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# THE PHENOLOGY OF OCCURRENCE OF DOMINANT PREDATORY SYRPHIDAE (DIPTERA) SPECIES IN APPLE ORCHARDS AND ON THEIR EDGES

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**ABSTRACT**

The blooming wild plants in the vicinity of orchards may attract adult Syrphidae to these cultivations. Hence in 2008–2010 studies were conducted around Czempiń (western Wielkopolska) which covered the occurrence of the imagines of 5 dominant predatory Syrphidae species in apple orchards and on their edges. The phenology of *Episyrphus balteatus* (De Geer), *Eupeodes corollae* (F.), *Melanostoma mellinum* (L.), *Sphaerophoria scripta* (L.) and *Syrphus vitripennis* Meigen in apple orchards as well as in the neighbouring shrubberies and on the side of the road overgrown with trees and bushes was analysed. A greater abundance of imagines of the studied species was found on the edges than in the apple orchards. Also a preference for either orchards or their sides was indicated for Syrphidae, as they appeared in these biocenoses earlier or later, but not at the same time. A correlation between a mass catch of Syrphidae in the orchards and their edges was found. It was shown that the blooming plants of orchard edges, such as *Tilia cordata*, *Symphoricarpos albus*, *Cirsium arvense* and *Galium aparine*, could attract Syrphidae imagines to the orchards.

**Key words:** hoverflies, apple orchard, wild attractive plants

## INTRODUCTION

The ecological structure of agrocenoses, which include orchards, can determine and help to fully use the phenomena related to functional biodiversity. The habitats which are not used for farming and border on agricultural cultivations, e.g. shrubberies, tree clumps, woodlots, hedges, belts of wild plants, field borders, can provide favourable conditions for development of beneficial entomofauna of the Syrphidae family [Wyss 1995, MacLeod 1999, Branquart and Hemptinne 2000, Colley and Luna 2000, Sutherland et al. 2001, Carreck and Williams 2002, Ambrosino et al. 2006, Kelm et al. 2009, Wnuk et al. 2009, Trzciński and Piekarska-Boniecka 2013].

The blooming wild plants in orchards provide food for Syrphidae imagines and so attract them to these biocenoses [Wyss 1995, Rossi et al. 2006]. These components maintain habitat diversity in time and space, thus stimulating self-controlling mechanisms in agrocenoses [Wnuk 1979, Wyss 1995, Wyss et al. 1999, Solomon et al. 2000, Rossi et al. 2006, Haenke et al. 2009, Piekarska-Boniecka et al. 2013]. The migration of entomophages among neighbouring habitats helps to increase their abundance on cultivated plants [Wnuk 1972, Sutherland et al. 2001, Miňarro et al. 2005, Wnuk and Wojciechowicz-Żytko 2007, Pineda and Marcos-Garcia 2008, Piekarska-

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-Boniecka et al. 2013], which can lead to decreasing in the number of phytophages feeding there.

The study aim was to determine the occurrence of imagines of 5 dominating predatory Syrphidae species in apple orchards, in the neighbouring shrubberies and on the roadside with trees and bushes and to establish the following:

– if the Syrphidae prefer to inhabit any of these habitats,

– if the appearance of Syrphidae in orchards is correlated with their appearance on orchard edges,

– if the blooming period of plants on orchard edges affects the appearance of Syrphidae in the orchards.

## MATERIAL AND METHODS

### Study area

The study was conducted in 2008–2010 in two orchards located in the vicinity of Czempiń in Wielkopolska (Western Poland). These were two orchards in Gorzyczki, located 1 km away from each other.

The study sites included:

1. Apple orchard I, Gorzyczki (UTM, XT27; 52.10106°N, 16.81199°E) 20 ha in area (A1 = Gorzyczki – orchard), where studies covered 5-hectare plots with 15-year-old apple trees of: 'Paulared', 'Red Delicious', 'Golden Delicious' and 'Jonagold' cultivars. The apple tree plot was surrounded by shrubberies (A2 = Gorzyczki – shrubberies), namely thicket phytocenoses of *Euonymo-Prunetum spinosae* and *Querco-Ulmetum* forest, herbaceous communities and ruderal plant communities. Tree communities were formed mainly by: European elm (*Ulmus laevis* Pall.), sessile oak (*Quercus robur* L.), ash tree (*Fraxinus excelsior* L.), maple (*Acer platanoides* L.), boxelder maple (*Acer negundo* L.) and single apple trees (*Malus domestica* Borkh.) with hybrid black poplar (*Populus* × *canadensis* Moench) and white willow (*Salix alba* L.). In the patches of ruderal shrubberies the following were recorded: elder (*Sambucus nigra* L.), common hawthorn (*Crataegus monogyna* Jacq.), matrimony vine (*Lycium barbarum* L.), dog rose (*Rosa canina* L.) and hazel (*Corylus avellana* L.). Herbaceous plants were dominated by stinging nettle (*Urtica dioica* L.), Canada thistle (*Cirsium arvense* (L.) Scop.) and cleavers (*Galium aparine* L.).

2. Apple orchard II, Gorzyczki (UTM, XT27; 52.10208°N, 16.81451°E) 10 ha in area (B1 = Gorzyczki – orchard). The studies were conducted on 2-hectar plots with 20-year-old 'Golden Delicious' apple trees. The orchard borders on a road (B2 = Gorzyczki – roadside) overgrown with plants typical of *Rhamno-Prunetea* class. The road was lined with walnut (*Juglans regia* L.), maples: boxelder (*Acer negundo* L.), common (*A. platanoides* L.), sycamore (*A. pseudoplatanus* L.), sessile oak (*Quercus robur* L.), sweet cherry (*Prunus avium* L.) and small-leaved lime (*Tilia cordata* Mill.), with some dog rose shrubs (*Rosa canina* L.), common hawthorn (*Crataegus monogyna* Jacq.), hawthorn (*Crataegus* × *media* Bechst.), hazel (*Corylus avellana* L.), elder (*Sambucusnigra* L.), white dogwood (*Cornus alba* L.), European spindle (*Euonymus europaea* L.), blackthorn (*Prunus spinosa* L.), snow current (*Ribes gracile* Michx.) and snowberry (*Symphoricarpos albus* Duhamel). Herbaceous plants were dominated by grass, stinging nettle (*Urtica dioica* L.), wormwood (*Artemisia absinthium* L.), yarrow (*Achillea millefolium* L.), Canada thistle (*Cirsium arvense* (L.) Scop.) and cleavers (*Galium aparine* L.).

In both the studied orchards apple trees grew 1.4 m from each other in rows set 3 m apart. Between the trees fallow land was maintained and the rows of trees were divided by sward. The orchards followed integrated fruit production policy. The apple protection programme was implemented in the same terms and against the same diseases and pests in all orchards. In each of the orchards 5–8 procedures against diseases and 6–8 procedures against pests were performed in the different years of study.

