Dipteran leafminers and an associated parasitoid in canola in Saskatchewan

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Abstract – Many species of insect herbivores feed on canola on the Canadian Prairies, but none have been reported to mine canola leaves. Mines were noted in canola leaves near Melfort, Saskatchewan in 2014, and near Prince Albert, Saskatchewan in 2015. Fly larvae were dissected from the mines and reared. Two adult *Scaptomyza flava* (Fallén) (Diptera: Drosophilidae), one adult *Liriomyza* sp. (Diptera: Drosophilidae) and two adult parasitoids *Halticoptera patellana* (Dalman) (Hymenoptera: Pteromalidae) emerged. The mines and lifecycles of the two species of flies are described. Based on experiences in other parts of the world, neither species is expected to become a significant pest of canola on the Prairies.

Virtually unknown as a crop on the Prairies sixty years ago, oilseed rape or canola (*Brassica napus* L.) (Brassicaceae) reached a high of 8.3 million ha harvested in Canada in 2014 (Canola Council of Canada 2016), rivalling wheat as the nation's leading agricultural commodity. A coterie of insect herbivores feeds on oilseed *Brassica* crops wherever they are grown. Many of these herbivores, both native and adventive, cause sufficient damage to achieve pest status (Lamb 1989). As the hectares of canola have increased on the Prairies, so has the number of insect pests of the crop (Altieri 1999). Insects known as pests early in *B. napus* production in Canada such as bertha armyworm, *Mamestra configurata* Walker (Lepidoptera: Noctuidae) (Turnock and Philip 1977), a native species, and flea beetles *Phyllotreta* spp. (Coleoptera: Chrysomelidae) (Burgess 1977), invasive alien species, have been joined by other species achieving pest status such as native and cosmopolitan *Lygus* spp. (Hemiptera: Miridae) (Butts and Lamb 1991), and diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) (Dosdall *et al*. 2011). With time, other introduced species such as swede midge, *Contarinia nasturtii* (Kieffer) (Diptera: Cecidomyiidae) (Hallett and Heal 2001), have arrived, adding to the list of insect pests of canola in Canada. In 2014 and 2015, several oilseed *Brassica* accessions

were compared for their susceptibility to *C. nasturtii* (Diptera: Cecidomyiidae) and flea beetles (Coleoptera: Chrysomelidae) at the Agriculture and Agri-Food Canada Melfort Research Farm (N52°49′ lat., W104°36′ long.). Plots were grown on canola stubble surrounded by peas, *Pisum sativum* L. (Fabaceae), in an area adjacent and to the south of a mature Manitoba maple (*Acer negundo* L. var. *interius* (Britt.) Sarg.) shelterbelt. In 2014, seeding took place 21 May. On 5 July, the majority of *B. napus* plants were in the bud stage, with their inflorescence raised above the level of the rosette. Many *B. napus* plants had mines in their leaves, with Diptera larvae inside, whereas none were observed on the *Brassica juncea* L. (four accessions), *B. rapa* L. (two), *B. carinata* A. Braun (three), *Sinapis alba* L. (two), and *Camelina sativa* (L.) Crantz (three) accessions that were part of the same study. Mines were noted on all 17 accessions of *B. napus.* There was no apparent relationship between the level of infestation and distance from the shelterbelt, nor among *B. napus* lines. Some leaves contained more than one larva, and frass could be seen as dark areas within the mined area (Figure 1), which aids in distinguishing insect mines from white leaf spot, *Pseudocercosporella capsellae* (Ellis & Everh.) Deighton (Capnodiales: Mycosphaerellaceae), infection. A leaf with one mine was collected from each of 15 different *B. napus* plants, the larvae were removed and placed on moist sand one per vial, in a laboratory growth chamber at 22°C, 16:8 h light:dark conditions. Four adult insects emerged, which were sent to the National Identification Service (Entomology) in Ottawa for identification. Two specimens were of *Scaptomyza flava* (Fallén) (Diptera: Drosophilidae), one was a female *Liriomyza* sp. (Diptera: Agromyzidae), and one was *Halticoptera patellana* (Dalman) (Hymenoptera: Pteromalidae). In 2015 at Melfort, plots were seeded on 14 May similar to the protocol of 2014, but no leafminers were found on any brassicaceous lines. Similar mines were observed near Prince Albert on 16 July, 2015, in plots of *B. napus* at the Saskatchewan Conservation and Learning Centre (52°02′ N, 105°77′ W). Only three mines were evident and all three leaves bearing mines were collected and kept individually in mini BugDorm cages (MegaView Scientific). Only one yielded an adult insect: one female *H. patellana*. Larval survival to emergence of either adult flies or parasitoids was low and a change in rearing tactics to placing leaf-mined leaves onto damp filter paper in a Petrie dish (Martin 2012) might improve rearing success.

