Agriculture and Agri-Food Canada
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Cutworm Pests of Crops on the Canadian Prairies

Identification and Management Field Guide

Canada

Cutworm Pests of Crops on the Canadian Prairie: Identification and Management Field Guide

Cover photo: Armyworm cutworm larva and damage,
Mike Dolinski, MikeDolinski@hotmail.com

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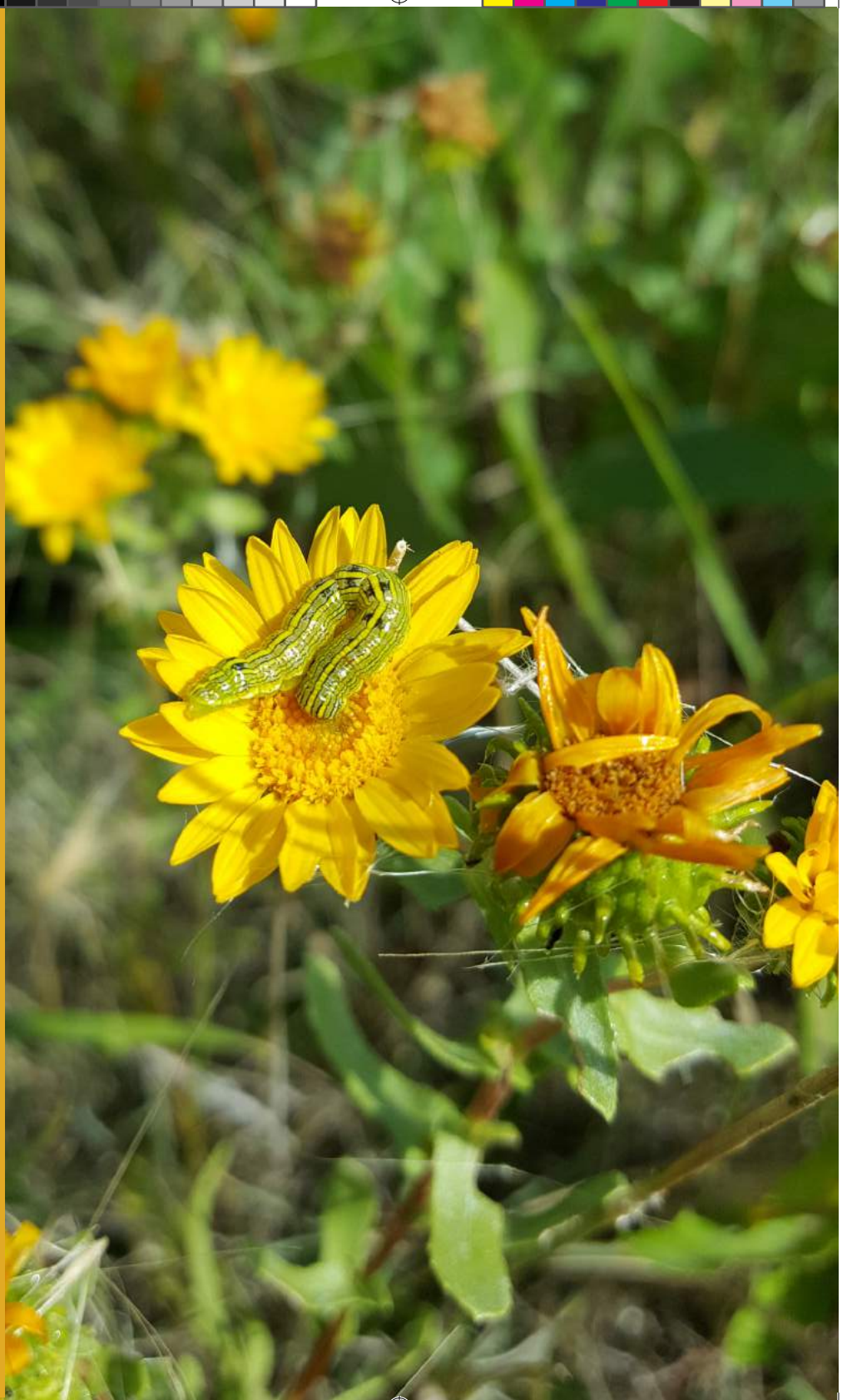
Foreword

This guide is intended to help producers identify and control oilseed and cereal crop cutworm pest species found on the Canadian Prairies. Included is general information on the biology and control of these pests followed by species-specific information. A list of registered cutworm chemical control products is not provided because available products frequently change. For this information, readers are instead directed to annual editions of provincial crop protection guides; links to updated online versions are listed in the *Internet Resources* section at the end of this guide.

Also found in this guide are summaries of previous cutworm research, older control methods, and reasons why some control methods are no longer recommended. Information sources, many of which can be found online, are cited throughout the text. The historical context combined with current information helps identify knowledge gaps to direct future research. Keeping track of citations also simplifies updating the guide in the future.

- Kevin Floate

Stubble field
C. Tracey, AAFC



Introduction

There are several pest cutworm species affecting Canadian Prairie crops. Much of the time, their impact is negligible. However, from time to time, outbreaks occur. These can be localized to small areas in a field or widespread across a large region, they can last years and, most importantly, can cause significant economic damage.

The key to successful cutworm management and limiting their impact is by first correctly identifying the species causing damage. Then, through an understanding of its biology, lifecycle, preferred habitats, behaviour, influences of climate and weather, and interactions with natural enemies and other factors, you can exploit its weaknesses by knowing when to control (susceptible stage and time of day) and only when it makes economic sense. Learning how to recognize damage, detect the species (scouting), and take advantage of natural processes are additional important elements in a management strategy.

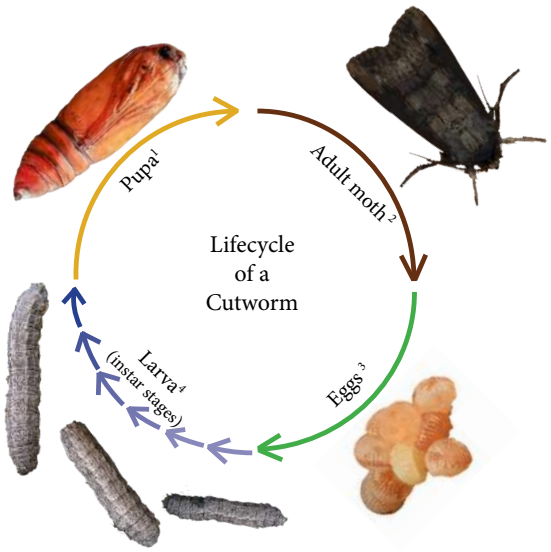
Key Species and General Biology

'Cutworm' is the common name given to the larva of several noctuid moth species (Lepidoptera: Noctuidae). Of the 1,555 species of noctuid moths in Canada (Zahiri et al. 2014), only a small number are considered pests. Prominent species that attack crops on the Canadian Prairies include army cutworm (*Euxoa auxiliaris* (Grote)), pale western cutworm (*Agrotis orthogonia* (Morrison)), and redbacked cutworm (*Euxoa ochrogaster* (Guenée)). Other pest species include armyworm (*Mythimna unipuncta* (Haworth)), black army cutworm (*Actebia fennica* (Tauscher)), black cutworm (*Agrotis ipsilon* (Hufnagel)), bristly cutworm (*Lacinipolia renigera* (Stephens)), darksided cutworm (*Euxoa messoria* (Harris)), dingy cutworm (*Feltia jaculifera* (Guenée)), and glassy cutworm (*Apamea devastator* (Brace)) (Strickland 1923; Ayre and Lamb 1990).

Caterpillar (*Cucullia* sp.) on gumweed (*Grindelia squarrosa*)
C. Tracey, AAFC

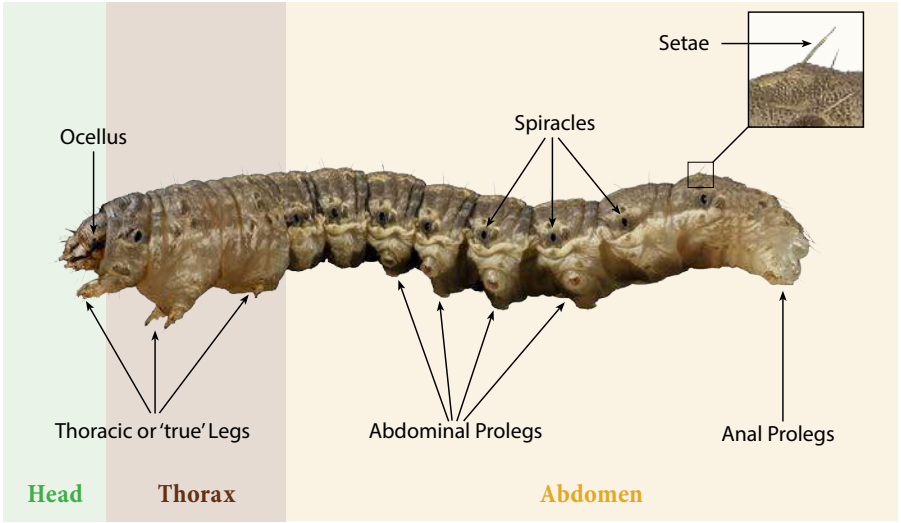
The species that make up the cutworm pest complex vary in terms of regional dominance, crops attacked, timing of different life stages and feeding behaviour. For example, the pale western cutworm is generally associated with drier regions and tends to be more dominant in the southern portions of Alberta and Saskatchewan. In contrast, the redbacked cutworm is less adapted to dry conditions and more often is a pest in the northern parkland regions of these provinces. Excessive soil moisture favours the black cutworm, which is more commonly a pest in Manitoba and further east. Two or more species may co-occur in the same field, which further adds to this complexity (Ayre and Lamb 1990).

Cutworms develop from egg to reproductive adult through a series of lifecycle stages (metamorphosis); i.e., egg → larva → pupa →adult. The duration of each lifecycle stage varies with cutworm species (table, p. 5). Eggs of some species may hatch within a few days of being laid or they may overwinter in the ground, hatching after several months. Eggs laid in autumn may begin developing prior to winter and then hatch the following spring with the onset of warmer temperatures and after the soil has thawed (Jacobson 1962b). For species that overwinter as eggs, a period of cold may be required before the eggs hatch; e.g., redbacked cutworm, pale western cutworm (Jacobson 1962b) and dusky cutworm (Ayre and Lamb 1990). This requirement prevents the eggs from hatching in autumn when there is no food for the larvae.



Cutworm lifecycle
[1,3] cc-by 2.0 USGS Bee Monitoring Lab,
[2] cc-by 2.0 Andy Reago and Chrissy McClarren
[4] John Gavloski (Manitoba Agriculture)

The larvae of some species that hatch in early spring may survive without feeding for two to three weeks, especially at cooler temperatures; e.g., 10°C (Jacobson 1952). Some species may complete larval or pupal



Black cutworm
cc-by 2.0 USGS Bee Monitoring lab (adapted by C.Tracey, AAFC)

development in four to six weeks, whereas species that overwinter as larvae or pupae may require eight to nine months to complete these life stages (table, p. 5). Larvae go through a number of developmental stages called 'instars'. Most cutworm species complete five or six instars (Guppy 1961), but individual cutworms may undergo seven to nine instars if parasitized (Byers et al. 1993), feed on poor quality food (Santos and Shields 1998) or are exposed to low winter temperatures (Breeland 1957). Cutworm larvae are generally smooth-skinned, hairless caterpillars with a base colour ranging from pale to dark brown or nearly black. They may be variously marked with lines or spots depending on the species. The larvae have three pairs of thoracic or 'true' legs located on the thorax (first three segments behind the head) and typically five pairs of abdominal false legs called prolegs. They curl up when disturbed and are roughly 3 to 5 cm long when mature. See *Species-Specific Information* section for detailed larval descriptions of each important cutworm pest species (also Crumb 1956).

Only cutworm larvae cause crop damage; adults, eggs and pupa have no impact on crop productivity and yield. Cutworms exhibit three general types of feeding behaviour: subterranean, above-ground and climbing (table, p. 5 and Walkden 1950).

- Subterranean cutworm larvae feed almost exclusively underground. Larvae cut the main stem of young plants but are otherwise not usually seen.

- Above-ground or surface-feeding cutworm larvae feed on foliage during the night and hide in the soil or under leaf litter during the day. Older larvae may cut the main stem of young plants at or near the soil surface. Tunnelling cutworms are considered here to be a subcategory of above-ground cutworms. Larvae hide in tunnels during the day and emerge at night to remove bits of foliage from the host plant that they then take back into their tunnels.
- Climbing cutworm larvae climb up plants to feed on the foliage without necessarily damaging the main stem.

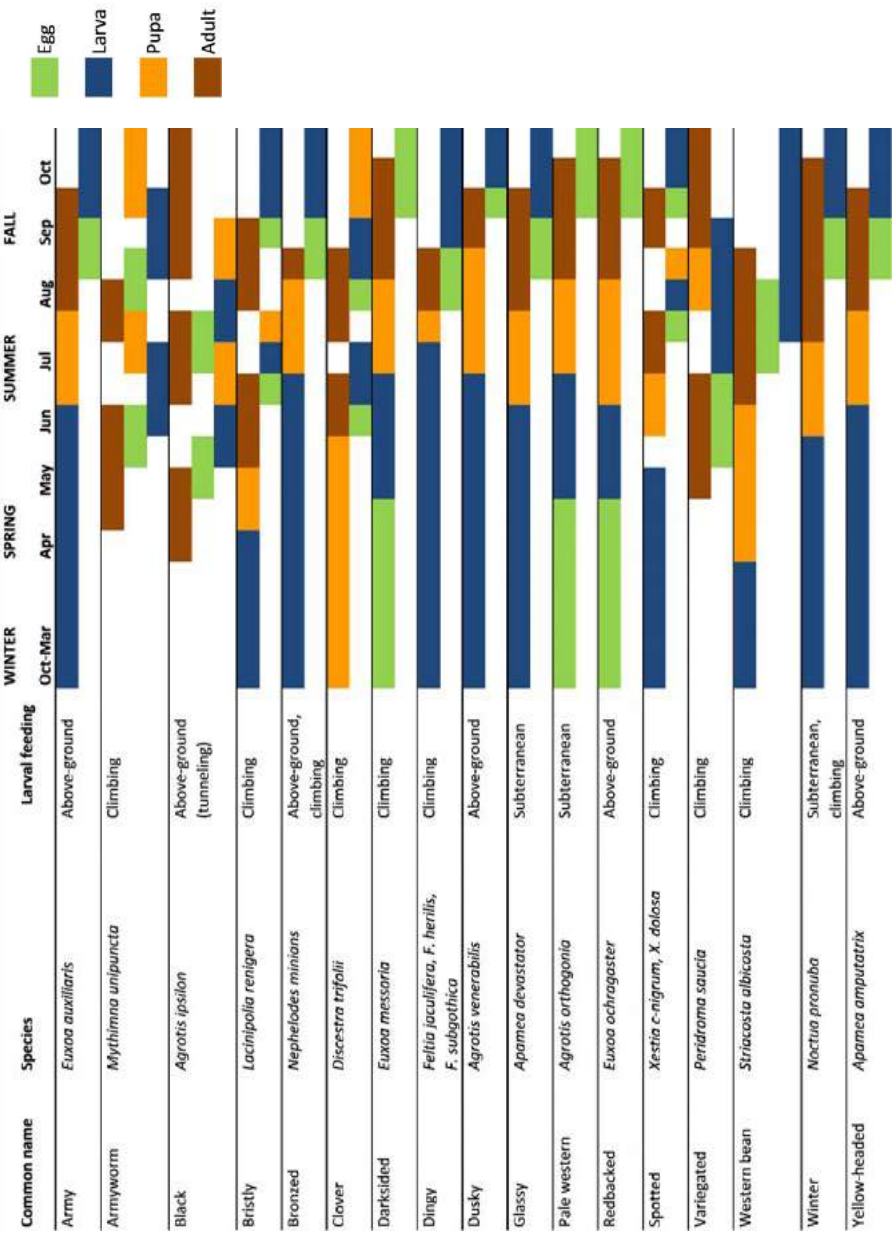
Depending on the crop and larval stage, a cutworm species may exhibit more than one type of feeding behaviour. These feeding differences affect the effectiveness of insecticide applications. For example, foliar insecticides are less effective against subterranean cutworm species.