### Weather conditions

The weather conditions in 2008–2010 were presented based on the data from the Research Station, Turew, which belongs to the Institute of Agricultural and Forest Habitat of PAN in Poznań. They included monthly average air temperatures (fig. 1) and monthly precipitation quantities (fig. 2). They were

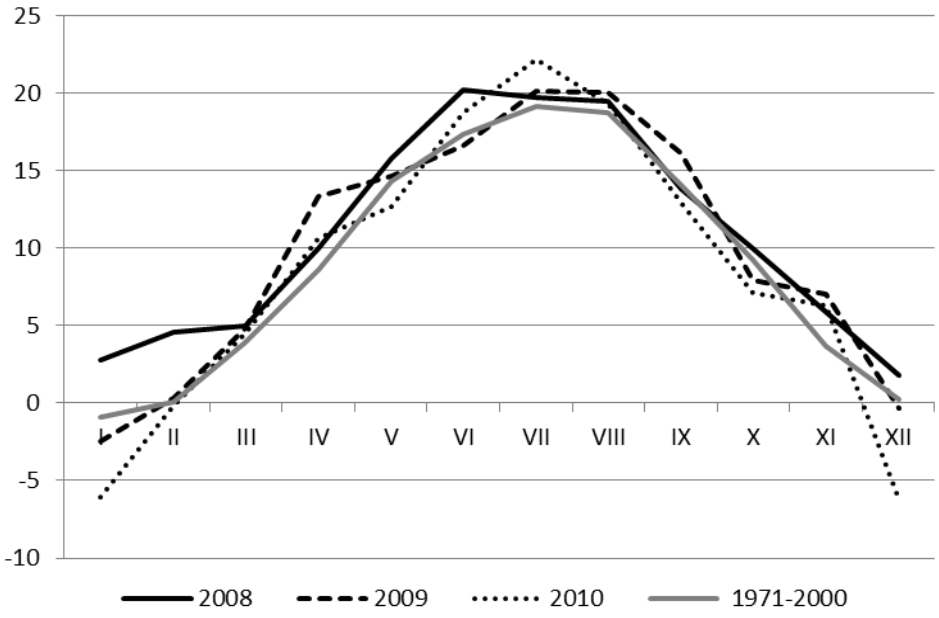


**Fig. 1.** Average monthly air temperatures in particular study years

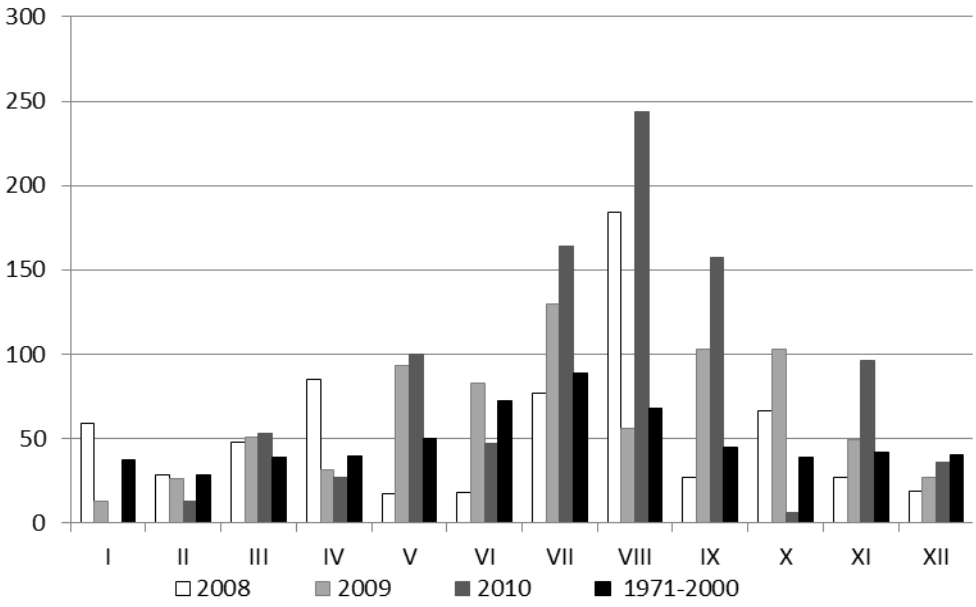


**Fig. 2.** Monthly precipitation in particular study years

**Table. 1.** Abundances of the dominant Syrphidae species caught in apple orchards and on their edges during study years (a –2008, b – 2009, c–2010, a–c – 2008–2010)

| Species | Habitats | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | orchard I (A1) | | | | shrubberies (A2) | | | | orchard II (B1) | | | | roadside (B2) | | | | |
| | a | b | c | a–c | a | b | c | a–c | a | b | c | a–c | a | b | c | a–c | |
| *Episyrphus balteatus* (De Geer 1776) | 139 | 499 | 82 | 720 | 419 | 508 | 64 | 991 | 216 | 184 | 101 | 501 | 383 | 304 | 65 | 752 | 2964 |
| *Eupeodes corollae* (Fabricius 1794) | 17 | 176 | 12 | 205 | 41 | 100 | 20 | 161 | 17 | 48 | 5 | 70 | 27 | 46 | 1 | 74 | 510 |
| *Melanostoma mellinum* (Linnaeus 1758) | – | 24 | 13 | 37 | – | 11 | – | 11 | 3 | 1 | – | 4 | 5 | 4 | 1 | 10 | 62 |
| *Sphaerophoria scripta* (Linnaeus 1758) | 2 | 38 | 1 | 41 | 5 | 15 | – | 20 | 1 | 11 | – | 12 | 10 | 3 | 1 | 14 | 87 |
| *Syrphus vitripennis* (Meigen 1822) | 4 | 43 | 3 | 50 | 12 | 51 | 6 | 69 | 4 | 6 | 2 | 12 | 12 | 10 | – | 22 | 153 |
| Total | 162 | 780 | 111 | 1053 | 477 | 685 | 90 | 1252 | 241 | 250 | 108 | 599 | 437 | 367 | 68 | 872 | 3776 |

**Table 2.** Correlation indices (r) and p-values for the correlation test between the abundances of the dominant Syrphidae species of the orchards and edges in particular study years

| Habitats | Years | | | | | |
|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | |
| | r | p-value | r | p-value | r | p-value |
| Gorzyczki I orchard (A1) – shrubberies (A2) | 0.999 | 0.004 | 1 | <0.001 | 1 | <0.001 |
| Gorzyczki II orchard (B1) – roadside (B2) | 0.988 | 0.099 | 0.996 | 0.060 | 0.966 | 0.167 |

compared with the data from 1971–2000 multiannual period. The years 2008 and 2009 were warm, and 2008 turned out to be the warmest and 2010 the coolest in comparison with the multiannual period. All the years were highly humid, however, the highest precipitation was reported in 2010. This was also confirmed in comparison with the multiannual period.

