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Trapping ambrosia beetles by artificially produced lures in an oak forest

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Abstract: Ambrosia beetles are among the most damaging forest pests. They are frequently moved intercontinentally and are therefore subject to quarantines. The objective of the current research was to determine whether two commercially produced lures for *Trypodendron* species also attract central European ambrosia beetles. In 2018, Theysohn® traps were deployed in an oak forest that also contained hornbeam and linden trees. Five pair of traps was baited with the standard synthetic pheromone lures, Trypowit® or Lineatin Kombi®. The 201 adults of ambrosia bark beetles that were trapped were identified to eight species, which represents almost the entire spectrum of oak ambrosia scolytids in the region. *Trypodendron domesticum*, *Xyleborinus saxeseni*, and *Xyleborus monographus* were the most abundant species and exhibited a slight preference for the lure with a higher content of alcohols (Lineatin Kombi®). Both lures attracted *T. lineatum* because both contain lineatin. The number of beetles trapped was low probably because food sources (damaged or wilting oaks) were rare and because the forest was surrounded by agricultural land and therefore isolated from other oak forests.

Keywords: *Xyleborinus saxeseni; Xyleborus monographus*; Xyleborini; Trypowit®; Lineatin Kombi®; Czech Republic

Ambrosia beetles, which include *Anisandrus* sp., *Trypodendron* sp., *Gnathotrichus* sp., *Xyleborus* sp., *Xylosandrus* sp. (Curculionidae: Scolytinae) and *Platypus* sp. (Curculionidae: Platypodinae), are among the most important pests of timber. For example, ambrosia beetles were estimated to damage an average of 6 000 m^3 of timber per year in Slovakia (Vakula et al. 2016), and damaged 250 000 m^3 of timber during a 15-month period in 2000–2001 in Belgium (Huart & Rondeux 2001). In 1980–1981, ambrosia beetles degraded C$63.7 million worth of sawlogs in British Columbia, Canada (McLean 1985). Large sums are also spent in protecting wood from ambrosia beetles (Dobie 1978; Wylie et al. 1999).

Pheromone lures have been used to monitor the ambrosia beetle *Trypodendron lineatum* (Olivier, 1795) for many years. All of these lures contain lineatin (the pheromone produced by *Trypodendron* females) and sometimes other substances (Kvamme 1986). New lures that have higher alcohol contents and that are attractive to other *Trypodendron* species, including *Trypodendron domesticum* (Linnaeus, 1758) and *Trypodendron signatum* (Fabricius, 1792), have been recently produced (Trypowit®) (http://www.witasek.com; Holuša & Lukášová 2017).

Ambrosia beetles are generally attracted to ethanol, which is consistent with their preference for aged woody material in which anaerobic respiration generates ethanol (Moeck 1970). Several studies have suggested that ethanol is produced from the fermentative processes in trees in response to various environmental stresses including flooding, drought, or high levels of pollutant gases (Montgomery & Wargo 1983).

The Lineatin Kombi® (Witasek PflanzenSchutz GmbH, Austria) lure contains quaiacol, nonyl aldehyde, and 3-hydroxy-2-methyl-2-butanone (http://www.witasek.com/). These substances were added

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because the isomers of 2-methoxy-phenol and methyl-butanol can attract *T. domesticum* (Holighaus & Schütz 2006) and cause the lure to be slightly more effective than the Trypowit® (Witasek PflanzenSchutz GmbH, Austria) lure for monitoring the *Trypodendron* species that attack broadleaf trees in forests dominated by coniferous trees (Holuša & Lukášová 2017).

The use of pheromone traps to monitor ambrosia beetles in deciduous forests has been studied several times (Grégoire et al. 2001; Petercord 2006; Franjević 2013; Franjević et al. 2019; Galko et al. 2019; Gossner et al. 2019). The aim of the current study was to determine whether two commercially produced lures for *Trypodendron* species also attract other species of central European ambrosia beetles like *Xyleborus* sp. and *Xyleborinus* sp.

MATERIAL AND METHODS

In 2018, five pairs of Theysohn traps were deployed in an oak forest near the village of Peruc (50.3549364N, 13.9686869E; 280–360 m a.s.l.); the forests were dominated by oak trees, but also contained hornbeam and linden trees. Pairs were 20 m apart, and pairs were ca 200 m apart. The traps were deployed in small clearings (< 0.5 ha) > 10 m from the forest edge.

