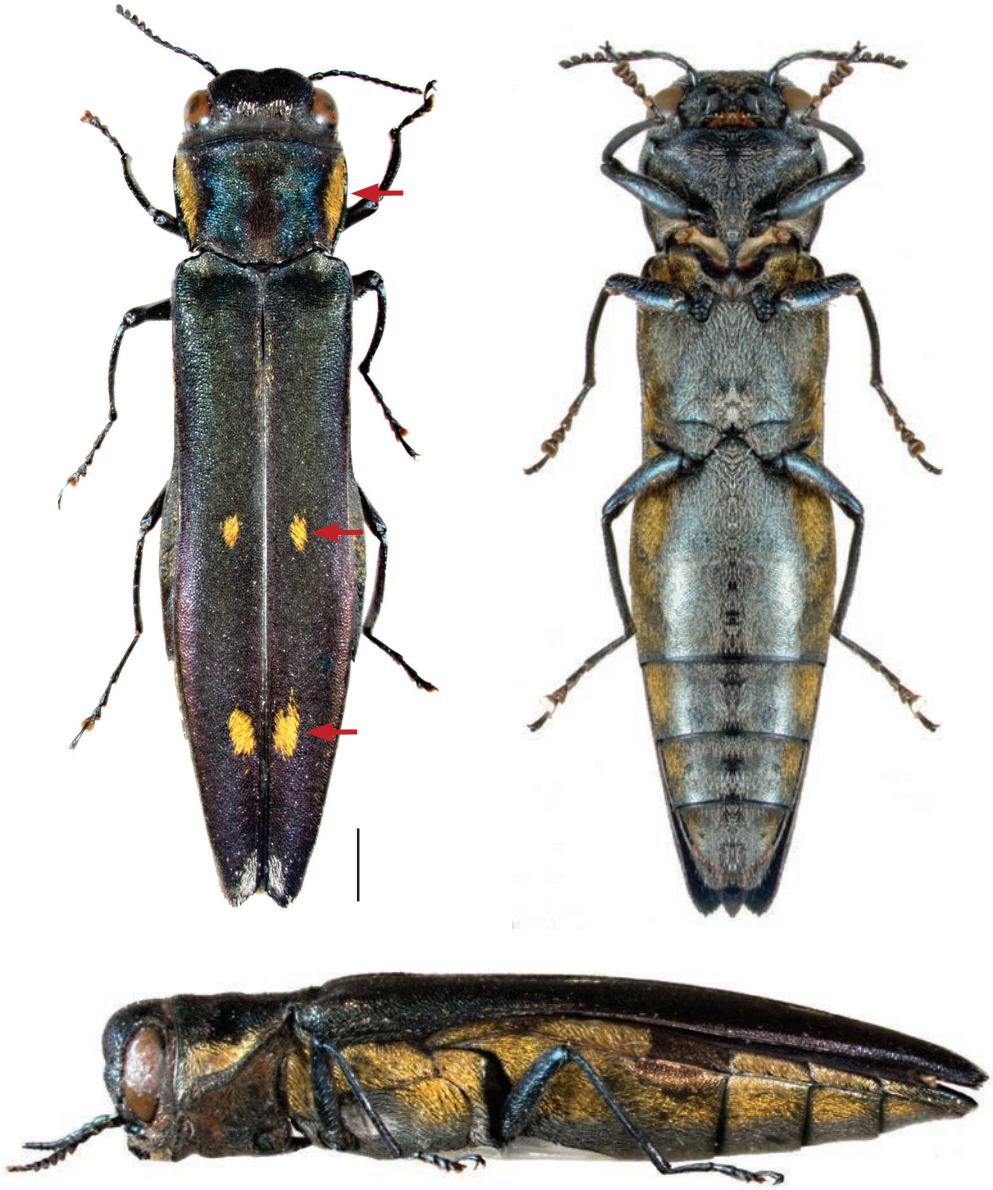


Diagnosis
Body slender, size large. Dorsally sapphire-green; laterosternites and ventral sides of abdomen with golden tomentum. Frons with weak medial impression. Eyes not protruding beyond head outline. Pronotum widest medially, glabrous; lateral margins evenly arcuate; marginal and submarginal carinae convergent; interspace broadening anteriorly (towards head); prehumeri filamentary, hair-like, narrowly convergent with pronotal margin beyond middle of pronotum. Scutellum very small, triangular. Elytra with pair of adsutural, whittish, tomentose spots in apical third; elytral apices narrowly arcuate, extending beyond the abdomen, less than length of ventrite 5. Aedeagus: male unknown.
Similar species: *Agrilus agnatus* and *A. qinling* are darker, have tomentum on pronotum, lack prehumeri and tomentum on elytra.

Size: 10–13 mm
Distribution: China: Yunnan.
Altitude range: 800–2500m.
Host plants: *Quercus*.
Similar species:
Agrilus agnatus Kerremans; *A. qinling* Jendek.



Agrilus bifoveolatus Kerremans, 1895

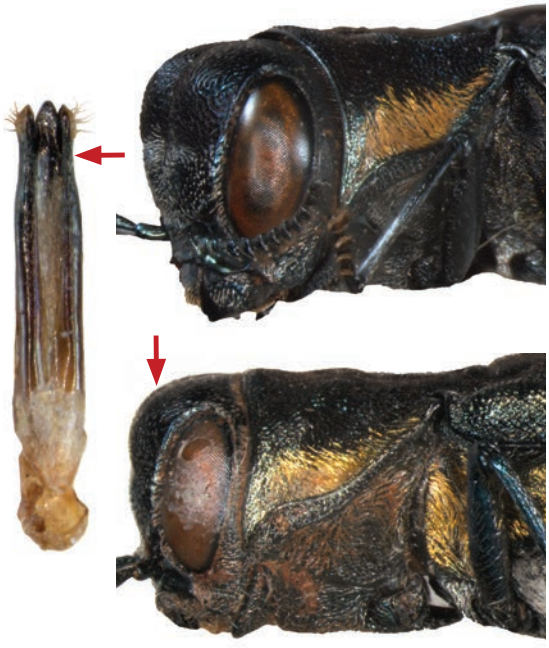


Diagnosis

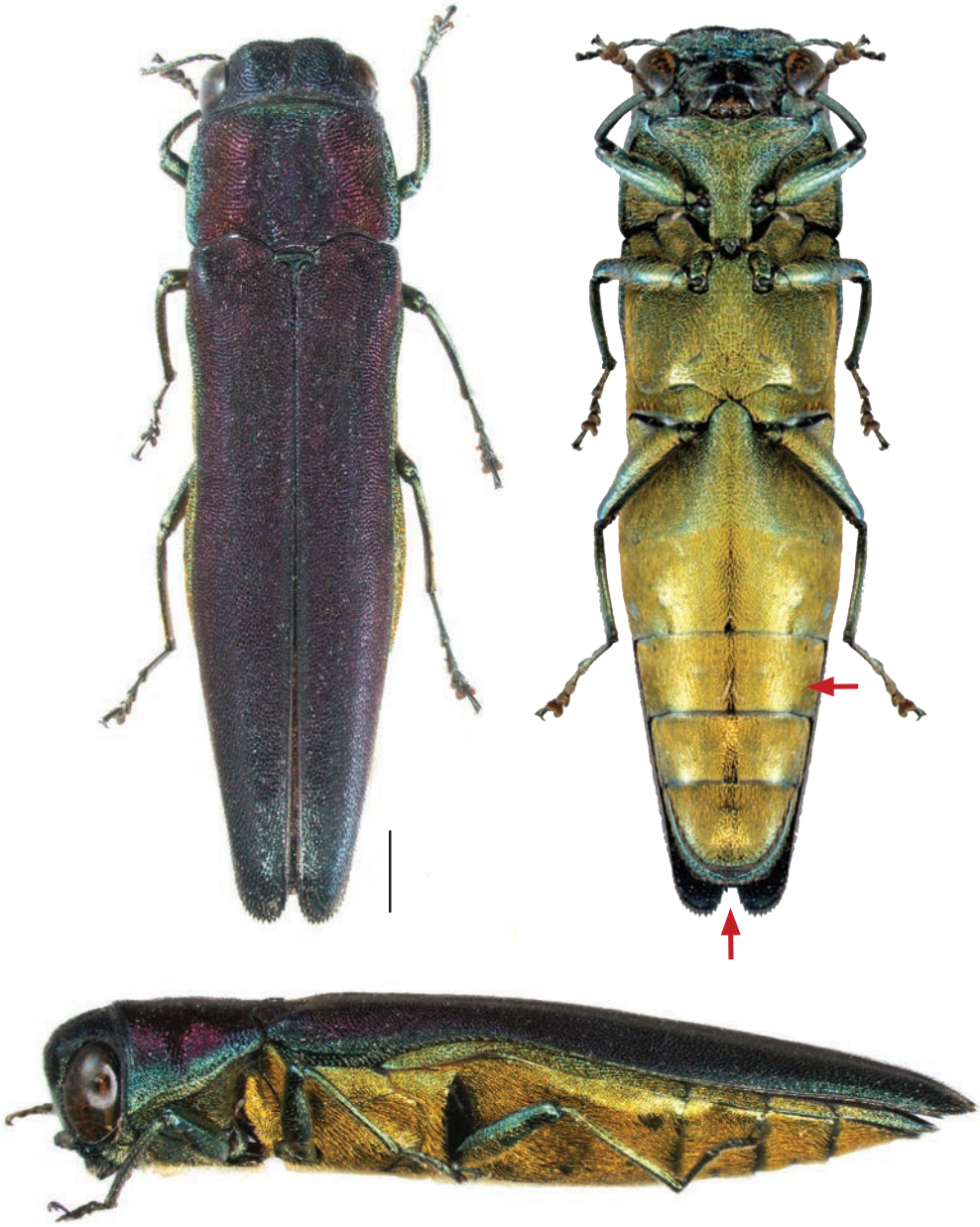
Body slender, size large. Dorsally metallic dark-blue-violet; laterosternites and ventral sides of abdomen with golden tomentose patches. Frons with well-developed medial impression and vertex strongly extended. Eyes protruding beyond head outline. Pronotum widest in anterior third, lateral impressions with narrow patches of golden tomentum; lateral margins narrowing posteriorly; marginal and submarginal carinae convergent; interspace broadening anteriorly (towards head); prehumeri absent. Scutellum very small, triangular. Elytra with 2 pairs of golden tomentose spots (may be rubbed off in some specimens); elytral apices widely subarcuate with patches of white setae near midline. Aedeagus: tegmen narrowing anterad of dorsal notch; phallus narrow, apex obtuse.

Similar species: *Agrilus qinling* has a vertex that is not strongly extended; the lateral margins of the pronotum are widest towards the middle and lacks 2 pairs of tomentose spots on the elytra.

Size: 11.2 mm
Distribution: India: Meghalaya; Sikkim; West Bengal. Nepal: Kosi zone.
Altitude range: 500–1750m.
Host plants: Unknown.
Similar species: *Agrilus qinling* Jendek.



Agrilus crepuscularis Jendek & Chamorro, 2012

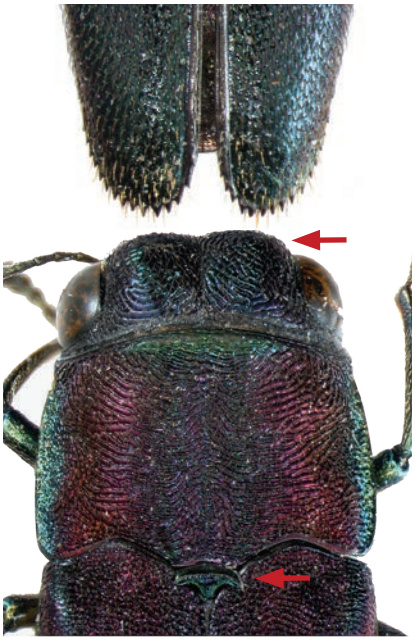


Diagnosis

Body slender. size large. Dorsum metallic uchsia-violet-blue with aqua lateral edge on pronotum; venter with golden tomentum. Eyes protruding from head outline. Frons markedly convex, with medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions; marginal and submarginal carinae convergent, marginal carina joining anterior pronotal margin; interspace broadest medially; prehumeri absent. Scutellum small, rectangular. Pygidium not extended into spine. Elytra glabrous, apices arcuate, margin finely denticulate. Hind tibiae with posterior margin entire. Aedeagus: tegmen subparallel, dorsal notch medial, located nearly at middle of tegmen; phallic apex acute.

Similar species: *Agrilus planipennis* and *A. tomentipennis* are larger, the scutellum is triangular to subrectangular, the medial frontal impression is well developed, the prehumeral carinae are prominent, and the venter is largely glabrous and never with golden tomentum.

Size: 10 mm
Distribution: Malaysia.
Altitude range: 50 m.
Host plants: Unknown.
Similar species:
Agrilus planipennis Fairmaire;
A. tomentipennis Jendek & Chamorro.



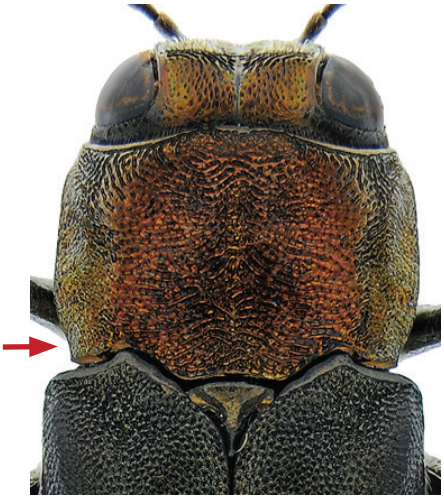
Agrilus cyaneoniger Saunders, 1873

Diagnosis

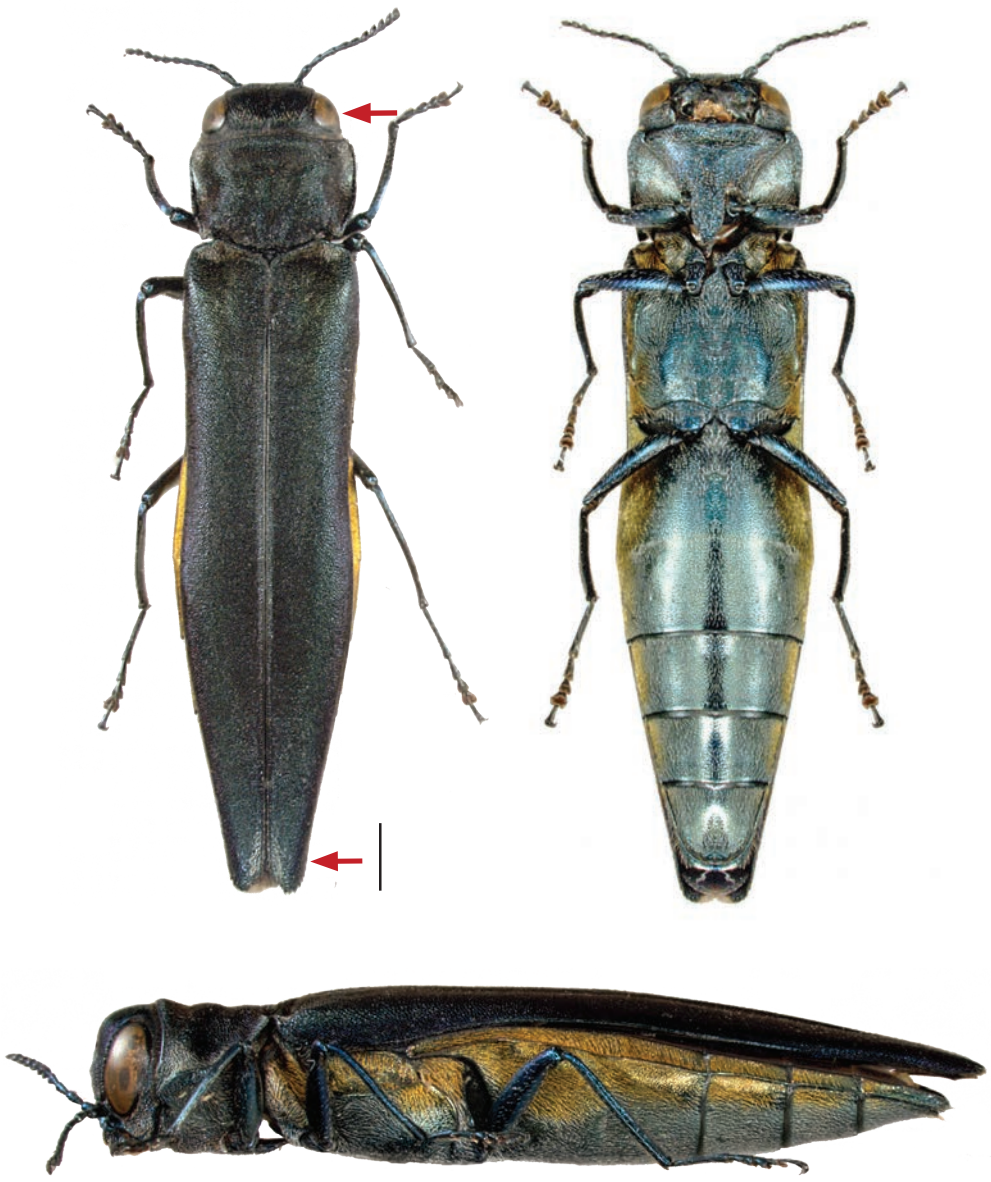
Body slender, size large. Elytra black, pronotum black with violet-blue sides or golden, golden-green, golden-orange, or bronze. Frons with well-developed medial impression. Pronotum widest medially, sides evenly arcuate; disk with anterior and posterior impressions; marginal and submarginal carinae convergent, joining the anterior pronotal margin; interspace broadening anteriorly (towards head); prehumeri absent. Scutellum very small, triangular, usually sunken. Elytral apices broadly, regularly arcuate, margin finely denticulate. Aedeagus: tegmen subparallel, dorsal notch proximal, located at middle of tegmen; apex of phallus acute.

Similar species: *Agrilus planipennis* is emerald, it has a pygidial spine, a highly sinuate posterior margin of the metatibiae, the carinal interspaces broadest medially and the prehumeri are tubercular to carinal. *Agrilus auristernum* is sapphire, prehumeri are filamentary, hairlike, and narrowly convergent with pronotal margin and reaching beyond middle of pronotal length, elytra with pair of adsutural whitish tomentum.

Size: 9.8–16.0 mm
Distribution: China. India: Jammu & Kashmir. Japan. North & South Korea. Russia: Amurskaya oblast', Primorskiy Kray. Vietnam.
Altitude range: 800–2500m.
Host plants: *Quercus acuta; Q. acutissima*; *Q. aliena*; *Q. dentata*; *Q. mongolica* var. *grosserrata*; *Q. mongolica*; *Q. myrsinaefolia*; *Q. serrata*; *Q. variabilis*.
Similar species:
Agrilus planipennis Fairmaire; *A. auristernum* Obenberger.

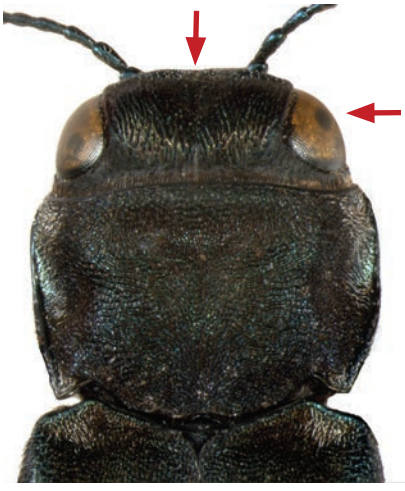


Agrilus lafertei Kerremans, 1892

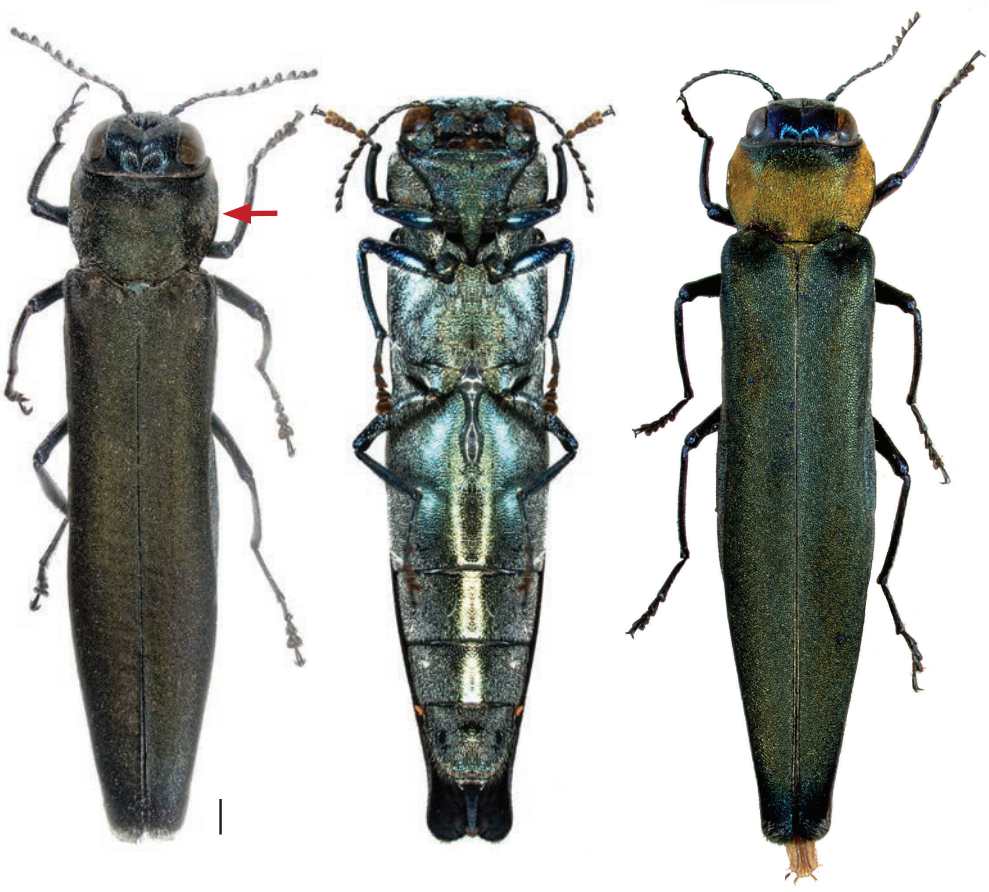


Diagnosis
Body slender, size large. Dorsally metallic dark-blue; laterosternites and sides of abdomen with golden tomenta. Frons with weak medial impression (medial carina not distinct). Eyes not protruding beyond head outline. Pronotum widest medially, sides evenly arcuate with white tomentose patches (visible dorsally, may be rubbed off); marginal and submarginal carinae convergent; interspaces broadening anteriorly (towards head); prehumeri absent. Scutellum very small, triangular. Elytral apices rounded with white tomentose patches near midline. Aedeagus: tegmen widest proximal to dorsal notch; phallus wide, apex cuspidate.
Similar species: *Agrilus agnatus* and *A. qinling* have a deeper, more pronounced central impression on the frons and the eyes in these two species protrude beyond the head outline. Phallus apex is not cuspidate, but acute.

