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ORIGINAL PAPER

Polydrusus aeratus (Coleoptera: Curculionidae: Entiminae): a potential pest of young coniferous stands

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Abstract
Polydrusus aeratus Gravenhorst, 1807 is a pest of both coniferous and deciduous trees in forests. It is widespread throughout the Czech Republic from the lowlands to the mountains. Adult beetles occur from April to September. In the western Czech Republic, a number of 1- to 2-m tall *Abies alba* were recently damaged by *P. aeratus* adults at an altitude of 750 m. *P. aeratus* can damage older saplings that were damaged as young saplings by the pine weevil. The damage caused by *P. aeratus* is so for rather small but should not be neglected by foresters. As the ongoing climate change modifies the relationship between trees and pests, also currently indifferent species may become dangerous for forests in near feature. Therefore, scientists would focus also on relatively less dangerous species of pests, especially insects. Possible methods for controlling of *P. aeratus* are suggested as main output of the study.

Key words: *Abies alba*; Central Europe; climate change; damage; sapling

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1. Introduction

True weevils (Curculionidae) are the most diverse group of beetles (Bouchard et al. 2009). They feed on a wide variety of plants and different parts of trees (leaves, stems, but also roots or woodthe resulting economic losses) (c.f. O´Brien & Wibmer 1982). They include the bark beetles as the subfamily Scolytinae, which are the most important forests pest in Northern Hemisphere (Jordal 2014). But also, in the rest of true weevils because they are herbivores, some species are important forest pests that cause economic losses (c.f. Balock & Kozuma 1964; El-Mergawy & Al-Ajlan 2011; Hue & Low 2015). The pine weevil *Hylobius abietis* Linnaeus, 1758, for example, is an economically important pest that kills high proportions of conifer seedlings (*Pinus*, *Picea*, *Abies*, and *Larix*) in reforestation areas (Day et al. 2007).

Among the approximately 220 species of *Polydrusus* that feed on trees in the world, 135 species and subspecies occur in Europe, and 17 species occur in the Czech Republic (Curculio 2011; Alonso-Zarazaga et al. 2020) (Fig. 1). The adults feed on the aboveground parts of trees, and the larvae feed on roots. Only a few details have been published on the life histories of individual species of *Polydrusus*. Under European conditions, *Polydrusus* species complete one generation per year. The adult beetles occur from April–July. Females lay eggs on attached leaves, on dry fallen leaves in the litter layer, or in cracks in the bark; eggs are laid individually or in clusters. Embryonic development requires about 2 weeks. The hatched larvae fall to the ground (if they are not already in the litter layer), and burrow into the soil, where they feed on the roots of the host tree. They overwinter as larvae and pupate in the soil in the spring. Pupal development requires at least 10 days (Dieckmann 1980).

Polydrusus aeratus Gravenhorst, 1807 has long been known as a pest of young conifers (Bargagli 1887; Nüsslin 1905; Kleine 1910; Pierce 1916; Escherich 1923), but our understanding of its biology and the damage that it causes is poor (Elton 1951; Willig 2003).

The goals of this research were (i) to assess the recent damage caused by *P. aeratus* in Central Europe, and (ii) to summarise its occurrence, life history, and ecology.

2. Materials and methods

All published information about *P. aeratus* was gathered (Strejček 1996, 2001; Farkač & Nakládal 2007; Matuška 2013; Januš 2016; Stanovský et al. 2018; AOPK 2021), and specimens in the National Museum Praha and the Ostrava Museum were reviewed. Data concerning the distribution of *P. aeratus* in the Czech Republic were also obtained from amateur entomologists (see acknowl-

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edge), who have been collecting data on the occurrence of these beetles in the country throughout the 20th and 21st centuries. Although the latter data were collected without any apparent design, the data are lacking for only a few areas in the countr). From these data, the altitudinal and seasonal occurrences were evaluated.

At the end of June 2020, damaged 10-year-old silver fir trees (*Abies alba* Mill.) were observed at an altitude of 750 m near the village of Nová Ves and the town of Sokolov (50°4.01647' N, 12°46.33585' E) in the western Czech Republic. The damage was assessed. Beetles were identified to species by Stanislav Benedikt (Plzeň, Czech Republic). Dead trees were dug up and inspected by both authors.