One trap of each pair was baited with Trypowit®, and the other was baited with Lineatin Kombi®. The main active ingredients in the Trypowit® lure are alfa-pinen (2,6,6-trimethyl-bicyclo-[3,1,1] hept-3-en) and lineatin (3,3,7-trimethyl-2,9-dioxatricyclo-[4.2.10 ^{4,7}] nonane), and those in the Lineatin Kombi® lure are lineatin (3,3,7-trimethyl-2, 9-dioxatricyclo-[4.2.10 ^{4,7}] nonane), quaiacol (2-methoxyphenol), nonyl aldehyde, and 3-hydroxy-2-methyl-2-butanone (http://www.witasek.com/). The traps were checked weekly from the 20th of March 2018 to the 31st of July 2018, and the lures were replaced after 8 weeks.

The *Trypodendron* species were identified by the authors, and the other species were identified by Miloš Knížek (Forestry and Game Management Research Institute, Jíloviště). The mean number of beetles trapped by each kind of lure was compared with a Wilcoxon pair test in Statistica software (version 12.0.).

RESULTS AND DISCUSSION

A total of 201 adult ambrosia beetles representing eight species were detected (Table 1). The most abundant species, *T. domesticum*, *Xyleborinus saxeseni* (Ratzeburg, 1837), *T. lineatum,* and *Xyleborus monographus* (Fabricius, 1792), are common polyphagous species, and the first three are recognised as serious pests (Tuncer et al. 2017).

Fewer than ten specimens in total of other ambrosia beetle species were trapped; these included the invasive *Xylosandrus germanus* (Blandford, 1894) (Fiala et al. in press.) and *Xyleborinus attenuatus* (Blandford, 1894) (Knížek 1988) (Table 1). The seven species represent almost all of the known oak ambrosia scolytids in Bohemia (Pfeffer 1989); the rare *Trypodendron signatum* (Fabricius, 1792) was not detected. *Anisandrus dispar* (Fabricius, 1792) is a secondary pest that attacks almost all of the deciduous tree species in forests and trees that have been weakened by other biotic and/or abiotic factors (Tanasković et al. 2016). *Xyleborus dryographus* (Ratzeburg, 1837) is a common polyphagous beetle at low elevations and feeds mainly on oaks (Pfeffer 1989).

The number of ambrosia beetles trapped was much lower than previously reported in central Europe (Galko et al. 2014), perhaps because bark and ambrosia beetles depend on ephemeral and usually scattered substrates for breeding (Forsse & Solbreck 1985). Few food sources (damaged or wilting oaks) may have been available in the study locality. The number of trapped beetles may also have been small because the traps were deployed in forests that are surrounded by agricultural land and, therefore, separated from other forests (Rukke 2000; Ryall & Fahrig 2005). Low numbers of beetles were also trapped in an isolated deciduous forest in western Bohemia (Fiala 2019). The population density of ambrosia beetles in fragmented forests is influenced by the flight capability of the beetles. Ambrosia beetles are weak fliers. Whereas other bark beetles can fly tens of kilometres (Nilssen 1984), *T. lineatum* and *T. domesticum* have a maximum range of 0.5 km, and *X. germanus* have a maximum range of 2 km (Salom & McLean 1989; Grégoire et al. 2001).

The number of trapped beetles may also be influenced by the height of the trap placement (Hanula et al. 2011); forest openness (Dodds 2011); trap type, colour, and shape, and the volatiles used as lures (Hanula et al. 2011). Theysohn traps are preferred by some, but not all, species of ambrosia beetles (Flechtmann et al. 2000).

