

ORIGINAL CONTRIBUTION

Abundance, interannual variation and potential pest predator role of two co-occurring earwig species in citrus canopies

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Abstract

Earwigs are usually considered pest predators in orchards. Because of its worldwide distribution, most research on earwigs focuses on the European earwig *Forficula auricularia* Linnaeus (Insecta: Dermaptera: Forficulidae). However, very little is known of this species in Mediterranean citrus orchards. Earwigs and aphids were collected monthly during 5 years (2006–2010) from citrus canopies. Two species of earwigs were found: *F. auricularia* and *Forficula pubescens* Gené (= *Guanchia pubescens*), with the latter seldom cited in the literature. The goals of this study were (i) to document the abundance of these two earwig species in Mediterranean citrus canopies; (ii) to determine whether they are positively or negatively associated with each other, or randomly distributed; (iii) to measure the interannual variation of the abundance of both species during a 5-year period and (iv) to evaluate the potential role of earwigs as pest predators in citrus canopies. As compared to colder regions, *F. auricularia* active period in citrus canopies in our study site lasted longer. Both species co-occurred randomly in canopies. In 2006, both species showed approximately the same abundance, but in 2010, *F. pubescens* abundance in canopies was 28 times greater than that of *F. auricularia*. The potential role of earwigs as pest predators is higher in the Mediterranean than in other colder regions, because of the longer active period. *F. auricularia* is a sedentary generalist predator, already present in citrus canopies at the onset of most pest outbreaks, while *F. pubescens* arrived later to the canopies, but most likely was abundant enough to contribute in the control of citrus pests.

Introduction

Earwigs (Insecta: Dermaptera: Forficulidae) are common insects in agro-ecosystems. They are mainly omnivorous, feeding on both plant and animal material (Albouy and Caussanel 1990). Earwigs are essentially nocturnal; they forage at night and seek dry and cool places to hide during the day (Albouy and Caussanel 1990). The life cycle of earwigs has been studied thoroughly, mainly because of their trait as pre-social insects. Earwig females take care of their eggs and feed and protect early instars in their subterranean nests (Vancassel and Foraste 1980; Albouy

and Caussanel 1990). This maternal behaviour has been proven crucial for increased larval survival (Kölliker 2007; Kölliker and Vancassel 2007).

Because of its worldwide distribution, the European earwig, *Forficula auricularia* Linnaeus, is the best-studied earwig species. Many questions about European earwig biology, phenology, natural habitats, dispersal rate, food habits and genetic aspects have been addressed in the literature (i.e. Behura 1956; Albouy and Caussanel 1990; Wirth et al. 1998; Moerkens et al. 2009, 2010, 2011). However, knowledge of other earwig species is limited to their pre-social condition (Vancassel and Foraste 1980;

Kohno 1997; Kamimura 2003; Matze and Klass 2005; Suzuki et al. 2005) and to evolutionary aspects (Jarvis et al. 2005; Kamimura 2006; Tworzydło et al. 2010). In general, little is known of the ecology of most earwig species.

Earwigs, as omnivorous insects often found in orchards, are frequently studied as key predators of pests and/or as pests themselves. As insectivores, earwigs have been considered key biological control agents for some important pests. For instance, the European earwig is an active predator of the woolly apple aphid *Eriosoma lanigerum* (Hausmann) (Mueller et al. 1988; Nicholas et al. 2005), the leafroller *Epiphyas postvittana* (Walker) in apple orchards and vineyards (Suckling et al. 2006; Frank et al. 2007) and the pear psyllid *Cacopsylla pyri* Linnaeus (Höhn et al. 2007). European earwigs, along with *Forficula pubescens* Gené (= *Guanchia pubescens*), are also the predominant natural enemies of the rosy apple aphid *Dysaphis plantaginea* Passerini (Dib et al. 2010). The earwig *Doru taeniatum* (Dohrn) is one of the three most common predators of the fall armyworm *Spodoptera frugiperda* (Smith) in Honduran maize (Wyckhuys and O'Neil 2006). As herbivores, earwigs can have negative effects on plants by feeding on soft fruits and vegetative tissue (Brindley 1918; Fulton 1924; McLeod and Chant 1952; Grafton-Cardwell et al. 2003). An example of this dual role of earwigs in orchards is *Forficula senegalensis* Audinet-Serville. This species was considered a pest on millet in the Sudanese-Saharan region of Niger. However, after analysing the gut content of more than 500 individuals, it was observed that arthropods were an important part of its diet, while plants were not. As a result, Boukary et al. (1997) concluded that its role as a pest should be reconsidered.

