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Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

Cooperating State Departments of Agriculture

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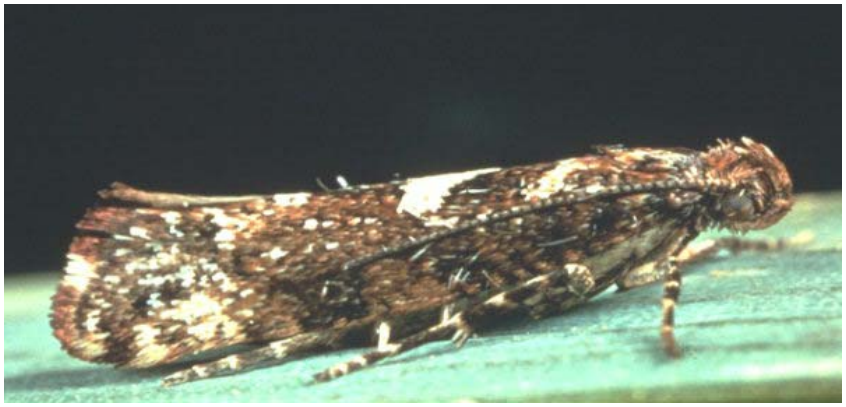
New Pest Response Guidelines

Leek Moth

Acrolepiopsis assectella (Zeller)



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November 25, 2004

New Pest Response Guidelines: Leek Moth was prepared by Susan E. Ellis, USDA APHIS PPQ PDMP and edited by Patricia S. Michalak, USDA APHIS PPQ/Manuals Unit.

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Cover photo: *Acrolepiopsis assectella* adult. (Image courtesy of Jean-Francois Landry, Agriculture and Agri-Food Canada)

Credits

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Appendixes

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Table of Contents

Chapter 1 Introduction

Purpose

Use New Pest Response Guidelines: Leek Moth as a guide when designing a program to detect, monitor, control, contain, or eradicate an infestation of this pest. If the pest is detected in the United States, USDA APHIS PPQ personnel will produce a site-specific action plan based on the Guidelines or new information available at the time. We hope that state agriculture department personnel and others concerned with developing local survey or control programs for this pest may find the Guidelines useful.

PPQ develops the New Pest Response Guidelines through discussion, consultation, or agreement with staff at Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS), Canadian Food Inspection Agency (CFIA), Ontario Ministry of Agriculture and Food (OMAF), and with university advisors.

Disclaimers and document comprehension

This document is not intended to be complete and exhaustive. It provides a foundation, based upon the literature available, to assist further work. Some key articles were not available at the time of writing, and not all specialists and members of the research community were consulted for their advice. For the most current information on this pest, consult with local agricultural experts, including personnel from Cooperative Extension Service, State Departments of Agriculture and USDA. Conduct your own literature search. Search websites frequently, since material is updated periodically.

Commercial suppliers or products

References to commercial suppliers or products should not be construed as an endorsement of the company or product by USDA.

Contacts

When an emergency program for the leek moth has been implemented, its success depends on the cooperation, assistance, and understanding of other involved groups. The appropriate liaison and information officers should distribute news of program progress and developments to interested groups, including:

- Other Federal, State, county, and municipal agricultural officials
- Grower groups (such as specific commodity or industry groups)

- Commercial interests
- Academic entities with agricultural interests
- Land-grant universities with Cooperative Extension Services
- State and local law enforcement officials
- Public health agencies
- Foreign agricultural interests
- National, State and local news media, and
- The public

Initiating an emergency pest response program

An emergency pest response program or incident response consists of detection and delimitation, and may be followed by programs in regulation, containment, eradication and/or control.

If a newly detected exotic or imminent pest threat does not have a current New Pest Response Guidelines document for reference, the New Pest Advisory Group (NPAG) evaluates the pest. After assessing the risk to U.S. plant health and consulting with experts and regulatory personnel, NPAG makes a recommendation to PPQ management for a course of action.

Follow this sequence in any order when initiating an emergency pest response program:

1. A new or reintroduced pest is discovered and reported
2. The pest is examined and pre-identified by regional or area identifier (see chapter 3)
3. Pest identity is confirmed by national taxonomic authority (see chapter 3)
4. New Pest Response Guidelines are consulted or NPAG is assembled to evaluate the pest
5. Depending on the urgency, official notifications are made to the National Plant Board, cooperators, or trading partners
6. A delimiting survey is conducted at sight of detection (see chapter 4)
7. A Incident Assessment Team may be sent to evaluate the site
8. A recommendation is made, based on the assessment of surveys, other data, and recommendations of the Incident Assessment Team and/or an NPAG, as follows (see chapter 6 and chapter 5):
    - Take no action

- Regulate the pest
- Contain the pest
- Suppress the pest
- Eradicate the pest

9. State Departments of Agriculture are consulted
10. If appropriate, a control strategy is selected
11. A PPQ Deputy Administrator authorizes a response
12. A command post is selected and the Incident Command System is implemented
13. Further detection surveys are conducted (see chapter 4)
14. Field identification procedures are standardized (see chapter 3)
15. Data reporting is standardized
16. Environmental assessments are completed as necessary
17. Treatment is applied for required pest generational time (see chapter 6)
18. Environmental monitoring is conducted if appropriate
19. Pest monitoring surveys are conducted to evaluate program success (see chapter 4 and chapter 6)
20. Programs are designed for eradication, containment or long-term control of the pest (see chapter 6)

Program safety

Safety of the public and the program personnel has priority in preprogram planning and training, and throughout operations. Safety officers and supervisors must enforce on-the-job safety procedures.

Support for program decision making

The USDA APHIS PPQ Center for Plant Health, Science and Technology (CPHST) provides technical support to emergency pest response program directors concerning risk assessments, survey methods, control strategies, regulatory treatments, and other aspects of pest response programs.

Chapter 2 Pest Information

Classification

Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Acrolepiidae
Superfamily:	Yponomeutoidea
Genus:	*Acrolepiopsis*
Scientific name:	
	Acrolepiopsis assectella Zeller
Also known as:	
	Acrolepsis assectella Zeller
	Acrolepia assectella
	Roeslerstammia assectella Zeller
Easily confused with:	
	Acrolepiopsis betulella
	Acrolepiopsis heppneri
	Acrolepiopsis incertella
	Acrolepiopsis leucoscia
	Acrolepiopsis reticulosa
	Acrolepiopsis sapporensis
	Diamondback moth (*Plutella xylostella*)
Common names:	
	Leek moth
	Onion leaf-miner (Gaedike 1997)

History and distribution

The leek moth has established populations in geographic areas with climates equivalent to USDA climatic zones 4 through 8. The leek moth and other members of the family Acrolepiidae have been found in Algeria, Canada, Hawaii, Japan, Siberia and most of Europe. Three *Acrolepiopsis* species are indigenous to North America (Borror et al., 1989).

Handfield (1997) published the first report of *A. assectella* in North America. Adult moths were collected in a black light trap in Aylmer, Quebec in the greater Ottawa area of eastern Canada. Since the first detection, subsequent surveys found moths on farms in the Ottawa-Hull area of Ontario.

Economic impact and host range

The leek moth is a potential threat to U.S. onion and leek production. U.S. onion-growing areas include the Great Lakes region, California, Oregon,

Colorado, Texas, New York, Washington and Georgia. In 1996, U.S. onion production was valued at approximately $600 million (NPAG, 2000).

The leek moth is a specialist and feeds on plants in the genus *Allium* (Liliaceae) (Table 2.1). It prefers leeks (*Allium porrum*) and onions (*Allium cepa*), although some reports have placed it on other cultivated *Allium* hosts. Wild leek, *Allium ampeloprasum,* is less attractive (Messiaen and Leroux 1968).

An isolated report (Picard 1910) mentioned the possibility that leek moths caused damage to ornamental day-lilies (*Hemerocallis sp.)* and onionweed (*Asphodelus fistulosis*). PPQ's Pest Interception Network data includes one interception on *Pimenta sp* (Myrtaceae or Myrtle family).

Table 2.1. Common host plants of the leek moth

Primary hosts	
Leek	*Allium porrum*
Onion	*Allium cepa* Cepa group
Secondary hosts	
Chives	*Allium schoenoprasum*
Garlic	*Allium fistulosum*
Welsh onion	*Allium cepa* Aggregatum group
Shallot	
Potential U.S. hosts (continental)	
	Allium ampletcens
	Allium biceptrum
Nodding/wild onion	*Allium cernuum*
Striped garlic	*Allium cuthbertii*
Red-skinned onion	*Allium haematochiton*
	Allium rubrum
	Allium textile
Wild leek, ramp	

Damage

Feeding by larvae damages plants and is particularly devastating on first-year *Allium* spp. plants. Most plant damage occurs at the perimeter of a cropped field (Nyrop et al., 1989).

Soon after hatching, larvae mine galleries 2-5 mm long in the epidermis of the leaves of the host (ARS 1960) (Figure 2.1). After about five days, the larvae move toward the heart of the plant, eventually boring through the folded inner leaves (Figure 2.2) (Carter 1984). Larvae may feed on the insides of hollow *Allium* spp. leaves, creating translucent "windows" or bands on the leaf tissue.

Mining and perforations, appearing as “pinholes” on inner leaves, are symptomatic of a leek moth infestation.

Figure 2.1. Damage to outer leaves. Soon after hatching, larvae mine galleries 2-5 mm long in the epidermis of the leaves of the onion hosts. (Image courtesy of Jean-Francois Landry.)

Figure 2.2. Damage to inner leaves. After about five days, the larvae move toward the heart of the plant, eventually boring through the folded inner leaves. (Image courtesy of Ontario Ministry of Agriculture and Food.)

In onions, larvae may bore downward into the bulb (Figure 2.3) (Carter 1984), causing plants to age prematurely as the larvae excavate galleries into the inner bulb tissue (NPAG 2000). In garlic, larvae may bore into stems (Figure 2.4). Host plants are unsightly and distorted because of this damage (Nyrop et al. 1989; INRA, 2000) and may rot. Entire lots of pest-free bulbs may rot when stored with infested bulbs.

Figure 2.3. Damage to onions. In onions, leek moth larvae may bore downward into the bulb. (Image courtesy of Institut National de la Recherche Agronomique.)

Figure 2.4. Damage to inner leaves. After about five days, the larvae move toward the heart of the plant, eventually boring through the folded inner leaves. (Image courtesy of Ontario Ministry of Agriculture and Food.)

Members of the leek moth family damage plants by mining in leaves, skeletonizing leaves, and feeding on fruit or bulbs. They do not directly damage seeds, which have chemical defenses against plant-feeding insects (Arnault and Mauchamp 1985). Larvae sometimes feed on flower stalks, preventing the development of seeds (ARS 1960). They typically avoid feeding on flowers of the host, since flowers contain a saponin compound that inhibits larval growth (Harmatha et al. 1987).

Life cycle

The life cycle of the leek moth in North America has not been reported. In northern Europe the leek moth has two generations each year. In southern Europe, the leek moth may have five or six generations each year (Carter 1984). The leek moth undergoes complete metamorphosis:

Egg→Larva (caterpillar) →Pupa→Adult (moth).