Both of the tested lures attracted *T. lineatum* because both contain lineatin. A higher content of alcohols probably explained the higher numbers of *A. dispar*, *T. domesticum*, and *X. saxeseni* in the traps

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Table 1. The total numbers of ambrosia beetles captured in the Theysohn traps, the mean numbers (± SE) captured per trap containing Trypowit® or Lineatin Kombi®, and a statistical comparison of trapping by Trypowit® vs. Lineatin Kombi®

Species	Total No. of beetles trapped	Mean No. of beetles per trap[1]	Mean No. of beetles per trap[2]	Wilcoxon pair test (z; P)
Anisandrus dispar (Fabricius, 1792)	8	0.2 ± 0.2	1.4 ± 0.5	1.83; 0.06
Trypodendron domesticum (Linnaeus, 1758)	95	6.6 ± 1.4	12.4 ± 3.0	1.35; 0.18
Trypodendron lineatum (Olivier, 1795)	35	3.8 ± 1.6	3.2 ± 1.1	0.73; 0.46
Xyleborinus attenuatus (Blandford, 1894)	2	0.2 ± 0.2	–	
Xyleborinus saxeseni (Ratzeburg, 1837)	46	1.2 ± 1.2	8.0 ± 3.8	1.83; 0.06
Xyleborus dryographus (Ratzeburg, 1837)	2	0.4 ± 0.4	–	
Xyleborus monographus (Fabricius, 1792)	12	0.4 ± 0.4	2.0 ± 1.0	1.60; 0.11
Xylosandrus germanus (Blandford, 1894)	1	–	0.2 ± 0.2	

[1]containing Trypowit®; [2]containing Lineatin Kombi®; z – Wilcoxon pair test

containing Lineatin Kombi® than in the traps containing Trypowit®, although the differences were not statistically significant (Table 1). However, ambrosia beetles could be also caught in high numbers in lineatin-baited traps (Franjević et al. 2019), although the reason is not known. The attraction of ambrosia beetles to ethanol is generally recognised, even in the very common *X. saxeseni* species (Markalas & Kalapanida 1997). Some semiochemicals are known to increase or reduce the attraction of ambrosia beetles to pheromone traps; conophthorin, for example, increases the attraction of *X. germanus* (Ranger et al. 2014), and terpinolene and verbenone reduce the attraction of *Xyleborus fornicatus* (Eichhoff, 1868) (Karunaratne et al. 2008). These compounds, however, probably represent only a few of the components of the complex mixtures of volatiles that affect beetle behaviour. In addition, different ratios of volatiles can elicit different reactions from insects.

Information on ambrosia beetle numbers and on the spread of pathogens by ambrosia beetles is generally based on randomly collected data that are not readily accessible to forest managers. This unfortunate situation could be improved to some extent by the permanent monitoring of the most important forest pests with ethanol lures. Also, however, the lures investigated in the current research could be useful for the monitoring of ambrosia beetles in oak forests, which have been in decline for many years in Europe (Oszako 1998).

Ambrosia beetles are among the pests that most damage forests and warrant being quarantined because they are frequently moved intercontinentally (Haack 2001; Westphal et al. 2008). Early detection of these potentially invasive species is critical for their effective management; although the current surveillance methods have intercepted many species, they failed to detect others that subsequently became significant pests (Bashford 2012; Rassati et al. 2015). Adding pheromones to host volatile-baited traps increased the number of species detected (Flaherty et al. 2018). We suggest further research using the lures in the current study for detection of pests in large wood-storage areas, because the mass trapping of ambrosia beetles in such areas could substantially reduce the damage to the wood (Lindgren & Fraser 1994).

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REFERENCES

Bashford R. (2012): The development of a port surrounds trapping system for the detection of exotic forest insect

https://doi.org/10.17221/133/2019-PPS

pests in Australia. New Advances and Contributions to Forestry Research. InTech: 85–100.

Dobie J. (1978): Ambrosia Beetles Have Expensive Tastes. Environment Canada Forestry Service, Victoria.

Dodds K.J. (2011): Effects of habitat type nad trap placement on captures of bark (Coleoptera: Scolytidae) and longhorned (Coleoptera: Cerambycidae) beetles in semiochemical-baited traps. Journal of Economic Entomology, 104: 879–888.

Fiala T. (2019): Kůrovci (Coleoptera: Curculionidae: Scolytinae) v národní přírodní památce Komorní hůrka. Západočeské entomologické listy, 10: 34–39.