In the citrus orchard studied, two species of earwigs were present in tree canopies: the European earwig *F. auricularia* and *Forficula pubescens*. The former has been studied worldwide, but few references can be found in the literature for the latter. Research on European earwig biology has been conducted in the USA (Fulton 1924; Crumb et al. 1941), New Zealand (Burnip et al. 2002; Suckling et al. 2006) and north-central Europe (Belgium: Gobin et al. 2008; UK: Behura 1956; the Netherlands: Helsen et al. 1998; and Czech Republic: Kocárek 1998), but we are not aware of any study in the Mediterranean Basin. The objectives of this study were as follows: (i) to describe *F. auricularia* and *F. pubescens* abundance in Mediterranean citrus tree canopies; (ii) to determine whether they are positively or negatively associated with each other, as both species often

co-occur in the same canopies, or otherwise randomly distributed; (iii) to establish the interannual variation in abundance during a 5-year period, as previous work revealed important temporal changes in the entire arthropod community (Piñol et al. 2011) and (iv) to evaluate the potential role of earwigs as pest predators in citrus canopies by exploring the relationship between aphid and earwig abundance, while also comparing prey and predator abundance for other citrus pests.

Materials and methods

Study site

The study was conducted in a citrus plantation at La Selva del Camp (Tarragona, NE Spain; 41°13'5"N, 1°9'7"E). The climate is Mediterranean, with a rainy spring and autumn, and a dry winter and summer. The grove consisted of ca. 320 clementine trees grafted on the hybrid rootstock Carrizo citrange [*Poncirus trifoliata* (Linnaeus) Raf. × *Citrus sinensis* (Linnaeus) Osb.]. The plantation complied with all organic agriculture standards during the whole studied period (2006–2010). Trees were regularly irrigated during dry periods.

Earwig and aphid sampling and classification

Trees were randomly selected each year from a subset of 69 individuals, all planted in 1999. Eight trees were sampled in 2006, 2007 and 2008, and nine in 2009 and 2010. No trees were sampled in two consecutive years. Earwigs and aphids in each canopy were sampled once a month using square beating trays of 0.50 m² (three vigorous hits of the tree canopy in opposite directions). This method is recommended by Albouy and Caussanel (1990) for earwig sampling. Insects were captured with entomological aspirators and immediately preserved in 70% ethanol. We counted the total number of aphids in each sample. Presence of wings in *F. auricularia* adults was used to distinguish this species from the wingless *F. pubescens*, while nymphs were differentiated by body colour and size, and by type of setae of the cerci: long and erect in *F. pubescens* and short and decumbent in *F. auricularia*. Nymphal stage within each species was determined by size and number of antennal segments (Albouy and Caussanel 1990). Sex of adults was determined by dimorphism of the cerci. Sex ratio of each species was analysed separately. We used a paired *t*-test comparing the mean number of males and females per month and tree (data in appendix;

Table S1). In this study, earwigs were sampled in tree canopies, so the abundance described is relevant only to populations from canopies.

In previous studies (Cañellas et al. 2005; Piñol et al. 2009a,b, 2010), all earwigs present in citrus canopies were erroneously identified as *F. auricularia*. Thus, future references to earwigs in those papers should be regarded as *Forficula* sp.

Interspecific association

Each sample (beating trays obtained per canopy per month) was classified into four categories according to earwig presence: (i) without earwigs, (ii) with both earwig species, (iii) with only *F. pubescens* and (iv) with only *F. auricularia*. Data from months in which samples only showed one species of earwig were excluded from the analyses. A contingency table was constructed for each year, and the Pearson chi-square test was conducted using SPSS 15.0 (SPSS Inc. Chicago, IL, USA). Although Sauphanor and Sureau (1993) used the point correlation coefficient to study the interspecific association of two earwig species, their method is numerically equivalent to the Pearson chi-square test used here.

