Polyurethane foam strips to estimate parasitism of hemlock looper (Lepidoptera: Geometridae) eggs by *Telenomus* spp. (Hymenoptera: Scelionidae)

Christian Hébert,[1] Richard Berthiaume

Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, 1055 du P.E.P.S., P.O. Box 3800, Sainte-Foy, Quebec, Canada G1V 4C7

Clément Bordeleau

Ministère des Ressources naturelles et de la Faune du Québec, Direction de la conservation des forêts, 2700 rue Einstein, Sainte-Foy, Québec, Canada G1P 3W8

Abstract—An oviposition trap recently developed to survey hemlock looper (*Lambdina fiscellaria* (Guenée)) eggs and consisting of a small strip of white polyurethane foam stapled to the tree bole provides reliable estimates of *Telenomus* spp. parasitism on hemlock looper eggs. Oviposition traps are a standard tool that never varies. They allow us to avoid the tedious and expensive extraction process used when collecting eggs from branches. This new method can be implemented rapidly in a high number of plots and provides the egg parasitism estimates needed in spring to improve hemlock looper population management.

Résumé—Un gîte de ponte récemment développé pour surveiller les populations d'œufs de l'arpenteuse de la pruche (*Lambdina fiscellaria* (Guenée)) et fait d'une petite pièce de mousse de polyuréthane blanc fixée sur le tronc des arbres fourni des évaluations valables du parasitisme des œufs par *Telenomus* spp. Les gîtes de ponte sont un outil standard qui ne varie pas. Ils permettent d'éviter le recours au processus laborieux et coûteux d'extraction des œufs utilisé lorsqu'on récolte des branches. Cette nouvelle méthode peut être déployée rapidement dans un nombre élevé de sites pour fournir les évaluations printanières du parasitisme des œufs nécessaires pour améliorer la gestion des populations de l'arpenteuse de la pruche.

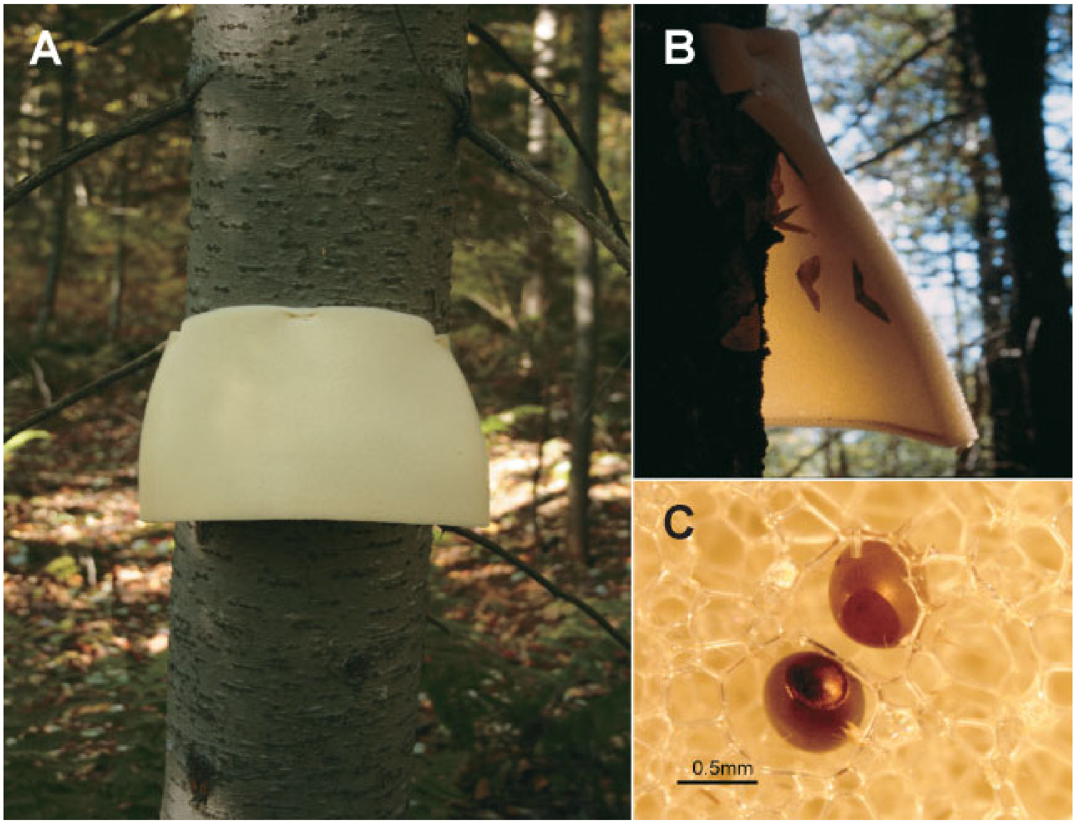
The hemlock looper, *Lambdina fiscellaria* (Guenée) (Lepidoptera: Geometridae), is a destructive defoliator of coniferous forests in North America (Hébert and Jobin 2001). This species is univoltine and overwinters in the egg stage. Because larvae feed wastefully on both current- and previous-year foliage (Carroll 1956), defoliation may rapidly result in tree mortality, even in the first year of severe defoliation (Jobin and Desaulniers 1981). Recently, a major outbreak of this species was forecast on the Gaspé Peninsula (Quebec, Canada), but it collapsed owing to the extremely high spring egg parasitism by *Telenomus* spp. (Hymenoptera: Scelionidae) (Hébert *et al.* 2001). *Telenomus coloradensis* Crawford was the most abundant of the three species attacking the looper (Pelletier and Piché 2003). Spring egg parasitism by *Telenomus* spp. appears to be a key factor in hemlock looper population dynamics (Hébert *et al.* 2001), and accurate estimates of spring egg parasitism are thus needed to improve damage forecasting and hemlock looper population management. However, because aerial spraying for control of hemlock looper populations is usually done when 50% of the larvae have reached the 2nd instar, the time available to estimate egg parasitism in spring and integrate it into management decisions is highly limited. In eastern Canada, hemlock looper egg populations are usually estimated by collecting 1 m branches in the middle of the lower crown of trees (Dobesberger 1989) and submitting them to an egg extraction process in the laboratory (Otvos and Bryant 1972). This is an expensive, tedious, and time-consuming method (Hartling *et al.* 1991; Liang *et al.* 1996; Hébert *et al.* 2003) that is poorly adapted for rapid implementation in a high number of plots. An oviposition trap,

