https://doi.org/10.17221/112/2020-PPS

Infestation of Norway spruce seedlings by *Cryphalus asperatus*: New threat for planting of forests?

Tomáš Fiala, Jaroslav Holuša*

Faculty of Forestry and Wood Sciences, Czech University of Life Sciences, Prague, Czech Republic

**Corresponding author: tomas.fiala@nature.cz*

Citation: Fiala T., Holuša J. (2021): Infestation of Norway spruce seedlings by *Cryphalus asperatus*: New threat for planting of forests? Plant Protect. Sci., 57: 167–170.

Abstract: *Cryphalus asperatus* (Coleoptera: Curculionidae, Scolytinae) is described as an exceptional but important secondary pest of Norway spruce seedlings. Of the 10 000 seedlings transported to one location in the Ore Mountains, Central Europe in 2020, in total 1 500 seedlings were killed by *C. asperatus*. The infestation and death of seedlings probably resulted in part from the substantial local increase in the local abundance of *C. asperatus* after the sanitation felling of many *Ips typographus*-infested and otherwise damaged trees; the felled trees provided many branches suitable for *C. asperatus* feeding. In addition, the seedlings were probably stressed by the multi-hour transportation (probably drought) from the forest nursery.

Keywords: bark beetle; drought stress; forest nursery; Scolytinae; seedling mortality; *Picea abies*

Bark beetles (Coleoptera: Curculionidae, Scolytinae) are currently the most important forest pests in both Eurasia and North America. The main bark beetle pests of spruce are species in the genus *Ips* in Eurasia (Douglas et al. 2019) and species in the genus *Dendroctonus* in North America (Wood 1963; Sherriff et al. 2011). These species infest the thick parts (trunks) of mature trees, attract other beetles, and produce characteristic galleries in which they lay eggs. The hatched larvae consume the phloem under the bark of infested trees, causing their mortality (Pfeffer 1955).

Economically less important species are developing in the thin parts (branches, twigs) of mature trees. They are smaller than species of the genus *Ips* or *Dendroctonus*. Although they may occur abundantly, they do not kill their hosts (Pfeffer 1955). Other species of bark beetle conduct only a maturation feeding on the thin parts of trees. Such feeding has no harmful effect on infested mature trees but can significantly damage seedlings (Lindelöw 1992; Leahy et al. 2007).

Bark beetles that conduct maturation feeding on seedlings mainly include species in the genus *Hylastes* Erichson, 1836 (Formánek 1907; Pfeffer 1955; Eidmann et al. 1991) but also species in other genera. The damage to conifer seedlings caused by other bark beetles, however, is marginal compared to the damage caused by the large pine weevil, *Hylobius abietis* (Nordlander et al. 2016).

In the present study, *Cryphalus asperatus* Gyllenhal, 1813 was first reported as a important pest of *Picea abies* seedlings. *Cryphalus asperatus*, however, is a common species that lives mainly under the bark of thin branches of spruce (*Picea* spp.), fir (*Abies* spp.), Douglas fir (*Pseudotsuga menziesii*), and pine trees (*Pinus* spp.) (Ritchie 1919; Fiala 2020).

MATERIAL AND METHODS

From mid-April to mid-May 2020, approximately 300 000 four year old spruce seedlings (*Picea abies*) were transported from a forest nursery to

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QK1920433.