### Study methods

The study used a commonly used method of trapping Syrphidae imagines in the yellow Moericke traps [Moericke 1953]. The trap was made from a yellow plastic pan filled with water and glycol (preservative) and liquid lowering surface pressure, 18 cm in diameter and 11 cm deep. 20 pans were laid out on each site, 1–1.5 m above the ground. The traps were situated in the following manner: 10 of them in the orchard and the other 10 further away, several meters from the orchard's edge. The traps were placed up to 10 m from each other. Specimens were collected in ten-day intervals. Insects caught in one pan during ten days constituted one sample. The traps were placed in the orchard from April to October in each study year.

Syrphidae imagines were classified based on the keys by van Veen [2004] and Speight and Sarthou [2010].

The study of relations between Syrphidae found in orchards and in both neibouring habitats in subsequent years was carried out by analyzing the correlation coefficients and p-value for the correlation test. Statistical calculations were performed with R software (R Development Core Team) [2012].

## RESULTS

In the years 2008–2010 in both apple orchards in Gorzyczki the total of 2.438 samples were collected, out which 1.208 from the orchards and 1.230 on their edges. The total number of individuals was 3.959 of 32 species of predatory Syrphidae. The orchards yielded 1.746 specimens of 22 species, while their edges 2.213 of 30 species. The phenology of Syrphidae imagines in the orchards and on their edges was presented based on the occurrence of 5 dominant Syrphidae (tab. 1), namely: *Episyrphus balteatus* (De Geer) (D = 75%), *Eupeodes corollae* (F.) (D = 12.9%), *Melanostoma mellinum* (L.) (D = 1.6%), *Sphaerophoria scripta* (L.) (D = 2.2%) and *Syrphus vitripennis* Meigen (D = 3.9%). In all the habitats the decided dominats were *E. balteatus* and *E. corollae.* Every year *E. balteatus*, *E. corollae* and *S. vitripennis* were also caught.

In 2008–2010 on orchards edges (A2 and B2) more specimens of dominant species were caught in total, because these habitats yielded 2.124 (56.3%) specimens, while in orchards (A1 and B1) respectively 1.652 (43.7%) (tab. 1). Also in 2008 in orchard I (A1) and shrubberies (A2) and similarly in 2008 and 2009 in orchard II (B1) and roadside (B2) such differences were observed, as definitely fewer specimens were caught on the edges than in the orchards. Those years yielded 64.5 to 74.7% of their total number on orchard edges.

In 2009 in all the habitats, except orchard II, the most dominants were caught (tab. 1). This can be explained with very favourable weather conditions that year, while in 2010 the fewest specimens were collected from all the habitats. The last year of studies was characterised by the lowest temperatures and the highest precipitation.

An analysis of correlations between the abundances of the dominant species caught in orchards and on edges in particular study years indicated they were very high (tab. 2). They reached almost 1. In 2009 and 2010 the correlation between Syrphidae abundances in the orchard and shrubberies was even 1. This means that there was a very strong relationship between the numbers of dominants caught in these habitats and confirms that Syrphidae moved between the orchard and its side. Moreover, p-value $< 0.05$ for the Syrphidae inhabiting the orchard and shrubberies indicated a higher correlation in the choice of place of occurrence.

The dominant Syrphidae species were collected at the earliest in the 1st ten-day period of April in orchard II (figs 7 and 8) and in shrubberies in 2009 and 2010 (figs 4 and 5). They were male of *E. balteatus* in the orchard and females of *S. vitripennis* and *E. balteatus* in the shrubberies.

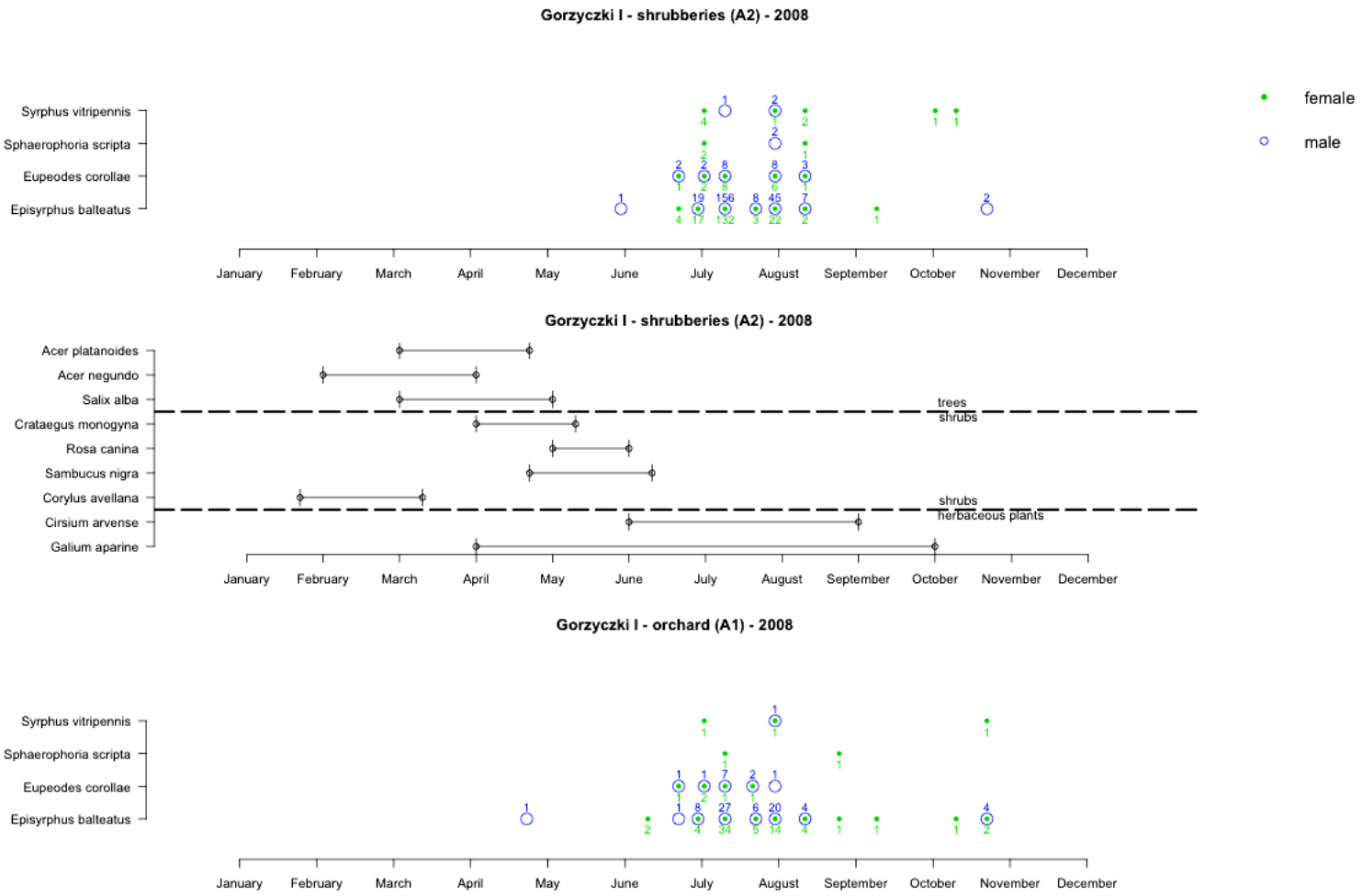


**Fig. 3.** Phenology of the occurrence of dominant Syrphidae in Gorzyczki I apple orchard (A1) and in shrubberies (A2) in 2008