Scaptomyza flava is Holarctic, found in Eurasia from Siberia to the Mediterranean Sea region. In North America, *S. flava* adults are usually grey but a yellow form that may have been introduced from Europe is present as well (Hackman 1959). Earlier believed to

Figure 1. A *Brassica napus* leaf with *Scaptomyza flava* (Diptera: Drosophilidae) mining injury, Melfort Research Farm, Melfort, SK, Canada, 18 July 2014 (T. Wist).

be absent from the Canadian prairies (Stone *et al*. 1965), *S. flava* seems now to be widespread here; there are specimens of *S. flava* in the Biodiversity Institute of Ontario collected at Jasper National Park in 2012, and at many locations from Calgary to Winnipeg in 2015 (Ratnasingham and Hebert 2007). At this point, it is unclear whether or not *S. flava* is adventive to North America from Europe or Asia. The larvae pupate in leaves or soil. Most adult flies emerge from puparia, in the early hours of the photophase, and most mating occurs at the same time a day later (Shakeel *et al*. 2009). Incisions created by the female flies' ovipositors leak plant fluid that they consume. Eggs are laid in some of these incisions (Shakeel *et al.* 2009). Under laboratory conditions of 20±1°C, 60%±5 R.H. and 16:8 h light:dark, a female starts to lay eggs about three days after emerging, reaches her peak rate of oviposition by about day 10, and may continue to lay a decreasing number of fertile eggs for up to about 25 days, with a potential lifetime total of around 70 eggs (Shakeel *et al*. 2009). Adults are weak fliers, as inferred from their tendency to lay more eggs near artificial windbreaks in experimental field plots (Lewis 1966). Upon eclosion, most larvae create a narrow, serpentine mine in the direction of the midvein. There are three larval instars, delineated by measurements of the mandibles and skeleton made with illumination by transmitted light (Martin 2012). This illumination method also helps to differentiate *S. flava* from *Liriomyza spp*. larvae. The mine may follow the vein a short way and then it widens to form a blotch (Fig. 1). The blotch mine can be used to differentiate between infestation by *S. flava* and *Liriomyza* spp. on brassicas (Fig. 1). Several *S. flava* larvae may be in the same blotch mine (Whiteman *et*

al. 2011). About 21 days are required for development from eggs to new adults at 22°C (Whiteman *et al*. 2011). *Scaptomyza flava* is polyphagous; the range of hosts mined by *S. flava* larvae comprises species in nine plant families, and includes such crops as *P. sativum*, *Solanum tuberosum* L. (Solanaceae), and leafy *Brassica* vegetables (Martin 2004). Although multivoltine and frequently present in leaves of young plants, *S. flava* is not considered a pest of oilseed *Brassica* crops in Europe (Frey 1951; Stapel 1961; Alford 2011), with the possible exception of Ukraine (Sekun and Snezhok 2014). In New Zealand, *S. flava* is considered a serious enough pest of brassicas (Martin 2012) that research into the most effective insecticides was warranted (Martin *et al.* 2006).

Females of *Liriomyza* are usually unidentifiable at the species level (Spencer 1986). In the United States, *Liriomyza brassicae* (Riley), *L. sativae* Blanchard, and *L. huidobrensis* Blanchard, are all known to mine *Brassica* species as well as *Pisum* (Spencer 1986). However, only the cosmopolitan *L. brassicae* has been recorded on the Canadian prairies (Ratnasingham and Hebert 2007; Spencer 1969; Sehgal 1971), and so the specimen collected at Melfort may belong to this species. *Liriomyza huidobrensis* was discovered recently in southern Ontario, but is believed to winter there only in greenhouses (Bahlai *et al.* 2006), and *L. sativae* also is known in Canada only from Ontario (CABI 2006). *Liriomyza bryoniae* (Kaltenbach) is also associated with Brassicaceae hosts, but is known only from the Palearctic region (CABI 1999). Like those of *S. flava*, female *Liriomyza* pierce leaves with their ovipositors to deposit eggs and feed from the wounds (Parella 1989). Larvae feed on leaf mesophyll tissue in a serpentine pattern that gives this genus the common name of "serpentine leafminer" (Werner 1982) and will remain in leaves unless crowding forces them into the stem (Parella 1989). *Liriomyza* larvae usually pupate in the soil (Parella 1989). *Liriomyza* species are not considered pests of oilseed *Brassica* crops, except perhaps in Egypt (Sayed and Teilep 2013).

The Universal Chalcidoidea Database (Noyes 2016) lists various hosts of *H. patellana*, including at least seven *Liriomyza* species, and *S. flava*. The CABI (2008) datasheet does not list *S. flava*, as a host. Other *Halticoptera* species though are associated with agromyzid (Bahlai *et al*. 2006) and drosophilid hosts, including *S. flava* [as *S. apicalis* Hardy (Hoffman and Joliffe 2005)], and so the *H. patellana* collected in our study may have come from either host species. Parasitism frequently contributes to the maintenance of leafminer density below that at which economic damage occurs, particularly when the marketable portion of the crop is other than the leaf (Liu *et al*. 2009), as is the case here. The leafminers discovered first at Melfort are likely to cause negligible losses to prairie canola production, considering their significance or lack thereof elsewhere, and especially given that a parasitoid already has been found. However, the crop and area will be worth monitoring in the future to confirm that leafminer densities remain low.

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