Digital images of Czech *Polydrusus* specimens were obtained with a Nikon Coolpix 4500 digital camera by Zbyněk Kejval (Domažlice).

3. Results and discussion

Polydrusus aeratus (syn. *Curculio atomarius* Olivier, 1807, *Mettalites pallidus* Gyllenhal, 1834, *Polydrusus laricis* Chevrolat, 1863, *Polydrusus melanopus* Schilsky, 1910) can be macroscopically distinguished from other species of *Polydrusus* that live in the Czech Republic (Fig. 1–3). The adult weevils are approximately 4.0–5.5 mm long and are about 1.8 times longer than wide. Dorsal part of body densely covered with appressed piliform

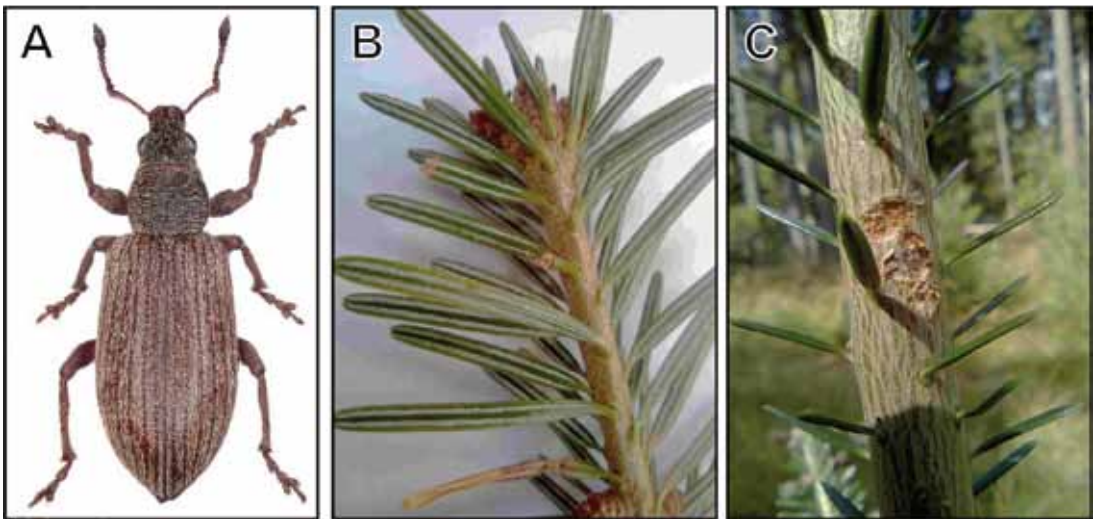


Fig. 1. An adult of *Polydrusus aeratus* (A) and needles (B) and bark (C) of *Abies alba* fed upon by this species in the western Czech Republic in 2020.

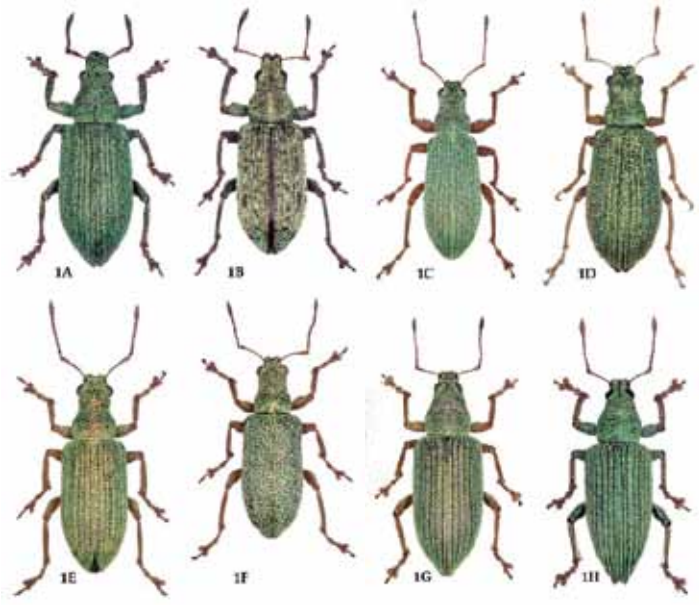


Fig. 2. Adults of *Polydrusus* species occurring in the Czech Republic (*Polydrusus amoenus* – A; *P. cervinus* – B; *P. impressifons* – C; *P. pterygomalis* – D; *P. corruscus* – E; *P. flavipes* – F; *P. formosus* – G; *P. thalassinus* – H).

