

New data on the occurrence of buprestid beetles (Coleoptera: Buprestidae) in the Białowieża Primeval Forest

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Abstract. The aim of this work was to expand current knowledge on the species composition and distribution of the jewel beetles (Coleoptera: Buprestidae) in Białowieża Primeval Forest (BPF) based on research conducted in 2000–2018 and a literature review. The BPF is considered the best-preserved forest of the European lowland and is a reference point for all forest research. Thus, knowledge of its fauna is vital. This research was conducted and incorporated the whole Polish part of the BPF, including Białowieża National Park (BNP), using standard methods for the faunistic studies of terrestrial beetles. We also investigated potential microhabitats of saproxylic buprestid beetles and reared larvae from inhabited host material. Collected larvae and/or pupae were identified in the laboratory or grown to the adult stage. However, most specimens were collected using various traps (Lindgren, Moericke, Netocia barrier type and IBL-2), especially traps placed in the upper tree canopy.

Two species previously unrecorded in the BPF (*Agrilus graminis*, *A. mendax*) and new information on several of the rarest central European Buprestidae species (*Buprestis splendens*, *Eurythyrea quercus*, *Anthaxia chevrieri*, *Chrysobothris chrysostigma*, *Agrilus antiquus croaticus*, *A. ater*, *A. auricollis*, *A. convexicollis*, *A. pseudocyaneus*) are presented here. Currently, 54 species of Buprestidae are known to occur in the BPF area, of which 49 were collected from the Polish part and 26 from the Belarusian part, while two species (*Dicerca berolinensis* and *Eurythyrea austriaca*) have no specified location data. Up to 39 species of buprestid beetles have been found in the BNP, which covers about 17% of the Polish part of BPF. We also provide an original key for differentiating *Agrilus nicolanus* – a species recently discovered in Poland (BPF and Biebrza Valley), that was previously known to occur only in Asia and the Lipetsk region in the European part of Russia – from the *Agrilus betuleti* species group. In conclusion, the BPF is an important refugium of buprestid beetle richness, including known forest relics.

Keywords: Coleoptera, Buprestidae, geographical distribution, new records, *Agrilus betuleti* species group, Białowieża Primeval Forest, north-eastern Poland

1. Introduction

Jewel beetles (Coleoptera: Buprestidae) have numerous species and are an economically important family of saproxylic beetles. Most species grow under the bark or in the wood of coniferous and deciduous trees and shrubs. Some species belonging to this family are considered significant tree pests in European forests, for example, *Phaenops cyanea* (Fabr.) for pines and the oak splendour beetle *Agrilus biguttatus* (Fabr.) for oaks (Kenis, Hilszczański 2004; Gutowski 2005). On the

other hand, there are also legally protected species in this family, such as the goldstreifiger, *Buprestis splendens* Fabr. and the very rare *Agrilus pseudocyaneus* Kiesw.

Research on this group of insects in the Białowieża Primeval Forest (BPF) was summarised by Gutowski and Ługowoj (2000) and Gutowski (2001) and then supplemented by Gutowski (2010). As a result, 51 Buprestidae species were found throughout the BPF (in the Polish and Belarusian parts). Recently, another species was reported from this area – *Agrilus nicolanus* Obenberger (Jendek, Grebennikov 2011;

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Jendek 2016). Information about the BPF Buprestidae fauna can also be found in many other publications (Mokrzycki 2001, 2004; Ehnström, Axelsson 2002; Faliński 2003; Dominik, Starzyk 2004; Gutowski 2004a, 2004b, 2004c, 2004d, 2010, 2015; Gutowski, Jaroszewicz 2004; Gutowski et al. 2004, 2006, 2009, 2015; Bobiec et al. 2005; Tsinkevich et al. 2005; Aleksandrowicz, Tsinkevich 2006; Byk et al. 2006; Kossak 2006; Lukashenya, Tsinkevich 2006; Kozłowski 2008, 2009; Lukin 2010; Lukin et al. 2010; Jendek, Grebennikov 2011; Malzahn 2011; Kajtoch et al. 2014, 2019; Tsinkevich, Lukashenya 2014, 2017; Jendek 2016; Lukashenya 2017; Tsinkevich 2017; Kolasa et al. 2018).

The aim of this study is to supplement existing knowledge of species composition and distribution of buprestid beetles in the BPF based on research conducted by the authors and literature searches. The BPF is considered the best preserved forest in the European lowlands and a reference point for any forest research, which is why learning about its fauna, including Buprestidae, is so important.

2. Study area and methodology

The BPF covers an area of about 1,500 km², of which about 620 km² is located in Poland. The Białowieża National Park (BNP) has an area of about 105 km², including about 60 km² under strict protection (Okolów et al. 2009, Kujawa et al. 2016). More detailed information about the study area can be found in the works cited above and in the publication of Gutowski and Ługowoj (2000).

