Study of diamondback moth and its natural enemy *(Cotesia plutellae)* populations native to different areas

Diamondback moth adult (Lepidoptera: Plutellidae)

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Damage by diamondback moth larvae on cabbage leaves

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Plutella xylostella (L.) (diamondback moth, DBM) (Lepidoptera :Yponomeutidae) is among the main pests of Brassicaceae crops (e.g. cabbage, radish, turnip, rapeseed) worldwide and is present on all six developed continents. A secondary pest in temperate climates, DBM has more than 20 generations/year in tropical areas. Excessive use of chemical pesticides, including bio-pesticides (e.g. *B. thuringiensis*), in some regions has led to the appearance of resistant strains.

Cotesia plutellae (Kurdjumov) (Hymenoptera : Braconidae) and *Oomyzus sokolowskii* (Kurdjumov) (Hymenoptera : Eulophidae) are effective natural enemies of DBM and are specific to DBM larvae. Probably native to temperate zones, both are also often collected in tropical climates. During our observations under natural conditions in different areas, the behavior of populations of these three species differed noticeably. In order to set up IPM programs it is important to know if the divergent behaviors are genetic in origin.

Four parallel studies were carried out to characterize this host/parasitoid complex:

- Biological differentiation: comparison of oviposition behavior, morphometry (DBM and *C. plutellae*), parasitim %, life-cycle time, sex ratio (natural enemies)
- Allozyme differentiation of populations (DBM and natural enemies)
- Genetic differentiation: detection of gene flow between populations (DBM and natural enemies)
- Molecular differentiation: by RFLP of polydnavirus DNA *(C. plutellae)*, by sequencing of mitochondrial DNA (COI) and by ISSR method (DBM).

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Host / parasitoid interactions in invasive *Anoplophora glabripennis* and *A. chinensis* populations

Why and how to use biological control to attack these two pests? Biological control can be helpful at two levels to solve the problem of the *Anoplophora* spp. introductions: (i) to contribute to their eradication and (ii) to abate the pest populations if eradication fails.

The control of these pests is based on preliminary monitoring of the infestations but the only technique currently available to inventory the attacked trees is a visual detection of the symptoms that are often tiny or masked. Therefore it is inevitable that some attacked trees are not located during initial inspections. Infested trees that might be missed by the monitoring officers, on the other hand, could be reached effectively by specific natural enemies attacking eggs and early stage larvae of the pests.

Moreover, if eradication of infestations in urban habitats fails, or if the pests establish in forests, biological control could be the most appropriate method to avoid outbreaks of these pests and their further spread. Studies of host/parasitoid interactions of *A. glabripennis* and *A. chinensis* are considered in two ways:

- **to better know** the complex of *Anoplophora* spp. natural enemies in their native area - inventory of parasitoids and the predators and evaluation of their impact on the hosts in the Far East;
- **to determine** if some natural enemies of European cerambycids that are closely related to *Anoplophora* spp. in terms of taxonomy, host-plants, and behaviour would be effective biological control agents against these pests (i.e. evaluation of new associations); the first step consists in determining if some parasitoids from the local fauna have already accepted the exotic pests as hosts in known European *Anoplophora* spp. infestations.

Some progress has been made in these two fields; a few of the promising parasitoid species are shown in this brochure. In conjunction with the eradication programs, biological control studies were implemented to identify and evaluate European parasitoids that could help control these pests. In Italy, parasitism of both hosts was studied by exposing sentinel plants infested with various stages of the pests at several sites within and outside the area infested with *A. chinensis*. It was shown that the oophagous parasitoid *Aprostocetus anoplophorae* Delvare (Hymenoptera: Eulophidae) (which was very likely introduced accidentally from the Far East with its host) is specific to *A. chinensis*. Six larval ectoparasitoids, *Spathius erythrocephalus* Wesmael (Hym.: Braconidae), *Eurytoma melanoneura* Walker (Hym.: Eurytomidae), *Calosota vernalis* Curtis (Hym.: Eupelmidae), *Cleonymus brevis* Boucek (Hym.: Pteromalidae, Cleonyminae), *Trigonoderus princeps* Westwood (Hym.: Pteromalidae, Pteromalinae), and *Sclerodermus* sp. (Hym.: Bethylidae) attacked early stage larvae (L1 and L2) of Anoplophora spp. These parasitoids were already known in Europe from other xylophagous hosts. From this study, six new associations with *A. chinensis* were identified, and four species among them also accepted *A. glabripennis* as a host. The evaluation of some of these species is in progress at EBCL and explorations continue in the field in Italy to discover other potential antagonists of *Anoplophora* spp. If eradication of these exotic pests fails, it is supposed that these parasitoids could be used in biological control by augmentation (following appropriate tests on their impact on non-target hosts in the local ecosystems).

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