Upon completing their final instar, larvae stop feeding and form an earthen cell a few centimetres underground where they pupate. Adult moths emerge from their pupal cases and feed on flower nectar. Moths are inconspicuous and usually do not fly during the day. Wings are coloured different shades of grey, brown or reddish-brown with silver or whitish markings. Female moths typically mate once and preferentially lay eggs in light-textured, dry, loose soils. However, some species (e.g., clover cutworm, western bean cutworm) oviposit on leaves. Depending on the species, they may lay several hundred (e.g., pale western cutworm (Jacobson 1965)) to more than a thousand eggs (e.g., darksided cutworm (Cheng 1972)).

Some species may have just one generation per year (univoltine) while others may have two or more generations (multivoltine) (Guppy 1961; Ayre and Lamb 1990). Most of the pest cutworm species in Canada overwinter locally. However, some like the armyworm and black cutworm re-establish each year in Canada when prevailing winds blow adults northward from the USA (McNeil 1987).

Cutworm pupa in an earthen cell
Lloyd Harris

Approximate seasonal occurrence of lifecycle stages for different species of cutworms. Crop damage is caused by larvae. Chart originally compiled by J. Otani and Gavloski, expanded and updated by K. Floate.



Common name	Species	Larval feeding
Army	*Euxoa auxiliaris*	Above-ground
Armyworm	*Mythimna unipuncta*	Climbing
Black	*Agrotis ipsilon*	Above-ground (tunneling)
Bristly	*Lacinipolia renigera*	Climbing
Bronzed	*Nephelodes minians*	Above-ground, climbing
Clover	*Discestra trifolii*	Climbing
Darksided	*Euxoa messoria*	Climbing
Dingy	*Feltia jaculifera, F. herilis, F. subgothica*	Climbing
Dusky	*Agrotis venerabilis*	Above-ground
Glassy	*Apamea devastator*	Subterranean
Pale western	*Agrotis orthogonia*	Subterranean
Redbacked	*Euxoa ochrogaster*	Above-ground
Spotted	*Xestia c-nigrum, X. dolosa*	Climbing
Variegated	*Peridroma saucia*	Climbing
Western bean	*Striacosta albicosta*	Climbing
Winter	*Noctua pronuba*	Subterranean, climbing
Yellow-headed	*Apamea amputatrix*	Above-ground

Cutworm Outbreaks

Almost all of the cutworm species that affect crops on the Canadian prairies are native to North America and were present prior to European settlement (Beirne 1971). The shift from native grassland complexes to simpler agriculture ecosystems dominated by relatively few crops and tilled soils increased the potential for these species to reach high, economically damaging densities. The likelihood of any one or a number of species achieving this potential in a given year and location is influenced by a combination of factors. The most important is weather, which affects the initial build-up of populations. However, not all cutworm species respond in the same way to environmental triggers. For example, successive dry years increase the potential for pale western cutworm outbreaks; successive wet years favour black cutworm (Walkden 1950).

Shorter term weather events moderate the ability of cutworm populations to cause damage. For example, a large cutworm population in autumn can be reduced by a harsh winter or wet spring to non-economically damaging levels the following growing season. Natural enemies (i.e., parasitoids, predators and pathogens; see *Natural Enemies*, p. 16) can further reduce pest populations. Because outbreaks are largely driven by climate cycles, they occur sporadically every five to thirty years. Outbreaks can occur locally or be more widespread, lasting one to three years before populations are reduced to pre-outbreak levels by weather events or a buildup of natural enemies. Beirne (1971) describes the history of outbreaks of different cutworm pests in Canada.

The extent of crop loss during a cutworm outbreak is highly variable. Damage may be limited to a few small patches in a field, requiring no control effort. Elsewhere, the entire crop may be lost if the outbreak is unmanaged. In the worst case, cutworm outbreaks can reduce crop yields across a large geographic area for successive years resulting in high economic losses. For example, damage by pale western cutworm was first reported in 1911 and 1912 in Alberta (Mabee 1929). Subsequently, widespread damage to cereal crops from 1918 to 1921 was observed in Montana with yield losses exceeding $4.1 million [= $53.8 million in 2015

Historical cutworm damage in Leader, Saskatchewan (1946)
WB Fox, AAFC

dollars] (Mabee 1929). Between 1927 and 1933, pale western cutworm damaged cereal crops from eastern Saskatchewan to western Alberta and northward up to 500 km from the Canada/USA border (Seamans 1935); total crop losses for the region were estimated at about $19 million [= $336 million in 2015 dollars] (McMillan 1935).

Pale western cutworm outbreaks affected an estimated 100,000 ha (250,000 ac) in southern Alberta in 1985. Based on insecticide sales at that time, total losses were estimated at $8 million [= $16 million in 2015 dollars] (J.R. Byers, unpublished data). Army cutworm outbreaks in 1990 affected more than 10,000 ha (25,000 ac) in southern Alberta of which about 6,000 ha (15,000 ac) were sprayed with the remainder reseeded without spraying (Jones et al. 1990 – cited in Byers et al. 1993). Outbreaks of glassy cutworm in fescue seed fields and pastures in Alberta caused estimated losses of $5 million [= $6.6 million in 2015 dollars] in 2000 (Dosdall et al. 2000). More recently and varying with region and crop, localized outbreaks in the Prairie Provinces have been reported for army cutworm, armyworm, black army cutworm, bristly cutworm, dingy cutworm, glassy cutworm, pale western cutworm, redbacked cutworm and variegated cutworm (WCCP 2012; WCCP 2013). Many local outbreaks go unreported.

Damage to field caused by pale western cutworm
J. Robert Byers, AAFC

Predicting Outbreaks

Light Trap
R. Batallas, University of Alberta

Early forecasting methods developed in the 1920s and 1930s used rainfall ('wet days') during the larval development period (May and June) to predict where outbreaks of pale western cutworm would occur in the following year (Cook 1926; Seamans 1935) – the fewer the 'wet days,' the more likely an outbreak. When soils are wet, this subterranean-feeding species moves to the soil surface where populations are reduced by parasitoids (Seamans 1935) and epizootics (Cook 1926). Seamans (1935) reported that the method was highly accurate during an 11-year period across southern Alberta and Saskatchewan. However, this method was ultimately not adopted, likely because of changes in farming practices and the increasing availability of synthetic chemical insecticides.

Pheromone trap
R. Batallas, University of Alberta

More recent efforts have tried to forecast cutworm outbreaks based on recovery of adults. Cutworm populations of some species can be roughly quantified (high, medium, low) by the number of adult moths recovered in traps baited with sex pheromones or in light traps. Sex pheromones are volatile chemicals that are produced and released by females to attract males. In a study in southern Alberta, the total number of moths recovered in pheromone traps baited with a combination of sex pheromones specific for darksided cutworm, pale western cutworm and army cutworm comprised more than 99% of these three target species (Byers and Struble 1987). In contrast, light traps attract both pest and non-pest

species. This means that light trap catches first have to be sorted before counting the species of interest (Ayre and Lamb 1990).

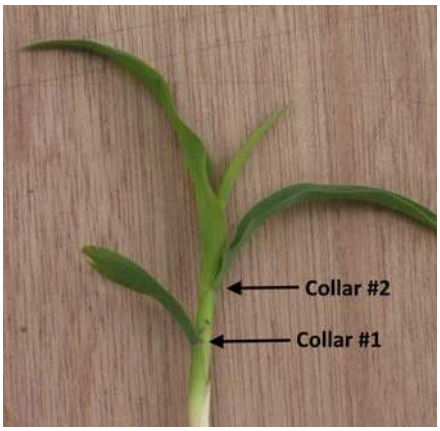
Unfortunately, predicting cutworm outbreaks based on adult numbers generally does not work (Ayre and Lamb 1990; Turnock et al. 1993) or is impractical. For most species, the cutworms that are damaging crops in the current year have developed from eggs laid in the previous year (table, p. 5). Thus, depending on overwintering mortality and other factors, catches of moths in autumn may not reflect cutworm numbers in the following spring. For example, catches of moths in a light trap operated for 11 years in southern Manitoba did not correspond to regional levels of damage caused by their larvae (Ayre and Lamb 1990). In addition, maintaining a network of traps to develop regional forecasts can be expensive. Furthermore, regional forecasts may not apply to individual fields where factors such as soil type and crop type greatly influence the risk of cutworm damage. Hence, timely scouting of individual fields remains the best method to minimize cutworm damage (see *Scouting*, p. 12).

Western bean cutworm is an exception. Adults lay eggs in mid-summer from which larvae hatch to feed on crops later in the same growing season. Thus, for this pest, use of pheromone traps is recommended to monitor adult numbers to assess the risk of subsequent crop damage by the larvae.

Cutworm damage to cereal crop

Scouting

Producers need to check their fields frequently in spring and early summer for signs of cutworm damage. Cutworms will sever canola seedlings. Cereal seedlings may be severed or have leaves removed near attachment points. In this latter case, the base of the plant may be visible on closer examination. For corn at growth stage V2 or V3 (i.e., when the lower two or three leaves, respectively, have visible collars [aka collared leaves]), cutworms may tunnel into the plant from below-ground to kill the inner whorl of developing leaves. The collared leaves remain alive and green but little further growth will occur. Damage in peas is visible as freshly cut or wilting plants within otherwise healthy stands. Sugar beet seedlings may be severed, whereas older plants may have single leaves removed.



Corn at V2 (two leaves with collars)
cc-by-sa 3.0 Rasbak


Dying plants with stems cut close to the ground
Canola Council of Canada

Individual cutworms tend to feed within the seed row, with movement between plants aided by the loosened soil caused by the seeding implement. When the attacked plant dies, it leaves a gap in the row. The length of the gap increases as cutworms move down the row to feed on the next healthy plant. When these lengthening gaps occur in adjacent rows, they form thinning or bare patches of expanding size surrounded by healthy young plants. Producers may attribute these patches to poor germination, but closer investigation will show dead and dying plants with stems cut close to

Armyworm larva outbreak in wheat
Mike Dolinski, MikeDolinski@hotmail.com

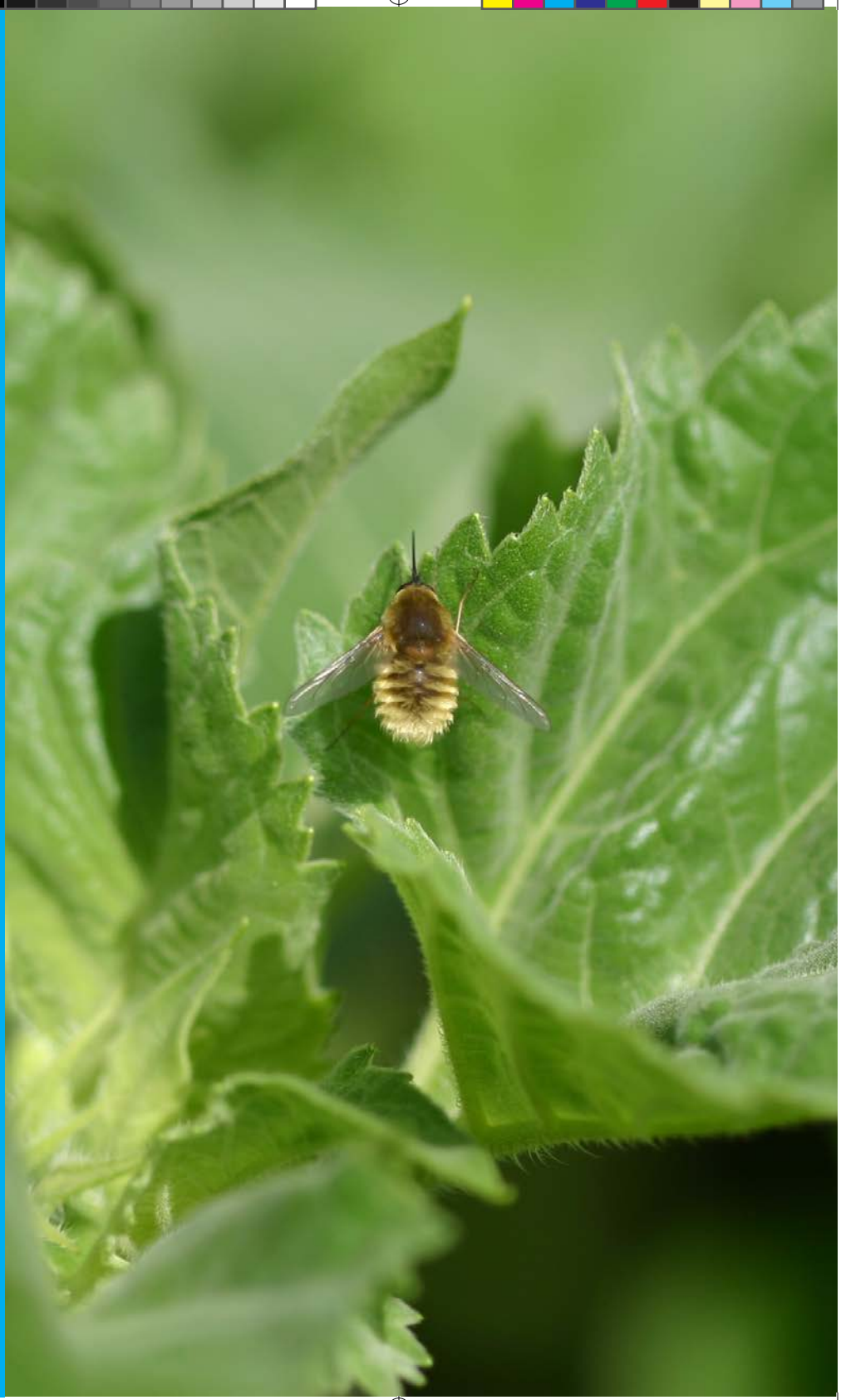
the soil surface. Cutworms are normally not visible: they typically shelter underground during the day and feed at night. However, aboveground activity may occur during daylight hours, particularly when conditions are cool and wet early in the growing season.