An extensive survey of Buprestidae was conducted in 2000–2018 throughout the Polish part of the BPF, including the BNP, by the senior author. Information on several rare species discovered in these surveys has been published (Gutowski 2010) and additional information is presented here. Standard faunistic methods were used, included looking for imagines on flowers, leaves, dying and dead trees and shrubs, in sunlit woodpiles and so on. Beetles observed were captured by hand or in a sweep net, identified, recorded and released. When specimens could not be identified to species in the field, they were taken to the laboratory and identified using a stereoscopic microscope. Buprestidae imagines were also captured by sweeping (or ‘mowing’) herbaceous plants, shrubs and the lower branches of trees, using an entomological sweep net. We also collected buprestid larvae and pupae from under the bark of logs and stumps and either identified these in the laboratory or reared them until adulthood. However, the best effects were obtained by using various types of traps for beetles (Lindgren's, Moericke's, barrier traps of the Netocia and IBL-2 types), especially those placed in tree crowns and baited with attractants. The following are the attractants used in specific years (only information on years and species is provided in the below list). We used racemic 3-hydroxyhexan-2-one, racemic 3-hydroxyoc-

tan-2-one, *syn*-2,3-hexanediol, *E/Z*-fusicumol, *E/Z*-fusicumol acetate and ethanol in 2015 and 2016, 10-methyldodecanal, racemic 2-hydroxyoctan-3-one, *syn*-2,3-octanediols and ethanol in 2017; 10-methyldodecanal, racemic 3-hydroxyoctan-2-one, *syn*-2,3-octanediols and ethanol in 2018.

The specimens are stored in the collections of the Forest Research Institute in Białowieża, the Atlantic Forestry Centre (Fredericton) in Canada and the collections of the first three authors.

The following abbreviations are used for presenting in the results of this study: ad – near (nearby), BNP – Białowieża National Park, coll. – collection, cult. – reared, det. – identified (by), ex – from [reared from], ex.(exx.) – specimen (specimens), photo – photographed (by), *in copula* – during copulation, JG – J.M. Gutowski, JŁ – J. Ługowoj, leg. – collected (by), *nomen dubium* – doubtful name, comp. – forest compartment, BPF – Białowieża Primeval Forest, RK – R. Królik, vic. – vicinity.

3. Results

Until recently, 52 Buprestidae species were known from the BPF (Gutowski 2010; Gutowski, Ługowoj 2000; Jendek, Grebennikov 2011). Here we report two species of Buprestidae previously unknown from the BPF (*Agrilus graminus*, *A. mendax*), detailed data on where and when nine additional buprestid species were collected, and new information about several other species of Buprestidae that are very rare in Poland and Europe.

Buprestis splendens Fabricius, 1775

- BNP, comp. 288C/318A (UTM: FD94), strict protection area, fresh mixed coniferous forest *Calamagrostio-Piceetum*, old pine and spruce trees with an admixture of silver birch and hornbeam, 20 VII 2011 – remains of a specimen in a Moericke trap suspended at a height of about 1.5 m (Gutowski 2015); 25 V–15 VI 2018 – 1 ex., 13 VII–7 VIII 2018 – 1 ex., both specimens in the purple-coloured Lindgren funnel trap, hung in the first case on a birch at a height of 7 m, in the second case – in the crown of a dead Scots pine *Pinus sylvestris* L., at a height of approximately 15 m, without attractants, leg. K. Sućko, det. JG.

- Białowieża Forest District, comp. 338D (FD84), VII 2011 – a pair *in copula* on a pole forming the fence of the ‘Royal Oaks’ tourist trail in the ‘Stara Białowieża’ wilderness area; observation – J. Mendzikowski.

Eurythyrea quercus (Herbst, 1780)

- BNP, strict protection area, comp. 255D (FD94), 17 VII 2011 – 1 ex. on a freshly overturned leaf of an old oak, leg. et photo M. Popławska et T. Niechoda, det. JG.

- BNP, comp. 398 (FD94), VIII 2015, at the entrance gate to the strict reserve, 1 ♀, leg. K. Sikorski, det. JŁ.

- BNP, strict protection area, comp. 283 (FD94), 3 VII 2018 – 1 ex., on the bark of a standing, living oak, at a height of 1 m, leg. et photo A. et T. Niechoda, det. JG.
- BNP, strict protection area, comp. 398A/B (FD94), oak-hornbeam forest, 18 VII 2018 – 1 ex. on a downed oak, leg. et photo G. Chyra, det. JG.
- Dąbrowa ad Teremiski vic., comp. 338A (FD84), oak-lime-hornbeam forest, old trees with a large share of oak, hornbeam, spruce, lime trees with an admixture of pines and other tree species, 7–20 VII 2015 – 1 ex. in a black-coloured Lindgren funnel trap, suspended in an oak crown, 5–18 VIII 2017 – 1 ex. in a purple-coloured Lindgren funnel trap, suspended at a height of 1.5 m from the ground; baited traps; leg. et det. JG.
- Browsk Forest District ad Zabrody, comp. 14C (FD96), IV 2016, 3 outlets and larval galleries from the previous year on a fallen oak; observation JŁ.

