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*George R. Stephens processes flax*

Fiber flax grows again in Connecticut

Saving energy in tomato production

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THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION,

founded in 1875, is the first experiment station in America. It is chartered by the General Assembly as an independent State agency governed by a Board of Control. Station scientists make inquiries and experiments regarding plants and their pests, insects, soil and water quality, food safety, and perform analyses for State agencies. Factual information relating to the environment and agriculture is provided freely and objectively to all. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Copies of this and other publications are available upon request to Publications; Box 1106; New Haven, Connecticut 06504

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# Fiber flax may once again be a crop in Connecticut

**By George R. Stephens**

Every once in a while a new agricultural opportunity appears. In late 1991 European investors inquired whether fiber flax could be successfully grown in Connecticut. Preliminary investigation showed our soils and climate to be suitable and that flax once grew here. In response, the Station began research on fiber flax in 1992. I report the progress to date.

Fiber flax, one of our oldest textile fibers, has been cultivated for an estimated 10,000 years. Remnants of linen, made from flax fiber, were found among the artifacts of prehistoric lake dwellers in Switzerland. Fine linen fabrics were found in Egyptian tombs. It is believed that Phoenician traders brought linen from the Mediterranean region to Gaul and Britain. The Romans introduced linen manufacture throughout their empire, and European colonists introduced fiber flax into North America.

Connecticut Colonial law required every family to grow 1/8th or 1/4th acre of either flax or hemp, depending on whether they owned livestock or a team. Flax production in Connecticut continued until about 1830. As new land became available during westward expansion, fiber flax accompanied the pioneers. Flax culture continued until weeds or disease no longer made it profitable to grow.

Commercial production of fiber flax persisted in the Willamette River Valley of Oregon until the 1950's. Withdrawal of government subsidies and introduction of new synthetic fibers caused fiber flax production in the United States to cease.

Fiber flax, *Linum usitatissimum* L., has been cultivated so long that it has no wild counterpart. It is believed to have been derived from *Linum angustifolium*, a wild flax, found from England to western Asia.

As its Latin name suggests, fiber flax is a "most useful" plant. Between the bark and woody stem core bundles of strong phloem or bast fibers extend from the root collar to the first branch. These long fibers are spun into thread for textiles. The short fibers, tow, are useful for cordage, tow cloth and paper. From the seed comes linseed oil and the remaining press cake is used as a high protein feed supplement. The shives, small pieces of woody stem removed from the fibers, may be used for fuel or the manufacture of fiberboard. With suitable markets little of the plant is wasted.

On April 29, 1992, nine test plots, 3.3 x 19.8 feet, were planted at Lockwood Farm in Hamden. Seed of two unnamed Italian selections and a French cultivar, 'Ariane', was sown with a hand seeder in drills 4 inches apart. On May 19 at Lockwood Farm and May 21 at The Valley Laboratory in Windsor, six additional plots at each location were similarly sown with French cultivars Ariane and 'Viking'. Sufficient fertilizer was added to provide approximately 75 pounds per acre of available nitrogen from fertilizer and soil reserve. Two half-acre fields were planted to Ariane and Viking on May 20 and 21 at Lockwood Farm and on May 22 at The Valley Laboratory. A grain drill with row spacing of 7 inches was used to plant the seed about 0.75 inches deep. Germination was prompt, 3-5 days. On June 9 and 10 at Lockwood Farm and June 12 at The Valley Laboratory, when the flax was 3-4 inches tall, a mixture of MCPA (Rhomene™) and sethoxydim (Poast™) was applied as a post emergent spray to control broad-leaved weeds and grasses.

