First record of *Agrilus hastulifer* (Ratzeburg, 1837) (Coleoptera: Buprestidae) in Poland with data of its bionomy, distribution, morphology and identification

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**Abstract:** The paper presents the first records in Poland of *Agrilus hastulifer* (Ratzeburg, 1837) (Buprestidae). It is the 31st species of the genus *Agrilus* Curtis, 1825 recorded in the country. It was found in two locations in eastern (Białowieża Primeval Forest) and central Poland (Kampinos National Park). All data of the biology and economic significance of this species, based on the literature and our observations, are summarized. Due to the great difficulty in distinguishing this species from *Agrilus graminis* Kiesenwetter, 1857, we also provide an original, richly illustrated comparison useful for discriminating the two species.

**Keywords:** faunistics, new records, diagnostic characters, Białowieża Primeval Forest, Kampinoski National Park

**Introduction**

Representatives of beetles in the genus *Agrilus* Curtis, 1825 are usually small (3–15 mm in length) with an elongated, wedge-shaped or cylindrical body (Jendek 2016a). Larvae develop under the bark and in the wood of deciduous trees and shrubs, very rarely in the stems and roots of herbaceous plants (Jendek 2016a). We know of only a single observation of the development in a conifer (Jendek 2013). Imagines do not visit flowers like many other species in the Buprestidae family, but usually feed on the leaves of plants in which their larvae develop (Bilý 2002).

The genus *Agrilus* has over 3 000 species and is the most species-rich genus in the world (Jendek 2016a). Representatives of this genus live on all continents, with 469 species recorded in the Palaeartic (Jendek 2016b), of which 44 species occur in Central Europe (Bilý 1999). To date, 30 *Agrilus* species have been reliably recorded in Poland (Burakowski et al. 1985, Gutowski 2005, Jendek & Grebennikov 2011, Gutowski et al. 2019). At least three publications mention that *Agrilus hastulifer* (Ratzeburg, 1837) occurs in Poland (Curletti 1994, Bilý 2002, Sakalian 2003) but source data on which these reports are based are unknown. Previous reports were based on erroneously determined specimens of other species or were from areas that are currently outside the country (Burakowski et al. 1985). Therefore, this species was not included in the Polish fauna (Burakowski et al. 1985, Gutowski 2005). Jendek (2016a) recently analysed the world distribution of this species and does not record it from Poland, nor was Poland mentioned in the latest edition of the Catalogue of Palaeartic Coleoptera (Jendek 2016b). *Agrilus hastulifer* is a holomedi-
terranean, thermophilic species, which in Central Europe occurs only in the warmest biotopes (Bílí 2002). Hence, the authors of this work were surprised to discover its presence in 2019 in the Białowieża and Kampinos Forests, which are located ca. 500 km to the north of the known borders of its range.

Materials and Methods

Site descriptions

Specimens were collected in two sites in Poland: Białowieża Primeval Forest (BPF) and Kampinos National Park. The Białowieża Primeval Forest is the best preserved forest massif in the lowlands of Europe, lying on the border of Poland and Belarus, with an area of about 1 500 km². There are about 620 km² in Poland, of which 105 km² is the Białowieża National Park (Kujawa et al. 2016, Jaroszewicz et al. 2019). Specimens were collected in the forest compartment 338A (UTM: FD84), near Teremiski village – the forest with big, old oaks (about 8 km WN from Białowieża). Geographical coordinates of the centre of the study area: N52.73907138 E23.76858939 (between: N52.71141831 E23.76436005 and N52.73691413 E23.7715532). The research area covers a dozen hectares of seminatural forest. Oak-lime-hornbeam forest (Tilio-Carpinetum) occupies the largest area. The stand is dominated by Quercus robur L. – 1–300 years, Carpinus betulus L. – 1–90 yrs, Betula pendula Roth – 1–80 yrs, Alnus glutinosa (L.) Gaert. – 1–110 yrs, Fraxinus excelsior L. – 1–110 yrs; Pinus sylvestris L. – 150–170 yrs, Picea abies (L.) Karst. – 1–60 yrs, Populus tremula L. – 1–80 yrs and Tilia cordata Mill. – 1–30 yrs; in the lower understory layer also: Corylus avellana L., Sorbus aucuparia L. and Frangula alnus Mill.