Size: 12–12.5 mm
Distribution: Bhutan. India: Arunachal Pradesh; Uttar Pradesh. Nepal.
Altitude range: 1300–2700 m.
Host plants: Unknown.
Similar species:
Agrilus agnatus Kerremans;
A. qinling Jendek.



Agrilus lubopetri Jendek, 2000

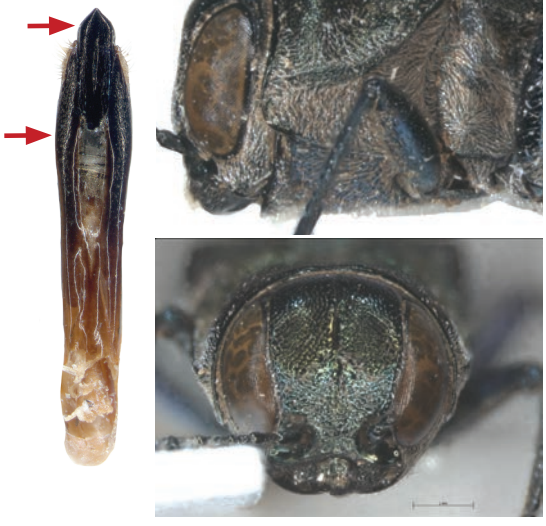


Diagnosis

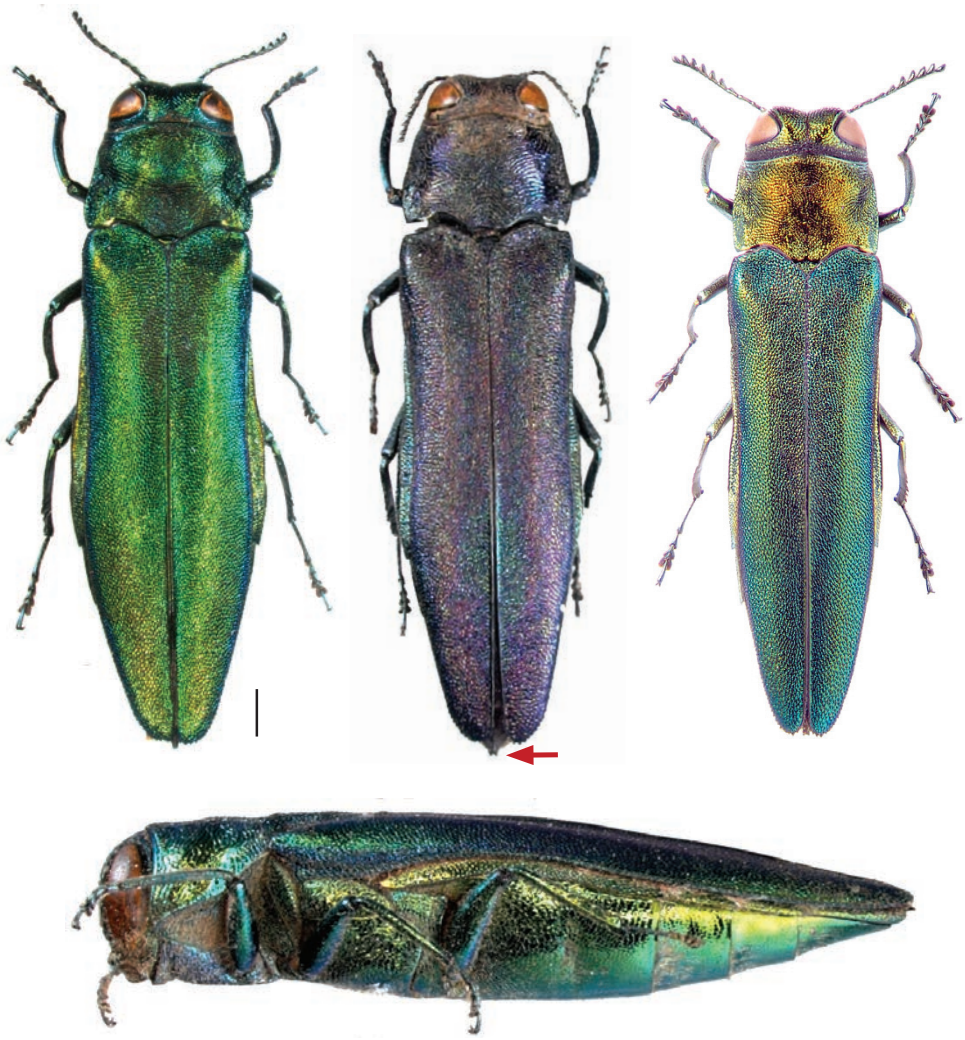
Body slender, size large. Males and females are metallic blue and olivaceous-copper. Females have orange tomentum on almost entire dorsum of pronotum. Frons with well-developed medial impression. Pronotum widest medially, apical half subparallel, basaly strongly arcuate; marginal and submarginal carinae convergent, neither joining the anterior pronotal margin; interspace narrow; prehumeri absent. Scutellum very small, triangular. Elytral apices broadly, regularly arcuate with white pubescence, elongate, extending beyond the abdomen approximately the entire length of ventrite 5, margin finely denticulate. Aedeagus: tegmen widest proximal to dorsal notch; apex of phallus deltoid.

Similar species: *Agrilus pseudolubopetri* has elytral apices extending slightly beyond the abdomen, less than length of ventrite 4. Aedeagus: tegmen widest at dorsal notch; apex of phallus acutely deltoid. Females are metallic violet with orange tometum on the sides of the pronotum, not covering the entire dorsum of the pronotum; *Agrilus rubensteini* females have bright, golden tomentum on sides of pronotum; body color is bluish-black.

Size: 11–17 mm
Distribution: China: Yunnan. Laos: Houaphan. Vietnam.
Altitude range: 900–2000m.
Host plants: Unknown.
Similar species: *Agrilus pseudolubopetri* Jendek & Chamorro; *A. rubensteini* Chamorro & Jendek.



Agrilus planipennis Fairmaire, 1888



Diagnosis

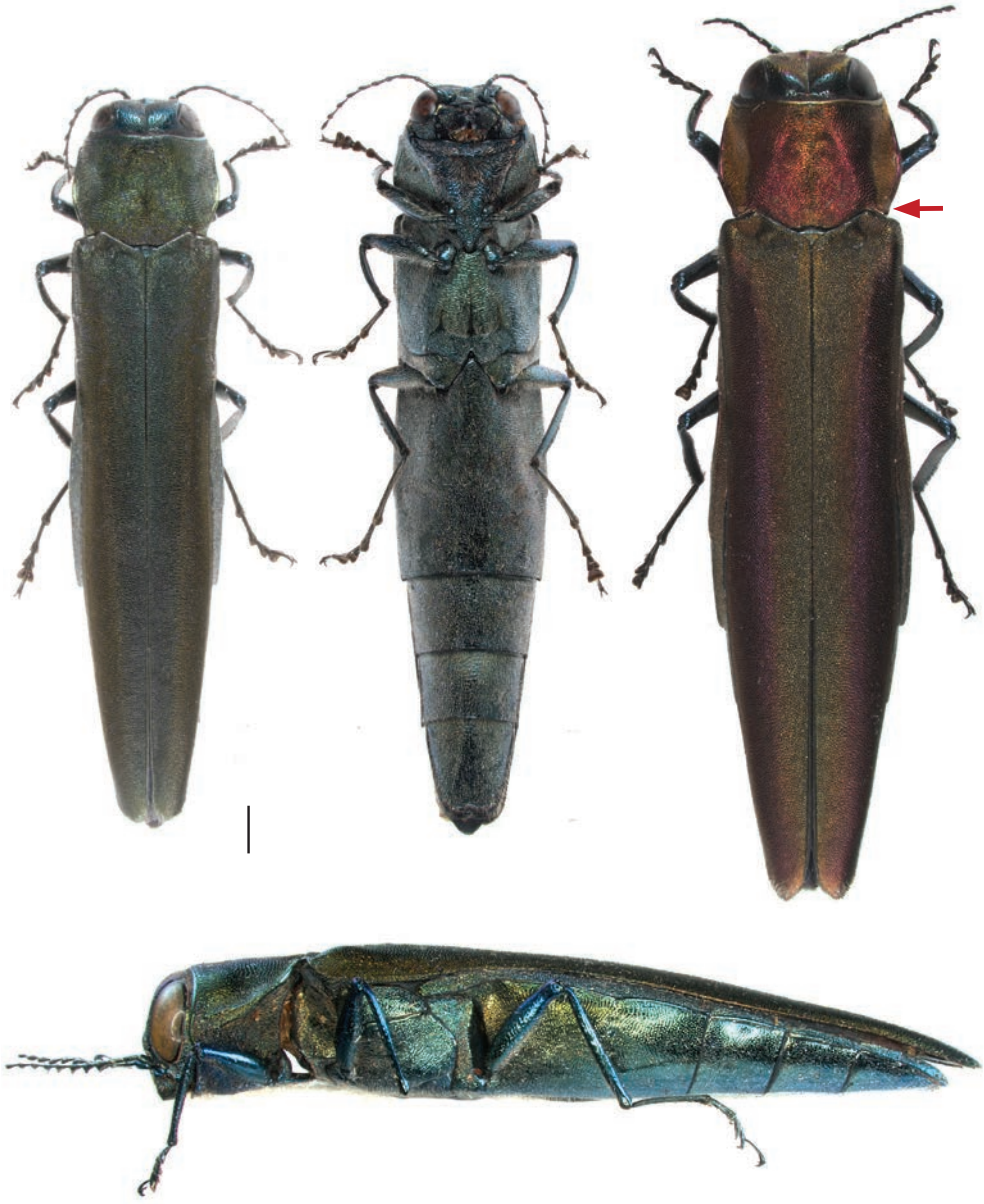
Body slender, size large. Emerald, cupreous pronotum and head and emerald elytra, or rarely violet-blue. Frons with medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions; marginal and submarginal carinae convergent, marginal carina joining anterior pronotal margin; interspaces broadest medially; prehumeri carinal to tubercular, arcuate, extending to third of pronotal length. Scutellum very small, diamond-shaped. Pygidium extended into spine. Elytra glabrous, apices arcuate, margin finely denticulate. Hind tibiae with posterior margin highly sinuate. Aedeagus: tegmen widest submedially, dorsal notch distal, located 1/3 from tegminal apex; phallus wide, apex acute.

Similar species: *Agrilus tomentipennis* is slightly larger, has preapical white tometum on the elytra, the scutellum is subrectangular, the prehumeral carinae are prominent, and the central frontal impression is deep. *Agrilus cyaneoniger* and *A. crepuscularis* lack a pygidial spine. *Agrilus s. sinensis* and *A. s. splendidicollis* have a large scutellum, lack a pygidial spine, and the pronotal marginal and submarginal carinae do not converge.

Size: 12–15 mm
Distribution: China; Japan; North Korea. South Korea; Mongolia; Russia: Khabarovskii kray; Primorskii kray. Introduced: Russia: 11 oblasts in the Central European part; USA and Canada.
Altitude range: 800–1000 m.
Host plants: *Fraxinus americana*; *F. chinensis*; *F. mandshurica*; *F. m. var. japonica*; *F. nigra*; *F. pennsylvanica*; *F. quadrangulata*; *F. rhynhophylla*; *F. velutina*. [*Juglans sp.*; *Juglans mandshurica var. sieboldiana*; *Pterocarya sp.*; *Pterocarya rhoifolia*; *Ulmus sp.*; *U. davidiana var. japonica*?]
Similar species: *Agrilus tomentipennis* Jendek & Chamorro; *A. crepuscularis* Jendek & Chamorro; *A. cyaneoniger* Saunders; *A. sinensis* (both subspecies).

Distribution as of May 2014

Agrilus pseudolubopetri Jendek & Chamorro, 2012

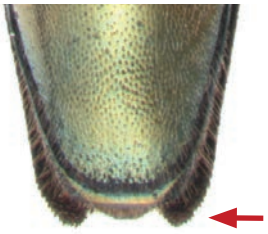


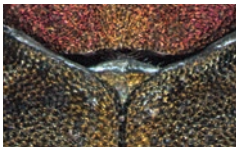
Diagnosis

Body slender, size large. Males are metallic blue and olivaceous-copper. Females are metallic violet with orange tomentum on sides of the pronotum, not covering the entire dorsum of the pronotum. Frons with well-developed medial impression. Pronotum widest medially, apical half subparallel, basaly strongly arcuate; marginal and submarginal carinae convergent, neither joining the anterior pronotal margin; interspaces narrow. Scutellum very small, triangular. Elytral apices broadly, regularly arcuate, elongate, extending beyond the abdomen less than length of ventrite 5, margin finely denticulate, with white pubescence. Aedeagus: tegmen widest at dorsal notch; apex of phallus acutely deltoid.

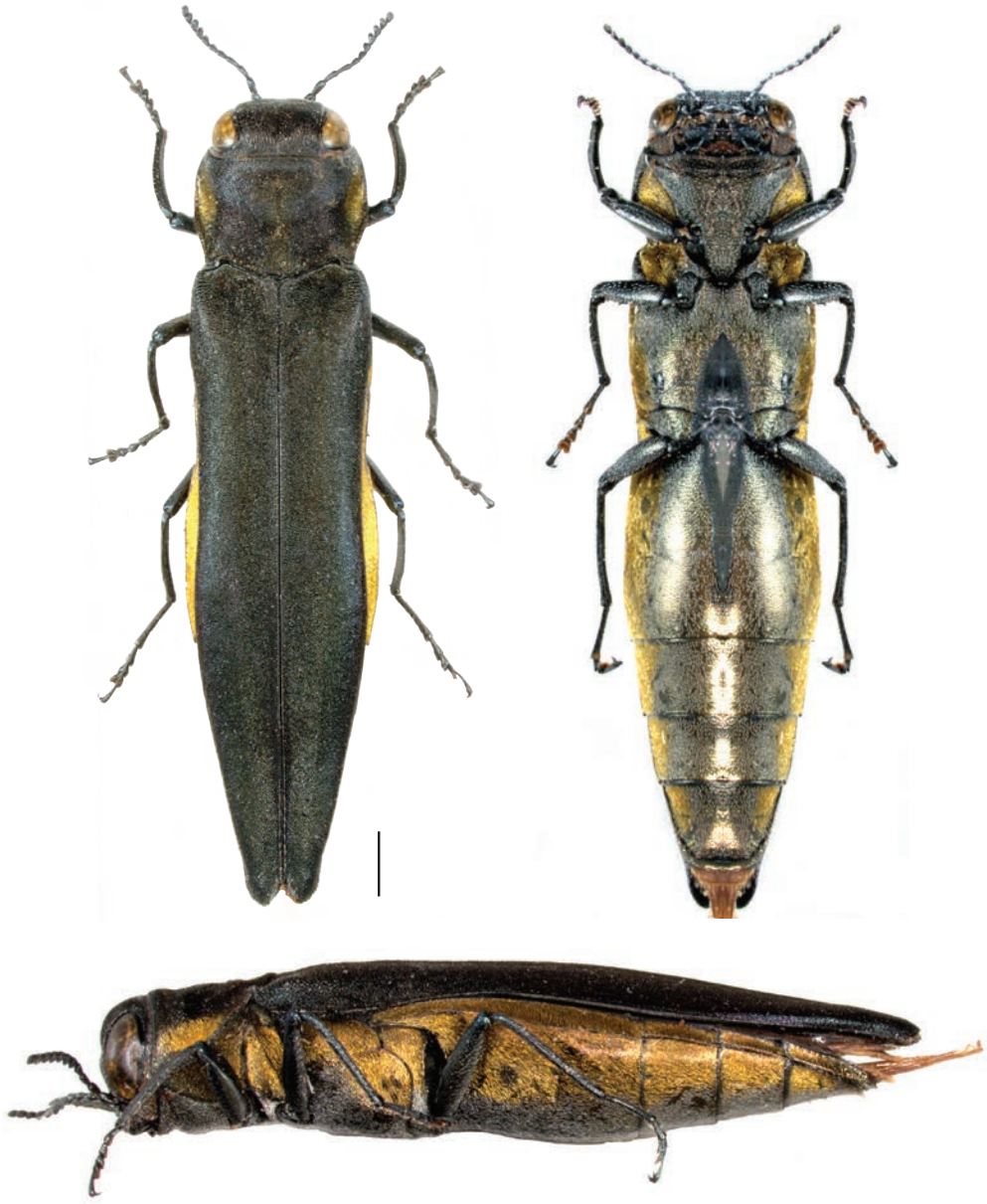
Similar species: *Agrilus lubopetri* has elytral apices greatly extending beyond the abdomen by approximately the length of ventrite 5. Aedeagus: tegmen widest proximal to dorsal notch; apex of phallus deltoid. Females with orange tomentum on almost entire dorsum of pronotum.

Size: 14–18 mm
Distribution: Laos; China: Taiwan.
Altitude range: 1300–1900 m.
Host plants: Unknown.
Similar species:
Agrilus lubopetri Jendek.





Agrilus qinling Jendek, 2000

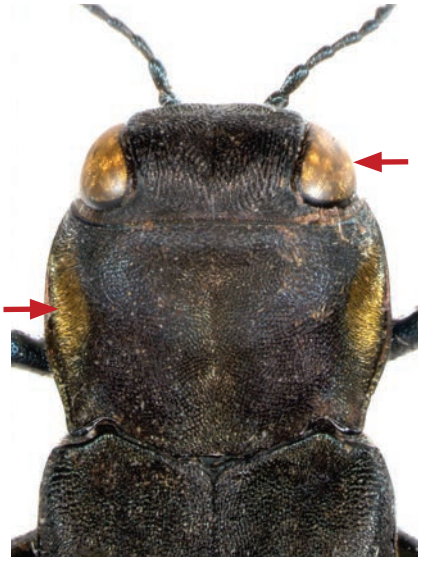


Diagnosis

Body slender, size large. Dorsally metallic dark-blue; laterosternites and ventral sides of abdomen with golden pubescence. Frons with well-developed medial impression (medial carina distinct). Eyes protruding beyond outline of the head. Pronotum widest medially, lateral impressions with golden tomentose patches; lateral margins evenly rounded anteriorly and posteriorly; marginal and submarginal carinae convergent; carinal interspaces broadening anteriorly; prehumerus absent. Scutellum very small, triangular. Elytral apices widely subarcuate with white tomentose patches near midline. Aedeagus: tegmen widest proximal to dorsal notch; phallus wide, apex acute.

Similar species: *Agrilus lafertei* has a weak medial frontal impression and the eyes do not protrude beyond head outline. *Agrilus agnatus* has elytral apices narrowly arcuately-acuminate and pronotal lateral impressions with narrow patches of whitish tomentum. Phallus apex acute.

Size: 10.3–13.5 mm
Distribution: China: Shaanxi.
Altitude range: 1000–1300 m.
Host plants: Unknown.
Similar species:
Agrilus agnatus Kerremans, 1892;
A. lafertei Kerremans, 1892.

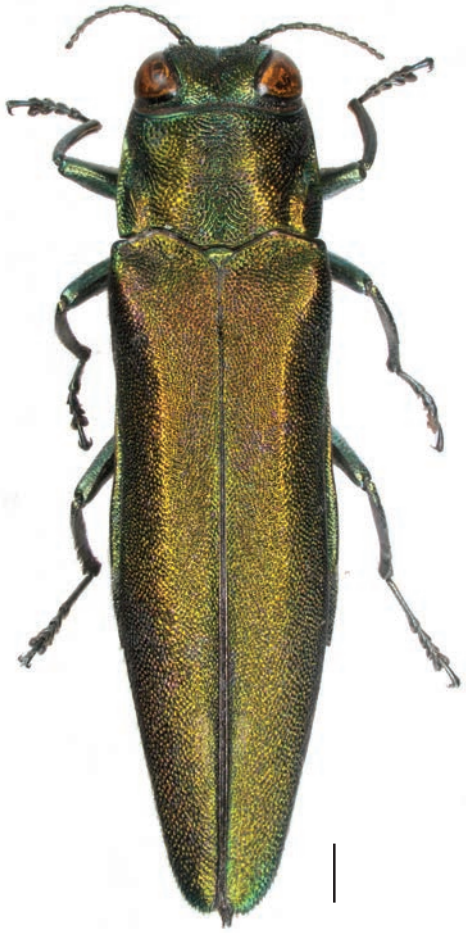


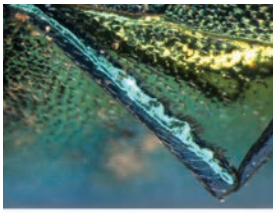
Agrilus rubensteini Chamorro & Jendek, 2014

Diagnosis
Body slender, size large. Female is metallic bluish-black with brihgt, golden tomentum on sides of pronotum. Frons with shallow medial impression. Pronotum widest medially, markedly arcuate; marginal and submarginal carinae convergent, neither joining the anterior pronotal margin; carinal interspaces narrow; prehumeri absent. Scutellum very small, subrectangular. Elytral apices separate, subangulate with white pubescence, margin obviously denticulate. Ventrites 3 and 4 with golden tomentose patches.
Similar species: *Agrilus pseudolubopetri* is metallic violet to cupreous, lacks golden abdominal tomentum, and females have orange tomentum laterad on the pronotum. *Agrilus lubopetri* is cupreous-green, the elytral apices extend beyond the abdomen by the length of the last ventrite; females have orange tomentum covering almost entire pronotum.