Leek moths over-winter as adults or pupae in host plant or other plant debris. In spring, when temperatures increase to approximately 50^0 F (9.5^0 C), adults emerge at dusk in search of mates. Females fly in an irregular, zigzag pattern at night and mate within 24 hours after emergence (ARS 1960). If the winter has been severe, the first generation of larvae will be sparse and cause little damage to plants.

Each leek moth female produces an average of 100 eggs during her lifetime. Where three generations emerge annually, the eggs of the second generation will hatch in 4-6 days. Eggs of the last generation, laid in the fall, may not hatch for 8-11 days.

Larvae mine leaves and bore in towards the center of the plant, causing tissue damage that creates unsightly plants and may lead to premature senescence of the plant and rotting of the tissue. Larvae develop through five instars over 15 days at a temperature of 77^0 F (25^0 C). Development is prolonged at lower temperatures. Larvae attain a length of 10-12 mm.

Mature larvae construct a mesh cocoon, often described as a “cargo net”. They attach the cocoon to foliage, usually on the host plant. Pupation spans approximately 10 days.

In climates that support a second generation, adult moths emerge from the cocoon to commence the second, and usually the most destructive generation. In climates that do not support a second generation, some adults will immediately emerge and seek shelter in plant debris. Remaining pupae will overwinter, and adult moths will emerge the next season (ARS 1960). Adults live for approximately 23 days. Females reportedly mate only once.

Development

The development of a pest will guide program actions and influence the selection and success of eradication treatments, the duration of trapping activities and regulatory functions. Many factors influence the development of insects, including host availability, pest population densities, photoperiod, rainfall, and temperature.

Temperature is one of the most important factors influencing the development of all insect life stages. Scientists use site-specific temperature data, along with knowledge of insect development, to predict when pests will be most abundant and likely to damage plants at a particular location. Scientists use temperature data in a tool known as the degree day value.

Degree day values are useful for the following:

- Predicting emergence of adults
- Determining the time to begin trapping
- Monitoring cycles of generation during a season
- Monitoring the effect of eradication or suppression measures

Degree day values are based on the developmental threshold temperature of an insect, and are species typical. Threshold temperatures may represent either upper or lower limitations, and may be measurements of air or soil temperature, depending on where the insect lives. The leek moth, which develops above ground, has a lower threshold air temperature of 42.8 F and requires about 630 degree days to develop from the egg to adult stages.

Accumulated degree day values that reflect local conditions may be available from local sources, such as your local Cooperative Extension Service or State University. Or, calculate accumulated degree days using the following three-step process:

Step 1. Use thermometers or soil probes to determine the average daily temperature for a 24-hour period:

Average daily temperature = (Maximum temperature – minimum temperature)/2.

Step 2. Calculate the degree days by subtracting the threshold temperature from the average daily temperature:

Daily degree-days = Average daily temperature – Threshold temperature.

Step 3. To monitor development of the leek moth, begin accumulating degree days each day once the average air temperature reaches 42.8 F. Degree days will accumulate less quickly at lower temperatures, and more quickly at higher temperatures.

Or, use the Degree-day Utility (DDU) available online from University of California, Integrated Pest Management Programs.

For sources of information on predicting insect development, and on collecting local temperature data, see chapter 10.

Behavior

Leek moths interact with their *Allium* spp. hosts at the molecular level. Plant compounds, called allelochemicals, help guide leek moths to the host plant, and influence mating behavior, as well as feeding activity of larvae.

Host location and response

The cultivated leek is the preferred host plant. General green leaf volatiles and sulfur compounds, particularly those with the propyl radical, positively affect orienting behavior of leek moths. The compounds are abundant in *Allium* spp. and in cruciferous species.

Unstable thiosulfinates form a molecular cloud immediately around the plant, while the disulfides and heavier trisulfonates diffuse outward. This creates a narrowly directional scent plume that guides leek moths down the molecular concentration gradient toward the plant. The alkyl radical propyl provokes the liveliest response by leek moths, as evidenced by antennal movement and locomotion. Of all the *Allium* spp., the leek contains this radical in most abundance (Lecomte et al. 1987).

Moth feeding stimulates the leek to alternate between sexual and asexual reproduction. Moderate feeding increases the leeks' level of sexual reproduction. Sexual reproduction is by seed and requires two years per generation. Severe feeding stimulates the plant to reproduce both sexually and asexually in order to produce a population of new, fertile plants rapidly (Boscher 1979).

Asexual reproduction is by bulblets, which may reproduce sexually within the first year. This relationship may provide evidence that the leek moth and its leek host share a common, perhaps co-evolved, evolutionary history (Boscher 1979).

Reproduction

The leek moth is an obligate feeder on *Allium* spp: The male must feed on the *Allium* spp. host to produce adequate amounts of sex pheromone. The female moth advertises her readiness and availability by emitting a sex pheromone (Thiboult 1972). The male responds by emitting its own pheromone (Thiboult 1978) that attracts the female and arrests her calls. This pheromone also acts powerfully on male leek moths at short distances (Lecomte et al. 1998). It does not repel other males, but inhibits their sexual behavior, by eliciting passivity (Lecomte et al. 1998). In fact, the male pheromone seems to have a more profound effect on male leek moths than on females, if judged by antennal response.

Females use a long-range scent cue, propyl propane thiosulfinate, to locate an appropriate egg-laying site (Auger et al. 1979). Once near the host, a non-volatile, non-sulfurous scent cue stimulates egg-laying (Auger et al. 1979). Waxes on the leaf surface contain weakly volatile substances that may be responsible for short-range attraction and host recognition.

Host recognition is particularly important to females when they select egg-laying sites. Although females lay eggs only after prolonged contact with leaves (Thibout and Auger 1996), the plant tissue rather than the surface

waxes probably provide actual chemical cues; the waxes may provide tactile stimulation.

Females engage in three phases of activity during oviposition: the slow walk, the pause, and egg laying. During the slow walk, the female sweeps the most sensitive areas of her antennae over the leaf surface and the sensillae of her ovipositor move back and forth touching the leaf surface. This may aid her in receiving chemical cues, from the plant tissue, that cause her to commence laying eggs. Propyl (Propyl CSO) appears to have a positive affect in stimulating oviposition. This amino acid is characteristic of *Allium* (Thibout and Auger, 1996). Thus prompted, she begins laying her eggs singly on the lower leaf surfaces of the host.

Larval feeding

Larvae are solitary unless the mines they excavate in the host leaves happen to intersect. After intersecting, larvae will live together, mining the inner layers of the leaves as they work their way towards the middle of the plant to feed on the inner leaves. Larvae are stimulated to feed by chemical components of the host and by other general plant compounds (Rouz and Thibout, 1988). Fifth instar larvae prefer to feed at night (Rouz and Thibout 1988).

Larvae sometimes feed on seed stalks, preventing the formation of seed (ARS, 1960). However, they do not directly damage seeds, which have chemical defenses against plant-eating insects (Arnault and Mauchamp 1985). Larvae generally avoid feeding on flowers, since they contain a saponin that inhibits larval growth (Harmatha et al. 1987).

Larvae in their fifth instar abandon their mines to seek a pupation site. Pupation typically occurs in the crown of the host plant where the larva has fed, but can occur in the soil, on another plant, or in plant debris. The pupa stage generally spans three weeks, but pupae can over-winter in plant debris (Wallace and Garland, 2003).

The pupa case is reddish-brown and the cocoon is a white, loose, mesh-like structure. Pupation site selection by the fifth instar larvae appears to have a tenuous connection to cues from host plant volatiles, but a stronger connection to mechanical stimuli, such as mechanical advantage of the site, appropriate humidity and light levels, and “gravitational forces” (Thibout and Nobahari 1987).

In autumn, adult leek moths may enter a resting stage (Thibout 1981). The absence of reproductive behavior, accompanied by underdeveloped genitalia and reproductive apparatus in both sexes, characterizes diapause. It may correlate with shortened photoperiods, lower temperatures, and the effects of these factors on late larval instars (Thibout and Abo-Ghalia1982).

Pertinent references

For more information on the history and distribution of the pest:

Agassiz 1996
Borror et al 1989
Common 1990
Gaedike 1970a; 1970b; 1984
Inoue et al 1982
Kyrki 1984; 1990
Zimmerman 1958

For more information on biology and behavior of the pest:

Balachowsky 1966
Carter 1984
Cooperative Economic Insect Report 1960
Frediani 1954
Gomez de Aizpurua 1990
McKinlay 1992
Passoa 1999
Landry 2002
Landry and Fraser 2003

Chapter 3 Identification

Importance

Accurate identification of the pest is pivotal to assessing its potential risk, developing a survey strategy, and determining the level and manner of control.

Authorities

Qualified local personnel may perform pre-identification and screening of suspected leek moth specimens. Before survey and control activities are initiated in the U.S., a USDA APHIS PPQ/National Identification Service (NIS)-recognized authority must verify the first detection of the leek moth. Contact NIS personnel specializing in Lepidoptera at the following address:

Systematic Entomology Laboratory, USDA
c/o U. S. National Museum of Natural History
Washington, DC. 20560-0168
Telephone: 202-382-1806

Pre-identification

Use this section as a guide to pre-identification of the leek moth.

Find a two-sided Field Guide in Appendix A. Use copies of the Field Guide when identifying the leek moth in the field.

Find a detailed description of the leek moth in Appendix B.

The leek moth is host specific on *Allium* spp. Therefore, leek moth suspects must be associated with *Allium* spp. They should be resting or feeding upon the proper host.

Where leek moth is established, larvae and pupae collected from pure stands of *Allium* spp. are likely to be the leek moth. However, it's possible that larvae found on *Allium* spp. are not leek moths. Some moth species may feed upon weeds within a field of *Allium* spp., and move to an *Allium* spp. for pupation. Be sure to make notes of weeds growing in the collection area.

Eggs

Eggs are elliptical (Chauvin et al. 1974) or shaped like a kidney (ARS 1960); approximately 0.3 X 0.2 mm, white with a fine, net-like surface (Carter 1984) (Figure 3.1). Single eggs are laid low on the host plant, usually on the leaf surface.

Figure 3.1. Egg of *Acrolepiopsis assectella*. (Image courtesy of Jean-Francois Landry.)

Larvae

The most important criteria for pre-identification of larvae is:

- host association with *Allium* spp.

Larvae develop through five instars. First instar larvae measure approximately one millimeter (mm), and grow to a length of 10-12 mm (Figure 3.2). The head capsule is yellowish to orangish brown and the body is yellowish-white (Frediani 1954) to yellowish-green (Carter 1984). At the fourth and fifth instars, sexes can be distinguished when the orange testicles of the male are visible dorsally (Frediani 1954).

Figure 3.2. *Acrolepiopsis assectella* larva. Image courtesy of Jean-Francois Landry.

Pupae

The most important criteria for pre-identification of pupae include:

- a netlike cocoon
- small size (about 1/3 inch)
- host association with *Allium* spp.

The small size of the leek moth and its host association with *Allium* spp. distinguish the leek moth from other small moths with a similar cocoon. Pupae are 7-8 mm long and reddish-brown (Figure 3.3).

Figure 3.3. Pupal case of the leek moth. (Image courtesy of de l'Institut National de la Recherche Agronomique.)

Adults

The most important criteria for pre-identification of adults include:

- 10-16 mm wingspan (about 2/3 inch)
- triangular white spot on the lower forewing margin surrounding brown markings
- host association with *Allium* spp.