Anthaxia chevrieri Gory et Laporte, 1839

- Orzeszkowo (FD74), 13–16 VII 1994 – 1 ex., leg. et det. RK.

Chrysobothris chryso stigma (Linnaeus, 1758)

- ad Grudki, comp. 526 (FD93), 10 V 2000 – 1 ex. ex larva, leg. et cult. L. Kruszelnicki, det. et coll. RK.
- Białowieża Forest District, ad Grudki (FD94), 25 V 2001 – 1 ex., leg. et coll. K. Sikorski, det. JG.
- Białowieża Forest District, comp. 520A (FD83), 14 VI 2001, 2 exx. on a spruce log, leg. et det. JŁ.
- Białowieża Forest District, ad Czerlonka, comp. 469C (FD84), 19 VII 2004 – 1 ex. on spruce logs, leg. J. Klonowski, det. et coll. JG.
- ad Nowe Masiewo, comp. 39A (FD95), 22 VI 2013 – 2 exx., leg. et det. RK.
- Białowieża Forest District, ad Podcerkwa, comp. 522D (FD83), VI 2018 – 1 ex. on a spruce woodpile, leg. et det. JG.

Agrilus antiquus croaticus Abeille de Perrin, 1897

[information about the occurrence of *Agrilus sperkii* Solsky in Poland, 1873 should refer to *A. antiquus croaticus*; according to Jendek (2016b) *A. sperkii* is a *nomen dubium*]

- Orzeszkowo, railway embankment, 7 VII 2008 – 1 ex., leg. et det. RK.

Agrilus ater (Linnaeus, 1767)

- Białowieża Forest District, comp. 520C (FD83), 4–8 VII 2005 – 6 exx. on the trunk of an aspen standing in an insolated location, leg. et det. JŁ.
- Browsk Forest District, ad Olchówka, comp. 38A (FD95), 3 II 2007 – 2 exx. ex larva from the trunk of a lying aspen, *Populus tremula* L., leg., cult. et det. JŁ.

- Orzeszkowo (FD74), railway embankment, 7 VII 2008 – 3 exx. on the trunk of a dead aspen, leg. et det. RK.
- Białowieża, Droga Browska (FD94), 22 VI 2013 – a dozen or so exx. on the lying trunks of white poplar, *Populus alba* L., leg. P. Górski et J. Tatur-Dytkowski.
- BNP, strict protection area, comp. 345A (FD94), IV 2011, abandoned larval galleries on a dead aspen trunk, leg. et det. K. Sućko.
- BNP, strict protection area, comp. 369A (FD94), 30 VI 2015, several larval galleries on a standing, dead aspen, alder forest, leg. et det. JG.
- Dąbrowa ad Teremiski vic., comp. 338A, 5–18 VI 2018 – 1 ex., 3–17 VII 2018 – 1 ex., in green-coloured Lindgren funnel traps, with attractants, suspended in the crown of living oaks *Quercus robur* L., leg. et det. JG.

Agrilus auricollis Kiesenwetter, 1857

- on SE from Sacharewo ad Hajnówka, comp. 413A (FD74), 7 VI 2010, on a lying elm *Ulmus* sp. at the edge of a clearing in the forest – a dozen or so abandoned larval galleries on branches with a diameter of 2–4 cm, insolated location; leg. et det. JG.
- Dąbrowa ad Teremiski vic., comp. 338A, 20 V–4 VI 2018 – 1 ex. in a green-coloured Lindgren funnel trap, with attractants, suspended in an oak crown, leg. et det. JG.

Agrilus convexicollis Redtenbacher, 1847

- ad Topiło (FD73), riverine/alder forest, →4 IX 2004 – 1 ex. in a yellow-coloured Moericke trap, leg. J. Sawoniewicz, det. et coll. JG.
- Dąbrowa ad Teremiski vic., comp. 338A, 23 VI–6 VII 2015 – 1 ex. in a green-coloured Lindgren funnel trap suspended at a height of 1–2 m; 23 VI–6 VII 2015 – 3 exx., 7–20 VI 2016 – 2 exx., 21 VI–4 VII 2016 – 1 ex., 22 V–22 VI 2017 – 2 exx., 20 V–4 VI 2018 – 3 exx., 5–18 VI 2018 – 2 exx., 19 VI 2018 – 1 ex., in green-coloured Lindgren funnel traps, with attractants, suspended in the crowns of oaks, leg. et det. JG.