It is important to confirm the presence and identity of cutworms before deciding on a course of action. For example, damping-off disease can cause wilting in seedlings that may be mistaken for cutworm damage. To confirm the presence of cutworms, carefully search the top 2.5 to 5 cm (1 to 2 in.) of soil around the base of severed plants at the end of within-row gaps or around the base of healthy plants at the end of these gaps. Also search the soil at the base of healthy plants in the middle of bare patches. To look for cutworms between rows with feeding damage, carefully remove plant residue and soil clumps. Large numbers of seagulls or other birds may be attracted to fields when cutworms are abundant (p. 21). When large flocks are observed, closer examination of the field to assess cutworm numbers may be warranted.

Depending on the size of the affected area(s), cutworm density, the crop, crop stage and whether the cutworms are still voraciously feeding, control measures may or may not be required (see *General Control Options*, p. 26).

Black cutworm larval damage

Natural Enemies



Natural Enemies

Mortality by natural enemies (parasitoids, predators, pathogens) can reduce the severity of cutworm outbreaks.

Emerging parasitoids
Vincent Hervet, AAFC

Mortality by parasitoidism can be determined by collecting cutworm larvae in the field and holding them indoors in containers for the emergence of parasitoids. During a redbacked cutworm outbreak at Saskatoon, Saskatchewan, estimated average parasitoidism ranged from 38 to 61% depending on the year (King and Atkinson 1928). Average parasitoidism was estimated to be 32% during an armyworm outbreak in Tennessee (Breeland 1957), and from 20 to 60% during an army cutworm outbreak in southern Alberta (Byers et al. 1993). Recent surveys of cutworms recovered in south, central and northern Alberta from 2012 to 2014 revealed about 20% parasitoidism (Floate 2016).

Pathogens (i.e., nematodes and fungal, viral or bacterial diseases) add further to this mortality. A black cutworm study in Ontario showed that, while parasitoidism averaged 21%, pathogens were responsible for a further 35% mortality (Bucher and Cheng 1971). Predators kill additional cutworms, but this type of mortality is difficult to quantify.

A recent review (Gavloski and Hervet 2013) lists known natural enemies that attack army, darksided and redbacked cutworms in North America. Other lists of natural enemies that affect pest cutworms are provided by Strickland (1923), Crumb (1929), Walkden (1950), Breeland (1957) and Schaaf (1972).

Parasitoids

In a generalized insect parasitoid lifecycle, females lay eggs near, on or in a host. The eggs hatch into larvae that then feed on the host's tissues.

Bee fly
Mike Dolinski, MikeDolinski@hotmail.com

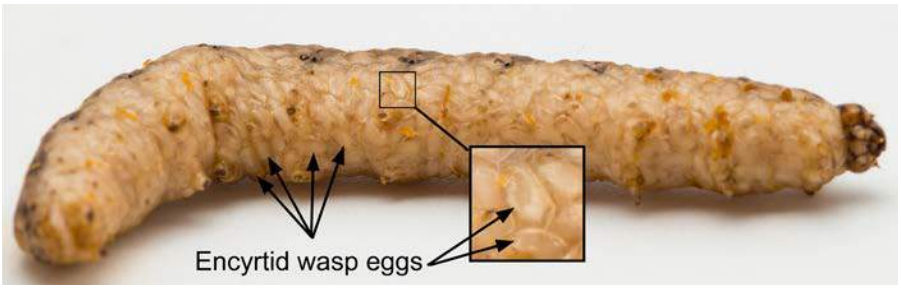
Once the larvae mature, they either pupate in their host or exit their host and then pupate. After pupation, the new adult parasitoids emerge to seek out new hosts. Unlike predators, which may be generalists, parasitoids typically attack and develop inside only a small number of closely-related species. Thus, two cutworm species in the same field may be attacked by different parasitoids. During winter months, parasitoids survive as immature stages inside a host.

Depending on the species, parasitoids may lay one or many eggs per host, may lay their egg(s) in the host's eggs or larvae, and have one or more generations per year. The eggs of some species require a period of time before hatching; the eggs of other species develop inside the female and hatch almost immediately when laid (O'Hara 2008). Some parasitoid species only have females while other parasitoid species may have populations that are all female and other populations that contain both males and females (Hervet et al. 2014). Cutworm parasitoids include wasps (Hymenoptera), flies (Diptera) and mermithid worms (Nematoda).

Parasite or Parasitoid?

Parasites and parasitoids both spend part of their life cycle developing in or on a host organism. When a parasite leaves its host to complete development, the host normally lives. When a parasitoid leaves its host organism, the host normally dies. A great deal of research has been devoted to the study of parasitoids as natural enemies of pest insects.

Parasitoid wasps of cutworms include braconid, encyrtid and ichneumonid species. Braconid and ichneumonid wasps lay their eggs in early-instar cutworm larvae. Parasitoidism by braconids kills the cutworm larva; parasitoidism by ichneumonids generally kills the cutworm in the prepupal or pupal stage. Encyrtid wasps have a particularly interesting lifecycle. Female encyrtids lay their eggs in the host's eggs. In a process called polyembryony, an encyrtid egg will divide several times to become many eggs. The development of the wasp larvae that hatch from these eggs is delayed until the cutworm has finished feeding as a late-instar larva. The wasp larvae then complete their development and pupate within the host; at this stage the host is called a 'mummy'. Army cutworm studies have shown show that one egg laid by the encyrtid wasp *Copidosoma bakeri* (Howard) may produce up to 2,500 adult offspring from the body of the host (Byers et al. 1993).



Encyrtid mummy — redbacked cutworm parasitoidized by *Copidosoma bakeri*
Miles Zhang

Parasitoid flies of cutworms mainly include bombyliid and tachinid species. Bombyliids (bee flies) lay their eggs on soil or vegetation where host species are likely to occur. Bombyliid eggs hatch to produce first-instar larvae with a specialized shape (planidium) adapted for dispersal. The planidium actively locates and then, depending on the species, attaches to or penetrates the host (Yeates and Greathead 1997). Second- and later instar bombyliid larvae are sedentary with a stouter shape. Development to the pupal stage for most species occurs on the outer surface of the host, although the larvae of some bombyliid species develop inside the host (Yeates and Greathead 1997). For tachinids, different species inject eggs directly into the host, lay their eggs on or near the host, or on vegetation with the eggs hatching only if they are consumed by the host (O'Hara 2008). Tachinid larvae normally exit their host to pupate nearby in soil or ground litter. Sarcophagid and muscid flies have been reported as cutworm parasitoids (Crumb 1929; Cheng 1977), but these reports are rare and possibly suspect (Dahlem and Downes 1996).

Mermithid worms have only rarely been reported from cutworms and are not an important source of mortality affecting cutworm populations (Schaaf 1972). Adults lay eggs on land or in water. Newly-hatched mermithid larvae are free-living until they infect a suitable host. They develop inside and ultimate fill the body cavity of the host until they emerge as free-living adults.

Mermithid worm exiting from host
Paul A. Lenhart

Predators

Ground beetles (Coleoptera: Carabidae) are among the most important cutworm predators in agro-ecosystems, with about 400 species on the Canadian Prairies and upwards of 80 species present in any field (Holliday et al. 2014 and references within). Normal densities range from about 10 to 50 beetles per m^2 (8 to 42 beetles per yd^2) (Thiele 1977; Brust et al. 1986b), but are occasionally much higher (Holliday and Hagley 1979; Floate and Spence 2015). Depending on the species, adults range in size from less than 3 mm to 30 mm (< 1/8 to 1 1/8 in.). Ground beetle larvae and adults may be herbivores, scavengers, omnivores or predators.

Plant-feeding ground beetle species are unlikely to damage field crops, but many reduce weed densities by feeding on seeds (Kulkarni et al. 2015).

Predaceous species are generalists and feed on a number of crop pests in addition to cutworms including aphids (Hemiptera: Aphididae), cabbage root maggot, (*Delia radicum* L.; Diptera: Anthomyiidae) (Finch 1996), Colorado potato beetle (*Leptinotarsa decemlineata* (Say); Coleoptera: Chrysomelidae) (Alvarez et al. 2013), grasshoppers (Orthoptera: Acrididae) (Songa and Holliday 1997), slugs (Mollusca: Gastropoda) (Pianezzola et al. 2013), wheat midge (*Sitodiplosis mosellana* (Géhin); Diptera: Cecidomyiidae) (Floate et al. 1990) and wireworms (Coleoptera: Elateridae) (Fox and MacLellan 1956), among others.

Calosoma beetle eating a Bertha armyworm
Vincent Hervet, AAFC

Depending on their size, beetles may attack eggs, early- and late-instar larvae, and pupae of cutworms (Frank 1971; Brust et al. 1986a; Frank and Shrewsbury 2004). Walkden (1950) reported that one adult of the ground beetle species *Calosoma lugubre* Leconte consumed 16 mature corn earworm larvae (*Helicoverpa zea* (Boddie); Lepidoptera: Noctuidae) before losing interest.

Other insect predators of cutworms include ants (Hymenoptera: Formicidae), rove beetles (Coleoptera: Staphylinidae) (King and Atkinson 1928; Frank 1971) and stiletto fly larvae (Diptera: Therevidae) (King and Atkinson 1928). Spiders capture adult cutworms but not in large numbers (Cheng 1973b). However, spiders do feed on even the largest cutworm larvae and may at times be important predators (Schaaf 1972).

Flock of gulls feeding on pests in a canola field
Canola Council of Canada

A number of vertebrate species also feed on cutworms. Birds (e.g., crows, grackles, starlings, seagulls and hawks) eat large numbers of cutworm larvae (King and Atkinson 1928; Walkden 1950; Cheng 1973b). Flocks of seagulls following tractors during field operations can be a useful indicator of cutworm outbreaks. Small rodents eat larvae and pupae in crops, and a number of animals feed on army cutworm moths. Each summer, army cutworm moths migrate in massive numbers from the prairies to the mountains. At night, as the moths feed on the nectar of alpine and subalpine flowers, they are eaten by owls and bats. During the day, the moths aggregate under rock formations where they are discovered and eaten by black bears, grizzly bears, coyotes, mountain bluebirds, ravens and American pipets. (French et al. 1994; White et al. 1998).

Western bluebird eating a winter cutworm
Sylvia of Northern California
(courtesy of www.whatsthatbug.com)

Pathogens

Pathogens that kill insects (i.e., entomopathogens) include bacteria, fungi, nematodes and viruses. Collectively, these disease agents can cause high levels of mortality (Walkden 1950). This has led to studies examining the potential for these pathogens to be developed as commercial microbial pesticides (aka biopesticides) (Ignoffo and Garcia 1979). And while microbial pesticides have been identified and developed (van Frankenhuyzen et al. 2015), none are registered for cutworm control in Canada.

Ingested pathogenic bacteria kill their insect hosts by producing toxins (Castagnola and Stock 2014). The toxins may attack the cells that line the inside wall of the insect gut to cause starvation and eventual death, or attack nervous tissue. Some groups of bacteria form spores that allow them to persist outside of the host in the soil and on vegetation (e.g., *Bacillus*). Other bacteria cannot survive in the environment but live inside as symbionts of nematodes that infect insects. The most widely studied entomopathogenic bacteria is *Bacillus thuringiensis* (Bt), which produces crystal (Cry) proteins with insecticidal activity. The bacterial gene that produces Cry proteins has been incorporated into the genomes of various plants to produce transgenic cultivars with insecticidal foliage (Shelton et al. 2002). Different Bt isolates produce different types of Cry proteins that vary in their toxicity to different insects. *B. t. kurstaki* (Btk) has been commercialized as a pest control product for different Lepidoptera (moths

Metarrhizium-infected larva
Scott Johnson, Simon Fraser University

and butterflies) species and *B. t. israelensis* (Bti) has been commercialized as a *Diptera* (flies) control product. Btk-based products have been tested in field studies against darksided cutworm, but were ineffective (Cheng 1973a). Bacteria pathogens isolated from cutworm pest species include *Achromobacter*, *Bacillus*, *Enterobacter*, *Klebsiella*, *Pseudomonas*, *Serratia* and *Streptococcus* species (Steinhaus and Marsh 1962; Cheng 1984).

Fungi attack insects by attaching as microscopic spores to the outer surface of the host. The spores germinate and develop threadlike hyphae that penetrate the insect's cuticle (i.e., the insect's outermost layer or 'shell') to colonize the body cavity. The fungal cells proliferate inside the cavity and typically kill the insect. New spores are formed either inside or on the dead host. Spore germination and the formation of new spores require optimal temperatures and high humidity. Entomopathogenic fungi recovered from cutworms include species of *Beauvaria*, *Isaria*, *Metarrhizium*, and *Sorosporella* (Speare 1920; Walkden 1950). Fungal infections can cause appreciable mortality levels in cutworm populations but are not normally a major source of mortality (King and Atkinson 1928; Walkden 1950).

Beauvaria-infected cutworm
Naomi DeLury, AAFC

Juvenile entomopathogenic nematodes (e.g., *Photorhabdus*, *Xenorhabdus*) infect insects by penetrating into their body cavity, usually through existing opening (e.g., mouth, anus) or through thin regions of cuticle. Once established in the body cavity, the infective juveniles release bacteria that produce a toxin to kill the host. As the dead host begins to liquefy, the nematodes (and bacteria) feed within, become adults and produce successive generations. When the food quality of the decaying host declines, the adult nematodes produce hundreds of thousands of new juveniles that exit the dead insect to locate and infect new hosts. The entire life cycle — from infection and host death to the release of new infective juveniles — is completed within a few days. Nematodes have been successfully commercialized as microbial pesticides for use against insect pests (Georgis et al. 2006), and have been studied for application against cutworms in laboratory and small-scale field trials (Capinera et al. 1988; Morris et al. 1990; Ebssa and Koppenhöfer 2012;

Mahmoud 2014). However, no commercial nematodal products for cutworms control are available yet.

