Assessing the ecological interactions between invasive and endemic species of gall midge pests of canola

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Introduction

The swede midge (SM), *Contarinia nasturtii* (Kieffer), is an invasive pest of brassicaceous crops in Canada and has colonized eastern Canada (Fig. 1) since its first detection in 2001[1]. The canola flower midge (CFM), *Contarinia brassicola* Sinclair, is an apparently endemic species first detected in 2016 and known to be distributed throughout the canola-growing regions of western Canada[2]. In 2021, CFM was detected for the first time in Ontario in pheromone-baited traps[3] and has since been found throughout Ontario[4]. Galled flowers (Fig. 2) are the only observed damage symptom of CFM infestation of canola (*Brassica napus* L. and *B. rapa* L.), while SM causes a variety of damage symptoms from the vegetative through reproductive stages of canola (Fig. 3). To date, no plants with the characteristic CFM flower galls seen in western Canada have been observed in Ontario.

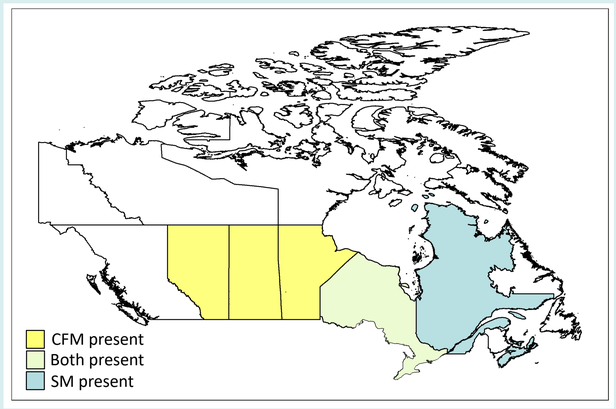

Fig. 1. Map of Canada showing provinces where *Contarinia nasturtii* (SM) *and C. brassicola* (CFM) have been recorded. Box describes study area in southern Ontario.

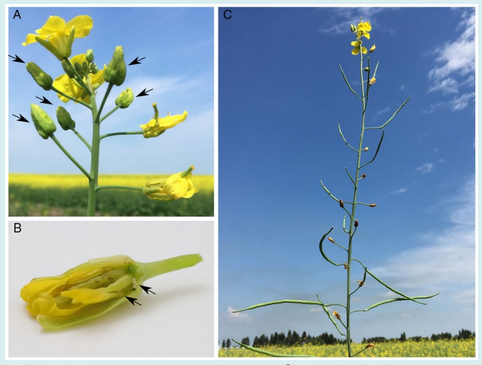

Fig. 2. Damage symptoms of *Contarinia brassicola* (CFM) on canola. A. Flower galls (arrows). B. Black, necrotic lesions on style (arrows indicate larvae). C. Dried, older flower galls. From Mori et al. (2019).

Fig. 3. Damage symptoms of *Contarinia nasturtii* (SM) on canola.

The co-occurrence of these two species in Ontario and their ecological interactions have implications for pest management. Our objectives are to determine the phenology and abundance of CFM in Ontario canola in comparison to SM, and to determine the abundance and location of CFM and SM larvae on canola plants. If these two congeners co-occur in canola fields and on individual plants, further research will investigate the specific nature of interactions between these species.

Seasonal Abundance

METHODS: Traps (Fig. 4) baited with SM or CFM pheromone lures were placed at the edges of 2 (2022) or 3 (2023) canola fields (2–4 traps/species/field) in Dufferin County, and sticky liners were replaced weekly. All captured midges were identified based on morphological characters. In 2023, 1 trap/species were also placed in a naturalized area of the University of Guelph Arboretum (Wellington County), with no *Brassica* crops nearby.

Fig. 4. Pheromone-baited Jackson trap with sticky liner.

RESULTS: Both midge species were found at all sites in both years. In 2023, SM outnumbered CFM at 2 of the 3 canola sites (Table 1). Weekly midge numbers were very low at the Arboretum site (WE23-01), but 10 times more CFM than SM were captured there. As reported in previous studies[5], SM were first captured in mid-late May and multiple peaks of adult captures were observed from mid-June to September (Fig. 5). First (early- to mid-June) and peak (late-July to mid-August) adult captures of CFM occurred later than for SM.