setae, brownish, at most with green or copper sheen, first segment of antennal funicle longer than second, scutellum isodiametric, antennal clubs darker than funicle, pronotum as long as wide, head and pronotum dark brown to black, elytra brownish (Fig. 1), thereby differing from the similar *P. marginatus* Stephens, 1831 (Dieckmann 1980) (Fig. 3).

Polydrusus aeratus is common and widespread throughout the Czech Republic. The nearly 200 localities in the Czech Republic where *P. aeratus* has been detected. The localities represent most regions (Fig. 4) and almost all latitudes (Fig. 5) in the Czech Republic. The species seems to be less common at altitudes > 900 m, perhaps because there are few areas with altitudes that high. Its occurrence at different altitudes indicates a great tolerance of ecological conditions, although two known sites at altitudes < 200 m represent moist habitats at a pond or around the river.

According to Dieckmann (1980), *P. aeratus* adults should appear from mid-May to September, which corresponds to our data. Adults occurred most frequently from May to July (Fig. 6). The larvae live and overwinter in the soil. Recently emerged adults occur specimens occur in May and June, and the females are fertilized in July (Dieckmann 1980).

Adults of *Polydrusus* spp. (Figs. 5–6) seldom cause enough damage to kill their hosts. They cause economic damage in orchards, where they weaken trees, which

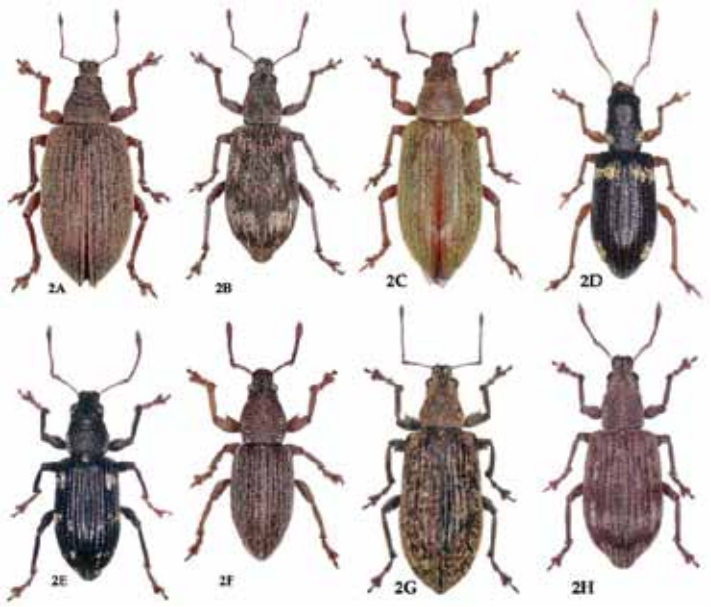


Fig. 3. Adults of other *Polydrusus* species occurring in the Czech Republic (*Polydrusus mollis* – A; *P. tereticollis* – B; *P. viridinitens* – C; *P. viridicinctus* – D; *P. picus* – E; *P. marginatus* – F; *P. pilosus* – G; *P. fulvicornis* – H).

