Biology of hop looper and its natural enemies

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Introduction

The hop looper, *Hypena humuli*, is a native noctuid moth widely distributed across the continental USA and Canada (Holland, 1905). The larvae usually feed only on hops, although they have occasionally been found on stinging nettle (*Urtica* sp.) (Grimble et al., 1992). The hop looper was first recorded as a pest of hops in the eastern US in the mid-1800s, but until recently has only been regarded as an occasional, or relatively minor, problem. However, hop looper is now beginning to re-emerge as a more frequent and damaging pest of Washington hops, probably as a result of the replacement of broad-spectrum organophosphate compounds for aphid and mite control by more selective products that provide little incidental control of loopers.

Biology and life history

Hop loopers overwinter in the adult stage. Both sexes of the adult have a distinctive, elongated snout that gave this species its original common name of "hop-vine snout moth." The females have a distinctive W-shaped dark patch along the leading edge of each forewing (Fig. 1), while in males this mark is generally obscured by the darker and more uniform color of their wings (Fig. 2). As the males age, however, some of the surface scales on their wings may be lost, making them appear more like the females. The overall wingspan of both sexes is approximately 26 mm (1 inch).

The adults leave the hop yards in autumn (late September/October) to seek shelter elsewhere. They have been found overwintering in caves (Kikukawa, 1982; Godwin, 1987) and probably also use other protected sites such as cracks and crevices in tree trunks, fallen logs, fence posts, etc. The adults are thought to be capable of dispersing several miles to and from their overwintering sites, but the maximum extent of their migratory flight is not yet known. They return to the hop yards in early spring (late

Fig. 1. Adult female hop looper

Fig. 2. Adult male hop looper

March/early April) and typically remain concealed within the hop foliage during the day, flying only at night or when disturbed.

Looper eggs may be found on hop foliage from mid-April onwards. The eggs are slightly flattened and are approximately circular when viewed from above, with an average diameter of 0.5 to 0.6 mm (about 1/5 inch) (Fig. 3). They are translucent and, when first

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Fig. 3. Hop looper egg

deposited, have a faint greenish tinge which gradually disappears as the eggs mature and turn white. In general, just a single egg is found on each leaf, although it is not unusual to find two or three on the same leaf, and very occasionally as many as eleven have been found; in such cases, however, the eggs are always laid singly, not in groups. The eggs are usually found on the underside of the leaf, either alongside a major vein (often at the point where the leaf blade joins the petiole) or on the leaf margin. Adult females can lay up to 600 eggs during their lifespan (three to four weeks for the summer generations), and it takes approximately three days for the eggs to hatch at a temperature of 26 °C (~79 °F). At this temperature, it takes the newly-emerged larvae fourteen to fifteen days to reach the pupal stage, and an additional nine days before the adults emerge. In the field, some larvae will pupate on the plant (e.g., where two leaves overlap), while others pupate in the surface litter at the base of the plant or just beneath the soil surface.

The larvae normally complete their development in five larval stages (instars), although a few individuals will undergo an additional (sixth) instar before pupating. The larvae are pale green with a narrow white line on each side of their upper surface and have a slightly flattened appearance (Fig. 4). They have three pairs of true (jointed) legs just behind the head and four additional pairs of fleshy "prolegs": three pairs on abdominal segments 4, 5, and 6, plus a pair on the final abdominal segment. They move with a characteristic "looping" motion. The larvae appear to feed mainly at night; during the day they are often found lying motionless along the main vein on the underside of a leaf or stretched out along the leaf stalk, making them very difficult to see. If disturbed, the younger larvae will often respond by dropping from the leaves on a silken thread, while the more mature larvae may react with a violent side-to-side thrashing motion.

Fig. 4. Mature larva of hop looper

The hop looper completes three larval generations per year in south-central Washington State. However, because the initial spring flight of overwintered adults (and their subsequent egg-laying period) extends over several weeks, the three generations do not remain discrete, but overlap to a considerable extent. As a result, from late May onwards, larvae of virtually all ages and sizes are present in the field at the same time, making it difficult to determine the best time to apply insecticides.

Damage

If large numbers of larvae are present, they can defoliate the plant, with attacked leaves taking on a characteristic "lacey" appearance (Fig. 5). Eggs are deposited with equal frequency at all heights in the canopy, but because the older leaves at the base of the plant can sustain damage from all three generations of larvae, this area often appears to be particularly badly affected. Of more concern to growers than leaf damage, however, is the direct damage to the cones that can result from the third (most numerous) generation of larvae.