Nematodes exiting dead host in search of new victims
cc-by 3.0 Peggy Greb, USDA ARS, bugwood.org

Viruses that infect insects (baculoviruses) are ingested by their hosts as occlusion bodies (OBs). These OBs contain one or more virus particles surrounded by a protein coat. The protein coat protects the virus particles from temperature extremes and ultraviolet radiation, allowing the particles to survive outside a host. The virus particles are released when the protein coat of ingested OBs is broken down by the combined action of the insect's gut acidity (i.e., low pH) and digestive enzymes. Once released, the particles enter the cells of the insect and undergo numerous replication cycles. In the latter stages of this replication process, virus particles reacquire the protein coat. The replication process kills the insect host by causing cell wall breakdown, which often given the insect a liquefied appearance. Dead insects contain billions of OBs that are readily spread by wind and water. Because baculoviruses have a narrow host range, they typically infect only one or a few closely-related insect species. Large scale epizootics (i.e., an epidemic non-human disease outbreak) of baculoviruses occur in pest cutworm populations (Federici 1978), but are not normally a significant cause of mortality. In Canada, baculoviruses have been reported in redbacked cutworm and have been tested for their efficacy against darksided cutworm. Initial results looked promising, but the study was not completed (Cheng 1984).

Once infected with a virus, the insect liquefies internally and dies. The outer covering of the insect body ruptures shortly after, releasing the liquefied contents and spreading virus particles that infect other larvae.
Daniel A. Potter, University of Kentucky

General Control Options

Options for cutworm control include biological, chemical and cultural. Effective use of these options relies on a strategy of integrated pest management (IPM). As described in Philip (2015), the six key elements of IPM are: i) implementing pest prevention strategies, ii) correct identification and knowledge of potential pests, damage and their natural enemies, iii) monitoring pests, damage, natural enemies and weather conditions, iv) applying economic thresholds, v) suppressing pest populations, and vi) evaluating results of control measures.

Biological

The best option for the biological control of cutworms is to conserve existing populations of their natural enemies (conservation biocontrol) (see Étilé 2014 for conservation practices and strategies). This approach employs farming practices that help maintain healthy populations of parasitoids and predacious insects which are essentially an army of unpaid employees working for the farmer to control pests. The most effective way to do this is to minimize the use of insecticides (i.e., spray only when necessary, apply products with high specificity, and limit sprays to the affected area and a zone surrounding the affected area; see 'Chemical').

Maintaining field boundaries (e.g., roadside margins, fence lines) in a semi-natural, undisturbed state with a diversity of flowering plants is also beneficial. These boundary areas provide critical habitat to enhance natural enemy overwintering survival. Plant species that flower at different times provide a continuous nectar and pollen source for adult parasitoids (and many pollinator species). Field boundaries also provide habitat for alternate prey and host species to sustain predators and parasitoids when cutworms are not present. Studies have repeatedly shown that natural enemy diversity is higher in field boundaries than in adjacent fields (Olfert et al. 2005).

Braconid wasp adult parasitizing beet armyworm

Diverse field boundary/ditch
Tyler Wist, AAFC

Natural enemy populations also can be enhanced by increasing plant diversity (and the availability of nectar and pollen) within fields (Altieri et al. 1993). Intercropping may be an option in some cases. For example, several studies have examined the effect of planting understories of flowering plants in orchards or along orchard boundaries on pest species and their natural enemies. A review of these studies shows that the practice mostly reduces the pest species or has no effect; however, in a few cases, pest numbers have increased (Simon et al. 2010). In annual cropping systems, it may be possible to leave a low density or scattered patches of flowering weeds without appreciably affecting crop yields.

A second option for biological control is to introduce natural enemies into regions where they do not already occur. This is normally done to control pest species that have originated elsewhere. In such cases, natural enemies from the pest's region of origin are relocated to where the pest has become established (classical biocontrol). Care is required when relocating natural enemies into new regions to avoid affecting organisms other than the target species. Classical biocontrol programs normally require many years of research and oversight by federal authorities (De Clerck et al. 2006). Unfortunately, classical biocontrol does not provide a good option for cutworm control for at least two reasons. First, most of the main cutworm pest species are native to North America and their

natural enemies, effective or not, are already present. Second, many non-pest noctuid species could also be attacked by non-native natural enemies released against pest species. However, on occasion, natural enemies may find their own way into a region (see sidebar).

The third option is to increase existing populations of natural enemies (augmentation biocontrol). In this approach, large numbers of natural enemies are mass-reared and then released to seek out and attack the target pest (Cranshaw et al. 1996). One example of this approach includes the mass-rearing and release of parasitoids in greenhouses to control aphids (Boivin et al. 2012). Another example is the mass-rearing and release of parasitoids in livestock facilities to control filth-breeding flies (Geden 2006). Purchasing biocontrol agents is relatively expensive and it may take days to weeks after release before pest numbers decline. For these reasons, augmentation biocontrol is typically only used to protect high value crops that are under continuous attack by pest species. Because cutworm outbreaks are sporadic and generally affect crops of relatively low value, augmentative biocontrol strategies for cutworms have not been developed.

A New Cutworm Enemy Arrives in North America

Cotesia vanessae (Reinhard) is a parasitoid wasp native to Europe and northern Africa. It was first recorded in North America in 2009, when it was reared from tomato looper, *Chrysodeixis chalcites* (Esper) and cabbage looper, *Trichoplusia ni* (Hübner) in southern Ontario. It may now also be present in southern Alberta (Hervet et al. 2014). Laboratory studies show that it develops well on alfalfa looper, dingy cutworm, darksided cutworm, army cutworm, early cutworm and, to a lesser extent, on redbacked cutworm and Bertha armyworm (V.A.D. Hervet, unpublished data). The wasp may have arrived in North America with overseas shipment of plants.

Chemical

Registered insecticides for cutworm control change from year to year. Consequently, specific products are not recommended here. For an up-to-date list of available products, producers should contact the appropriate provincial agriculture department/agency or search through the Pesticide Management Regulatory Agency (PMRA) label database (see *Internet Resources*, p. 77).

Pesticides should be used according to label instructions and only when cutworm numbers exceed economic thresholds. Economic thresholds vary by cutworm species, crop type, and stage of crop development (see *Species Specific Information*, p. 32). Target applications only to infested areas of the field and at the correct time-of-day for maximum efficiency. For example, apply treatments to control night-feeding species (above-ground cutworms, climbing cutworms) in early evening.

Target and non-target organisms are killed directly by exposure to the insecticide at time of application and indirectly by contact with insecticide residues. When options exist, use insecticides with a high specificity. This approach reduces the harmful effects of applications to non-target organisms including many natural enemies of not just cutworms but also of other pest species (see *Natural Enemies*, p. 16). For example, chlorpyrifos is an organophosphate and has a broad spectrum of activity. When applied, care must be taken to avoid poisoning birds, wildlife, fish, other aquatic organisms and honey bees (Brooks and Cutts 2016). Deltamethrin is a synthetic pyrethroid and also has a broad spectrum of activity. Soil residues of chlorpyrifos and deltamethrin are toxic to ground beetles for at least one week after application (Floate et al. 1989).

Given the potential damaging effects of insecticides on non-target organisms, producers should carefully assess the need for applications. Control is most effective when cutworms are small/young (early instars). Cutworms in the final instar have largely finished feeding and will soon pupate (i.e., little further crop damage will occur). If most of the cutworms are in this stage, insecticide application may be an unnecessary cost. Depending on species, final-instar larvae may be about 25 to 50 mm (1 to 2 inches) in length. Furthermore, cutworm damage is typically isolated to one or a few patches in a field. Depending on the size of the affected area and potential for future damage, pesticide applications may not be justified. If a decision is made to apply insecticides, spot-treat affected areas plus a surrounding 10 meter (30 feet) wide buffer zone.

Cultural

There are few cultural control options. In the early part of the last century, soil packing and the use of a drill press was shown to reduce the movement of subterranean species. However, this practice did not provide satisfactory cutworm control (Parker et al. 1921). Allowing soils to build up a crust later in the season can reduce egg laying by cutworm species that prefer to oviposit (i.e., lay eggs) in loose soils (King 1926; Sorenson and Thornley 1941). Cutworm-damaged fields can be reseeded. However, if reseeded immediately without applying an insecticide, cutworm larvae can survive to feed on the reseeded crop. For this reason, cultivate to remove living plants that may provide a food source. Then wait 10 to 14 days before reseeding to starve the cutworm larvae to death. Historically, this method was shown to be effective to control pale western cutworm (Seamans and Rock 1945), but the practice was not generally adopted as it required an additional field operation and later-seeded crops are at greater risk to frost damage. Insecticide application eliminates the need for a waiting period prior to reseeding.

Resistant crop cultivars may provide a future option to reduce cutworm damage; unfortunately, none are currently available. And while pest resistant cultivars have been successfully developed for some crops for some pests (e.g., wheat midge resistant wheat cultivars (Vera et al. 2013); genetically modified cultivars of several crops containing Bt toxin genes (see *Natural Enemies*, p. 16), they are not a 'silver bullet' (i.e., insects routinely adapt to resistant plant cultivars (Tabashnik et al. 2013)). This means that long-term cutworm control will continue to require a comprehensive integrated pest management strategy.

Species Specific Information

The following pages describe the economic pest cutworm species on the Canadian Prairies, listed in alphabetical order by their common names. This information has been extracted from scientific papers and government reports, based mainly on research in Canada, but also in the USA.

The main heading of each page identifies the common and scientific name that the species is currently known by. Other names that the species may be known by also are provided. Each species is described separately with two exceptions. Three species of *Feltia* with the same common name (dingy cutworm) and similar life histories are combined in one entry. Two species of *Xestia* with the same common name (spotted cutworm) and similar life histories are also combined in one entry.

Information is provided to help identify species by both their adult and larval forms. However, identification can be difficult, even for experts. There are many species of noctuid moths that look similar to pest species. Within a species, there may be different colour forms for adults (e.g., redbacked cutworm moth) or larvae (e.g., bronzed cutworm). Knowing when the species is present in the field as a larva or adult can aid in correct identification.

Information on when different life stages are most likely to be encountered in the field is provided in life cycle charts (see also table on p. 5 and individual species descriptions). With minor exception (e.g., bronzed cutworm), the overwintering stage indicated for a given species will be the same across Canada. However, the timing of when life stages are present may vary by a few weeks depending on geographic regions and year. For example, redbacked cutworm overwinters in Canada in the egg stage. Egg hatch will occur sooner in warmer regions of the country and in years with an early spring.

Information is also provided to help identify cutworm infestations when they occur. Economic thresholds are provided when they are known. Unless otherwise specified, the thresholds provided in this guide are from Gavloski (2016) and Gavloski and Olfert (2016). Species *Notes* provide additional information that may be of general interest or which may further aid in pest control.

Redbacked cutworm larvae
John Gavloski, Manitoba Agriculture

Army Cutworm

Euxoa auxiliaris (Grote)

Army cutworm larva
cc-by 3.0 Whitney Cranshaw, bugwood.org

Other common name
Miller moth

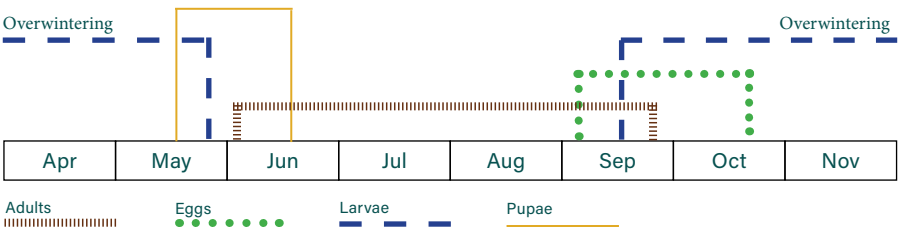
French common name
Légionnaire gris

Identification
ADULTS: Forewings variable in colour, but each with two prominent spots, one round to oval, the other kidney- or crescent-shaped. Wingspan is 40-45 mm.
MATURE LARVAE: Hairless; about 37-40 mm in length. Body mottled pale greenish-grey to brown with a broad whitish dorsal stripe running lengthwise. Head is light brown with darker spots.

Distribution
Native to North America. Distributed throughout much of the western part of the continent, east to Michigan and north into the Northwest Territories. It is particularly common in arid regions.

Life cycle
Overwinters as half-grown larvae in the soil before pupating starting mid-May. Adults emerge in early June and spend summer in sheltered sites to escape heat. Eggs are laid in or on loose soil late in the season. One generation per year.

Hosts
Wheat, oat, triticale, barley, canola, mustard, flax, alfalfa, sweet clover, pea, cabbage, sugar beet, various weeds (notably stinkweed) and grasses.



Army cutworm pupa
cc-by 3.0 Whitney Cranshaw, bugwood.org

Feeding damage

Above-ground cutworm: Young larvae chew holes in leaves and notch leaf margins while older larvae will consume entire leaves.

Monitoring/Control

Monitor forage crops and pastures closely in April and early May for feeding damage. Count the number of larvae in a 50 cm by 50 cm area of the crop; multiply by four to estimate the number of larvae per m^2. Repeat this process 5 to 10 times at 50 m intervals.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Economic thresholds

Cereal crops: 5-6 larvae/m^2.
Canola: Thresholds not established; however, a density of 5 larvae/m^2 was reported to destroy a field of mustard (Jacobson 1962a).

Notes

When food is scarce, larvae will move aboveground as a group in the same direction to locate more host plants. Hence the nickname 'army' cutworm.

Crops are at greatest risk to damage by overwintered larvae in early spring. Crops seeded later in spring are at a lower risk of damage; crops seeded in autumn (e.g., winter wheat, winter triticale) and alfalfa are at a higher risk of damage in the following spring.

Larvae are similar in appearance to armyworm (p. 36) and fall armyworm.

Outbreak years are often preceded by a year with an abnormally dry July and wet autumn.

Most important as a potential pest of crops in southern Alberta, of lesser importance in southern Saskatchewan, and only rarely of importance in Manitoba (Beirne 1971).

Army cutworm adult
cc-by-nc 3.0 Mark Dreiling, bugwood.org

Armyworm Cutworm

Mythimna unipuncta (Haworth)

Armyworm cutworm larva
cc-by 3.0 Joseph Berger, Bugwood.org

Other common names
Rice armyworm, true armyworm

French common name
Légionnaire uniponctuée

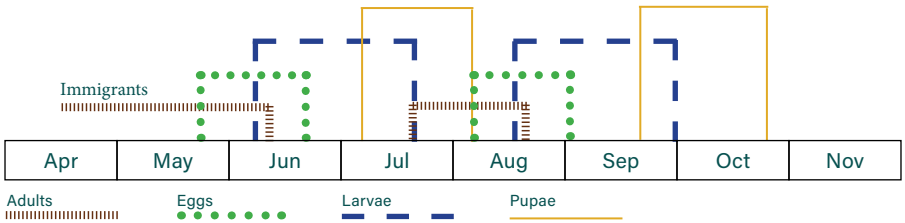
Identification
Adults: Forewings pale brown with a single small white spot. Wingspan of 40-50 mm.
Mature larvae: Hairless, about 38-50 mm in length. Body greenish-black with two alternating dark and orange stripes along each side plus a faint white line down the back. Head has honey-comb like markings.

