

Insects and globalization: sustainable control of exotic species in Italian agro-forestry ecosystems

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Abstract: One of the negative consequences of globalization is the increased introduction of exotic pests into new areas. Italy, in particular, is at high risk of introduction, because of its geographical position and climate, which allows the settlement of (even subtropical) exotic species. In this context, native natural enemies may play a major role in the biological control of exotic species. The mechanisms involved in adaptation processes, which are crucial in studies of biological invasions, are only partially known. A joint effort by researchers operating in Italy and abroad is needed to deeply investigate this phenomenon and to develop appropriate strategies for sustainable control of exotic species. The present work illustrates the objectives and preliminary results of the project “Insects and globalization: sustainable control of exotic species in agro-forestry ecosystems (GEISCA)” focused on control of exotic species by native entomophagous insects. The overall goal of the project is to gain, at the end of three years, useful knowledge on the development of appropriate procedures for sustainable control of target pest species.

Key words: exotic insect pests, native natural enemies, biological control

Introduction

Modern transports and international trade simplify economic and cultural exchanges between countries all over the world. As a consequence, many species can colonize new geographic areas and ecological niches becoming invasive. The initial success of an exotic pest is strictly related to habitat characteristics, its biological performance – such as fecundity, dispersal ability and voltinism – and interactions with other species (Gröbler & Lewis, 2008; Jucker & Lupi, 2011). Native natural enemies need time to recognize and adapt to new potential hosts/prey, and this process is often differently expressed in diverse natural enemy species and depends also on human environmental modifications (Folcher *et al.*, 2011).

Many studies on exotic pest insects and their native natural enemies have already been conducted in Italy. Research on *Dryocosmus kuriphilus* (Hymenoptera Cynipidae) was carried out since its first detection in 2002, finding about 30 native parasitoid species of this invasive gall wasp (Aebi *et al.*, 2007; Quacchia *et al.*, 2013), of which *Torymus flavipes* (Hymenoptera Torymidae) was recorded in many Italian regions (Santi & Maini, 2012; Panzavolta *et al.*, 2013). Moreover, in the Mediterranean basin several native natural enemies were found in

association to *Tuta absoluta* (Lepidoptera Gelechiidae), a major tomato pest native to South America reported for the first time in Europe, in Spain in 2006 and in Italy in 2008 (Ferracini *et al.*, 2012; Tropea Garzia *et al.*, 2012; Zappalà *et al.*, 2013).

The mechanisms involved in the host-adaptation processes, which are central for studies focussing on biological invasions and their biological control, are only partially known (Roy *et al.*, 2011). Long-term studies are hence necessary to evaluate the adaptation of native enemies to exotic species, their complex, their geographic and environmental distribution according to their interaction with native hosts on other host plants. Therefore, a joint effort by groups operating in different geographical areas is needed to assess the potential of native natural enemies for the biological control of invasive pests. A 3-year project [Insects and globalization: sustainable control of exotic species in agro-forestry ecosystems (GEISCA) 2013-2015] has been developed in Italy with the main aim of investigating the sustainable control of introduced exotic pests by native natural enemies.

Approach

GEISCA accounts for 7 research units working in different Italian regions. The project is focused on model species of great economic or ecological importance. Some are already largely widespread as they were introduced years ago, whereas others are more localized. The focal species are:

1. oriental chestnut gall wasp *D. kuriphilus*;
2. xylophagous species associated to woody plants, *Psacotheta hilaris hilaris* (Coleoptera: Cerambycidae) and *Anoplophora glabripennis* (Coleoptera: Cerambycidae);
3. spotted-wing drosophila *Drosophila suzukii* (Diptera: Drosophilidae);
4. leafminer moths, *T. absoluta*, *Phyllocnistis vitegenella* (Lepidoptera: Gracillariidae), *Antispila oinophylla* (Lepidoptera: Heliozelidae) and *Coptodisca* sp. (Lepidoptera: Heliozelidae);
5. piercing-sucking plant-feeding insects, exotic thrips species in citrus orchards and eucalyptus psyllid *Glycaspis brimblecombei* (Hemiptera: Psyllidae);
6. harlequin ladybird *Harmonia axyridis* (Coleoptera: Coccinellidae), an active predator of aphids, which has raised concern because of its invasiveness.

The current studies have different aims according to the state of the art of each exotic insect. For *D. kuriphilus* and *T. absoluta*, for which associations with native parasitoids have already been identified in Italy, the objective is to improve the knowledge on the complex of parasitoids, and to assess their ecology and effectiveness. For *D. suzukii*, *A. glabripennis*, *P. hilaris hilaris*, *P. vitegenella*, *A. oinophylla*, *Coptodisca* sp., *G. brimblecombei* and exotic thrips, the purpose is to investigate both the complex of native parasitoids that can be recruited on these species and their role in the sustainable pest control. For *H. axyridis*, the aim is to study the interactions between native parasitoids and this exotic predator vs. indigenous ladybirds. The effect of habitat complexity on the biological control potential of native beneficial arthropods will also be assessed in all the model species.

Results and perspectives

The research is in progress for all species. In the first year, several native parasitoids associated to the investigated exotic species have been detected, with the only exception of *A. glabripennis* and *G. brimblecombei* for which natural enemies have not yet been found

(Table 1). Some of these interactions were already known (e.g., *D. kuriphilus*; *T. absoluta*; *D. suzukii*), whereas others are new. Ongoing activities will improve the knowledge on the biology and ecology of these native enemies, and on the relation with the surrounding habitat. Finally, some native enemies will be evaluated for their use in applied biological control, developing appropriate protocols for their mass rearing, conservation and augmentation in the field. Poorly known species of pest and parasitoids will be characterized using morpho-bio-molecular tools. These project objectives will be achieved in collaboration with international research institutions.

Table 1. Native natural enemies associated to exotic pests studied in the GEISCA project.

Exotic pest	Native Parasitoids		Italian region
	Order	Family	
<i>Dryocosmus kuriphilus</i>	Hymenoptera	Eurytomidae	Calabria; Emilia-Romagna; Lombardy; Piedmont; Veneto
		Ormyridae	
		Pteromalidae	
		Torymidae	
		Eulophidae	Calabria; Piedmont
		Ichneumonidae	Lombardy
<i>Psacotheta hilaris hilaris</i>	Hymenoptera	Bethylidae	Lombardy
<i>Drosophila suzukii</i>	Hymenoptera	Pteromalidae	Emilia-Romagna; Lombardy; Piedmont
<i>Tuta absoluta</i>	Hymenoptera	Ichneumonidae	Liguria; Campania; Sardinia; Sicily; Tuscany
		Braconidae	
		Chalcididae	
		Eulophidae	
		Pteromalidae	
		Trichogrammatidae	
<i>Phyllocnistis vitegenella</i>	Hymenoptera	Eulophidae	Veneto
<i>Antispila oinophylla</i>	Hymenoptera	Eulophidae	Veneto
<i>Coptodisca</i> sp.	Hymenoptera	Eulophidae	Campania; Lazio
<i>Harmonia axyridis</i>	Hymenoptera	Braconidae	Emilia-Romagna
	Diptera	Phoridae	

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