Received 7 March 2005. Accepted 26 October 2005.

[1]Corresponding author (e-mail: chebert@nrcan.gc.ca).

https://doi.org/10.4039/n05-031 Published online by Cambridge University Press

Fig. 1. (A) White polyurethane foam strip (17 cm × 30 cm) placed at breast height on the bole of a balsam fir (*Abies balsamia*); (B) hemlock looper (*Lambdina fiscellaria*) moths hidden under the foam strip; and (C) hemlock looper eggs inserted into the network of artificial fibres that form the foam material.

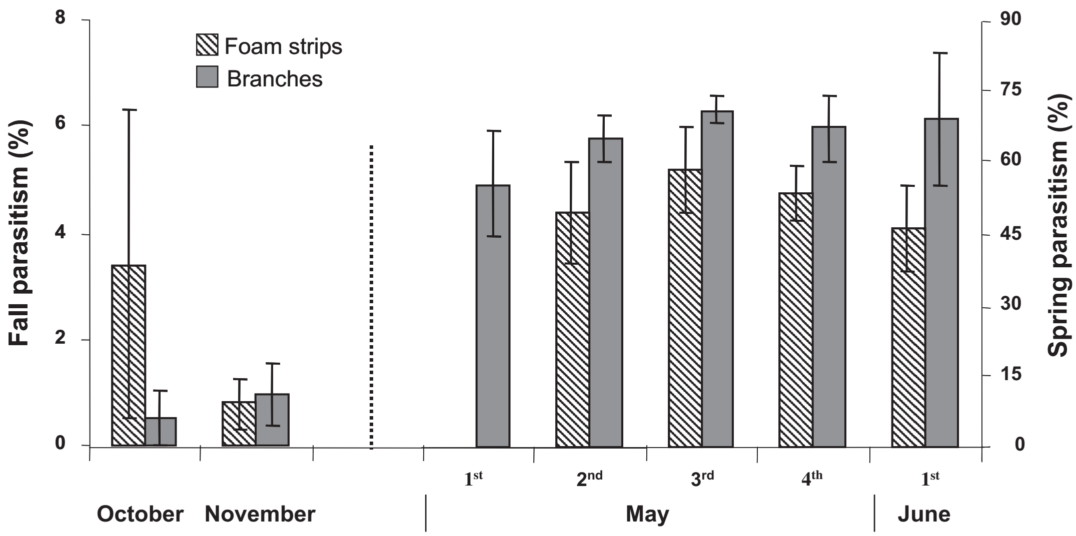


consisting of a small strip of white polyurethane foam stapled to a tree bole, was recently developed to survey hemlock looper eggs (Hébert *et al.* 2003). This paper shows that these foam strips can provide rapid, inexpensive, and accurate estimates of spring egg parasitism of the hemlock looper, which are essential for improving damage forecasting and population management.

