



Enemies of the Spruce Budworm Flushed Out Using their DNA

The spruce budworm (SBW), the most significant insect pest affecting coniferous stands in North America, is present in every province of Canada. In Quebec, the country's most afflicted province, it feeds mainly on the young needles of balsam fir and white spruce. Although the SBW plays an important ecological role, it causes heavy losses. With the current epidemic which began in 2006, Quebec's infested forests reached a new level in 2018, covering 8.1 million hectares.

For years, researchers have been closely following the SBW's natural enemies (①). Monitoring them will help researchers assess their impact on SBW population densities and learn what role they play in triggering, expanding, then abating these epidemics. In order to facilitate monitoring, Canadian Forest Service scientists are working on the development of a faster and more reliable method based on the creation of a simple and innovative molecular tool capable of «recognizing» the SBW's natural enemies by means of their DNA.

①

Who are the SBW's natural enemies?

PARASITOIDS: flies (Diptera) or wasps (Hymenoptera) that lay their eggs inside the budworm. The parasitoid larva feeds on the internal tissues of the SBW larva. At the end of the parasitoid's larval phase, the SBW caterpillar dies.

MICROSPORIDIA (pathogens): small single-celled fungi that cause an internal infection in SBW larvae. Their presence does not necessarily kill the caterpillar, but it can weaken it considerably.

A painstaking and expensive traditional method

Even today, the parasitoids and microsporidia that attack the SBW are identified by collecting SBW larvae in the field and rearing them on an artificial diet in a laboratory setting. If present, the SBW's natural enemy will grow as well.

Subsequently, the parasitoid is identified based on morphological criteria, while fungal pathogens (microsporidia) are identified through microscopic analysis.

Not only is this approach of limited accuracy in identifying all the SBW's natural enemies, it is also very expensive. It requires a great deal of manpower and considerable time, i.e. from three weeks to two months. In addition, a laboratory technician can only process a limited number of samples each day.

When a good idea sparks

To advance the technique used to recognize the SBW's natural enemies, Canadian Forest Service researchers from the Great Lakes and Laurentian Forestry Centres hit on the idea of using the information contained in the SBW's DNA. Approximately the same number of SBW caterpillars are harvested in the field as with the traditional method. Once in the laboratory,

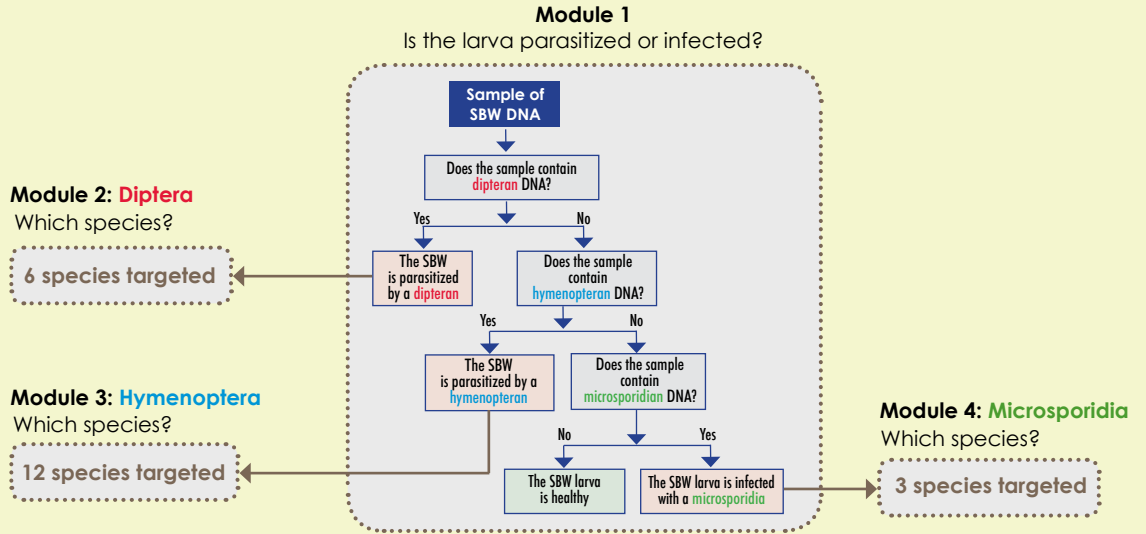
they are crushed and their DNA is extracted. The genetic markers specific to each natural enemy are then detected by attaching a fluorescent molecule to the targeted DNA (genetic marker) (②).

②

From DNA to genetic marker

DNA contains all of an organism's **genetic** information. A **gene** is a segment of DNA that contains a code used to produce a very specific **protein**. For a given type of **protein**, this code varies from one species to the next, and these variations serve as **genetic markers**. Thus, each species has a unique **molecular signature (genetic marker)** that can be used in its identification.

③ Molecular tool for identifying the SBW's natural enemies



How to use the diagram

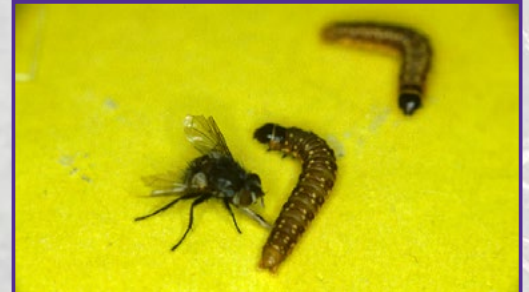
In order to structure the researcher's work, a tool has been developed: a «molecular identification key» that functions as a decision tree, where the answers to the questions depend on the presence or absence of molecular signatures. It consists of four modules, as shown in Diagram ③.

With the first module, the user determines if the SBW caterpillar is carrying a natural enemy, in which case it identifies the category to which the parasite belongs (Diptera, Hymenoptera or microsporidia). It is then sent to one of the other three modules, which will attempt to recognize which species of **Diptera**, **Hymenoptera**, or **microsporidia** is present in the sample, if need be.

In summary, the following steps must be taken to make proper use of this molecular tool.

1. Bring the insects into the laboratory.
2. Crush them.
3. Extract their DNA.
4. Detect the presence of genetic markers through fluorescence production.
5. Identify species using the molecular tool's decision tree.
6. Find the answer you are looking for!

This innovative tool, which is much less hands-on and provides a more accurate diagnosis in only two to three days, has helped researchers greatly improve the method used to identify the SBW's natural enemies.



Winthemia. SBW parasitoid.
Credit: NRCan.



Meteorus trachynotus. SBW parasitoid.
Crédit: NRCan.

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