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Predators of the rosy apple aphid, *Dysaphis plantaginea* (Pass.), in Asturian (NW Spain) apple orchards

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Abstract: Alternative strategies to the common practice of spraying with insecticide in order to control the rosy apple aphid *Dysaphis plantaginea* (Pass.) (Homoptera: Aphididae) are required. Biological control by natural enemies is a possible tool. In Asturies, despite the tradition of growing local cider apple trees, there are no studies about the community of *D. plantaginea* predators and their impact on these aphid populations. The aim of this work is to fill this gap.

The presence of beneficials in the *D. plantaginea* colonies was important reaching in some surveys to 100 % of the infested terminals. The three most abundant predators were *Episyrphus balteatus* (DeGeer) (Diptera: Syrphidae), *Adalia bipunctata* (L.) (Coleoptera: Coccinellidae) and *Aphidoletes aphidimyza* (Rond.) (Diptera: Cecidomyiidae). When the first colonies of *D. plantaginea* developed in April, only syrphids and coccinellids were present. Syrphid eggs or larvae occurred in more than 80 % of the colonies, coccinellids were less frequent but their population increasing progressively. Cecidomyiids appeared in mid-May and their number increased quickly. Other Coccinellidae and Syrphidae, as well as Anthocoridae and Miridae (Heteroptera), Cantharidae (Coleoptera), Forficulidae (Dermaptera) and Chrysopidae (Neuroptera) were also observed preying on *D. plantaginea* colonies.

Although these predators are considered to play an important role in the regulation of aphid populations, they did not prevent *D. plantaginea* damage that affected up to 37 % of the terminals in one orchard and up to 54 % in another. Some possible causes for this ineffectiveness are discussed.

Keywords: apple, aphids, predators, biological control.

Introduction

The rosy apple aphid, *Dysaphis plantaginea* Pass. (Homoptera: Aphididae), is along with the codling moth, the most important pest in Asturian apple orchards. It can curl leaves, distort shoots and reduce the fruit growth. To control *D. plantaginea*, one or more insecticide sprays are required in early spring. However, the range of insecticides respecting pollinator or beneficial arthropods is narrow, and the loss of efficacy because of induced resistance poses a serious problem with this key pest. Thus, alternative strategies are needed. The growing of resistant cultivars probably provides the best long term solution. A breeding programme with the resistant cultivar ‘Florina’ has been developed to transfer the resistance to our local cider apple cultivars (Dapena & Miñarro, 2001). Biological control by natural enemies, either by weed strips to enhance the number of aphidophagous predators (Wyss, 1995; Wyss *et al*., 1995), or augmentative releases of indigenous natural enemies (Wyss *et al*., 1999a), may be other powerful tools. However, despite the traditional growing of local cider apple trees, the community of *D. plantaginea* predators has not been still studied in Asturies. This work aims at describing this community in Asturian orchards and to estimate their effectiveness in the control of these aphid populations.

Material and methods

Study orchards

Trials were carried out in 1999 in one experimental and one commercial apple orchards. The experimental orchard of 0.3 ha at Villaviciosa, consisted of 5-year old apple trees of 17 different cider apple cultivars growing on Pajam 2 rootstocks. Neither insecticide, acaricide nor fungicide were ever sprayed in this orchard in order to allow the presence of both pests and beneficials.

The 0.4-ha commercial orchard at Pruvia, consisted of 8-year old cv 'Reineta Encarnada' and cv 'Reineta Blanca del Canadá' apple trees, grafted on M9 rootstocks. This orchard was conducted following organic guidelines. Thus, summer white oil and Rotenon were sprayed to control aphids and granulosis virus to control codling moth. Treatments against other apple pests were not needed. Copper and sulphur preparations were used against fungal diseases.

Sampling method

In order to minimise cultivar effects in the experimental orchard, four trees of each of the 17 varieties were sampled for the presence of *D. plantaginea.* Five shoots of each selected tree were marked with coloured plastic strips. From mid April to the moment when *D. plantaginea* left apple trees, all selected shoots were examined weekly for the presence of colonies. In the commercial orchard, 10 trees of each cultivar were selected. Five marked shoots per tree were weekly inspected.