Size. The wingspan of the leek moth is 11 to 16 mm (Agassiz 1996, Zagulyaev 1989). Thus, any moth larger than 20 mm can not be a leek moth. Unfortunately, many moths under 15 mm are also captured in sticky traps. Therefore, other characters must be used to screen out suspects.
Wing color. The leek moth can be recognized by the white spot in the middle of the lower forewing margin (Figures 3.4 and 3.5). The shape of this spot varies, but usually it is round or triangular. The rest of the forewing is brown with some scattered white scales, especially at the apex. The hind wing is light gray.

The color pattern is common to several members of the genus *Acrolepiopsis* and several other small moths. In the eastern U.S., the most closely related non-target is *Acrolepiopsis incertella*.

Any moth with a triangular white spot on the lower forewing margin should be considered a suspect leek moth. If the white spot surrounds small brown markings, the moth is very likely a leek moth. Moths in sticky traps often lose

their coloration and scales when immersed in the glue. When that happens, damaged specimens must be identified by morphological characteristics.

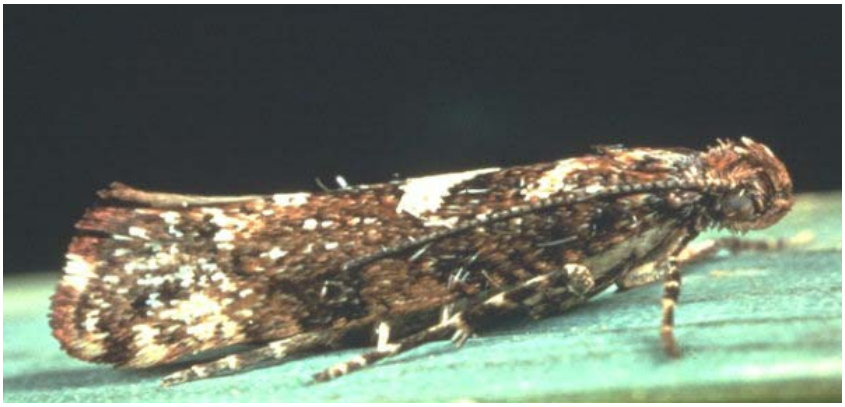

Figure 3.4. *Acrolepiopsis assectella* adult. (Image courtesy of Jean-Francois Landry).

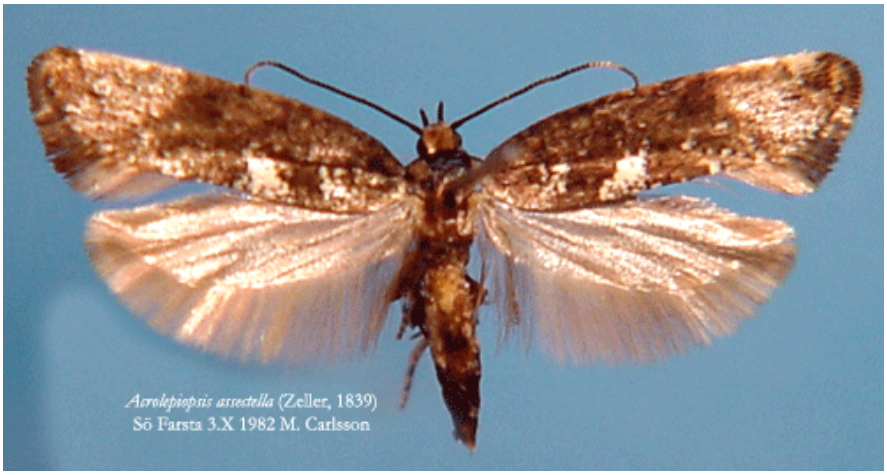

Figure 3.5. *Acrolepiopsis assectella* adult. (Image courtesy of Swedish Museum of Natural History.)

Similar species

In the eastern United States, the leek moth is most likely to be confused with *Acrolepiopsis incertella, Acrolepiopsis heppneri* and *Plutella xylostella.*

Acrolepiopsis incertella

This insect is also known as the carrion flower moth (Landry 2002). Adults bear a white costal margin stripe on the hind wings, and have a reddish iridescence on their grayish-brown wings (Borror et. al. 1989). Both features are absent in the leek moth. A few specimens of *A. incertella* were captured in sticky traps in Virginia using a leek moth lure (specimens in collection of Dr. Steven Passoa, USDA APHIS collection). Expect more captures of this closely related non-target species.

Covell (1984) reported *A. incertella* in the area from New Hampshire to Kentucky, then west to Arkansas. Hosts are *Smilax* and bulbs of lilies (Gaedike 1997; Forbes 1923). In Illinois, *A. incertella* has been reared from *Smilax* (specimens in Passoa collection). There are no recent records of *A. incertella* feeding on lilies.

Acrolepiopsis heppneri

Acrolepiopsis heppneri is an eastern United States species likely to be confused with the leek moth. However, this rare species is only known from New Hampshire south to North Carolina (Gaedike 1984).

Plutella xylostella

The diamondback moth, *Plutella xylostella*, is similar to the leek moth. However, the bottom margin of the forewing has a series of pointed white spots. The leek moth has only a single forewing spot. *Plutella xylostella* is commonly captured in leek moth traps in Canada (J. F. Landry, personal communication), and is likely to be found throughout the United States as well. Other Lepidoptera have the bottom forewing margin with white markings, but they are not the same size as the leek moth.

Other species

In the central and western United States, the leek moth is most likely to be confused with three species of *Acrolepiopsis*: *A. liliivora, A. reticulosa* and *A. leucosia*. The biology of the latter two moths is unknown (Gaedike 1997), but each has genitalia somewhat similar to the leek moth (Gaedike 1984). *Acrolepiopsis reticulosa* is only known from Wyoming. *A. leucosia* occurs in Missouri, Texas, and probably northern Mexico (Gaedike 1997, Landry 2002). *Acrolepiopsis liliivora* has been collected from California, Oregon (Gaedike 197) and Alberta, Canada (J.F. Landry, personal communication).

Collection, rearing and preparation of specimens

Labeling

Label samples immediately with the following information:

- location
- time of sampling
- survey method used to obtain the sample
- name of the sample-taker
- temperature and habitat

Rearing

If possible, collect eggs, larvae and pupae with sufficient host material for rearing purposes. Adult specimens raised from eggs or larvae are easier to identify, compared with specimens collected from sticky traps. Consult with identifiers for instructions on artificially rearing insects. Facilities must meet the security standards for quarantine insect-rearing.

Eggs

Collect eggs carefully. Do not try to lift the eggs from the leaf surface. Scraping the eggs into a vial, or putting pressure on them, will kill the developing larvae because the chorion is soft.

Preserving

Larvae. Boil larvae in water for 30-45 seconds before placing in leak-proof vials filled with 70% ethanol.
Adults**.** Handle adults gently, taking care to preserve the scales. Sacrifice adults by freezing in vials or jars with loose cotton wool padding, to prevent them from damaging themselves against the container.

Reared adults

Pin the moth but do not spread the wings. Spreading the adult makes the specimen more fragile; the specimen will be bulky and require more shipping time. Save the pupa and larva cast skins (exuviae) in a dry vial with the adult moth. Do not place adults in alcohol.

Adults on sticky traps

You have several options:

- Remove specimens by cutting away a section of the trap. Place the trap piece containing the moth in a vial or jar filled with histological cleaning solution, OR
- Pin the trap piece as a card mount, OR
- Remove the abdomen, rinse in histological cleaning solution and place in 95% alcohol (available from liquor suppliers), OR
- Review Miller et al. (1993) for more information on cleaning specimens

Screening

Qualified local personnel may perform pre-identification and screening of suspected leek moth specimens. Use an illuminated low power magnifying glass on a table stand to sort through the samples. Or, use a stereoscope with a 0.05 X objective, on a boom stand. Do not use microscopes since the traps do not fit under the stand, the working distance is too short, the field of view is too narrow, and the sticky substrate is hard to clean from the optics.

When the number of traps is great (e.g., a Regional Survey), the screener must take a sub sample from among the possible suspects. If sub samples are necessary, consult with the Lepidoptera specialist for instructions.

If a screener is not available, the traps can be modified to allow better quality specimens and save time. Modify the traps before placement by scraping off the sticky substance with a flat knife until only a thin layer remains. When moths are captured, they will be covered with less sticky glue and will usually show a wing pattern. However, removing the sticky glue will make the traps less effective. Consult with the Lepidoptera specialist before modifying traps.

Training is available for leek moth identification. Contact Dr. Steven Passoa for details.

Shipping

Double box and ship the specimens with at least 2 inches of padding around the sample.

Before survey and control activities are initiated in the U.S., a USDA APHIS PPQ/National Identification Service (NIS)-recognized authority must verify the first detection of the leek moth. Contact NIS personnel specializing in Lepidoptera at the following address:

Systematic Entomology Laboratory, USDA
c/o U. S. National Museum of Natural History
Washington, DC. 20560-0168
Telephone: 202-382-1806

Include PPQ Form 391 Specimens for Determination marked "Urgent" with all specimens.

Pertinent references

For more information on identification of the pest:

Agassiz, D. J. L. 1996
Balachowsky, A. S. 1972
Christopher, D. 1994
Covell, C. V. Jr. 1984
Gaedike, R. 1997; 1984; 1970a; 1970b
Gomez de Aizpurua, C. 1990
Handfield, L. 1999
Heppner, J. B. 1987
Kyrki, J. 1984; 1990
Landry, J. F. 2002
Landry, J. F. and H. Fraser. 2003
McKinlay, R. G. 1992
Miller, R. S., S. Passoa, R. D. Waltz, and V. Mastro. 1993
Professional Development Center. 1989
Werner, K. 1958
Zimmerman, E. C. 1978

Find high-quality color images of the pest at:

- North American Plant Protection Organization, Phytosanitary Alert System
- Ontario Ministry of Agriculture and Food

Chapter 4 Survey Procedures

Before starting

When using sticky traps to catch small moths, ensure that proper taxonomic support and funds are present. Leek moths are difficult to work with because they are so small. Managers considering a survey need to take this into account BEFORE a large project is approved. Large projects require statewide or regional surveying. In particular, the following questions should be addressed:

- Who will screen the samples? Tiny insects are easy to miss. Screeners must be qualified to recognize the target.
- Who will prepare the samples so they can be forwarded to a specialist? Making slides of Lepidoptera genitalia or wings is difficult. If specimen quality is poor, timely results are impossible.
- Does the specialist have time to examine samples? For a statewide survey, this could mean many extra samples to fit in the work plan. National specialists often have backlogs of very worthy projects and it is inappropriate to assume there is time for extra work.
- If the local staff doesn't have expertise, are funds available for training? In most cases, training is the key to solving the above problems.

For guidance on screening procedures, contact:

Dr. Steven C. Passoa
National Lepidoptera Specialist
USDA/APHIS/Plant Protection and Quarantine
The Ohio State University
Museum of Biodiversity
1315 Kinnear Road
Columbus, OHIO 43212
Telephone 614 688 4471
Fax 614 688 4487

Survey types

The purpose of a survey is to determine the extent and means of pest spread. Surveys are also used to identify pest-free areas. Human and natural means of dispersal should be considered.

Use two methods to survey the leek moth: detection and delimiting surveys (Table 4.1).