Distribution
Global. Distributed throughout the USA and southern Canada. Present in parts of Europe, Asia, Africa, Central America, and South America.

Life cycle
Moths migrate into Canada from the southern USA each spring. Females lay white eggs in batches of about 100 at the base of host plants. Usually two larval generations per year before populations die off in the fall.

Hosts
Preferred hosts include native grasses, oat, wheat, fall rye, corn, barley, and forage grasses. Secondary hosts include alfalfa, bean, cabbage, onion, pea, sugar beet, turnip and other species.

Feeding damage
Above-ground (climbing) cutworm: Larvae feed at night on leaf margins and growing tips of host plants. During the day, they hide



near the base of plants. Larvae gradually move up the plants to feed on the panicles and flowers, stripping off awns and kernels.

Monitoring/Control

Monitor for larvae and feeding damage from mid-June through early-August. Count the number of larvae in a 50 cm by 50 cm area of the crop; multiply by four to estimate the number of larvae per m^2. Repeat this process 5 to 10 times at 50 m intervals.

Preferentially sample locations that are attracting birds. These tend to be grassy, show signs of lodging or areas with feeding damage.

Armyworm cutworm adult

DAY TIME MONITORING: Remove ground debris and count the exposed larvae.

NIGHT TIME MONITORING: Beat the plants to dislodge larvae and, using a flashlight, count the number of larvae on the soil. Check the backs of larvae for eggs of parasitoids (p. 39).

Control weedy stands of grass in fields before the arrival of adults to reduce egg-laying opportunities and the risk of subsequent infestations. Apply foliar insecticides at night when larvae are feeding; only treat areas where larval densities exceed the economic threshold.

Do not spray once larvae begin to pupate or when the crop is ripening.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Economic thresholds

CEREAL CROPS (PRIOR TO HEADING): 40 small (<2.5 cm long) non-parasitoidized larvae/m^2.

CEREAL CROPS (AFTER HEADING): 20 larvae/m^2, if heads are clipped. [Note: Wheat at the boot and anthesis stages has been reported to be able to sustain up to 75% defoliation by armyworms with the little loss in yield and with negligible head cutting (Steinkraus and Mueller 2003)].

FORAGE CROPS: 50 small (<2.5 cm long) larvae/m^2.

SEEDLING CROPS: 20-30 small (<2.5 cm long) larvae/m^2.

Avoid insecticide treatments when large numbers of parasitoidized larvae are present.

Notes

First larval generation is most damaging; second larval generation can damage maturing crops later in the summer.

When food is scarce, larvae will move aboveground as a group in the same direction to locate more host plants; hence the nickname 'armyworm'. When armyworms are observed migrating into the field, treat a couple of swaths in front of the infestation in the direction of movement to form a barrier strip.

Larvae are similar in appearance to fall armyworm, army cutworm (p. 34) and redbacked cutworm (p. 58).

Armyworm cutworm larval damage
Mike Dolinski, MikeDolinski@hotmail.com

Armyworm cutworm with three parasitoid eggs

Black Cutworm

Agrotis ipsilon (Hufnagel)

Black cutworm larva

Other common name
Dark sword-grass cutworm

French common name
Ver-gris noir

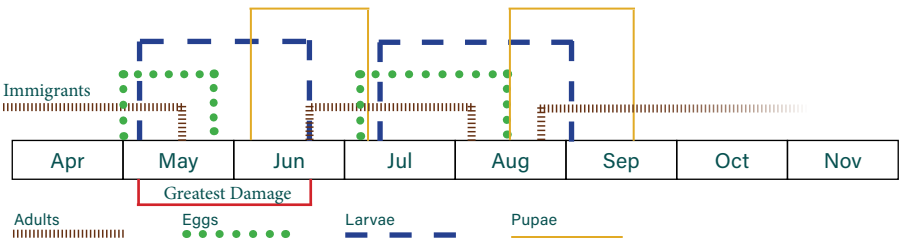
Identification
ADULTS: Forewings long, narrow and usually dark; tips lighter in colour with three black dashes. Wingspan of 38-50 mm.

MATURE LARVAE: Hairless; about 35-45 mm in length. Upper body nearly uniform in colour varying from light grey to nearly black. Head pale to dark brown.

Distribution
Native to North America. Distributed throughout the USA and southern Canada (Walkden 1950) and generally throughout the world. More common in moister regions of Canada; e.g., Manitoba and east.

Life cycle
Adults blow in (migrate) into Canada from the southern USA each spring; females lay eggs on weed and grass hosts in fields or margins. One or two larval generations per year before populations die off in the fall.

Hosts
Primarily corn, but also feeds on alfalfa, clover, sunflower, asparagus, bean, beet, cabbage, lettuce, field pea, pepper, potato, radish, spinach, squash, strawberry and tomato. Favoured weed hosts include bluegrass, curled dock, lamb's-quarters, yellow rocket and redroot pigweed.



Black cutworm larval damage
cc-by 3.0 WM Hantsbarger, bugwood.org

Feeding damage

Above-ground (tunnelling) cutworm: Larvae make burrows into which they will drag their food. The first larval generation is the most damaging. Most larvae sever young plants from roots near the soil as they feed at the base of the leaves; other larvae will feed on the roots and underground stems of cut plants. For corn at growth stage V2 or V3 (i.e., when the lower two or three leaves, respectively, have visible collars [aka collared leaves]), cutworms may tunnel into the plant from below-ground to kill the inner whorl of developing leaves. The collared leaves remain alive and green but little further growth will occur. One larva can kill many plants before it pupates.

Monitoring/Control

Monitor germinating crop for expanding thinned or bare areas. In corn, examine ten plants in a row at ten sites and estimate the percent of dead or severed plants. For sampling in cereals, see pale western cutworm (p. 56). Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Economic thresholds

Cereals: 3-4 larvae/m^2.
Oilseeds: 25-30% stand reductions.
Peas: 2-3 larvae/m^2 in top 7 cm (3 in.) of soil (Philip 2015).

Notes

An occasional pest of golf course greens and fairways (Frank and Shrewsbury 2004).

Larvae cause damage out of proportion to their numbers by cutting plants without feeding on them (Walkden 1950).

Avoid planting corn on newly-broken sod or in fields that were grassy or weedy the previous summer. Corn is susceptible to damage up to growth stage V3 (= lower 3 leaves have visible collars; see *Scouting*, p. 12). Use planting practices to encourage rapid, vigorous seedling development.

Black cutworm adult
cc-by 2.0 Andy Reago and Chrissy McLarren

Bristly Cutworm

Lacinipolia renigera (Stephens)

Bristly cutworm adult

Other common names
Kidney-spotted minor moth, bristly groundcat

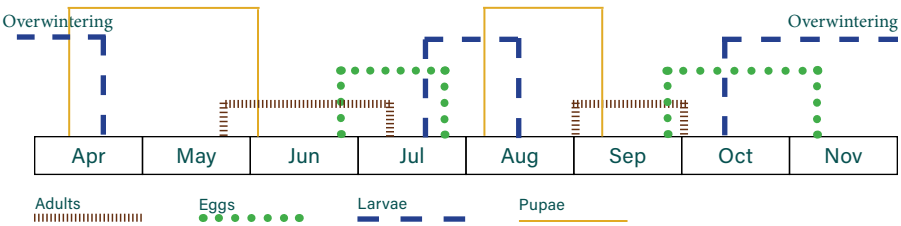
French common name
Ver-gris hérissé

Identification
ADULTS: Forewings purplish-brown with green patch. The green patch on the lower half of each forewing is kidney-shaped with a white margin; above that is a distinct black mark. Wingspan of 20-26 mm.

MATURE LARVAE: Generally hairless, but with short stout hairs projecting from darkened warts; about 25 mm in length. General body colour is pale gray; a dark band along the back is constricted at regular intervals to form a chain of diamond shapes.

Distribution
Native to North America. Widely distributed from the southern USA and north as far as the Northwest Territories and east to Nova Scotia.

Life cycle
Overwinters as larvae. Two generations per year (Walkden 1950) in Canada with more generations in the southern USA. Larvae pupate in earthen cells or in flimsy cocoons spun in debris.



Hosts
Alfalfa, clover, corn, tobacco, turnip, apple, grape, cottonwood, and many other species of herbaceous plants and grasses (Crumb 1956; Wagner et al. 2011).

Feeding damage
above-ground (climbing) cutworm:
The larvae feed near the ground. Rarely reported as a pest but local outbreaks occasionally cause economic damage.

Monitoring/Control
Among the most abundant of cutworm species. Larvae cling to stems when disturbed. In contrast, many other cutworm species will coil up when disturbed.

Economic threshold
None developed.

Notes
Cryptic/well-hidden or camouflaged. When alarmed, the larva can fully retract its head into its thorax. Associated with boreal and northern transition forests (Wagner et al. 2011).

Bristly cutworm larva
(c) Rob Bercha, www.insectsofalberta.com

Bronzed Cutworm

Nephelodes minians (Guenée)

Bronzed cutworm larvae: first, third, and sixth instar
D. Shetlar

Other common name
None available

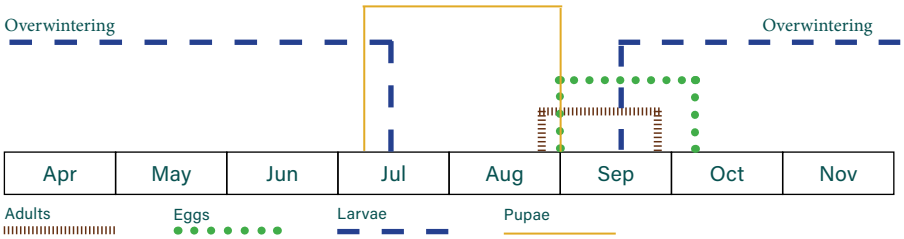
French common name
Ver-gris bronzé

Identification
ADULTS: Forewings highly variable in colour, ranging from gray-brown, tan, or reddish brown; darker band, running left to right across the middle of the wings, outlines pale-filled spots. Wingspan of 30-40 mm.

MATURE LARVAE: Hairless; about 35-45 mm in length. General body colour dark brown to blackish usually with a distinct bronzy sheen; distinctly paler on its underside. Three distinct pale stripes extending entire length of back. Head dark brown to brownish gray. Early-instar larvae are bright green, only turning dark brown in later instars.

Distribution
Native to North America. Distribution coast-to-coast extending from the southern USA north to central Canada.

Life cycle
Overwinter as larvae or occasionally eggs (see *Notes*, following page). Only one generation per year.



Hosts
Primarily feeds on grasses and cereal crops; also reported to feed on fruit tree buds and leaves.

Feeding damage
ABOVE GROUND CUTWORM: Can climb.

Monitoring/Control
Occasional pest of corn, hay crops, pastures and turf grass; more so a concern in eastern Canada and the USA (Gibson 1915).

Economic threshold
None developed.

Notes
A portion of the eggs laid in late summer will hatch prior to winter; larvae will feed until soil freezes and may even feed during winter under snow cover. Remaining eggs will not hatch until spring. Larvae hatching from overwintered eggs may not complete development until mid-summer.

Bronzed cutworm adult

Bronzed cutworm larva

Clover Cutworm

Anarta trifolii (Hufnagel)

Clover cutworm larva

Other common name
Nutmeg moth

French common name
Ver-gris du trèfle

Identification
Adults: Forewings uniform or mottle ashy-gray to pale brownish-gray in colour. Wingspan 25-36 mm.

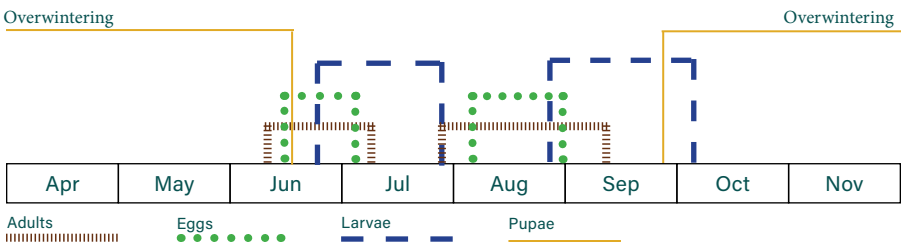
Mature larvae: Hairless; about 40 mm in length. Body velvety-black (occasionally green) with three narrow, broken white lines along the length of the upper surface and a broad yellowish-pink stripe along each side. Head is light brown.

Distribution
Native to North America. Wide distribution from Mexico north into Alaska, excluding south-eastern USA.

Life cycle
Overwinters as pupae 5-16 cm (2-6 in.) below the soil surface; eggs laid singly on leaves. Two generations per year. The first generation is the most damaging.

Hosts
Canola, mustard, flax are major field crop hosts. Other hosts include cruciferous weeds, sugar beet, clover, and some forages.

Feeding damage
Above-ground (climbing) cutworm: Young larvae feed on the undersides of leaves. Early signs of damage in canola and mustard appear as areas of the field becoming lighter green to white; older larvae feed on all parts of the plant. Damaged areas typically have a patchy distribution in fields.



Monitoring/Control

Canola, vegetative through early pod stage: Shake the plants in a 50 cm x 50 cm (0.25 m^2) area; count the larvae on the ground after removing leaves and debris [multiply number by four to determine number of larva per square meter]. Repeat at 10 to 15 locations separated by at least 50 m following a zig-zag pattern; calculate the average number of larvae/m^2.

Apply foliar treatments in early morning or late evening when larvae are feeding. Because of the patchy nature of infestations, spray only where pest pressure warrants.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Economic threshold

Not established. As a nominal threshold in canola, use provincial recommendations given for bertha armyworm, *Mamestra configurata* (Walker).

Clover cutworm adult
cc-by-nc-sa 2.0 Ilona Loser

Notes

A viral disease of larvae can reduce populations through the summer.

Similar in appearance and size to Bertha armyworm larvae. However, the majority of clover cutworm larvae will be green or light brown with fewer velvety black individuals than in a Bertha armyworm population. Also, the side band on a Bertha armyworm is yellowish-orange versus of yellowish-pink for a clover cutworm.