The site in Kampinos National Park [central Poland; Forest District (= Nadleśnictwo) Kampinos, Forest Division (= Leśnictwo) Różin, compartment 258b, UTM: DC79], was a fresh mixed forest composed of: Quercus spp. (90%) and Betula spp. (10%) at the age of 108, with an admixture of Pinus sylvestris and Salix spp., with the Frangula alnus undergrowth, Quercus spp. and Juniperus communis L. The stand had been disturbed by a strong wind event in 2017, creating an irregular and intermittent lane of wind-felled trees of about 5 ha (about 400 m long by maximum width of 250 m). The strip contained several gaps of various size separated by standing trees. Increased sun exposure in the gaps likely resulted in rapid heating of trunk and log surfaces.

Collection methods

In the Białowieża Primeval Forest, specimens were collected in Lindgren 12-funnel traps that had been coated with 50% Fluon in water to reduce friction and increase beetle catches (Allison & Redak 2017) and with 50% ethylene glycol in water in the collecting cups. There were 40 funnel traps altogether, 20 green traps suspended in the upper canopy of old, living oaks (17.4 to 24.7 m high), and 20 black traps in the understory, suspended from rope tied between two trees such that the collecting cup was 30–50 cm above the forest floor and the trap was at least 1 m from the nearest tree trunk. Traps were spaced a minimum of 30 m apart and baited with various combinations of ethanol, E,Z-6,10-dimethyl-5,9-undecadien-2-ol (fuscumol), and E,Z-6,10-dimethyl-5,9-undeca-2-di-yl acetate (fuscumol acetate) as part of study testing effects of trap colour, trap height, and trap lure on detection of bark and wood boring beetles (Cerambycidae, Buprestidae, Scolytinae), the main results of which will be reported separately (Sweeney J, Gutowski JM, LeClair G, Hughes C. Response of Agrilus spp. to the synthetic longhorned beetle sex-aggregation pheromones, E,Z-fuscumol acetate and E,Z-fuscumol, in prep.). Traps were up from May 13 to July 8, 2019 and checked every 2 weeks. In Kampinos National Park, fifteen IBL-5 barrier, transparent, traps were hung either on standing trunks of oaks broken by wind damage (10 traps) and in crowns of oaks lying
on the ground (5 traps). IBL-5 barrier traps are the standard sampling method for saproxylic fauna in Kampinos National Park (Marczak 2020). The traps were up from April 1 to July 31, 2018 and 2019, and checked every month.

**Results and Discussion**

During the experiment presented above, 37 specimens of *A. hastulifer* were caught in the Białowieża Primeval Forest: 27.05–9.06.2019 – 3 indiv.; 10–23.06.2019 – 21 indiv.; 24.06–8.07.2019 – 13 indiv. No specimen was found during the first trap display period (13–26 May), which indicates that this species has a slightly later activity period in BPF, mainly in the second and third decades of June and the first decade of July. All the specimens were caught in green traps placed in the upper canopy. No specimens of *A. hastulifer* were caught in the black traps located in the understory. Greater efficacy of detecting *Agrilus* spp. in the upper canopy vs. the understory and in green vs. black or purple traps has been previously documented (e.g. Francese et al. 2011, Flaherty et al. 2019, Rassati et al. 2019). It should be noted, however, that not all *Agrilus* species prefer green to purple traps; Rhainds et al. (2017) reported that catches of *Agrilus viridis* (Linnaeus, 1758) were 2-3 times greater on purple traps than on green traps. There was no significant effect of trap lure on catch of *A. hastulifer*.

Figs. 1–2. Imagines (males) of *Agrilus* - habitus. 1) *A. hastulifer* from Poland, Białowieża Primeval Forest, comp. 338A (UTM-FD84); 2) *A. graminis* from Poland, Wrocław-Wojnów (XS56).
In the Kampinos National Park, 1 indiv. (male) A. hastulifer was caught in an IBL-5 barrier trap (phot. in Marczak 2020) hanging on an oak snag; caught from 1–31.07.2019.

This is the first documented report of this species in Poland. The new locations are about 500 km from the nearest known locations in Ukraine. The Polish Buprestidae fauna is currently represented by 88 species (Gutowski 2005, Byk & Mokrzycki 2009, Jendek & Grebennikov 2011).