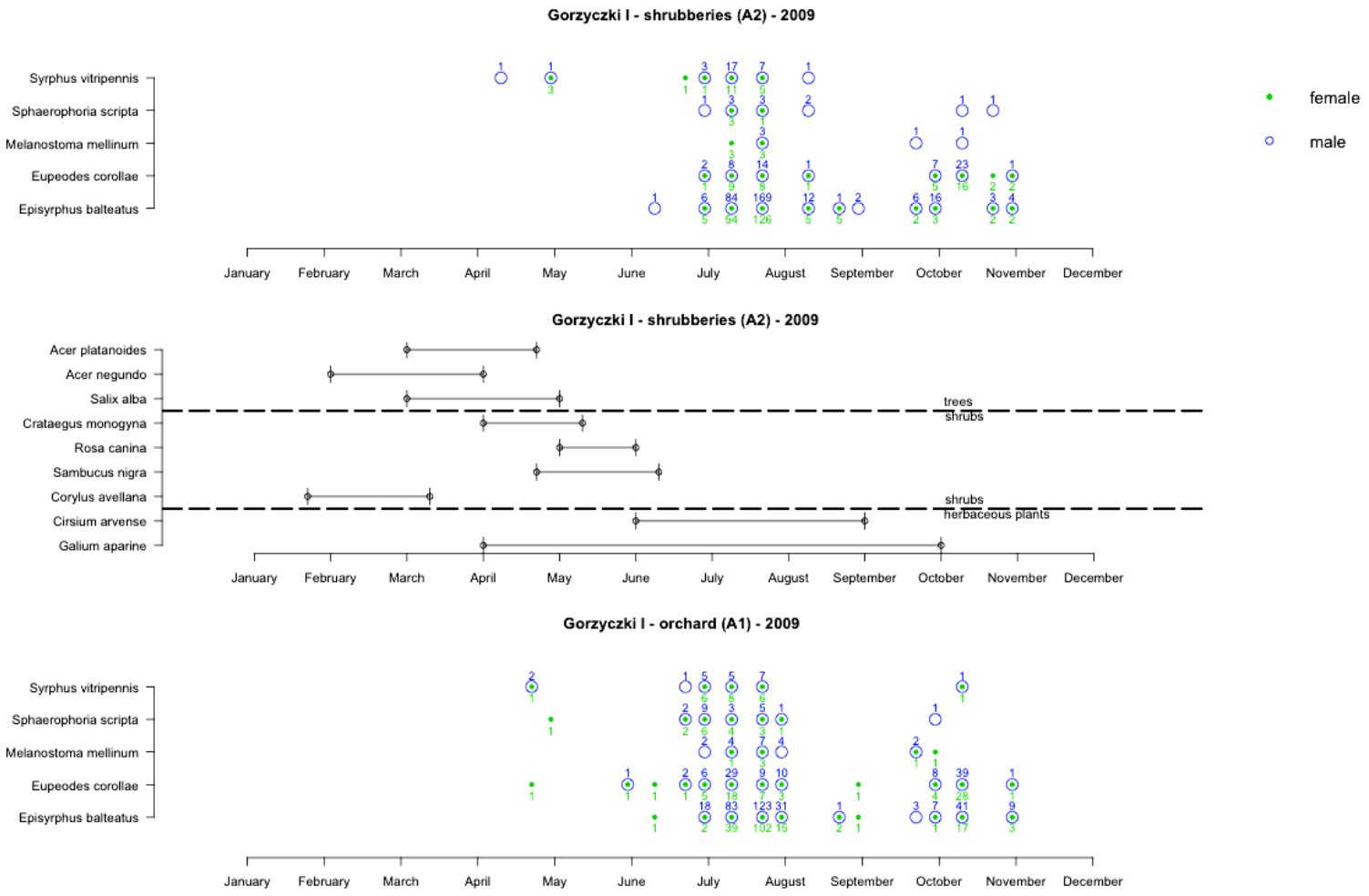


**Fig. 4.** Phenology of the occurrence of dominant Syrphidae in Gorzyczki I apple orchard (A1) and in shrubberies (A2) in 2009