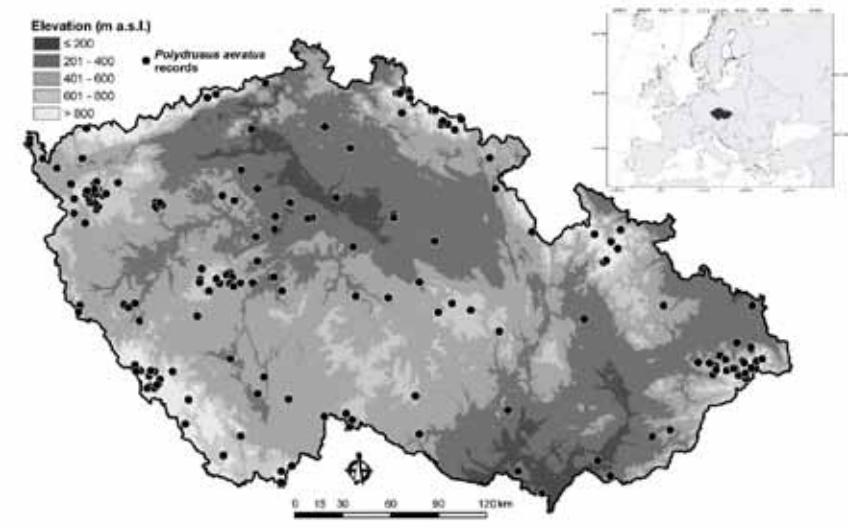


Fig. 4. Distribution of *Polydrusus aeratus* in the Czech Republic based on the data presented in this study.

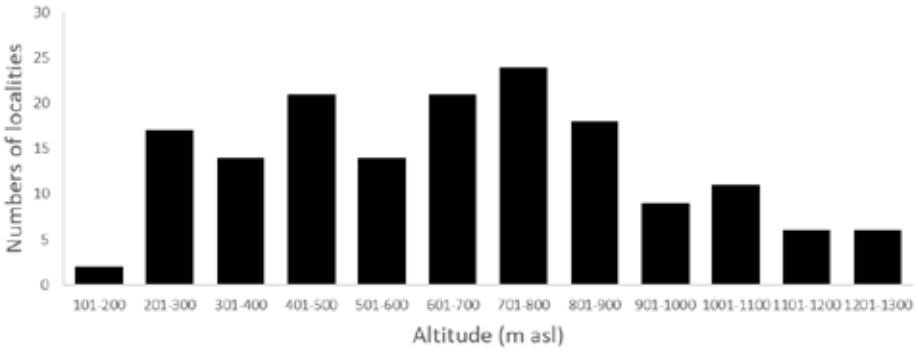


Fig. 5. Distribution of localities with occurrence of *Polydrusus aeratus* in the Czech Republic (N=163) according to altitude.



Fig. 6. Seasonal occurrence of *Polydrusus aeratus* in the Czech Republic based on the dates of individual detections (N=183).

then produce fewer fruits (Bolu & Özgen 2009; Öztürk & Ulusoy 2014; Bolu 2016). The damaged parts of the plants provide entry to fungal pathogens (Hatcher & Ayres 1997) or other pests (Stürzer-Gilbert 1983).

Polydrusus aeratus is known as a forest pest on *Abies*, *Carpinus*, *Fagus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Salix*, and *Quercus*. The adults eat needles and shoots of saplings, which then become dessicated and stunted (Pierce 1916; Escherich 1923; Dieckmann 1980; Gourov & Tagliapietra 1997).

In the 19th century and beginning of the 20th century, descriptions of damage caused by *P. aeratus* were general, and the reporting authors often cite each other in a manner suggesting that the observations were not always original. From those reports, nothing can be deduced about *P. aeratus* frequency or intensity (Bargagli 1887; Nüsslin 1905; Kleine 1910; Pierce 1916; Escherich 1923). Only one report from that time period states that in the case of high *P. aeratus* abundance, 30–50% of spruces were infested (Judeich & Nitsche 1889). We are unaware of any other relevant data from 1923 to nearly the end of that century, when Dormont et al. (1996) reported that *P. aeratus* attacked young cones of *Pinus cembra* L., thereby reducing seed germination in the French Alps. The absence of data for much of the 20th century says nothing about the actual occurrence of damage. We speculate that the lack of information may be due to the intensification of forestry, which resulted in foresters being responsible for such very large areas that they did not spend much time closely observing trees.

In 2020, the attacked trees observed in the western Czech Republic were 1 to 2 m high. All of the silver fir trees in the locality (area = 0.16 ha) were damaged. Damage was greater to shoots than to needles, and the shoots were partially consumed about every 10 cm along their length (Fig. 1).