Interannual variation of earwig abundance

The abundance between years of each earwig species was compared using a univariate permutational ANOVA on the square root of the cumulative abundance per sample (beating trays per canopy per year). Year was considered a fixed factor, and the Euclidean distance was used to calculate the dissimilarity among samples. Pair-wise tests (corrected with the Bonferroni adjustment) were conducted following significant differences between years. The software used was PRIMER v6 and PERMANOVA + (Anderson et al. 2008).

Relationship between earwig and aphid abundance

To study the relationship of each earwig species with aphids, we used the sum of individuals present each year in each canopy during the main aphid attack (April to July). A power (log–log) function was fitted to these cumulative values of aphid and earwig abundance. A negative relationship between aphid and earwig abundance would suggest a top-down regulation of aphids by earwigs. A positive relationship would suggest a bottom-up regulation of earwigs by aphids (McQueen et al. 1989; Worm and Myers 2003; Piñol et al. 2009a). Top-down regula-

tion would probably imply that earwigs are sedentary predators already in canopies when aphid attack starts and, thus, able to control aphid population since the beginning (Piñol et al. 2009a).

Results

Earwig abundance in Mediterranean citrus tree canopies

Forficula auricularia was generally active in canopies from April to November (fig. 1a). On some occasions, *F. auricularia* was even found in tree canopies in January, March and December. Nymphs of *F. auricularia* were found in April, and in two of the 5 years, they were also captured in December. First instars were never captured in canopies. Second instars were occasionally found in canopies, and the following stages were progressively more abundant until adults emerged (Table S1). There were no differences between male and female frequencies in canopies (Mean \pm SE; $n = 36$ months; males 0.27 ± 0.23 ; females 0.26 ± 0.30 ; $t = 0.23$; $P = 0.81$).

Forficula pubescens did not arrive in canopies until May, but remained there until December (fig. 1b). Nymphs of *F. pubescens* were only found once a year in May–June. First instars were never found in canopies. Male and female frequencies in canopies did not differ (Mean \pm SE; $n = 36$ months; mean SE; males 1.89 ± 2.89 ; females 1.87 ± 2.64 ; $t = 0.15$; $P = 0.87$).

Interspecific association

The distribution in canopies of the two species appeared to be random ($n = 48$, $\chi^2 = 0.13$, $P = 0.72$ for 2006; $n = 56$, $\chi^2 = 1.22$, $P = 0.27$ for 2007; $n = 56$, $\chi^2 = 1.57$, $P = 0.21$ for 2008; $n = 72$, $\chi^2 = 1.67$, $P = 0.20$ for 2009; $n = 36$, $\chi^2 = 1.09$, $P = 0.30$ for 2010). Data represented in appendix (Figure S1).

Interannual variation of earwig abundance

The abundance of *F. auricularia* significantly changed during the studied 5-year period (Pseudo- $F_{4,37} = 5.93$, $P < 0.001$). The abundance of *F. pubescens* also varied during the studied period (Pseudo- $F_{4,37} = 29.10$; $P < 0.001$), having its maximum in 2009. In 2006 and 2007, both species had approximately the same abundance, but from 2008 onwards, there was a gradual increase in *F. pubescens* abundance, and in 2010, it was 28 times more abundant in canopies than *F. auricularia* (fig. 2).