Clover cutworm larva
R. Underwood, AAFC

Darksided Cutworm

Euxoa messoria (Harris)

Darksided cutworm larva
John Gavloski, Manitoba Agriculture

Other common name
Reaper dart moth

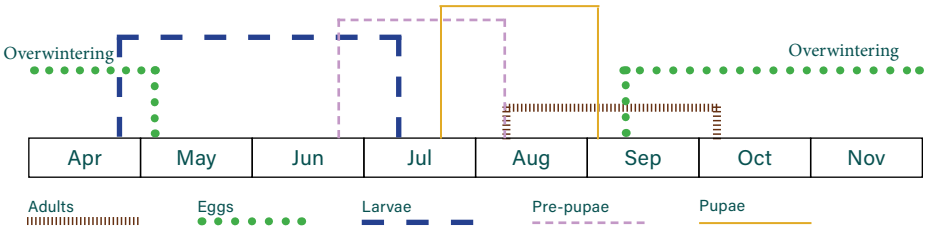
French common name
Ver-gris moissonneur

Identification
ADULTS: Forewings grayish, each with an oval and a kidney-shaped paler spot with darker margins among irregular dark lines. Wingspan of about 35 mm.
MATURE LARVAE: Hairless, up to 37 mm in length. Grayish in colour with a prominent white stripe along each side just above the legs; upper surface with a reddish background colour. Head is orange-brown with darker spots.

Distribution
Native to North America. Distributed from Atlantic to Pacific coasts, north from the southern USA into southern Canada.

Life cycle
Females lay up to 1000 eggs in soil or under debris in cultivated fields. Mature larvae enter a non-feeding pre-pupal stage for about 30 days before pupating. One generation per year.

Hosts
Broad range of herbaceous and woody hosts including vegetables, cereals, canola, corn, tobacco, flax, sunflower, vine, berry and tree fruits.



Feeding damage

Above-ground (climbing) cutworm: Larvae feed at night on the leaves and stems of young plants causing defoliation and death. Areas of bare soil increasing in size soon after crop emergence may indicate cutworm feeding damage.

Monitoring/Control

Inspect bare patches and surrounding margins for larvae, which hide at the base of plants during the day. Count the number of larvae in a 50 cm x 50 cm area of the crop; multiply by four to estimate the number of larvae per m^2. Repeat this process 5 to 10 times at 50 m intervals.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Darksided cutworm pupa
John Gavloski, Manitoba Agriculture

Darksided cutworm adult
cc-by-nc-sa 3.0 Phil Meyers

Economic threshold

Cereal and oilseed crops: 5-6 larvae/m^2 (Phillip 2015).
Peas: 2-3 larvae/m^2.
Dry beans and soy beans: 1 small (<2.5 cm long) larva/m of row or 20% of plants cut.

Notes

Larvae are similar in colour to redbacked cutworm.

The most destructive pest of tobacco throughout most tobacco growing regions of Canada (Cheng 1984). Can be particularly damaging to buds of trees and shrubs (Walkden 1950).

Dingy Cutworm

Feltia herilis (Grote)

Feltia jaculifera (Guenée)

Feltia subgothica (Haworth)

Dingy cutworm larvae (*F. jaculifera*)
John Gavloski, Manitoba Agriculture

Other common names

Herald or Master's dart (*F. herilis*)
Bentline dart (*F. jaculifera*)
Gothic or Subgothic dart (*F. subgothia*)

French common name

Ver-gris du terne

Identification

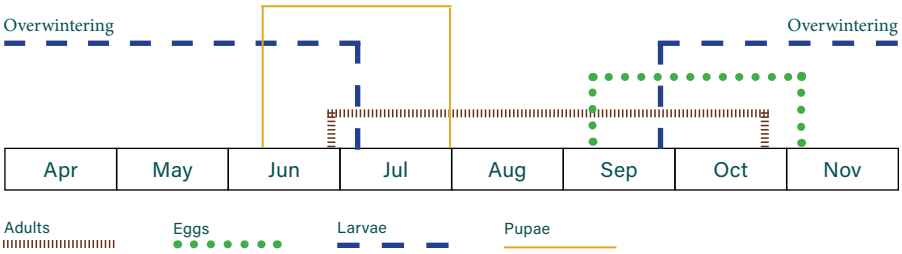
ADULTS: Forewings are dark brown with pale stripes and bean-shaped markings. *Feltia herilis* and *F. subgothica* are most similar while *F. jaculifera* has more prominent pale streaks. Wingspan of 35-40 mm.
MATURE LARVAE: Hairless; about 25-32 mm in length. General body colour pale grayish-brown; broad gray stripe down the back with light gray V-shaped patterns and four black spots on each segment.

Distribution

Native to North America. *Feltia jaculifera* and *F. herilis* are distributed from Atlantic to Pacific coasts, north from the southern USA into southern Canada; *F. subgothica* is restricted to east of the Rocky Mountains, but otherwise similar to *F. jaculifera* and *F. herilis*.

Life cycle

Overwinters as young larvae that complete development in the spring. Females lay eggs in the soil near host plants, especially in weedy, moist areas of fields. Larvae feed in fall before burrowing into



the soil to overwinter.

Hosts
Sunflower, alfalfa, corn, flax, canola, oat, barley, rye and wheat; many other vegetable, grass, ornamental and weed hosts.

Feeding damage
ABOVE-GROUND CUTWORM, ALSO CLIMBS: Crops at greatest risk in the spring, when partially mature larvae emerge to feed. Larvae feed primarily above ground on leaves and only rarely on stems. Areas of bare soil increasing in size soon after crop emergence may indicate cutworm feeding damage.

Monitoring/Control
Inspect bare patches and surrounding margins for larvae. Larvae hide at the base of plants during the day. Use a trowel or shovel to count the number of larvae in the top 2-6 cm of soil in a 50 cm x 50 cm area of the crop; multiply by four to estimate the number of larvae per m^2. Repeat this process 5 to 10 times at 50 m intervals.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26). As with other climbing cutworms, apply necessary foliar treatments in the evening just before larvae begin to feed.

Economic threshold
CEREALS: 3-4 larvae/m^2.
OILSEEDS: 25-30% stand reductions
PEAS: 2-3 larvae/m^2 in top 7 cm (3 in.) of soil (Phillip 2015).

Notes
Control of weed hosts in fallow fields and post-harvest will reduce attraction of females for egg laying. Spring and fall cultivation will expose larvae to predation by birds and predatory insects.

The common name 'dingy cutworm' is generally applied to three closely-related species that are similar in appearance, distribution and life cycles (Crumb 1956; Ayre and Lamb 1990).

Dingy cutworm adult (*F. jaculifera*)
see p. 90 for photos of *F. herilis*, *F. subgothica* adults
Carl D. Barrentine

Dusky Cutworm

Agrotis venerabilis (Walker)

Dusky cutworm adult

Other common name
Venerable dart moth

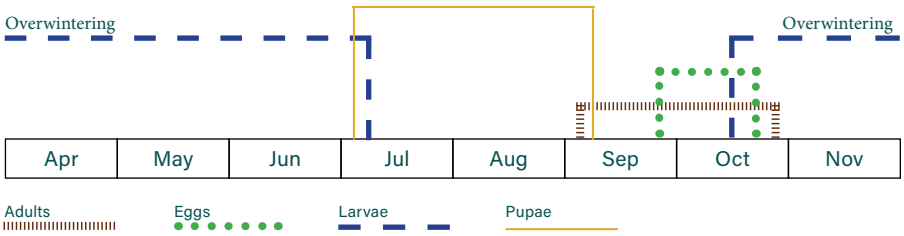
French common name
None available

Identification
ADULTS: Light to medium dark gray-brown forewings with indefinite markings. Wingspan of 30-36 mm.
MATURE LARVAE: Hairless; about 40-43 mm in length. Body colour nearly uniform, varying from dull grayish to nearly black with pale flecks; traces of pale lines along back. Head pale brownish with heavy black markings that are much broader along the back.

Distribution
Native to North America. Coast-to-coast in southern Canada, throughout the USA and south to Mexico (Crumb 1956).

Life cycle
One generation per year. In the USA, overwinters as larvae (Crumb 1929). In Canada, overwintering may occur as eggs in the top 1 cm of soil, with completion of larval development in June, pupation in late July and then emergence as adults in September (Ayre and Lamb 1990).

Hosts
Pasture grasses, oat, corn, alfalfa, clover, tobacco, chickweed, dandelion and other roadside weeds (Walkden 1950).



Feeding damage

Above-ground (tunnelling) cutworm: Larvae hide in tunnels during the day. They emerge at night to remove pieces of foliage from the host plant which they consume back in their tunnels (Walkden 1950).

Monitoring/Control

Common, but rarely a crop pest (Rings et al. 1976; Ayre and Lamb 1990). May damage turf grasses when abundant; a minor pest of gardens.

Economic threshold

None developed.

Notes

Mature larvae enter a prolonged non-feeding dormant stage during summer months before pupating in late summer or autumn (Crumb 1929).

Dusky cutworm larva

Glassy Cutworm

Apamea devastator

(Brace)

Glassy cutworm larva
cc-by 3.0 Joseph Berger, bugwood.org

Other common name
None available

French common name
Ver-gris vitreux

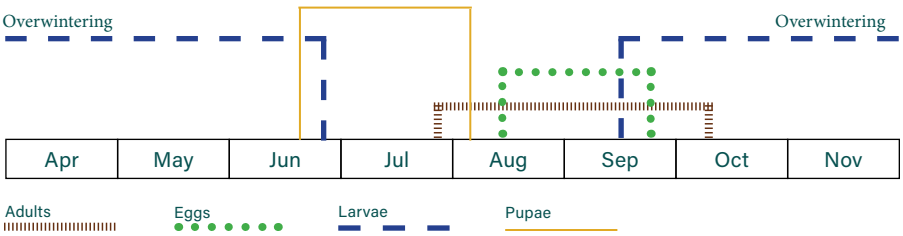
Identification
Adults: Long grayish-brownish body; forewings with several dark spots. Wingspan of 35-40 mm.
Mature larvae: Hairless; about 35-40 mm in length. Body semi-translucent, greenish-white or gray; no prominent markings. Head bright reddish-brown.

Distribution
Native to North America. Distributed from east to west coasts, north from Mexico to Alaska.

Life cycle
Overwinters as young larvae that resume feeding in the early spring. They pupate in soil cells. Females lay their eggs in the soil near host plants.

Hosts
Primarily grasses; occasional damage reported to cereals and corn.

Feeding damage
Subterranean (below-ground) cutworm: Larvae feed underground on plant crowns and roots, or, in the case of bunch grasses, within the crown and rarely come to the surface. They often clip off more leaves than they can consume.



In corn at growth stage VE (= 2 leaves visible, none with collars), clipped plants die and remain upright. Outbreaks can last 2-3 years.

Monitoring/Control

In the fall and early spring, check for larvae in fields by examining the roots, crowns and nearby soil of plants showing browned or clipped leaves or slow growth. In corn at growth stage VE (= 2 leaves visible, none wiapameath collars), look for sections of dead and upright plants within rows.

Economic threshold

None developed.

Notes

Newly broken land and summer fallow with grassy weeds should be well cultivated in August to prevent new growth suitable for egg laying and larval feeding.

Corn planted in fields seeded to wheat in the previous year may be at particular risk.

Apply insecticide using a high water volume (200 L/ha) to ensure the product reaches the larvae beneath and within the plant foliage. Apply insecticide just before rains or irrigation to improve control.

May co-occur with other cutworm species, including lined Quaker moth (*Apamea inficita*), thoughtful apamea moth (*Apamea cogitata*), plus dingy, pale western, redbacked, variegated and yellow-headed cutworm.

Glassy cutworm adult

Pale Western Cutworm

Agrotis orthogonia (Morrison)

Pale western cutworm larva

Other common name
None available

French common name
Ver-gris orthogonal

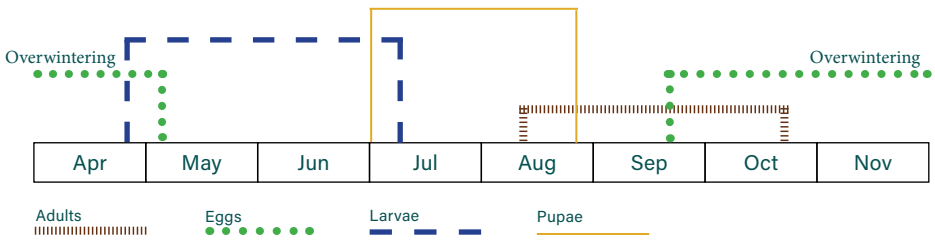
Identification
Adults: Light gray forewings with indefinite markings. Wingspan of about 38 mm.
Mature larvae: Hairless; about 40 mm in length. Body pale gray to greenish gray in colour. No distinguishing markings except for the yellow-brown head which has two distinct vertical black dashes.

Distribution
Native to North America. Largely restricted to arid and semi-arid regions. Common in Canada on the southern prairies in Alberta and Saskatchewan.

Life cycle
Overwinter as eggs in the top 1 cm of soil. Larvae pupate in earthen cells. One generation per year.

Hosts
Cereals preferred, with greatest damage observed in wheat, oat and barley. Other hosts include canola, mustard, flax, corn, sugar beet, field peas and other legumes, and certain weeds.

Feeding damage
Below-ground cutworm: Newly-hatched larvae feed on the surface of newly-emerging shoots and furled leaves of young plants causing small holes. Older larvae sever plants just below the soil surface. They occasionally pull and eat severed plants underground.



Pale western cutworm damage
cc-by-nc 3.0 Phil Sloderbeck

Monitoring/Control

Check for the presence of gaps within rows. Monitor germinating cereal crops for expanding thinned or bare areas, especially on sandy hilltops and south-facing slopes. Examine the top 5-7 cm of soil in a 30 cm x 30 cm (0.1 m^2) area for larvae at a minimum of 10 sites along the edges of an affected area. Multiply average by 10 to calculate number of larvae per square meter.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Apply insecticides to infested areas in late evening when larvae begin feeding. Larvae that do not contact residues on the soil surface will be exposed when they feed on treated leaves pulled underground. Infested fields should be sprayed before reseeding.

Economic thresholds

Cereals: 3-4 larvae/m^2. [Note: pale western cutworm at 8.4 larvae/m^2 caused 25% loss in wheat and a 30 larvae/m^2 caused 100% loss]
Flax: 4-5 larvae/m^2.
Canola: 4-5 larvae/m^2.
Pea: 2-3 larvae/m^2.
Dry beans and soy beans: 1 small (< 2.5 cm long) larva per meter of row, or 20% of plants cut.

Notes

Weed-free uncultivated fields in August to mid-September are less attractive to females for egg laying.

If volunteer cereals show signs of feeding damage in the spring, cultivate the soil and keep it black for 10 days before seeding to starve young larvae (Salt and Seamans 1945).