Table 4.1. Methods for surveying the leek moth.

IF:	**THEN use this survey method:**
You're unsure if the pest is present	Detection survey. Use visual inspection, sweep net sampling, and/or traps to capture specimens. Place traps or inspect plants at suspect locations. Consult with a leek moth specialist to confirm your identification.
You know the pest is present and you need to define its geographic location	Delimiting survey. Use traps at specific locations and densities to capture specimens according to the plan outlined below. Consult with a leek moth specialist to confirm your identification.
You have applied a control and need to measure its effectiveness	Monitoring survey: Use visual inspection, sweep net sampling, and/or traps to capture specimens. Place traps or inspect plants at suspect locations. Consult with a leek moth specialist to confirm your identification.

Detection survey

Use a detection survey to determine if the leek moth exists in an area. Conduct a detection survey by using a combination of survey tools, including visual inspection of plants, sweep net sampling of *Allium* spp. and surrounding vegetation, and/or trapping. Search for the leek moth wherever *Allium* spp. are growing. In your survey, consider human and natural means of dispersal. Canadian scientists have frequently detected leek moth near organic farms and home gardens. Where available, use these sites to initiate detection surveys.

Positive results indicate that the leek moth is present. Based strictly on a detection survey, it is not valid to claim that a pest *does not* exist in an area if the trapping results are negative. Negative results are valuable clues to pest movement, particularly when considered with positive trapping results from similar areas.

Once the moth has been detected in an area, use backtracking to locate the source of the moth.

Delimiting survey

Once you have confirmed the presence of the pest, use a delimiting survey to gather sufficient information about the leek moth population to facilitate containment, suppression or eradication. Sticky traps with a pheromone lure are the best tool to use for a delimiting survey of the leek moth. If necessary, supplement trapping with visual surveys.

The site of the detection is the core area. Place 36 sticky traps at the core area and in each square mile in the first and second buffer areas in a standard grid array. Bait traps with the appropriate pheromone and service weekly.

Use the delimiting survey decision table (Table 4.2) and the trapping scheme (Figure 4.1) as guidelines when conducting a delimiting survey.

Table 4.2. Delimiting survey decision table for leek moth.

If you detect:	**In an area that is:**	**Take this action:**	**And supplement with:**
One or more adults	Apparently in the original infestation site	Set 36 traps per square mile in the core area	
One or more (any stage)	Within a 1-mile square area	Set 36 traps per square mile in 9 square miles around the core area	Visual survey of 100 host plants per square mile in the 9 square mile area
	Within a 6-square mile area	Set 36 traps per square mile in 25 square miles around the core area	Visual survey of 100 host plants per square mile in the 25 square mile area

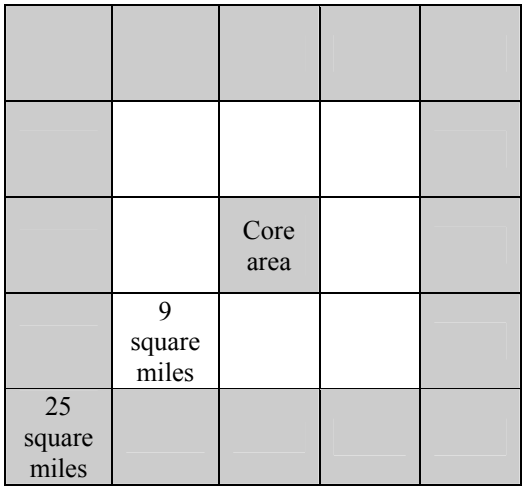

Figure 4.1. Trapping scheme. Begin by setting 36 traps per square mile in the core area where the leek moth has been detected. Each block represents one square mile.

Monitoring survey

Use a monitoring survey to evaluate the effectiveness of an action taken to contain, suppress or eradicate the pest. Use the same survey tools as detection and delimiting surveys.

Backtracking

Use backtracking to locate the source of an introduction after the leek moth has been detected. Backtracking is necessary for determining if an isolated detection is spurious—for example, the moth was conveyed into an area by air currents—or if it is evidence of an established population. Typically, if a single adult leek moth is found in an area far removed from a port of entry or host plant, it is likely that it was transported to the site. The same is true for isolated detections during cool seasons. The leek moth is inactive at air temperatures lower than 42.8 F.

Use wind field maps to plot the possible path of the leek moth. Calculate the estimated day and time of arrival (based on the circumstances at the site and likely air mass movements) and work backward in time and space to construct a logical path.

Site circumstances that provide clues to the estimated time of arrival include detections:

- Associated with the arrival of a weather system
- Of adults with no evidence of larval feeding
- Located in inland locations away from obvious ports of entry
- That end abruptly
- Of a new generation or stage in the life cycle
- Of sudden outbreaks or increases in numbers not associated with local breeding populations.

Once the path of the moth is plotted, carry out surveys along the path until the likely introduction site is located. Likely origins include port environs, areas where over-wintering is possible, or agricultural areas where hosts are abundant. Allowing for the imprecision of this method, surveys add weight to conjecture about the origin of an introduction.

Computer generated atmospheric trajectory analyses are available to help identify potential sources of infestation and to trace the probable movement of plant pests with air masses. One such program is the Branching Atmospheric Trajectory (BAT), which is available from the following address:

National Climatic Center
Data Base Administration
Box 34, Federal Building
Asheville, North Carolina 28801

Visual inspection of plants

Check crop fields, fencerows, ditch banks, roadsides or other habitats for suitable hosts. Be sure to check field edges, since the moth favors these areas. Areas with damaged or poorly growing plants should receive priority in the survey.

Follow a similar sampling pattern for each field surveyed. Examine plants at equally spaced intervals around the site, from at least five different locations in the field, at least 75 feet from the edge of the field (Figure 4.2). At each sample location, inspect at least 10 plants from three adjoining rows (or at equally spaced intervals). Preferentially inspect plants with leaves that are "mined" or have a "shot-holed" appearance.

Eggs Look for single eggs (up to about 100) on the top side of leaves near the heart of the host.

Larvae Check leaves for feeding signs and young larvae. Transparent streaks in the leaves indicate mining activity. “Shot hole” perforations that are repeated through the inner leaves are characteristic of leek moth larval feeding. Check bulbs for decay.

Pupae White cocoons are easily seen on green leaf surfaces.

Adults Check for adults resting on the undersides of leaves or tree bark. Flush them from herbaceous growth by beating or sweeping with a net.

Sweep-net sampling

Sweeping with a collection net is a useful method for collecting leek moth larvae from undersides of leaves. It may be used for collecting flying moths, too. Look for mined leaves that indicate larval feeding. Sweeping at dusk or dawn, in synchrony with the larval leek moth feeding patterns, will produce the best yield.

Sweep net sampling can be performed in combination with visual inspection. While walking forward, swing the net rapidly from side to side over the tops of the foliage. A typical sample unit is 25 sweeps. When performing aerial sweeps for adults, move the net in a horizontal “figure-8” path, passing the handle from hand to hand at the body mid-point during the down stroke.

Trapping

Use sticky wing traps baited with a pheromone lure to catch the leek moth (Figure 4.3). Delta traps are not as effective for trapping this pest. Bait traps with the sex pheromone 10:1 blend (Z)-11-hexadecenal and (Z)-11hexadecen-1-ol acetate (Minks et al 1994) and service weekly.

Trapping supplies are available from Great Lakes Supply, Inc. (see chapter 10).

Use the site of the detection as the focal point. Set out traps at the focal point and in each square mile in the first and second buffer areas in a standard grid array. Place traps in or near hosts. Maintain traps through three estimated generations of leek moth after the last detection.

Use manufactured pheromone lures whenever possible. If these are unavailable, use a pheromone-impregnated device such as a plastic stopper or rubber septum. Inject the device with 1 milligram of the appropriate pheromone. Install the device in the trap by pushing a small thumbtack through the outside of the trap then fixing the device onto the tack point on the inside. Hang traps from stakes among host plants at the approximate height of the host, adjusting as plant height increases through growing season.

Figure 4.3. Sticky wing trap Pherocon 1C.

Handling specimens

See chapter 3.

Orientation of survey personnel

Experienced personnel should train their replacements. Adequate training on survey techniques and procedures will likely require three working days.

Survey records

Survey records and data recording formats should be standardized. Maintain survey records, noting the areas surveyed, sites trapped, dates, locations, and hosts. Enter all survey data in NAPIS.

Chapter 5 Regulatory Procedures

Instructions to officers

Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures is essential when explaining procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatments may be used in accordance with labeling restrictions.

Find instructions for regulatory treatments in the PPQ Treatment Manual.

Issuing an emergency action notification

An Emergency Action Notification may be issued pending positive identification and/or further instruction from the USDA, APHIS, PPQ Deputy Administrator.

If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate a specific emergency action under the Plant Protection Act until emergency regulations can be published in the Federal Register.

The Plant Protection Act of 2000 provides for authority for emergency quarantine action. This provision is for interstate regulatory action only. Intrastate regulatory action is provided under State authority. However, if the Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the State are inadequate, USDA can take intrastate regulatory action provided that the Governor of the State has been consulted and a notice has been published in the Federal Register. If intrastate action cannot or will not be taken by a State, the PPQ may find it necessary to quarantine an entire State.

PPQ works with state departments of agriculture to conduct surveys, enforce regulations, and take control actions. PPQ employees must have permission of the property owner before accessing private property. Under certain situations during a declared extraordinary emergency or if a warrant is obtained, PPQ may enter private property without owner permission. PPQ prefers to work with the state to facilitate access when permission is denied; each state government has varying authorities regarding accessing private property. A General Memorandum of Understanding exists between PPQ and each state that specifies various areas where PPQ and the state department of agriculture cooperate.
For clarification, check with your State Plant Health Director (SPHD) or State Plant Regulatory Official (SPRO) in the affected state.

Regulated articles

Allium spp. listed as hosts (see chapter 2) are regulated articles if they exist in the regulated area. These include shallots, bulb onions, green onions, leeks, garlic, chives, and ornamental or wild onions used for decorative purposes. ~~Green portions of the plant present greater risk than dry bulbs.~~

Any other product, article, or means of conveyance of any type may be regulated if an inspector determines that it may spread the leek moth. Persons in control or possession of the article must be notified that the article is regulated.

Quarantine actions

Regulatory action will be required if:

- More than one moth is found in an area less than 6 square miles within one estimated life cycle; or
- One mated female, or a larva, or a pupa are detected; or
- A single moth is detected that is determined to be associated with a current eradication project

Regulated establishments

Field personnel will attempt to detect the pest within the regulated area at all establishments where regulated articles are sold, grown, handled, moved, or processed. Establishments that might be included are airports, landfill sites, processing plants, produce and flea markets, nurseries, flower shops, onion or leek farms, home gardens, and any other establishment that handles regulated articles. Surveys may be set up at establishments deemed to be at risk by project personnel. Survey personnel should install and service two pheromone traps per establishment. Service traps weekly if catches of insects are high, or every two weeks if trap catches are low.

Use of pesticides

The PPQ Treatment Manual and this Guidelines identify authorized pesticides, and describe methods, rates of application, and special application instructions. Concurrence by PPQ is necessary before using any other pesticide or procedure for regulatory purposes.