https://doi.org/10.17221/112/2020-PPS

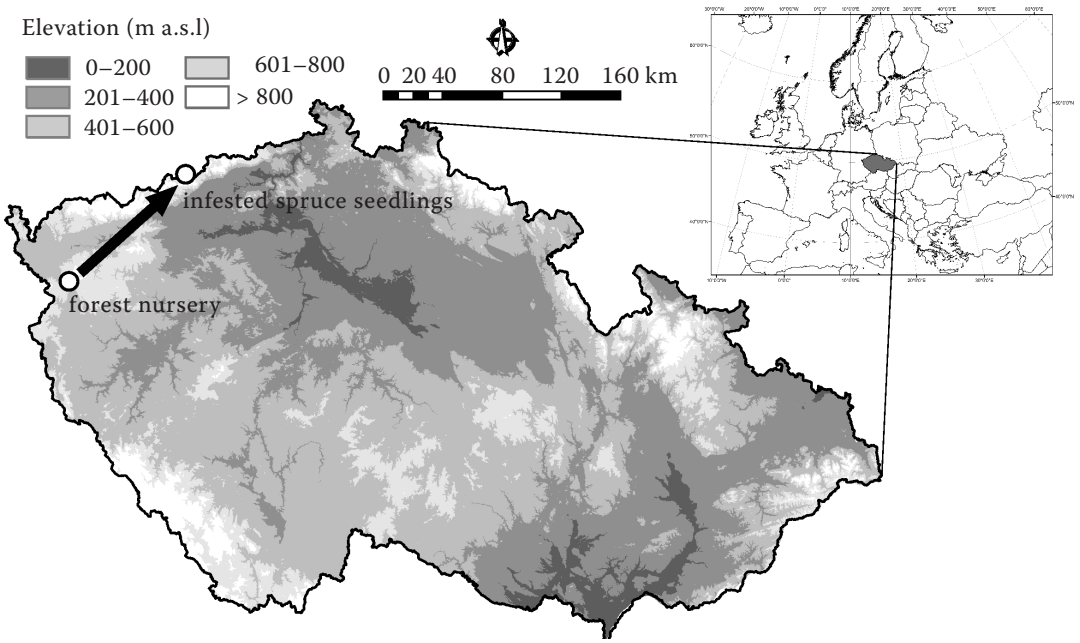

Figure 1. Location of the nursery where *Picea abies* seedlings were produced and the forest location in the Czech Republic where the seedlings were rapidly infested by *Cryphalus asperatus* before they were planted

10 forest-clearing locations in the Ore Mountains, Czech Republic. The nursery was located near the town of Lázně Kynžvart in the Emperor's Forest at an elevation of 840 m (50°0'36.9"N 12°38'35.3"E) (Figure 1). The seedlings were approximately 40 cm tall and approximately 0.9 cm in diameter at the root collar. From 14 May to 18 May 2020, the shaded seedlings at all 10 locations were examined for the infestation by *C. asperatus*. The foresters found damaged and dried seedlings during planting of individual trees in single location. Damaged seedlings were counted at this location. The damage was assessed, and the beetles from the root collar to the first branch were counted on 10 randomly selected seedlings.

RESULTS AND DISCUSSION

Cryphalus asperatus is a common species in coniferous forests (Nüsslin 1905, Ritchie 1919; Fiala 2020). Here, it is a secondary pest of no economic significance; it feeds on dying or felled trees in the shade of the canopy (Ritchie 1919; Pfeffer 1955). *Cryphalus asperatus* also and reproduces in older trees, where it attacks dying twigs (Pfeffer 1955). The only known report of *C. asperatus* on young trees (two to six year old *P. abies* and six to ten year old *Pinus strobus*) was provided by Nüsslin (1905). *Cryphalus asperatus* has been previously reported to kill trees in only one case in which this species *Pityophthorus pityographus* Ratzeburg, 1837 together killed *P. orientalis* trees thinner than 20 cm (Benz 1985); the latter report, however, provided no additional details.

In the current study, *C. asperatus* was detected at only one (Brandov: 50°37'00.5"N 13°23'03.1"E; 740 m a.s.l.) of the 10 locations where Norway spruce seedlings of the same origin and treatment history. The first infestation of seedlings by the beetle was recorded on 14 May 2020 when the seedlings were still in the bundles as obtained from the nursery. The bundles of seedlings (approximately 10 000 seedlings in total) were stored in the shade next to the clearing that was intended for planting.

Entrance holes and the beginnings of mature galleries in the seedlings were first noticed on 18 May 2020. The weather at the location in the first half of May 2020 was variable, temperatures ranged between 10–20 °C, precipitation was 16 mm/14 days, and the wind speed varied between 2–5 m/s (https://www.accuweather.com/cs/cz/hora-svate-kateiny/1377643/weather-forecast/1377643). Entrance holes had irregular shape, probably because the seedlings were wither. Mature galleries were subsequently found on the stems between the root neck and branches of the seedlings (Figure 2). On average 5.3 ± 1.5 (mean ± SD) *C. asperatus* adults were found in the seedlings from the root neck to the first branches (n = 10). Larval galleries were not found because studied seedlings were very dried. At the Brandov