Agrilus graminis Kiesenwetter, 1857

- Dąbrowa ad Teremiski vic., comp. 338A, 7–20 VII 2015 – 2 ex., 21 VI–4 VII 2016 – 1 ex., 8–21 VII 2017 – 4 exx., 22 VII–4 VIII 2017 – 4 exx., 5–18 VIII 2017 – 3 exx., 20 V–4 VI 2018 – 1 ex., 5–18 VI 2018 – 1 ex., 19 VI–2 VII 2018 – 3 exx., 3–17 VII 2018 – 7 exx., leg. et det. JG. All specimens (except one that fell into a trap located at a height of 1.5 m) were caught in green-coloured Lindgren traps, with attractants, suspended in the crowns of oaks at a height of 18.5–26.5 m. A new species for the BPF.

Agrilus mendax Mannerheim, 1837

• Browsk Forest District, comp. 153C (FD85), 26 VI 2018 – 1♂ dead, extracted from the pupal cell on a rowan *Sorbus aucuparia* L. em. Hedl., leg. et det. JŁ.

• Browsk Forest District, comp. 79B (FD85), 16 V 2018 – 1♂, ex larva from a rowan, leg., cult. et det. A. Lasoń; 16–18 V 2018 – 1♂ and 1♀ and 14 I 2019 – 1♂ – all ex larva from a partially dead rowan (diameter 3–12 cm), leg., cult. et det. JŁ.

A new species for the BPF.

Agrilus pseudocyanus Kiesenwetter, 1857

• Białowieża Forest District, comp. 520C, 6 VII 2005 – 3 exx. on the trunk of a lying aspen, leg. et det. JŁ.

• Browsk Forest District, ad Masiewo, comp. 66B (FD95), 30 VI 2008 – 7 exx., 2 VII 2008 – 10 exx., on a pile of aspen wood, leg., det et coll. JŁ et RK.

• Browsk Forest District, ad Łączyno, comp. 66B, 2 VII 2008 – 10 exx. on a pile of aspen wood, leg. JŁ, coll. RK.

• ad Łączyno, comp. 51C (FD95), 22 VI 2013 – 7 exx. on a pile of *Populus tremula* wood, leg. et det. RK.

• Browsk Forest District, ad Olchówka, comp. 49B (FD95), 15 VI 2018 – 2 exx. on the branches of a downed aspen, leg. et det. RK.

• Browsk Forest District, ad Olchówka, comp. 49C (FD95), 19 VI 2018 – 2 exx. on the trunk of a lying aspen, leg. et det. JŁ.

• Dąbrowa ad Teremiski vic., comp. 338A, 20 V–4 VI 2018 – 1 ex. in a green-coloured Lindgren funnel trap, with attractants, suspended in the crown of an oak, leg. et det. JG.

Fifty-four Buprestidae species are currently known to occur in the BPF (both the Polish and Belarusian parts; Table 1).

4. Discussion

Thus far, 88 species of Buprestidae have been found in Poland (Gutowski 2005; Byk, Mokrzycki 2009; Jendek, Grebennikov 2011). Fifty-four species of Buprestidae were found in the entire area of the Białowieża Forest (61.4% of all Buprestidae species occurring in Poland), including five that were recently confirmed as new for this area: *Poecilnota variolosa*, *Lamprodila decipiens*, *Agrilus derasofasciatus*, *A. guerini*, and *A. nicolanus* (Gutowski 2010; Jendek, Grebennikov 2011; Jendek 2016a), as well as two new species records presented in this article – *Agrilus graminis* and *A. mendax*. Forty-nine species were found in the Polish part of the Forest, but two of them (*Dicerca berolinensis* and *Eurythyrea austriaca*) did not have their location specified. There are 45 Buprestidae species in Belarus, of which 26 have been reported from the Belarusian part of the BPF (Gutowski, Ługowoj 2000; Gutowski 2001; Tsinkevich et al. 2005; Aleksandrowicz, Tsinkevich

2006; Lukashenya, Tsinkevich 2006; Lukin 2010; Lukin et al. 2010; Kajtoch et al. 2014; Tsinkevich, Lukashenya 2014; Lukashenya 2017; Tsinkevich 2017; Tsinkevich, Lukashenya 2017). Three of them – *Dicerca moesta*, *Coraebus elatus* and *Agrilus salicis* – have not yet been found in the Polish part of the BPF. In the BNP, which covers about 17% of the Polish part of the BPF, 39 Buprestidae species have been confirmed thus far, of which 28 were in strict protection areas and 32 in the areas of active and landscape protection. Outside of the BNP, 47 Buprestidae species were confirmed in the Polish part of the Forest, of which 9 are absent or have not yet been found in the BNP (Gutowski, Ługowoj 2000; Gutowski 2001, 2004a, 2004b, 2004c, 2004d; Gutowski 2010; new data).

