Branching out

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Hemlock looper egg hatching: regular as clockwork

In late summer, the female hemlock looper lays her eggs singly on tree trunks and branches, where they overwinter before hatching the following spring. Researchers with the Canadian Forest Service and Université Laval have been able to explain the synchronized hatching of the eggs of this insect species by studying its embryonic diapause, which consists of three phases: prediapause, diapause and postdiapause. The external factors governing the duration of each of the three phases have been studied in order to develop a model to predict egg hatching, an essential tool for the integrated management of this major pest of balsam fir in eastern Canada.

Hemlock looper exiting its egg.
Photos: A. Labrecque (CFS)

Diapause is an adaptation that allows insects to survive environmental conditions, such as winter, which are expected to become increasingly unfavourable to the insects' growth, development or reproduction. Diapause is a period of suspended development and slow-down in basal metabolism. In hemlock looper (*Lambdina fiscelleria*), diapause occurs at the egg stage, when the embryo has just begun to develop. It is obligatory, meaning that it is genetically predetermined in the insect's development.

Three phases of diapause

Prediapause is the preparatory phase for entry of the egg into diapause. During this stage, the egg turns from light green at oviposition to coppery brown at diapause. This change in colour is in no way influenced by photoperiod, but rather by temperature alone: the higher the temperature, the faster the egg enters diapause or turns brown.

The second phase is diapause proper, a period of rest comparable to dormancy in plants or hibernation in certain animals. The researchers have determined that diapause in hemlock looper lasts three months. Its duration is fixed, i.e., it is not affected by either photoperiod or temperature. For example, eggs that enter diapause in early September complete it in early December, before the extreme cold arrives.

In the postdiapause phase, the eggs go through a period of quiescence, i.e., they are physiologically ready to

continue their development but are unable to do so due to excessively cold temperatures. However, this phase allows the eggs to synchronize. Regardless of how long it takes them to reach this stage, they will all resume development at the same time as soon as spring temperatures are favourable. Temperature therefore has a major influence on postdiapause development of the eggs, which will culminate in the synchronized hatching of the entire population.

Synchronized hatching of hemlock loopers.
Photo: J. Delisle (CFS)

Modelling, control and climate change

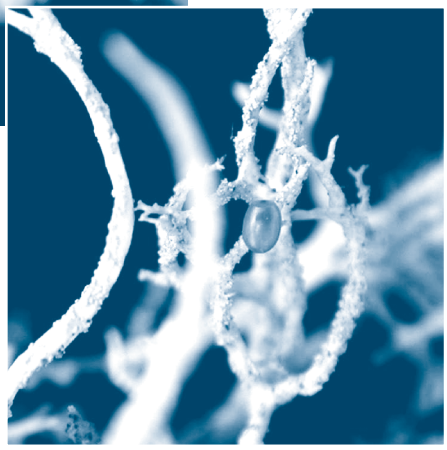
Using the knowledge gained about the various phases of embryonic diapause in the hemlock looper, the researchers have developed a model to predict the timing of egg hatching in the spring. Based on the postdiapause development rates of the eggs at different constant temperatures, the model was validated by monitoring natural hatching in various climate regions over several years. Because the timing of larval emergence in the field was known in advance, it was easier to manage control strategies to ensure they coincided with the most vulnerable stage of the insect. This explains the researchers' interest in modelling the entire seasonality of the hemlock looper in eastern Canada.

Hemlock loopers mating.
Photo: A. Labrecque (CFS)

The hemlock looper egg hatching model can also be used to predict how the process of diapause will respond to the effects of climate change. For example, the warmer summers and autumns will shorten the prediapause period, and hemlock looper eggs will enter diapause sooner, hence the possibility that they will hatch before the end of autumn. Milder winters, characterized by frequent freeze-thaw periods, will accelerate postdiapause egg development, with the possibility of hatching prior to bud burst.

Finally, because the hemlock looper reproduces only once a year due to its obligatory diapause, the number of eggs that survive the effects of a warmer climate will have a direct influence on the dynamics of the next larval population.

USEFUL LINK:
Insects and diseases of Canada's forests:
http://imfc.cfl.scf.rncan.gc.ca/accueil-home-eng.html



Hemlock looper egg in diapause.
Photo: A. Labrecque (CFS)

FOR MORE INFORMATION, PLEASE CONTACT:
Johanne Delisle
Natural Resources Canada
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.P.S.
P.O. Box 10380, Stn. Sainte-Foy
Quebec City, Quebec G1V 4C7
Phone: 418-648-2526
Fax: 418-648-5849
E-mail: johanne.delisle@nrcan.gc.ca
Web site: cfs.nrcan.gc.ca

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