Approved regulatory treatments

Approved regulatory treatments appropriate for this pest are determined by program management and/or a Technical Advisory Committee in conjunction with the Center for Plant Health, Science, and Technology. Check the PPQ Treatment Manual for current recommendations.

Treatment options include:

- Sanitation, and/or
- Destruction of wild and cultivated hosts, and/or
- Application of recommended insecticides (aerial or ground) and/or
- Application of other cultural controls, and/or
- Application of biological controls

Principal activities

The degree of regulatory activity required depends, among many other factors, on the degree of the infestation. For example, it may not be necessary to safeguard vegetable stands throughout the regulated area if they are engaged in local retail activity only and the infestation is limited.

Principle activities for conducting a regulatory program to contain leek moths could include:

- Advise regulated industry (ies) of required treatment procedures
- Supervise, monitor, and certify commodity treatments of commercial lots of regulated articles
- Make regulatory visits to:
  - Security and airline personnel
  - Vegetable stands
  - Flower stands
  - Onion and leek growers
  - Home gardens
  - Packers and processing plants
  - Farmer's associations, produce markets, and flea markets
  - Commercial haulers of regulated articles
  - Public transportation and
  - Post offices
- Visit canneries and other processing establishments
- Monitor the movement of waste material to and from landfills to ensure adequate disposal of regulated articles
- Monitor the movement of regulated articles through major airports and other transportation centers
- Observe major highways and quarantine boundaries for movement of host materials

Removing quarantines

Project managers identify and remove areas from quarantine requirements after the leek moth is declared eradicated. Eradication is assumed when sufficient time, equal to three leek moth life cycles, has passed since the last specimen recovery. At minimum, one life cycle must elapse after control activities have ceased. APHIS will publish a Notice of Quarantine Revocation in the Federal Register when areas are removed from quarantine requirements.

Orientation of regulatory personnel

Initially, program personnel will be limited to those already trained or experienced. Experienced individuals train their replacements. A training period of three working days should be sufficient for the orderly transfer of these functions.

Regulatory records

Maintain standardized regulatory records and database(s) in sufficient detail to carry out an effective, efficient, and responsible regulatory program.

Chapter 6 Control

Overview

The objective is to control the pest while minimizing negative environmental effects. Consider all possible methods of control--biological, cultural or chemical--before beginning a program

Pest control includes measures taken to eradicate, contain or suppress a pest population. Eradication is the first priority when a new pest has been introduced. Follow the guidelines in Eradication and Containment below to eradicate or contain the pest. To suppress a pest, refer to the guidelines in Pest Suppression.

Emergency programs

Plant Protection and Quarantine (PPQ) develops and makes control measures available to involved States. Pesticides must be labeled for use on the site where they will be applied and must be registered for use in the State where the eradication program is occurring.

If treatments selected or proposed are not in conformance with current pesticide labels, an emergency exemption can be requested and obtained under Section 18, or 24(c), special local need (SLH), of FIFRA, as amended. For additional information, see the Emergency Programs Manual, Section 14.

Environmental documentation

Obtain all required environmental documentation before beginning. Contact Environmental Services staff for the most recent documentation.

ERADICATION AND CONTAINMENT

Defining the treatment area

Once a decision has been made to eradicate the leek moth, use the decision table (Table 6.1) to define the treatment area.

Table 6.1. Decision table for eradication treatment area of leek moth.

IF:	Are detected in an area of this size:	Treatment will commence and extend:
1-5 larvae, pupae or gravid females OR 2-5 males or virgin females	Less than 6 square miles	200 yards beyond the detection
6 or more of any stage	Greater than 6 square miles	2 ½ miles beyond the detection

Treatment options

Treatment may include:

- Sanitation, and/or
- Destruction of wild and cultivated hosts, and/or
- Application of recommended insecticides (aerial or ground) and/or
- Application of other cultural controls, and/or
- Application of biological controls

Continue eradication measures for at least two life cycles of the leek moth. Monitor the success of the program for at least one life cycle after the termination of eradication measures.

Sanitation

Carry out sanitation in nurseries, farms, gardens, and other establishments where hosts are present within the core and buffer areas. Depending on the circumstances and equipment available, use the following techniques:

- Burn debris Collect, pile and burn host material if local ordinances permit. Disk under residue or bury in an approved landfill.
- Feed to animals Some host materials may be used as animal food. However, some *Allium* spp. may be toxic in large

quantities to some animals. Exercise caution when considering this disposal option.

- Control weeds Trim or cultivate grasses and weeds growing along roadsides, in fields, or in row crops. Adult leek moths hibernate in plant debris, often in shrubs and herbs at field margins (Legutowska and Plaskota 1986; Plaskota and Dabrowski 1986), so keeping these areas cleared may help reduce their populations.
- Bag and bury Collect and transport host material to an approved landfill.
- Inspect and clean vehicles Inspect vehicles, trucks, wagons, and other vehicles used in host fields or used to transport host material to avoid accidental movement of host material with eggs or larvae.

Destruction of wild and cultivated hosts

Use the following methods to destroy all host material completely:

- Disking or plowing under
- Removal and burial or incineration
- Application of herbicides

Application of recommended insecticides

At the initiation of an eradication program, evaluate available insecticides for their use in program operations. Select an insecticide after considering local conditions along with survey results.

Choose from the following recommended insecticides:

- Azinphos-methyl
- *Bacillus thuringiensis* (BT)
- Carbaryl
- Deltamethrin
- Etrimphos
- Malathion
- Parathion-methyl – all foliar applications [Restricted Use Product (RUP)]
- Permethrin
- Pirimiphos-methyl
- Neem kernel 2%

To control persistent populations of leek moth, apply malathion or pirimiphosmethyl (Greenwood and Halstead 1997).

Using Bacillus thuringiensis (BT)

Use this biological pesticide in sensitive areas or in urban areas. When possible, obtain BT biotypes that are specific for the leek moth. Apply as a full-coverage spray when 1st to 3rd instar larvae are present. Repeat at 10- to 14-day intervals while larvae are active. Effectiveness of aerial delivery is enhanced if done by helicopter since the downdraft turns the leaf surfaces for better exposure.

Using Neem Kernel antifeedant

Use this antifeedant in biologically sensitive areas or in urban areas. Two percent Neem Kernel suspension is effective against Lepidoptera larvae. Neem Kernel may be used after pesticide applications. However, do not use it after applications of BT, since BT inhibits feeding. Do not treat dense populations since it may prompt larvae to migrate.

Timing of application

Apply an insecticide immediately upon discovery of a leek moth infestation. Apply insecticides in the late afternoon, evening, or at night to coincide with nocturnal habits of adults and most larvae.

Consider delaying applications if weather reports indicate greater than a 50 percent chance of precipitation within 48 hours after application. If rain reduces the effectiveness of an application, retreat the area immediately, or as soon as the label permits.

After an estimated two generations of negative trapping and survey, applications may be discontinued.

Confined environments (nurseries and greenhouses)

Apply an insecticide labeled for indoor use. Treat all plants within the enclosure. Direct sprays to the underside of leaves where larvae congregate. Drench the soil beneath each plant/host where older (3rd to 4th instar) larvae hide during the day.

Outdoor residential or commercial environments

Use the decision table (Table 6.2) when applying insecticides in outdoor residential or commercial environments.

Table 6.2 Ground or aerial insecticide applications: outdoors and commercial.

USE this application method:	**IF:**	**THEN apply to the infested area AND:**	**AND discontinue after two generations of negative survey results OR:**
Ground	Necessary environmental documentation has been obtained	¼-miles or more beyond the known infestation	Aerial treatments are initiated
Aerial	Ground treatment is not practical AND NEPA and ESA allows for such use	2½ miles or more beyond any known infestation	

Avoid insecticide resistance

To avoid the development of resistance, rotate the application of recommended insecticides.

PEST SUPPRESSION

Application of other cultural controls

Rely on a combination of cultural and biological control methods to suppress the pest. Cultural control may be subject to obtaining environmental documentation under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). Check with the program manager to make sure such documentation is in order. Cultural controls may be used in conjunction with pesticide application in an eradication or containment program.

Crop rotation

Because the second generation of leek moths inflicts the heaviest toll on plants (Nyrop et al. 1989), single plantings may help reduce losses from leek moth damage. Coupled with sanitation, crop rotation may be one of the most effective eradication strategies for leek moth.

Flooding

If a field can be flooded, this may be preferable to using insecticidal controls. Pupae suffocate, thus reducing adult populations. Water should remain on the field for at least 2 days.

Barriers

If a heavy infestation is evident and larvae disperse, they may be contained by plowing a deep furrow around the infested area or field (if possible). The furrow should have straight sides to prevent larvae from crawling out. Dig postholes at least 1 foot deep at 20 foot intervals in the furrow. Larvae will collect in the postholes and can be scooped up and drowned in a solution of soapy water or kerosene. Keep furrows clear of rubbish. This technique is labor intensive and should be employed in conjunction with other control measures only at times when fifth instar larvae may be seeking pupation sites or burrowing in plant debris for over-wintering.

Fertilizing

Fertilizing the crop increases the rate of growth and the plant's ability to recover from insect damage. However, over fertilization may make the plant more attractive to other pests.

Trap cropping

Planting economically unimportant crops may divert leek moths away from a valuable cash crop. However, since *Allium* spp. differ in their attractiveness to leek moths and since the moths prefer cultivated species, this technique may be of limited use.

Pheromones

Mate-finding and reproduction by leek moths is a chemically-mediated process. Pheromones may interfere with the reproductive success of the leek moth.

Lure and kill trapping

The sex pheromone (Z)-11-hexadecenal and (Z)-11hexadecen-1-ol acetate is a reliable lure for the leek moth (Minks et al. 1994) and is effective in lure and kill trapping schemes to reduce populations.

Deterrent cropping

Lecomte et al. (1987) field tested anecdotal accounts of the deterrent effect of tomato plants growing near leeks. They found that when tomato plants were present in large quantities near leek plants, leeks (cultivar Malabar) used in their study were no longer attractive to the moths. Since leek moths favor field margins, tomatoes should be planted closest to those areas.

Intercropping

Asman et al. (2001) concluded that intercropping was not effective for reducing oviposition by leek moths.

Application of biological controls

Biological control agents are useful for suppressing pest populations, but rarely eradicate them. They are effective when used in combination with other techniques. They are characterized as predators, parasites, parasitoids or pathogens. Use Table 6.3 as a guide when investigating biological control agents active against the leek moth.

Find links to more information about biological controls in chapter 10.

Table 6.3. Biological control agents active against the leek moth.