Table 1. Yield of retted flax straw in small test plots (4-inch drill spacing) at Lockwood Farm in Hamden and The Valley Laboratory in Windsor, 1992

| | Lockwood Farm | | Valley Laboratory | |
|---|---|---|---|---|
| Cultivar | Sowing date | Yield lb/A | Sowing date | Yield lb/A |
| Italian-1 | 4/29 | 5776 | | |
| Italian-2 | 4/29 | 6111 | | |
| Ariane | 4/29 | 7329 | | |
| Ariane | 5/19 | 6260 | 5/21 | 2913 |
| Viking | 5/19 | 6049 | 5/21 | 2561 |

Flax is harvested by pulling when the lower two-thirds of the leaves have yellowed or fallen and the seed bolls begin to turn yellow-brown. The wiry stems are difficult to cut, and useful fiber remaining in the stubble after cutting would be lost.

At Lockwood Farm, flax in small plots sown April 29 was pulled during July 28-August 3. Plots sown on May 19 were pulled August 17 or September 11. At The Valley Laboratory flax in small plots was pulled September 15-17. Six or eight sample plots, 6 x 10 feet, were pulled from each large field at both locations on August 18-19.

After pulling, the flax straw remains in the field for 3-8 weeks to undergo retting, microbiological decomposition that loosens the fiber bundles from the underlying woody stem and from one another. During retting the flax is turned one or more times to ensure uniform treatment. When the flax is sufficiently retted and dry, it is baled and stored dry until processing to extract the fibers.

The early planted test plots at Lockwood Farm were retted 22-24 days in the warm, moist weather of August. Test plots planted and pulled later retted for 52 days in the cooler, drier weather of September and October. At The Valley Laboratory the test plots retted for 32 days. Samples from the large fields retted for 56-57 days.

The yield goal was 6200 pounds/A of retted flax straw, including seed bolls. This yield was achieved on most of the small plots sown at 4-inch drill spacing at Lockwood Farm (Table 1). However, yield of the second planting of Ariane, made 3 weeks later, was reduced by 15 percent. At The Valley Laboratory, yield of the small plots was less than half the late planting at Lockwood Farm. The reason was not obvious.

On the large fields, sown at 7-inch drill spacing, about two-thirds of the yield goal was realized (Table 2). At Hamden, the field sown to Ariane was drilled twice in an attempt to increase plant density; yield increased to about three-fourths of the goal. At Windsor, however, Ariane yielded less than Viking. Part of the reduction was likely due to a malfunctioning grain drill that caused missing rows.

The retted flax straw samples were broken (crushed), scutched (beaten) and hackled (combed) by hand to extract the silvery gray flax fibers. Preliminary estimates of fiber quality suggest that it is excellent.

Estimates of costs and returns suggest that production of fiber flax in Connecticut will cost about $600-700/A. Current European prices indicate that a yield of 6200 lb/A of retted flax straw should result in a gross return of about $1000/A and provide a net return of $200-300/A to the farmer.

Fiber flax offers exciting possibilities. The 1992 tests indicate that, with proper equipment and technique, good yield of high quality fiber can be achieved. The low nitrogen requirement reduces the threat of groundwater pollution. Further, to be a viable crop, a large acreage must be grown. To avoid problems with soil-borne disease, flax is normally grown in rotation with other crops. A suggested 5-year rotation would commit a large acreage to production, thus helping to keep Connecticut farms, especially former dairy farms, productive. In addition, crop rotation would encourage a diversified agriculture.

Table 2. Yield of retted flax straw in large fields (7-inch drill spacing) at Lockwood Farm in Hamden and The Valley Laboratory in Windsor, 1992

| | Lockwood Farm | | Valley Laboratory | |
|---|---|---|---|---|
| Cultivar | Yield lb/A | Goal % | Yield lb/A | Goal % |
| Ariane | 4942 | 79 | 4080 | 65 |
| Viking | 4140 | 66 | 4504 | 72 |

In 1993, the European investors are attempting to enlist sufficient farmers to grow 800 acres of fiber flax in Connecticut, the amount necessary to keep a scutching mill with a single processing line in operation one shift daily throughout the year. At present, any flax fiber produced in Connecticut would have to be shipped elsewhere to be spun into thread or yarn. However, a large acreage of flax in Connecticut and adjacent states could one day lead to the establishment of a spinning mill. Once Connecticut was dotted with small textile mills; flax may be the key for the return of a textile industry.