A significant number of the above-mentioned species were found by using green-coloured funnel traps suspended in tree crowns (effective in relation to the genus *Agrilus* Curtis) or purple-coloured ones – suitable for species of the genus *Buprestis* L., *Chrysobothris* Esch. and *Eurythyrea* Dej. (Petrice, Haack 2015; own data).

The BPF or its vicinity serves as the northern border of the range of the following species: *Dicerca berolinensis*, *Eurythyrea austriaca*, *E. quercus*, *Anthaxia chevrieri*, *Chrysobothris igniventris*, *Agrilus antiquus croaticus*, *A. auricollis*, *A. derasofasciatus*, *A. graminis*, *A. obscuricollis* and *A. ribesi*. The northern boundary of *Anthaxia nitidula* is not too far; it is not known in Fennoscandia and occurs only sporadically in the Baltic countries (Silfverberg 2004). The western range limit of *Agrilus nicolanus* is in the BPF (Jendek, Grebennikov 2011; new data). Taking into account the geographical ranges and ecological requirements, it should be possible to find several more native species in the BPF, for example, *Phaenops formaneki* Jakobson, 1913 and *Agrilus delphinensis* Abeille de Perrin, 1897. A separate issue is the possibility of the introduction or spontaneous expansion of alien species that may prove to be serious tree pests. One such invasive species that is spreading throughout the world is the East Asian *Agrilus planipennis* Fairmaire, 1888, which is currently causing severe damage to ash trees in North America (Haack et al. 2002; Jendek, Grebennikov 2009). It is also spreading to the west of Eurasia – it has attacked ash trees near Moscow and has already reached the borders of Belarus and Ukraine (Musolin et al. 2017). It is highly probable that it will soon reach Poland's borders. Another dangerous species may be *Agrilus bilineatus* (Weber, 1801), a serious pest of oaks (*Quercus* L.), which was introduced from North America to Turkey (Jendek 2016a, Hizal et al. 2018).

Research conducted in the past 19 years in various sites of the BPF, using different methods, allows us to estimate the relative abundance of selected species in several habitats. We found that such assessments largely depend on the survey methods used. Funnel traps placed in the upper canopy captured a significant number of Buprestidae individuals, including those previously considered very rare or rare in the BPF, e.g., *Agri-*

Table 1. Buprestid beetles (Coleoptera: Buprestidae) occurring in the Białowieża Primeval Forest [systematic order, species within genera – alphabetically; special care species are distinguished in bold; ! – species new to the BPF; the asterisk (*) indicates species occurring in the Białowieża National Park; PL – known from the Polish part of the BPF (S – occurs in the strict protection area of BNP, P – occurs in the remaining part of BNP, M – occurs in the managed forests outside BNP), BY – known from the Belarusian part of the BPF]

Species	Remarks
* <i>Chalcophora mariana</i> (L.)	PL: P, M; BY
* <i>Dicerca alni</i> (FISCH.)	PL: S, P, M; BY
<i>Dicerca berolinensis</i> (HERBST)	PL: ?
<i>Dicerca moesta</i> (FABR.)	BY
<i>Poecilnota variolosa</i> (PAYK.)	PL: M
<i>Lamprodila decipiens</i> (GEBL.)	PL: M
* <i>Lamprodila rutilans</i> (FABR.)	PL: S, M
<i>Eurythyrea austriaca</i> (L.)	PL: ?
* <i>Eurythyrea quercus</i> (HERBST)	PL: S, P, M
* <i>Buprestis haemorrhoidalis</i> HERBST	PL: S, P, M; BY
* <i>Buprestis novemmaculata</i> L.	PL: S, P, M; BY
* <i>Buprestis octoguttata</i> L.	PL: S, P, M; BY
* <i>Buprestis rustica</i> L.	PL: S, P, M; BY
* <i>Buprestis splendens</i> FABR.	PL: S, P, M
* <i>Anthaxia chevrieri</i> GORY et LAP.	PL: S, M
* <i>Anthaxia godeti</i> GORY et LAP.	PL: S, P, M; BY
* <i>Anthaxia morio</i> (FABR.)	PL: S, M; BY
<i>Anthaxia nitidula</i> (L.)	PL: M
* <i>Anthaxia quadripunctata</i> (L.)	PL: S, P, M; BY
* <i>Melanophila acuminata</i> (DE GEER)	PL: P, M; BY
* <i>Phaenops cyanea</i> (FABR.)	PL: S, P, M; BY
* <i>Chrysobothris affinis</i> (FABR.)	PL: S, P, M; BY
* <i>Chrysobothris chrysostigma</i> (L.)	PL: S, P, M; BY
* <i>Chrysobothris igniventris</i> REITT.	PL: S, P
<i>Coraebus elatus</i> (FABR.)	BY
* <i>Agrilus angustulus</i> (ILL.)	PL: S, P, M; BY
<i>Agrilus antiquus croaticus</i> AB.	PL: M; BY

