SCIENTIFIC NOTE

Agriotes oregonensis (Coleoptera: Elateridae) in Canada

W. G. VAN HERK[1],
H. B. DOUGLAS[2], AND R. S. VERNON[3]

The larvae of *Agriotes* spp. click beetles (Coleoptera: Elateridae) are among the most important pests of cereals, potatoes, and other agricultural crops in Europe and Canada, damaging germinating seeds and seedlings in the spring and belowground vegetables (*e.g.,* potato tubers, carrots) in the fall (Ritter and Richter 2014; Traugott *et al*. 2015; Vernon and van Herk 2022). The economic costs of these pests to crops in Canada is difficult to assess, but in Prince Edward Island, the combined cost of annual potato crop damage due to *A. sputator* (Linnaeus, 1758) and associated costs for control are currently estimated at $CAD 10 million (Singleton *et al*. 2023). *Agriotes* species that cause significant economic damage in Canada include three introduced European species. Of these, *A. obscurus* (Linnaeus, 1758) and *A. lineatus* (Linnaeus, 1767), both occur in southern British Columbia (BC) and Atlantic Canada, and *A. sputator* is known in Atlantic Canada and recently also in Quebec (van Herk *et al*. 2021b; Singleton *et al*. 2022b). Canada also has native *Agriotes* pests, such as *A. mancus* (Say, 1823) in central and eastern Canada (Eidt 1953; LaFrance 1967; Saguez *et al*. 2017) and *A. ferrugineipennis* (LeConte, 1861) and *A. sparsus* (LeConte, 1884) in southern BC (Wilkinson 1963; Singleton *et al*. 2022a). The three European species appear to dominate the *Agriotes* fauna in some regions where native species once predominated; for example, *A. sparsus* is now infrequently collected in the lower Fraser valley, where it was once the predominant *Agriotes* species (Wilkinson 1963), and *A. mancus* is now relatively uncommon in Prince Edward Island and Nova Scotia, where once it was common (Eidt 1953). Pre-invasion assessment of *Agriotes* diversity would assist our understanding of how native wireworm communities may be affected by introduced species.

Monitoring for pest *Agriotes* species such as *A. obscurus*, *A. lineatus*, and *A. sputator* is generally done with pheromone-baited traps (Vernon *et al.* 2001; Traugott *et al.* 2015). Sometimes this trapping inadvertently captures many native *Agriotes* or other click beetle genera, either because these are abundant in the field and inadvertently trapped (*e.g., A. ferrugineipennis*, in van Herk *et al.* 2021a) or because they are attracted to the pheromone lures. For example, the native *A. pubescens* (Melsheimer, 1845) is commonly captured in traps baited with *A. lineatus* lures, *A. mancus* in traps baited with *A. obscurus* lures, and *A. sputator* in traps baited with components of the *A. mancus* pheromone (van Herk, unpublished data; Singleton *et al*. 2022b).

[1]Agassiz Research and Development Centre, Agriculture and Agri-Food Canada, P.O. Box 1000, Agassiz, BC V0M 1A0; wim.vanherk@agr.gc.ca
[2]Ottawa Research and Development Centre, Agriculture and Agri-Food Canada, Ottawa, ON K1A 0C6
[3]Sentinel IPM Services, 4430 Estate Drive, Chilliwack, BC V2R 3B5

Cross attraction of non-target species to lures developed for specific pest species may be detrimental or serendipitously beneficial. One detriment is the possible reduction of local populations of uncommon native species that may reduce their population viability. One benefit is the simultaneous reduction of native pest species. Our work also points to another possible benefit of trapping with lures — that is, the discovery of previously unreported species that are inadvertently trapped. Specifically, a pheromone-based delimitation survey for *A. obscurus* and *A. lineatus* in southern BC from 2017 to 2019 (van Herk *et al*. 2021a) also collected 76 specimens of the little-known native North American species *A. oregonensis* Becker (1956) in the northern Okanagan Valley (Figure 1). Van Herk *et al*. (2021a) first recorded this species in Canada but provided few details. Here, we report the discovery of this species in detail and comment on its implications for pest management and *Agriotes* monitoring.

Figure 1. Dorsal and lateral habitus, frontal view of head, and dorsal view of aedeagus of *Agriotes oregonensis* males captured in the Okanagan Valley, British Columbia, in 2019. All scale bars are 0.5 mm long.