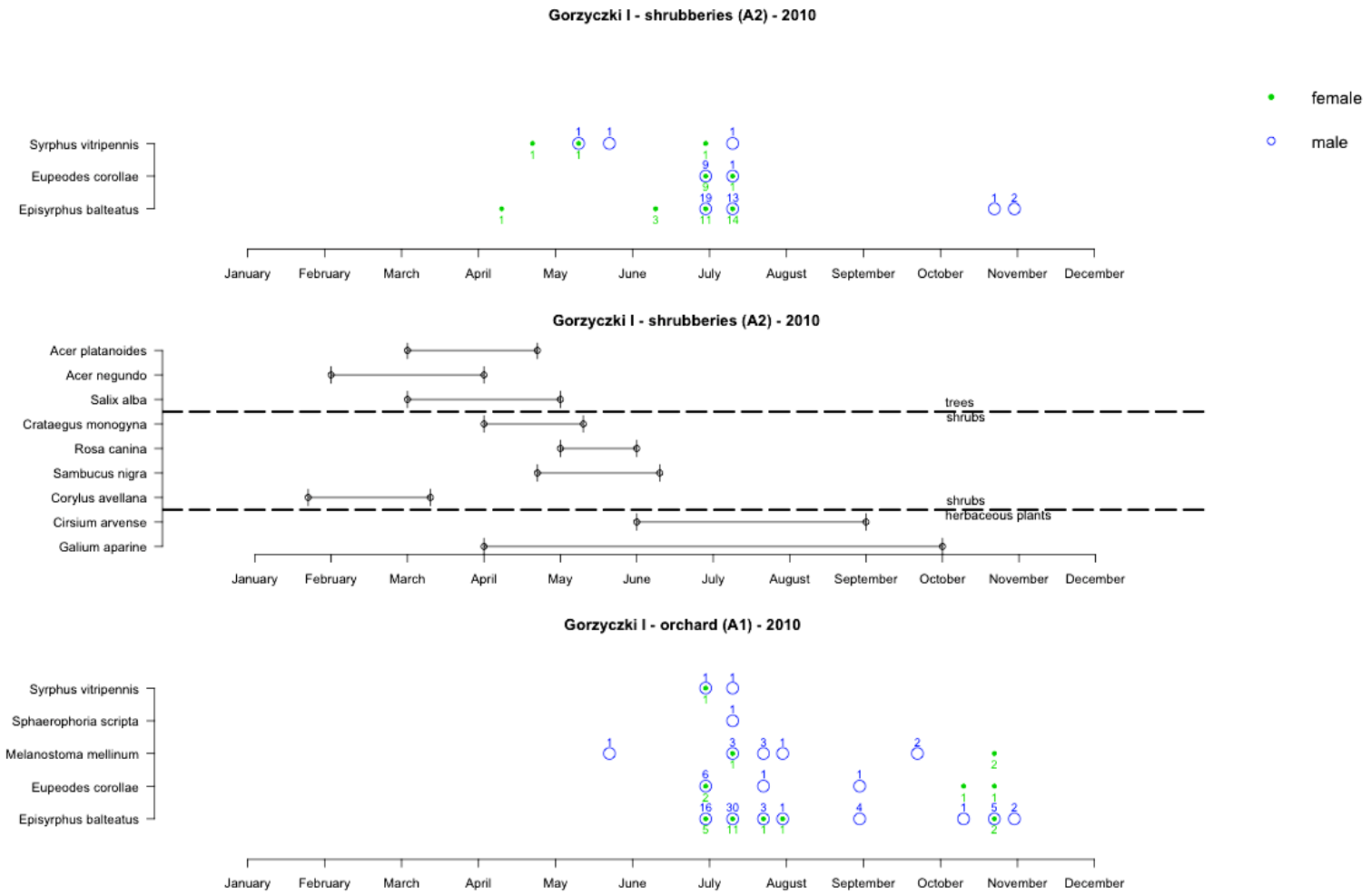


**Fig. 5.** Phenology of the occurrence of dominant Syrphidae in Gorzyczki I apple orchard (A1) and in shrubberies (A2) in 2010

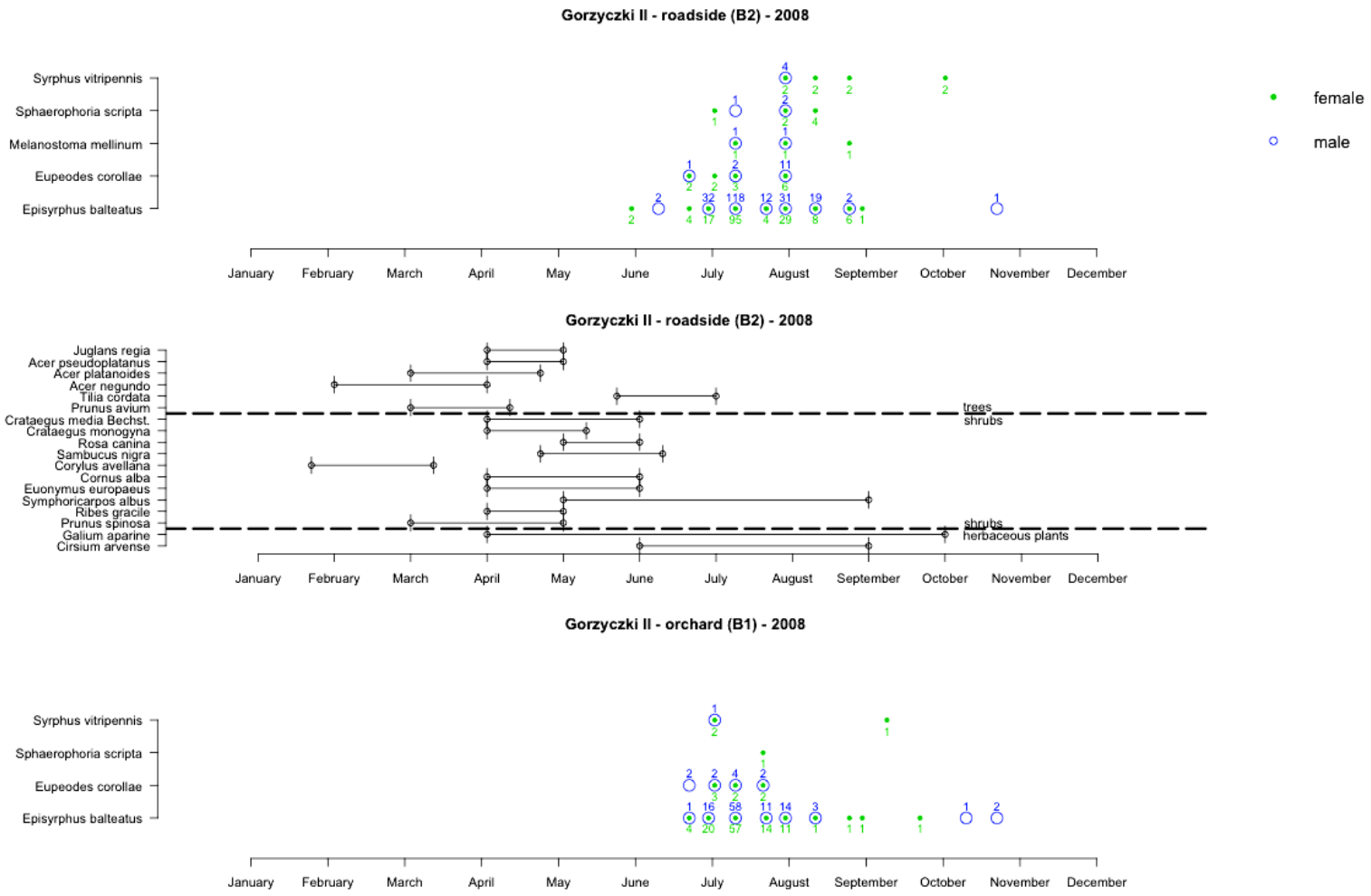


**Fig. 6.** Phenology of occurrence of dominant Syrphidae species in Gorzyczkach II (B1) apple orchard and the roadside (B2) in 2008