Most adults of *P. aeratus* have been found on terminals or upper whorls of fir saplings, although adults have also been found on branches near the ground (Gourov & Tagliapietra 1997). The same locality near the village of Nová Ves in the western Czech Republic also had several dead fir trees with weevil-damaged roots. The roots were also bitten by rodents, which was probably the main mortality factor, but we suspect that even smaller roots were further damaged by the larvae of *P. aeratus*. Stress or the feeding of another pest increases the attractiveness of young saplings to *P. aeratus* and to other members of the Curculionidae, such as the bark beetle *Cryphalus piceae* Ratzeburg, 1837, which have been observed in the same area as *P. aeratus* (Fiala 2020).

In the studied area, the plateau of the Slavkovský les uplands (also called the Emperor's Forest and Kaiserwald in German) has homogeneous natural conditions (Divíšek et al. 2014) and firs that were planted only within the last 20 years. According to a recent study (Balín & Sychrava 2016), among a total of 202 ha of silver fir forest stands in the Emperor's Forest, 160 ha are occupied by trees that are less than 20 old. Although damage and mortality of fir trees caused by *P. aeratus* have been found in only one locality, the species may pose a threat to young firs in other localities as well.

Fir damage is undesirable, especially because fir currently represent <1% of the forest trees in the Czech Republic even though the natural percentage of fir would be about 25% (Balín & Sychrava 2016). In Central Europe, fir has rejuvenated naturally for the last 20 years (Dobrowolska 1998). The number of regenerated fir sap-

lings has increased by about 2% per year, but almost 50% of the fir saplings are damaged by game (Kučera & Adolt 2019). This is not an exceptional situation; in western Europe, all fir saplings that are not fenced are damaged by deer (Bernard et al. 2017). Silver firs are thus already weakened such that *Polydrusus* weevils represent another weakening or mortality factor for young firs. Among forest trees, young firs are probably the most frequently damaged by *P. aeratus* (Judeich & Nitsche 1889; Altum 1898 in Escherich 1923; current study), because this species is more numerous in younger than mature forests (Schauermann 1977).

When *P. aeratus* adults feed on silver fir, however, they seldom cause substantial damage because conifers use monoterpenes as a defense against desiccation and pest infestation (Lewinsohn et al. 1991). Feeding-induced emissions can continue for several weeks after the weevils have been removed from the trees (Priemé et al. 2000).

Damage by *P. aeratus* can follow damage by the pine weevil, i.e., *P. aeratus* can damage saplings that were damaged when they were young by the pine weevil. This is because the pine weevil requires fresh stumps for oviposition and larval development (Lalík et al. 2019), whereas *P. aeratus* can develop on the living roots of the host. As a consequence, *P. aeratus* has a continuous environment for development whereas the pine weevil does not.

The damage caused by *Polydrusus* species mainly results from the feeding by the adults on the bark and the cambium. The adults feed from May–July (Dieckmann 1980). If the infestation involves a small number of beetles in a small area, damage can be limited by simply collecting and destroying the beetles (Őztürk & Ulusoy 2014).

The weevil problem is closely related to the practice of clear-cutting and planting. There is strong evidence that pine weevil problems are smaller in areas with natural regeneration than in plantations, which are commonly initiated by clear-cutting. Allowing natural regeneration, i.e., the absence of clear-cutting, is an effective way to reduce *Hylobius* damage at sites where it can be practiced; because old spruce stands are often unstable, however, natural regeneration is risky (Löf 2000); this also applies to other *Polydrusus* weevils.

4. Conclusion

Polydrusus aeratus is common throughout the Czech Republic, although it prefers middle and higher altitudes or wetter places. It occurs in younger coniferous stands. The damage it causes is probably small and is mostly neglected by foresters. Changing climatic conditions may increase *P. aeratus* abundance, resulting in local damage to young trees. At present, when trees are being weakened by drought, we recommend that fir samplings and saplings be monitored to prevent possible damage. Because *P. aeratus* damage can often be confused with pine weevil damage, the monitoring should be conducted by an experienced person.

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