Vernon Pitfall Traps® (van Herk *et al*. 2018) baited with lures containing either the sex pheromone for *A. obscurus* (60 µL, 1:1 geranyl hexanoate:geranyl octanoate) or for *A. lineatus* (40 µL, 1:1 geranyl butanoate:geranyl octanoate; CSALOMON® Plant Protection Institute, Centre for Agricultural Research, Budapest, Hungary) were deployed on agricultural land at 42 sites (150 trap pairs, with 1–9 pairs per site) throughout lowland agricultural areas in southern BC from mid-May to late July in 2017, 2018, and 2019 (Figure 2; see van Herk *et al*. 2021a for a complete list of sampling locations). Of these, traps placed in the northern Okanagan Valley (approximately between Okanagan Lake and Shuswap Lake) in 2019 collected a total of 76 *A. oregonensis*: 24 in Armstrong (50.4297, –119.1911), three in Coldstream (two at 50.2203, –119.1818 and one at 50.2234, –119.1189), 48 in Enderby (35 at 50.5180, –119.1394, eight at 50.5401, –119.1362, and five at 50.5313, –119.1167), and one in Salmon Arm (50.6801, –119.2479). Beetles were identified, and voucher specimens were deposited at the Canadian National Collection of Insects, Arachnids and Nematodes (CNC; Ottawa Research and Development Centre, Ottawa, Ontario, Canada). It is notable that no *A. oregonensis* were collected in the northern Okanagan Valley in 2017 and 2018, despite trapping efforts, suggesting this species may be very localised or a recent introduction to the area. Furthermore, no *A. oregonensis* were collected in traps placed in the Fraser, Pemberton, southern Okanagan, Creston, Kootenay, or Similkameen valleys in any year, suggesting that this species may be very rare in or absent from those areas.

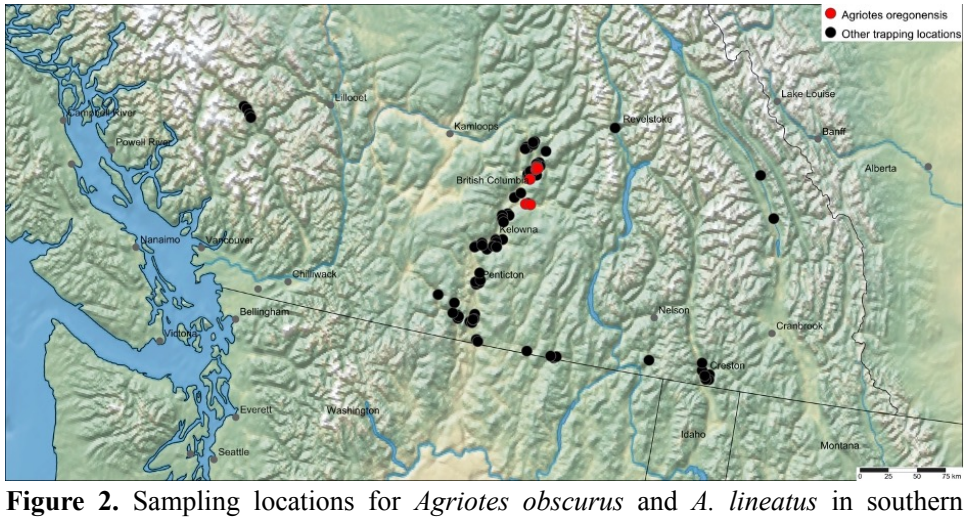

Figure 2. Sampling locations for *Agriotes obscurus* and *A. lineatus* in southern British Columbia in 2017–2019, and locations where *A. oregonensis* were collected. Map made with SimpleMappr (projection: North America Lambert).