Systematics and distribution

Within A. hastulifer, no subspecies are currently distinguished (Jendek 2016b). Although the form found in Iran (A. hastulifer aladaghensis Obenberger, 1918) was previously considered a subspecies (Bilý 1983), it has since been synonymized with A. hastulifer (Jendek 2007). A. hastulifer is also wrongly known as Agrilus barbatus Abeille de Perrin, 1897 (Curletti 1994, Prokhorov 2010, Fauna Europaea 2020), because Jendek (2007) proved that it is a synonym of A. graminis Kiesenwetter, 1857. Agrilus hastulifer belongs in either the subgenus Anambus Thomson, 1864 or Quercuagrilus Alexeev, 1998. The subgenus system within the genus Agrilus is still unstable (Jendek 2016b).

Agrilus hastulifer was described from Prussia, without specifying a typical place (Ratzeburg 1837). This historic land was located in several existing countries (Germany, Poland, Russia, Lithuania). Descriptive types probably did not survive in the collections (Jendek 2007). The species is known from Europe (Azerbaijan, Albania, Armenia, Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, France, Greece, Hungary, Italy, Kazakhstan, North Macedonia, Montenegro, Portugal, Romania, Russia-Central and South European Territory, Serbia, Slovakia, Slovenia, Spain, Switzerland, Turkey, Ukraine), North Africa (Algeria, Morocco, Tunisia) and from Asia (Iran, Iraq, Israel, Turkey) (Jendek 2016b). It inhabits areas up to 900 m asl (Sakalian 2003).
Figs. 5–8. Ventral view of males *Agrilus hastulifer* (5, 7) and *A. graminis* (6, 8): 5, 6) hind coxae and basal ventrite; 7, 8) last visible ventrite.

Biology

They pupate in the spring of the following year. The development lasts one year, and the appearance of imagines begins from mid-May and lasts until mid-August, with a maximum in July (Khramcov & Padij 1965, Bilý 2002, Prokhorov 2010); in Israel it is active even in September (Halperin & Argaman 2000). In the Bialowieża Primeval Forest, most adults were collected in June (this study). Adults feed on oak leaves. In Ukraine, A. hastulifer was common in oak woodlands up to the age of 15 (Khramcov & Padij 1965). Known parasitoids include: Spatius curvicaudis Ratzeburg, 1844, S. umbratus (Fabricius, 1798) (Hymenoptera: Braconidae) (Schimitschek 1944, Tobias et al. 1986); Pachyneuron flavipes (Foerster, 1841), Trichomalopsis pospelovi (Kurdjumov, 1912) (Hymenoptera: Pteromalidae); Metapelma spectabile Westwood, 1835 (Hymenoptera: Eupelmidae) (Thompson 1958, Cobos 1986).

Morphology

The adult of A. hastulifer is commonly 5–7 mm long (Bilý 1989) but some specimens from Bialowieża Primeval Forest are up to 8 mm long. Mature larvae can be as long as 13 mm (Bilý 1999) and even 16 mm (Khramcov & Padij 1965). Eggs and pupae of A. hastulifer have not yet been described.

The imago of A. hastulifer is very similar to that of A. graminis, which is already known from Poland. Their most important identifying characters are presented in Table 1.

Table 1. Comparison of imaginal characters between Agrilus hastulifer and A. graminis.

