SCIENTIFIC NOTE

Chilothorax distinctus (Coleoptera: Scarabaeidae): an occasional pest in agro-ecosystems on the Canadian Prairies?

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Chilothorax distinctus (Müller) (Coleoptera: Scarabaeidae), formerly *Aphodius distinctus* (Müller), is an aphodiine dung beetle of European origin. Present in North America prior to 1845 (Melsheimer 1844), it is now widely established across southern Canada and much of the United States of America (Klimaszewski et al. 2017; Bezanson and Floate 2019). Adults are arguably beneficial, but larvae may be pests of turf and agricultural crops. Here I review the biology of the species and summarize reports and observations of suspected larval feeding damage to different crops from the Canadian Prairies. These data support suspicions that *C. distinctus* is an occasional pest in agro-ecosystems for which control measure may not be warranted or even possible.

In Canada, *C. distinctus* has one generation per year. Overwintered adult females emerge in April and May to oviposit in soil (Christensen and Dobson 1976; Floate and Gill 1998). Developing larvae feed on decaying vegetable matter (Landin 1961) and living plant roots. Jerath and Ritcher (1959) reported larval feeding damage on roots of commercial mint (Lamiaceae: *Mentha* sp.). Christensen and Dobson (1976) identified the larvae as potential pests of pasture and lawns. Larvae complete development by the end of June or early July and then pupate to emerge as new adults in September (Figure 1A–C). The adults (ca. 4.5–5.5 mm in length) can be recognised by distinct black markings on olive–gold elytra, with additional taxonomic features described in Gordon and Skelley (2007). They are strong fliers and are attracted to accumulations of rotting organic material. In late afternoon on days with little or no wind, large flights of adults may be seen near silage pits, feedlots, and behind tractors spreading livestock manure on farm land (KDF, personal observation). Particularly in autumn, numerous adults are attracted to fresh dung to feed and possibly mate. Seamans (1934) describes clouds of adults hovering over manure piles and horse droppings. Mohr (1943) reports recovery of about 1100 adults from a two-hour-old cow pat. Tens of thousands of adults may be recovered in dung-baited pitfall traps (Floate and Gill 1998; Floate and Kadiri 2013; Bezanson 2019), with upwards of 5000 individuals recovered in one trap in one week (Figure 1D). In such cases, it may be more efficient to estimate beetle numbers by their bulk mass rather than by counting them individually (Bezanson and Floate 2020).

Beginning in 2000, I received several reports of outbreaks of scarab larvae (white grubs) associated with crop damage in agricultural fields. Most of these

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reports were sent by farmers in Alberta asking for a species identification, whether the larvae were causing the damage, if control measures were warranted, and if reseeding the field was advisable. To better understand the circumstances leading to these outbreaks, I solicited further details on the reports received and visited affected fields. Social media (e.g., most recently on Twitter 23 June 2021, @FloateKevin, https://twitter.com/FloateKevin/status/1407733336060145667), newspaper and magazine articles (Glen 2013; Barker 2014), a fact sheet posted to an Alberta government website (Floate 2013), and articles posted in 2016, 2017, and 2018 on the blog of the Prairie Pest Monitoring Network (https://prairiepest.ca/?s=distinctus) were used to obtain additional reports.