Size: 12 mm
Distribution: Philippines: Luzon.
Altitude range: 1000–1300m.
Host plants: Unknown.
Similar species:
A. pseudolubopetri Jendek & Chamorro; *A. lubopetri* Jendek

Agrilus tomentipennis Jendek & Chamorro, 2012



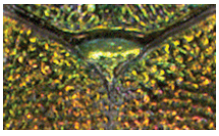


Diagnosis

Body slender, size large. Emerald to cupreous. Frons with well-developed medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions; marginal and submarginal carinae convergent, marginal carina joining anterior pronotal margin; carinal interspaces broadest medially; prehumeri carinal, arcuate, extending to third of pronotal length. Scutellum very small, subrectangular. Pygidium extended into spine. Elytra with pair of white perisutural tomentose stripes and preapical tomentum, eltyral apices arcuate, margin finely denticulate. Hind tibiae with posterior margin highly sinuate. Aedeagus: male unknown

Similar species: *Agrilus planipennis* lacks tomentum on the eltyra. *A. s. sinensis* and *A. s. splendidicollis* have a large scutellum, lack a pygidial spine, and the pronotal marginal and submarginal carinae do not converge.

Size: 14.0–14.3 mm
Distribution: Laos; China: Taiwan
Altitude range: 1,000 m.
Host plants: Unknown.
Similar species:
Agrilus planipennis Fairmaire; *A. sinensis* (both subspecies).



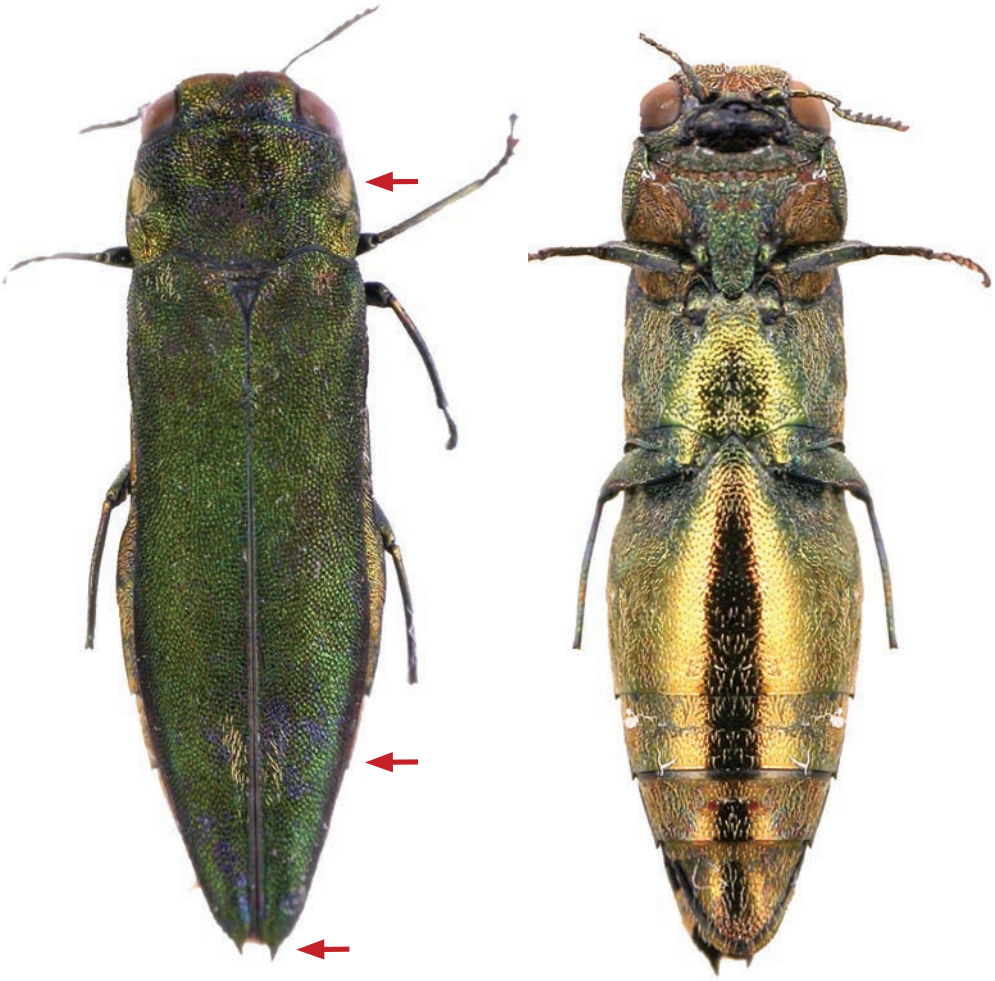
Agrilus piliventris group

Agrilus ampliatus Kerremans, 1900

Diagnosis
Body broad, size moderate. Dorsally black, golden pubescence on pronotum, elytra proximally and distally (ornamentally), and on abdomen and laterosternites (visible dorsally). Eyes not bulging beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior. Prehumeri carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection approximately as long as disk length. Elytral apices sharply unispinate.
Similar species: *Agrilus ostrinus* is metallic reddish-purple dorsally and bears copious golden tomentum ventrolaterally; prosternum and legs are metallic blue; elytra lack distinct tomentose patches and the elytral spines are small. *Agrilus maculipennis* is dorsally metallic olive green, ventrally green and gold, golden tomentum mesolaterally on pronotum, in humeral depresesions, and as pair of tomentose patches on elytral sutural margin approximately 1/4 from apex.

Size: 9-10mm (from original description).
Distribution: Indonesia: Sumatra.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ostrinus Kerremans;
A. maculipennis Kerremans.

Agrilus maculipennis Kerremans, 1900



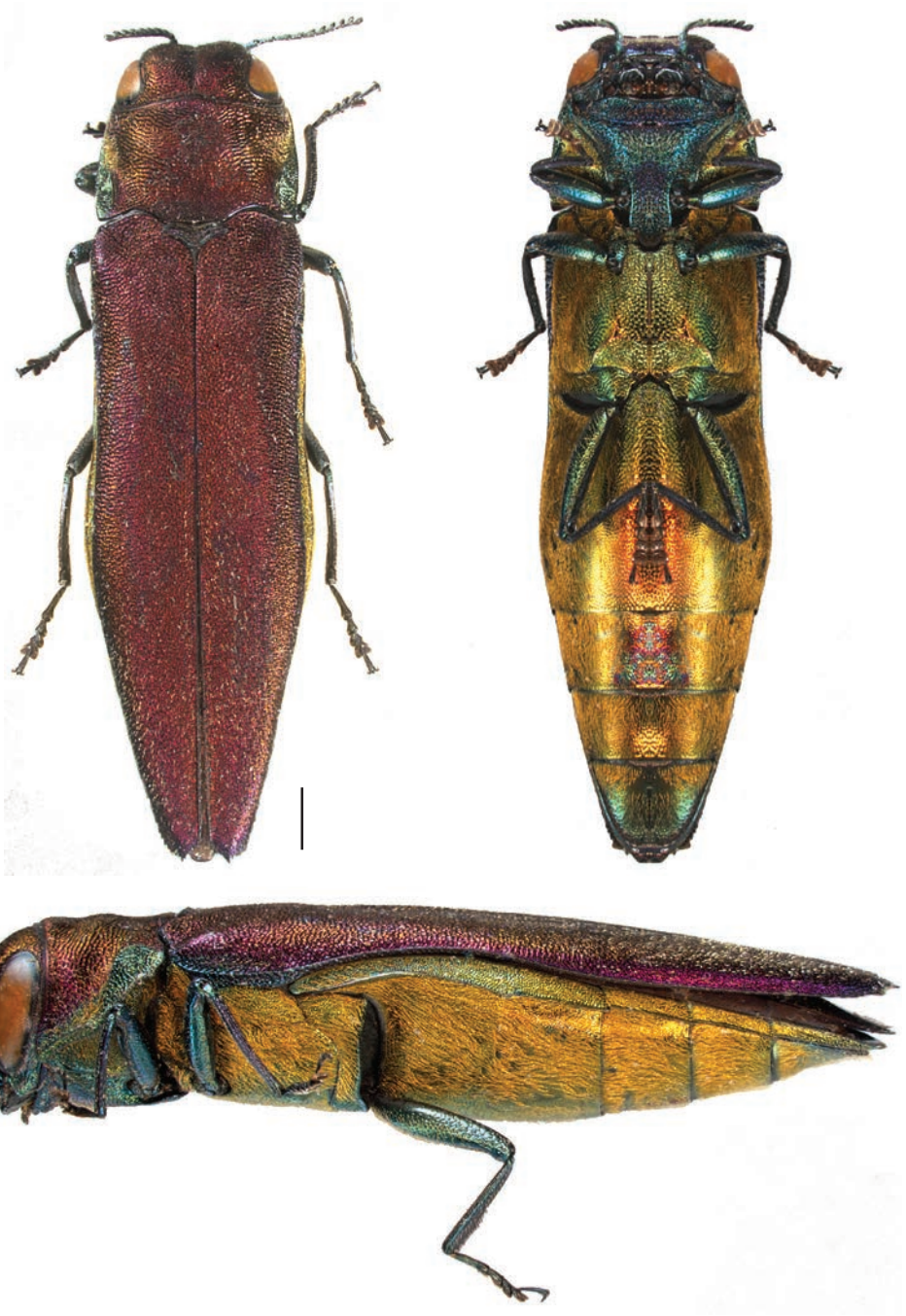
Diagnosis

Body broad, size moderate. Dorsally metallic olive green, ventrally green and gold, golden tomentum mesolaterally on pronotum, in humeral depresesions, as a pair of tomentose patches on elytral sutural margin approximately 1/4 from apex, on abdomen and laterosternites (visible dorsally). Eyes not bulging beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior. Pronotum with carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection approximately as long as disk length. Elytral apices sharply unispinate.

Similar species: *Agrilus ostrinus* is dorsally metallic reddish-purple and bears copious golden tomentum ventrolaterally; prosternum and legs are metallic blue; elytra lack distinct tomentose patches and the elytral spines may be smaller. *Agrilus ampliatus* is black with ornamental (proximal and distal) golden pubescence.

Size: 8 mm (from original description).
Distribution: Indonesia: Sumatra.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus ostrinus Kerremans;
A. ampliatus Kerremans.

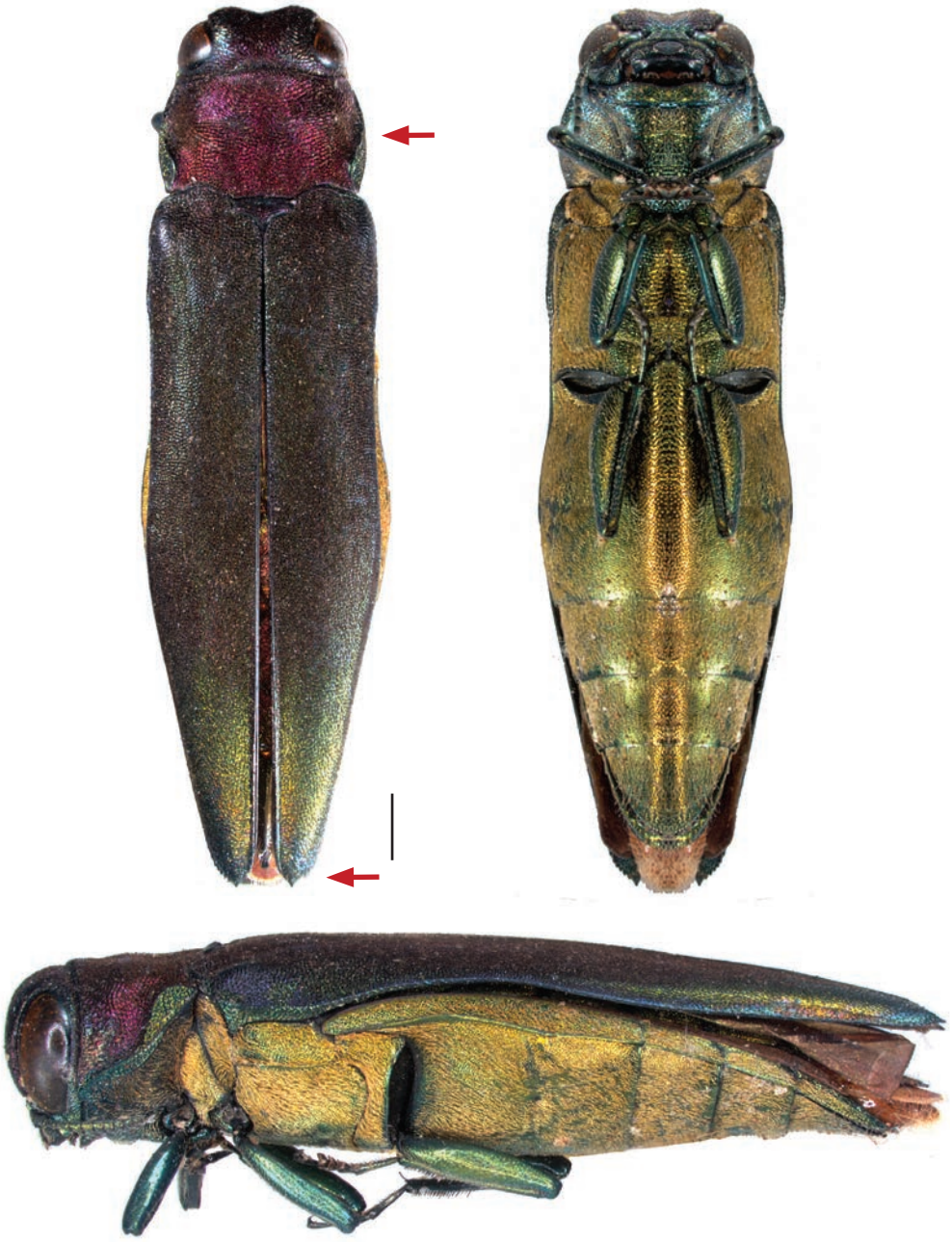
Agrilus ostrinus Kerremans, 1892



Diagnosis
Body broad, size moderate to large. Dorsally metallic reddish-purple, abdomen ventrolaterally with copious golden tomentum visible also dorsally on laterosternites; prosternum and legs metallic blue. Eyes not bulging beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior. Pronotum with carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk slightly impressed; scutellar projection less than disk length. Elytral apices weakly unispinate.
Similar species: *Agrilus piliventris* has a metallic reddish-purple pronotum and black elytra with metallic greenish-yellow apex; pronotal margins are more arcuate. *Agrilus ampliatus* is black with golden ornamental pubescence; elytral spines well-developed.

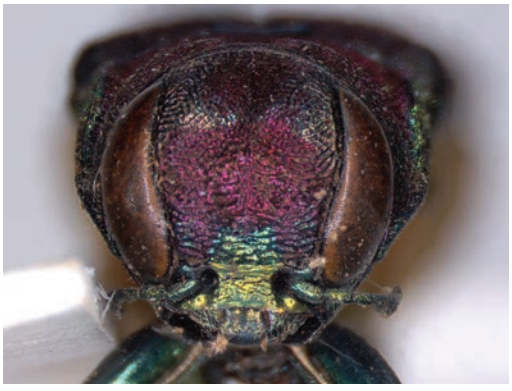
Size: 10–11.2 mm
Distribution: Laos: Louang Namtha. Myanmar.
Altitude range: 900–1200 m.
Host plants: Unknown.
Similar species:
Agrilus piliventris Deyrolle;
A. ampliatus Kerremans.

Agrilus piliventris Deyrolle, 1864

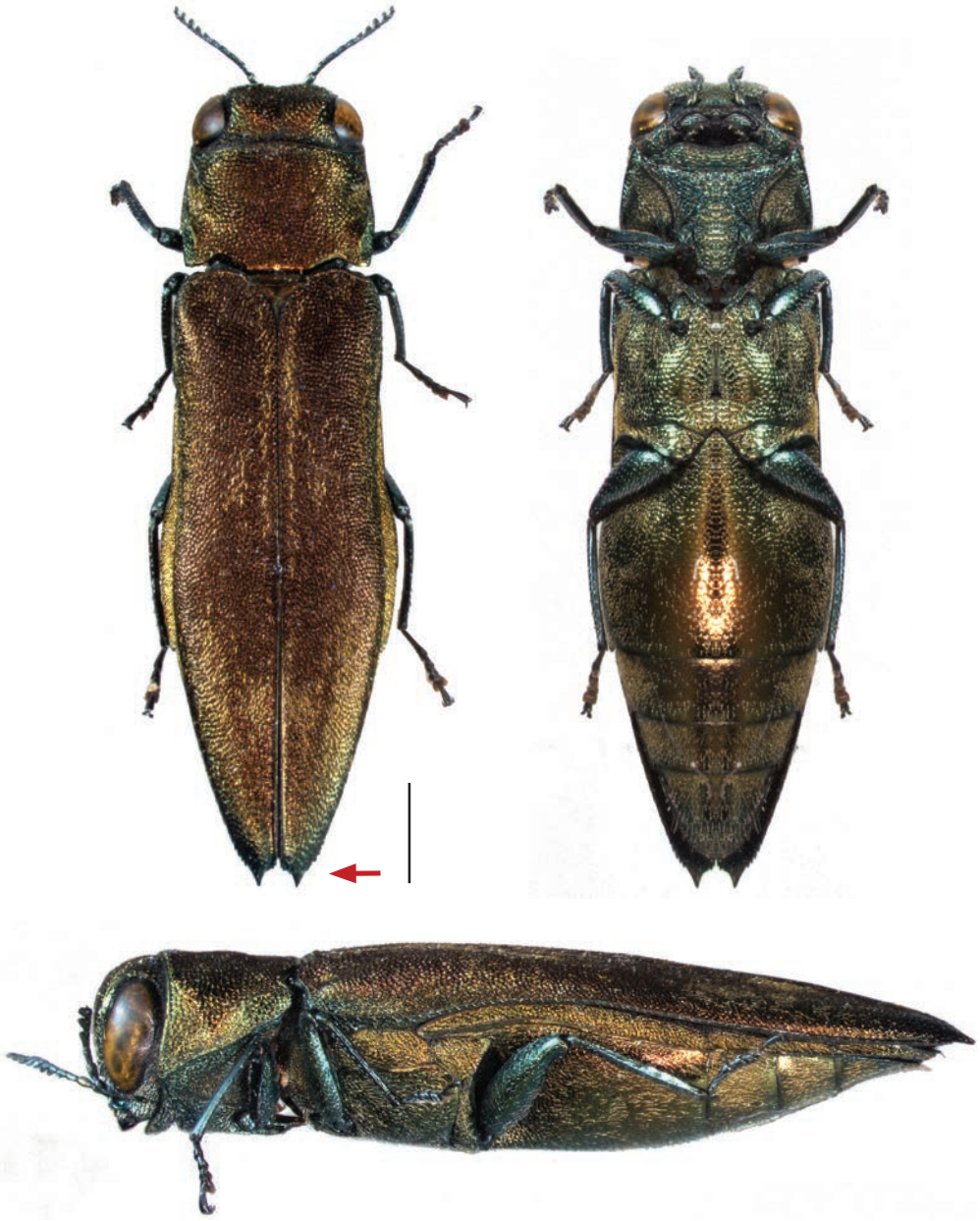


Diagnosis
Body broad, size large. Pronotum metallic reddish-purple, elytra olive-black with metallic olive-yellow apex, abdomen ventrolaterally with copious golden tomentum also visible dorsally on laterosternites; prosternum and legs metallic blueish-green. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior. Pronotum with margins arcuate; carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk slightly impressed; scutellar projection less than disk length. Elytral apices weakly unispinate.
Similar species: *Agrilus ostrinus* is entirely purplish-red dorsally; pronotal margins are not arcuate, but rather entire.

Size: 12.2 mm
Distribution: Indonesia: Kalimantan; Sumatra. Malaysia: Malaysian Peninsular; Sabah; Sarawak.
Altitude range: Unknown.
Host plants: Unknown.
Similar species: *Agrilus ostrinus* Kerremans.