Table 1. Total numbers of male *Contarinia nasturtii* (SM) and *C. brassicola* (CFM) captured in pheromone traps, June to end of August 2023, at sites in Dufferin (DU) and Wellington (WE) Counties, Ontario.

Site	Number of males		Ratio
	SM	CFM	SM:CFM
DU23-01	1315	2067	0.64
DU23-02	682	498	1.37
DU23-03	1808	411	4.40
WE23-01	4	41	0.10

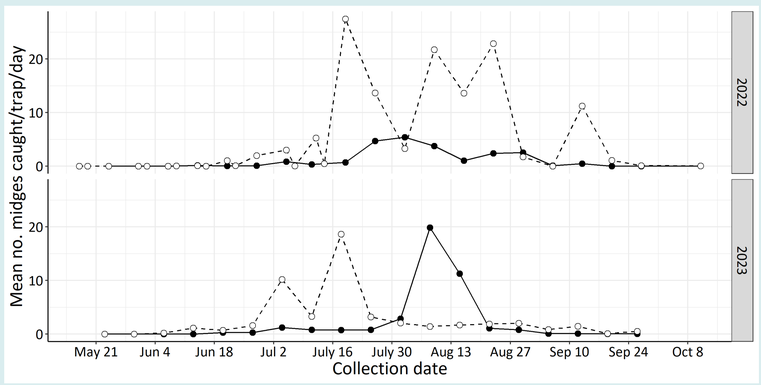

Fig. 5. Trap captures of male *Contarinia nasturtii* (SM) (--○--) and *C. brassicola* (CFM) (–●–) on pheromone traps in 2022 and 2023.

Presence on Canola

METHODS: From 21 June to 9 August 2022, canola plants (30/field) were collected from 2 fields in Dufferin County. Growing points from each plant were removed and placed into emergence containers (Fig. 6) according to tissue type: reproductive (growth point with visible bud or reproductive tissue) or vegetative (growth point without visible reproductive tissue). Containers were held in controlled environment chambers (25˚C, 16:8 L:D, 30-50% RH) and emerged adults were removed 3 times/week. All emerged adults were stored in ethanol and later identified based on morphological characters.

Fig. 6. A. Canola growing points in emergence containers. B. Emergence containers held in growth chamber. C. Aspirating emerged adults.

RESULTS: Both SM and CFM adults emerged from both tissue types, but both were most abundant in reproductive tissues (Table 2). On canola plants, 8–12% of emerged midges were CFM. Of the 162 plants from which midges emerged, both species emerged from 100 plants. Of those, 93 had both species emerge from reproductive tissue and 16 had both species emerge from vegetative tissues.

Table 2. Total numbers of adult *Contarinia nasturtii* (SM) and *C. brassicola* (CFM) emerged from canola plant tissue from June to September 2022 at sites in Dufferin (DU) County, Ontario.

Type of plant tissue	Total number of midges emerged			Total number of plants with midges emerged		
	SM	CFM	% CFM	SM only	CFM only	Both
Reproductive	4517	636	12.3	52	4	93
Vegetative	581	56	8.8	53	2	16
Total	5098	692	12.0	58	4	100

Conclusions

CFM tended to be less abundant than SM in canola, but the reverse was true at a naturalized site. This result lends support to the assumption that CFM is an endemic species that has recently adapted to use canola as a host plant.

While SM is multivoltine and has multiple emergence phenotypes, CFM appears to be univoltine with a single emergence phenotype in Ontario. This difference in phenology, as well as the presence of CFM on both vegetative and reproductive tissues, may have implications for pest management.

The presence of CFM in vegetative tissues and the lack of observed flower galls in Ontario suggest that CFM uses canola differently in eastern Canada than has been observed in western Canada. More research is needed to differentiate symptoms of CFM and SM infestation.

The earlier emergence of SM adults in the spring may provide a competitive advantage against CFM where both occur. However, the presence of both species on the same plants and the same tissue types suggests that no niche differentiation exists between these congeners. Further investigation is needed to determine the nature of their interspecific interactions.

As CFM and SM larvae cannot be distinguished morphologically, an assay will be developed to identify individual larvae based on the PCR amplification of different length amplicons from the COI gene for each species. This approach will be used to provide more precise information on the use of host plant tissues and ecological interactions between CFM and SM larvae living on the same plants.

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