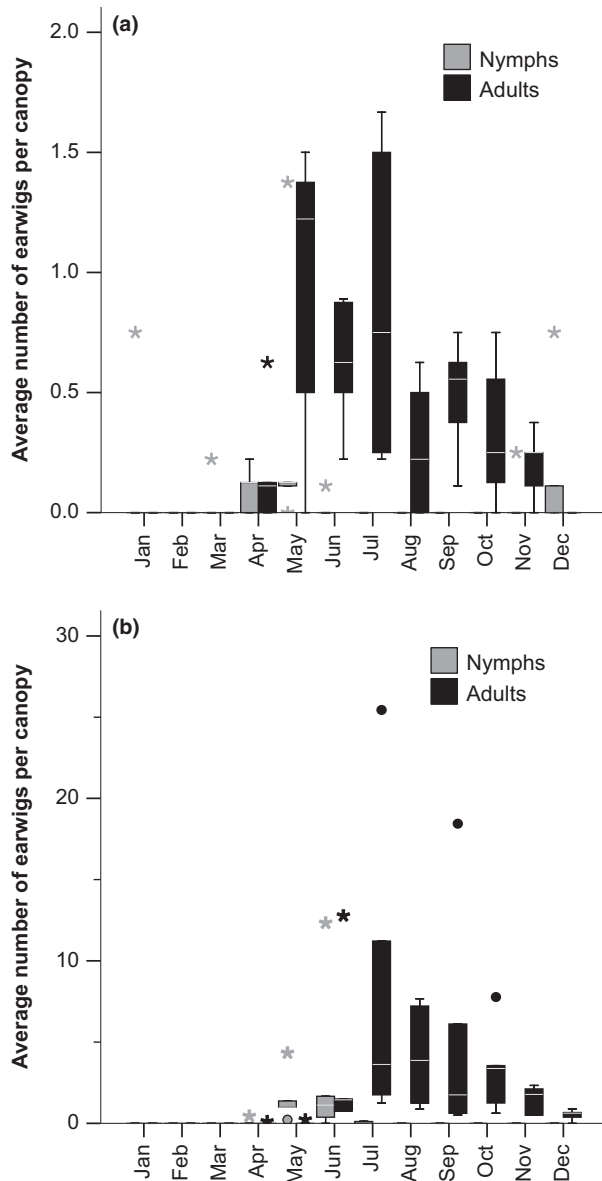


Fig. 1 Boxplot of the average number of earwigs captured per canopy per month during the studied period (2006–2010). The top of the box is the 75th percentile, the bottom the 25th percentile and the middle line the median. In the absence of outliers and/or extreme values, the bars that extend out of the top and bottom of the box represent the highest and lowest values. Outliers (values that are 1.5- to 3-fold the interquartile range) and extreme values (values that are more than 3-fold the interquartile range) are represented by circles and asterisks, respectively. (a) *Forficula auricularia*. (b) *Forficula pubescens*. Note that y-axis scales for both graphics are different.

Relationship between earwig and aphid abundance

There was a significant negative relationship between the cumulative abundance of aphids and

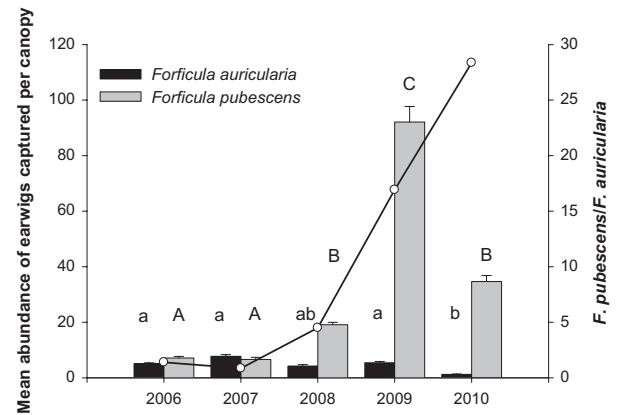


Fig. 2 Mean (\pm SE) abundance of earwigs, measured as the cumulative abundance (from January to December) per canopy for each year sampled (2006–2010). Different letters indicate years with significantly different abundance (Pair-wise test adjusted at $P < 0.005$). Lower case refers to *Forficula auricularia* and upper case to *Forficula pubescens*. The line is the ratio of *F. pubescens* to *F. auricularia* mean abundance.