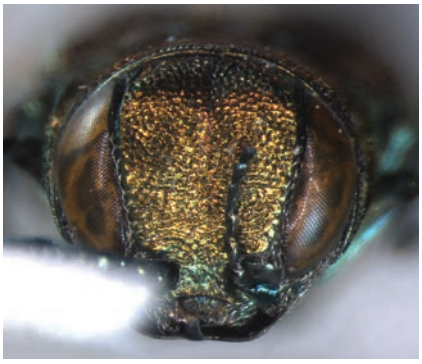


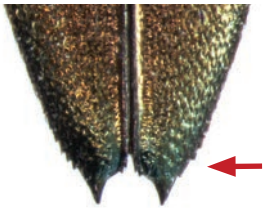
Agrilus pseudoostrinus Jendek, 2000

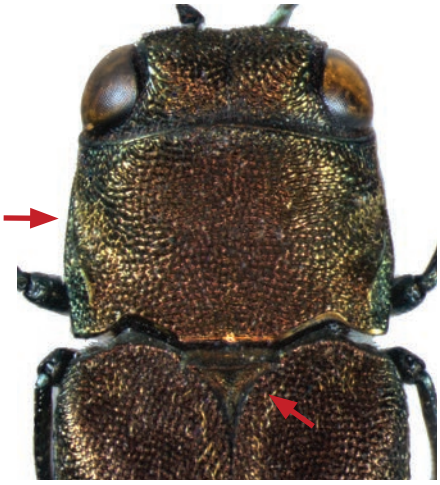


Diagnosis
Body broad, size small to moderate. Metallic copper, golden pubescence on elytra perisuturally proximally and distally, on abdomen including laterosternites (visible dorsally). Eyes slightly bulging beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior; shape almost as wide as long. Pronotum with carinal interspaces broadening distally. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection approximately as long as disk length. Elytral apices unispinate, straight.
Similar species: *Agrilus spineus* is metallic olive green-blue with golden tomentum mesolaterally on pronotum and scattered pubescence on elytra; pronotum is strongly transverse. *Agrilus ampliatus* has more pubescence dorsally, ornamental, and pronotum is wider.

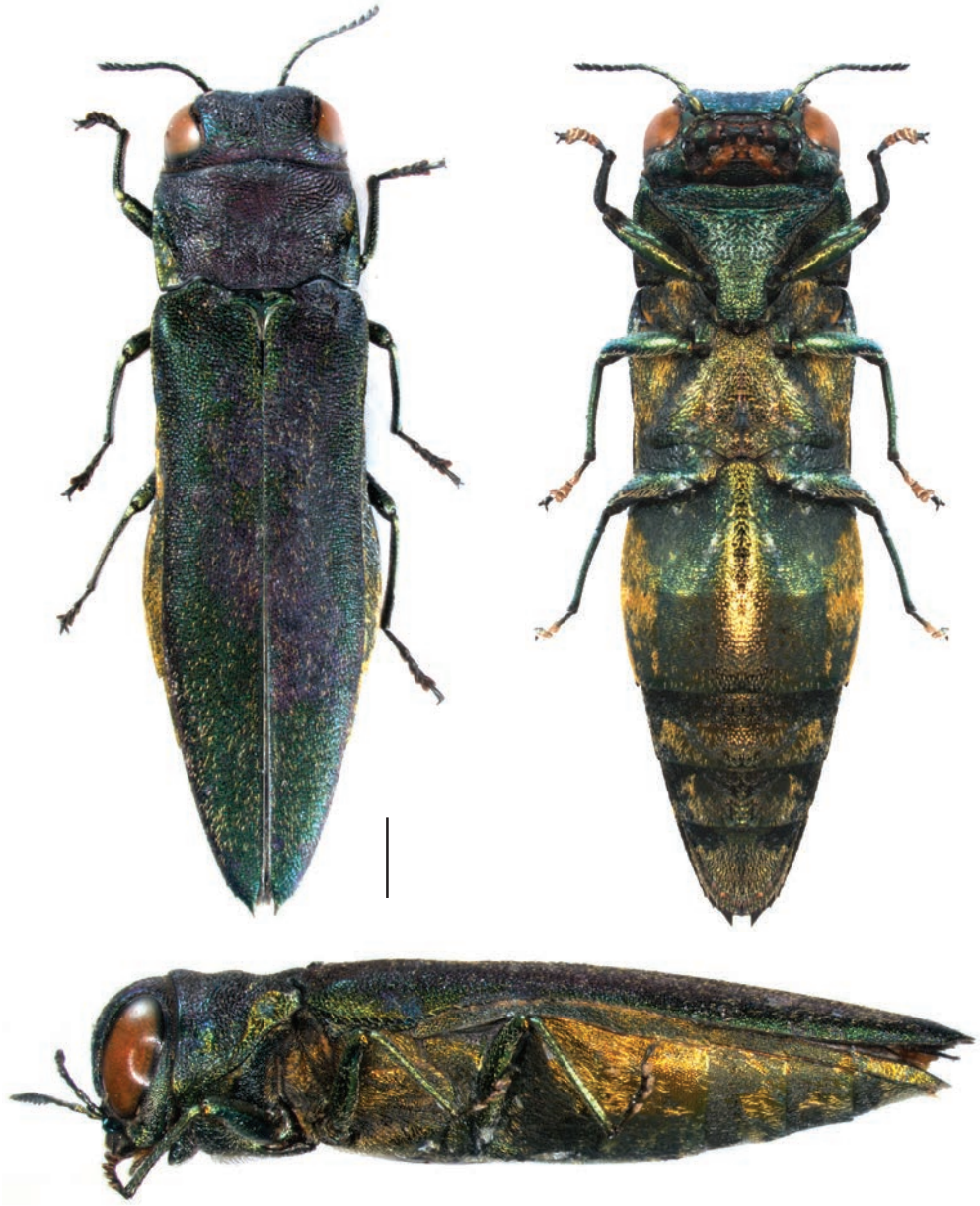
Size: 7.4–8.9 mm
Distribution: Indonesia: Sumatra.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus spineus Jendek & Chamorro; *A. ampliatus* Kerremans.







Agrilus spineus Jendek & Chamorro, 2012

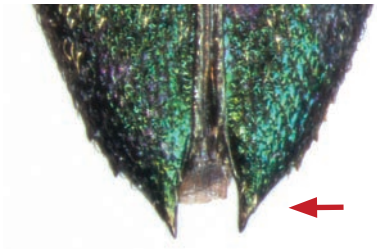


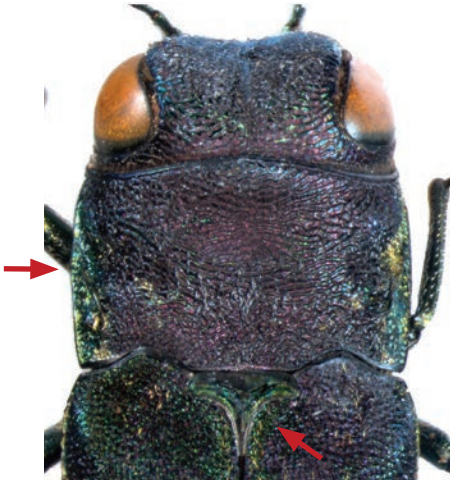
Diagnosis

Body broad, size moderate. Dorsally metallic olive green-blue, green with golden reflections ventrally, golden tomenta mesolaterally on pronotum, with scattered pubescence on elytra, tomentum on abdomen and laterosternites (visible dorsally). Eyes slightly bulging beyond head outline. Frons with medial vertical impression. Anterior margin of pronotum narrower than posterior; shape wider than long. Pronotum with carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carinae and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk slightly impressed; scutellar projection approximately as long as disk length. Elytral apices sharply unispinate, angled.

Similar species: *Agrilus pseudoostrinus* is metallic cupreous with proximal and distal perisutural golden tomentum; pronotum is less transverse. *Agrilus maculipennis* is larger; lacks bulging eyes beyond head outline; and has elytral tomentose patches.

Size: 9.0 mm
Distribution: Malaysia: Sarawak.
Host plants: Unknown.
Similar species:
Agrilus pseudoostrinus Jendek;
A. maculipennis Kerremans.





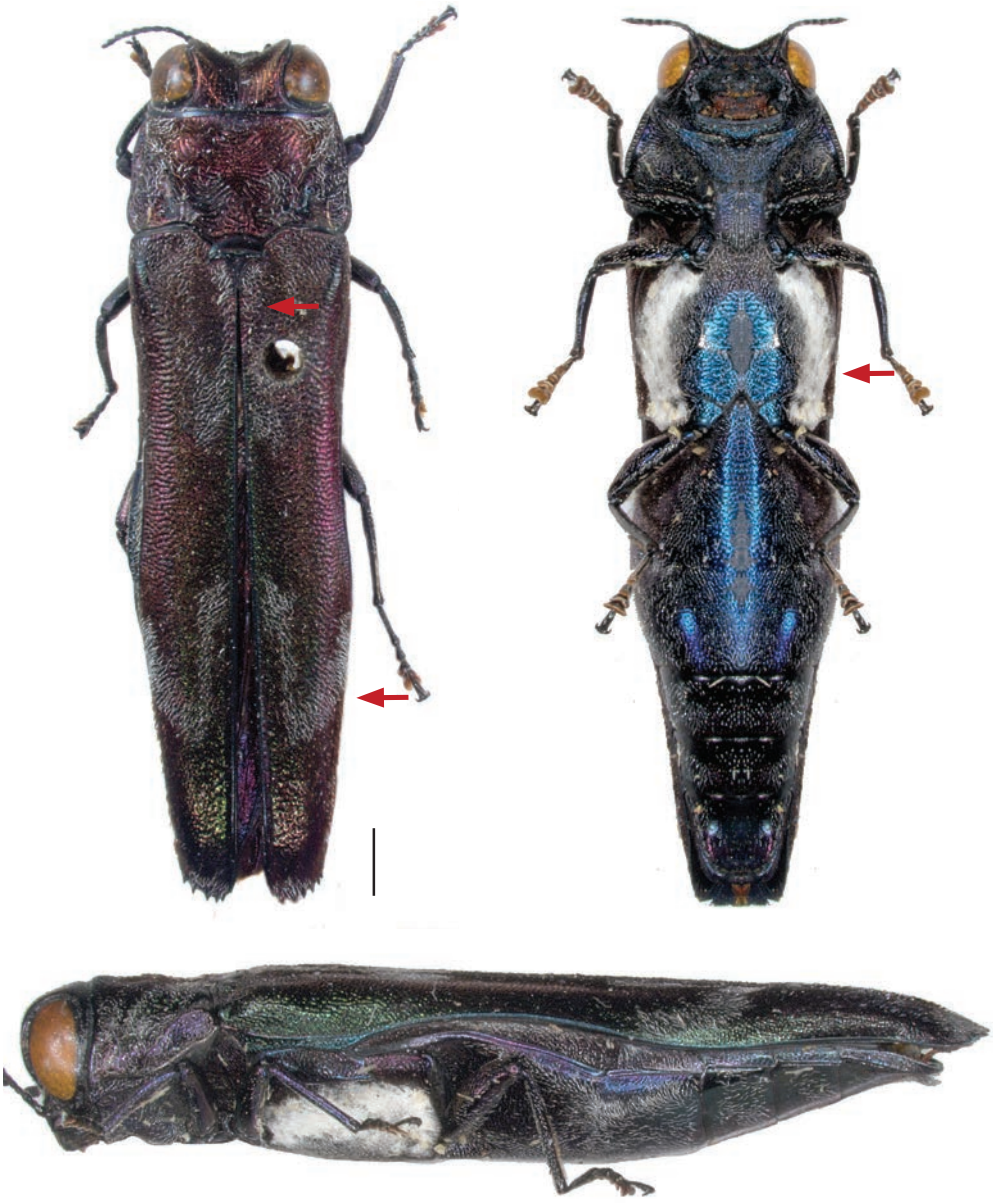
Agrilus hewitti group

Agrilus daillieri Baudon, 1965

Diagnosis
Body broad, size large. Metallic blue pronotum, elytra black becoming blue-violet apically, blue venter; white tomentum ventrally on frons, on elytra forming a proximal perisutural strip, and sparsely on venter. Eyes greatly enlarged, bulging beyond head outline. Frons with deep medial vertical impression. Anterior margin of pronotum narrower than posterior; shape wider than long. Pronotum with carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection shorter than disk length. Elytral apices arcuate, denticulate. Apex of phallus acute.
Similar species: *Agrilus hewitti* has a metallic violet pronotum with white tomentum; elytra wth white ornamental pubescence. Apex of phallus subacute.

Size: 12 mm
Distribution: Laos, Thailand.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus hewitti Kerremans.

Agrilus hewitti Kerremans, 1912



Diagnosis

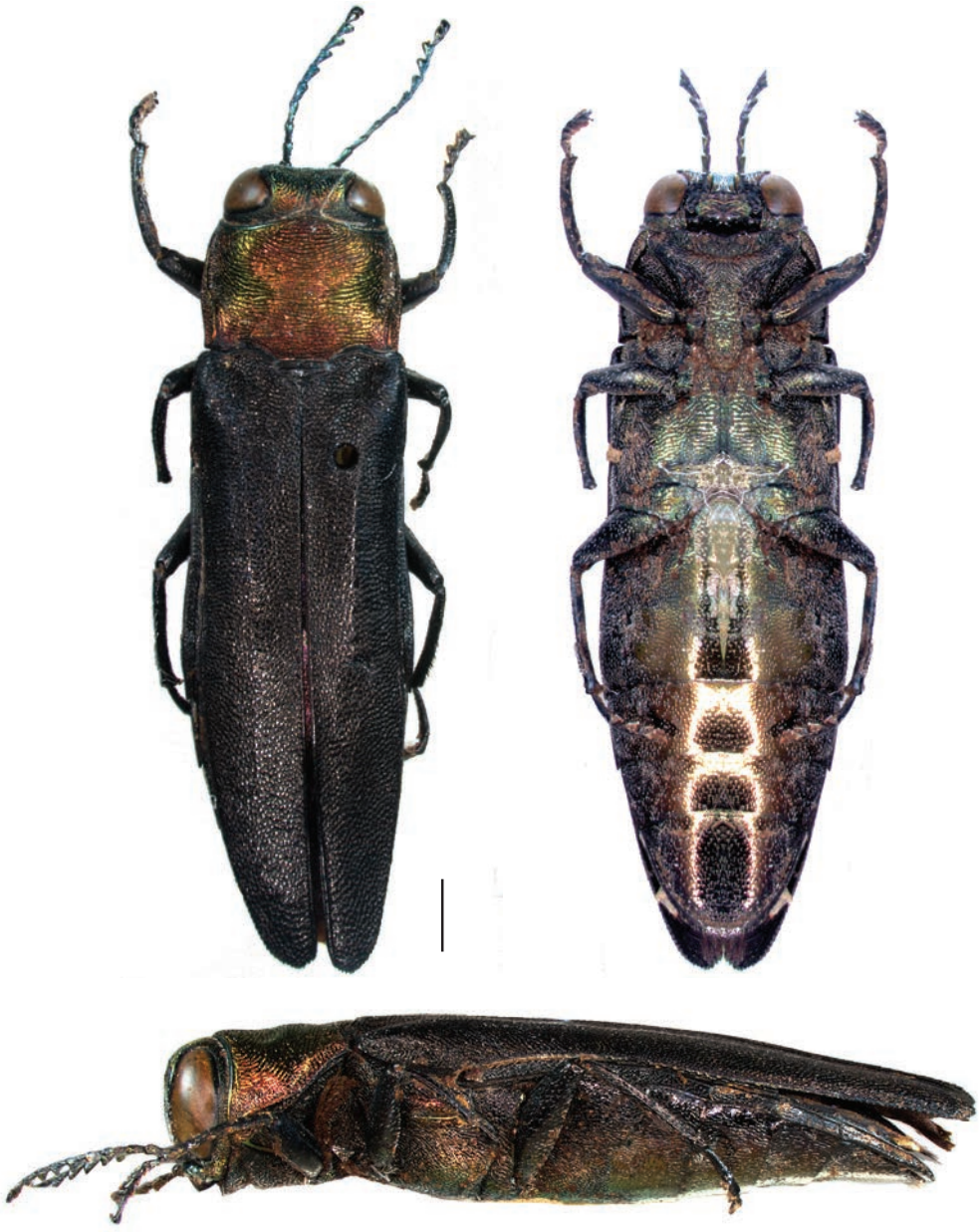
Body broad, size large. Metallic cupreous-violet dorsally, blue-violet venter; white tomentum ventrally on frons, pronotum, laterosternites, and laterally on meso- and metasternites; elytra with white ornamental pubescence basally and along perisuture, and subapically. Eyes greatly enlarged, bulging beyond head outline. Frons with deep medial vertical impression. Anterior margin of pronotum narrower than posterior; shape wider than long. Pronotum with carinal interspaces narrow. Prehumeri carinal, anterior end close to pronotal marginal carina and terminating distally beyond middle of pronotum. Scutellum width roughly 1/3 width of base of pronotum; transverse scutellar carina present; disk not impressed; scutellar projection approximately as long as disk length. Elytral apices arcuate, denticulate. Apex of phallus subacute.

Similar species: *Agrilus daillieri* has a metallic blue pronotum devoid of white pubescence; elytra has white pubescence restricted to proximal perisutural strip; apex of phalllus acute.

Size: 11.9 mm
Distribution: Malaysia: Sabah; Sarawak.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus daillieri Baudon.

Agrilus sinensis group

Agrilus coreanus Obenberger, 1935

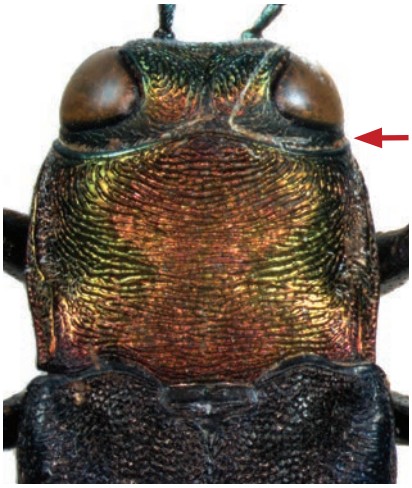


Diagnosis

Body slender, size large. Pronotum and head cupreous-red, elytra black. Frons with moderate medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions, anterior pronotal lobe obvious, subangulate; marginal and submarginal carinae not convergent, junction absent, marginal carina joining anterior pronotal margin; interspaces moderate, broadest anteriorly; prehumeri filamentary to carinal, arcuate, extending to anterior pronotal angle. Scutellum large, rectagular. Pygidium arcuate. Elytra glabrous, apices arcuate, margin finely denticulate. Hind tibiae entire. Aedeagus with phallobase not produced dorsad, parameral membrane elongate sinuate, apex of phallus rounded.

Similar species: *Agrilus planipennis* has the marginal and submarginal carinae converging and the junction obvious, the scutellum is very small, triangular, the elytra are never black, and the pygidium has an apical spine. *Agrilus s. sinensis* has frons with deep medial impression and a moderately-sized anterior pronotal lobe; the aedeagus has an enlarged and dorsally produced phallobase, parameral membrane elongate, subparallel, and the apex of the phallus is concave. *Agrilus s. splendidicollis* has the same differences as *A. s. sinensis*, but has cupreous-green elytra, not black.

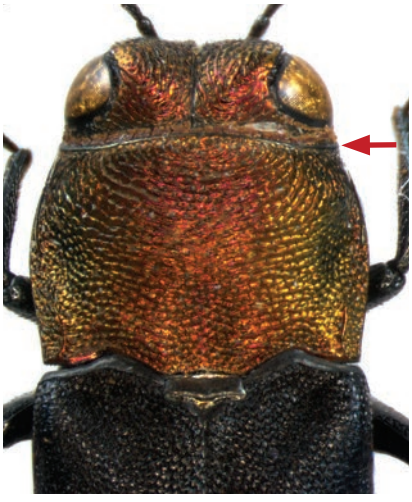
Size: 11 mm
Distribution: South Korea.
Altitude range: Unknown.
Host plants: Unknown.
Similar species:
Agrilus sinensis sinensis Thomson; *A. sinensis splendidicollis* Fairmaire.