https://doi.org/10.17221/112/2020-PPS

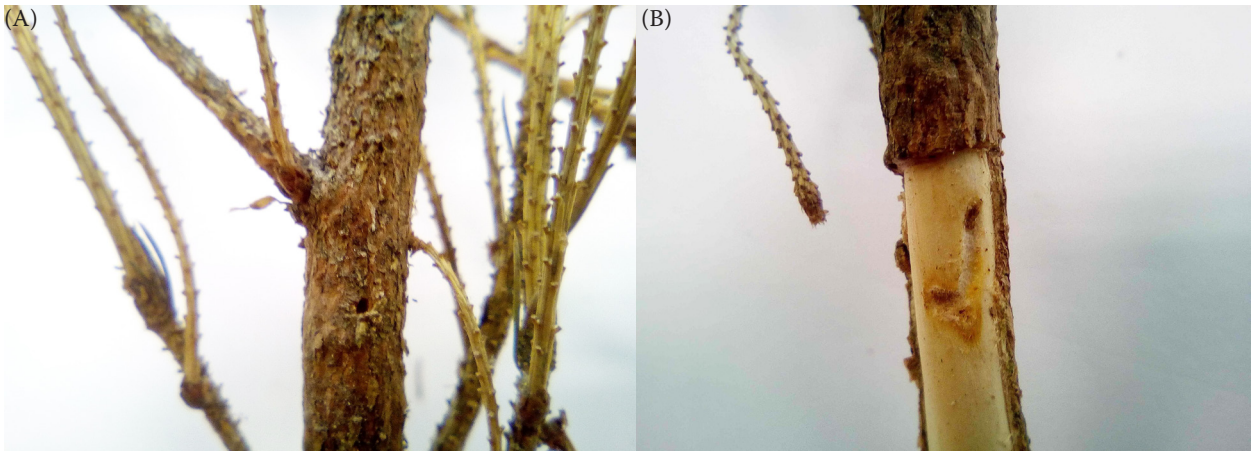

Figure 2. (A) An irregular entrance hole of *Cryphalus asperatus* in a *Picea abies* seedling and (B) the beginning of a mature gallery

location, approximately 1 500 of the 10 000 seedlings were attacked. After the needles of the attacked seedlings dropped, the plants began to dry and became unsuitable for planting.

It is clear that this was an exceptional situation in which a very abundant local population of a common species of bark beetle (Kula et al. 2009) was able to kill the seedlings prior to planting. Recent outbreaks of *Ips typographus* and other bark beetle associates of Norway spruce in Central Europe result from the weakening of spruce trees by highly excessive droughts and/or wind damage (Holuša et al. 2018) as well as a large-scale sanitation felling in outbreak areas. Many branches left in forests as a result of sanitation felling, become suitable for the feeding of *C. asperatus* feeding become available and remain in the forests (Pop et al. 2010; Kula et al. 2013; Kacprzyk & Bednarz 2015).

The infestation of *P. abies* seedlings by *C. asperatus* may be explained as follows:

(*i*) the seedlings were kept in the shade for at least one week hence, in favourable microclimates for *C. asperatus* (Ritchie 1919);

(*ii*) because the seedlings likely suffered from an abiotic stress during the 130 km (Stjernberg 1996) transportation from the nursery (Figure 1), they probably produced volatiles attracting *C. asperatus* (Klepzig et al. 1995; Templeton & Colombo 1995; Manter & Kelsey 2008; Klutsch et al. 2017).

(*iii*) the seedlings were deposited on the ground at the flight height (0.7 to 4.3 m above the ground) of *C. asperatus* (Byers et al. 1989).

(*iv*) the thickness of the seedlings corresponded to that preferred by *C. asperatus* (Pfeffer 1955; Fiala 2020).

Although the described infestation of spruce seedlings by *C. asperatus* was unusual, similar infestations may occur in the future because the ongoing pruce bark beetle outbreaks will generate breeding substrates suitable for *C. asperatus* development as well as many clearings that will require afforestation with seedlings.

Acknowledgement: The authors thank Bruce Jaffee (USA) for the editorial and linguistic improvement of the manuscript, and Milan Pelikán (LZ Kladská) and Petr Chvála (LS Klášterec) for cooperation in solving the problem of infested seedlings.

REFERENCES

Benz G. (1985): *Cryphalus abietis* (Ratz.) and *Ips typographus* (L.) new for Turkey, and a note on the tree killing capacity of *Pityophthorus pityographus* (Ratz.). Mitteilungen der Schweizerischen Entomologischen Gesellschaft, 58: 275.

Byers J.A., Anderbrant O., Löfqvist J. (1989): Effective attraction radius: A method for comparing species attractants and determining densities of flying insects. Journal of Chemical Ecology, 15: 749–765.

Douglas H.B., Cognato A.I., Grebennikov V., Savard K. (2019): Dichotomous and matrix-based keys to the *Ips* bark beetles of the world (Coleoptera: Curculionidae: Scolytinae). Canadian Journal of Arthropod Identification, 38: 1–234.