# Energy saving growing methods help produce greenhouse tomatoes

**By Martin P.N. Gent**

Until the 1970's there was a significant industry devoted to greenhouse production of out-of-season tomatoes in Connecticut. However, high fuel prices drove all but a few growers to switch to ornamental crops, which allowed them to produce more crops per year and avoid having to heat their greenhouses during the coldest months of winter.

In the last 5 years, however, a new group of growers has begun to produce tomatoes in greenhouses. These are vegetable growers who want an early season crop for their own retail stands. Greenhouses allow harvest to begin in June, about one month earlier than is possible with a field grown crop.

The economics of greenhouse production are good for this situation. Based on a single 24 x 96 foot greenhouse, made from metal hoops and a plastic cover, fixed costs above the cost of normal field production are about $4,000 for hoops and hardware, plastic cover and furnace. Production costs are about $300 for seed and fertilizer, $600 for heat, and $1,500 for labor to plant, prune and harvest. The gross return can be large: $13,000 from a single greenhouse producing 6,500 pounds of tomatoes, sold at retail at $2 a pound. Thus, the net return can be $6,000 or more. Most growers feel a price of $1.00 a pound is required to break even.

Because the cost of heating is about 20% of the cost of production, I began to search for energy saving methods in 1978. I examined split-night temperatures, where the greenhouse is allowed to cool for part of the night to save energy. I found that physiological processes were not inhibited by a cool period as long as the plants were warmed at dawn. However, growth was slowed, compared to warm nights, according to the average temperature the plants experienced. I also tried row covers or low tunnels to force early production, but they did not work for tomato. High temperatures under covers on sunny days caused flowers to abort and promoted vegetative rather than reproductive growth. When row covers were removed in warm weather, plants grew no faster than those grown without covers.

In 1988, assisted by Michael Short, I began studies to see if unheated greenhouses, also called hoop houses or high tunnels, could be used for early production. These use no fuel for heat, but rely solely on energy from the sun. Adequate ventilation is achieved by opening the doors or rolling up the sides.

Edward Naughton and his crew at The Experiment Station's Lockwood Farm in Hamden built four identical high tunnels to test the timing of planting and the effect of

Table 1. Earliness, yield and size of tomatoes produced in greenhouses with different minimum temperatures.

| Minimum temperature degrees F | Results, 1991 Date first ripe | Yield lb/ plant | Size oz/ fruit | Results, 1992 Date first ripe | Yield lb/ plant | Size oz/ fruit |
|---|---|---|---|---|---|---|
| 36 | 6/12 | 6.0 | 4.7 | 6/28 | 7.0 | 4.7 |
| 42 | 6/9 | 6.7 | 5.5 | 6/24 | 6.8 | 4.4 |
| 50 | 6/9 | 7.0 | 5.5 | 6/18 | 8.4 | 4.3 |
| 58 | 6/7 | 8.1 | 5.9 | 6/15 | 10.6 | 5.0 |

different ventilation schemes on tomato production. In 1989 and 1990, I planted as early as April 1 and grew plants in unheated high tunnels vented at 58, 72, 86 or 100F to see how fast tomatoes would ripen.

The earliest yields came from seedlings transplanted on April 3 into a high tunnel ventilated at 86F. The fruit ripened in early June. In cooler tunnels that were ventilated more, tomatoes ripened later. The optimum duration of ventilation on sunny days was 3 hours in early April, increasing to 5 hours in early May and 7 hours in early June. Seedlings planted later produced ripe tomatoes later, but yield and fruit size were greater. A mid-April planting was the best compromise between earliness, yield and quality. Although planting in early April lead to harvest in early June, plants in the high tunnels did not take up nutrients shortly after transplant, and yield and size of the tomato fruit were small when planted this early.

In 1991, the tunnels were modified with heaters and a double-layer polyethylene cover. Minimum temperatures of 36, 42, 50 and 58F were established to see if cool nights were the cause of poor yields in earlier trials. Six-week-old seedlings of 12 different cultivars were transplanted into peat-lite bags on April 1, 1991 and March 15, 1992, and ripe fruit were picked through July.