Fig. 5. Typical hop looper damage to hop foliage, showing distinctive "lacey" appearance

Natural enemies

At least nine species of parasitoids have been found associated with the various life stages of the hop looper. Two species of *Trichogramma* wasps attack the egg stage, with as many as three adult wasps emerging from each looper egg. When not disrupted by pesticide applications, these minute wasps are capable of season-long parasitism rates of about 20%, with occasional peaks of up to 70% parasitism.

Five species of parasitic tachinid flies have been found attacking the larval stages, although a European species, *Compsilura concinnata* (originally introduced to control the gypsy moth), is by far the most common (Fig. 6). It typically attacks the larger larvae, usually laying a single egg inside each host. The developing fly larva feeds next to the wall of the looper's gut, eventually killing it and emerging from either the mature host larva or pupa. As with the egg parasites, the level of larval parasitism is generally highest in the third generation, but even then rarely exceeds 30%.

Fig. 6. Compsilura concinnata*, a parasitic tachinid fly that attacks hop looper larvae (shown with pupal case)*

Pupae of the hop looper are attacked by two ichneumonid wasps, *Pimpla sanguinipes* (Fig. 7) and *Vulgichneumon brevicinctor* (Fig. 8). These two species can be very abundant in hop fields after harvest and probably help reduce the number of adult loopers entering the overwintering stage. However, they seem to be largely absent from hop yards until very late in the season.

In addition to these parasitic species, generalist predators (e.g. yellowjacket wasps, rove beetles, big-eyed bugs, etc.) are also capable of killing many looper larvae. Birds do not appear to be important predators of the larvae, although their effect on adult populations is unknown.

Chemical control

No economic threshold has been established for hop loopers, and determining the best time at which to apply insecticides is complicated by the fact that, for most of the season, the larval population consists of a mixture of virtually all ages and sizes, with considerable overlap between the second and third generations. As a result, there is no point at which

Fig. 7. Pimpla sanguinipes *(female), a parasitic wasp that attacks hop looper pupae*

Fig. 8. Vulgichneumon brevicinctor*, another parasite of hop looper pupae*

the final (most damaging) generation is dominated by the small larvae that are the preferred target for insecticidal treatments. However, research trials suggest that even the larger instars are readily killed by a range of pesticides, although the use of broad-spectrum compounds (e.g., synthetic pyrethroids such as bifenthrin) should be avoided in order to preserve beneficial insects and mites. *Bacillus thuringiensis* subsp. *aizawai* (currently marketed under the trade name of XenTari®) has proved effective in field trials (even against large larvae) and has the advantage of preserving natural enemies not only of the hop looper but also of other pests such as mites and aphids. (Note: users are reminded to check label for current registrations and rates prior to using any pesticide.)

Other Lepidoptera found on hops in Washington State

Bertha armyworm (*Mamestra configurata*) appears to be the only other relatively common lepidopteran found on Washington hops, and it, too, can occasionally reach damaging levels. It has a much broader host range than hop looper, and its eggs tend to be laid in groups rather than singly. The first instar larvae can be distinguished from those of the hop looper by their black heads (which become paler in later instars) and by their often clumped distribution. The older larvae have a slightly more cylindrical body than do loopers and an additional pair of prolegs (five rather than four). Other Lepidoptera collected and reared from hops in Washington State are listed in Table 1, together with a subjective estimate of their relative abundance.

Table 1

Other Lepidopteran larvae found on hops in south-central Washington

Species	Relative abundance on hops
Mamestra configurata (Bertha armyworm)	Common
Anavitrinella pampinaria (Common gray)	Fairly common (but heavily parasitized)
Spilosoma sp. (No common name)	Fairly common (but heavily parasitized)
Lacanobia subjuncta (Speckled cutworm/ Lacanobia fruitworm)	Occasional
Trichoplusia ni (Cabbage looper)	Occasional
Xestia c-nigrum (Spotted cutworm)	Occasional
Autographa californica (Alfalfa looper)	Occasional
Strymon melinus (Gray hairstreak)	Occasional
Udea profundalis (False celery leaf-tier)	Rare

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By Tessa Grasswitz and David James, WSU Prosser Irrigated Agriculture Research and Extension Center.

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