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Test flights of meadow communites by *Apidae* insects

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Abstract. The performed investigations were carried out on meadow complexes situated in the region of Wielkopolska recognised for its long traditions of meadow management and bee-keeping. The results of our investigations and observations show that permanent meadows exhibit sufficient floristic diversity to make them attractive for *Apidae*. However, flights of *Apidae* to visit meadow communities in order to collect nectar vary. The attractiveness of *Cirsium oleraceum* communities is evidently higher than that of *Alopecurus pratensis*, while communities with *Trifolium repens* and *Taraxacum officinale* occupy intermediate positions. All the above-mentioned plant communities are more attractive for *Apoidae* than *Brassica napus* cultivations. In addition, visits paid to individual species of plant communities also vary. *Apoidae* appear to favour in particular the following plant species: *Vicia cracca*, *Trifolium* sp., *Taraxacum officinale*, *Cirsium* sp., *Leontodon autumnalis*, *Melilotus* sp., *Polygonum bistorta*, *Euphrasia rostkoviana* and *Lychnis flos-cuculi*. Another advantage of permanent meadows is the presence in their sward of plants which blossom during the entire period of vegetation. Therefore, if we want to enhance meadow floristic diversity, it is necessary to introduce (by oversowing) into their communities plant species which are visited by *Apidae* most readily. In addition, it can be concluded on the basis of the performed experiments that the *Apoidae* population in our region is very poor and is limited to the following little species: *Apis mellifera, Bombus terrestris* and *B. lapidaries, B. sylvarum, B. pascuorum* and *Halictus* sp.

K e y w o r d s**:** *Apidae,* beekeeping, meadow community, species visiting the community

1. Introduction

Apidae is one of the largest and the most important families in the *Apidea* superfamily. According to modern systematics, this family is made up of 453 species (PRABUCKI, 1998). Populations of different species vary greatly with regard to their numbers. In the case of the European Continent, the most numerous ones are: *Apis mellifera*, *Bombus maculidorsis* and *B. terrestris, B. lapidarius, B. mesomelas*, *B. soroeensis*, *B. confusus*, *B. jonellus*, *B. ruderatus*, *B. humilis, B. veteranus, B.. pomorum, Anthophora pubescens, A. plumipes, A. plagiata, Anthidium manicatum, Megaschile ericetorum, M. rotundata, Osmia rufia, O. mustelina, Hiplitis adunca, Panurgus calaratus, Dasypoda hirtipes*, *Halictus sp*. The existence of *Apidae* is determined by many factors. Chemicalization of agriculture remains one of the leading factors of direct threat. Another important factor is the decreasing area of plants

providing bee nectar flow. Susceptibility of the *Apidae* family to various diseases is also an important factor in this respect. The scope and intensity of influence of the above-mentioned factors vary in individual regions of the world and Europe. Permanent meadows provide an unappreciated and poorly recognised place of collection of the nectar flow. They are characterised by a very diverse and varied plant cover, both with regard to areas occupied by individual communities and the participation of individual plant species in their swards (Wilkaniec *et al*., 1996; Wyłupek and Trąba, 1999; Kaczmarek and Kozłowski, 2008). Poland is becoming increasingly interesting in this regard as one of the countries which did not yield to West-European trends of intensification of fodder production from permanent meadows and many meadow complexes have preserved their floristic diversity. However, important questions arise about how to utilise these complexes and how to use them, (Grzegorczyk and Alberski, 1999; Kozłowski and Swędrzyński, 1998). One of the possibilities of their rational (albeit not forage) utilisation of meadows is to treat them as sources of the nectar flow. However, this leads to another question, namely – what is the current species diversity of the *Apidae* population. The undertaken investigations were to find some answers to the above questions.The objective of our experiments was to try and determine flights made to meadow communities by *Apidae*.

2. Material and methods

The investigations were carried out in years 2004–2006 on five large complexes of permanent meadows in the region called Wielkopolska known for its considerable traditions of meadow and bee-keeping economy. The performed experiments comprised the following basic problems:

- Determination of the floristic variability of meadow communities,
- Determination of the variability of the *Apidae* populations visiting the examined meadow communities.

The point of departure for our investigations was to recognise the plant cover of permanent meadows. The percentage share of individual plants was determined with the assistance of the Klapp (1955) method and sward floristic types were identified. The key developed by Mirek *et al*. (1995) and widely employed in Poland was very helpful for the identification of plant species. Sward floristic composition and the number of species which made it up were determined before each flight observation of plant inflorescences by *Apidae.*

The investigation of the second problem consisted in registering and identification of the *Apidae* species making flights to the communities of permanent meadows. For the *Apidae* species identification, the authors employed the key elaborated by Banaszak (2003). The flight intensity of individual communities as well as individual elements of the sward by the *Apidae* species was determined by marking off permanent micro plots of 1 m^2 area each and carrying out systematic weekly observations throughout the vegetation period, (15.04–15.09). Observations were carried out during mid-day hours (from 10 o'clock in the morning to 3 o'clock in the afternoon). The regularity of the performed observations depended on the weather, which always had to be dry and warm. In the case

of bad weather, observations were moved to the next day. During the entire vegetation season, the total of 25 observations was carried out of bee visits to each community and each of its elements. Throughout the period of observations, air temperature was measured every hour using for this purpose a liquid thermometer placed about 20 cm above the sward.