**Figure 1. Martin P.N. Gent in high tunnel used to grow early tomatoes.**

In 1991, the effects of different minimum temperatures for heating were slight because early April was unusually warm, with five consecutive nights warmer than 50F. The trials did not reveal a critical temperature necessary for good production. Total yield increased from 6 to 8 pounds per plant as minimum temperature increased from 36 to 58F (Table 1). Fruit size also increased from 4.7 to 5.9 ounces per fruit.

In 1992, both the spring and summer were cooler than usual, so differences in earliness and yield were significant, depending on the minimum temperature. On average, the first fruit ripened on June 15 in the 58F greenhouse, 2 weeks earlier than in the 36F house (Table 1). Consequently, early yield in the 36F house was substantially less than that in the 58F house. Over the whole season, the yield from the 36 and 42F houses was two-thirds that from the 58F house. Yields from the house heated to 50F were intermediate. The 58F house also produced larger fruit than houses with cooler minimum temperatures. Different varieties of tomato reacted differently to the temperature settings (data not shown). Early yield of determinate cultivars was least sensitive to the temperature. The early yield of the greenhouse types was depressed most, about 70%, by cool nights.

When considered together, the results in 1991 and 1992 suggest that the cooler the outside temperature, or the earlier in the spring that seedlings are transplanted into the greenhouse, the more necessary it is to maintain a minimum temperature near 60F to promote rapid growth and development of the tomato plants.

I am now experimenting with root zone heating. If cool soil rather than cool air is the principal limitation to growth in high tunnels, heating the soil should allow earlier planting, and would require less energy than heating the air. At Lockwood Farm, I am testing various combinations of heating the air and the soil, to see which results in good production with the least expenditure of fuel for heating.

As part of this research, I am collaborating with Vincent Malerba, a grower in Norwich. He devised a simple system for heating the soil, namely blowing hot air from a forced air heater through drainage pipe buried in the soil under the rows of plants. The most common way to heat the soil is to circulate hot water through tubes, or to use electric heating cables in the soil. Such methods are a substantial and expensive modification of the typical greenhouse, requiring an additional heating system.

Table 2. Effect of soil heating on earliness and yield and quality of greenhouse tomatoes.

| Factor | Date first ripe | Yield by 1 July lb/plant | Yield by 1 Sept lb/plant | Number one quality by July 1 % by weight | Number one quality by Sept 1 % by weight |
|---|---|---|---|---|---|
| Heated | 6/11 | 4.1 | 17.6 | 0.62 | 0.82 |
| Control | 6/14 | 3.6 | 14.7 | 0.66 | 0.78 |

Together, we set up an experiment to test his method. Malerba grew two varieties of tomatoes in raised beds in a greenhouse in which the air was heated to maintain 60F. The soil in some beds was heated and in other beds it was not. The seedlings were transplanted in mid March and tomatoes began to ripen in early June.

The soil temperature was 58F at planting. The soil in the heated rows warmed to 66F in 1 day and 68F in 1 week. The soil in the unheated rows was 58F 1 day after planting and 59F 1 week later. In April, the heated rows averaged 69F and the unheated rows were 60F in the first week and 62F for the rest of April. In May the heated rows cooled from 68 to 66F because the furnace was used much less for heating. The unheated rows had an average soil temperature of 64F in May.

Soil heating resulted in slightly earlier ripening and a substantial increase in yield of tomatoes. In the heated beds, the first fruit ripened 3 days earlier than in the unheated beds (Table 2). The heated rows were more productive than the unheated rows throughout the season, resulting in a 24% increase in the total yield by the end of August.

These experiments show that a farmer has several strategies available for early tomato production, depending on the expense he will assume and the desired date for the start of production. Unheated high tunnels are a simple and inexpensive way of forcing production to begin in mid June. For earlier production, tomato plants should be grown in heated greenhouses with minimum temperatures of 60F or more. Early in the spring, it may be necessary to warm the soil to maximize production from the greenhouse tomato plants.