F. auricularia (fig. 3a), but a non-significant one between aphids and *F. pubescens* (fig. 3b).

Discussion

Earwig abundance in Mediterranean citrus canopies

Forficula auricularia was generally present in canopies from April to November and sometimes until December. In colder regions, European earwig appears in canopies in May (reviewed in Moerkens et al. 2011) and moves back to the soil in October (Crumb et al. 1941; Behura 1956; Gobin et al. 2008; Moerkens et al. 2009). Thus, the active period of *F. auricularia* in Mediterranean citrus canopies lasted longer than in colder regions. This is not surprising as it is well known that earwig activity is dependent on temperature (Crumb et al. 1941; Behura 1956; Helsen et al. 1998; Moerkens et al. 2011). First instars were not found in canopies probably due to maternal care taking place in the soil (Vancassel and Foraste 1980; Albouy and Caussanel 1990; Helsen et al. 1998; Kölliker 2007; Kölliker and Vancassel 2007). In the study site, *F. auricularia* had two reproductive periods per year. Nymphs were found active in April, earlier than in most regions studied (Moerkens et al. 2011). The abundance of males and females at the canopies was not different from a 50 : 50 sex ratio. Brindley (1912) and Behura (1956; and included references) reached a similar conclusion on the proportion of sexes of European earwigs in the British Isles.

Forficula pubescens was usually found in citrus canopies from May to December. The species had one

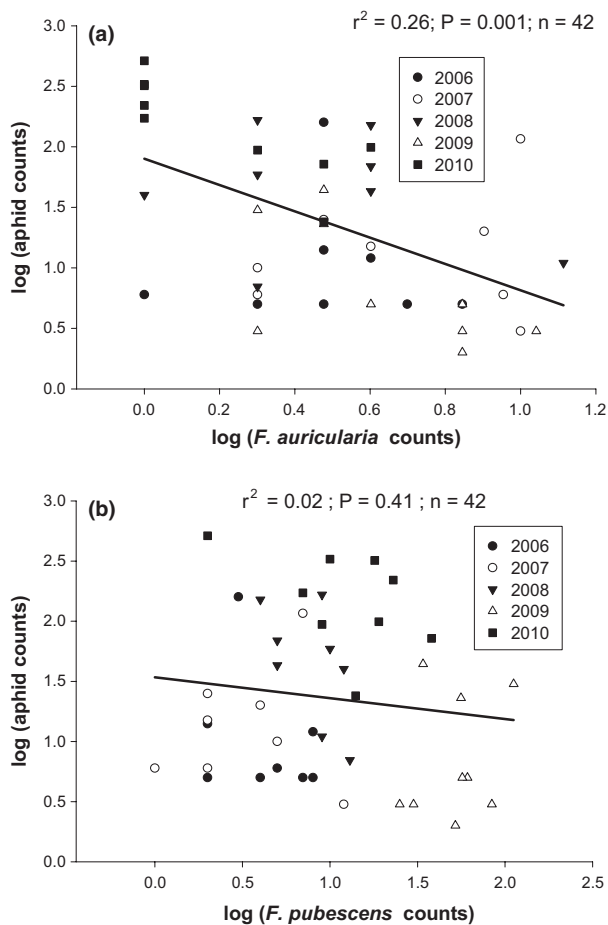


Fig. 3 Cumulative abundance of aphids vs. cumulative abundance of earwigs captured per canopy per season (from April to July) for the 5 years sampled (2006–2010). (a) *Forficula auricularia* vs. aphids. (b) *Forficula pubescens* vs. aphids. For each diagram, the total number of samples, the coefficient of determination and its statistical significance are given.

reproductive period per year, with nymphs present in canopies in May to June. Similarly to *F. auricularia*, first instars were never found in canopies. This might indicate that they remained in the subterranean nest with females, as a result of parental care of early instars (Herter 1964; Albouy and Caussanel 1990). Males and females were found in the proportion 50 : 50 in the canopies. We are unaware of published information on sex ratio in *F. pubescens*, although the scarce data in Herter (1964) of captures in 2 years in Corsica (28 males, 23 females) indicate a similar situation.

Interspecific association

Forficula auricularia and *F. pubescens* co-occurred in time and in space in citrus tree canopies, as they did

in cardboard shelters in pear tree trunks (Debras et al. 2007) and in rolled-up leaves (Herter 1964). However, both species were not in association. By contrast, Sauphanor and Sureau (1993) observed a high level of association between individuals of both species under laboratory conditions. These contrasting results may indicate that both species can coexist without having a negative effect on each other, and sometimes, as in the experiments of Sauphanor and Sureau (1993), even gaining benefits from each other.