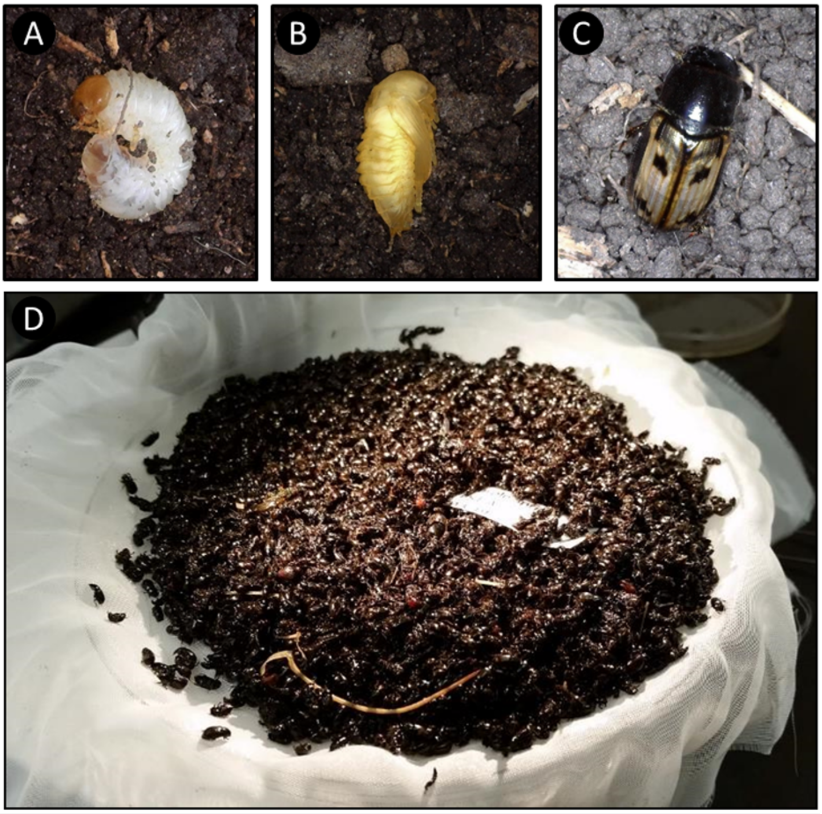

Figure 1. *Chilothorax distinctus*: **A**, third-instar larva; **B**, pupa; **C**, adult; **D**, *C. distinctus* comprised 99 per cent of the beetles (n = 5114) in this sample collected in one week from a dung-baited pitfall trap (see Bezanson and Floate (2020) for details). Photo credit: K.D. Floate.

Given the attraction of adults to fresh dung, I suspected that composted manure spread on fields in spring acts as a bait to concentrate oviposition events. In 2021, I was able to test this hypothesis in a field about 10 km northwest of the town of Coaldale, Alberta. The field had high densities of larvae in 2020 and failure of a pea crop, after which it was reseeded to oats. In early April of 2021, the producer incorporated composted chicken manure into half of this field (manure treatment) but left the other half of the field in oat stubble (control treatment). The manure-treated side of the field was subsequently seeded to kamut (*Triticum turgidum* Jakubz.) on 13 May 2021, whereas the nonmanured (control) side of the field was seeded to a 15-species cover crop on 8 June.

To assess the attraction of adult *C. distinctus* to composted manure, pitfall traps (n = 8 traps per treatment; Figure 2) baited with cattle dung were operated from 20 to 23 April and again with fresh baits from 26 to 30 April. Pitfall traps were as described in Bezanson *et al.* (2021). Each trap comprised two plastic pails (2-L capacity), one nested inside the other, buried with the lip of the trap level with the soil surface. A mixture of propylene glycol and water (1:1, *ca.* 100 mL) added to the inner pail served as a preservative. A wire screen (ca. 25-mm grid) was secured with metal pins over the mouth of each trap to support a suspended dung bait. Baits comprised fresh cattle dung (ca. 250 mL) wrapped in three-ply cheese cloth and secured with a twist tie.

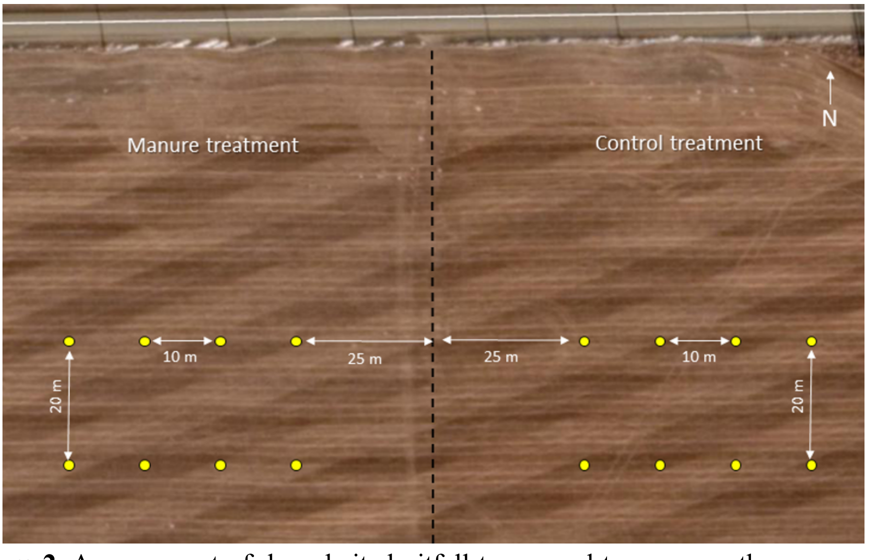

Figure 2. Arrangement of dung-baited pitfall traps used to compare the recovery of adult *Chilothorax distinctus* in portions of a field with (manure treatment) or without (control) incorporation of composted chicken manure.

Beetles recovered in the traps were identified using Gordon and Skelley (2007) and reference material in the main insect collection at the Lethbridge Research and Development Centre, in Lethbridge, Alberta, Canada. Voucher specimens from the current study were deposited in this same collection. To accommodate the many '0' values in the data set, the nonparametric Mann–Whitney U test was used to test for an effect of treatment on beetle captures. For statistical rigour, analyses were arbitrarily restricted to species represented in the total trap capture by at least 16 individuals (*i.e.,* corresponding to one beetle/ trap).