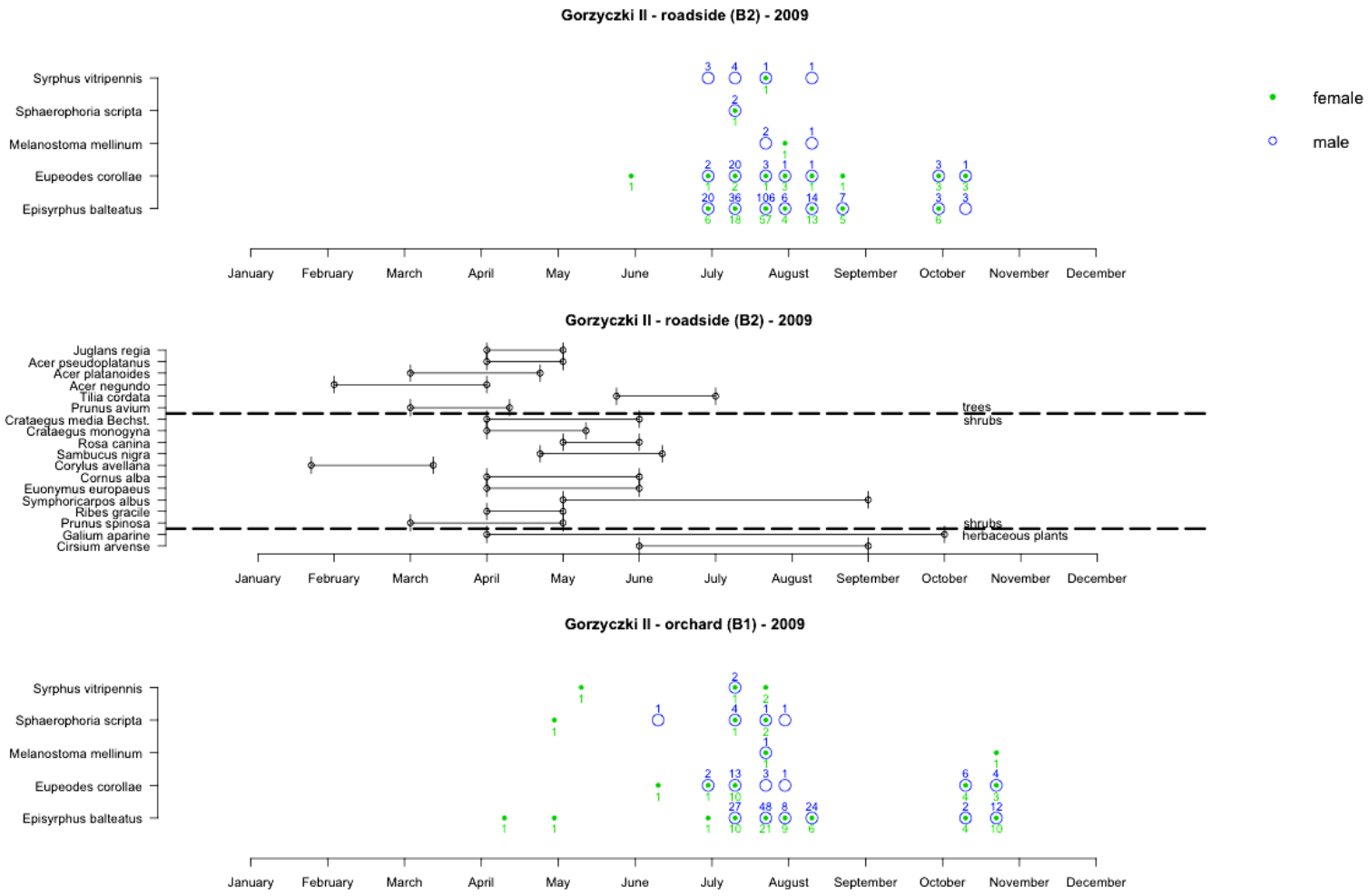


**Fig. 7.** Phenology of occurrence of dominant Syrphidae species in Gorzyczkach II (B1) apple orchard and the roadside (B2) in 2009

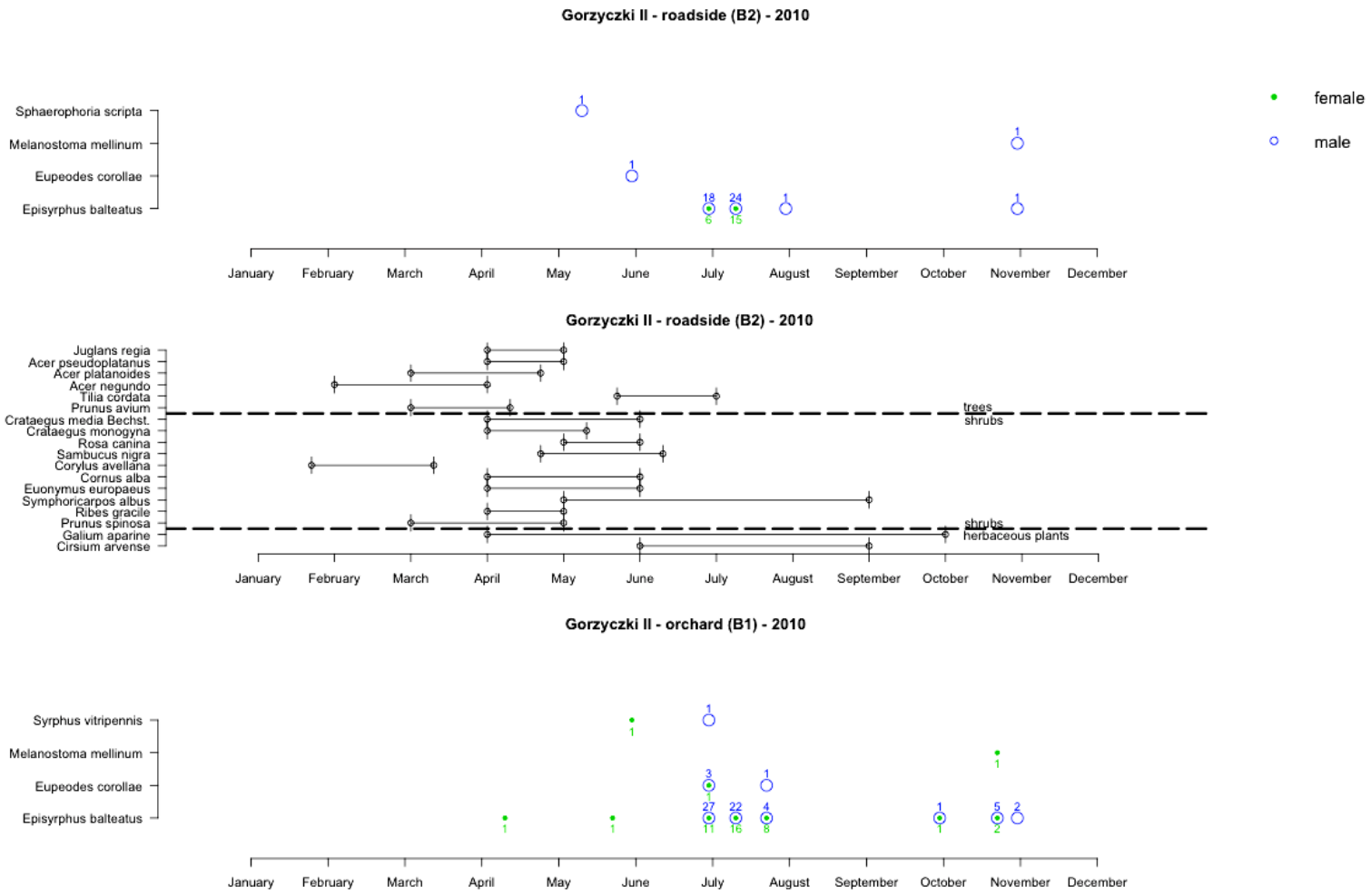


**Fig. 8.** Phenology of occurrence of dominant Syrphidae species in Gorzyczkach II (B1) apple orchard and the roadside (B2) in 2010

The last specimens were recorded in the 3rd ten-day period of October in orchard I and the shrubberies in 2009 and 2010 (figs 4 and 5) and in orchard II and on the roadside in 2010 (fig. 8. They included specimens of both sexes of *E. balteatus* and *E. corollae* and, additionally, a male of *M. mellinum*, caught on the roadside.