Arthropod predators were assessed weekly during the spring aphid ocurrence by visual controls on 20 shoots infested with *D. plantaginea* colonies in both orchards. These 20 shoots were selected randomly in the orchards among those which had a high infestation of *D. plantaginea*. All insects described as aphidophagous in this study were observed feeding on *D. plantaginea*. Some eggs and larvae were reared on *D. plantaginea* or *Aphis pomi* colonies in laboratory in order to determine the species.

Results

Aphids

The percentage of growing shoots with *D. plantaginea* colonies was high in both apple orchards, reaching 50 % in some moments (Fig.1). In the experimental orchard, the first colonies were observed at the beginning of April and the last ones at the end of June, when aphids migrated to *Plantago* spp., their secondary host (Fig.1). In the commercial orchard, aphids remained on the growing shoots up to mid-July (Fig.1). The Rotenon and summer oil sprays did not have strong consequences on *D. plantaginea* population (Fig.1). This may be due to the fact that the effectiveness of contact insecticides in curled leaves decreases substantially (Hull & Starner, 1983).

Predators

The three most abundant predator families in both orchards were Syrphidae, Coccinellidae and Cecidomyiidae (Fig.2). Anthocoridae and Miridae (Heteroptera), Chrysopidae (Neuroptera), Cantharidae (Coleoptera) and Forficulidae (Dermaptera) were also observed preying on *D. plantaginea* colonies. The most abundant and the first observed syrphid was *Episyrphus balteatus*, although *Scaeva pyrastri*, *Syrphus ribesii* and *Epistrophe* sp. larvae were also recorded. *Adalia bipunctata* constituted more than 80 % of the coccinellids. *Coccinella septempunctata*, *Propylea quatuordecimpunctata* and *A. decempunctata* were also identified. The cecidomyiid fly was *Aphidoletes aphidimyza*.

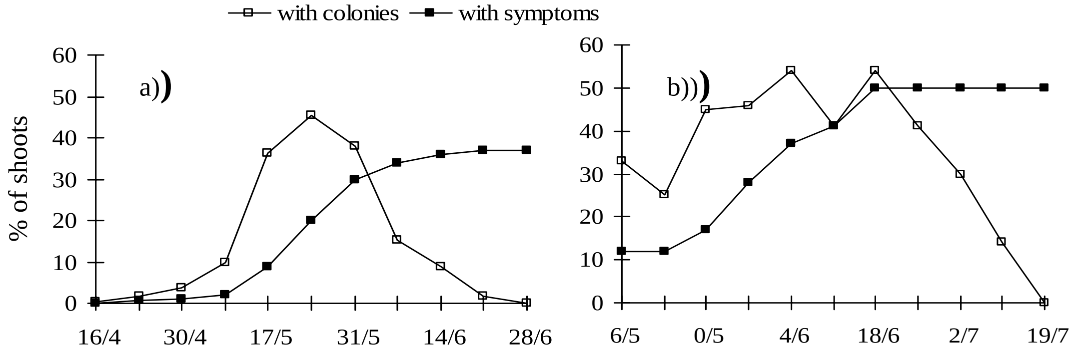

Fig. 1. *D. plantaginea* occurrence and shoot damage in the experimental (a) and the commercial (b) orchards in 1999. Rotenone and summer oil were sprayed on 10/5, 21/5, 1/6 and 16/6 in the commercial orchard.

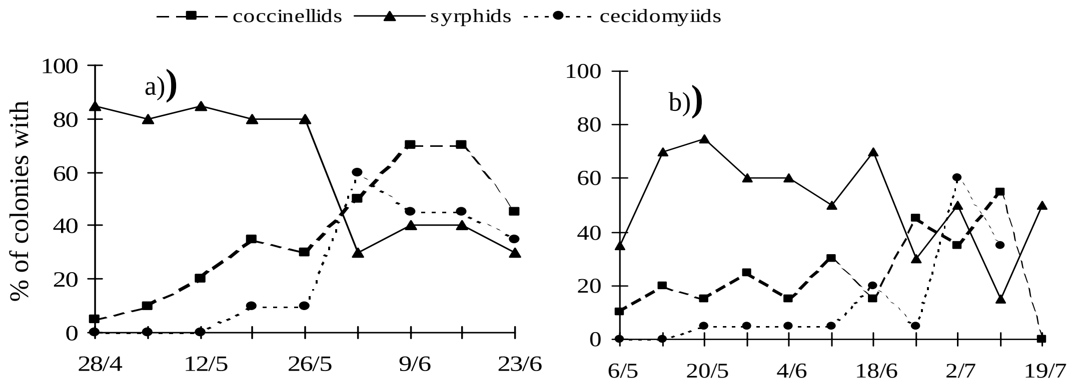

Fig. 2. Coccinellid, syrphid and cecidomyiid ocurrence on *D. plantaginea* colonies in both the experimental (a) and the commercial (b) orchards in 1999.