Species	Remarks
* <i>Agrilus ater</i> (L.)	PL: S, M
* <i>Agrilus auricollis</i> KIESW.	PL: S, M
* <i>Agrilus betuleti</i> (RATZB.)	PL: P, M
* <i>Agrilus biguttatus</i> (FABR.)	PL: S, P, M; BY
* <i>Agrilus convexcollis</i> REDTB.	PL: S, M
<i>Agrilus cuprescens</i> MÉNETR.	PL: M
* <i>Agrilus cyanescens</i> (RATZB.)	PL: P, M
<i>Agrilus derasofasciatus</i> LAC.	PL: M
!<i>Agrilus graminis</i> KIESW.	PL: M
<i>Agrilus guerini</i> LAC.	PL: M
* <i>Agrilus integerrimus</i> (RATZB.)	PL: P, M; BY
* <i>Agrilus laticornis</i> (ILL.)	PL: P, M
!<i>Agrilus mendax</i> MANNERH.	PL: M
* <i>Agrilus nicolanus</i> OBENB.	PL: P
* <i>Agrilus obscuricollis</i> KIESW.	PL: S, M
* <i>Agrilus olivicolor</i> KIESW.	PL: S, P, M
* <i>Agrilus pratensis</i> (RATZB.)	PL: P, M
* <i>Agrilus pseudocyanus</i> KIESW.	PL: P, M; BY
* <i>Agrilus ribesi</i> SCHAEF.	PL: S, P, M; BY
<i>Agrilus salicis</i> FRIV.	BY
* <i>Agrilus sinuatus</i> (OLIV.)	PL: P, M; BY
* <i>Agrilus subauratus</i> (GEBL.)	PL: P, M
* <i>Agrilus sulcicollis</i> LAC.	PL: S, P, M
* <i>Agrilus suvorovi</i> OBENB.	PL: S, P, M; BY
* <i>Agrilus viridis</i> (L.)	PL: S, P, M; BY
* <i>Trachys minutus</i> (L.)	PL: S, P, M; BY
<i>Habroloma nanum</i> (PAYK.)	PL: M

lus obscuricollis and *A. laticornis* (Gutowski, Ługowoj 2000). The funnel traps also detected a new species from the BPF – *Agrilus graminis*, which, as it turned out, is not so rare in the oak crowns of oak-hornbeam forests. On the other hand, some species may have actually decreased in numbers because they were either not captured at all (*Melanophila acuminata*) or we found only one or very few specimens (*Chalcophora mariana*,

Buprestis novemmaculata and *Agrilus pseudocyanus*), whereas before 2000, they had occurred in large numbers in the BPF.

Amongst Poland's natural sites similar in nature to the BPF, only two have well-recognised Buprestidae fauna – Roztocze (Gutowski 1992, Yanytsky 1998) and Kozińska Forest [*Puszcza Kozińska*] (Gutowski, Miłkowski 2008; Miłkowski 2017). Fifty-four species of Buprestidae were found in

Roztocze and 48 in Kozienicka Forest. The great faunal richness of Roztocze is influenced by its location – it stretches as far as Podole, which feeds this region with thermophilic species from the southeast. It should also be noted that Roztocze has an area about twice as large as the Białowieża Forest and consists of more xerothermic open areas, which favours many species in this family. In turn, the Kozienicka Forest, which is five times smaller than the BPF, has a surprisingly high number of Buprestidae species. This fact is partly explained by its location, which is further south than the BPF and in a zone influenced by the fauna of submountains, such as species associated with *Abies*.

It was surprising to find extremely thermophilic, southern species in the BPF such as *Anthaxia chevrieri*, *Coraebus elatus*, *Agrilus antiquus croaticus*, *Habroloma nanum* (Gutowski, Ługowoj 2000; Gutowski 2001) and *Agrilus derasofasciatus* (Gutowski 2010). The latter is becoming increasingly more numerous from year to year in places where grapes are grown (it is a monophage of grapevines in Poland).