Pale western cutworm adult
Van Truan, bugguide.net

Redbacked Cutworm

Euxoa ochrogaster

(Guenée)

Redbacked cutworm larvae
John Gavloski, Manitoba Agriculture

Other common name
None available

French common name
Ver-gris à dos rouge

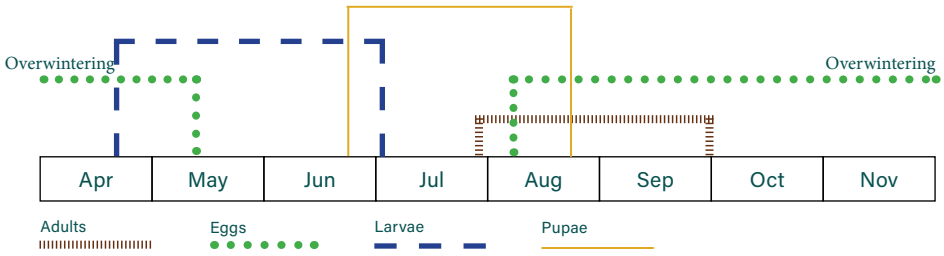
Identification
ADULTS: Forewings variable in colour, ranging from light yellow-brown, orange-brown, or red-brown with a pale brownish-yellow kidney-shaped spot pale. Tips of forewings for all colour-forms have a dark gray band. Wingspan of about 40 mm.

MATURE LARVAE: Hairless; about 38 mm in length. Broad reddish-brown stripe extending down the back with a dark center line bordered by a dark band on each side.

Distribution
Native to North America; globally present in most of the northern hemisphere in dry open habitats.

Life cycle
Overwinters as eggs in the top 1 cm of soil. Larvae pupate in earthen cells. One generation per year.

Hosts
Cereals, flax, canola, corn, mustard, sunflower, sugar beet, forage legumes, vegetables and many other crops.



Feeding damage

Above-ground cutworm: Newly-hatched larvae feed on the surface of newly-emerging shoots and furled leaves of young plants causing small holes. Plants damaged in this manner may or may not recover. Older larvae move along rows cutting off leaves and sever plants just below the soil surface. They occasionally pull and eat severed plants underground.

Redbacked cutworm adult
John Gavloski, Manitoba Agriculture

Monitoring/Control

Monitor germinating cereal crops for sections within rows of dead or dying plants; adjacent rows with this damage may be visible as thinned or bare areas. Examine the top 5-7 cm of soil in a 30 cm x 30 cm (0.1 m^2) area for larvae at a minimum of 10 sites along the edges of an affected area. Multiply average by 10 to calculate number of larvae per square meter.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Apply insecticides to infested areas in late evening when larvae begin feeding. Larvae that do not contact residues on the soil surface will be exposed when they feed on treated leaves. Infested fields should be sprayed before reseeding.

Economic thresholds

Cereals: 5-6 larvae/m^2.
Grain corn: 5-6 larvae/m^2.
Flax: 4-5larvae/m^2.
Canola: 4-5 larvae/m^2.
Pea: 2-3 larvae/m^2.
Dry beans and soy beans: 1 small (< 2.5 cm long) larva per meter of row, or 20% of plants cut.

Notes

May co-occur with pale western cutworm (p. 56), black cutworm (p. 40) and other species.

Uncultivated fields with broadleaf perennial and winter annual weeds attract egg-laying females. Therefore, keep uncultivated fields weed-free from late July to the end of September. If volunteer cereals show signs of feeding damage in the spring, cultivate the soil and keep it black for 10 days before seeding to starve young larvae (Salt and Seamans 1945).

Spotted Cutworm

Xestia c-nigrum (Linnaeus)

Xestia dolosa (Franclemont)

Spotted cutworm larva
cc-by-sa, Hsuepfle

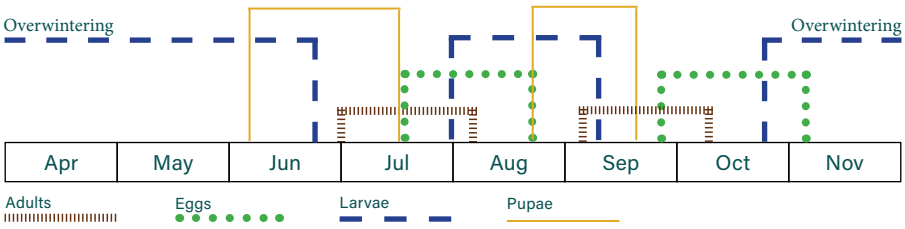
Other common names
Lesser black-letter dart moth, Setaceous Hebrew character

French common name
Ver-gris tachete

Identification
The two species are indistinguishable to the layperson.
Adults: Forewings reddish brown (males) or purplish gray (females) with a pale ochre V-shaped mark at the costa (p. 61). The base of the wing is purplish gray in both sexes. Wingspan of about 35-40 mm.
Mature larvae: Hairless, about 35 mm in length. Upper body mottled light to dark brown or gray with darker dorsal-lateral chevrons; the lower side of the body is distinctly paler in colour with a yellow or orange tint, and may be bordered by an irregular wavy black line. Head white or pale brown with black submedian arcs (p. 61); fine interlaced black to rust-coloured markings along body.

Distribution
Xestia c-nigrum has broad distribution across the northern hemisphere. In North America, it occurs from Mexico north throughout the USA (uncommon or absent in drier regions and southern states) and Canada into Alaska (in the west) and James Bay (in the east). *Xestia dolosa* is known from northcentral to northeastern USA and southeastern Canada.

Life cycle
Overwinter as larvae; emerge the following spring to complete the first and then a second generation. May complete a third generation in



southern regions of its distribution (e.g., Tennessee).

Hosts

Broad host range; includes many agricultural (alfalfa, clover, corn, oat, pea, sunflower, tobacco, wheat) and horticultural (apple, beet, cabbage, carrot, cauliflower, celery, maple, pear, peppermint, rhubarb, tomato, turnip) crops. Other hosts include ferns, Canada thistle, chickory, chickweed, currant, goldenrod, gooseberry, violets and grasses.

Feeding damage

ABOVE-GROUND (CLIMBING) CUTWORM:
Larvae feed on leaves, sever seedlings and eat roots.

Monitoring/Control

Commonly reported as pests during outbreaks, particularly in vegetable gardens.

Economic threshold

None developed.

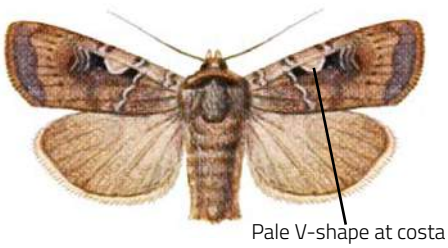
Spotted cutworm larva (early instar)

Notes

'Spotted cutworm' is the common name that has been generally used for two closely-related species that are similar in appearances and lifecycles, and which have overlapping distributions (Franclemont 1980).

In the Maritimes, larvae are reported to pupate in late April and May, with the first flight of adults in mid-May/early June (Gibson 1915). In Ontario, the first and second flights of adults are reported to occur in May and September (Rockburne and Lafontaine 1976).

Spotted cutworm larva (submedian arcs labelled)
Tina Schulz



Spotted cutworm adult
George F. Hampson (ed.) adapted by Dysmorodrepanis

Variegated Cutworm

Peridroma saucia

(Hubner)

Variegated cutworm larva

Other common name
Pearly underwing

French common name
Ver-gris panaché

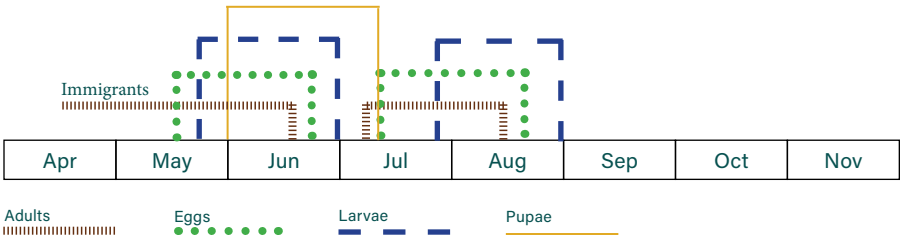
Identification
ADULTS: Forewings are yellow or brown with a pale oval marking near the wing edge, adjacent to a darker kidney-shaped marking. Wingspan of 45-50 mm.

MATURE LARVAE: Hairless, about 35-40 mm in length. Body pale gray or light brown mottled with dark brown. Larvae have four to seven pale yellow spots along their back with a large black followed by a large yellow spot on the last (8th) segment. They also have a narrow orange-brown stripe along their side.

Distribution
Broad global distribution. In North America, it occurs in Mexico, throughout the USA and across southern Canada.

Life cycle
A study from Manitoba concluded that variegated cutworm does not overwinter in Manitoba, and moths of this species are blown in from the south in the spring (Ayre et al. 1983). Two or three larval generations per year depending on weather conditions.

Hosts
Broad host range that includes corn, bean, alfalfa, cereals, sweet clover, potato, soybean, garden crops, trees, vines, grasses, ornamentals and greenhouse plants.



Feeding damage

Above-ground (climbing) cutworm: Larvae climb up plants at night to feed on foliage, flowers, buds and fruits.

Monitoring/Control

Adults can be detected with pheromone-baited traps. When cutworm damage is suspected:
Daytime: Examine the top 3-6 cm of soil around the plants for larvae.
Nighttime: Use a sweep net on foliage to catch feeding larvae.

Insecticide treatments may be warranted if cutworm numbers are high, but take steps to minimize effects on natural enemies; see *General Control Options* (p. 26).

Apply insecticides to infested areas in late evening when larvae begin feeding.

Economic threshold

None specifically for this pest; for other cutworms 2-4 larvae/m^2 can cause significant injury or loss depending on crop (Philip 2015).

Notes

Eggs laid on host plants in clusters averaged about 130 eggs (Wadley 1921); each female may lay up to 2000 eggs.

Fields free of weeds and volunteer crop hosts are less attractive for egg laying.

Variegated cutworm adult

Western Bean Cutworm

Striacosta albicosta (Smith)

Western bean cutworm larva
Laboratoire de diagnostic en phytoprotection, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, www.iriisphytoprotections.qc.ca

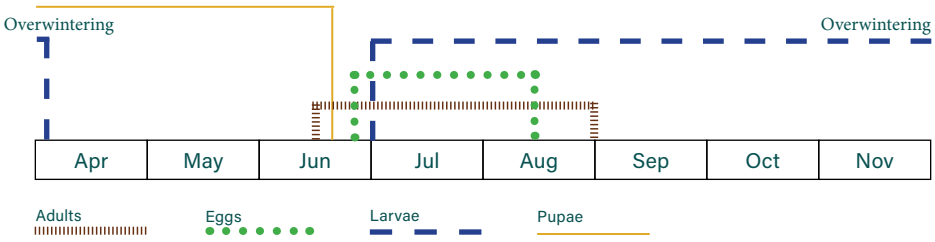
Other common name
None available

French common name
Ver-gris occidental du haricot

Identification
ADULTS: Forewings are mainly grayish-brown in colour with a broad white margin along leading edge (costa). On each forewing, there is also a small spot above a kidney-bean shaped surrounded by a white margin. Wingspan of 35-40 mm.

MATURE LARVAE: Hairless and generally smooth (no bumps or warts); about 35-40 mm in length. Body tan or pinkish in colour; two distinct black 'rectangles' located on the segment immediately behind the brown-coloured head.

Distribution
Native to North America. Historical occurrence on the Great Plains, extending from northern Mexico northward to the southern Prairie Provinces (Crumb 1956; Michel et al. 2010). Since about 2000, its range has rapidly expanded east and north to include southern Ontario and Quebec and the northeastern United States (Michel et al. 2010). Although damage by this pest has not been reported in the Prairie Provinces, corn and dry bean producers are advised to be aware of the potential for such damage.



Life cycle

Mature larvae typically drop from the host plant to the ground by early November and tunnel into the ground to overwinter within a soil chamber. Pupation occurs in the spring with adults emerging in mid- to late summer. Eggs are laid in masses of 5-200 eggs on leaves of the host plant and hatch in about a week. One generation per year.

Hosts

Primarily a pest on corn, secondarily on dry beans, pea, squash, cucumber; it is not a soybean pest. A generalist feeder on many herbaceous species with a preference for legumes. In addition, it has a high survival on red root pigweed, nightshade and lamb's quarters (Smith et al. 2011).

Feeding damage

Above-ground (climbing) cutworm:

In corn, eggs are laid on the upper leaf surface of typically the youngest 3 to 4 leaves; cultivars with upright leaves are preferred. Newly-hatched larvae feed on silks and tassels; older larvae tunnel into the ear to feed on kernels. Mature larvae are most often seen feeding on the tips (occasionally on the side) of mature ears. Larval feeding damage makes the ear prone to fungal infection, mycotoxin accumulation, and attack by secondary pests.

Western bean cutworm adult
Jocelyn Smith, University of Guelph

Pretassel corn fields are preferred by egg-laying females. Females may shift to oviposit in nearby fields of dry beans when cornfields have begun to shed pollen.

In dry beans, eggs are typically laid on the underside of leaves deep in the canopy. Newly-hatched larvae feed on leaves and flowers, but don't cause economic losses. Older larvae hide on the soil surface during the day and feed at night on the outside of pods, or tunnel into the pod to feed on developing beans. Damaged pods have an increased incidence of bacterial and fungal diseases.

Monitoring/Control

Summarized from Michel et al. (2010) and OMAFRA (2013):
Use western bean cutworm (WBC) pheromone traps starting in late June to monitor adult activity. Begin scouting fields for eggs and larvae when trap counts are nearing peak flight. Peak flight in Ontario tends to occur in late July to early August. Infestations are more difficult to detect once eggs hatch — newly-hatched larvae eat their empty egg shells while older larvae are hard to find in corn once they enter whorls or tunnel into ears.

CORN: Examine the youngest 3-4 leaves of 20 plants at a minimum of 5 scattered locations in the field. Give preference to pretassel corn fields or individual plants that will soon or have just begun to shed pollen. Because infestations are patchy and the egg-laying period may extend for several weeks, repeated visits to fields may be necessary.

It is critical that foliar insecticides be applied to coincide with egg hatch. After egg hatch, larvae enter the corn ear where they are protected from insecticide applications. If only whitish eggs are seen on plants, mark the plants and return in 3-4 days. If eggs have begun to turn purple, they will hatch in 1-2 days.

Western bean cutworm adult and egg mass
Jocelyn Smith, University of Guelph

DRY BEANS: Place one WBC pheromone trap on either side of the field, along the field's edge; monitor trap catches regularly starting in late June and keep a running tally of the cumulative catch per trap. Peak flight is reached once numbers begin to decline from the previous week's total.

Focus scouting efforts in the field approximately 10–20 days after peak moth flight when pod feeding is likely to occur; search for early signs of feeding damage. Scouting for egg masses in adjacent cornfields (which are easier to find than in dry edible beans) can also help determine local WBC populations.