In the first surveys only syrphids and coccinellids occurred in the *D. plantaginea* colonies: syrphids eggs or larvae were detected in more than 80 % the aphid colonies in the experimental orchard, whilst coccinellids occurred in few number in both orchards (Fig.2). *A. aphidimyza*, the third most abundant predator, was observed for the first time in mid May in both orchards, and quickly increased in number (Fig.2). Syrphid larvae were the most abundant predator during the first part of the surveys, but when the abundance of *D. plantaginea* decreased, coccinellids and cecidomyiids were more important. Anthocorids and mirids ocurrence was more important in the experimental than in the commercial orchard. In the former, anthocorids occurred in 50 % of the *D. plantaginea* colonies in mid-June. *Forficula auricularia* (Forficulidae) and *Rhagonycha fulva* (Cantharidae) had a weak presence.

Spiders were rarely observed in both apple orchards and although they were not seen feeding on *D. plantaginea*, they can play an important role in decreasing aphid populations principally in autumn (Wyss *et al.*, 1995).

The presence of ants attending *D. plantaginea* colonies was important and probably favoured the development of colonies because of their negative effect on predaceous arthropods.

Discussion

In a recent study, Wyss *et al.* (1999b) showed the predaceous efficiency of *A. bipunctata*, *E. balteatus* and *A. aphidimyza* on *D. plantaginea* colonies. In the present work, these three species are the most abundant predators. However, despite playing an important role in decreasing the aphid populations, they were not able to reduce *D. plantaginea* populations under an economic threshold (Fig.1). Some possible reasons may explain the ineffectiveness of these control agents in preventing *D. plantaginea* damage. In one hand, the response of apple leaves to the feeding of *D. plantaginea* is very rapid and symptoms may be observed within 24 hours (Forrest & Dixon, 1975). Thus, although aphid populations could be controlled by natural enemies, most of the infested shoots could already show the typical leaf-rolling. In this sense, the importance of these aphidophaga may be greater with the growing of low susceptible cultivars. Secondly, there is a considerably different developmental rate between prey and predator. If the predators develop considerably slower than their prey, they are not able to track the prey accurately and, as a consequence, are not as effective as if the developmental times were similar. This happens in, at least, the case of the aphidophagous coccinellids (Dixon *et al*., 1997). Thirdly, aphidophagous coccinellids behave as if they were ‘prudent predators’ (Hemptinne & Dixon, 1998). Optimal foraging theory for aphidophagous ladybirds (Kindlmann & Dixon, 1993) predicts that there is an optimal number of eggs laid in an aphid colony which maximizes the resulting offspring biomass. Theory also predicts that if the ovipositing females lay the optimal number of eggs, their offspring will not affect substantially the size of aphid colonies (Kindlmann & Dixon, 1993). Field and experimental results confirm the prediction of the model. Thus gravid females respond to both the abundance and quality of their prey, avoiding aphid colonies that are already exploited and/or too old to support the full development of the ladybird offspring, and so they are not effective biological control agents (Hemptinne *et al*., 1992; Hemptinne *et al*., 1993). There is also evidence that aphidophagous syrphids behave similarly (Hemptinne *et al*., 1993; Scholz & Poehling, 2000).

Parasitism has not been studied in this work, and although some parasited aphids were observed, parasitoids seem to play a minor role in regulating populations of *D. plantaginea*, probably due to the host alternation of this species, ant attendance and hyperparasitism (Cross *et al*., 1999).

Intraguild predation was not studied in this experiment. However, Wyss *et al.* (1999b) showed that the two most numerous predators in our apple orchards, *A. bipunctata* and *E. balteatus*, not only do not interact but also have a negative effect on aphid populations, explained by an additive model.

This work reinforces the need of future research in other strategies to improve the natural control of this aphid species, and may be the basis for research in strategies such as the augmentative release of predators or the increase of the natural enemy density by weed strips.

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