Type	Species	Family	Reference
Parasitoid	*Diadegma fenestralis*	Ichneumonidae	Noyes 1974; Thiboult pers. comm. 2000.
Parasitoid	*Diadegma semiclausum*	Ichneumonidae	Thiboult pers.comm. 2000
Parasitoid	*Diadromus (Thraeella) collaris*	Ichneumonidae	LeComte 1977 Labeyrie 1966, Frediani 1957
Parasitoid	*Diadromus Pulchellus*	Ichneumonidae	Noyes 1974; Labeyrie 1960
Parasitoid	*Itoplectis alternans*	Ichneumonidae	Labeyrie 1966 Frediani 1954
Parasitoid	*Itoplectis europeator (tunetana)*	Ichneumonidae	Aubert 1969
Parasitoid	*Limnerium gracilis*	Ichneumonidae	Suire 1926 Frediani 1954
Parasitoid	*Microgaster globata*	Braconidae	Maan 1945 Labeyrie and Pons 1950
Hyper-parasitoid	*Eupteromalus nidulans*	Chalcidae	Frediani 1957
Hyper-parasitoid	*Gelis sp.*	Ichneumonidae	Thiboult pers. comm. 2000
Predator		Staphilinidae	Velitchkevitch 1924
Predator		Coccinelidae	Velitchkevitch 1924
Predator		Formicidae	Thibout pers. comm. 2000
Predator		Arachnida	Thibout pers. comm. 2000
Predator	*Chrysopa carnea*	Chrysopidae	Thibout pers. comm. 2000
Predator	*Orius*	Nabidae	Thibout pers. comm. 2000
Predator	*Forficula auricularia*	Dermaptera	Noyes 1974
Predator	*Philonthus sp.*	Staphilinidae	Noyes 1974
Predator	*Pterostichus niger*	Carabidae	Noyes 1974
Predator	*Harpalus rufipes*	Carabidae	Noyes 1974
Predator	*Amara sp.*	Carabidae	Noyes 1974
Parasitoid	*Zaglyptus varipes*	Ichneumonidae	Labeyrie 1966
Parasitoid	*Campoletis raptor*	Ichneumonidae	Thiboult pers. comm. 2000
Parasitoid	*Pimpla spuria*	Ichneumonidae	Thiboult pers. comm. 2000
Parasitoid	*Phaeogenes fuscicornus*	Ichneumonidae	Thiboult pers. comm. 2000
Parasitoid	*Chelonus eleaphilus*	Braconidae	Labeyrie 1966
Parasitoid	*Chelonus depressus*	Braconidae	Labeyrie 1966
Parasitoid	*Xanthandrus comtus*	Syrphidae	Labeyrie 1966

Orientation of control personnel

Only trained and experienced personnel will be used initially. These personnel will train replacements. A training period of three working days should be sufficient for the orderly transfer of these functions.

Records

Program personnel must maintain records and maps noting the locations of all detections, the number and type of treatments, and the materials and formulations used in each treated area.

Monitoring

Program personnel must implement an effective monitoring program to evaluate program efforts, pesticide use, and environmental impact, including any concerns of the agency or cooperators. Personnel must provide data for assessment of application method. Include the following analyses in any monitoring program:

- Determine pesticide efficacy against the target pest

- Evaluate dye cards to monitor aerial applications for:
    - Droplet size information
    - Droplet distribution information
    - Bait distribution information
    - Identification of wind drift components
    - Verification of spray block boundaries and
    - Identification of skips

- Evaluate environmental impact by sampling:
    - Water, to detect insecticide levels resulting from direct application, leaching, and runoff
    - Soil, to determine insecticide levels and residues
    - Foliage, to identify residues
    - Biological organisms before, during and after applications and post treatments, to determine impact of pesticides on non-target organisms; and
    - Air, to determine presence of residual airborne pesticides
    - The monitoring program must be a combined effort between PPQ and the state in which the emergency program is being conducted

Chapter 7 Environmental Concerns

Overview

Environmental Services (ES) is a unit of APHIS' Policy and Program Development Staff (PPD). ES manages the preparation of environmental documentation, such as environmental impact statements and environmental assessments, to aid in program operational decisions. ES also coordinates pesticide registration and approvals for APHIS pest control and eradication programs, ensuring that registrations and approvals meet program use needs and conform to pesticide use requirements.

Disclaimer

All uses of pesticides must be registered or approved by appropriate Federal, State, and/or Tribal agencies before application. Pesticide labels may not reflect all State or local restrictions. Read and abide by the label, including labeling that has been approved for the particular State or locality. Comply with all Federal, State, Tribal, and local laws and regulations relating to the use of the pesticide. APHIS program staffs are responsible for their compliance with applicable environmental regulations.

Chapter 8 Pathways

Overview

In the U.S., the leek moth was intercepted 61 times between 1985 and 2003 on *Allium* spp., primarily *A. cepa* (36% of total identified to species). One interception was noted on the leaf of *Pimenta sp.* Fifty-four percent of the interceptions were from ship's stores. These numerical data were extracted from the USDA Pest Information Network Database (2003).

Commerce or natural spread appear to be the most likely pathways for introduction of this pest.

Natural

The presence of the leek moth in Quebec and southern Ontario and the proximity of these areas to New York make this a pest of concern. New York rated fifth in onion acreage harvested in the U.S. in 1996.

The Canadian Food Inspection Agency found the leek moth on farms located 50 to 100 km from the New York border. Although these moths are not migratory, they are specialists on *Allium* spp. They locate host material very effectively through their keen perception of long-range volatiles, and the potential exists for movement from Canada to New York.

Travel

Since 1985, 34 % of U.S. interceptions were from international airline passenger baggage.

Commerce

Ten percent of the interceptions were from cargo (7% permit and 3% general).

A leek moth pupa was reported from a box in a ship (Christopher 1994). However, this identification should have been listed as *Acrolepiopsis* sp. because the host was unknown (see chapter 3). This situation indicates that ship's stores may represent a pathway for leek moth entry into the United States. However, Christopher (1994) noted that crucifers provide most of the plant records on his list.

Since this moth remains viable in stored host product for lengthy intervals, the potential for transportation in onions imported from Canada to the U.S. as food or propagative material is high.

Countries of origin

The majority (25%) of leek moths were intercepted in a variety of *Allium* spp. from Japan. Hawaiian pre-clearance interceptions on *Allium cepa* accounted for 21%. However, the identifications may be inaccurate due to the taxonomic confusion noted earlier in these Guidelines (see chapter 3). Fourteen percent of interceptions were from the Netherlands. Other countries of origin were Spain, Greece, Portugal, Poland, France, West Germany and Norway.

Destinations

The leek moth has been intercepted at 10 international ports of entry. The majority of interceptions were reported from Hawaii and New Orleans (21% of total). Hawaii and New Orleans provide favorable climates for establishment of this moth.

Chapter 9 Glossary

Aerial treatment Application of insecticide to a treatment area by aircraft.

Array The arrangement of traps within one square mile (1 mi2).

Array sequence The layout of traps (arrays) from the core area outward to the perimeter (buffer areas).

Block A unit (e.g., 1 square mile area) of a detection survey in which all survey activities are conducted.

Buffer area Survey area that is:

- Beyond the core block
- 1-2 miles from the perimeter of a regulated area, or
- 50 miles from the core of a regulated area (in an extended survey)

Calling Emission of sex pheromones by the female leek moth to attract mates.

Cold treatment Exposure of a host product to cold temperatures lethal to a target pest. May be used alone or with fumigants.

Confirmed detection A positive identification by a recognized expert.

Containment Application of phytosanitary measures in and around an infested area to prevent spread of a pest.

Control Suppression, containment or eradication of a pest population.

Core area An area of 1 square mile surrounding a confirmed detection.

Crepuscular Of an organism, active in twilight hours.

Degree day A measure of physiological time using the accumulation of heat units (degrees) above an insect's developmental threshold for a 24-hour period.

Delimiting survey Determination of the extent of an infestation (e.g., distribution, density) in an area where an exotic species has been detected.

Delta trap A five-sided insect trap, configured with three lateral sides arranged triangularly, equipped with a lure (i.e., pheromone), a baffled edge, and an adhesive surface inside to capture and secure attracted insects.

Detection The collection of any life stage of an exotic species.

Detection survey An activity conducted in a susceptible area not known to be infested with an exotic species to determine its presence.

Developmental threshold The minimum and/or maximum temperatures that support physiological development for a species.

Diurnal Of an organism, active during the day.

Eclosion Of an insect, leaving the egg or the terminal molt into an adult.

Epicenter The initial site of an infestation.

Eradication Application of phytosanitary measures to eliminate a pest from an area.

Exotic species An organism or pest species not native to or historically resident in North America.

Fumigation The application of an approved insecticidal chemical that enters the target pest's tracheal system in volatile form.

Generation The offspring of a parent population that move through the life cycle together.

Ground spray Insecticide application in droplet form, from equipment positioned on the ground or at the vegetation level.

Host A species that provides food, shelter or reproductive requirements for another organism.

Host collection/Holding.The collection and retention of infested host material for the purposes of determining characteristics of a pest's use of the material.

Infestation The collection of:

- Two or more of an exotic species
- A pupa, larva, or a mated female from an area, or
- The detection of a single adult associated with a current infestation

Infested area An area surrounding a single detection site or a group of sites. The standard designated area of 2.5 miles is used, unless biotic or abiotic factors dictate adjustment of this area.

Migratory species A species in which individuals habitually move from place to place especially in search of mates or egg-laying sites.

Monitoring/Evaluation survey Conducting visual and/or trapping surveys in an area that has been treated with insecticide to evaluate the effectiveness of the treatment.

Natural enemies Living organisms found in a natural community that kill, weaken, or inhibit the biological potential of a pest species.

Nocturnal Of an organism, active at night.

Non-migratory A species in which individuals typically do not move far from the area of their birthplace.

Parasites Parasites live on the host (frequently the adult stage) at one or multiple life stages. Parasites sometimes kill but usually merely debilitate the host.

Parasitoid Parasitoids live on the host (often an immature stage) when immature, but are free-living as adults. Parasitoids always kill the host. Like parasites, these organisms are typically host-specific, and some are obligate on certain hosts. They find hosts effectively even when host population numbers are not particularly dense.

Pathogen An agent, usually microbial, that induces illness. Entomopathogens induce illness in insects. These include baculoviruses (primarily those in the genus Nucleopolyhedrovirus), nematodes and fungi. Many are species-specific, and cause no collateral infection of other organisms.

Phenology The timing of recurrent biological events.

Predator Free-living organisms that consume substantial numbers of prey. They generally do not prey exclusively on one target species over the course of a season. However, when the population of one species is dense (e.g., when swarming or aggregating to mate; when larvae cluster on hosts), they can be very efficient.

PPQ/APHIS/USDA Plant Protection and Quarantine, Animal and Plant Health inspection Service, United States Department of Agriculture.

Regulated area An area that extends at least 2 1/2 miles in any direction from the epicenter of an infestation.

Regulated articles All known or suspected hosts of a confirmed infestation of an exotic species, including soil and any other suspected product or article.

Regulatory survey A trapping or detection program conducted around establishments where regulated articles are sold, handled, processed or moved.

Sex pheromone A chemical substance that is secreted by an insect to attract or to advertise reproductive competence to the opposite sex of the same species.

Soil treatment The application of an approved insecticide to the soil of nursery stock or within the drip line of host plants.

Suppression The application of phytosanitary measures in an infested area to reduce pest populations.

Sweep net A survey method in which a mesh net suspended around a hoop is swept through the air or around vegetation to collect insects.

Trap survey Determination of the presence of a pest through the use of randomly or strategically placed devices that capture insects (sometimes aided

by an attractant). These traps are maintained and serviced on a schedule dictated by the goal of the survey.

Visual survey Examination of areas for eggs, larvae, pupae, cocoons, or other evidence that a particular insect species is present.

Wing trap A disposable, adhesive-coated capture device used primarily for surveying moths.

Urban/residential An area containing a number of multiple- or single family dwellings.