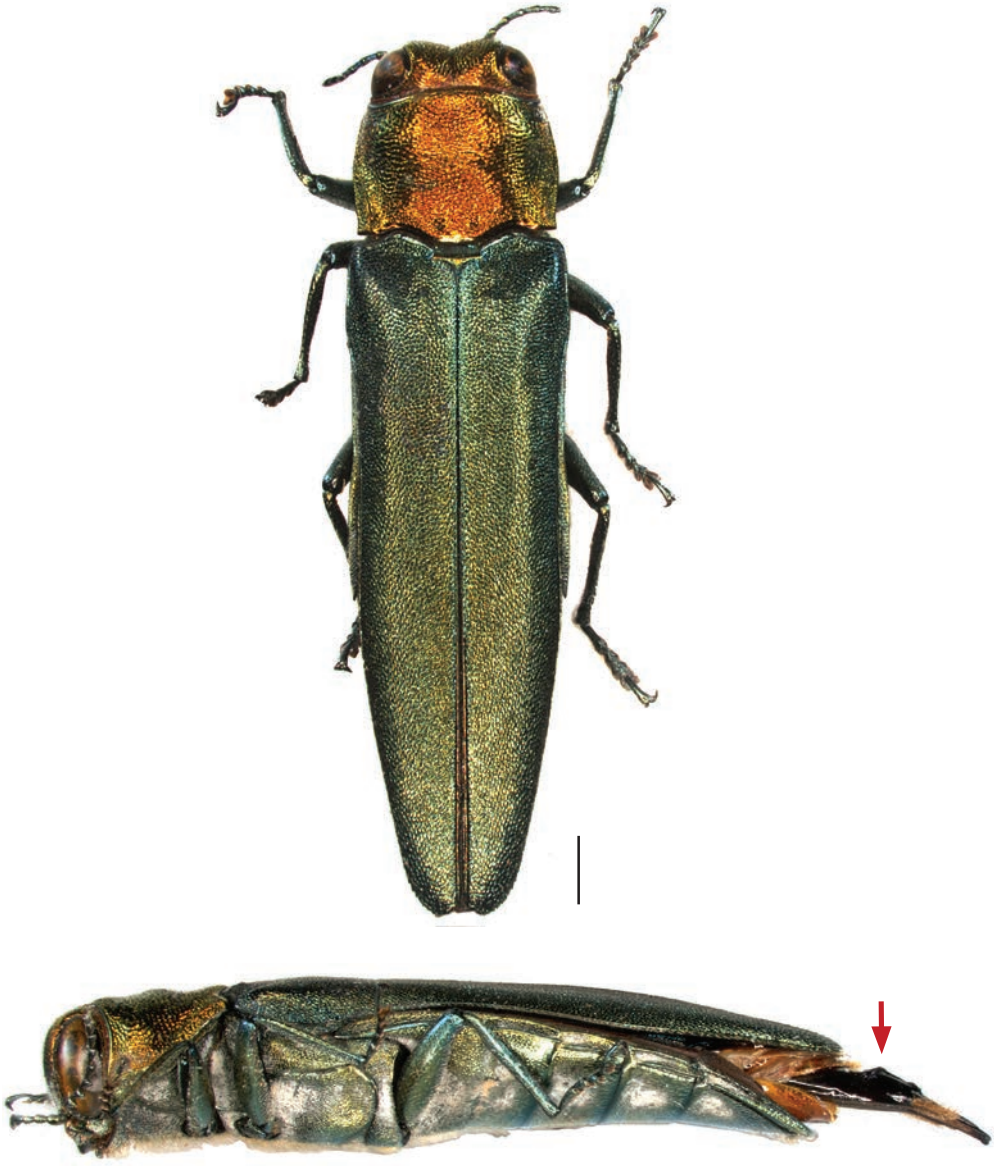
Agrilus sinensis sinensis Thomson, 1879

Diagnosis
Body slender, size large. Pronotum and head ruby-red, elytra black. Frons with deep medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions, anterior pronotal lobe moderate; marginal and submarginal carinae not convergent, junction absent, marginal carina joining anterior pronotal margin; interspaces moderate, broadest anteriorly; prehumeri filamentary, arcuate, extending to 2/3 of pronotal length. Scutellum large, rectagular. Pygidium arcuate. Elytra glabrous, apices arcuate, margin finely denticulate. Hind tibiae entire.
Similar species: *Agrilus planipennis* has prehumeri carinal, the marginal and submarginal carinae converge and the junction is obvious, the scutellum is very small, triangular, the elytra are never black, and the pygidium has an apical spine. *Agrilus sinensis splendidicollis* has cupreous elytra. *Agrilus coreanus* has a very obvious, subangulate anterior pronotal lobe and the phallobase of the aedeagus is less robust and the apex of the phallus is rounded.

Size: 8–13 mm
Distribution: China: Beijing, Fujian, Guizhou, Heilongjiang, Hunnan, Jiangxi, Jiangsu, Shanghai, Sichuan, Xizang, Yunnan. Japan: Honshu. Laos.
Altitude range: 700–1000m.
Host plants: Unknown.
Similar species:
Agrilus coreanus Obenberger; *A. planipennis* Fairmaire; *A. sinensis splendidicollis* Fairmaire



Agrilus sinensis splendidicollis Fairmaire, 1889



Diagnosis

Body slender, size large. Pronotum and head cupreous-red, elytra cupreous-green. Frons with deep medial impression. Pronotum widest medially, sides arcuate, anterior margin narrower than posterior; disk with anterior and posterior impressions, anterior pronotal lobe moderate; marginal and submarginal carinae not convergent, junction absent, marginal carina joining anterior pronotal margin; interspaces moderate, broadest anteriorly; prehumeri filamentary, arcuate, extending to 2/3 of pronotal length. Scutellum large, rectagular. Pygidium arcuate. Elytra glabrous, apices arcuate, margin finely denticulate. Hind tibiae entire. Aedeagus with enlarged and dorsally produced phallobase, parameral membrane elongate subparallel, apex of phallus concave.

Similar species: *Agrilus planipennis* has prehumeri carinal, the marginal and submarginal carinae converge and the junction is obvious, the scutellum is very small, triangular, the elytra are never black, and the pygidium has an apical spine. *Agrilus sinensis sinensis* has black elytra. *Agrilus coreanus* has a very obvious, subangulate anterior pronotal lobe, the phallobase of the aedeagus is less robust and the apex of the phallus is rounded.

Size: 8.5–12 mm
Distribution: China: Sichuan, Xizang, Yunnan. India: West Bengal. Laos. Thailand. Vietnam.
Altitude range: 700–2800m.
Host plants: Unknown.
Similar species:
Agrilus sinensis sinensis Thomson; *A. coreanus* Obenberger; *A. planipennis* Fairmaire.

Detailed taxonomy of species included in this guide

Agrilus ascanius group

Agrilus ascanius Deyrolle, 1864

ascanius Deyrolle, 1864 (*Agrilus*)
– Deyrolle, 1864: 138, 159 (description).
– Gemminger & Harold, 1869: 1436 (catalog).
– Saunders, 1871: 122 (catalog).
– Kerremans, 1892c: 247 (catalog).
– Kerremans, 1903: 282 (catalog).
– Obenberger, 1936a: 1073 (world catalog).
– Jendek, 1998: 317 (lectotype designation).
– Bellamy, 2008: 1977 (world catalog).

Type material: *Agrilus ascanius* Deyrolle, 1864. **Type locality:** I. Céram. **Type specimens:** Lectotype designated by Jendek (1998), (MNHN).

Specimens examined: INDONESIA: Maluku: 1 ♀ (EJCB): "Maluku, Seram, Solea, 12 km SE Wahai, 17.1.–6.2.1997, S. Bílý leg."; 1 ♀ (EJCB): "Maluku, Seram, Unit O, 35 km E Pasahari, 24.–30.X.1998, S. Bílý leg."; 3 ♀ (EJCB): "Indonesia, Maluku, Seram, 12 km SE Wahai, Solea, 31.10.– 4.11.1998, J. Horák leg."; 1 ♀ (EJCB): "Maluku, Seram, Unit O, 35 km E Pasahari, 24.–30.X.1998, J. Horák leg.".

Host plants: Unknown.

Distribution: INDONESIA: Maluku.

Agrilus cuprifrons Deyrolle, 1864

cuprifrons Deyrolle, 1864 (*Agrilus*)
– Deyrolle, 1864: 138, 159–160 (description).
– Gemminger & Harold, 1869: 1438 (catalog).
– Saunders, 1871: 122 (catalog).
– Kerremans, 1892c: 253 (catalog).
– Kerremans, 1903: 284 (catalog).

– Obenberger, 1936a: 1079 (world catalog).
– Jendek, 1998: 320 (lectotype designation).
– Bellamy, 2008: 2049 (world catalog).

Type material: *Agrilus cuprifrons* Deyrolle, 1864. **Type locality:** Célèbes (Tondano). **Type specimens:** Lectotype designated by Jendek (1998), (MNHN).
Specimens examined: Known to us only from the type.
Host plants: Unknown.
Distribution: INDONESIA: Sulawesi.

Agrilus maculiventris Deyrolle, 1864

maculiventris Deyrolle, 1864 (*Agrilus*)
– Deyrolle, 1864: 138, 158 (description).
– Gemminger & Harold, 1869: 1442 (catalog).
– Saunders, 1871: 122 (catalog).
– Kerremans, 1892c: 263 (catalog).
– Kerremans, 1903: 287 (catalog).
– Moulton, 1911: 178 (faunal records; Borneo: Sarawak)
– Obenberger, 1936a: 1090 (world catalog).
– Jendek, 1998: 325 (lectotype designation).
– Jendek, 2005: 13 (synonymy).
– Bellamy, 2008: 2175 (subgenus *Pinarinus*; world catalog).

Type material: *Agrilus maculiventris* Deyrolle, 1864. **Type locality:** I. Batchian. **Type specimens:** Lectotype designated by Jendek (1998), (MNHN).
Specimens examined: Known only from type.
Host plants: Unknown.
Distribution: INDONESIA: Maluku. **MALAYSIA:** Sarawak.

Agrilus mcgregori Fisher, 1926

mcgregori Fisher, 1926 (*Agrilus*)
– Fisher, 1926: 242–244 (description).
– Obenberger, 1936a: 1090 (world catalog).
– Bellamy, 1994: 361 (holotype in USNM).
– Bellamy, 2008: 2182 (world catalog).

Type material: *Agrilus mcgregori* Fisher, 1926. **Type locality:** Samar Island, Philippines. **Type specimens:** Holotype by monotypy (USNM).

Specimens examined: PHILIPPINES: 3 (USNM): "Island Samar Baker [p]"; 1 (EJCB): "Philippinen ... 27.iii.[19]15".

Host plants: Unknown.

Distribution: PHILIPPINES: Visayas islands.

Agrilus opulentus Kerremans, 1900

opulentus Kerremans, 1900 (*Agrilus*)
– Kerremans, 1900a: 336–337 (description).
– Kerremans, 1903: 278 (catalog).
– Obenberger, 1936a: 1096 (world catalog).
– Roberts, 1987: 59–64 (biology; insect pest; Papua New Guinea)
– Curletti, 2003: 154–155, 158 (subgenus *Pinarinus*; characters; faunal records; remarks; key; Solomon Islands).
– Jendek, 2005: 13 (synonym of *maculiventris*; lectotype designation).
– Curletti, 2006: 168, 169 (subgenus *Pinarinus*; valid species; characters; faunal records; New Guinea; Solomon Islands).
– Bellamy, 2008: 2219 (subgenus *Pinarinus*; world catalog).

Type material: *Agrilus opulentus* Kerremans, 1900a. **Type locality:** Nouvelle-Guinée. **Type specimens:** Lectotype designated by Jendek (2005), (BMNH).

Specimens examined: PAPUA NEW GUINEA: 1 ♀ (BPBM): "New Guinea (NE), Karimui, 1000 m, 4.vi.1961 / J.L. & M. Gressitt, Malaise trap"; 1♀ (BPBM): "New Guinea (NE), Mt. Missim, 1400 m, 7.xii.1966 / G.A. Samuelson Collector"; **SOLOMON ISLANDS:** 1 ♀ (BPBM): "Solomon Is., Fauro I., Toumoa Village, 10m. 12.iv.1964 / P. Shanahan Collector Bishop, Malaise Trap"; [all determined by G. Curletti 2002].

Host plants: *Eucalyptus deglupta*; *Terminalia brassii*; *Elaeocarpus*: Curletti, 2006 [Note: The genus *Terminalia* is cited by Curletti (2006) by wrong interpretation of Roberts (1987); *Elaeocarpus* is undocumented]).

Distribution: PAPUA NEW GUINEA. SOLOMON ISLANDS.

Agrilus sapphirinus Jendek & Chamorro, 2012

sapphirrinus Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 83 (description).

Type material: *Agrilus sapphirinus* Jendek & Chamorro, 2012. **Type locality:** North Laos, Louang Namtha environ, N 21°00.3, E 101°24.6. **Type specimens:** Holotype (EJCB).

Specimens examined: Known only from holotype.

Host plants: Unknown.
Distribution: LAOS: Louang Namtha Province.

Agrilus seramensis Jendek & Chamorro, 2012

seramensis Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 85 (description).

Type material: *Agrilus seramensis* Jendek & Chamorro, 2012. **Type locality:** Indonesia, Maluku, Seram Island, 35 km East of Pasahari, Unit O. **Type specimens:** Holotype (EJCB).
Specimens examined: Known only from type specimens; see Jendek & Chamorro, 2012.
Host plants: Unknown.
Distribution: INDONESIA: Maluku, Seram Island.

Agrilus validus Deyrolle, 1864

validus Deyrolle, 1864 (*Agrilus*)
– Deyrolle, 1864: 144, 192–193 (description).
– Gemminger & Harold, 1869: 1446 (catalog).
– Saunders, 1871: 124 (catalog).
– Kerremans, 1892c: 276 (catalog).
– Kerremans, 1903: 292 (catalog).
– Obenberger, 1936a: 1106 (world catalog).
– Jendek, 1998: 332 (lectotype designation).
– Jendek, 2003: 187 (synonymy).
– Bellamy, 2008: 2343 (world catalog).
= *nobuyukii* Tôyama, 1987 (*Agrilus*)
– Tôyama, 1987: 310–311 (description).
– Jendek, 2003: 187 (synonym of *validus*).
– Bellamy, 2008: 2343 (synonym of *validus*; world catalog).

Type material: *Agrilus validus* Deyrolle, 1864. **Type locality:** Célèbes (Menado). **Type specimens:** Lectotype designated by Jendek (1998), (MNHN).
Agrilus nobuyukii Tôyama, 1987. **Type locality:** Tohjambu, 400–1000 m alt. near Palopo, C. Sulawesi, Indonesia. **Type specimens:** Holotype (NSMT).
Specimens examined: Known only from type specimens.
Host plants: Unknown.
Distribution: INDONESIA: Sulawesi.

Agrilus viridissimus Cobos, 1964

viridissimus Cobos, 1964 (*Agrilus*)
– Cobos, 1964: 200–203 (description).
– Mercer, 1985: 103–105 (cited as *Agrilus* sp.; biology; faunal records; Papua New Guinea)
– Mercer, 1986: 89 (biology)
– Roberts, 1987: 59–64 (biology; insect pest; Papua New Guinea)
– Jendek, 2005: 13 (synonym of *maculiventris*)
– Curletti, 2006: 168–169 (subgenus *Pinarinus*; valid species; characters; faunal records; Papua New Guinea)
– Bellamy, 2008: 2358 (subgenus *Pinarinus*; world catalog)

Type material: *Agrilus viridissimus* Cobos, 1964. **Type locality:** Oro Bay, Nueva Guinea. **Type specimens:** Holotype (CAS).

Specimens examined: PAPUA NEW GUINEA: "New Guinea NE Sepik: Augoram, 20–30 m, 14–16.viii.1969 / J.L. Gressitt collector"; "West New Guinea, Nabire, 5–50 m, 25.viii–2.ix.62 / J. Sedlacek, Malaise Trap, Bishop" [all determined by Curletti 2002].

Host plants: *Terminalia catappa*: Curletti, 2006.

Distribution: PAPUA NEW GUINEA: Morobe, Chimbu.

Agrilus woodlarkianus Kerremans, 1900

woodlarkianus Kerremans, 1900 (*Agrilus*)
– Kerremans, 1900b: 82–83 (description).
– Kerremans, 1903: 277 (catalog).
– Carter, 1929: 276 (*Agrilus*).
– Obenberger, 1936a: 1108 (world catalog).
– Curletti, 2001: 35, 36, 40 (subgenus *Pinarinus*; characters; faunal record; notes; Australia).
– Bellamy, 2002: 355 (subgenus *Pinarinus*; catalog; Australia).
– Curletti, 2003: 156 (subgenus *Pinarinus*; doubtful synonym of *opulentus*).
– Jendek, 2005: 13 (synonym of *maculiventris*; lectotype designation).
– Curletti, 2006: 169 (subgenus *Pinarinus*; valid species; characters; faunal records).
– Bellamy, 2008: 2363 (subgenus *Pinarinus*; world catalog).

Type material: *Agrilus woodlarkianus* Kerremans, 1900b. **Type locality:** Woodlark. **Type specimens:** Lectotype designated by Jendek (2005), (BMNH).

Specimens examined: Known to us only from type specimens.

Host plants: Unknown.

Distribution: PAPUA NEW GUINEA: Milne Bay province; **AUSTRALIA**: Queensland.

Agrilus cyaneoniger group

Agrilus agnatus Kerremans, 1892

agnatus Kerremans, 1892b (*Agrilus*)
– Kerremans, 1892b: 820–821 (description).
– Kerremans, 1903: 281 (catalog).
– Obenberger, 1936a: 1071 (world catalog).
– Descarpentries & Villiers, 1963: 8 (synonym of *lafertei*; characters; faunal records; Inde; Birmanie; Tonkin; Laos).
– Tôyama, 1988: 759 ([Note: Specimens from Thailand are misidentified as *lafertei* according to Jendek, 2000b: 189]; faunal records; Thailand [pertains to *agnatus*]; Nepal [pertains to *lafertei*]).
– Jendek, 2000b: 189–190, 192 (valid species; lectotype designation; notes; key; faunistic data).
– Jendek, 2006a: 396 (Palaearctic catalog).
– Bellamy, 2008: 1955 (world catalog).
– Jendek & Grebennikov, 2011: 37–38 (references; type; diagnosis; faunal records; distributional summary; East Asia).

Type material: *Agrilus agnatus* Kerremans, 1892b. **Type locality:** Carin Cheba, 900–1100 m. **Type specimens:** Lectotype designated by Jendek (2000b), (MCSN).

Specimens examined: See Jendek (2000b), Jendek & Grebennikov (2011).

Host plants: Unknown.

Distribution: CHINA: Guizhou; Yunnan. **LAOS. MYANMAR. THAILAND. VIETNAM.**

Agrilus auristernum Obenberger, 1924

auristernum Obenberger, 1924 (*Agrilus*)
– Obenberger, 1924b: 34–35, 37 (description).
– Obenberger, 1926: 654 (Palaearctic catalog).
– Obenberger, 1936a: 958 (world catalog).
– Peng Zhongliang, 1987: 354 (cited as *auristermum*; checklist; China).
– Jendek, 2000b: 188, 190 (lectotype designation; faunal records; key).
– Hua Li Zhong, 2002: 89 (checklist; China).
– Jendek, 2006a: 396 (Palaearctic catalog).
– Bellamy, 2008: 1984 (world catalog).

– Jendek & Grebennikov, 2011: 45 (diagnosis; faunal records; host plants; distributional summary; East Asia).

Type material: *Agrilus auristernum* Obenberger, 1924. **Type locality:** Yünnan (China). **Type specimens: Primary:** Lectotype designated by Jendek (2000b), (NMPC).

Specimens examined: See Jendek (2000b), Jendek & Grebennikov (2011).

Host plants: adult collected from *Quercus*, which is probably the larval host plant: Jendek, 2000b

Distribution: CHINA: Yunnan.

Agrilus bifoveolatus Kerremans, 1895

bifoveolatus Kerremans, 1895 (*Agrilus*)
– Kerremans, 1895: 219 (description).
– Kerremans, 1903: 277 (catalog).
– Obenberger, 1936a: 1075 (world catalog).
– Jendek, 2000b: 190, 192 (lectotype designation; notes; key; faunistic data).
– Jendek, 2006a: 397 (Palaearctic catalog).
– Bellamy, 2008: 1997 (world catalog).

Type material: *Agrilus bifoveolatus* Kerremans, 1895. **Type locality:** Pedong. **Type specimens:** Lectotype designated by Jendek (2000b), (MNHN).

Specimens examined: See Jendek (2000b).

Host plants: Unknown.

Distribution: INDIA: Meghalaya; Sikkim; West Bengal. **NEPAL.**

Agrilus crepuscularis Jendek & Chamorro, 2012

crepuscularis Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 75 (description).

Type material: *Agrilus crepuscularis* Jendek & Chamorro, 2012. **Type locality:** Malaysia, Pahang state, 35 km Southwest Kuala Rompin, 2.617N, 103.337E, Endau Rompin State Park. **Type specimens: Holotype** (EJCB).

Specimens examined: Known only from the holotype.

Host plants: Unknown.

Distribution: MALAYSIA: Pahang state.

Agrilus cyaneoniger Saunders, 1873

cyaneoniger Saunders, 1873 (*Agrilus*)
– Saunders, 1873: 515 (description).
– Lewis, 1879: 15 (catalog; Japan).
– Kerremans, 1885: 152 (catalog).
– Schönfeldt, 1887: 113 (*Anambus*; catalog; Japan).
– Kerremans, 1892c: 254 (catalog).
– Lewis, 1893: 331–332 (faunal records; Japan).
– Kerremans, 1903: 276 (catalog).
– Jakobson, 1913: 798 (catalog; Russia and Europe).
– Obenberger, 1926: 659 (Palaearctic catalog).
– Yuasa, 1932: 654 (characters; Japan).
– Miwa & Chűjô, 1936: 16 (catalog; Japan).
– Obenberger, 1936a: 980–981 (world catalog).
– Chűjô & Matuda, 1940: 65 (checklist; faunal records; Japan).
– Iga, 1947: 15 (notes; characters; faunal records; Japan).
– Kurosawa, 1947: 1–2 (*Agrilus*).
– Yuasa, 1949: 127 (characters; Japan).
– Chűjô & Kurosawa, 1950: 8–9 (catalog; faunal records; Japan).
– Kurosawa, 1950: 1114 (*Agrilus*).
– Mühlmann, 1954: 83 (notes).
– Iga, 1955: 78 (iconography; Japan).
– Kurosawa, 1956: 1114 (characters; Japan).
– Obenberger, 1958: 237 (faunistic redords; China).
– Iga, 1962: 78 (iconography; Japan).
– Kurosawa, 1963: 153 (characters; Japan).
– Ko, Je Ho, 1969: 213 (pest; Korea).
– Kurosawa, 1974a: 1 (*Agrilus*).
– Kurosawa, 1974b: 1, 2 (characters; notes).
– Tôyama, 1985: 22–23 (iconography; Japan).
– Anonymous, 1986: 177 (insect pest; Korea).
– Hou, 1987: 589 (notes; Yunnan).
– Peng Zhongliang, 1987: 355 (checklist; China).
– Alexeev, 1989: 479 (subspecies of *cyaneoniger*; characters in key).
– Hirashima, 1989: 323 (checklist; Japan).
– Anonymous, 1991: 106 (faunal records; Japan).
– Li Jingke, 1992: 92 (checklist; northeastern China).
– Peng Zhongliang, 1992: 399 (characters; notes; China).
– Jendek, 1995: 140–141 (lectotype designation; synonymy; characters).
– Morimoto & Tadauchi, 1995: 231 (checklist; Japan).