Flaherty L., Gutowski J.M.G., Hughes C., Mayo P., Mokrzycki T., Pohl G., Silk P., Van Rooyen K., Sweeney J. (2018): Pheromone-enhanced lure blends and multiple trap heights improve detection of bark and wood-boring beetles potentially moved in solid wood packaging. Journal of Pest Science, 92: 309–325.

Flechtmann C.A.H., Ottati A.L.T., Berisford C.W. (2000): Comparison of four trap types for ambrosia beetles (Coleoptera, Scolytidae) in brazilian *Eucalyptus* stands. Journal of Economic Entomology, 93: 1701–1707.

Forsse E., Solbreck C. (1985): Migration in the bark beetle *Ips typographus* L.: duration, timing and height of flight. Zeitschrift für angewandte Entomologie, 100: 47–57.

Franjević M. (2013): Bivoltinism of european hardwood ambrosia beetle *Trypodendron domesticum* in Croatian lowland oak stands of Jastrebarski Lugovi. Šumarski List, 137: 495–498.

Franjević M., Šikić Z., Hrašovec B. (2019): First occurence of *Xylosandrus germanus* (Blandford, 1894) – black steam borer in pheromone baited panel traps and population build up in croatian oak stands. Šumarski List, 143: 215–219.

Galko J., Nikolov C., Kimoto T., Kunca A., Gubka A., Vakula J., Zúbrik M., Ostrihoň M. (2014): Attraction of ambrosia beetles to ethanol baited traps in a Slovakia oak forest. Biologia, 69: 1376–1383.

Galko J., Dzurenko M., Ranger C.M., Kulfan J., Kula E., Nikolov C., Zúbrik M., Zach P. (2019): Distribution, habitat preference and management of the invasive ambrosia beetle *Xylosandrus germanus* (Coleoptera: Curculionidae: Scolytinae) in european forests with an emphasis on the West Carpathians. Forests, 10: 10.

Gossner M.M., Falck K., Weisser W.W. (2019): Effects of management on ambrosia beetles and their antagonists in European beech forests. Forest Ecology and Management, 437: 126–133.

Grégoire J.-C., Piel F., De Proft M., Gilbert M. (2001): Spatial distribution of ambrosia-beetle catches: A possibly useful knowledge to improve mass-trapping. Integrated Pest Management Reviews, 6: 237–242.

Haack R.A. (2001): Intercepted Scolytidae (Coleoptera) at U.S. ports entry: 1985–2000. Integrated Pest Management Reviews, 6: 253–282.

Hanula J.L., Ulyshen M.D., Horn S. (2011): Effect of trap type, trap position, time of year, and beetle density on captures of the Redbay Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae). Journal of Economic Entomology, 104: 501–508.

Holighaus G., Schütz S. (2006): Odours of wood decay as semiochemicals for *Trypodendron domesticum* L. (Col., Scolytidae). Mitteilungen der deutschen Gesellschaft für allgemeine und angewandte Entomologie, 15: 161–165.

Holuša J., Lukášová K. (2017): Pheromone lures: Easy way to detect *Trypodendron* species (Coleoptera: Curculionidae). Journal of the Entomological Research Society, 19: 23–30.

Huart O., Rondeux J. (2001): Genèse, évolution et multiples facettes d´une maladie inhabituelle affectant le hêtre en région wallonne. Forêt Wallone, 52: 8–19.

Karunaratne W.S., Kumar V., Pettersson J., Kumar N.S. (2008): Response of the shot-hole borer of tea, *Xyleborus fornicatus* (Coleoptera: Scolytidae) to conspecifics and plant semiochemicals. Acta Agriculturae Scandinavica Section B – Soil and Plant Science, 58: 345–351.

Knížek M. (1988): *Xyleborus alni* Niijima, 1909. Acta Entomologica Bohemoslovaca, 85: 396.

Kvamme T. (1986): *Trypodendron piceum* Strand (Col., Scolytidae): Flight period and response to synthetic pheromones. Fauna Norvegica, Series B, 35: 65–70.

Lindgren B.S., Fraser R.G. (1994): Control of ambrosia beetle damage by mass trapping at a dryland log sorting area in British Columbia. The Forestry Chronicle, 70: 159–163.

Markalas S., Kalapanida M. (1997): Flight pattern of some Scolytidae attracted to flight barrier traps baited with ethanol in oak forest in Greece. Anzeiger für Schädlingskunde, Pflanzenschutz, Umweltschutz, 70: 55–57.