Chapter 10 Resources

Suppliers

Suppliers of Beneficial Organisms in North America. A free 32-page booklet available online at http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm from:
California Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring and Pest Management Branch
1020 N. Street, Room 61
Sacramento, CA 95814-5604
Telephone (916) 324-4100

Sources of information

Association of Natural Biocontrol Producers
10202 Cowan Heights Drive
Santa Ana, CA 92705
Telephone (714) 544-8295
http://www.anbp.org/

Cornell University
Weedon, C.R., A.M. Shelton, Y. Li, and M.P. Hoffmann. Biological Control: A Guide to Natural Enemies in North America.
http://www.nysaes.cornell.edu/ent/biocontrol/

Biological Control Virtual Information Center. Center for IPM. North Carolina State University. http://cipm.ncsu.edu/ent/biocontrol/

Suppliers of entomological equipment

BioQuip Products, Inc.
2321 Gladwick Street
Rancho Dominguez, CA 90220
Telephone (310) 667-8800
http://www.bioquip.com/

Wards Natural Science
PO Box 92912
Rochester, NY 14692-9012
Telephone 800-962-2660
http://www.wardsci.com/

Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215-3398
Telephone (800)334-5551
http://www.carolina.com/

Hercon Environmental Corporation
PO Box 467 Aberdeen Road
Emigsville PA 17318-0467 USA
Telephone (717) 764-1191
Fax (717) 767-1016
http://www.herconenviron.com/

Cooper Mill Ltd
RR3
Madoc, Ontario K0K 2K0
CANADA
Telephone (613) 473-4847
Fax (613) 473-5080
http://www.coopermill.com

ISCA Technologies, Inc.
P.O. Box 5266
Riverside, CA, 92521
United States of America
Telephone (909) 686-5008
Fax (815) 346-1722
http://www.iscatech.com/exec/index.htm

Great Lakes IPM, Inc
10220 Church Road
Vestaburg, Mi 48891-9746
Telephone (989) 268-5693 or (989) 268-5911
Fax (989) 268-5311
http://www.greatlakesipm.com/index.html

USDA/APHIS/Environmental Services

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4700 River Road
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Other

Sources of information on predicting insect development:

University of California Statewide Integrated Pest Management Program 2003 (http://www.ipm.ucdavis.edu/WEATHER/ddconcepts.html#Using or

http://www.ipm.ucdavis.edu/MODELS/DDU/)

For more information on collecting local temperature data:

- National Oceanic and Atmospheric Administration (NOAA Home Page)
- U.S. Department of Commerce
- Local Cooperative Extension Service
- Private, State, university, or industry sources

Chapter 11 References

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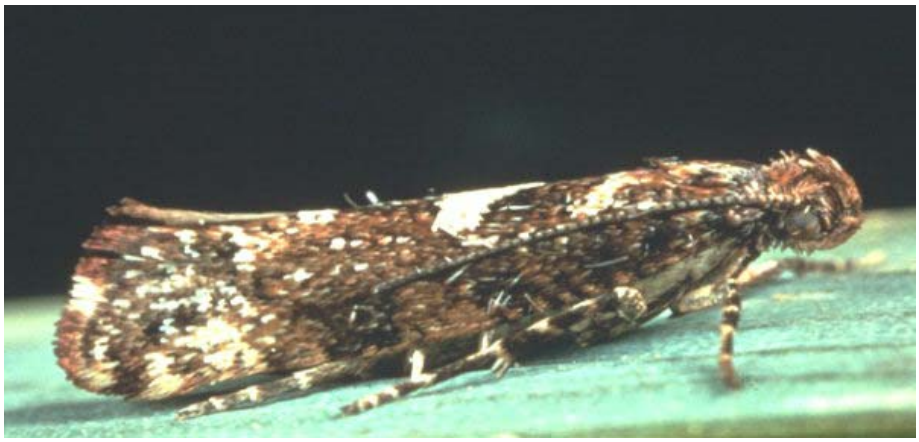
Appendix A Field guide

A

B

C

D



E

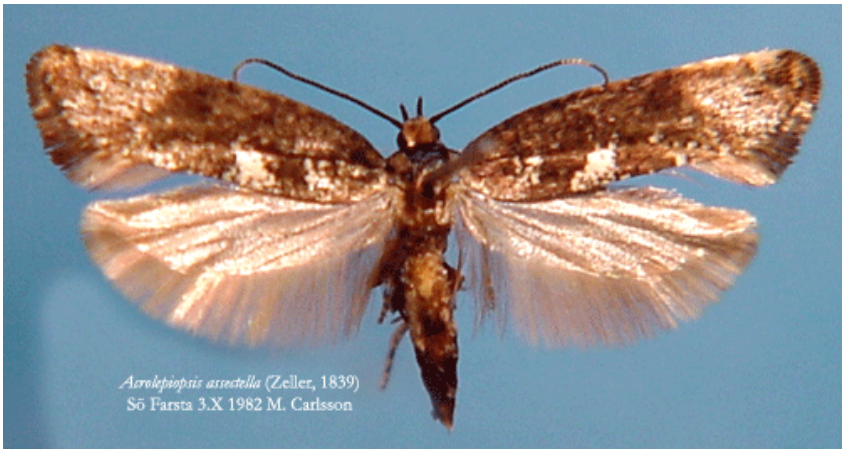


Figure A.1. Field guide to identification of leek moth eggs (A), larvae (B) pupae (C) and adults (D and E). (Images A, B and D courtesty of Jean-Francois Landry. Image C courtesy of Institut National de la Recherche Agronomique. Image E courtesy of Swedish Museum of Natural History.)

Eggs

Eggs are elliptical (Chauvin et al. 1974) or kidney-shaped (ARS 1960); approximately 0.3 X 0.2 mm, white with fine, net-like surface sculpturing (Carter 1984) (Figure 3.1). Single eggs are laid low on the host plant, usually on the leaf surface.

Larvae

The most important criteria for field identification of larvae includes:

- Host association with *Allium* spp.

Adults

The most important criteria for field identification of adults includes:

- 10-16 mm wingspan (about 2/3 inch)
- Triangular white spot on the lower forewing margin surrounding brown markings
- Host association with *Allium* spp

Appendix B Microscopic identification

Larvae

The most important criteria for identification of larvae includes:

- SD1 is anterodorsad of the spiracle on A1-8
- L2 anteroventrad of L1 on A1-8
- Only six setae on each side of A9 with L1 and L2 on the same
- Pinaculum and uniordinal crochets in a circle on short prolegs
- Host association with *Allium* spp

Larvae develop through five instars. At the fourth and fifth instars, sexes can be distinguished when the orange testicles of the male are visible dorsally (Frediani 1954).

First instar larvae measure approximately one millimeter (mm) and grow to a length of 10-12 mm. The head capsule is yellowish to orangish brown and the body is yellowish-white (Frediani 1954) to yellowish-green (Carter 1984).

The external spiracular openings are encircled by sclerotized tissue (Carter 1984). The prothoracic and anal plates are yellowish with brown markings (Carter 1984). The thorax bears three pairs of yellowish-brown legs. The abdomen is pale green with groups of four black plaques borne both laterally and dorsally on each segment (ARS 1960). Each plaque is adorned with a single seta (ARS 1960). Each abdominal proleg bears a short row of 3-5 crochets arranged in a uniserial circle (Carter 1984).

According to Heppner (1987), larvae of the Acrolepiidae can be recognized in North America by having SD1 anterodorsad of the spiracle on A1-8, L2 anteroventrad of L1 on A1-8, only six setae on each side of A9 with L1 and L2 on the same pinaculum, and uniordinal crochets in a circle on short prolegs (Figure B.1). Sometimes the crochets are weakly multiserial (a few extra crochets are located inside the circle).

Based on the PDC manual (1989), a second criteria can be added to the above set. All leek moth suspects must have the SD1 pinaculum at least touching the spiracle. Often these two structures are partially fused. (The larva of *A. incertella* [specimens in Passoa collection] also has the characters listed above; especially noteworthy is the fusion of the SD1 pinaculum with the spiracle.)

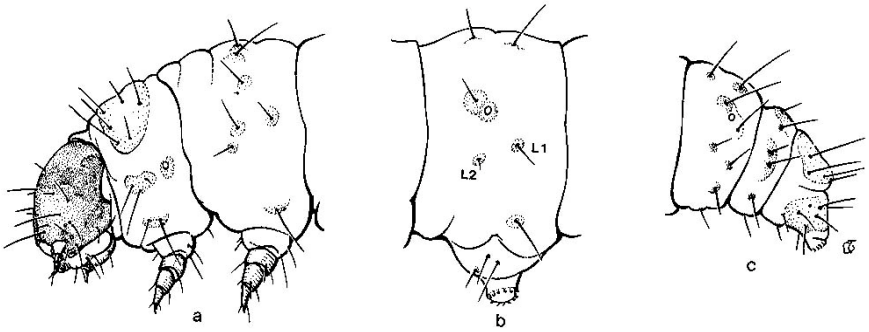


Figure B.1. Leek moth larvae. (Image courtesy of Stehr (1987)).

One interesting taxonomic detail merits further study. Werner (1958) illustrated three Adf setae in the adfrontal area of the leek moth and the related species, *Digitivalva granitella* and *Digitivalva cariosella*. Normally, Lepidoptera larvae only have two Adf setae. Therefore, the presence of three Adf may be an additional identification feature of the genus *Acrolepiopsis*. Additionally, these two related species feed on composites.

Pupae

The most important criteria for identification of pupae includes:

- A netlike cocoon
- Small size (about 1/3 inch)
- Host association with *Allium* spp.
- Exposed labial palpi
- Long tubular mesothoracic spiracles
- A long broad cremaster

The small size of the leek moth and its host association with *Allium* spp. distinguish it from other small moths with a similar cocoon.

Pupae are 7-8 mm long and reddish-brown. Abdominal spiracles are present on raised tubercles. The cremaster is short and blunt. Pupae are enclosed in 7-10 mm fusiform cocoons with the larval exuviae (Frediani 1954). The silken cocoon is cream-colored, opens at both ends, and is constructed in a loose, net-like mesh by the fifth instar larva. It is usually attached to a leaf, flower stalk, or between the flower peduncles of the host plant on which the larva fed (Frediani 1954).

Adults

The most important criteria for field identification of adults includes:

- 10-16 mm wingspan (about 2/3 inch)
- Triangular white spot on the lower forewing margin surrounding brown markings
- M3 and Cu1 stalked in the hind wing
- Host association with *Allium* spp

Moths in the family Acrolepiidae are recognized by their small to medium size; heads bearing tufts of scales on the vertex and compressed scales on frons and face; massive, long, curved labial palps with equal 2nd and 3rd segments; filamentous maxillary palps; slender antennae on a knobbed basal segment; and the absence of ocelli. They are separated from similar families (such as Plutellidae) by their folded maxillary palps and smooth labial palps. Species within the Acrolepiidae are best separated by characteristics of the males' genitalia.

The forewings of the *Acrolepiopsis* spp. are grayish to dark chocolate brown, and bear a light triangular spot slightly before the midpoint of the posterior wing margin (Zagulyaev 1989).

Size

The wingspan of the leek moth is 11 to 16 mm (Agassiz 1996, Zagulyaev 1989). Thus, any moth larger than 20 mm can not be a leek moth. Unfortunately, many moths under 15 mm are also captured in sticky traps. Therefore, other characters must be used to screen out suspects.