<table>
<thead>
<tr>
<th>Agrilus hastulifer (Ratzeburg, 1837)</th>
<th>Agrilus graminis Kiesenwetter, 1857</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body</strong> wider, dark green to black (Fig. 1).</td>
<td><strong>Body</strong> narrower, lighter, usually olive green (Fig. 2).</td>
</tr>
<tr>
<td>White elytral pubescence:</td>
<td>White elytral pubescence:</td>
</tr>
<tr>
<td>• proximal – large, clearly visible,</td>
<td>• proximal – weakly visible,</td>
</tr>
<tr>
<td>• distal – in the form of an elongated triangle located along the suture, with a base located behind half of elytra and tapering towards the apex.</td>
<td>• distal – in the form of a roughly equal width of the narrow strip at the suture, starting behind half an elytra and reaching the end of them.</td>
</tr>
<tr>
<td>Sides of pronotum arcuate, posterior angles of pronotum slightly acute.</td>
<td>Sides of pronotum in anterior part almost parallel, slightly tapering backwards, posterior angles of pronotum rectangular.</td>
</tr>
<tr>
<td>Prehumerus arcuate.</td>
<td>Prehumerus straight.</td>
</tr>
<tr>
<td>Prosternal process flat with homogeneous pubescence (Fig. 3).</td>
<td>Prosternal process impressed with protruding sides, in male with medial „brush” of setae at the root (Fig. 4).</td>
</tr>
<tr>
<td>Hind coxae of male with homogeneous pubescence with distinct microsculpture (Fig. 5).</td>
<td>Hind coxae of male, on the inner side elevated, without distinct microsculpture, with „brush” of setae on the top (Fig. 6).</td>
</tr>
<tr>
<td>Basal ventrite of male with pair of median tubercles (Fig. 5).</td>
<td>Basal ventrite of male without tubercles (Fig. 6).</td>
</tr>
<tr>
<td>Last ventrite regularly convex (Fig. 7).</td>
<td>Last ventrite longitudinally depressed (Fig. 8).</td>
</tr>
<tr>
<td>Antennae of male not modified, antennomeres not extended to the outside (Fig. 9).</td>
<td>Antennomeres 6th-10th of male with elongated bases, clearly extended to the outside (Fig. 10).</td>
</tr>
<tr>
<td>Aedeagus wider, the widest part of the parameres in a quarter of length before the apex (Fig. 11).</td>
<td>Aedeagus slender, the widest part of the parameres just before the apex (Fig. 12).</td>
</tr>
<tr>
<td>In female, 6th ventrite partially hidden with two oblique, straight, widely spaced lines visible, running towards the top (Fig. 13).</td>
<td>In female, on the 6th ventrite, the oblique lines before the apex bend and merge to form a semicircle (Fig. 14).</td>
</tr>
</tbody>
</table>
One particular feature in previous keys to differentiate these species, i.e. differences in the depth of the longitudinal depression in the middle of the pronotum, (Bilý 1989), shows such a great variability that it is not effective for species discrimination.
Remarks

The species has a different status within its range. In many countries it is rare or very rare, e.g. in the Czech Republic, Poland, Spain, Israel. It was placed on the Red Lists in Germany (in the critically endangered category) (Geiser 1984) and in the Czech Republic (as endangered) (Škorpik 2005). Speight (1989) classifies A. hastulifer as a species useful in identifying forests of international importance to nature conservation. In other countries, however, it is common, e.g. in France, Hungary, Romania, Turkey, Ukraine (Schaefer 1949, Muskovits 2001, Prokhorov 2010, original data). In the 20th century A. hastulifer was considered a serious physiological pest of oak forests occurring among the steppes in Ukraine (Zverezomb-Zubovskij 1913, Stark 1951, Dmitriev 1959). This species, when massively reproduced, can inhabit healthy-looking trees and cause them to die. Outbreaks of A. hastulifer often arose there in young plantings of Quercus (Maslov et al. 1973). Trap trees, i.e. girdled young oaks or freshly cut oak trees in sunny locations, were suggested as a management tactic (Khramcov & Padij 1965). Schaefer (1949) and Cobos (1986) also mention it as a pest of cork oaks.

In Russian, there are two names for this buprestid: dubovaja zubchataja zlatka (Rimskij-Korsakov 1935) or shelkovistaja uzkotelaja zlatka (Maslov et al. 1973); in Ukrainian: zlatka vuz’kotila zubchasta (Zagajkevich 1962); in German: Gezähnter Prachtkäfer (Ratzeburg 1837) or Gezähnter Eichen-Prachtkäfer (Geiser 1984).

Agrilus hastulifer is the twenty-seventh representative of the genus Agrilus known from the Białowieża Primeval Forest and brings the total number of Buprestidae species from this best preserved forest in Europe to 55 (Gutowski 2001, Gutowski et al. 2019, this study). In the Kampinos National Park this species is the twentieth representative of the Agrilus genus; the list of all known Buprestidae species from this forest complex currently has 36 (Marczak, Królík & Borowski in press).

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References


Fauna Europaea: https://fauna-eu.org/cdm_dataportal/taxon/c3c5803becfc-4915-b789-5e730fe5921d#synonymy [accessed 1.01.2020].


https://doi.org/10.1007/978-3-319-08410-7


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