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Biodiversity and pollen feeding habits of syrphids in olive groves and surrounding landscape in Northeastern Portugal during spring

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Abstract: Many syrphid larvae are predators of aphids and early stages of moths and psyllids, being potential control agents of some olive pests. However, adults need pollen and nectar for energy and reproduction. An increase of plant resources biodiversity in heterogeneous landscape could benefit these natural enemies. Thus, our goal of was to study the syrphid biodiversity and their pollen sources in olive agroecosystems from the northeast of Portugal during spring, that coincides with the availability of pests. For that, syrphids were captured in three not-tilled olive groves and two surrounding field areas (an herbaceous vegetation patch and a scrubland) next to each olive grove. Simultaneously, flowering plant inventories were carried out. Syrphids and the pollen contained in the guts of the most abundant species were identified. Thereafter pollen in guts was compared with pollen in the environment to evaluate a potential pollen selection. The most abundant species were *Sphaerophoria scripta* and *Melanostoma mellinum*. During the spring syrphids did not consume all the occurring plant species but did not actively selected pollen types. Results indicated that Asteraceae, Plantaginaceae, Caryophyllaceae, *Echium* type, *Rumex* type and *Jasione* type are important food sources for *M. mellinum* and *S. scripta*. These results will allow managing ground cover vegetation more efficiently in order to conserve syrphids in the olive agroecosystem.

Key words: *Sphaerophoria scripta*, *Melanostoma mellinum*, pollen analyses, pest control, flowering resources

Introduction

The olive tree is an important crop that is cultivated in all climatologically suitable regions. It is attacked by several pests, such moths and psyllids, that its early stages are potentially consumed by many syrphids' species (Speight, 2011). Its action could be relevant in the predation of the Lepidoptera *Prays oleae* (Bern.) (Praydidae) and *Palpita vitrealis* (Rossi) (Crambidae) and the Hemiptera (Psyllidae) *Euphyllura olivina* (Costa) and *Euphyllura straminea* Loginova. However, adult syrphids need nectar for energy and pollen for reproduction (Haslett, 1989). Therefore, heterogeneous agricultural landscapes could positively affect their presence in agroecosystems through increasing their flowering food resources.

Syrphids are mainly active during spring (Speight, 2011), coinciding with the flowering period of many plants. In Europe, the feeding behavior of syrphids during this period have been studied by several authors in different agroecosystems (e. g., Burgio and Sommaggio, 2007; Viattale et al., 2017). However, to our knowledge any study addressed the feeding behavior of syrphids during spring in landscapes dominated by olive trees. During periods of scarcity (autumn and winter in Mediterranean areas), previous studies highlighted the importance of conserving heterogeneous agricultural landscapes in the olive agroecosystem to guarantee the existence of food resources (Villa et al., 2016). In this context, analysis of pollen contained in the syrphid guts allows determining flower visitation in field (Villa et al., 2016; Viattale et al., 2017).

Thus, in the present work we intended to study the syrphid biodiversity and their pollen sources in olive agroecosystems during spring through analyzing pollen composition inside guts.

Material and methods

The study was conducted in the northeast of Portugal, in three not-tilled olive groves and two surrounding field areas (an herbaceous vegetation patch and a scrubland) next to each olive grove.

During the spring 2013, adult syrphids were captured weekly with a sweep net in the nine patches during approximately 30 minutes. In the laboratory syrphids were identify and dissected for pollen analyses. The gut content was diluted in a glycerine:water solution (1:1) in a microcentrifuge tube (1.5 ml). The solution was 1 ml for females due to their larger consume of pollen, and 0.5 ml for males. Then, those solutions were mixed in a vortex, 65 µl were transferred onto a glass slide and a coverslip (22 × 22 mm) was applied. Pollen grains were counted and identified to pollen type using a microscope. When there were more than 5,000 pollen grains, half of the slide was counted, and when there were more than 15,000, a quarter of the slide was counted; the total number of grains was estimated thereafter.

Simultaneously, five flowering plant inventories were carried out in circular plots of 25 m^2 (olive groves and herbaceous patches) and three plots of 100 m^2 (scrubland patches). The percentage ground cover for each flowering plant species was recorded following the Daubenmire cover scale modified by Bailey (Mueller-Dombois and Ellenberg, 1974).

Then, Jacobs`s second selection index ($D_i$) was used to compare the consume frequency of a species to its availability. A positive Jacobs`s index value indicates selection of the resource and a negative avoidance (Vialatte et al., 2017).