McLean J.A. (1985): Ambrosia beetles: A multimillion dollar degrade problem of sawlogs in coastal British Columbia. The Forestry Chronicle, 61: 295–298.

Moeck H.A. (1970): Ethanol as the primary attractant for the ambrosia beetle *Trypodendron lineatum* (Coleoptera: Scolytidae). The Canadian Entomologist, 102: 985–995.

Montgomery M.E., Wargo P.M. (1983): Ethanol and other host-derived volatiles as attractants to beetles that bore into hardwoods. Journal of Chemical Ecology, 9: 181–190.

Nilssen A.C. (1984): Long-range aerial dispersal of bark beetles and bark weevils (Coleoptera, Scolytidae and Curculionidae) in northern Finland. Annales Entomologici Fennici, 50: 37–42.

Oszako T. (1998): Oak decline in European forests. In: First EUFORGEN Meeting on Social Broadleaves, Oct 23–25, 1997, Bordeaux, France: 145–151.

https://doi.org/10.17221/133/2019-PPS

Petercord R. (2006): Flight period of the broad-leaved ambrosia beetle *Trypodendron domesticum* L. in Luxembourg and Rhineland-Palatinate between 2002 and 2005. In: Forests Pests: Monitoring – Risk Assessment – Control. IUFRO Working Party 7.03.10 Proceedings of the Workshop "Methodology of Forest Insect and Disease Survey in Central Europe", Sept 11–14, 2006, Gmunden, Austria: 213–218.

Pfeffer A. (1989): Kůrovcovití (Scolytidae) a jádrohlodovití (Platypodidae). Praha, Academia.

Ranger C.M., Gorzlancyk A.M., Addesso K.M., Oliver J.B., Reding M.E., Schultz P.B., Held D.W. (2014): Conophthorin enhances the electroantennogram and field behavioural response of *Xylosandrus germanus* (Coleoptera: Curculionidae) to ethanol. Agricultural and Forest Entomology, 16: 327–334.

Rassati D., Faccoli M., Toffolo E.P., Battisti A., Marini L. (2015): Improving the early detection of alien wood-boring beetles in ports and surrounding forests. Journal of Applied Ecology, 52: 50–58.

Rukke B.A. (2000): Effects of habitat fragmentation: increased isolation and reduced habitat size reduces the incidence of dead wood fungi beetles in a fragmented forest landscape. Ecography, 23: 492–502.

Ryall K.L., Fahrig L. (2005): Habitat loss decreases predator-prey ratios in a pine-bark beetle system. Oikos, 110: 265–270.

Salom S.M., McLean J.A. (1989): Influence of wind on the spring flight of *Trypodendron lineatum* (Oliver) (Coleoptera: Scolytidae) in a second-growth coniferous forest. The Canadian Entomologist, 121: 109–119.

Tanasković S., Marjanović M., Gvozdenac S., Popović N., Drašković G. (2016): Sudden occurrence and harmfullness of *Xyleborus dispar* (Fabricius) on pear. The Serbian Journal of Agricultural Sciences, 65: 57–62.

Tuncer C., Knížek M., Hulcr J. (2017): Scolytinae in hazelnut orchards of Turkey: clarification of species and identification key (Coleoptera, Curculionidae). ZooKeys, 710: 65–76.

Vakula J., Galko J., Gubka A. (2016): Podkôrny a drevokazný hmyz v letech 1960–2014. In: Kunca A., Zúbrik M. (eds): Výskyt škodlivých činiteľov v lesoch Slovenska v rokoch 1960–2014, v roku 2015 a prognóza ich vývoja. Zvolen, Národné lesnícké centrum.

Westphal M.I., Browne M., MacKinnon K., Noble I. (2008): The link between international trade and the global distribution of invasive alien species. Biological Invasions, 10: 391–398.

Wylie F.R., Peters B., DeBaar M., King J., Fitzgerald C. (1999): Managing attack by bark and ambrosia beetles (Coleoptera: Scolytidae) in fire-damaged *Pinus* plantations and salvaged logs in Queensland, Australia. Australian Forestry, 62: 148–153.

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