Interannual variation of earwig abundance

The abundance of the two species of earwigs in canopies significantly changed over a 5-year period. In 2006, both species had similar abundance, but at a later point, *F. pubescens* gradually increased its abundance to the extent that by 2010, it was 28 times more abundant than *F. auricularia*. As both species were randomly distributed, strong interspecific competition can hardly be the cause of the observed temporal change in their relative abundance. Other factors such as climate, predation, reproduction success and/or survival rate may have differentially influenced both species. Climate variables (such as temperature or wind velocity) were shown to significantly correlate with European earwig abundance (Chant and McLeod 1952). Predation could have also been differential, as *F. auricularia* is nearly double in size than *F. pubescens*, and may have been subjected to a heavier predation rate, especially by birds, which are known to feed on European earwigs (Brindley 1918) and to significantly affect their abundance (Gunnarsson et al. 2009; Piñol et al. 2010). Although egg number seems to be of a similar magnitude in both species – around 30 eggs/brood (Crumb et al. 1941; Herter 1964) – survival rate or pathogen, parasite or parasitoid loads might have also differed in both species. A similar significant interannual variation in the abundance of other insects has already been described in the citrus canopy arthropod community (Piñol et al. 2011). A consequence of these findings is that short-term studies can be misleading, and that, long-term monitoring should be conducted whenever possible.

Relationship between earwig and aphid abundance

The abundance of *F. auricularia* was negatively related to that of aphids. This suggests a top-down regulation of aphids by *F. auricularia* (McQueen et al. 1989; Worm and Myers 2003; Piñol et al.

2009a). A possible explanation for this regulation is the role of *F. auricularia* as a generalist sedentary predator (Piñol et al. 2009b). As *F. auricularia* was already present in citrus canopies as early as April, it could feed on aphids from the very beginning. Early arrival of predators, such as heteropterans and coccinellids, has already been proved to be important in the biological control of aphid populations (Pons et al. 2009; Brown 2010). If predators are already present in canopies when pest population growth starts, they can prevent the outbreak; otherwise, they can only help to reduce the attack when it has already taken place (Murdoch et al. 1985). The other species present in citrus canopies, *F. pubescens*, did not show a significant relationship with aphids, probably due to its late appearance in canopies (in May).

Potential role of earwigs as pest predators

The European earwig has been considered as an effective biocontrol agent of aphids (Mueller et al. 1988; Nicholas et al. 2005) and midges (He et al. 2008) in apple orchards, psyllids in pear orchards (Höhn et al. 2007) and leafrollers in vineyards (Frank et al. 2007). In Mediterranean citrus orch-

ards, *F. auricularia* was present in canopies in April, earlier than in colder regions (Moerkens et al. 2011) and prior pests major attack (fig. 4). Thus, as a sedentary predator with generalist feeding habits, *F. auricularia* may assist in controlling citrus pests since the onset of the infestation (Piñol et al. 2009b). *F. pubescens* apparently did not regulate aphid populations. However, we know that it did predate on aphids, as preliminary visual gut-content analysis of *F. pubescens* individuals showed aphid remains (legs and bucal syphons) in their stomachs. In fact, *F. pubescens* is considered an active predator of aphids in apple orchards (Dib et al. 2010) and of the psyllid *Cacopsylla pyri* in pear trees (Debras et al. 2007). Thus, *F. pubescens* may also play its role as pest predator in citrus tree canopies, especially because of its high abundance. The following citrus pests co-occurred with both earwig species in our study site: the citrus leafminer, *Phyllocnistis citrella* Stainton, the woolly whitefly *Aleurothrixus floccosus* (Maskell) and soft scales such as the Chinese wax scale *Ceroplastes sinensis* Del Guercio and the cottony cushion scale *Icerya purchasi* Maskell. Although it remains unknown whether earwigs feed on these particular species, different studies indicate that earwigs are important natural enemies of Lepidoptera and



Fig. 4 (a) Months of medium (grey line) and major (black line) abundance of most important citrus pests in the Mediterranean, according to Garcia-Marí (2009) and to personal field observations. Underlined species are those observed in the study site. *Forficula auricularia* (b) and *Forficula pubescens* (c) monthly abundance in canopies each year. Months with low earwig abundance (<1 earwig captured per beating trays per canopy on average) are in grey.

non-aphid Homoptera (McLeod and Chant 1952; Badji et al. 2004; Suckling et al. 2006; Xiushan et al. 2006; Debras et al. 2007; Frank et al. 2007).