Results and discussion

A total of 313 syrphids belonging to six species were captured during the spring of 2013. The most abundant species was *Sphaerophoria scripta* (Linnaeus, 1758) followed by *Melanostoma mellinum* (Linnaeus, 1758). *Sphaerophoria scripta* was more abundant in olive groves while *M. mellinum* was more abundant in the herbaceous patches (Table 1). The role of these species as biological control agents in the olive agroecosystem is unknown. However, larvae of syrphids prey on aphids and the early stages of moths and phyllids (van Veen, 2010; Speight, 2011), therefore they could act as natural enemies of moths and psyllids pests in the olive orchards and as a reservoir of beneficial insects for other surrounding crops providing services such as pollination or natural control.

In cereal fields in France, Viattale et al. (2017) captured 112 syrphids belonging to 13 taxa in during the spring. Regarding to the syrphids abundance, accordingly to our results Viattale et al. (2017) found *M. mellinum* among the most abundant species. However, although the flight period of both *Eupeodes corollae* (Fabricius) and *Episyrphus balteatus* (De Geer) occurs from the beginning of the spring until the end of the autumn (Speight, 2011), in this study these species were only represented by few individuals.

Table 1. Syrphid species captured with sweep net during spring 2013 in olive (Oliv), herbaceous (Herb) and Scrubland (Scrub) patches. Female and male numbers are showed between brackets as follow (females, males).

Syrphid species	Oliv	Herb	Scrub	Total
Episyrphus balteatus (De Geer, 1776)	1	2	2	5
	(1, 0)	(1, 1)	(0, 2)	(2, 3)
Eristalis tenax (Linnaeus, 1758)	1	0	0	1
	(1, 0)			(1, 0)
Eristalis sp	0	2	0	2
		(0, 2)		(0, 2)
Eupeodes corollae (Fabricius, 1794)	3	1	1	5
	(3, 0)	(0, 1)	(1, 0)	(4, 1)
Eupeodes sp	0	1	0	1
		(0, 1)		(0, 1)
Melanostoma mellinum (Linnaeus, 1758)	31	47	11	89
	(19, 12)	(38, 9)	(7, 4)	(64, 31)
Melanostoma scalare (Fabricius, 1794)	1	0	0	1
	(0, 1)			(0, 1)
Platycheirus sp	0	1	0	1
		(0, 1)		(0, 1)
Sphaerophoria scripta (Linnaeus, 1758)	132	58	18	208
	(58, 74)	(20, 38)	(11, 7)	(89, 119)
Total	169	112	32	313
	(82, 87)	(59, 53)	(19, 13)	(160, 153)

Contrastingly, in a previous study we found *E. balteatus* and *E. corollae* to be the most abundant species collected in the delta traps during the autumn (Villa et al., 2016). Both species were also well represented in Viattale et al. (2017) work. Contrarily, the most abundant species observed *S. scripta* was represented by few individuals in Viattale et al. (2017). Differences among studies could be due to variations in the capture method (sweep net versus yellow water traps), weather conditions, crop, food resources and/or landscape structure among regions.

The most abundant species *M. mellinum* and *S. scripta* were analyzed for pollen and 7% of the insects had an empty gut, value considerably low in comparison with the 25% observed by Viattale et al. (2017). A total of 67 pollen types were identified in the studies patches. Females of *M. mellinum* consumed a total of 36 pollen types while males consumed 16.

Females and males of *S. scripta* consumed a similar amount of pollen, 34 and 35, respectively. In *M mellinum* the pollen types consumed by a higher number of individuals was Asteraceae and Plantaginaceae for both females and males but the D_i was only positive for Plantaginaceae in the case of the females (0.561). In *S. scripta* Asteraceae was the pollen type consumed by more individuals. Also Caryophyllaceae, *Echium* type, *Rumex* type were consumed by high number of both females and males and *Jasione* type and *Olea europaea* in the case of the males. However, only Asteraceae presented a positive D_i (Females = 0.122; Males = 0.217). Rijn and Wäckers, 2016 found that the range of plant species that can effectively support syrphids seem to be limited to those that have accessible nectar. Accordingly, in general pollen types found in this study belonged to taxa with accessible nectar for syrphids.

In this study syrphids did not consume all the occurring species but did not actively selected pollen types. During the spring in the studied olive agroecosystem, the ground cover and heterogeneous landscapes could provide more abundance of resources than needed making unnecessary to select pollen types by these syrphid species. However, results indicated that Asteraceae, Plantaginaceae, Caryophyllaceae, *Echium* type, *Rumex* type and *Jasione* type are important for *M. mellinum* and *S. scripta*. Contrastingly, Viattale et al. (2017) found positive selection and this could be related with the lower general abundance of pollen resources in their agroecosystem. Similarly to our results they did not found a big contribution of the woody vegetation to the pollen consume. However, woodlands could have a relevant importance as overwintering habitats (Arrignon et al., 2007) and pollen provision in food scarcity periods (Villa et al., 2016). These results will allow managing ground cover vegetation more efficiently in order to conserve syrphid in the olive agroecosystem.

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