# Experiment Station continues long tradition of breeding chestnut for resistance to blight

**By Sandra L. Anagnostakis**

The American chestnut (*Castanea dentata*), once one of the dominant species in our Connecticut forests, has many desirable characteristics. Their tall, straight trunks yielded valuable timber, and the nutritious nuts provided food for people, livestock, and wildlife. Since the wood resists rot, it was once the major source of telephone poles and railroad ties. However, the chestnut blight fungus, *Cryphonectria parasitica*, which came into the United States on Japanese chestnut trees has reduced our native species to an understory shrub throughout its natural range. Since the discovery of the blight in New York City in 1904, scientists have studied the blight and have carried out extensive breeding in hopes of finding a way to bring back this majestic forest species.

Efforts to produce American-like hybrids that were resistant to chestnut blight were begun in many places, but only The Connecticut Agricultural Experiment Station has continued the work and has maintained records and its many valuable trees. The Experiment Station now has the finest collection of species and hybrids of chestnut in the world.

When breeding trees, seeds are planted, seedlings grow for several years before becoming mature, flowers are formed and crosses made, and new seeds are planted. American chestnut trees take 7-10 years to become mature and able to produce nuts, and seedlings must be at least 5 years old to be tested for blight resistance. This is a project for several lifetimes.

Early chestnut breeding in Connecticut focused on making hybrids that were combinations of species, looking for a single ideal progeny that could be propagated clonally.

Arthur H. Graves of the Brooklyn Botanical Garden planted trees on land that he owned in Hamden, and started making crosses in 1930. Donald F. Jones, The Experiment Station's renowned geneticist soon became interested, and started collaborating and planting trees at Lockwood Farm. In 1947, Graves deeded his land with the Sleeping Giant Chestnut Plantation to the state, to ensure that the work would continue.

Richard A. Jaynes, a Yale University graduate student who was supervised by Graves and Jones, joined the Experiment Station staff in 1961 and continued chestnut breeding research until he retired in 1984.

Keeping American chestnut trees alive for breeding is now easier because of a biological control agent: a virus that keeps the fungus from killing trees. This biocontrol was discovered in Italy, and introduced into North America

**Figure 1. Sandra L. Anagnostakis holds germinating American chestnuts from Cornwall, CT.**

by The Experiment Station in 1972. Although the control works well in an orchard, and helps trees survive in a forest if they have good growing conditions and few competitors, it is clearly not working well enough to be the final answer. However, a combined approach of breeding trees with more resistance and using the biological control looks promising.

At the urging of Charles R. Burnham, a well-known geneticist, I searched Experiment Station records for hybrids that were crosses of blight resistant and susceptible trees, especially for any that were backcrossed again to (susceptible) American chestnut trees. Burnham suggested that three generations of backcrossing with selection of progeny for blight resistance and form, followed by crosses of those progeny with each other and another round of selection, could result in trees that had the form and nut quality needed, combined with resistance to chestnut blight. If we are fortunate, such trees would produce "true to type" offspring, and allow reforestation with hybrid American-like chestnuts.

Chestnut trees produce both male and female flowers, but trees are not "self fertile": they must be cross pollinated to produce nuts. All seven species of *Castanea* are cross-fertile, so many kinds of crosses have been done. When our chestnut trees flower in late June we tie wax-paper bags over the female flowers that we wish to cross. This protects them from pollen that might be brought to them by the wind, or by the many insects that frequent the flowers. Pollen collected by hanging the male flowers upside-down in paper shopping bags is transferred to small tubes to transport it. When the female flowers are ready for crossing, we remove the wax-paper bags and dust on pollen of our choice, and then replace the bags to provide continued protection. The nuts that form in the burs are usually ready for harvest in October. These are collected, labeled, and stored in the cold for planting in the spring.

