Laboratory rearing of the eastern hemlock looper (Lepidoptera: Geometridae) on artificial diet and grand fir foliage

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ABSTRACT

This paper describes a technique to rear the eastern hemlock looper, *Lambdina fiscellaria fiscellaria* (Guen.) on a modified spruce budworm artificial diet and foliage of grand fir, *Abies grandis* (Dougl. ex D.Don).

Key words: *Lambdina fiscellaria fiscellaria, Abies*, artificial diet, rearing

DISCUSSION

The eastern hemlock looper, *Lambdina fiscellaria fiscellaria* (Guen.), is distributed from Newfoundland to Alberta in Canada, and is a serious forest pest in mature stands of balsam fir, *Abies balsamea* (L.), and eastern hemlock, *Tsuga canadensis* (L.) Carrière. To ensure a continuous and qualitatively uniform supply of this insect for research, efficient and reliable laboratory rearing techniques are needed. Larvae can be successfully reared by feeding early larval instars CSM (corn, soy flour and milk solids) artificial diet, and later instars foliage of balsam fir (Grisdale 1975, 1985); however, the lack of availability of balsam fir in western Canada presents a major problem in the laboratory rearing of this species there. Here we describe rearing procedures for eastern hemlock looper, using a spruce budworm artificial diet (Robertson 1979) without formalin, for the first two instars, and foliage of grand fir, *A. grandis* (Dougl. ex D. Don) for later instars. The modified artificial diet was used in this study because of its availability in our laboratory. The grand fir is in the same genus as the balsam fir, a primary host of eastern hemlock looper, and available near our laboratory.

Cheesecloths with eggs of eastern hemlock looper were placed inside of sealed plastic bags that were placed inside of paper bags. To satisfy diapause requirements, eggs on the cheesecloth were stored in darkness at 2 ± 0.5°C, 100% RH for a minimum of 3 months. After diapause, eggs were moved to an insect rearing room with conditions of 20 ± 1°C, 55-60% R.H., and 16:8 h (L:D). The cheesecloths with eggs were sprayed with distilled water twice before larval hatching. Approximately 9 days after being moved to the rearing room, the eggs started hatching and most of them hatched over 2-4 day period. Over 90% of the eggs hatched.

Newly hatched larvae were transferred with a camel's-hair brush into 20-ml creamer cups, at the rate of five larvae per cup. Each cup had previously been half-filled with the artificial diet (Table 1). Larvae in the cups were kept at the above rearing conditions for 2 weeks, and then transferred to rearing containers filled with one-year-old grand fir foliage. The survival of neonates on the artificial diet was greater than 90%, and cannibalism in the cups was lower

than 10% when the late-second-instar larvae were transferred onto grand fir foliage. After transfer, late-second-instar larvae accepted both dormant and new, flushing grand fir foliage, however, larval survival on new foliage was higher [about 90% (n = 455) versus 70% (n = 470), $t_{18\ df} = 10.54$, $P < 0.01$]. A single young grand fir tree (about 1 m high) in a cage (0.8 x 1.0 x 1.5 m) provides enough food for 100 late-second-instar larvae to develop to pupae. Rearing eastern hemlock looper larvae on young caged trees greatly reduced labor by eliminating foliage changes, and minimized injury to larvae due to handling. This technique depends upon availability of young trees. If young flushing trees are not available, larvae can still be reared on one-year-old grand fir foliage collected from the field. Under the rearing conditions we used, larval development was uniform and completed in about 45 days.

Table 1

Ingredients of an artificial diet for neonate larvae of *Lambdina fiscellaria fiscellaria*[1]

Ingredients	Quantity/batch (1000 grams of diet)
Agar solution	
Distilled water	620.0 ml
Powder agar	27.0 g
Dry ingredients	
Casein (vitamin-free)	39.0 g
Cellulose (fiber)	6.0 g
Salt mix, Wesson	10.0 g
Sucrose	29.0 g
Methyl parahydroxybenzoate	1.7 g
Ascorbic acid (vitamin C)	4.0 g
Sorbic acid	1.2 g
Aureomycin (5.5% chlorotetracycline)	0.93 g
Vitamin mix Vanderzant-Adkisson	12.0 g
Wheat germ	33.0 g
Liquid ingredients	
Distilled water	167.0 ml
Potassium hydroxide (4M)	6.7 ml
Raw Linseed oil	2.0 ml

[1] Agar solution was autoclaved for 20 min before being poured into a running blender that contained dry and liquid ingredients. The diet was dispensed into 20-ml creamer cups manually before it cooled. One batch of the diet will supply about 90 cups, if each is half filled. After cooling, diet in the cups was sprayed with an anti-fungal solution (1.5 g sorbic acid and 0.6 g methyl parahydroxybenoate in 100 ml 95% ethyl alcohol). Cups with diet were stored at 4°C for up to 5 days before being fed to larvae.

Upon pupation, the pupae were separated by sex according to Grisdale (1985), and placed in petri dishes. Male pupae were held at 4°C for 4 days to synchronize emergence with females, and then joined females at the same conditions as those of the larvae. Forty pupae (20 of each sex) were placed on the bottoms of cardboard ice cream cartons (30 cm diam by 45 cm height) with the open tops covered by five layers of cheesecloth held in place by rubber bands. After adult emergence had begun, an 8% sugar solution was provided. Adult emergence was 100% in our rearing. The emerging adults were held under the same rearing conditions as the larvae. The cartons served as mating cages and the females laid their eggs on the cheesecloth. The cheesecloths were sprayed with distilled water once or twice a day to maintain high humidity inside of the cartons. Adults survived for 3-4 weeks. After all adults had died, the cheesecloths were removed and placed at the same conditions as larvae for 1

week before sealing them inside a plastic bag. The plastic bags were then placed inside paper bags and stored in darkness at 2 ± 0.5°C, 100% RH. Eggs kept at these conditions for 3-6 months can break diapause and be ready for future research. Using the above-described procedures, we can readily rear more than 3000 larvae at a time.

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