Seasonal egg parasitism was monitored, during fall 1997 and spring 1998, in three mature balsam fir (*Abies balsamia* (L.) Mill.; Pinaceae) stands located at Rivière-Saint-Jean (48°50′N, 64°55′W), Mont-Louis (49°15′N, 65°44′W), and Lac Berry (48°42′N, 66°02′W) in the eastern part of the Gaspé Peninsula. Hemlock looper egg populations in these stands were high (over 20 eggs/branch). By mid-August 1997, a 17 cm × 30 cm foam strip (Fig. 1*a*) was stapled at breast height to the bole of each of 60 balsam fir trees in each of the three selected sites, its basal part slightly raised to provide female moths with easy access to a favourable egg-laying site (Fig. 1*b*). In mid-October, and again in mid-November, we collected one 1 m branch in the mid lower crown of each of three randomly selected balsam fir trees and we also recovered 10 randomly selected foam strips. The other foam strips (40/site) were left on the trees in each site until spring 1998. The first branches (3/site) were collected during the first week of May 1998, when the sites became accessible. Following this first sampling, branches (3) and foam strips (10) were collected weekly in the three stands. Eggs were extracted from branches in the laboratory using the methodology described by Otvos and Bryant (1972). This method, in which branches are soaked for 45 min in a 2% bleach solution, does not have deleterious effects on egg hatching or parasitoid emergence and has been recommended for determining rates of parasitism on hemlock looper eggs (Otvos and Bryant 1972). Eggs inserted into the foam strips were

https://doi.org/10.4039/n05-031 Published online by Cambridge University Press

Fig. 2. Seasonal parasitism (mean ± SE) of hemlock looper eggs by *Telenomus* spp., estimated from eggs collected from lower crown branches of balsam fir and from white polyurethane foam strips stapled to boles of balsam fir.



firmly attached to the artificial fibres (Fig. 1*c*) and were extracted using fine forceps. After extraction, the eggs were placed on damp filter paper in 10 cm petri dishes sealed with parafilm and reared at 21 °C, 40% RH, 16L:8D to allow emergence of hemlock looper larvae or adult parasitoids; unhatched eggs were dissected to provide the best estimates of parasitism in each site. These estimates (number of parasitized eggs / number of reared eggs) were based on the total number of eggs collected on the three branches or in the 10 foam strips. Parasitism data were transformed (arcsine square root) and two nested analyses of variance (one for each season) were conducted to compare methods over time, using SAS® programs (SAS Institute Inc. 1999).

Nearly 10 000 eggs were reared (7444 from foam strips and 2523 from branches) and the average number of eggs collected and reared for each site-date varied between 146 and 697 for foam strips and between 60 and 282 for branches. Fall parasitism by *Telenomus* spp. was low (<5%) and did not differ ($F_{3,9}$ = 0.74; P = 0.5651) between branches and foam strips (Fig. 2). In the first week of May, parasitism on branches had already reached 55.6% ± 11.1%. Parasitism then increased slightly to reach a maximum of 71.2% ± 3.0% by the third week of May. The rapid increase in egg parasitism rates in spring, both on branches and in foam strips, compared with the fall estimates, confirms the important spring activity of *Telenomus* spp. reported earlier (Hébert *et al.* 2001). Although spring parasitism in foam strips was slightly lower than that on branches, no significant difference was found between the two methods ($F_{8,26}$ = 1.08; P = 0.4219). Tree boles are less exposed to the sun and are obviously in a cooler microhabitat than lower crown branches, and it is possible that in the present study the foam strips were still covered by snow when parasitism began (50 cm of snow still covered the ground in the first week of May). Therefore, we recommend stapling the foam strips higher on the bole in future surveys. Nevertheless, our results indicate that foam strips stapled to tree boles can be used to provide reliable estimates of *Telenomus* spp. parasitism on hemlock looper eggs. Foam strips could be collected in spring and placed at a high temperature to accelerate development and provide early estimates of egg parasitism. The optimal timing of foam strip removal for accurate estimation of hemlock looper spring egg parasitism remains to be determined by future research.