– Akiyama & Akiyama, 1996: 184 (faunal records; Japan).
– Akiyama & Ohmomo, 1997: 31 (checklist; Japan: Hokkaido, Honshu, Shikoku, Kyushu, Yakushima I., Oki).
– Alexeev, 1998: 369 (subgenus *Anambus*; subgeneric classification).
– Nonnaizab, Qi Baoying & Li Yabai, 1999: 112 (checklist; China: Inner Mongolia).
– Jendek, 2000b: 187–188, 192 (faunal records; key).
– Hou Taoqian & Zeng Rui, 2002: 357 (checklist; China: Hainan).
– Hua Li Zhong, 2002: 89 (checklist; China).
– Peng Zhongliang, 2002: 267 (characters; China).
– Fukutomi & Hori, 2004: 14 (checklist; faunal records; Japan).
– Ohmomo, 2005: 236–241 (phenotypical analysis; faunal records; Russia; Japan; Korea).
– Jendek, 2006a: 390 (subgenus *Anambus*; Palaearctic catalog).
– Ohmomo, 2006: 6 (checklist; Japan).
– Anonymous, 2007: 32 (checklist; Japan).
– Bellamy, 2008: 2051–2052 (subgenus *Anambus*; world catalog).
– Jendek & Grebennikov, 2011: 73–75 (synonymy; references; types; diagnosis; host and distributional summary).

= *melanopterus* Solsky, 1876 (*Agrilus*)
– Solsky, 1876: 277–279 (description).
– Heyden, 1881: 119 (catalog).
– Kerremans, 1885: 153 (catalog).
– Marseul, 1887: 252 (catalog).
– Kerremans, 1892c: 263 (catalog).
– Heyden, 1893: 90 (catalog).
– Abeille de Perrin, 1897: 4 (characters in key).
– Kerremans, 1903: 287 (catalog).
– Jakobson, 1913: 797 (catalog; Russia and Europe).
– Obenberger, 1926: 655 (Palaearctic catalog).
– Obenberger, 1935: 162 (*Agrilus*).
– Obenberger, 1936a: 980 (variety of *cyaneoniger*; world catalog).
– Iga, 1955: 78 (variety of *cyaneoniger*; iconography; Japan).
– Iga, 1962: 78 (variety of *cyaneoniger*; iconography; Japan).
– Kurosawa, 1974c: 1 (subspecies of *cyaneoniger*).
– Alexeev, 1989: 479 (subspecies of *cyaneoniger*; characters in key; Korea; China).
– Hirashima, 1989: 323 (subspecies of *cyaneoniger*; checklist; Japan).
– Jendek, 1995: 140 (synonym of *cyaneoniger*; lectotype designation).
– Morimoto & Tadauchi, 1995: 231 (subspecies of *cyaneoniger*; checklist; Japan).
– Akiyama & Ohmomo, 1997: 31–32 (subspecies of *cyaneoniger*; checklist; Japan).
– Jendek, 2000: 187, 188, 192 (subspecies of *cyaneoniger*; faunal records; key).
– Hua Li Zhong, 2002: 89 (subspecies of *cyaneoniger*; checklist; China).
– Jendek, 2003: 181 (subspecies of *cyaneoniger*; synonymy).

– Ohmomo, 2005: 236–241 (synonym of *cyaneoniger*; phenotypical analysis).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Ohmomo, 2006: 6 (synonym of *cyaneoniger*).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Volkovitsh, 2009: 134 (subgenus *Anambus*; subspecies of *cyaneoniger*; faunal records; Russia: Primorskiy kray).
– Gao, Ye, Yu & Pi, 2010: 12–15 (subspecies of *cyaneoniger*; characters; larva; biology; China: Jilin).
– Jendek & Grebennikov, 2011: 73, 74 (synonym of *cyaneoniger*).
– Ye, Yu & Gao, 2011: 20–25 (subspecies of *cyaneoniger*; extensive infestation; China: Jilin).
– Yu, Ye & Gao, 2011: 16–19 (subspecies of *cyaneoniger*; biology; China: Jilin).
= *cyaneoniger* Thomson, 1879 ([preoccupied])
– Thomson, 1879: 71–72 (description).
– Jakobson, 1913: 798 (synonym of *jamesi*; catalog).
– Obenberger, 1936a: 980 (synonym of *cyaneoniger* Saunders).
– Jendek, 1995: 140 (synonym of *cyaneoniger*; lectotype designation).
– Akiyama & Ohmomo, 1997: 31 (synonym of *cyaneoniger* Saunders).
– Jendek, 2006a: 390 (synonym of *cyaneoniger* Saunders; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 73, 74 (synonym of *cyaneoniger* Saunders).
= *impressifrons* Kiesenwetter, 1879 (*Agrilus*)
– Kiesenwetter *in* Kraatz & Kiesenwetter, 1879: 254–255 (description).
– Heyden, 1881: 119 (catalog).
– Heyden, 1884: 290 (faunal record; Amur region).
– Kerremans, 1885: 153 (catalog).
– Marseul, 1887: 252 (catalog).
– Kerremans, 1892c: 260 (catalog).
– Heyden, 1893: 90 (catalog).
– Abeille de Perrin, 1897: 3 (characters in key).
– Kerremans, 1903: 286 (catalog).
– Semenov, 1903: 171–172 (synonym of *melanopterus*).
– Jakobson, 1913: 797 (synonym of *melanopterus*; catalog).
– Fisher, 1925: 4 (notes).
– Obenberger, 1936a: 981 (synonym of *cyaneoniger* variety *melanopterus*).
– Jendek, 1995: 140 (synonym of *cyaneoniger*).
– Akiyama & Ohmomo, 1997: 32 (synonym of *cyaneoniger melanopterus*).
– Jendek, 2003: 181 (synonym of *cyaneoniger melanopterus*; lectotype designation).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 73, 74 (synonym of *cyaneoniger*).
= *marquardti* Obenberger, 1914 (*Agrilus*)
– Obenberger, 1914: 41–42 (in Czech), 47–48 (in German) (description).

– Obenberger, 1926: 654 (Palaearctic catalog).
– Obenberger, 1936a: 980 (variety of *cyaneoniger*; world catalog).
– Descarpentries & Villiers, 1963: 2, 8 (subspecies of *cyaneoniger*; characters; faunal records; Tonkin; China).
– Peng Zhongliang, 1987: 355 (subspecies of *cyaneoniger*; checklist; China).
– Jendek, 1995: 140 (synonym of *cyaneoniger*; lectotype designation).
– Akiyama & Ohmomo, 1997: 31 (synonym of *cyaneoniger melanopterus*).
– Hua Li Zhong, 2002: 89 (subspecies of *cyaneoniger*; checklist; China).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 74 (synonym of *cyaneoniger*).
= *ataman* Obenberger, 1924 (*Agrilus*)
– Obenberger, 1924b: 35, 38 (description).
– Obenberger, 1926: 654 (Palaearctic catalog).
– Mandl, 1931: 13 ([Note: Misidentified as *sinensis* according to Mandl, 1941: 788]; faunal record; Ussuri).
– Obenberger, 1935: 162 (subspecies of *melanopterus*).
– Obenberger, 1936a: 981 (variety of *cyaneoniger*; world catalog).
– Mandl, 1941: 788 (comments and emandations to Mandl, 1931; Ussuri).
– Jendek, 1995: 140, 141 (synonym of *cyaneoniger*; lectotype designation).
– Akiyama & Ohmomo, 1997: 32 (synonym of *cyaneoniger melanopterus*).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 74 (synonym of *cyaneoniger*).
= *mikado* Obenberger, 1924 (*Agrilus*)
– Obenberger, 1924b: 35–36, 38 (description).
– Obenberger, 1926: 654 (Palaearctic catalog).
– Miwa & Chŭjô, 1936: 18 (catalog; Japan).
– Obenberger, 1936a: 981 (synonym of *cyaneoniger*; world catalog).
– Kurosawa, 1963: 153 (form of *cyaneoniger*; characters; Japan).
– Jendek, 1995: 140, 141 (synonym of *cyaneoniger*; lectotype designation).
– Akiyama & Ohmomo, 1997: 31 (synonym of *cyaneoniger* Saunders).
– Ohmomo, 2005: 236–241 (synonym of *cyaneoniger*).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 74 (synonym of *cyaneoniger*).
= *cupreoviridis* Lewis, 1893 (*Agrilus* variety of *cyaneoniger* Saunders; [Note: Although Lewis did not explicitly state that *cupreoviridis* was a variety he did say that it was named for a "permanent variety" of *cyaneoniger*; **Unavailable name** (Article 45.6.4)])
– Lewis, 1893: 332 (description).
– Kerremans, 1903: 276 (variety of *cyaneoniger*; catalog).
– Jakobson, 1913: 798 (variety of *cyaneoniger*; catalog; Russia and Europe).

– Obenberger, 1926: 659 (aberration of *cyaneoniger*; Palaearctic catalog).
– Miwa & Chûjô, 1936: 16 (variety of *cyaneoniger*; catalog; Japan).
– Obenberger, 1936a: 981 (variety of *cyaneoniger*; world catalog).
– Kurosawa, 1947: 1–2 (variety of *cyaneoniger*; characters; notes).
– Iga, 1955: 78 (variety of *cyaneoniger*; iconography; Japan).
– Iga, 1962: 78 (variety of *cyaneoniger*; iconography; Japan).
– Kurosawa, 1963: 153 (form of *cyaneoniger*; characters; Japan).
– Jendek, 1995: 140, 141 (synonym of *cyaneoniger*).
– Akiyama & Ohmomo, 1997: 31 (synonym of *cyaneoniger* Saunders).
– Ohmomo, 2005: 236–241 (synonym of *cyaneoniger*; phenotypical analysis).
– Jendek, 2006b: 39 (unavailable name).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
= *jamesi* Jakobson, 1913 (replacement name for *cyaneoniger* Thomson not Saunders)
– Jakobson, 1913: 798 (replacement name proposal).
– Obenberger, 1926: 659 (Palaearctic catalog).
– Obenberger, 1936a: 980 (synonym of *cyaneoniger*; world catalog).
– Peng Zhongliang, 1992: 399 (synonym of *cyaneoniger*).
– Jendek, 1995: 140 (synonym of *cyaneoniger*).
– Akiyama & Ohmomo, 1997: 31 (synonym of *cyaneoniger* Saunders).
– Hua Li Zhong, 2002: 89 (synonym of *cyaneoniger*).
– Jendek, 2006a: 390 (synonym of *cyaneoniger*; Palaearctic catalog).
– Bellamy, 2008: 2052 (synonym of *cyaneoniger*; world catalog).
– Jendek & Grebennikov, 2011: 73, 74 (synonym of *cyaneoniger*).

Type material. *Agrilus cyaneoniger* Saunders, 1873. **Type locality:** Japan. **Type specimens:** Lectotype designated by Jendek (1995), (BMNH).

Agrilus melanopterus Solsky, 1876. **Type locality:** sur les bords de l'Oussouri. **Type specimens:** Lectotype designated by Jendek (1995), (ZIN).

Agrilus cyaneoniger Thomson, J., 1879. **Type locality:** Japonia. **Type specimens:** Lectotype designated by Jendek (1995), (MNHN).

Agrilus impressifrons Kiesenwetter, 1879. **Type locality:** not given [Amur is cited in the title of the publication]. **Type specimens:** Lectotype designated by Jendek (2003), (ZSMC).

Agrilus marquardti Obenberger, 1914. **Type locality:** Kiang-si in China. **Type specimens:** Lectotype designated by Jendek (1995), (NMPC).

Agrilus ataman Obenberger, 1924. **Type locality:** Vladivostok. **Type specimens:** Lectotype designated by Jendek (1995), (NMPC).

Agrilus mikado Obenberger, 1924. **Type locality:** Japan. **Type specimens:** Lectotype designated by Jendek (1995), (NMPC).

Specimens examined: See Jendek (2000b), Jendek & Grebennikov (2011).

Host plants: *Quercus*: Alexeev, 1989; Hua Li Zhong, 2002; Mühlmann, 1954.

***Quercus acuta*:** Ko, Je Ho, 1969.
***Quercus acutissima*:** Akiyama & Ohmomo, 1997; Ko, Je Ho, 1969.
***Quercus aliena*:** Ko, Je Ho, 1969.
***Quercus dentata*:** Kurosawa, 1947.
***Quercus mongolica* var. *grosserrata*:** Akiyama & Ohmomo, 1997.
***Quercus mongolica*:** Gao, Ye, Yu & Pi, 2010 (as *melanopterus*); Ye, Yu & Gao, 2011 (as *melanopterus*; erroneously translated as *Xylosoma recemosum*); Yu, Ye & Gao, 2011 (as *melanopterus*).
***Quercus myrsinaefolia*:** Ko, Je Ho, 1969.
***Quercus serrata*:** Akiyama & Ohmomo, 1997.
***Quercus variabilis*:** Akiyama & Ohmomo, 1997.
Distribution: CHINA: Guizhou; Hainan; Hebei; Jiangxi; Jilin; Nei Mongol; Shaanxi; Shanxi; Sichuan; Yunnan; Zhejiang. **INDIA:** Jammu & Kashmir. **JAPAN:** Hokkaido; Honshu; Kyushu; Ryukyu isl.; Shikoku; Tsushima. **KOREA NORTH. KOREA SOUTH. RUSSIA:** Amurskaya oblast'; Primorskiy kray. **VIETNAM.**

Agrilus lafertei Kerremans, 1892

lafertei Kerremans, 1892a (*Agrilus*)
– Kerremans, 1892a: 212–213 (description).
– Kerremans, 1903: 286 (catalog).
– Obenberger, 1936a: 1089 (world catalog).
– Descarpentries & Villiers, 1963: 2, 8 (characters; faunal records; Inde; Birmanie; Tonkin; Laos [Note: Records from Vietnam and Laos probably pertain to *A. agnatus* according to Jendek (2000b)]).
– Tôyama, 1988: 759 ([Note: Specimens from Thailand are misidentification of *A. agnatus* according to Jendek (2000b)]; faunal records]).
– Jendek, 2000b: 188–189, 192 (notes; characters; faunal records).
– Jendek, 2006a: 399 (Palaearctic catalog).
– Bellamy, 2008: 2157 (world catalog).
= *auriventris* La Ferté, (Unpublished name; [Note: **Unavailable name** (Article 11.1)])
– Kerremans, 1892a: 212 (synonym of *lafertei*).
– Jendek, 2000b: 188 (unavailable name).
– Bellamy, 2008: 2157 (synonym of *lafertei*; world catalog).

Type material: *Agrilus lafertei* Kerremans, 1892a. **Type locality:** Inde. **Type specimens:** Holotype by monotypy, (MNHN).
Specimens examined: See Jendek (2000b), Jendek & Grebennikov (2011).
Host plants: Unknown.
Distribution: BHUTAN. INDIA: Arunachal Pradesh; Uttar Pradesh. **NEPAL.**

Agrilus lubopetri Jendek, 2000

lubopetri Jendek, 2000 (*Agrilus*)
– Jendek, 2000b: 188, 190 (description).
– Bellamy, 2008: 2170 (world catalog).
– Jendek & Grebennikov, 2011: 122 (references; types; diagnosis; faunal records; distributional summary; East Asia).

Type material: *Agrilus lubopetri* Jendek, 2000. **Type locality:** N Vietnam, 21°27N, 105°39E, 70 km NW of Hanoi, Tam Dao, 900–1200 m. **Type specimens:** Holotype (EJCB).
Specimens examined: see: Jendek & Grebennikov (2011).
Host plants: Unknown.
Distribution: CHINA: Yunnan. **LAOS. VIETNAM.**

Agrilus planipennis Fairmaire, 1888

planipennis Fairmaire, 1888 (*Agrilus*)
– Fairmaire, 1888: 121 (description).
– Kerremans, 1892c: 268 (catalog).
– Kerremans, 1903: 289 (catalog).
– Jakobson, 1913: 796 (catalog; Russia and Europe).
– Obenberger, 1926: 654 (Palaearctic catalog).
– Obenberger, 1936a: 1022 (world catalog).
– Peng Zhongliang, 1987: 357 (checklist; China).
– Jendek, 1994: 21 (lectotype designation; synonymy; Russian Far East; Mongolia; Japan; China, Taiwan).
– Akiyama & Ohmomo, 1997: 37 (checklist; Mongolia; North China; Korea).
– Alexeev, 1998: 372 (subgenus *Uragrilus*; subgeneric classification).
– Akiyama & Ohmomo, 2000: 275 (characters; distributional summary; host plants).
– Haack et al., 2002: 1–5 (new pest in America; USA: Michigan and Canada, Ontario).
– Hua Li Zhong, 2002: 90 (checklist; China: Beijing).
– McCullough & Roberts, 2002: 1–2 (introduction to Michigan; characters; biology; USA).
– Scarr et al., 2002: 1–4 [not paginated] (life cycle).
– Herms et al., 2003: 2–10 (economic and ecological impact; taxonomy; biology; diagnostic; eradication; USA).
– Liu Houping et al., 2003: 191–203 (exploratory survey; natural enemies; China).
– Mühle, 2003: 44, 47 (checklist; Taiwan).
– Bartels, 2004: 19 (remote sensing for detection of infestations).
– Bauer et al., 2004: 36–37 (laboratory rearing).
– Bauer et al., 2004: 8 (life cycle).

– Bauer et al., 2004: 31–32 (microbial control).
– Bauer et al., 2004: 33–34 (natural enemies: fungi, hymenopteran parasitoids).
– Bauer et al., 2004: 9 (flight potential).
– Bean, 2004: 4 (detection and quarantine; Maryland).
– Brown Rytlewski & Wilson, 2004: 11 (emergence of adult).
– Francese et al., 2004: 22 (survey tools).
– Fukutomi & Hori, 2004: 14 (checklist; faunal records; Japan (Hokkaido).
– Gates & Gibson, 2004: 12 (new parasitoid of Mymaromatidae (Hymenoptera, Chalcidoidea); USA).
– Gould et al., 2004: 35 (biocontrol; parasitoids and predators attacking related borers).
– Haack & Petrice, 2004a: 10 (adult dispersal; Michigan).
– Haack & Petrice, 2004b: 26 (tests of insecticides).
– Haack & Petrice, 2004c: 14 (attraction to trap logs).
– Haack & Petrice, 2004d: 23 (survival in firewood).
– Haack et al., 2004: 38 (host range evaluation by foliage of several trees and shrubs as food for adults).
– Herms et al., 2004: 41 (resistance of Asian and North American ashes).
– Lewis, 2004: 29 (control by trunk injection).
– Liu Houping & al., 2004: 20 (parasitoid *Spathius* sp. (Hymenoptera, Braconidae); China).
– Lyons et al., 2004: 5 (biology and phenology).
– MacFarlane & Friedman, 2004: 21 (spatial distribution and abundance model).
– Marchant, 2004: 3 (delimitation and detection survey; Ontario).
– McCullough et al., 2004: 39–40 (host range and host preference; alternate hosts).
– McCullough et al., 2004: 27–28 (control of adults and larvae with insecticides).
– McCullough et al., 2004: 6–7 (dispersal of one generation; Michigan).
– McCullough et al., 2004: 24–25 (survival in wood chips).
– Oliver et al. 2004: 17–18 (traps developing).
– Poland et al., 2004: 15–16 (attractants and trapping techniques).
– Rauscher & Mastro, 2004: 1–2 (eradication plan; Michigan, Ohio, Virginia, Maryland).
– Reardon, 2004: 30 (natural enemies).
– Schaefer, 2004: 13 (faunal record; Japan: Honshu).
– Schröder, 2004: 25–26 (placed on list of regulated pests by EPPO; Germany).
– Schröder, 2004: 222–226 (overview on biology and risk analysis for Europe).
– Smith et al., 2004: 12 (genetic analysis to determinate point of origin in North American infestation).
– Timms et al., 2004: 42 (susceptibility and within-tree distribution).
– Wei et al., 2004: 679–685 (characters; biology; parasitoids; distribution; damages; China).
– Anonymous, 2005: 436–438 (quarantine pest datasheet).
– Cappaert et al. 2005: 152–165 (research history in North America).
– Chornesky et al., 2005: 336–337 (significance to sustianable forestry; USA).
– Francese et al., 2005: 93–95 (color traps evaluation).

