Early Intervention Strategy – DNA Barcoding

The spruce budworm (*Choristoneura fumiferana*) is the most serious pest affecting forests in eastern North America. Records indicate that spruce budworm outbreaks are cyclical, occurring every 30 to 40 years. The last extensive outbreak in eastern Canada reached its peak between 1974 and 1985, damaging more than 50 million hectares. An outbreak is currently occurring in Quebec, and populations are on the rise in New Brunswick. Scientists from Natural Resources Canada's Canadian Forest Service (CFS) are focusing their efforts on an early intervention approach to keep budworm populations below threshold levels. One important area of research involves an innovative use of DNA barcoding to further understand the complexities of spruce budworm ecology.

Early Intervention Strategy

In February 2014, funding was announced to support research projects aimed at testing an early intervention strategy (EIS) to control spruce budworm outbreaks before populations reach epidemic levels. Scientists are examining a more strategic approach to budworm management, where areas with rising populations or "hot spots" are treated with control products early in the outbreak cycle.

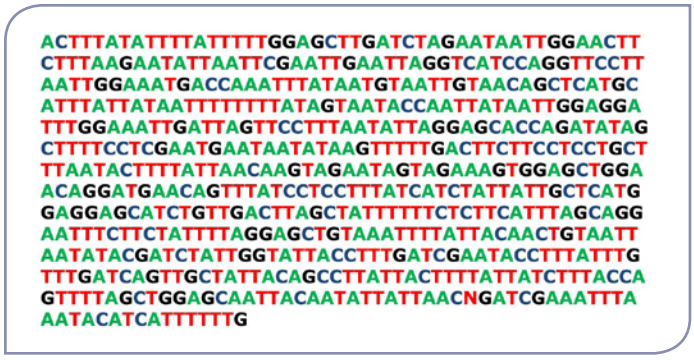
Balsam Fir Food Web

A critical part of the EIS builds on the long-term research on spruce budworm ecology conducted by CFS scientist Dr. Eldon Eveleigh. Eveleigh's research reveals a very complex food web between the spruce budworm and its primary food source, balsam fir. By unraveling the balsam fir food web, Eveleigh and his team identified 66 primary parasitoids (parasitic wasps and flies), 23 primary pathogens (bacteria, protozoans, viruses, fungi), as well as many secondary and tertiary parasitoids and pathogens. These natural enemies (parasitoids, pathogens and predators) are believed to play an important role in helping to control budworm numbers, especially when budworm populations are low.

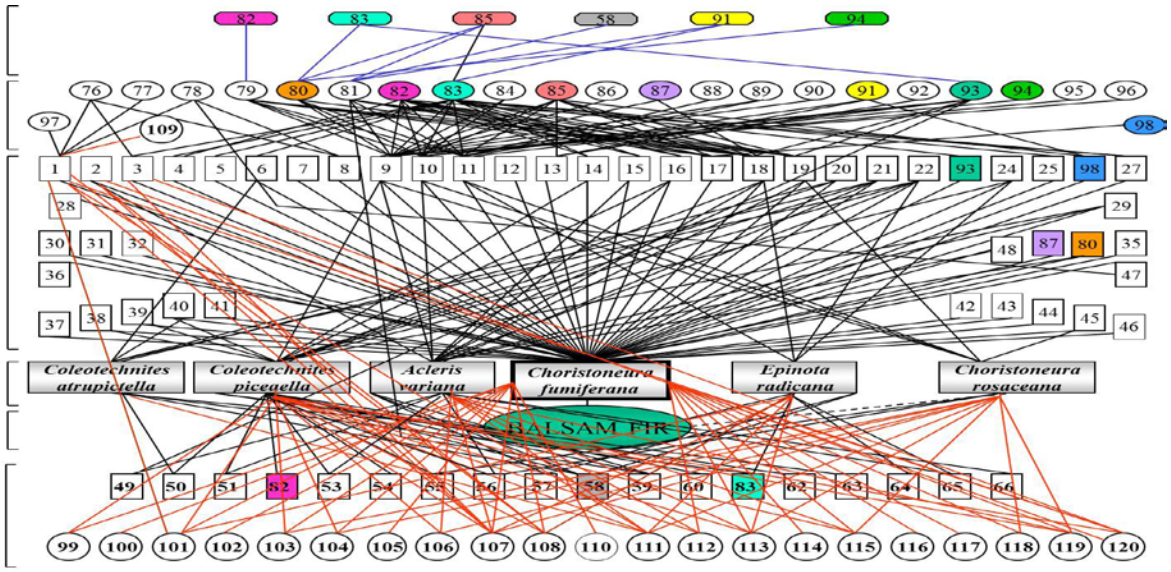
Using DNA to Unlock the Food Web

Currently, identification of spruce budworm parasitoids consists of rearing budworm hosts until parasitoids emerge from the hosts and develop into adults. The adults are then examined under a microscope by taxonomists to determine the species. This method is time-consuming and expensive, and cannot identify organisms present in dead budworm larvae. In addition, many of these organisms are morphologically cryptic (very similar in appearance), making positive identification of individual specimens difficult.

These shortcomings can be overcome by using DNA markers. Eveleigh and his colleague, Dr. Alex Smith (University of Guelph), are developing DNA markers (barcoding) to identify organisms in the spruce budworm food web. DNA barcoding is a taxonomic method of identifying organisms that uses a specific section of DNA to identify "who is who" and "who eats whom." All species have unique sections of DNA that make them different from other organisms, and the barcoding technique will even work on dead organisms (parasitoids and pathogens inside dead budworm larvae), thus providing researchers with a very useful tool to monitor the organisms that make up the spruce budworm food web.



A DNA barcode is a standardized 650-letter "word" representing the four nucleotides found in DNA: A = Adenine; C = Cytosine; G = Guanine; T = Thymine.



Structure of the balsam fir food web

DNA Research Project Activities

1. Complete the construction of a DNA barcode library for the parasitoids and pathogens and other conifer-feeding herbivores that could serve as hosts for budworm parasitoids.

2. Design a microarray chip ("lab on a chip") to provide a quicker and more accurate identification of the organisms involved in the food web and their interrelationships with one another. A "lab on a chip" will allow scientists to carry out laboratory operations on small scales by using miniature devices.

3. Test the microarray chip to determine its use in monitoring food web organisms as budworm populations change over time.

The parasitoids, pathogens and other conifer feeding herbivores are believed to be important factors in controlling SBW populations, especially when numbers are low. This food web is extremely complex, and the interrelationships that exist between and among the organisms that comprise it are largely unknown. Some of these organisms could prove to be our friends and may be the chink in the armor that will lead to controlling the budworm. As researchers study control options, such as *Bacillus thuringiensis kurstaki* (Btk) and the insect moulting hormone tebufenozide (Mimic®), they will be able to monitor their effects on these organisms and determine what these changes mean to the budworm population. The barcoding work being carried out by Eveleigh and Smith will provide an essential tool that will enable woodland managers to make better decisions on how best to manage our forests against this most destructive of forest insect pests.

For more information, contact:

Dr. Eldon Eveleigh
Insect Ecologist
Natural Resources Canada
Canadian Forest Service, Atlantic Forestry Centre
Email: Eldon.Eveleigh@nrcan-rncan.gc.ca

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