The use of pitfall traps indicates where adults are concentrated but not necessarily where they are ovipositing. To test for an association between larval density and composted manure, the field was revisited on 22 June 2021 to recover soil cores (10.1 cm diameter × 15 cm deep; n = 12 cores per treatment) within the approximate areas outlined by the traps (Figure 2). The recovered soil was handsifted to recover scarab larvae.

Reports received of outbreaks are summarised in Table 1. In all but two cases, observations were made in June. For the latter two cases, the month of observation was not provided to me (Table 1, reports #5 and 6). On several occasions, I reared larvae that identified, with rare exception (Table 1, report #1), the species as *C. distinctus* (Table 1, reports #1, 8, 12, and 16). On one other occasion, larvae were reared by a colleague who also identified the adults as *C. distinctus* (Table 1, report #5). The field identified in report #16 is the same field in which the experiment was conducted in 2021.

Results of the pitfall trapping experiment identified a stark difference in beetle recovery between the two treatments. Five-fold more *C. distinctus* were recovered per trap (mean ± standard error) in the manure (M) treatment than in the control (C) treatment; *i.e.,* M: 40.9 ± 11.6; C: 8.4 ± 1.5 ($P < 0.001$). Recovery of most other aphodiine species also was greater in the manure treatment, although significantly so in only one case; *i.e., Calamosternus granarius* (Linnaeus) (M: 11.4 ± 1.8; C: 7.9 ± 3.1; $P = 0.188$); *Planolinellus vittatus* (Say) (M: 1.9 ± 0.8; C: 1.5 ± 0.8; $P = 0.273$); *Melinopterus prodromus* (Brahm) (M: 2.9 ± 1.2; C: 0.4 ± 0.3; $P = 0.011$); *Aphodius pedellus* (de Geer) (M: 2.6 ± 0.7; C: 1.9 ± 0.7; $P = 0.311$); *Colobopterus erraticus* (Linneaus) (M: 0 ± 0; C: 0.1 ± 0.1); and unidentified individuals (M: 0.3 ± 0.3; C: 0.1 ± 0.1).

Recovery of larvae from soil cores reflected the results of the pitfall trapping. A mean (± standard error) of 0.7 ± 0.4 aphodiine larvae per soil core, corresponding to 82.2 ± 51.1 aphodiine larvae/m^2, were recovered from the manure treatment. No larvae were recovered from the control treatment.

The biology of the aphodiine species recovered in the traps is well known (Gordon 1983; Gordon and Skelley 2007). Adults of *Aphodius pedellus*, *C. erraticus*, *C. granarius*, *M. prodromus*, and *P. vittatus* are "general surface dung feeders" with a preference for open pasture habitats. *Planolinellus vittatus* shares this preference for habitat but not for cattle dung. All of these species have wide distribution across southern Canada and the United States of America (Floate and Gill 1998; Bezanson and Floate 2019). The field in which the pitfall traps were operated is in a rural area with scattered pastures on which cattle and horses are grazed during summer months.

These findings do not confirm that outbreaks of *C. distinctus* cause crop damage, but support for this conclusion is provided by published reports for other species of aphodiines of similar size. Larvae of *Diapterna hamata* (Say), reported as *Aphodius hamatus* Say, have been reported to damage turf in pastures (Jerath and Ritcher 1959). Larvae of *Ataenius spretulus* (Haldeman) and *C. granarius* (reported as *Aphodius granarius* (Linnaeus)) can cause significant damage to turf grass on golf courses (Sears 1978; Wegner and Niemczyk 1981). On damaged fairways of a golf course in June and early July, Sears (1978) recorded average densities of mainly *C. granarius*, of 78 to 188 larvae and pupae/m^2. In agricultural fields, I have recorded average densities of 66 and 88 *C. distinctus* larvae/m^2 (Table 1, report #2; the present study) with a density of 615 larvae/m^2 based on an individual soil core.

Table 1. Summary of observations pertaining to reports of aphodiine larvae associated with crop damage in agro-ecosystems on the Canadian Prairies.