– Gibson, 2005: 31–36 (parasitoid *Balcha indica* (Eupelmidae) accidental introduction from the Oriental region).
– Kluza & Jendek, 2005: 50 (potential distribution in North America).
– Liu Hai Jun et al., 2005: 348–352 (biological characteristics).
– Liu Houping & Bauer, 2005: 594–598 (host range).
– MacFarlane & Meyer, 2005: 15–23 (potential ash tree hosts).
– Wang Xiaoyi et al., 2005: 98–102 (larval instars).
– Yang Zhongqi et al., 2005: 636–641 (new species of parasitoid *Spathius agrili*).
– Zhang Yan Zhou et al., 2005: 253–259 (new species of egg parasitoids).
– Zhao Tong Hai et al., 2005: 594–599 (host range and damage in China).
– de Groot et al., 2006: 1–16 (life stages; signs and symptoms of infested trees; measures; Canada).
– Haack, 2006: 270, 271 (summary data about introduction to North America).
– Jendek, 2006a: 395 (subgenus *Uragrilus*; Palaearctic catalog).
– Liu Houping & Bauer, 2006: 1096–1103 (entomopathogenic fungi *Beauveria* and *Metarhizium*).
– Ohmomo, 2006: 6 (checklist; Japan).
– Poland et al., 2006: 118–124 (threat to North America's ash).
– Rodriguez Saona et al., 2006: 75–84 (host plants findings; induced volatiles).
– Timms et al., 2006: 313–320 (within-tree distribution patterns; Canada (Ontario).
– Bartelt et al., 2007: 1299–1301 (pheromonal function of lactone).
– Bauer et al., 2007: 51N–54N (progress in biological control).
– Izhevskii & Mozolevskaya, 2007: 153–155 (emerald ash borer in Moscow, Russia).
– Lelito et al., 2007: 537–551 (trapping; mating behavior).
– Liu Houping et al., 2007: 61–71 (parasitoids: *Oobius agrili*; *Tetrastichus planipennisi;* China).
– Lyons et al., 2007: 1–58 (biology; life cycle; host plants; monitoring; Canada).
– McCullough & Siegert, 2007: 1577–1585 (estimated surface area of infested plants; eradication).
– McCullough et al., 2007: 1304–1315 (phytosanitary treatment).
– Mozolevskaya, 2007: 137–138 (new pest discovered in 2004; Russia: Moscow region).
– Petrice & Haack, 2007: 92–95 (survival in cut logs).
– Rodriguez Saona et al., 2007: 1–15 (adult behaviors).
– Wei Xia et al., 2007: 367–372 (damage traits; life history; northeastern China).
– Yurchenko et al., 2007: 94–98 (faunal records; parasitoids; Russia: Primorsk, Khabarovsk).
– Zhao et al., 2007: 826–831 (induced outbreak by an introduction of exotic tree species; China).
– Anulewicz et al., 2008: 230–240 (host range; oviposition preference; host selection).
– Baranchikov et al., 2008: 233–236 (invasion in Russia and impact for Europe).
– Bauer et al., 2008: 38–39 (developing a biological control program).
– Bellamy, 2008: 2238–2239 (subgenus *Uragrilus*; world catalog).
– Buck & Marshall, 2008: 197–199 (secondary dispersal pathways of adult dispersal).
– Crook et al., 2008a: 1103–1111 (antennal sensilla structure).
– Crook et al., 2008b: 356–365 (development of a semiochemical lure).
– de Groot et al., 2008: 1170–1179 (response to green leaf volatiles).

– Francese et al., 2008: 1831–1837 (trap placement and design).
– Lelito et al., 2008: 668–673 (effectivity of the visual-cue based sticky traps).
– Lindell et al., 2008: 434–442 (woodpecker predation).
– Rebek et al., 2008: 242–245 (host plant resistance).
– Smitley et al., 2008: 1643–1650 (progression ash canopy thinning).
– Vasanthakumar et al., 2008: 1344–1351 (gut microbial communities).
– Wessels-Berk & Scholte, 2008: 165–168 (phytosanitary risk; Europe).
– Nelson et al., 2008: 172 (subgenus *Agrilus*; catalog; North America)
– Cappaert & McCullough, 2009: 16–28 (abundance of parasitoid *Atanycolus planipennis*).
– Crook et al., 2009: 2160–2169 (response to the electromagnetic spectrum).
– Douglas et al., 2009: 96 (history of discovery in North America).
– Duan et al., 2009: 588–592 (parasitoids; biocontrol).
– Jendek & Grebennikov, 2009: 243 (notes).
– Lelito et al., 2009: 104–110 (evidence of a contact pheromone).
– Lyons et al., 2009: 40–52 (host selection).
– Marsh et al., 2009: 8–14 (new species of parasitoid *Atanycolus cappaerti* (Hymenoptera, Braconidae)).
– McCullough et al., 2009: 1331–1344 (attraction to stressed ash tree).
– Mercader et al., 2009: 421–424 (dispersal in newly-colonized sites).
– Petrice et al., 2009: 173–182 (biology; larval morphology).
– Pureswaran et al., 2009: 757–765 (host selection and feeding preference).
– Silk et al., 2009: 601–608 (sex pheromone).
– Volkovitsh, 2009: 136 (subgenus *Uragrilus*; faunal records; notes; Russia: Primorskiy kray).
– Baranchikov, 2010: 870–871 (biology; habitat; introduced range; pathways; impact; management).
– Bauer et al., 2010: 26–27 (biological control).
– Crook & Mastro, 2010: 101–112 (chemical ecology of adults).
– Duan et al., 2010: 1513–1522 (impact of biotic factors).
– Grant et al., 2010: 26–32 (response to hexenol and manuka oil).
– Francese et al., 2010: 1235–1241 (optimizing trap color).
– Haack et al., 2010: 1682–1692 (bark- and wood-boring insects in firewood).
– Kovacs et al., 2010: 569–578 (cost of damage in USA in 2009–2019).
– Kula et al., 2010: 246–257 (parasitoid, *Leluthia astigma*, Braconidae)).
– Marshall et al., 2010: 296–302 (trap and lures efficacy).
– Poland & McCullough, 2010: 4–8 (biological control).
– Taylor et al., 2010: 128–148 (flight performance).
– Wang Xiao Yi et al., 2010: 128 (biology; China).
– Duan et al., 2011: 1–9 (biology of the parasitoid *Balcha indica*).
– Grant et al., 2011: 173–179 (response to phoebe oil and hexenol).
– Jendek & Grebennikov, 2011: 153–155 (synonymy; references; types; diagnosis; host and distributional summary).
– Marshall et al., 2011: 91–96 (larvae detection model).

– Silk et al., 2011: 904–916 (pheromone and foliar volatile attraction).
– Belokobylskij et al., 2012: 165–177 (parasitoid *Spathius galinae*; faunal records; Russia; South Korea; China).
– Chamorro et al., 2012: 1–11 (biology; larva; pupa; characters).
– Chen Yigen et al., 2012: 324–330 (nutritional ecology).
– Coleman et al., 2012: 220 (parasitoids and predators overview).
– Crook et al., 2012: 429–436 (influence of trap color and host volatiles).
– Cullen, 2012: D6 (impact on urban trees in Ottawa; Canada: Ontario).
– Duan & Oppel, 2012: 792–800 (parasitoid *Tetrastichus planipennisi* Eulophidae).
– Duan et al., 2012: 199–207 (biocontrol; parasitoids).
– Duan et al., 2012: 245–253 (biotic factors affecting immature stages; Russia: Khabarovsk, Vladivostok).
– Fissore et al., 2012: 1015–1030 (impacts on biogeochemical and water cycling in residential landscapes).
– Johny et al., 2012: 41–48 (virulence of entomopathogenic fungus *Beauveria*).
– Lu Ji-Fang et al., 2012: 330–335 (adult longevity and fecundity).
– Mercader et al., 2012: 272–279 (population density and dispersal in detection and monitoring).
– Mittapalli et al., 2012: 455–459 (mRNA profiles of piRNA genes).
– McKenney et al., 2012: 81–91 (cost of damage to Canadian municipalities).
– Paiero et al., 2012: 138–139 (characters; host plants summary).
– Rutledge & Keena, 2012a: 66–72 (mating frequency and fecundity).
– Ryall et al., 2012: 648–654 (attraction to volatile pheromone).
– Sobek-Swant et al., 2012: 23–31 (potential distribution in native and invaded range).
– Taylor et al., 2012: 3–6 (parasitoid guilds compilation).
– Yang Zhong-Qi et al., 2012: 619–626 (parasitoid *Sclerodermus pupariae* (Hymenoptera: Bethylidae); China)
– EPPO, 2013: (pest risk analysis).
– Duan et al., 2013a: 166–172 (*Tetrastichus planipennisi* (Hymenoptera, Eulophidae) in Michigan).
– Duan et al., 2013b: 166–172 (hymenopteran parasitoids).
– Foelker et al., 2013: 532–538 (within tree colonization patterns and subsampling technique).
– Petrice et al., 2013: 13–30 (trap color and shape)
– Rutledge et al., 2013: 75–80 (survey technique by *Cerceris fumipennis*; faunal records).
– Volkovitsh & Mozolevskaya 2014: 8–19 (research history in Russia, distributional, host-range, ecological, parasitoid, control summary).
= *marcopoli* Obenberger, 1930 (*Agrilus*)
– Obenberger, 1930: 108–109 (description).
– Miwa & Chűjô, 1940: 74 (cited as *malcopoli*; faunal record; Japan: Sapporo).
– Iga, 1955: 78 (iconography; Japan).
– Kurosawa, 1956: 40 (faunal records; Korea).
– Iga, 1962: 78 (iconography; Japan).
– Kurosawa, 1963: 153 (characters; Japan).

– Ko, Je Ho, 1969: 214 (pest; Korea).
– Kurosawa, 1974b: 3 (notes).
– Alexeev, 1979: 127–128 (subgenus *Anambus*; cited as *markopoli*; faunal records; characters; Russia; China).
– Tôyama, 1985: 23 (iconography; Japan).
– Alexeev, 1989: 482 (characters in key; Primorsk; Japan; China).
– Li Jingke, 1992: 92 (checklist; northeastern China).
– Yu Chengmin, 1992: 400–401 (characters; biology; China; Mongolia; Korea; Japan).
– Jendek, 1994: 21 (synonym of *planipennis*; lectotype designation).
– Akiyama & Ohmomo, 1997: 37 (synonym of *planipennis*).
– Nonnaizab et al., 1999: 113 (checklist; China: Inner Mongolia).
– Hua Li Zhong, 2002: 90 (cited as *macropoli*; checklist; China).
– Xu Gongtian, 2003: 321 (biology; instars).
– Jendek, 2006a: 395 (synonym of *planipennis*; Palaearctic catalog).
– Bellamy, 2008: 2238 (synonym of *planipennis*; world catalog).
– Jendek & Grebennikov, 2011: 154 (synonym of *planipennis*).
– Paiero et al., 2012: 138 (synonym of *planipennis*)
= *feretrius* Obenberger, 1936b (*Agrilus*)
– Obenberger, 1936b: 37–38 (description).
– Miwa & Chűjô, 1936: 16 (catalog; Japan).
– Obenberger, 1936a: 1105 (cited as *teretrius*; world catalog).
– Kurosawa, 1974b: 3 (cited as *teretrius*; related to *A. marcopoli*).
– Peng Zhongliang, 1987: 355 (checklist; China).
– Jendek, 1994: 21 (synonym of *planipennis*; lectotype designation).
– Akiyama & Ohmomo, 1997: 37 (synonym of *planipennis*).
– Hua Li Zhong, 2002: 89 (cited as *feretrius* on page 89 and as *teretrius* on page 90; checklist; China: Taiwan).
– Mühle, 2003: 47 (cited as *teretrius*; checklist; Taiwan).
– Jendek, 2006a: 395 (synonym of *planipennis*; Palaearctic catalog).
– Bellamy, 2008: 2238 (synonym of *planipennis*; world catalog).
– Jendek & Grebennikov, 2011: 154 (synonym of *planipennis*).
= *ulmi* Kurosawa, 1956 (subspecies of *marcopoli*)
– Kurosawa, 1956: 40–41 (description).
– Kurosawa, 1963: 153 (subspecies of *marcopoli*; notes; Japan).
– Kurosawa, 1974b: 3 (subspecies of *marcopoli*; notes).
– Kurosawa, 1974c: 1 (characters; notes).
– Alexeev, 1979: 127 (subspecies of *marcopoli* cited as *markopoli*; notes).
– Tôyama, 1985: 23 (subspecies of *marcopoli*; iconography; Japan).
– Hirashima, 1989: 323 (subspecies of *marcopoli*; checklist; Japan).
– Jendek, 1994: 21 (synonym of *planipennis*).
– Morimoto & Tadauchi, 1995: 231 (subspecies of *marcopoli*; checklist; Japan).

– Akiyama & Akiyama, 1996: 185 (subspecies of *planipennis*; faunal records; Japan: Honshu).
– Akiyama & Ohmomo, 1997: 5, 37 (subspecies of *planipennis*; checklist).
– Akiyama & Ohmomo, 2000: 275 (subspecies of *planipennis*; faunal records; Japan).
– Jendek, 2006a: 395 (synonym of *planipennis*; Palaearctic catalog).
– Ohmomo, 2006: 6 (synonym of *planipennis*).
– Bellamy, 2008: 2238 (synonym of *planipennis*; world catalog).
– Jendek & Grebennikov, 2011: 154 (synonym of *planipennis*).
– Paiero et al., 2012: 138 (synonym of *planipennis*)

Type material: *Agrilus planipennis* Fairmaire, 1888. **Type locality:** Pekin. **Type specimens:** Lectotype designated by Jendek (1994), (MNHN).

Agrilus marcopoli Obenberger, 1930. **Type locality:** Mongolia or: Chan-Heu. **Type specimens:** Lectotype designated by Jendek (1994), (NMPC).

Agrilus feretrius Obenberger, 1936b. **Type locality:** Formosa. **Type specimens:** Lectotype designated by Jendek (1994), (NMPC).

Agrilus marcopoli ulmi Kurosawa, 1956. **Type locality:** Sapporo. Hokkaidō. **Type specimens:** Holotype, ♀ (NSMT).

Specimens examined: see: Jendek & Grebennikov (2011); [*A. m. ulmi*]: JAPAN: "Sapporo, Hokkaidoh, 31.vii.1942, H. Hasegawa / HOLOTYPE, Agrilus marco-poli OBB. ssp. ulmi Y. Kurosawa, 1956"; Paratypes: JAPAN: Hokkaidoh: 3 ♀ (NSMT): "Sapporo, Hokkaidoh, 31.vii.1942, H. Hasegawa"; 1 ♀ (NSMT): "Kotambetsu, Tomamae, Kokkaidoh, 17.viii.1949, K. Katsumura"; 1 ♀ (NSMT): "Nippara, Oku-tama, Tokio, 4.viiii.1957, M. Hyakijtake"; 1 ♀ (NSMT): "Hokkaido, Shikotsu-ko, 14.viii.1970, J. Akiyama"; 1 ♀ (NSMT): Tokyo, Nippara, 26.vii.1966, Y. Kurosawa"; 1 ♀ (NSMT): "Ogawadani, Okutama, 1966.9.11, Coll. T. Goh"; 1 ♀ (NSMT): "1975.viii.14, Koganesawa (Yamanashi), R. Mayashi"; 1 ♀ (NSMT): "Naidaijin, Yabe T., Kumamoto Pref., 12.viii.1979, H. Irie"; [*A. m. marcopoli*]: 1 ♂ (NSMT): "Sugasaka Pass, Maizuru, Kioto Pref, 23.vi.1943, M. Kawai / [red label] / No . 240".

Host plants: ***Fraxinus*:** Gates & Gibson, 2004; Haack et al., 2002; Herms et al., 2003; Mühle, 2003; Wei Xia et al., 2007.

***Fraxinus americana*:** Herms et al. 2003; Liu Houping & Bauer, 2005; McCullough & Roberts, 2002.

Fraxinus chinensis: Liu Houping & Bauer, 2005; Wei et al., 2004; Yu Chengmin, 1992 (as *marcopoli*).

Fraxinus mandshurica: Liu Houping & Bauer, 2005; Liu Houping et al., 2007; Rodriguez Saona et al., 2006; Wei et al., 2004; Yu Chengmin, 1992 (as *marcopoli*); Yurchenko et al., 2007.

***Fraxinus mandshurica* var. *japonica*:** Akiyama & Ohmomo, 1997 (as *ulmi*).

***Fraxinus nigra*:** Herms et al., 2003; Liu Houping & Bauer, 2005; McCullough & Roberts, 2002.

***Fraxinus pennsylvanica*:** Herms et al., 2003; Liu Houping & Bauer, 2005; Liu Houping et al., 2007; McCullough & Roberts, 2002.

***Fraxinus quadrangulata*:** Herms, Stone & Chatfield, 2003.

Fraxinus rhynchophylla: Liu Houping & Bauer, 2005; Liu Houping et al., 2007; Wei et al., 2004; Yu Chengmin, 1992 (as *marcopoli*); Yurchenko et al., 2007.

***Fraxinus velutina*:** Liu Houping & Bauer, 2005; Wei, Reardon, Wu & Sun, 2004.

***Juglans*:** Mühle, 2003.

***Juglans mandshurica* var. *sieboldiana*:** Akiyama & Ohmomo, 1997 (as *ulmi*).

***Pterocarya*:** Mühle, 2003.

***Pterocarya rhoifolia*:** Akiyama & Ohmomo, 1997 (as *ulmi*).

***Ulmus*:** Alexeev, 1989 (as *marcopoli*); Mühle, 2003.

***Ulmus davidiana* var. *japonica*:** Akiyama & Ohmomo, 1997 (as *ulmi*); Ko, Je Ho, 1969 (as *marcopoli*).

Distribution: (as of may 2014) **Asia**: **CHINA:** Beijing; Hebei; Heilongjiang; Jilin; Liaoning; Nei Mongol; Shandong; Sichuan; Taiwan; Tianjin. **JAPAN:** Hokkaido; Honshu; Kyushu; Shikoku. **NORTH KOREA. SOUTH KOREA. MONGOLIA**. **RUSSIA:** (native) Khabarovsk Kray; Primorskiy Kray; (introduced) Kaluga; Moscow; Orel; Ryazan; Smolensk; Tambov; Tula; Tver; Vladimir; Voronezh; Yaroslavl. **North America** (introduced): **CANADA:** Ontario; Quebec. **UNITED STATES:** Colorado; Connecticut; Georgia; Illinois; Indiana; Iowa; Kansas; Kentucky; Maryland; Massachusetts; Michigan; Minnesota; Missouri; New Hampshire; New Jersey; New York; North Carolina; Ohio; Pennsylvania; Tennessee; Virginia; West Virginia; Wisconsin.

Agrilus pseudolubopetri Jendek & Chamorro, 2012

pseudolubopetri Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 78 (description).

Type material: *Agrilus pseudolubopetri* Jendek & Chamorro, 2012. **Type locality:** Northeastern Laos, Hua Phan Province, ~20°12'N 104°01'E, Phu Phan Mt. **Type specimens: Holotype** (EJCB).

Specimens examined: see: Jendek & Chamorro, 2012; **CHINA: [Taiwan]:** 1 ♀ (NSMT): "Formosa, nr Hori, vi.1968".

Host plants: Unknown.

Distribution: LAOS: Hua Phan Province. **CHINA: Taiwan**.

Agrilus qinling Jendek, 2000

qinling Jendek, 2000 (*Agrilus*)
– Jendek, 2000b: 190, 192 (description).
– Jendek, 2006a: 401 (Palaearctic catalog).

– Bellamy, 2008: 2257 (world catalog).
– Jendek & Grebennikov, 2011: 167 (references; types; diagnosis; East Asia).

Type material: *Agrilus qinling* Jendek, 2000. **Type locality:** China, 1000–1300 m, Shaanxi, Qinling mts., Xunyangba (6 km E). **Type specimens:** Holotype (EJCB).

Specimens examined: Known only from the type specimens.

Host plants: Unknown.

Distribution: CHINA: Shaanxi.

Agrilus rubensteini Chamorro & Jendek, 2014

rubensteini Chamorro & Jendek, 2014 (*Agrilus*)
– Chamorro & Jendek, 2014: 33 (description).

Type material: *Agrilus rubensteini* Chamorro & Jendek, 2014. **Type locality:** Philippines, Luzon, Ifugao Province, Liwo 8 km E Mayoyao, 1000–1300 m. **Type specimens:** Holotype, ♀ (BPBM).

Specimens examined: Known only from the holotype.

Host plants: Unknown.

Distribution: PHILIPPINES: Luzon.

Agrilus tomentipennis Jendek & Chamorro, 2012

tomentipennis Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 91 (description).

Type material: *Agrilus tomentipennis* Jendek & Chamorro, 2012. **Type locality:** Northeastern Laos, Xieng Khouang province, 45 km East of Phonsavan: Ban Namseung. **Type specimens:** Holotype (EJCB).

Specimens examined: see: Jendek & Chamorro, 2012; **CHINA: [Taiwan]:** 1 ♀ (NSMT): "Sulo (nr. Palin), Taoyuan, N. Formosa, 19.vii.1978, T. Shimomura".

Host plants: Unknown.

Distribution: LAOS: Xieng Khouang Province; **CHINA: Taiwan.**

Agrilus hewitti group

Agrilus hewitti Kerremans, 1912

hewitti Kerremans, 1912 (*Agrilus*)
– Kerremans, 1912: 74 (description).
– Obenberger, 1936a: 1085 (world catalog).
– Obenberger, 1960: 125–126 (type examination; redescription).
– Jendek, 2006b: 34 (*Sarawakita*; lectotype designation; synonymy).
– Bellamy, 2008: 2380 (*Sarawakita*; world catalog)
– Jendek & Chamorro, 2012: 73 (references; faunal records)
= *latifrons* Obenberger, 1924 (*Sarawakita*)
– Obenberger, 1924a: 40 (description).
– Jendek, 2006b: 34 (*Sarawakita*; synonym of *hewitti*; lectotype designation)
– Bellamy, 2008: 2380 (*Sarawakita*; synonym of *hewitti*; world catalog)
– Jendek & Chamorro, 2012: 73 (synonym of *hewitti*)

Type material: *Agrilus hewitti* Kerremans, 1912. **Type locality:** Sarawak: Kuching**. Type specimens**: Lectotype designated by Jendek (2006b), (MNHN).

Agrilus latifrons Obenberger, 1912. **Type locality:** Sarawak: Kuching**. Type specimens**: Lectotype designated by Jendek (2006b), (NMPC).

Specimens examined: See Jendek & Chamorro (2012).

Host plants: Unknown**.**

Distribution: MALAYSIA: Sabah; Sarawak.

Agrilus daillieri Baudon, 1965

daillieri Baudon, 1965 (*Agrilus*)
– Baudon, 1963: 54 ([Note: Unavailable name, cited without characters]).
– Baudon, 1965: 223–224 (description).
– Descarpentries & Villiers, 1967: 149 (*sinensis* species group).
– Baudon, 1968: 135, 168 (characters in key; Laos).
– Ohmomo, 2002: 23 (Thailand).
– Bellamy, 2008: 2057 (world catalog).
– Jendek & Chamorro, 2012: 73 (type examination; faunal records; notes)

Type material: *Agrilus daillieri* Baudon, 1965. **Type locality:** Laos: Pak Ca Dinh. **Type specimens:** Holotype (MHNB).