Insecticide treatments may be warranted if economic thresholds are exceeded, but take steps to minimize effects on natural enemies (see *General Control Options*, p. 26).

Economic threshold

CORN: Eggs or small larvae detected on 5% of scouted plants. If the eggs have hatched, spray at 95% tassel emergence; if tassels are already emerged, spray when most of the eggs are expected to hatch. Select insecticides that have some residual activity during the moth flight/oviposition period.

DRY BEANS: If WBC has reached a threshold in the neighbouring corn field, then adjacent dry edible bean fields are likely at risk, especially if the corn fields have passed the pre-tassel stage. If entry holes are observed in the pods prior to R6 stage, an insecticide application is necessary. Select insecticides that have some residual activity, and pay attention to pre-harvest intervals.

Notes

Overwintering survival is favoured in sandy soils where larvae can tunnel to greater depths that protect from soil tillage and cold temperatures Deep tillage may kill overwintering larvae.

Larvae from the same egg mass may move 2–3 m to feed on different plants.

Transgenic Bt corn hybrids containing Vip3A protein are reported to provide nearly 100% control. Transgenic Bt corn hybrids containing Cry1F protein may provide some protection, although WBC appears to be developing resistance in the USA and Ontario (Ostrem et al. 2016).

Western bean cutworm larval damage in corn
Jocelyn Smith, University of Guelph

Western bean cutworm larval exit wounds on bean
Jocelyn Smith, University of Guelph

Winter Cutworm

Noctua pronuba (Linnaeus)

Winter cutworm larva

Other common names
Snow cutworm,
Large yellow underwing moth

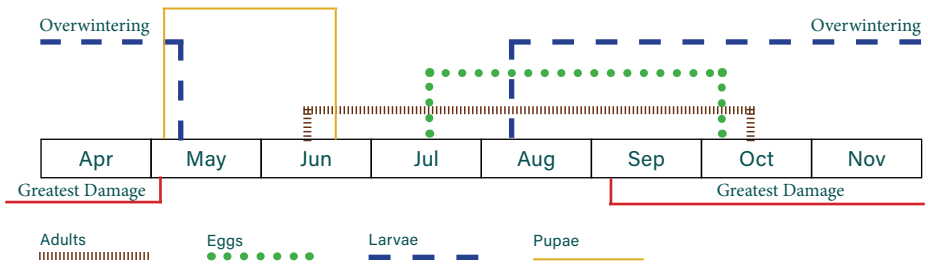
French common name
Fiancée

Identification
ADULTS: Forewings brown with prominent small black dots near tip; hindwings bright yellow-orange with a black marginal band. Wingspan of 50-55 mm. Distinct from other species.
MATURE LARVAE: Hairless; about 35-40 mm in length. Body typically olive brown, occasionally green or with a reddish-hue. Each body segment has a distinct black and cream-coloured dash on either side of the dorsal mid-line. Head tan in colour with two thick black lines that form a 'V' extending out from the 'neck' of the larva.

Distribution
Non-native; broad distribution in Eurasia. In North America, it occurs throughout most of the USA and southern Canada.

Life cycle
Information is unavailable for Canada. In Idaho, it overwinters as partially or nearly mature larvae. Adults require 4-6 weeks to mature before laying egg masses and are active into early October (Bechinski et al. 2009). Typically one generation per year, although three to four may occur in warmer climates (Passoa and Hollingsworth 1996).

Hosts
Broad host range. Feeds on alfalfa, oat, rye, wheat, and grass



hay. Vegetables hosts include carrot, onion, potato, spinach, rhubarb, sugar beet and tomato. Other hosts include strawberry, hawkweed, dandelion, plantain, grape, marigold, chrysanthemum and others.

Feeding damage

Climbing or subterranean (below-ground) cutworm, depending on host species: At night, winter cutworm will climb into the canopy of some host species to feed on leaves, buds and open flowers. They will also sever young plants near ground-level. During the day, they hide under crop residue or clumps of soil. For other host species (e.g., root crops), they will feed in the crown and on roots.

Monitoring/Control

Common pest of gardens. Damage to field crops has been reported in alfalfa and rye (Michigan) and winter wheat (Idaho) (Bechinski et al. 2009). No research has been done on managing this species as an agronomic pest.

Winter cutworm adult

Economic threshold

None developed.

Notes

First reported in North America in Nova Scotia in 1979; now present in all provinces and often common.

Larvae will feed during mild winter days (temperatures of about 7°C and above). Hence, the common name of 'winter' or 'snow' cutworm.

There are no reports of crop damage by this pest in Canada. This may be because the species is a relatively new arrival to North America, or because our colder weather prevents it from reaching high densities.

Winter cutworm larva

Yellow-headed Cutworm

Apamea amputatrix (Fitch)

Yellow-headed cutworm larva
Roxanne S. Bernard

Other common names
None available

French common name
Ver-gris á tête jaune

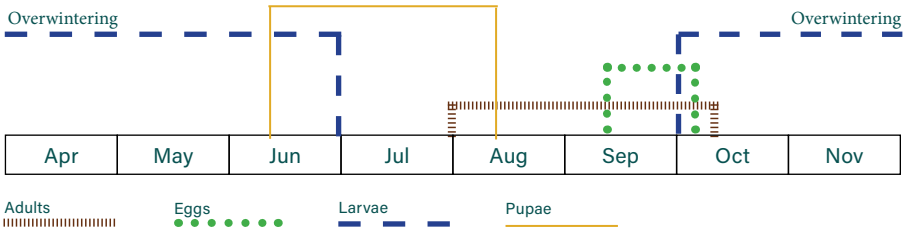
Identification
ADULTS: Variable multicolored dark red-brown to chocolate brown forewings with a row of white or ochre spots along the kidney-shaped spot. Wingspan of about 40 mm.

MATURE LARVAE: Hairless, about 30 mm in length. Body dull greenish-white and somewhat semitransparent; sides wrinkled in appearance. Reddish head with black mandibles. Each segment with a few very small brownish dots, each dot with one fine brownish hair.

Distribution
Native to North America. Widespread, excluding parts of southeastern USA and much of the Great Plains. Present across the Prairie Provinces.

Life cycle
Overwinters as an early instar larva. One generation per year.

Hosts
Broad host range that includes oat, wheat, triticale, corn, pea, potato, cabbage, currant, grape, lettuce, rose, spinach, and turnip.



Feeding damage

Subterranean (below-ground) cutworm: Feeds on roots and can sever young plants below the soil line.

Monitoring/Control

Not usually considered a pest of economic importance, although local outbreaks have been associated with crop damage.

Economic threshold

None developed.

Notes

Identified as *Septis arctica*, Knutson (1944) reports that larvae of the yellow-headed cutworm feed mainly underground on the roots of cereals, grasses and corn. Secondarily, it is reported to feed on shoots of vegetables and shrubs.

Other sources identify it as an above-ground feeding cutworm, and it is indicated as such in the table on p. 5.

During local outbreaks, larvae may climb into hardwood shrubs to feed.

Yellow-headed cutworm adult

Other Common Cutworms of Economic Importance

Black army cutworm

Black army cutworm larvae
John Gavloski, Manitoba Agriculture

Also called the Finnish dart moth, *Actebia fennica* (Tauscher) is a common boreal species that occurs across North America and south into the northern tier states. Adults somewhat resemble those of redbacked cutworm. Larvae are hairless and black with wavy white bands along either side of the body. There is one generation per year, with larval-feeding completed by the end of May or early June.

Huckleberry (*Vaccinium* spp.) is the common host plant, and larvae have become an economic pest of blueberries in northeastern North America. During outbreaks, larvae will feed on many other species and may defoliate conifers.

Claybacked cutworm

Claybacked cutworm larva
cc-by-nc 3.0 James Kalisch, bugwood.org

Also called the Swordman Dart moth, *Agrotis gladiaria* (Morrison) is generally distributed east of the Rocky Mountains. It is most often associated with grasslands in the prairie region. Adults are patterned with various markings with a light-coloured fringe along the tip of the wings. Larvae are hairless with a broad dorsal reddish-tan stripe divided lengthwise by a mid-dorsal line. Winter is passed as partly grown larvae with one generation per year.

Larvae feed on garden, berry and field crops. They have been reported to be quite destructive at times in parts of their range. On the prairies, populations can reach high numbers on pastures and in alfalfa, but do not normally cause economic damage (Walkden 1950).

Strawberry cutworm

Strawberry cutworm adult

Also called the Interoceanic Ear Moth, *Amphipoea interoceanica* (Smith) occurs across Canada from Nova Scotia and west into Alberta. The forewings of adults are light reddish-brown with darker brown wavy lines and circles, and each a prominent whitish spot near the foremargin. Larvae are hairless with a yellowish-brown head. The body is cream-coloured with a broad dorsal band and narrower subdorsal bands, each coloured purplish-brown. Winter is passed in the egg stage, with larvae feeding from May into July. There is one generation per year.

Larvae feed on grasses and sedges and on the leaves, stems and fruits of strawberry, for which they can be economically-important pests of commercial fields (Ayre 1980).

White cutworm

Euxoa scandens (Riley) is a common species of climbing cutworm widely distributed throughout Canada east of the Rocky Mountains. Adults have light grey or gray-brown (rarely pink) forewings and white hindwings. Larvae are hairless, whitish in colour with a brown head. Larvae can be found starting in late July and overwinter. There is one generation per year.

Larvae are occasionally reported to cause economic damage to various vegetable crops and to fruit trees, the latter by feeding on buds and leaves. Larvae also have been reported in sweet clover, and from around the base of dock (*Rumex* spp.) and among willow sprouts along irrigation ditches.

White cutworm larva
Canadian National Collection, AAFC

Insects Commonly Mistaken as Cutworms

By the time crop damage is detected, cutworms may range in size from about 1-2 cm (0.5-0.75 in.) before reaching their final instar size of about 3-4 cm (1.25-1.5 in.). Organisms that are occasionally mistaken as cutworms include leatherjackets, millipedes, white grubs and wireworms.

Leatherjacket

Leatherjacket is the common name for crane fly larvae (Diptera: Tipulidae). Adult crane flies resemble large mosquitoes, with a similar body shape and delicate long legs. They feed on nectar and are not pests. In contrast, the larvae of some crane fly species can cause extensive damage to grass and forage crops (Jackson and Campbell 1975) and can be remarkably similar in size, shape and colour to cutworms. However, cutworms have a distinct head capsule and legs which leatherjackets lack.

Crane fly larva (*Tipula* sp.)
John Gavloski, Manitoba Agriculture

Early cutworm larvae (left) vs. cranefly larvae (right)
Vincent Hervet, AAFC

Millipede

Millipede
cc-by-nc-sa 3.0 Jeorg Spelda

Millipedes have hard, long and cylindrical bodies that may reach 30 mm for species found in Canada. Each body segment has two pairs of legs with usually more than 20 segments per millipede. They feed on a wide variety of plant material, but tend to prefer decaying plants and are not considered crop pests. Although they have a head capsule, the presence of more than three pairs of true legs immediately distinguishes them from cutworms.

White grub

White grubs are the larvae of scarab beetles (Coleoptera: Scarabaeidae). There are many scarab beetle species. Adults of some of these species are commonly called June beetles or Chafer beetles. Depending on the species, larvae may feed in dung, rotting vegetation or on plant roots. Larval feeding by some species is a common cause of damage to turf on golf courses (Smitley et al. 1998). Crop damage by scarab beetle larvae on the prairies is uncommon. Fields that have composted manure incorporated or have recently been converted from pasture, meadow or rangeland may be at particular risk.

White grub larva (scarab beetle) (*Chilothorax distinctus*)
K.D. Floate, AAFC

Similar to cutworms, scarab larvae have a head capsule and three pairs of true legs on the thorax (p. 3). Unlike cutworms, scarab larvae lack abdominal prolegs, are whitish in colour and typically rest with their body

curved in a 'C' shape. The abdomen of scarab larvae is distended with an obvious swollen appearance and often appears darkish, due to digested material in the gut. The maximum larval body length for white grub species most often reported from crop land (i.e., from scarab subfamily Aphodiinae) is unlikely to exceed 5 mm. Larger species (*Phyllophaga* spp.; subfamily Melolonthinae) with a maximum larval size of 2-4 cm may occasionally be encountered at sub-economic levels.

White grub adult (scarab beetle) (*Chilothorax distinctus*)
K.D. Floate, AAFC

Wireworm

Wireworm (click beetle larva)
John Gavloski, Manitoba Agriculture

Wireworms are click beetle larvae (Coleoptera: Elateridae). The larvae of many click beetle species feed underground on seeds, roots and other below-ground plant parts of different types of plants and can cause significant crop damage when present at high densities. Pastures, meadows and rangeland can have high densities of wireworms. When these lands are converted to annual cropping, crops in the first or second year following the conversion may be at particular risk.

Both cutworms and wireworms have a cylindrical body shape with a head capsule and three pairs of true legs on the thorax. However, wireworms have a hard body, range in colour from pale yellow to reddish-brown, have a distinct notch in the tail segment, and do not have abdominal prolegs. Cutworms, on the other hand, are soft-bodied, lack a notched tail segment, and have abdominal prolegs.

Internet Resources

Prairie Pest Monitoring Network

Regional risk maps, in-season weekly updates, monitoring protocols, insect of the week, etc.

www.prairiepestmonitoring.blogspot.ca/

Pesticide Management Regulatory Agency (PMRA) pesticide label search

View product information and full labels. The pesticide label search is also available as a mobile app (iPhone and Android)

http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php

Crop Protection Guides

Alberta

http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex32

Saskatchewan

http://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/crop-protection/guide-to-crop-protection

Manitoba

www.gov.mb.ca/agriculture/crops/guides-and-publications/#gfcp

Insect Guides

Canola Council - Canola Encyclopedia - Insects - Cutworms

www.canolacouncil.org/canola-encyclopedia/insects/cutworms

Canola Watch - Cutworm Management Tips

www.canolawatch.org/2011/05/26/cutworm-management-tips/

Cutworms in field crops - Manitoba Ministry of Agriculture, Food, and Rural Development

www.gov.mb.ca/agriculture/crops/insects/cutworms-field-crops.html

Field Crop and Forage Pests and their Natural Enemies in Western Canada - Identification and Management Field Guide

http://publications.gc.ca/site/eng/9.630050/publication.html

Guide des ravageurs de sol en grandes cultures (Soil crop pests guide – French only):

www.agrireseau.net/grandescultures/documents/guide%20des%20ravageurs%20du%20sol_dec%202012.pdf

Western Forum on Pest Management – guidelines for insect pest control in cereal grains, oilseeds, forage crops, pulse crops, tree fruits, turf, and wood and timber structures

www.westernforum.org

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Notes



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Identification and Management Field Guide