Eidmann H.H., Kula E., Lindelöw Å. (1991): Host recognition and aggregation behaviour of *Hylastes cunicularius* Erichson (Col., Scolytidae) in the laboratory. Journal of Applied Entomology, 112: 11–18.

Fiala T. (2020): Zajímavé nálezy kůrovců rodu *Cryphalus* (Coleoptera: Curculionidae: Scolytinae) v jedlových porostech v chráněné krajinné oblasti Slavkovský les. Západočeské entomologické listy, 11: 26–29.

https://doi.org/10.17221/112/2020-PPS

Formánek R. (1907): Kůrovci (Ipidae) v Čechách a na Moravě žijící. Prague, Česká společnost entomologická.

Holuša J., Lubojacký J., Čurn V., Tonka T., Lukášová K., Horák J. (2018): Combined effects of drought stress and *Armillaria* infection on tree mortality in Norway spruce plantations. Forest Ecology and Management, 427: 434–445.

Kacprzyk M., Bednarz B. (2015): The occurrence of bark beetles on cut Norway spruce branches left in managed stands relative to the foliage and bark area of the branch. Journal of Forest Research, 20: 143–150.

Klepzig K.D., Kruger E.L., Smalley E.B., Raffa K.F. (1995): Effects of biotic and abiotic stress on induced accumulation of terpenes and phenolics in red pines inoculated with bark beetle-vectored fungus. Journal of Chemical Ecology, 21: 601–626.

Klutsch J.G., Shamoun S.F., Erbilgin N. (2017): Drought stress leads to systemic induced susceptibility to a nectrotrophic fungus associated with mountain pine beetle in *Pinus banksiana* seedlings. Plos ONE, 12:e0189203. doi: 10.1371/journal.pone.0189203

Kula E., Kajfosz R., Polívka J. (2009): Cambioxylophagous fauna of blue spruce (*Picea pungens* Engelmann) in the Krušné hory Mts. (Czech Republic). Beskydy, 2: 149–156.

Kula E., Kajfosz R., Polívka J. (2013): Development cambioxylophagous insect fauna on blue spruce after chemical thinning. Beskydy, 6: 117–126.

Leahy M.J.A., Oliver T.H., Leather S.R. (2007): Feeding behaviour of the black pine beetle, *Hylastes ater* (Coleoptera: Scolytidae). Agricultural and Forest Entomology, 9: 115–124.

Lindelöw Å. (1992): Seedling mortality caused by *Hylastes cunicularius* Er. (Coleoptera, Scolytidae) in *Picea abies* plantations in northern Sweden. Scandinavian Journal of Forest Research, 7: 387–392.

Manter D.K., Kelsey R.G. (2008): Ethanol accumulation in drought-stressed conifer seedlings. International Journal of Plant Sciences, 169: 361–369.

Nordlander G., Hellqvist C., Hjelm K. (2016): Replanting conifer seedlings after pine weevil emigration in spring decreases feeding damage and seedling mortality. Scandinavian Journal of Forest Research, 32: 60–67.

Nüsslin O. (1905): Leitfaden der Forstinsektenkunde. Berlin, Verlagsbuchhandlung Paul Parey.

Pfeffer A. (1955): Fauna ČSR. Svazek 6. Kůrovci – Scolytoidea (Řád: Brouci – Coleoptera). Prague, Československá akademie věd.

Pop M., Kula E., Maňas P., Kajfosz R. (2010): Chemical thinning in blue spruce (*Picea pungens* Engelm.) stands and its effects on cambioxylophagous fauna. Journal of Forest Science, 56: 225–235.

Ritchie W. (1919): The structure, bionomics and forest importance of *Cryphalus abietis* Ratz. Annals of Applied Biology, 5: 171–199.

Sherriff R.L., Berg E.E., Miller A.E. (2011): Climate variability and spruce beetle (*Dendroctonus rufipennis*) outbreaks in south-central and southwest Alaska. Ecology, 92: 1459–1470.

Stjernberg E.I. (1996): Mechanical shock during transportation: Effects on seedling performance. New Forests, 13: 395–414.

Templeton C.W.G., Colombo S.J. (1995): A portable system to quantify seedling damage using stress-induced volatile emissions. Canadian Journal of Forest Research, 25: 682–686.

Wood S.L. (1963): A revision of the bark beetle genus *Dendroctonus* Erichson (Coleoptera: Scolytidae). The Great Basin Naturalist, 23: 1–116.

Received: July 20, 2020
Accepted: January 4, 2021
Published online: February 9, 2021