Report #	Date received	Nearest community	Affected crop	Field history and comments
1	7 June 2000	Vauxhall, AB	corn	• field planted to sugar beet in previous year; larval densities est. by producer at 30 larvae/m^2. • third-instar larvae received by KDF on 7 June; held in damp soil at room temperature. Larvae pupated by 16 June. Adult emergence beginning 5 July; mainly *Chilothorax distinctus*, with some *Calamosternus granarius* (Linnaeus) and *Melinopterus prodromus* (Brahm).
2	15 June 2000	Lethbridge, AB	pea	• field planted to cabbage in previous year; residue left on surface then incorporated into soil in spring. KDF est. density of 66 ± 23 larvae /m^2 based on 20 soil cores[1] taken 15 June; recovered individuals were three third-instar larvae + one adult *C. distinctus*. • KDF resampled field 23 June; est. density of 88.4 ± 30.8 and 0.0 ± 0.0 larvae/m^2 in areas of the field with high and low levels of surface crop residue (n = 15 core/treatment).
3	16 June 2000	Morinville, AB	corn	• no other details available
4	16 June 2000	Taber, AB	corn	• no other details available
5	2000	Wilkie, SK	canola	• larvae reared and identified as *C. distinctus* by J. Soroka (AAFC, retired), who was convinced that larvae were feeding on live roots and causing serious damage.
6	2000	Bow Island, AB	dry bean	• field planted to sugar beet in previous year; producer estimated 26 ha to be affected.
7	4 June 2000	southern AB	onion	• dead larvae received by KDF identified as aphodiine species.
8	25 June 2009	southern AB	canola	• larval densities est. by producer at 10 larvae/m^2; they lost most of the crop and believed the larvae were responsible. • third-instar larvae received by KDF on 25 June; held in damp soil at room temperature with adult *C. distinctus* recovered 13 July.

9	7 June 2012	Enchant, AB	unknown	• two separate reports received with photographs of aphodiine larvae; both fields with incorporation of composted manure in spring.
10	11 June 2012	Vauxhall, AB	canola	• field planted to sugar beet in previous year; third-instar larvae recovered.
11	9 June 2015	southcentral AB	unknown	• photographs received of aphodiine larvae recovered from crop land; no other details provided.
12	15 June 2015	Rycroft, AB	wheat	• field planted to canola in previous year; no obvious crop damage to the wheat crop, low crop residue, no spring application of manure. • third-instar larvae received by KDF on 15 June; held in damp soil at room temperature with pupation by 7 July; adult *C. distinctus* recovered on 15 July.
13	22 June 2016	Nobleford, AB	hemp	• field planted to fall rye in previous year; after harvest, composted hog manure spread on crop residue. Damage to volunteer rye in spring 2016 attributed by producer to over-application of manure; field then seeded to hemp. • producer curious (not concerned) about large numbers of larvae recovered in dead patch of fall rye in middle of mulch layer; affected area moister than rest of field.
14	13 June 2016	southern MB	corn	• composted manure applied to field before seeding; photograph received indicates an aphodiine species.
15	12 June 2017	Lacombe, AB	canola	• field planted to potato in previous year; bare patches in canola stand associated with large numbers of beetle larvae not observed elsewhere in field.
16	4 June 2020	Coaldale, AB	pea	• field planted to carrots in previous year; composted chicken manure spread on field in March and then incorporated into soil after one week. • complete failure of pea crop (26 ha); field reseeded in late-June to oats. • KDF visited site, observed adult *C. distinctus* and collected several dozen second- and third-instar larvae that were held in damp soil at room temperature. Five adults recovered from soil from 21 to 29 July; all were *C. distinctus*.

[1]15-cm diameter, depth of ca. 8 cm.

Assuming that crops are being damaged by *C. distinctus*, larvae appear to be generalists that feed on the roots of whichever crop is present. Damage associated with outbreaks was reported for canola, corn, dry bean, and pea (Table 1). Additional reports were received of outbreaks in fields of corn, hemp, onion, and wheat for which damage was not specifically noted by the producer. Of potential relevance is the absence of reported damage in fields of wheat and barley, which are common crops on the Canadian Prairies. The absence of such reports may be an artefact of a small sample size and (or) higher planting densities used for small-grain cereals may mask the effect of early-season root feeding. Conversely, these crops may potentially better tolerate root damage.

In the absence of further information, mitigation strategies may not be warranted or even possible. Despite considerable effort, I have received only 16 reports over 20 years of aphodiine damage to crops (Table 1). Thus, *C. distinctus* is perhaps best portrayed as a species whose larvae are common in soils, particularly after manure applications, but rarely present in sufficient numbers to cause visible damage to crops. When it is observed, typically in June (Table 1), most of the damage may already have occurred, given that larvae begin to pupate at the end of June and in early July. Furthermore, damage may be spotty, such that only a portion of the crop is significantly affected. Regardless, given that the larvae are subterranean feeders, foliar insecticidal applications may not be an option and soil applied insecticides and seed treatments may be impractical. In cases where *C. distinctus* is suspected of causing crop failure, reseeding of the field later in the summer to an alternate crop may be an option.

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