3. Results and discussion

The objects of investigations included permanent meadows of varying sward species composition which was apparent both in the number of plant species and their percentage proportion in the sward. The dominant species or a group of species were taken as the basis of the identification of a floristic type. In the discussed paper, four sward floristic types considered as the most representative (Tab. 1) were selected from among 20 types which are found to occur in permanent meadows of this region of our country. The sward of all the examined communities should be considered as multi-species. However, the number of plant species identified in the sward of individual communities was not too high and fluctuated in the interval from 15 to 33, whereas the proportion of individual species in the community varied greatly and ranged from trace quantities to dominant ones. It should be mentioned here that in the list of species in Table 1, apart from the dominant species, there are also those which can be described as attractive for *Apidae* flights. The performed analysis of the research results in this area and their comparison with literature data (KRYSZAK, 2001) make it possible to conclude that meadows situated in the region of Wielkopolska are characterised by such floristic diversity which make them attractive for their non-fodder utilisation, including the collection of nectar and pollen.

The objective of the performed faunistic investigations was to recognise *Apidae* species which make flights to meadow communities. The sward of all the examined communities was visited by a small number of species – maximally by 5 species. Each community was visited by *Apis mellifera* as well as by *Bombus terrestris* and *Bombus lapidarius*, while some communities were also visited by other species of *Apoidae*. So, for example, the community with *Cirsium oleraceum* situated on wet sites was also visited by *Bombus pascuorum* and *Bombus sylvarum*, while *Halictus*. sp. was found present only in communities with z *Alopecurus pratensis* and *Taraxacum officinale.* The above remarks also refer to the communities presented in Tables 2–4.

When analysing the actual state of the *Apoidae* species visiting all the examined meadow communities in our region, it can be stated that they were very meagre and *Osmia rufia* presence was observed only sporadically. This finding corresponds well with the reports of other researchers from various regions of Poland and Europe. The list of species visiting meadow communities is similar to that visiting agricultural or horticultural crop plants.

Table 1. Characterisation of selected meadow communities and *Apoidae* species visiting them

Name of the meadow community	Number of species in sward	Share of dominating and accompanying plant species in the sward (%)	Species visiting the community
Community with *Trifolium repens*	28	*Trifolium repens* – 25 *Trifolium pratense* – 9 *Potentilla anserina* – 9 *Lotus corniculatus* – 6 *Trifolium dubium* – 4 *Poaceae* – 15	*Apis mellifera* *Bombus terrestris* *Bombus lapidarius*
Community with *Cirsium oleraceum*	15	*Cirsium oleraceum* – 25 *Cirsium palustre* – 8 *Urtica dioica* – 6 *Lythrum salicaria* – 4 *Valeriana officinalis* – 3 *Phragmites australis* – 12 *Poaceae* – 10	*Apis mellifera* *Bombus terrestris* *Bombus lapidarius* *Bombus pascuorum* *Bombus sylvarum*
Community with *Taraxacum officinale*	24	*Taraxacum officinale* – 25 *Potentilla* sp. – 10 *Achillea millefolium* – 3 *Plantago* sp. – 3 *Bellis perennis* – 1 *Caltha palustris* – 1 *Poaceae* – 25	*Apis mellifera* *Bombus terrestris* *Bombus lapidarius* *Halictus* sp.
Community with *Alopecurus pratensis*	33	*Alopecurus pratensis* – 13 *Lychnis flos-cuculi* – 10 *Centaurea jacea* – 6 *Taraxacum officinale* – 6 *Cirsium sp.* – 6 *Mentha* sp. – 5 *Plantago* sp. – 4 *Ranunculus* sp. – 2 *Myosotis scorpioides* – 2 *Poaceae* – 20	*Apis mellifera* *Bombus terrestris* *Bombus lapidarius* *Halictus* sp.

Table 2. Visits made to the community by *Apidae* – year 2004

Community with	Temperature of air during observation	Number of insects per 1 m^2 in one minute	
		Apis mellifera	*Bombus sp.*
Trifolium repens	20.2	9.11	0.09
Cirsium oleraceum	18.6	5.22	3.11
Taraxacum officinale	19.1	4.75	1.25
Alopecurus pratensis	19.3	3.25	3.25
$LSD_{\alpha = 0.05}$		0.872	0.409

Table 3. Visits made to the community by *Apidae* – year 2005

Community with	Temperature of air during observation	Number of insects per 1 m^2 in one minute	
		Apis mellifera	*Bombus sp.*
Trifolium repens	18.3	6.63	0.07
Cirsium oleraceum	19.2	8.35	10.90
Taraxacum officinale	16.6	7.86	2.33
Alopecurus pratensis	16.2	5.55	1.75
$LSD_{\alpha = 0.05}$		0.536	0.611