Specimens examined: see: Jendek & Chamorro, 2012.
Host plants: Unknown.
Distribution: LAOS. THAILAND.

Agrilus piliventris group

Agrilus ampliatus Kerremans, 1900

ampliatus Kerremans, 1900 (*Agrilus*)
– Kerremans, 1900c: 4, 21, 23–24 (description).
– Kerremans, 1903: 277 (catalog).
– Obenberger, 1936a: 1073 (world catalog).
– Bellamy, 2008: 1963 (world catalog).
– Jendek, 2012: 4 (lectotype designation).

Type material: *Agrilus ampliatus* Kerremans, 1900c. **Type locality:** [Sumatra] Hindrapoera. **Type specimens:** Lectotype designated by Jendek (2012), (MNHN).
Specimens examined: Known only from the type specimens.
Host plants: Unknown.
Distribution: INDONESIA: Sumatra.

Agrilus maculipennis Kerremans, 1900

maculipennis Kerremans, 1900 (*Agrilus*)
– Kerremans, 1900c: 4, 21, 24–25 (description).
– Kerremans, 1903: 277 (catalog).
– Obenberger, 1936a: 1090 (world catalog).
– Bellamy, 2008: 2175 (world catalog).

Type material: *Agrilus maculipennis* Kerremans, 1900c. **Type locality:** [Sumatra] Hindrapoera. **Type specimens:** Holotype by monotypy (BMNH).
Specimens examined: Known only from the type specimen.
Host plants: Unknown.
Distribution: INDONESIA: Sumatra.

Agrilus ostrinus Kerremans, 1892

ostrinus Kerremans, 1892b (*Agrilus*)
– Kerremans, 1892b: 819–820 (description).
– Kerremans, 1903: 288 (catalog).
– Obenberger, 1936a: 1096 (world catalog).
– Jendek, 2003: 184 (lectotype designation).
– Bellamy, 2008: 2221 (world catalog).

Type material: *Agrilus ostrinus* Kerremans, 1892b. **Type locality:** Carin Cheba, 900–1100 m [Myanmar]. **Type specimens:** Lectotype designated by Jendek (2003), (MCSN).

Specimens examined: LAOS: Louang Namtha: 1 ♀ (EJCB): "Laos, Louang Namtha pr., 21°09'N, 101°19'E, Namtha - Muang Sing, 5–31.v.1997, 900–1200 m, Vit Kubáň leg.".

Host plants: Unknown.

Distribution: LAOS: Louang Namtha. **MYANMAR.**

Agrilus piliventris Deyrolle, 1864

piliventris Deyrolle, 1864 (*Agrilus*)
– Deyrolle, 1864: 138, 157–158 (description).
– Gemminger & Harold, 1869: 1444 (catalog).
– Saunders, 1871: 122 (catalog).
– Kerremans, 1892c: 267 (catalog).
– Kerremans, 1903: 289 (catalog).
– Obenberger, 1936a: 1098 (world catalog).
– Jendek, 1998: 328 (lectotype designation).
– Jendek, 2003: 185 (synonymy).
– Bellamy, 2008: 2235–2236 (world catalog).
= *takedai* Tôyama, 1987 (*Agrilus*)
– Tôyama, 1987: 316–318 (description).
– Jendek, 2003: 185 (synonym of *piliventris*).
– Bellamy, 2008: 2236 (synonym of *piliventris*; world catalog).
= *takehiroi* Tôyama, 1987 (*Agrilus*)
– Tôyama, 1987: 318 (description).
– Jendek, 2003: 185 (synonym of *piliventris*).
– Bellamy, 2008: 2236 (synonym of *piliventris*; world catalog).

Type material: *Agrilus piliventris* Deyrolle, 1864. **Type locality:** Bornéo. **Type specimens:** Lectotype designated by Jendek (1998: 328), (MNHN).

Agrilus takedai Tôyama, 1987. **Type locality:** Crocker Range (ca 800 m alt.), Kimanis Road, near Keningau, Sabah, East Malaysia. **Type specimens:** Holotype by monotypy (NSMT).

Agrilus takehiroi Tôyama, 1987. **Type locality:** Cameron Highlands, West Malaysia. **Type specimens:** Holotype (NSMT).

Specimens examined: INDONESIA: Sumatra: 1 ♀ (EJCB): "Sumatra, III.1992, Mt. Talang, Cermak lgt.". **MALAYSIA: Perak:** 1 ♀ (MNHN): "Perak, 1100 m, Gounong Boubou, W. Doherty".

Host plants: Unknown.

Distribution: INDONESIA: Kalimantan; Sumatra. **MALAYSIA:** Malaysia Peninsular; Sabah; Sarawak.

Agrilus pseudoostrinus Jendek, 2000

pseudoostrinus Jendek, 2000 (*Agrilus*)
– Jendek, 2000a: 152 (description).
– Bellamy, 2008: 2251 (world catalog).

Type material: *Agrilus pseudoostrinus* Jendek, 2000. **Type locality:** W Sumatra Padang. **Type specimens:** Holotype (EJCB).

Specimens examined: Known only from the holotype.

Host plants: Unknown.

Distribution: INDONESIA: Sumatra.

Agrilus spineus Jendek & Chamorro, 2012

spineus Jendek & Chamorro, 2012 (*Agrilus*)
– Jendek & Chamorro, 2012: 88 (description).

Type material: *Agrilus spineus* Jendek & Chamorro, 2012. **Type locality:** Malaysia, Borneo Island, Sarawak Province, Bako National Park. **Type specimens:** Holotype (EJCB).

Specimens examined: see: Jendek & Chamorro, 2012.

Host plants: Unknown.

Distribution: MALAYSIA: Sarawak state.

Agrilus sinensis group

Agrilus coreanus Obenberger, 1935

coreanus Obenberger, 1935 (*Agrilus*)
– Obenberger, 1935: 163 (description).
– Miwa & Chûjô, 1936: 15 (catalog; Japan).
– Obenberger, 1936a: 978 (world catalog).
– Jendek, 1995: 145 (lectotype designation; characters).
– Alexeev, 1998: 379 (subgenus *Sinagrilus*; subgeneric classification).
– Jendek, 2006: 394 (subgenus *Sinagrilus*; Palaearctic catalog).
– Bellamy, 2008: 2039 (subgenus *Sinagrilus*; world catalog).
– Jendek & Grebennikov, 2011: 64 (synonymy; references; types; diagnosis; host and distributional summary).

Type material: *Agrilus coreanus* Obenberger, 1935. **Type locality**: Korea: Chemulpo. **Type specimens**: Lectotype designated by Jendek (1995), (NMPC).
Specimens examined: Known only from the holotype.
Host plants: Unknown.
Distribution: SOUTH KOREA.

Agrilus sinensis sinensis Thomson, 1879

sinensis Thomson, 1879 (*Agrilus*)
– Thomson, 1879: 73 (description).
– Kerremans, 1903: 278 (cited as *chinensis*, catalog).
– Jakobson, 1913: 798 (catalog; Russia and Europe).
– Bodemeyer, 1915: 447 (cited as *chinensis*; faunal record; China: Heilongjiang).
– Obenberger, 1924b:36, 37 (note).
– Obenberger, 1926: 654 (Palaearctic catalog).
– Obenberger, 1934: 14 (note).
– Obenberger, 1935: 163 (note).
– Obenberger, 1936a: 1098 (world catalog).
– Obenberger, 1958: 237 (faunistic records; China).
– Descarpentries & Villiers, 1963: 8 (notes).
– Cobos, 1972: 56 (subgenus *Agrilus*; checklist; Mongolia).
– Kurosawa, 1975: 1 (note).
– Hou, 1987: 590 (notes; Yunnan).
– Peng Zhongliang, 1987: 358 (checklist; China).

– Peng Zhongliang, 1992: 398–399 (characters; notes; Hunan).
– Jendek, 1995: 144, 145 (lectotype designation; characters; central and southeastern China).
– Akiyama & Ohmomo, 1997: 39 (checklist; Japan: Honshu; China; Indochina).
– Alexeev, 1998: 379 (subgenus *Sinagrilus*; genotype of the subgenus *Sinagrilus*).
– Hua Li Zhong, 2002: 90 (checklist; China: Inner Mongolia, Gansu, Hubei, Jiangsu, Jiangxi, Fujian, Hainan, Hunan, Guangxi, Guizhou, Sichuan, Yunnan, Xizang).
– Lin Gui Rui, 2002: 234 (checklist; pest).
– Peng Zhongliang, 2002: 267 (characters; Fujian).
– Jendek, 2006: 396 (subgenus *Sinagrilus*; Palaearctic catalog).
– Bellamy, 2008: 2294 (subgenus *Sinagrilus*; world catalog).
– Jendek & Grebennikov, 2011: 186 (synonymy; references; types; diagnosis; host and distributional summary).
= *obscuripennis* Fairmaire, 1888 (*Agrilus* [preoccupied])
– Fairmaire, 1888: 120 (description).
– Kerremans, 1892c: 256 (synonymy of *fairmairei*; catalog).
– Kerremans, 1903: 285 (synonym of *fairmairei*).
– Jakobson, 1913: 798 (synonym of *fairmairei*; catalog).
– Obenberger, 1936: 990 (synonym of *fairmairei*).
– Jendek, 2006: 398 (synonym of *fairmairei*; Palaearctic catalog).
– Bellamy, 2008: 2089 (synonym of *fairmairei*; world catalog).
– Jendek & Grebennikov, 2011: 186 (synonymy; references; types; diagnosis; host and distributional summary).
= *fairmairei* Kerremans, 1892 (*Agrilus*; replacement name for *obscuripennis* Fairmaire not Gory)
– Kerremans, 1892c: 252 (replacement name proposal).
– Kerremans, 1903: 285 (catalog).
– Jakobson, 1913: 798 (catalog; Russia and Europe).
– Obenberger, 1936: 990 (world catalog).
– Peng Zhongliang, 1987: 355 (checklist; China).
– Hua Li Zhong, 2002: 89 (checklist; China: Beijing).
– Jendek, 2006: 398 (Palaearctic catalog).
– Bellamy, 2008: 2089 (world catalog).
– Jendek & Grebennikov, 2011: 186 (synonymy; references; types; diagnosis; host and distributional summary).
= *pseudimitans* Miwa & Chûjô, 1940 (*Agrilus*)
– Miwa & Chûjô, 1940: 54, 60, 73 (description).
– Kurosawa, 1947: 2 (erroneously cited as the variety of *cyaneoniger*; lapsus; see Akiyama & Ohmomo, 1997).
– Kurosawa, 1975: 1 (synonym of *sinensis*).
– Akiyama & Ohmomo, 1997: 39 (synonym of *sinensis*).
– Jendek, 2006: 394 (synonym of *sinensis sinensis*; Palaearctic catalog).
– Bellamy, 2008: 2294 (synonym of *sinensis*; world catalog).

– Jendek & Grebennikov, 2011: 186 (synonymy; references; types; diagnosis; host and distributional summary).

Type material: *Agrilus sinensis* Thomson, 1879. **Type locality:** Shang-Haï. **Type specimens:** Lectotype designated by Jendek (1995), (MNHN).

Agrilus obscuripennis Fairmaire, 1888. **Type locality**: Pekin. **Type specimens**: Not located. Not in MNHN.

Agrilus fairmairei Kerremans, 1892. **Type locality and specimens**: see: *Agrilus obscuripennis* Fairmaire, 1888.

Agrilus pseudimitans Miwa & Chûjô, 1940. **Type locality**: Nikkô, Japan. **Type specimens**: Not located. Described from 1 specimen.

Specimens examined: see: Jendek & Grebennikov (2011)

Host plants: Unknown.

Distribution: CHINA: Beijing, Fujian, Guizhou, Heilongjiang, Hunan, Jiangxi, Jiangsu, Shanghai, Sichuan, Xizang, Yunnan. **JAPAN**: Honshu. **LAOS**.

Agrilus sinensis splendidicollis Fairmaire, 1889

splendidicollis Fairmaire, 1889 (*Agrilus*)
– Fairmaire, 1889: 348 (description).
– Kerremans, 1892c, 273 (catalog).
– Kerremans, 1900a: 341 (synonym of *sinensis*).
– Kerremans, 1903: 278 (synonym of *sinensis* cited as *chinensis*).
– Jakobson, 1913: 798 (synonym of *sinensis*; catalog).
– Obenberger, 1924b:36, 37 (subspecies of *sinensis*).
– Obenberger, 1926: 654 (subspecies of *sinensis*; Palaearctic catalog).
– Obenberger, 1936a: 1041 (cited as *splendidicollis*; subspecies of *sinensis*; world catalog).
– Baudon, 1963: 54 (subspecies of *sinensis*; misspelled as "*chinensis* s.sp. *auricollis*; faunal record; Laos).
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= *lameyi* Obenberger, 1924 (*Agrilus*; subspecies of sinensis)
– Obenberger, 1924: 36–37 (description).
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Type material: *Agrilus sinensis splendidicollis* Fairmaire, 1889. **Type locality:** Tonkin. **Type specimens:** Lectotype designated by Jendek (1995), (MNHN).

Agrilus sinensis lameyi Obenberger, 1924. **Type locality**: Na-lang (Tonkin nord). **Type specimens**: Lectotype designated by Jendek (1995), (NMPC).

Agrilus bayeri Obenberger, 1935. **Type locality**: China, prov. Yunnan, vallis flum. Soling-ho. **Type specimens**: Lectotype designated by Jendek (1995), (NMPC).

Specimens examined: see: Jendek & Grebennikov (2011).

Host plants: Unknown.

Distribution: CHINA: Sichuan, Xizang, Yunnan. **INDIA**: West Bengal. **LAOS**. **THAILAND**. **VIETNAM**.

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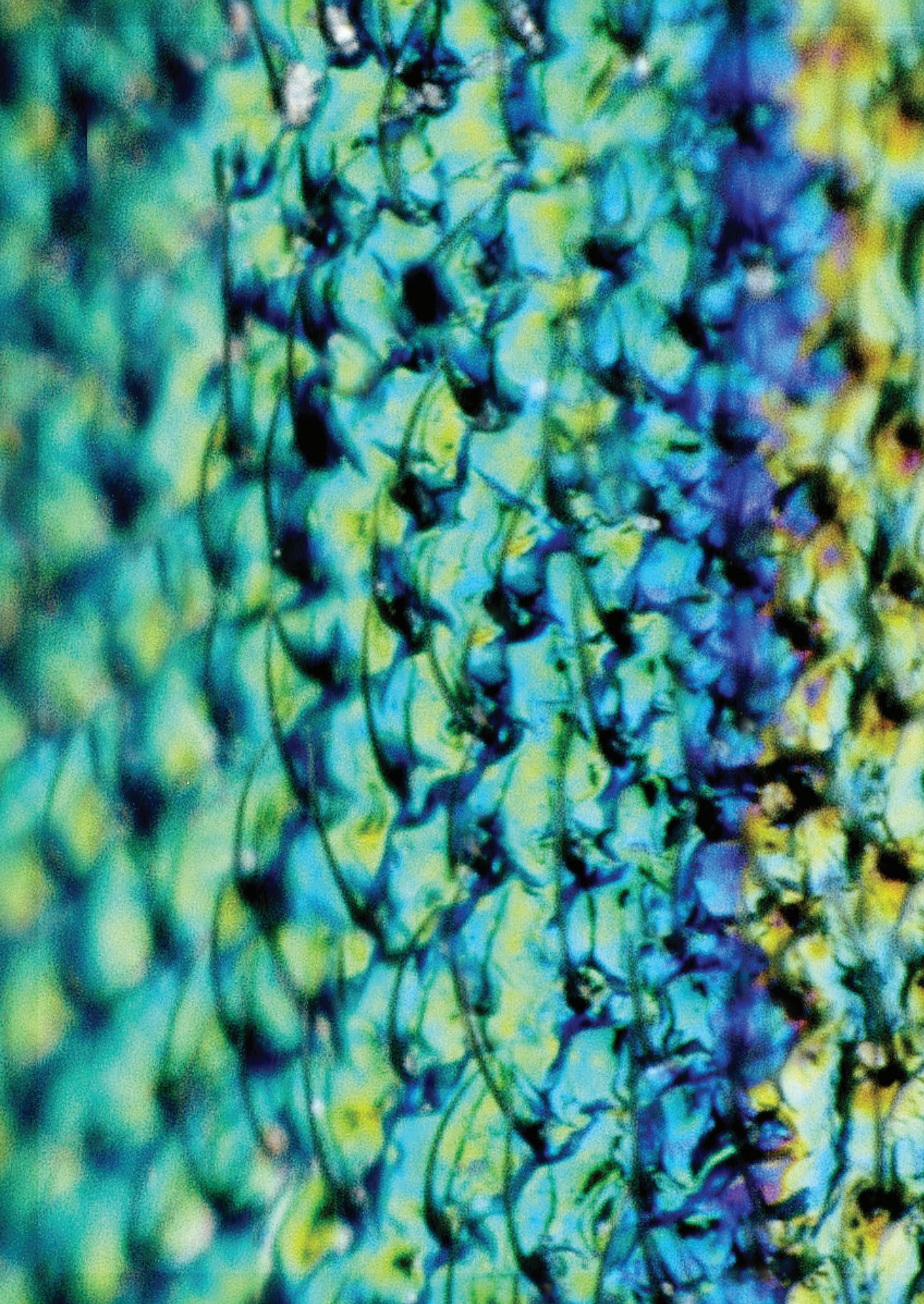

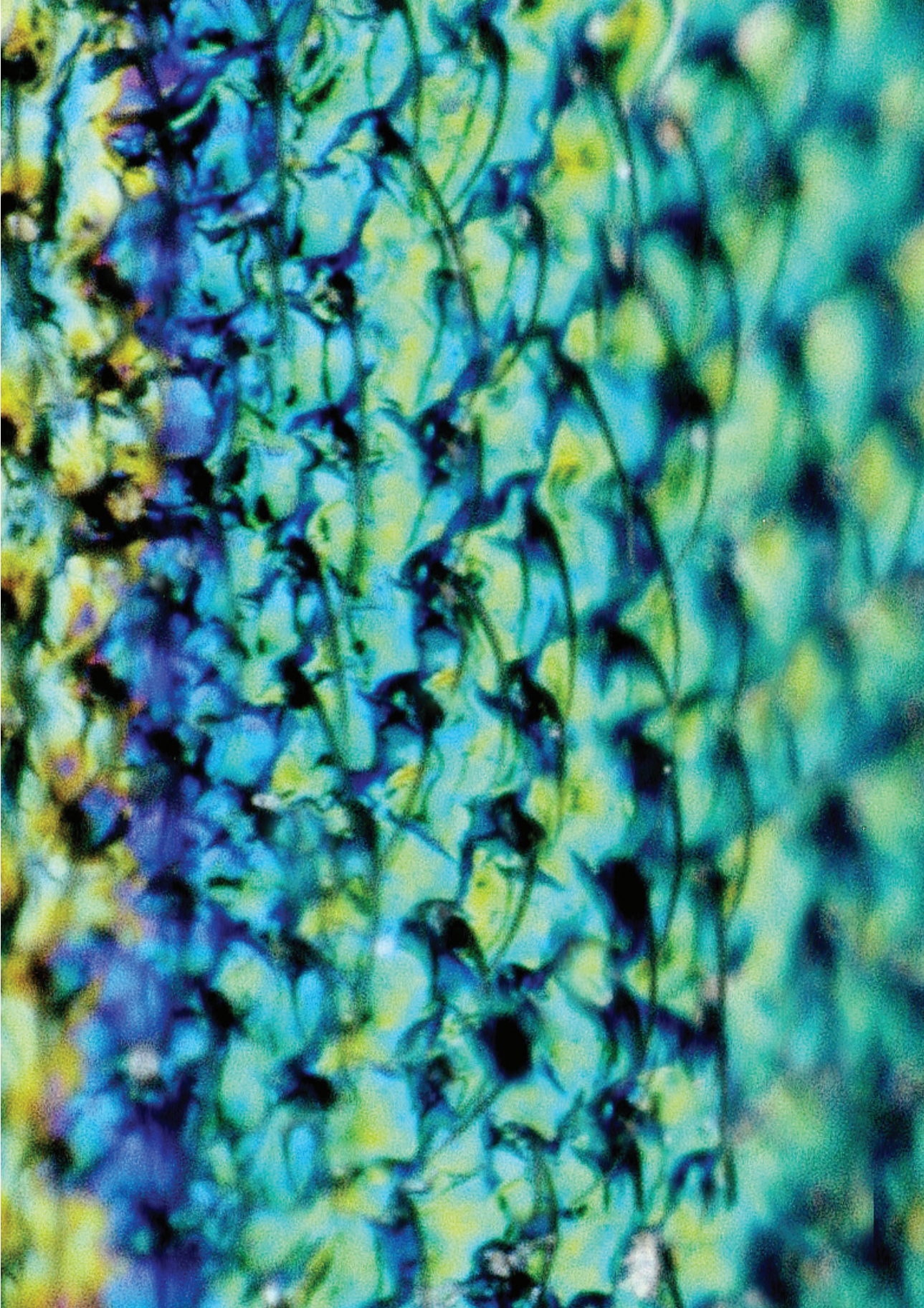

The 33 species of *Agrilus* (Coleoptera: Buprestidae) hypothesized to be most closely related or most similar to *Agrilus planipennis* Fairmaire (emerald ash borer, EAB), are described and illustrated. Morphology (adults and immatures), biology, distribution, detailed taxonomic history and systematics are presented for each species, along with a full literature review and bibliography. Large, high resolution photos displaying all diagnostic characters are presented as well as an illustrated dichotomous identification key to adult species of *Agrilus* treated in this work. A general review of *Agrilus* biology, ecology and buprestid collecting and curation methods is also provided.