Compared with branches, which vary in size, structure, defoliation, and lichen abundance, foam strips are a standard tool that never varies (Hébert *et al.* 2003). Furthermore, foam strips do not require a tedious and expensive extraction process such as the branch method (Hartling *et al.* 1991; Liang *et al.* 1996; Hébert

https://doi.org/10.4039/n05-031 Published online by Cambridge University Press

et al. 2003). Irrespective of egg density, it takes 15 min, on average, to prepare and process a branch sample for egg extraction. It also takes an average of 20 min to count and collect eggs on filters, where eggs are mixed with branch debris, for a total of 35 min per branch sample. For foam strips, no time is required for preparation and it takes an average of 15 min to count and collect eggs when density is high. When density is low, processing a foam strip takes less than 2 min. The use of foam strips requires two field visits, compared with one for branch samples, but the installation and collection of foam strips can be done by nonspecialized people because it requires no specialized equipment or training, contrary to branch sampling, which requires a pole pruner and training to use it. Therefore, the involvement of collaborators may help to keep down the cost of field work when foam strips are used.

Foam strips could also be used to develop an egg sentinel trapping approach (eggs produced from laboratory rearings) to estimate parasitism of the hemlock looper. This would be a powerful tool to study egg parasitism in hemlock looper populations because, as for most insects, estimating parasitism in low-density populations is difficult. This approach might also be useful for estimating parasitism and studying population dynamics of other Lepidoptera that overwinter in the egg stage.

We are grateful to D. Simoneau and the numerous technicians of the Direction de la conservation des forêts, Ministère des Ressources naturelles et de la Faune du Québec (MRNFQ), who collected and processed the samples, and D. Paré, who supervised the rearing and diagnostics of hemlock looper eggs. We thank C. Germain and Y. Dubuc of the Canadian Forest Service (CFS), who contributed photographs in Figure 1. We also thank R. Lavallée of the CFS and P. Therrien of the MRNFQ for their comments on an earlier version of the manuscript. Special thanks to P. Cheers of the CFS for editing the manuscript.

Carroll, W.J. 1956. History of the hemlock looper, *Lambdina fiscellaria fiscellaria* (Guen.), (Lepidoptera: Geometridae) in Newfoundland, and notes on its biology. The Canadian Entomologist, **88**: 587–599.

Dobesberger, E.J. 1989. A sequential decision plan for the management of the eastern hemlock looper, *Lambdina fiscellaria fiscellaria* (Lepidoptera: Geometridae), in Newfoundland. Canadian Journal of Forest Research, **19**: 911–916.

Hartling, L., McNutt, P.M., and Carter, N. 1991. Hemlock looper in New Brunswick: notes on biology and survey methods. Timber Management Branch, Forest Pest Management Section, Department of Natural Resources and Energy, Fredericton, New Brunswick.

Hébert, C., and Jobin, L. 2001. The hemlock looper. Information Leaflet LFC-4 [revised version 2001]. Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, Sainte-Foy, Quebec.

Hébert, C., Berthiaume, R., Dupont, A., and Auger, M. 2001. Population collapses in a forecasted outbreak of *Lambdina fiscellaria* (Lepidoptera: Geometridae) caused by spring egg parasitism by *Telenomus* spp. (Hymenoptera: Scelionidae). Environmental Entomology, **30**: 37–43.

Hébert, C., Jobin, L., Auger, M., and Dupont, A. 2003. Oviposition traps to survey eggs of *Lambdina fiscellaria* (Lepidoptera: Geometridae). Journal of Economic Entomology, **96**: 768–776.

Jobin, L.J., and Desaulniers, R. 1981. Results of aerial spraying in 1972 and 1973 to control the eastern hemlock looper (*Lambdina fiscellaria fiscellaria* (Guen.)) on Anticosti Island. Information Report LAU-X-49E. Environment Canada, Canadian Forestry Service, Laurentian Forest Research Centre, Sainte-Foy, Quebec.

Liang, Q., Otvos, I.S., and Bradfield, G.E. 1996. Distribution pattern and sampling of eggs of the western hemlock looper (Lepidoptera: Geometridae) in mature western hemlock stands. Journal of Economic Entomology, **89**: 1531–1536.

Otvos, I.S., and Bryant, D.G. 1972. An extraction method for rapid sampling of eastern hemlock looper eggs, *Lambdina fiscellaria fiscellaria* (Lepidoptera: Geometridae). The Canadian Entomologist, **104**: 1511–1514.

Pelletier, G., and Piché, C. 2003. Species of *Telenomus* (Hymenoptera: Scelionidae) associated with the hemlock looper (Lepidoptera: Geometridae) in Canada. The Canadian Entomologist, **135**: 23–39.

SAS Institute Inc. 1999. SAS/STAT® user's guide, Version 8. Vols. 1, 2, and 3. SAS Institute Inc., Cary, North Carolina.