In the orchard I in 2008 Syrphidae imagines appeared in the 2nd ten-day period of April and considerably later, i.e. in the 3rd ten-day period of May, in the shrubberies (fig. 3). A mass catch recorded in the 1st ten-day period of July in both habitats. In that period 70 specimens were reported from the orchard (43.2%) and 305 (63.9%) in the shrubberies. In that period a similar abundance of females and males was found in the orchard (36♀, 34♂), while fewer females were reported from the shrubberies (140♀, 165♂). The last specimens were caught in the 2nd ten-day period of October in both habitats.

In orchard II in 2008 the specimens of dominant Syrphidae occurred in the 2nd ten-day period of June (fig. 6), i.e. definitely later than in orchard I (fig. 3). Imagines were found on the roadside in the 3rd ten-day period of May (fig. 6), i.e. the same period as in the shrubberies (fig. 3). A mass appearance was reported in the 1st ten-day period of July in both habitats. Then 121 (50.2%) specimens were found in the orchard, and 221 (50.6%) on the roadside. In the mass catch period similar numbers of females and males were caught in the orchard (59♀, 62♂), while fewer females were caught on the roadside (99♀, 122♂). The last specimens were found in the 2nd ten-day period of October in both habitats.

To sum up, in 2008 the imagines of Syrphidae occurred definitely earlier in the orchard I, and later in the shrubberies and later in the orchard II than the roadside. In the period of mass catch similar numbers of specimens of both sexes were found in the orchards, while on the edges there were more males.

In orchard I in 2009 Syrphidae occurred in the 2nd ten-day period of April and slightly earlier, i.e. the 1st ten-day period of April, in the shrubberies (fig. 4). Mass catch was reported from the 1st ten-day period of July in both habitats, when 272 (34.9%) specimens were caught in the orchard and 341 (49.8%) in the shrubberies. Both in the orchard and the roadside fewer females were caught in this period, as 121♀ and 151♂ were caught in the orchard and 145♀ and 196♂ on the roadside. The last imagines were reported in the 3rd ten-day period of October in both habitats.

In orchard II in 2009 the first Syrphidae were found in the 1st ten-day period of April (fig. 7), i.e. slightly earlier than in orchard I (fig. 4). They appeared on the roadside in the 3rd ten-day period of May (fig. 7), i.e. considerably later than in the shrubberies (fig. 4). Mass catch was recorded in the 2nd ten-day period of July in both habitats. Then the orchard yielded 79 (31.6%), and the roadside 170 (46.3%) specimens. In both habitats definitely fewer females were caught, i.e. 26♀ and 53♂ in the orchard and 59♀ and 111♂ on the roadside. The last imagines were collected in the 2nd ten-day period of October in the orchard and the 1st ten-day period of October on the roadside.

To sum up, in 2009 Syrphidae specimens occurred in the orchard I and shrubberies in similar periods, while they appeared definitely earlier in the orchard II than on the roadside. In the mass catch period males were definitely more numerous in both habitats.

In orchard I in 2010 first Syrphidae imagines were found only in the 3rd ten-day period of May, and definitely earlier in the shrubberies, i.e. in the 1st ten-day period of April (fig. 5). Mass appearance in the orchard occurred in the 1st ten-day period of July, and slightly earlier in the shrubberies: in the 3rd ten-day period of June. The orchard yielded 47 (42.3%), and the shrubberies 49 (54.4%) specimens. In this ten-day period definitely fewer females were caught, as there were 12♀ and 35♂, while on the roadside the numbers of females and males were similar (21♀, 28♂). The last imagines were recorded in the 3rd ten-day period of October in both habitats.

In orchard II first Syrphidae in 2010 occurred in the 1st ten-day period of April (fig. 8), which is clearly earlier than in orchard I (fig. 5). They were found on the roadside in the 1st ten-day period of May, i.e. definitely later than in the shrubberies. The mass appearance in the orchard was in the 3rd ten-day period of June, when 43 (39.8%) specimens were caught in that period definitely fewer females were

caught (12♀ i 31♂). That year only 68 specimens were caught on the roadside, so no mass catch was reported. It was only established that at the break of June and July most imagines were caught. Also in that period definitely fewer females were collected (21♀, 42♂). The last specimens were collected in the 3rd ten-day period of October in both habitats.

To sum up: in 2010 the imagines of Syrphidae appeared in the orchard I definitely later than in the shrubberies and clearly earlier in the orchard II than at the roadside. During mass catch males definitely predominated in both habitats.

Based on an analysis of catch periods for the dominant Syrphidae species in particular study years in the orchards and their edges it was established that:

– first specimens appeared mainly in the 1st or 2nd ten-day period of April in orchards and in the 1st ten-day period of April in the shrubberies and in the 3rd ten-day period of May on the roadside, i.e. definitely later than in the orchards,

– the mass occurrence of imagines was most often in the 1st or 2nd ten-day period of July both in the orchards and on their edges,

– last specimens were mainly caught in the 3rd ten-day period of October in both habitats.

The study showed thus that in spring Syrphidae preferred habitats neighbouring on each other, as they appeared earlier or later in the orchard and roadside, but not at the same time in both habitats. Also in 2008 and 2010 in spring in the orchard and shrubberies a time shift was established in the appearance of Syrphidae imagines in those habitats. The preferences could not be found later on, because mass Syrphidae occurrence happened most often in the same ten-day periods in both habitats. This confirms that imagines moved within the orchard and its edges, without choosing any particular site.

The obtained results indicate that there was a correlation between the appearance of dominant Syrphidae species in the orchards and on their edges, because the period of mass catch most often fell in the same ten-day periods in both habitats.

An analysis of the blooming period of plants forming orchard edges and the occurrence of Syrphidae in the orchards established that it is impossible to determine clearly whether there was a correlation between plant blooming period and the occurrence of Syrphidae in the orchards. The blooming period of the shrubberies edge occurred considerably earlier than a numerous appearance of Syrphidae in the orchard (figs 3, 4 and 5). Most plants finished blooming as early as the beginning of May, except *Rosa canina* and *Sambucus nigra*, which finished soon before the numerous occurrence of imagines in the orchard. More numerous catches of Syrphidae in the orchard were noted from the 3rd ten-day period in June to the 3rd ten-day period of July. Then *Cirsium arvense* and *Galium aparine* bloomed; thus they can be deemed attractive for these entomophages. It was also found that the same time correlations occurred between the blooming of plants in shrubberies and Syrphidae occurrence on them.