Using Asian trees and hybrids that have proved their resistance to chestnut blight and their winter hardiness by surviving for many years I have developed over 150 new hybrids to evaluate. Some of these hybrids can be seen at The Experiment Station's Lockwood Farm, growing next to the orchard of American chestnut trees where the biocontrol was first tested.

I am now making selections for orchard as well as timber trees. Some hybrids made by Jaynes have the Chinese shrub *C. seguinii* in their background, and are compact dwarfs. I have used them in crosses with chestnut trees that have exceptional nut quality to select short, reliable nut producers. These and other Connecticut hybrids will be tested against some of the commercially available chestnut cultivars in an orchard in cooperation with Steven Broderick of the UCONN Extension System.

We expect to have timber-type chestnut trees for forest tests within 10 years, and orchard-type trees ready for yield and nut quality tests within 15 years. The renewed interest in chestnuts should allow cooperation with many people to speed our progress towards growing of usable chestnut timber stands and a new nut-producing industry for Connecticut.

# Spring hemlock looper returns to attack hemlock forests in Connecticut

**By Chris T. Maier, Carol R. Lemmon, Ronald M. Weseloh, and Theodore G. Andreadis**

Hemlock trees in Connecticut are under siege. They have suffered devastating attacks from scale insects and woolly adelgids, and now spring hemlock loopers, *Lambdina athasaria*. This is the first outbreak of this geometrid moth in Connecticut since the 1940's. When abundant, loopers can defoliate and kill trees in just 1 year.

In 1992, the spring hemlock looper infested about 5,000 acres of hemlock forest in Connecticut and additional acreage in other New England states. Because of damage to public and private forests in areas such as Barkhamsted, we have begun research to learn about the life cycle of the looper and to determine natural factors that might control it.

Despite the looper's destructive potential, few entomologists have studied it. We are the first to study its ecology. We know that the looper has four distinct stages: egg, larva (the feeding stage), pupa (the transitional non-feeding stage), and moth (the reproductive stage). Although we know that the pupa overwinters, we do not know precisely when each of the four developmental stages is present or when each is attacked by natural enemies.

Before the snow melted in the spring of 1992, assisted by foresters and park supervisors of the Department of Environmental Protection, we located looper populations in Connecticut forests. We selected Devil's Hopyard State Park in East Haddam (Middlesex County) as our principal study site because it had a thriving population of looper pupae. We chose hemlock forests in Barkhamsted and Washington (Litchfield County), Newtown (Fairfield County), and Colchester (New London County) as additional research sites to compare pupal density and natural enemies for several years to discern population trends. All of these sites are important because they have magnificent hemlock forests that are threatened by loopers.

After selecting the sites, we determined pupal densities by counting the mottled brownish pupae (Figure 2) overwintering in leaves and other debris under hemlock trees. We found that pupal density varied greatly among sites (Table 1). The density at Barkhamsted, the most northern site, was seven times higher than that at any other site. Sites with 12 or more pupae per square meter had substantial defoliation by late autumn. In coming years, we plan to investigate how pupal density and defoliation are related.

At Devil's Hopyard, we sampled the foliage of hemlocks and the litter beneath them from May to November to determine when the various stages of looper were present. We used screen traps to capture moths (Figure 3) when they emerged from pupae. The light brown adults emerged between late May and late June, and flew mostly during June. Moths laid greenish eggs (Figure 4) singly or in small groups on the underside of hemlock needles. Most of the larvae (also called loopers for their style of walking) hatched in June, and fed on foliage until completing development about 4 months later. Fully-grown larvae (Figure 5) descended from the trees in September and October to form pupae under leaves and other debris on the soil. Pupae remain in these sheltered spots until the springtime emergence of moths.