Concluding remarks

(i) The active period of *F. auricularia* in Mediterranean citrus canopies was longer than in colder regions. (ii) *F. auricularia* and *F. pubescens* co-occurred randomly in citrus canopies. (iii) The relative abundance of both species changed during a 5-year period. In the first year, 2006, both species had similar abundance, but in 2010, *F. pubescens* became much more abundant than *F. auricularia*. (iv) The potential role of earwigs as pest predators in tree canopies is likely to be higher in Mediterranean than in colder regions, because of a longer active period in the former. Our data suggested a possible top-down control of aphids by *F. auricularia*, probably as a consequence of their early presence in canopies, at the onset of aphid outbreak.

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Supporting Information

Additional supporting information may be found in online version of this article:

Fig. S1. Percentage of samples (beating trays per canopy per month) classified into the following categories: (a) without earwigs, (b) with both earwig species, (c) with only *Forficula pubescens* and (d) with only *Forficula auricularia*.

Table S1. Average number (Mean \pm SE) of earwigs captured per canopy each month of the studied period (2006–2010).

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1 **Supplementary material**

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3 **Fig. S1.** Percentage of samples (beating trays per canopy per month) classified into
4 the following categories: (a) without earwigs, (b) with both earwig species, (c) with only
5 *Forficula pubescens* and (d) with only *Forficula auricularia*.

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7 **Table S1.** Average number (Mean \pm SE) of earwigs captured per canopy each month
8 of the studied period (2006-2010). The number of tree canopies sampled each year is
9 indicated in the upper left corner. Nymphs are classified according to its stage of
10 development (first instars = N1, second instars = N2, and so on). Adult numbers are
11 segregated by sex.

33 Table S1.

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2006 n=8		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
<i>Forficula auricularia</i>	♀	0	0	0	0.13 ± 0.13	0.50 ± 0.19	0.38 ± 0.26	0.13 ± 0.13	0	0.13 ± 0.13	0.38 ± 0.18	0.25 ± 0.16	0
	♂	0	0	0	0	0.88 ± 0.30	0.13 ± 0.13	0.13 ± 0.13	0	0.50 ± 0.27	0.38 ± 0.26	0	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0.13 ± 0.13	0
	N4	0	0	0	0.13 ± 0.13	0	0	0	0	0	0	0.13 ± 0.13	0.75 ± 0.31
<i>Forficula pubescens</i>	♀	0	0	0	0	0	0.13 ± 0.13	0.88 ± 0.35	0.38 ± 0.26	0.25 ± 0.16	0.38 ± 0.26	0.25 ± 0.16	0
	♂	0	0	0	0	0	0.63 ± 0.26	0.88 ± 0.48	0.50 ± 0.19	0.38 ± 0.26	0.88 ± 0.52	0.25 ± 0.16	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0
	N5	0	0	0	0	1.00 ± 0.38	0.38 ± 0.26	0	0	0	0	0	0

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2007 n=8		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
<i>Forficula auricularia</i>	♀	0	0	0	0.25 ± 0.25	1.00 ± 0.50	0.38 ± 0.26	0.25 ± 0.16	0.13 ± 0.13	0.13 ± 0.13	0.25 ± 0.16	0.25 ± 0.16	0
	♂	0	0	0	0.38 ± 0.18	0.50 ± 0.19	0.25 ± 0.25	0.50 ± 0.38	0.50 ± 0.27	0.63 ± 0.26	0	0.13 ± 0.13	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0.13 ± 0.13	0	0	0	0	0	0	0	0	0	0	0
	N3	0.25 ± 0.16	0	0	0	0.13 ± 0.13	0	0	0	0	0	0	0
<i>Forficula pubescens</i>	♀	0	0	0	0	0	0.63 ± 0.18	1.00 ± 0.42	0.38 ± 0.18	0.13 ± 0.13	0.38 ± 0.26	0.25 ± 0.16	0.13 ± 0.13
	♂	0	0	0	0	0	0.13 ± 0.13	0.25 ± 0.25	0.88 ± 0.30	0.38 ± 0.26	0.25 ± 0.16	0.25 ± 0.16	0.25 ± 0.16
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0
	N5	0	0	0	0	1.13 ± 0.48	0	0	0	0	0	0	0