The plants on the roadside were more varied. Most plants also finished blooming before a numerous occurrence of Syrphidae in the orchard (figs 6, 7 and 8). Some of them finished blooming soon before a numerous catch of Syrphidae in the orchard, namely *Cornus alba*, *Euonymus europaeus*, *Crataegus* × *media*, *Rosa canina* and *Sambucus nigra*. The imagines appeared in large numbers in the orchard from the 3rd ten-day period of June to the 3rd ten-day period of July. Then the following plants were blooming: *Tilia cordata*, *Symphoricarpos albus*, *Cirsium arvense* and *Galium aparine*. Thus it can be deemed that the blooming period of these plants could have influenced the appearance of imagines in the orchard. The same time correlations were found between the blooming of the roadside plants and the occurrence of imagines in the same spot.

## DISCUSSION

The study conducted in apple orchards and on their edges in 2008–2010 proved the domination of the following 5 predatory Syrphidae species: *Episyrphus balteatus*, *Eupeodes corollae*, *Melanostoma mellinum*, *Sphaerophoria scripta* and *Syrphus vitripennis*. These species also appear numerously in agrocenoses in Poland and Europe.

The domination of *S. scripta*, *E. balteatus* and *M. mellinum* was established by Wnuk et al. [2009] by studying the attractiveness of *Phacelia tanacetifo-*

*lia* Benth. flowers for the predatory Syrphidae in the surroundings of grass, agricultural cultivations and an orchard. Also Wnuk and Gospodarek [1999] as well as Wnuk and Medvey [1986], in their earlier studies of agrocenoses established that *E. balteatus* definitely dominates among entomophages of aphids which infest agricultural cultivations and orchards. Also the studies performed by Wnuk [2004] and Wojciechowicz-Żytko [2004] showed that this species along with *S. scripta* and *S. vitripennis* belong to the complex of predators controling the number of aphids occurring on decorative plants.

Due to *E. balteatus* dominance in orchards this species is included in effective predators of aphids, particularly *Aphispomi* De Geeri *Dysaphi splantaginea* (Pass.) in apple orchards of Poland. These aphids occur on a mass scale and are economically important pests of apple trees. The information on the effectiveness of *E. balteatus* in controlling the orchard aphid abundance in our country was presented in the studies by Wnuk [1972, 1977, 1979] and Wnuk and Medvey [1986]. In apple orchards of Romania the abundance of *Dysaphis devecta* (Walker) and *D. plantaginea* (Pass.) aphids was decreased by predatory Syrphidae, including also *E. balteatus* [Trandafirescus et al. 2004].

Haenke et al. [2009] showed the domination of *E. balteatus* among predatory Syrphidae caught in an agricultural landscape of complex structure in northern Germany, while Sutherland et al. [2001] in marginal habitats of agricultural landscape of central England. Dean [1982] and Chambers et al. [1986] proved that in the agricultural landscape of England it is a definitely dominating species, as its imagines feed nectar and pollen of wild plants which grow on the edges of fields. Wyss [1999] proved clear domination of *E. balteatus* in the complex of aphid predators (Aphidoidea) infesting apple orchards in Switzerland. Also Miñarro and Dapena [2001] established the domination of this species in apple orchards in Spain. On the other hand, Rossi et al. [2006] proved a clear domination of *S. scripts* and *E. corollae* in apple orchards in north-western Italy. Also Solomon et al. [2000] showed *E. balteatus*, *S. scripts* and *E. corollae* are among dominants in apple and plum orchards in North and central Europe.

Studies established a higher attractiveness for Syrphidaeof wild plants of apple orchard edges in comparison with orchards, as more imagines were caught on the edges. The attraction of wild blooming plants for Syrphidaewas showed by Haenke et al. [2009], who found a greaternumber of these entomophages in the belts with blooming flowers than in agricultural cultivations. Studies of the attractiveness of *Phacelia tanacetifolia* Benth. for predatory Syrphidae in agrocenoses were conducted in Poland by Wnuk et al. [2009]. They clearly found that phacelia can be used to attract Syrphidae species which feed on aphids. Also Wojciechowicz-Żytko and Wnuk [2012] determined that cultivating fava bean (*Vicia faba* L.) with phacelia is more attractive for Syrphidae. It lowers the abundance of *Aphis fabae* Scop. in cultivations and the losses caused by this aphid. On the other hand Hurej et al. [2015] found that a mixture of blooming plants attracts useful insects, including Syrphidae, to agricultural cultivations. Also Wyss [1995] proved that Syrphidae particularly attracted by patches of blooming wild plants in the vicinity of apple orchards.

Studies established that in spring Syrphidae preferred neighbouring habitats, i.e. orchards and their edges, which was not showed later on in the vegetation season.

Mass catches of Syrphidae were in the 1$^{st}$ or 2$^{nd}$ ten-day period of July. Also Wnuk et al. [2009] established that the peak catch of Syrphidae on *Phacelia tanacetifolia* Benth. was in the 2$^{nd}$ and 3$^{nd}$ ten-day period of July. The phenology of imagines occurrence depends on weather conditions and can differ in various years. Rossi et al. [2006] stated that mass occurrence of *S. scripts* and *E. corollae* in apple orchards near Turin, Italy, took place in the 2$^{nd}$ ten-day period of June.

The studies showed that the mass catch of imagines in both habitats happened at the same time and proves a correlation between Syrphidae occurrence in orchards and on their edges. This also proves migration of imagines between neighbouring habitats.

The studies showed that *Tilia cordata* (Tiliaceae), *Symphoricarpos albus* (Caprifoliaceae), *Cirsium arvense* (Asteraceae) and *Galium aparine* (Rubiaceae), which grow on apple orchard edges, could

have attracted Syrphidae imagines to the orchards. The usefulness of plants of Apiaceae, Asteraceae, Labiateae, Hypericaceae, Ranunculaceae and Rosaceae families as the source of nectar and pollen for Syrphidae imagines was quoted by Branquart and Hemptinne [2000] and Sadeghi [2008]. Also Souza-Silva et al. [2001] indicated the Asteraceae as a family most frequently visited by Syrphidae. Colley and Luna [2000] indicated Apiaceae and Asteraceae as attractive families for Syrphidae. Also Wnuk and Gut [1994] proved the Apiaceae as attracting Syrphidae, while Wnuk and Wojciechowicz-Żytko [1991] indicated the Brassicaceae family. Kelm et al. [2009] found that Syrphinae representatives most frequently and numerously visited the flowers of Lamiaceae family among herbacerous plants.

## CONCLUSION

The phenology of occurrence of imagines of dominant predatory Syrphidae species in apple orchards and on their edges was strongly correlated. This proves that Syrphidae move between these habitats. Wild plants of orchard edges, particularly the plants of Asteraceae andRubiaceae families attracted Syrphidaeand thanks to that positively affected the occurrence of these entomophages in apple orchards. In spring the occurrence of Syrphidae in orchards was determined rather by blooming trees and shrubs, while in summer – by blooming herbaceous plants.

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