The discovery in BPF of a site with the East Asian species *Agrilus nicolanus* Obenberger, 1924, was unexpected (FD94, BNP, unit 398–399). It is known from China, Japan, North Korea, South Korea and southeastern Russia – Kemerovo, Primorye (Jendek, Grebennikov 2011). It has also been recently found in the European part of Russia – Lipetsk (Jendek 2016), so it probably has a very wide, Eurasian perhaps continuous distribution. This species belongs to the subgenus *Robertius* Théry, the group *Agrilus betuleti*. The biology of *A. nicolanus* is not known; it was captured from May to July. Attention should be paid to specimens from this group found in European collections – it may be more widely distributed than is indicated by the discovery in the BPF and the Biebrza Valley (see below). We reviewed specimens from the *Agrilus betuleti* species group from Poland in the available collections for the presence of *A. nicolanus*. We found one specimen (♂) captured on 11 June 1982 in the ‘Kapice’ wilderness area (FE13) near the village of Kapice not far from Grajewo, leg. et coll. JG. It was sitting on a *Salix cinerea* L. leaf at the edge of an almost solid birch grove growing in a moist, swampy habitat. This discovery suggests that its host plants may be willows or birches. *Agrilus nicolanus* beetles are most similar to *A. betuleti*. Specimens of *A. nicolanus* are unicolorous, dark olive (slightly lighter than *A. betuleti*), have a pronotum with nearly parallel sides (anteriorly widening in *A. betuleti*), the prosternal lobe is distinctly emarginated medially (straight in *A. betuleti*), different shape of the prosternal process (Figs. 2 and 4), and a vertex with fine longitudinal wrinkles (*A. betuleti* has two concentric circles of elongated points). The key to identifying all central European species of the *A. betuleti* species group is provided below. Species from this group, excluding *A. nicolanus*, were able to be determined according to the key contained in the work of Gutowski (1993), remembering that *Agrilus bialowiezaensis* Gutowski is

a synonym of *A. pseudocyaneus*, and *A. delphinensis* has occurred under the name *A. pseudocyaneus* according to the current findings (Jendek 1995).

Identification key for Polish species of the *Agrilus betuleti* species group

The key takes into account the feature of claw shape (Fig. 7) from the work of Harde (1979). This feature is very useful in distinguishing males of many European species of the genus *Agrilus*. Females of all domestic species from the *A. betuleti* species group have the type C claw.

1. Species with a pronounced dark blue colouration of the entire upper body, sometimes with a greenish hue 2.
 - Dark-coloured elytra, with olive, brown to black hues, if with a navy blue hue, then the pronotum has a contrasting colouration in relation to the elytra 3.
 2. Larger: 5.6–7.8 mm and more robust; vertex with delicate wrinkles; colouration ♀ uniformly dark blue, ♂ – delicately bicolorous: head, pronotum and sometimes the basal part of the elytra with a greenish hue; ♂ – type C claws ***A. pseudocyaneus* Kiesenwetter, 1857**
 - Smaller: 4–5.3 mm and slimmer; vertex with puncturation; blue colouration; ♂ – type F claws ***A. delphinensis* Abeille de Perrin, 1897**
 3. Distinctly bicolorous: elytra black covers with a dark blue hue, pronotum golden-copper to purple; vertex very convex; 4–8 mm; ♂ – type F claws ***A. pratensis* (Ratzeburg, 1837)**
 - Unicolorous, darkly coloured species, no contrast in the pronotum and elytra colouration; vertex less convex; ♂ – type C claws 4.
 4. Dark olive, frons and pronotal sides are greenish in the male; vertex longitudinally strigose; pronotum with nearly parallel sides – Figure 1; prosternal lobe distinctly emarginated medially (Fig. 2); prosternal process – Figure 2; aedeagus – Figure 5; 3.7–5.8 mm ***A. nicolanus* Obenberger, 1924**
 - Dark brown, almost black, sometimes with a greenish or copper hue, ♂ a little lighter; vertex has two concentric circles of elongated points; pronotum clearly anteriorly widening (Fig. 3); prosternal lobe without distinct emargination (Fig. 4); prosternal process – Figure 4; aedeagus – Figure 6; 4–6 mm ***A. betuleti* (Ratzeburg, 1837)**

The species richness of thermophilic beetle families, such as the Buprestidae, is very high in the BPF. The dense forest complex with a relatively small share of open areas, so generally a rather shady, humid habitat, is not conducive to the widespread occurrence of this group. Buprestidae species prefer very warm, strongly insolated locations – as they are in large part xerothermophilic. Nevertheless, progressing global warming and natural disturbances (hurricane damage, insect infestations) seem to favour some species in this family.

Amongst the particularly valuable and endangered (‘species of special concern’ – Table 1) Buprestidae species (24 species included here), the majority occur in the BNP (12 spe-



Figure 1. 2, 5. *Agrilus nicolani* Obenberger, 1924 (1 – pronotum, 2 – prosternum, 5 – aedeagus); 3, 4. *Agrilus betuleti* Ratzeburg, 1837 (3 – pronotum, 4 – prosternum, 6 – aedeagus); 7. shape of tarsal claws (according to Harde 1979) – females and males in both species C (F – males in *A. delphinensis* and *A. pratensis*)

cies), the location of 2 additional species (*D. berlinensis* and *E. austriaca*) was not specified and 3 are known only from the Belarusian part of BPF. The remaining seven species have been confirmed, so far, in areas outside the BNP. However, it cannot be ruled out that these species are very scattered throughout the park (Buprestidae lead a secretive lifestyle and are very difficult to find) and may be found there in the future.