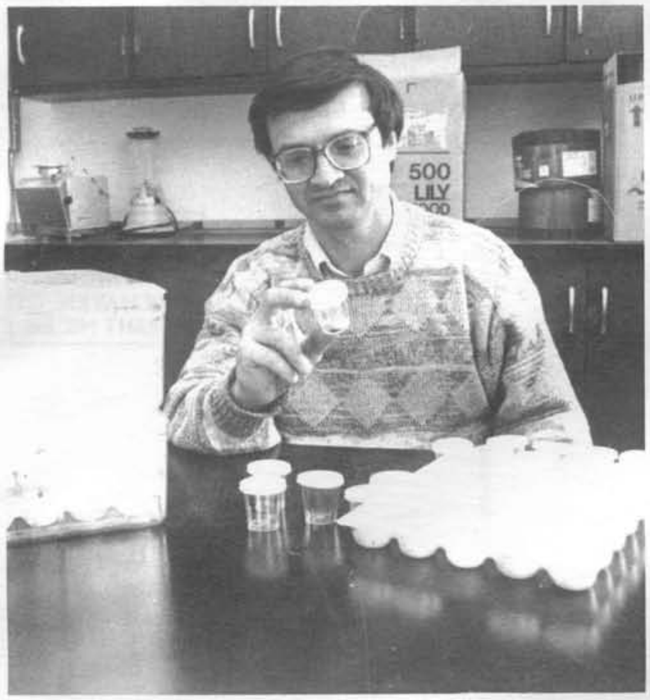

**Figure 1. Chris T. Maier checks for emerging parasites of spring hemlock looper.**

**Figure 2. Pupa in the leaf litter; 1/2-5/8" long.**

Between 29 and 72% of the pupae collected in the spring of 1992 were killed by insects, a fungus, or undetermined factors (Table 1). Parasitic wasps and flies killed 17.8-58.7% of the pupae, indicating great variability among sites. Although a fungus (*Paecilomyces* sp.) killed only 1.2-6.5% of the pupae collected in spring, its impact needs to be reassessed periodically during the outbreak cycle to learn if it changes.

Future sampling will determine if the amount of parasitism increases with decreasing pupal density or with time. We also are conducting an experiment to determine the amount of predation during pupal diapause (the insect equivalent of hibernation). We suspect that predation may be an important source of pupal mortality.

Table 1. Pupal density and mortality of the spring hemlock looper sampled in Connecticut towns during the spring of 1992.

| | Pupae per | % mortality caused by | | | |
|---|---|---|---|---|---|
| Town | Square meter | Parasitic insects | Pathogenic fungus | Unknown factors | All factors |
| Newtown | 15.2 | 58.7 | 2.3 | 11.1 | 72.1 |
| Washington | 1.6 | 50.0 | 6.5 | 6.5 | 63.0 |
| Barkhamsted | 112.0 | 24.1 | 4.7 | 18.0 | 46.8 |
| Colchester | 13.2 | 29.2 | 1.2 | 8.9 | 39.3 |
| East Haddam | 12.8 | 17.8 | 1.7 | 9.8 | 29.3 |

Figure 3. Moth on hemlock bark; 1" wingspan.

Figure 4. Eggs on foliage; about 1/32" in dia.

Figure 5. Fully-grown larva; about 1" long.

The rearing of parasitic insects from larvae was a challenging task because the loopers had to be kept alive for many months until the parasites completed their development. We learned that parasitic insects killed only a few larvae. We found that a pathogenic protozoan, called a microsporidian, infected larvae with increased frequency as the season progressed. The effect of all mortality agents will be evaluated further in coming years to determine their role in causing the decline of looper populations.

We have already learned much about the life of the spring hemlock looper, but more remains to be discovered. We want to determine how the appearance of life stages varies from year to year, how the impact of natural enemies changes temporally and spatially, and if and how pupal density and defoliation are related. In the end, we shall know how the spring hemlock looper lives and dies and how we might improve its control.

## Plant Science Day

The annual Plant Science Day open house will be held at Lockwood Farm in Hamden from 10 a.m. to 4 p.m. on Wednesday, August 11.

The main speaker will be Bruce P. Bickner, President and Chief Executive Officer of the DeKalb Genetics Corp., DeKalb, IL.

There will be short talks by staff, and exhibits and field plot displays throughout the day

For more information, call 789-7223.

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