Agriotes oregonensis was first described by Becker (1956) and placed in the *sparsus* species group. Members of this species group are recognised by females lacking sclerotised plates on the bursa copulatrix and possessing several external characters: large, simple (non-umbillicate) punctures on the head; pronotum with deep, simple punctures; and non-serrate antennae (Becker 1956). Some of the external characters are subjectively defined, so that both Becker's key and authoritatively identified reference specimens are important tools for

identification. According to Becker (1956), *A. oregonensis* is "usually" confused with the agricultural pest species *A. sparsus* because the two species have overlapping distributions and are similar in size (6–8 mm) and body shape (slender, elongate; Figure 1). However, the species differ clearly in the shape of the male genitalia (especially the parameres). Several subjectively defined external characters can also be useful: prosternal sutures (strongly excavated in *A. oregonensis*, strongly concave in *A. sparsus*) and carina on the hind angle of the pronotum (more distant from the side in *A. oregonensis*, very close to the side in *A. sparsus*). Larvae of *A. oregonensis* have not been described, but because larvae of closely related *Agriotes* species are generally similar in appearance, those of *A. oregonensis* may be similar to, and mistaken for, *A. sparsus* by pest managers. Larvae of *A. sparsus* lack an eye spot (ocellus) on each side of their head and have muscular impressions on their ninth abdominal tergite similar to larvae of *A. obscurus* and other members of Becker's (1956) *sputator* group of *Agriotes*.

Our discovery of *A. oregonensis* in the north Okanagan Valley may represent a significant range extension for the species. Becker (1956) reported *A. oregonensis* from northern California, Nevada, Utah, central Idaho, Oregon, and southern and western Washington, in the United States of America, with the northernmost extent of its range near Seattle, Washington. The only prior record for *A. oregonensis* in BC that we are aware of is of a single beetle collected in 15 May 1958 in Vernon by AT Wilkinson, but this specimen has since gone missing from the collection at the Agassiz Research and Development Centre (WvH, personal observation). The fact that the species was not collected elsewhere in southern BC in the present survey, despite equivalent survey effort at all sites over three years, and is not present in the CNC reference material from BC, suggests that the northern Okanagan population may be either naturally disjunct or, less likely, may represent an inadvertent, recent introduction to the area.

Most of the *A. oregonensis* specimens collected were male, and 75 of 76 specimens were collected in traps baited with the sex pheromone for *A. lineatus*, despite deployment of an equal number of *A. obscurus*–baited traps at these locations. This suggests these male *A. oregonensis* were probably attracted to geranyl butanoate because this compound is present in the *A. lineatus* but not in the *A. obscurus* pheromone lure. Geranyl butanoate also appears to be attractive to males of the closely related *A. sparsus* (Kamm *et al*. 1983; van Herk *et al*. 2021a). It is common for *Agriotes* spp. to share pheromone constituents (Tóth 2013) and to be either attracted to pheromones of other congeneric species (*e.g., A. pubescens* and *A. mancus*, as noted above) or repelled by them (*e.g*., *A. obscurus* by *A. lineatus* pheromone; Vernon *et al*. 2014; van Herk *et al*. 2022).

The introductions of *A. obscurus* and *A. lineatus* in the Okanagan Valley, which appear to have occurred recently — they were first detected in 2017 but not collected during earlier surveys (Vernon *et al.* 2001) — could adversely affect the population of *A. oregonensis* (van Herk *et al*. 2021a). Pest activity has not been reported for *A. oregonensis* in the 66 years since it was described, suggesting that it is not an important agricultural pest. It would be of interest to continue to passively monitor for *A. oregonensis* in the north Okanagan Valley to ascertain whether there is a substantial change in number of specimens collected per unit of sampling effort (*e.g.,* trap-days) in traps baited with *A. lineatus* lures. This could help ascertain whether trapping for pest monitoring can reduce

populations of *A. oregonensis*. Furthermore, by-catch in traps baited with *A. lineatus* lures should continue to be assessed elsewhere in southern BC to obtain additional distribution data for *A. oregonensis* and to assess risk to its conservation.

ACKNOWLEDGMENTS

We thank Karine Savard at Agriculture and Agri-Food Canada, Ottawa, for preparing Figure 1, participating farmers for allowing us to collect beetles on their land, and three reviewers for their kind and constructive comments.

REFERENCES

Becker, E. 1956. Revision of the Nearctic species of *Agriotes* (Coleoptera: Elateridae). Memoirs of the Entomological Society of Canada, **88**: 5–101.

Eidt, D.C. 1953. European wireworms in Canada, with particular reference to Nova Scotian infestations. The Canadian Entomologist, **85**: 408–414.

Kamm, J.A., Davis, H.G., and McDonough, L.M. 1983. Attractants for several genera and species of wireworms (Coleoptera: Elateridae). The Coleopterists Bulletin, **37**: 16–18.