Wing color

Recognize the leek moth by the white spot in the middle of the lower forewing margin (Figures 3.4 and 3.5). The shape of this spot varies, but usually it is round or triangular. The rest of the forewing is brown with some scattered white scales, especially at the apex. The hind wing is light gray.

The color pattern is common to several members of the genus *Acrolepiopsis* and several other small moths. In the eastern United States, the most closely related non-target is *Acrolepiopsis incertella*. This species differs from the leek moth in having a uniform cream forewing spot without brown markings. However, this observation is based on a very small sample size and more study is needed to confirm this potential difference. A few specimens of *A. incertella* were captured in sticky traps in Virginia using a leek moth lure (specimens in Passoa collection). Expect more captures of this closely related non-target species.

In the western United States, only *A. reticulosa* has a wing pattern somewhat similar to the leek moth. The forewing costal margin of *A. reticulosa* has a series of dark spots (specimens in Passoa collection) which are poorly developed in the leek moth. In addition, there are apparently no brown markings in the forewing white spot on the lower margin of *A. reticulosa*. The wing pattern of *A. liliivora* is close to that of the leek moth, although the genitalia of the two species are quite different.

Glyphipterix (Glyphipterigidae) and some Olethreutinae (Grapholita, Epiblema, Epinotia) (Tortricidae) also have white spots on the lower forewing margin. Unlike the leek moth, the wings of *Glyphipterix* are very narrow and the white spot is clearly curved and pointed. Genitalia of Olethreutinae are unlike that of the leek moth.

The diamondback moth, *Plutella xylostella*, is similar to the leek moth. However, the bottom margin of the forewing has a series of pointed white spots. The leek moth has only a single forewing spot. *Plutella xylostella* is commonly captured in leek moth traps in Canada (J. F. Landry, personal communication), and is likely to be found throughout the United States as well. Other Lepidoptera have the bottom forewing margin with white markings, but they are not the same size as the leek moth.

Any moth with a triangular white spot on the lower forewing margin should be considered a suspect leek moth. If the white spot surrounds small brown markings, the moth is very likely a leek moth. Moths in sticky traps often lose their coloration and scales when immersed in the glue. When that happens, damaged specimens must be identified by morphological characteristics.

Head and wing venation

According to Covell (1984), the family Acrolepiidae can be recognized in North America by their almost smooth head, forewing areole (small cell), forewing pterostigma (thickened area), and M3 and Cu1 stalked in the hind wing (Figure B.2). These features are useful in screening samples. Because the head and forewing are usually covered with sticky substances from the trap, I emphasized the hind wing venation as a criterion. The hind wing often is relatively clean, especially if it is covered by the fore wing. Tear off the forewing on one side to expose the hind wing. Any moth of the right size and wing pattern with M3 and Cu1 stalked in the hind wing should be considered a leek moth suspect.

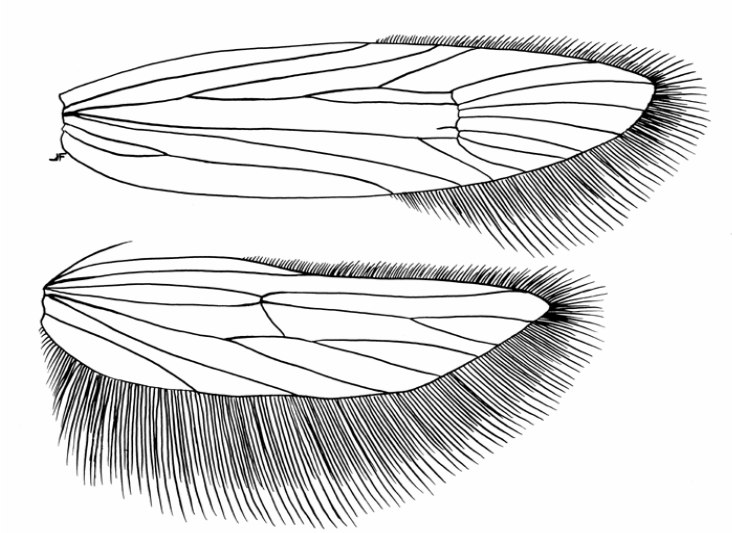


Figure B.2. Forewing (top) and hindwing of the leek moth. (Drawing courtesy of Joel Floyd, USDA APHIS.)

Genitalia

Accurate identification of *Acrolepiopsis* requires study of the genitalia (Figure B.3, B.4). Landry (2002) provided details on how to separate the leek moth and *A. incertella* based on genitalia.

In the male leek moth, the distal portion of the valve is slightly spatulate and the saccus is longer than the rest of the genitalia. *Acrolepiopsis incertella,* in contrast, has a rounded and enlarged apex of the valve, with a saccus that is almost triangular and approximately equal to the length of the rest of the genitalia.

In females, the ductus bursa of the leek moth is wider and more sclerotized than *A. incertella* (Landry 2002).

The apex of the valve is bluntly triangular in *A heppneri*, rather than rounded as in the leek moth. The funnel-shaped ostium bursa and associated structures separate the female of *A. heppneri* from the leek moth. Gaedike (1984) illustrated the genitalia of *A. heppneri*.

Figure B.3. Male genitalia. (Image courtesy of Steven Passoa, USDA APHIS.)

Figure B.4. Male genitalia. (Image courtesy of Steven Passoa, USDA APHIS.)

This report is authorized by law (7 U.S.C. 147a). While you are not required to respond your cooperation is needed to make an accurate record of plant pest conditions. *See reverse for additional OMB information.*

FORM APPROVED
OMB NO. 0579-0010

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

SPECIMENS FOR DETERMINATION

Instructions: Type or print information requested. Press hard and print legibly when handwritten. Item 1 - assign number for each collection beginning with year, followed by collector's initials and collector's number. Example (collector, John J. Dingle): 83-JJD-001.
Pest Data Section – Complete Items 14, 15 and 16 or 19 or 20 and 21 as applicable. Complete Items 17 and 18 if a trap was used.

FOR IIBIII USE
LOT NO.

PRIORITY

1. COLLECTION NUMBER

2. DATE

MO	DA	YR

3. SUBMITTING AGENCY
☐ State Cooperator ☐ PPQ ☐ Other _____

SENDER AND ORIGIN

4. NAME OF SENDER

6. ADDRESS OF SENDER

ZIP

INTERCEPTION SITE

5. TYPE OF PROPERTY *(Farm, Feedmill, Nursery, etc.)*

7. NAME AND ADDRESS OF PROPERTY OR OWNER

COUNTRY/ COUNTY

PURPOSE

8. REASON FOR IDENTIFICATION *("x" ALL Applicable Items)*

A. ☐ Biological Control (Target Pest Name)	E. ☐ Livestock, Domestic Animal Pest
B. ☐ Damaging Crops/Plants	F. ☐ Possible Immigrant *(Explain in* REMARKS*)*
C. ☐ Suspected Pest of Regulatory Concern *(Explain in* REMARKS*)*	G. ☐ Survey *(Explain in* REMARKS*)*
D. ☐ Stored Product Pest	H. ☐ Other *(Explain in* REMARKS*)*

9. IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE PROVIDE A BRIEF EXPLANATION UNDER "REMARKS".

HOST DATA

10. HOST INFORMATION
NAME OF HOST *(Scientific name when possible)*

11. QUANTITY OF HOST
NUMBER OF ACRES/PLANTS
PLANTS AFFECTED *(Insert figure and indicate* ☐ Number ☐ Percent*):*

12. PLANT DISTRIBUTION
☐ LIMITED
☐ SCATTERED
☐ WIDESPREAD

13. PLANT PARTS AFFECTED

☐ Leaves, Upper Surface	☐ Trunk/Bark	☐ Bulbs, Tubers, Corms	☐ Seeds
☐ Leaves, Lower Surface	☐ Branches	☐ Buds	
☐ Petiole	☐ Growing Tips	☐ Flowers	
☐ Stem	☐ Roots	☐ Fruits or Nuts	

PEST DATA

14. PEST DISTRIBUTION
☐ FEW
☐ COMMON
☐ ABUNDANT
☐ EXTREME

15. ☐ INSECTS ☐ NEMATODES ☐ MOLLUSKS

NUMBER SUBMITTED	LARVAE	PUPAE	ADULTS	CAST SKINS	EGGS	NYMPHS	JUVS.	CYSTS
ALIVE								
DEAD								

16. SAMPLING METHOD

17. TYPE OF TRAP AND LURE

18. TRAP NUMBER

19. PLANT PATHOLOGY – PLANT SYMPTOMS *("X" one and describe symptoms)*
☐ ISOLATED ☐ GENERAL

20. WEED DENSITY
☐ FEW ☐ SPOTTY ☐ GENERAL

21. WEED GROWTH STAGE
☐ SEEDLING ☐ VEGETATIVE ☐ FLOWERING/FRUITING ☐ MATURE

22. REMARKS

23. TENTATIVE DETERMINATION

24. DETERMINATION AND NOTES *(Not for Field Use)*

SIGNATURE

DATE

FOR IIBIII USE
DATE RECEIVED
NO.
LABEL
SORTED
PREPARED
DATE ACCEPTED
RR

PPQ FORM 391 *Previous editions are obsolete.*
(AUG 02)

This is a 6-Part form. Copies must be disseminated as follows:
☐ PART 1 – PPQ ☐ PART 2 – RETURN TO SUBMITTER AFTER IDENTIFICATION ☐ PART 3 – IIBIII OR FINAL IDENTIFIER
☐ PART 4 – INTERMEDIATE IDENTIFIER ☐ PART 5 – INTERMEDIATE IDENTIFIER ☐ PART 6 – RETAINED BY SUBMITTER

OMB Information
According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0010. The time required to complete this information collection is estimated to average .25 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Instructions

Use PPQ Form 391, Specimens for Determination, for domestic collections (warehouse inspections, local and individual collecting, special survey programs, export certification).

BLOCK	INSTRUCTIONS
1	1. Assign a number for each collection beginning the year, followed by the collector's initials and collector's number **EXAMPLE** In 2001, Brian K. Long collected his first specimen for determination of the vear. His first collection number is 01-BLK-001 2. Enter the collection number
2	Enter date
3	Check block to indicate Agency submitting specimens for identification
4	Enter name of sender
5	Enter type of property specimen obtained from (farm, nursery, feedmill, etc.)
6	Enter address
7	Enter name and address of property owner
8A-8L	Check all appropriate blocks
9	Leave Blank
10	Enter scientific name of host, if possible
11	Enter quantity of host and plants affected
12	Check block to indicate distribution of plant
13	Check appropriate blocks to indicate plant parts affected
14	Check block to indicate pest distribution
15	• Check appropriate block to indicate type of specimen • Enter number specimens submitted under appropriate column
16	Enter sampling method
17	Enter type of trap and lure
18	Enter trap number
19	Enter X in block to indicate isolated or general plant symptoms
20	Enter X in appropriate block for weed density
21	Enter X in appropriate block for weed growth stage
22	Provide a brief explanation if Prompt or URGENT identification is requested
23	Enter a tentative determination if you made one
24	Leave blank

Distribution of PPQ Form 391

Distribute PPQ Form 391 as follows:
1. Send Original along with the sample to your Area Identifier.
2. Retain and file a copy for your records.