Perspective of the research on *Anoplophora chinensis* in Lombardy - Italy

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Abstract
The Citrus Longhorned Beetle (CLB) *Anoplophora chinensis* (Förster) (= *malasiaca*) (Coleoptera, Cerambycidae), was first discovered in northern Italy in 2001 (Colombo & Limonta, 2001; Maspero *et al*. 2007), where it is considered a serious threat to urban environments, nurseries and natural ecosystems. Since this time the number of interceptions of *A. chinensis* in the EU have significantly increased, specifically in grafted maple trees originating from the Far East. As a quarantine pest, an eradication program is ongoing. Since its first discovery, studies have focused on the biology, ecology, behavior and biological control of CLB in northern Italy, as well as development of chemical control and innovative techniques for detection of incipient populations. We report here key results of the first decade of this cooperative

Text

Life History - In Lombardy, screen-house studies were conducted within the infested zone around Parabiago t0 evaluate CLB life history traits, including survival, fecundity, sex ratio, host tree preference, and external signs of attack (egg slits and exit holes). In addition, studies were initiated in 2009 to determine if 1 and 2 cm diameter *Acer palmatum* trees are viable hosts for harboring CLB. Although still in progress, preliminary results provide evidence for oviposition, eggs hatch and larval feeding, and thus 1 and 2 cm diameter trees may represent a threat for movement and introduction of CLB through the nursery industry. Results are critically important to risk assessment (i.e. pathways), to the Plant Protection and Survey Programs, and to Regulatory Agencies.

Biological Control – In concert with CLB life history studies and the eradication program, biological control studies were initiated to explore, collect, identify and evaluate parasitoids as potential biological control agents of CLB. Exploration of the CLB-infested areas in northern Italy was first conducted to inventory native natural enemies that have accepted CLB as a host. Eight native Hymenoptera ectoparasitoids, belonging to five families, were found parasitizing early stage larvae. In addition, an egg parasitoid (Hym.: Eulophidae) of CLB was discovered at Parabiago, likely originating from the Far East and accidentally introduced with its host. This new species was described and named *Aprostocetus anoplophorae* (Delvare *et al.,* 2004). Field studies were then conducted in 2008 near Parabiago, at Canegrate, in a CLB-infested woodlot of mixed deciduous tree species (e.g. *Acer campestre, Acer pseudoplatanus, Corylus avellana, Malus domestica, Prunus avium, Ulmus pumila*). Results showed *A. anoplophorae* is host specific, strictly parasitizing *A. chinensis* and undergoes 2-3 generations per year from June to late August. Results from the sixty stumps sampled showed that 72% of the 136 CLB eggs recovered were parasitized by *A. anoplophorae*. In addition, results also indicated that *A. anoplophorae* appears to be widely and firmly established throughout the major infestation around Parabiago, which is considered the site of the initial infestation of CLB in northern Italy. Finally, *A. anoplophorae* was found to be gregarious, particularly advantageous for rearing in large numbers. Collectively, it appears that *A. anoplophorae* is the best candidate for biological control of CLB. Eradication of CLB remains the priority in northern Italy, and central to successful eradication is early and effective survey and detection of CLB and infested hosts. However, the limitations of visual inspection for signs of attack puts eradication at great risk. Therefore, based upon our results to date, release of *A. anoplophorae* throughout the areas where the parasitoid has not yet been found will help to contain CLB during the eradication effort. Furthermore, release of *A. anoplophorae* is the key element in both eradication and containment programs when *A. chinensis* populations are low and infested trees difficult to detect using visual inspection, e.g. areas that have only recently become infested and/or areas still harboring incipient populations after removal of all trees thought to be infested. Moreover, *A. chinensis* attacks many woody plants that are difficult to survey using visual inspection, including dense ground cover plants like *Cotoneaster horizontalis* and dense hedges of *Prunus laurocerasus*. In other words, *A. anoplophorae* possesses the ability to locate and parasitize *A. chinensis* when infested trees would otherwise go unnoticed.

In 2009 several new lines of research were initiated that that aim to develop methods for early detection of *A. chinensis* and infested trees, and its direct control. In concert with biological control, these methods are essential when and where conventional visual surveys are destined to fail. In northern Italy, *A. chinensis* has attacked a large number trees (i.e. 10,000 from 2001 to 2009) among more than twenty tree species in different landscapes (e.g. urban, rural countryside) of varying levels of heterogeneity, and over an expanded and discontinuous geographic area. Towards this end, methods and technologies used in integrated adaptive strategies are of foremost importance. The proposed research program includes six objectives:

1. ***Where to Implement Detection, Survey and Control:*** Evaluation of the dispersal and population spread of adult of *A. chinensis* will result in development of predictive spatial-temporal models that will be used to establish boundaries inside of which to focus survey, detection and control strategies. Furthermore, the models will play the major role in making decisions of where to focus release of natural enemies. Because local landscape features (e.g. urban, residential, rural, homogeneous woodlots, heterogeneous woodlot-agriculture areas) greatly influence where ALB will spread, these models will be adaptable to the unique landscapes in northern Italy and other areas at risk in Europe.

2. ***When to Implement Detection, Survey and Control:*** Evaluation of the relative abundance and seasonal occurrence of adult CLB emergence will result in development of a predictive Degree-Day model that will be used to establish when to implement survey, detection and control strategies, including when to release and conserve natural enemies for biological control of CLB

3. ***How to Detect, Survey and Control:*** **(a)** Evaluate the host selection process of adult *A. chinensis* for development of methods for early detection and Attract-and-Kill of adult beetles, e.g. sentinel trees and artificial lures. (b) Investigate biology and behavior of *A. chinensis* larvae feeding within infested trees for development technologies for detection of infested trees, e.g. acoustic detection technologies. (c) Investigate adult *A. chinensis* behavior analysis of the key behaviors (e.g. mating, oviposition, and feeding), for development of technologies for detection and control of adult beetles, and/or protection of tree from attack. (d) Develop control methods for containing adult populations and/or protecting trees from attack, i.e. contact encapsulated insecticide (Demand).

References

Colombo M, Limonta L. 2001. *Anoplophora malasiaca* Thomson (Coleoptera Cerambycidae Lamiinae Lamiini) in Europe. Boll. Zool. Agrar. Bachic. 33:65–68

Delvare G, Bon M-C, Hérard F, Cocquempot C, Maspero M, et al. 2004. Description of *Aprostocetus anoplophorae* n. sp. (Hymenoptera: Eulophidae), a new egg parasitoid of the invasive pest *Anoplophora chinensis* (Forster) (Coleoptera: Cerambycidae). *Ann. Soc. Entomol. Fr.* 40:227–33

Maspero M, Cavalieri G, D'Angelo G, Jucker C, Valentini M, et al. 2007. *Anoplophora chinensis* - eradication program in Lombardia (Italy). http://www.eppo.org/QUARANTINE/anoplophora chinensis/chinensis IT 2007.htm

References

Colombo M, Limonta L. 2001. *Anoplophora malasiaca* Thomson (Coleoptera Cerambycidae Lamiinae Lamiini) in Europe. Boll. Zool. Agrar. Bachic. 33:65–68

Delvare G, Bon M-C, Hérard F, Cocquempot C, Maspero M, et al. 2004. Description of *Aprostocetus anoplophorae* n. sp. (Hymenoptera: Eulophidae), a new egg parasitoid of the invasive pest *Anoplophora chinensis* (Forster) (Coleoptera: Cerambycidae). *Ann. Soc. Entomol. Fr.* 40:227–33

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