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2008 n=8		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
<i>Forficula auricularia</i>	♀	0	0	0	0	0.13 ± 0.13	0.63 ± 0.18	0.75 ± 0.62	0.13 ± 0.13	0	0	0.13 ± 0.13	0
	♂	0	0	0	0	0.38 ± 0.26	0.25 ± 0.16	0.75 ± 0.37	0.38 ± 0.18	0.38 ± 0.18	0.13 ± 0.13	0.13 ± 0.13	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0
	N4	0	0	0	0	0.13 ± 0.13	0	0	0	0	0	0	0
<i>Forficula pubescens</i>	♀	0	0	0	0	0	1.25 ± 0.31	1.88 ± 0.64	2.00 ± 0.73	0.63 ± 0.26	1.88 ± 0.99	1.13 ± 0.35	0.50 ± 0.27
	♂	0	0	0	0	0	0.25 ± 0.16	1.75 ± 0.53	1.88 ± 0.69	1.13 ± 0.30	1.50 ± 0.46	1.00 ± 0.33	0.13 ± 0.13
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0.13 ± 0.13	0	0	0	0	0	0	0
	N5	0	0	0	0	0.50 ± 0.27	0.88 ± 0.23	0.13 ± 0.13	0	0	0	0	0

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2009 n=9		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
<i>Forficula auricularia</i>	♀	0	0	0	0	0.56 ± 0.38	0.44 ± 0.24	1.44 ± 0.67	0	0.22 ± 0.22	0.11 ± 0.11	0.11 ± 0.11	0
	♂	0	0	0	0	0.67 ± 0.33	0.44 ± 0.18	0.22 ± 0.15	0	0.33 ± 0.24	0.44 ± 0.18	0	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0.11 ± 0.11
	N4	0	0	0	0.22 ± 0.15	0.11 ± 0.11	0	0	0	0	0	0	0
<i>Forficula pubescens</i>	♀	0	0	0	0.11 ± 0.11	0.22 ± 0.15	7.00 ± 1.20	11.56 ± 2.72	3.22 ± 1.44	8.89 ± 4.22	3.22 ± 0.62	0.89 ± 0.35	0.56 ± 0.29
	♂	0	0	0	0	0	5.78 ± 1.02	13.89 ± 4.76	4.44 ± 1.39	9.56 ± 3.87	4.56 ± 0.75	0.89 ± 0.42	0.11 ± 0.11
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0.33 ± 0.17	0.11 ± 0.11	0	0	0	0	0	0	0
	N5	0	0	0	0	2.67 ± 0.67	0.22 ± 0.15	0.11 ± 0.11	0	0	0	0	0

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2010 n=9		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
<i>Forficula auricularia</i>	♀	0	0	0	0.11 ± 0.11	0	0.11 ± 0.11	0	0.11 ± 0.11	0	0	0	0
	♂	0	0	0	0	0	0.11 ± 0.11	0.22 ± 0.15	0.11 ± 0.11	0.11 ± 0.11	0	0	0
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0
	N4	0	0	0.22 ± 0.15	0	0	0.11 ± 0.11	0	0	0	0	0	0
<i>Forficula pubescens</i>	♀	0	0	0	0	0	0.67 ± 0.29	6.33 ± 1.78	4.22 ± 1.19	2.78 ± 0.89	1.78 ± 0.55	1.22 ± 0.36	0.44 ± 0.18
	♂	0	0	0	0	0	0.78 ± 0.28	4.89 ± 1.26	3.00 ± 0.75	3.33 ± 1.80	1.78 ± 0.49	1.11 ± 0.56	0.44 ± 0.19
	N1	0	0	0	0	0	0	0	0	0	0	0	0
	N2	0	0	0	0	0	0	0	0	0	0	0	0
	N5	0	0	0	0	0.11 ± 0.11	0.67 ± 0.67	0	0	0	0	0	0