This study has allowed us to present a number of rare/valuable species that are on the red lists and in the red books of

threatened and endangered species in various countries and regions. The following are only examples of species from the highest threat categories amongst those listed in these studies.

Buprestis splendens – a dying relic of primeval forests – is currently known in Poland only from the BPF. This species is listed on the ‘European Red List of Saproxyllic Beetles’ as an endangered species (EN) (Nieto, Alexander 2010). It is also on the Polish ‘Red List’ as critically endangered (CR) (Pawłowski et al. 2002). In addition to *B. splendens*, Pawłowski et al. (2002)

included the following species occurring in the BPF on the Polish ‘Red List’: *Dicerca moesta* – DD (data deficient – incomplete data on the threats and status of this species), *Eurythyrea austriaca* – VU (vulnerable), *E. quercus* – EN (endangered), *Agrilus guerini* – DD, *A. integerrimus* – NT (near threatened), *A. mendax* – DD, and *A. pseudocyaneus* – EN. Several species (*E. quercus*, *B. splendens* and *A. pseudocyaneus*) have been listed in the ‘Polish Red Book of Animals’ (Głowaciński, Nowacki 2004). Four species of Buprestidae occurring in the BPF (*B. splendens*, *D. moesta*, *E. austriaca* and *E. quercus*) are on the list of protected animals in Poland (Rozporządzenie 2016).

Buprestis splendens was listed in the Red Book of Ukraine as an example of an extinct species in that country (Puchkov 2009). The list of the Federal Republic of Germany (Geiser 1984) includes the following species (known to occur in BPF): extinct species – *Eurythyrea austriaca*, *Buprestis splendens*; threatened with extinction – *Dicerca moesta*, *Eurythyrea quercus*, *Coraebus elatus*, *Agrilus guerini*, *A. pseudocyaneus*. The more recent red list prepared for Saxony (Schwier et al. 2004) includes: extinct – *Dicerca berlinensis*, *Buprestis haemorrhoidalis*, *B. rustica*, *Agrilus ater*, *A. guerini*; endangered with extinction – *Dicerca alni*, *Poecilnota variolosa*, *Lamprodila decipiens*, *Anthaxia similis*, *Coraebus elatus*, *Agrilus derasofasciatus*, *A. mendax*, *A. olivicolor*, *A. sinuatus*, *A. subauratus*, *Habroloma nanum*. Finland’s red list includes: endangered – *Chalcophora mariana*, *Lamprodila rutilans*, *Agrilus ater*; vulnerable – *Agrilus pseudocyaneus* (Rassi, Väisänen 1987). In the Czech Republic, the red list (among those occurring in BPF) includes, among others: extinct – *Eurythyrea austriaca*; critically endangered – *E. quercus*, *Buprestis novemmaculata*, *Chrysobothris chrysostigma*, *Agrilus antiquus croaticus*, *A. mendax* (Škorpik 2005).

Many species among those included on red lists in neighboring countries still have numerous and stable populations in BPF. They include: *Dicerca alni*, *Buprestis haemorrhoidalis*, *Agrilus betuleti*, *A. cuprescens*, *A. olivicolor*, *A. ribesi*, and *A. suvorovi*.

Some Buprestidae species could be classified as the so-called forest relics. Such species have survived to this day in only a few places on our continent. The most valuable of such places for the European lowlands is the BPF. Amongst the Buprestidae species, relics of primeval forests – in addition to *Buprestis splendens* mentioned above – include: *Dicerca alni*, *D. berlinensis*, *D. moesta*, *Eurythyrea austriaca*, and *E. quercus* (Eckelt et al. 2017). We believe that such a list could also include: *Chalcophora mariana*, *Buprestis haemorrhoidalis*, *B. novemmaculata*, *Chrysobothris chrysostigma*, and *A. pseudocyaneus*. These species meet the criteria for the definition of forest relics, in particular because they occur only where there has been a continuous presence of large-sized deadwood since prehistoric times.

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Conflict of interest

The authors declare the lack of potential conflicts of interest.

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J.M.G. – concept, fieldwork, data analysis, manuscript writing, proofreading; J.L. – fieldwork, manuscript writing; R.K. – fieldwork, manuscript writing; K.S. – fieldwork, analysis of collected materials; J.S. – organisation of research using attractants, proofreading, verification of the English text.