LaFrance, J. 1967. The life history of *Agriotes mancus* (Say) (Coleoptera: Elateridae) in the organic soils in southwestern Quebec. Phytoprotection, **48**: 53–57.

Ritter, C. and Richter, E. 2013. Control methods and monitoring of *Agriotes* wireworms (Coleoptera: Elateridae). Journal of Plant Diseases and Protection, **120**: 4–15.

Saguez, J., Latraverse, A., De Almeida, J., van Herk, W.G., Vernon, R.S., Légaré, J.-P., *et al*. 2017. Wireworm in Quebec field crops: specific community composition in North America. Environmental Entomology, **45**: 814–825.

Singleton, K., Gries, R., van Herk, W.G., Alamsetti, S.K., Lemke, E., Furtado, K., and Gries, G. 2022a. Identification of the major sex pheromone component of the click beetle *Agriotes ferrugineipennis*. Journal of Chemical Ecology, **48**: 491–501.

Singleton, K., van Herk, W.G., Saguez, J., Douglas, H.B., and Gries, G. 2022b. First record of invasive wireworm *Agriotes sputator*, Linnaeus, 1758 (Coleoptera: Elateridae) in Quebec (Canada), and the implications of its arrival. The Pan Pacific Entomologist, **98**: 184–187.

Singleton, K., van Herk, W.G., Saguez, J., Scott, I., Gries, R., and Gries, G. 2023. Sex pheromone of Neartic *Agriotes mancus*, and its similarity to those of three invasive *Agriotes* in North America. Agriculture and Forest Entomology. *In press.*

Tóth, M. 2013. Pheromone and attractant of click beetles: an overview. Journal of Pest Science, **86**: 3–17.

Traugott, M., Benefer, C., Blackshaw, R., van Herk, W., and Vernon, R. 2015. Biology, ecology and control of elaterid beetles in agricultural land. Annual Review of Entomology, **60**: 313–334.

van Herk, W.G., Vernon, R.S., Acheampong, S., Otani, J.K., and Uloth, K. 2021a. Distribution of two European elaterids, *Agriotes obscurus* and *A. lineatus*, in British Columbia: new records and potential implications of their dispersal. Journal of Asia-Pacific Entomology, **24**: 688–694.

van Herk, W.G., Vernon, R., and Borden, J. 2018. A pheromone-baited pitfall trap for monitoring *Agriotes* spp. click beetles (Coleoptera: Elateridae) and other soil surface insects. Journal of the Entomological Society of British Columbia, **115**: 101–103.

van Herk, W., Vernon, B., Bourassa-Tait, G., Tóth, M., and Kovacs, E. 2022. Field evaluation of selected plant volatiles and conspecific pheromones as attractants for *Agriotes obscurus* and *A. lineatus* (Coleoptera: Elateridae). Insects, **13**: 173. https://doi.org/10.3390/insects13020173.

van Herk, W.G., Vernon, R.S., Richardson, J., Richardson, M., and Beaton, A. 2021b. Evaluation of pheromone traps and lures for trapping male *Agriotes sputator* (Coleoptera: Elateridae) beetles in eastern Canada. The Florida Entomologist, **104**: 42–50.

Vernon, R.S., LaGasa, E., and Philip, H. 2001. Geographic and temporal distribution of *Agriotes obscurus* and *A. lineatus* (Coleoptera: Elateridae) in British Columbia and Washington as determined by pheromone trap surveys. Journal of the Entomological Society of British Columbia, **98**: 257–265.

Vernon, R.S. and van Herk, W.G. 2022. Wireworms as pests of potato. *In*: Insect pests of potato: Global perspectives on biology and management. Second edition. *Edited by* P. Giordanengo, C. Vincent, and A. Alyohkin. Academic Press, Cambridge, Massachusetts, United States of America. Pp. 103–148.

Vernon, R.S., van Herk, W.G., and Tanaka, J.A. 2014. Blending of pheromone lures for two exotic European pest elaterid beetle. Journal of Pest Science, **87**: 619–627.

Wilkinson, A.T.S. 1963. Wireworms of cultivated land in British Columbia. Proceedings of the Entomological Society of British Columbia, **60**: 3–17.