Table 4. Visits made to the community by *Apidae* – year 2006

Community with	Temperature of air during observation	Number of insects per 1 m^2 in one minute	
		Apis mellifera	*Bombus sp.*
Trifolium repens	18.3	8.75	2.84
Cirsium oleraceum	19.5	4.90	6.45
Taraxacum officinale	17.5	4.24	0.75
Alopecurus pratensis	16.8	1.75	4.33
$LSD_{\alpha = 0.05}$		1.113	0.847

One of the reliable measures of the sward attractiveness of a given plant community as the source of bee nectar flow is the number of insects visiting it in a unit of time. This correlation was presented with reference to 4 communities (Tab. 2–4). The number of insects visiting a community varied. In the case of *Apis mellifera*, it fluctuated in the interval of 2 to 9 individuals, whereas in the case of the *Bombus* sp. – from 0 to 11. It is worth emphasising that some communities were favoured by *Apis* or by *Bombus*. It is also interesting to quote here the results of investigations on *Brassica napus* L. (JABŁOŃSKI, 1998) who reported that during one minute the above-mentioned plant species growing on the area of 1 m^2 was visited, on average, by 4.25 insects, with fluctuations ranging from 0 to 9.5 *Apis mellifera*.

Differences in the number of flights can undoubtedly be attributed to individual components of plant communities. The results of our observations of all communities make it possible to conclude that such plant species as: *Vicia cracca*, *Trifolium* sp., *Taraxacum officinale, Cirsium* sp., *Leontodon autumnalis*, *Melilotus* sp., *Polygonum bistorata* and *Euphrasia rostkoviana,* were visited by insects very readily, whereas such plant species as: *Hypericum perforatum*, *Agrimonia eupatoria* and *Stachys palustris*, were visited reluctantly or even omitted. However, the opinion that – the more varied the sward floristic composition is, the more insects visit it – needs to be verified.

The attractiveness of meadow communities and plant species growing there were referred to specific species from the *Apidae* and *Bombus* genera. When analysing this problem, we took under consideration different lengths of tongues of the above-mentioned insects and the different flower structure of visited plants as this influenced the availability of the nectar.

There is no doubt that weather conditions exert a distinct impact on the flight intensity of plant communities by the *Apidae*. Observations described in the Methodology were carried out during warm and sunny weather, hence the effect of this factor on flight intensity was minimised.

4. Conclusions

The results of our investigations and observations indicate that permanent meadows exhibit such sward floristic diversity which makes it attractive for the *Apidae*. Nevertheless, visits that these insects pay to meadow communities vary considerably. The attractiveness of *Cirsium oleraceum* communities is distinctly greater in comparison with *Alopecurus pratensis*, while communities with *Trifolium repens* and *Taraxacum officinale* occupy an intermediate place in this regard. All the above-mentioned communities are more attractive for the *Apidae* than *Brassica napus* cultivations. An important advantage of permanent meadows is the fact that insects can find in their swards plants that blossom during the entire vegetation season. In order to enhance meadow floristic diversity, it is necessary to introduce (by oversowing) into their communities plant species which are visited by *Apidae* most readily. In addition, it can be concluded on the basis of the performed experiments that the *Apidae* population in our region is very poor and is limited to the following little species: *Apis mellifera, Bombus terrestrism, B. lapidarius, B. sylvarum, B. pascuorum* and *Halictus* sp.

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Oblatywanie przez pszczołowate zbiorowisk łąkowych

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Streszczenie

Prace badawcze prowadzono na kompleksach łąkowych regionu Wielkopolska, który posiada duże tradycje gospodarki łąkowej oraz pszczelarstwa. Wyniki naszych badań i obserwacji wskazują, że łąki trwałe wykazują różnorodność florystyczną runi na takim poziomie, który czyni ją atrakcyjną dla *Apidae*. Oblatywanie zbiorowisk łąkowych przez *Apidae* jest jednak zróżnicowane. Atrakcyjność zbiorowisk z *Cirsium oleraceum* jest wyraźnie większa niż z *Alopecurus pratensis*. Miejsca pośrednie zajmują zbiorowiska z *Trifolium repens* i z *Taraxacum officinale*. Wszystkie te zbiorowiska są dla *Apidae* bardziej atrakcyjne niż uprawy *Brassica napus*. Zróżnicowane jest także oblatywanie poszczególnych gatunków zbiorowisk. *Apidae* szczególnie faworyzują *Vicia cracca*, *Trifolium* sp., *Taraxacum officinale, Cirsium* sp., *Leontodon autumnalis*, *Melilotus* sp., *Polygonum bistorta*, *Euphrasia rostkoviana.* Atutem łąk trwałych jest także obecność w runi roślin kwitnących przez cały okres wegetacji. Dla zwiększenia różnorodności florystycznej łąk zasadne jest wprowadzanie, poprzez podsiew, gatunków roślin najchętniej oblatywanych przez *Apidae.* W świetle naszych badań i obserwacji można również stwierdzić, że populacja *Apidae* w sferze gatunkowej jest w naszym regionie uboga i ogranicza się niewielkiej liczby gatunków *Apis mellifera, Bombus terrestris, B. lapidarius, B. sylvarum, B. pascuorum* oraz *Halictus* sp.

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