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## Flower visitation patterns of butterflies and burnet moths in the Aggtelek-Karst (Hungary)

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**Summary.** The article is based on the results of a series of observations in the Aggtelek-Karst (northern Hungary) over several years. The plant species in the survey area, the butterfly species visiting these plants and the number of visits are recorded.

**Zusammenfassung**. Der Aufsatz arbeitet eine Beobachtung-Serie von mehr Jahre aus, die wir an dem Berg Aggteleki-karszt (Nordhungarien) gemacht haben. Wir haben an dem herauswählenden Gelände die Schmetterlingbesucher, beziehungsweise die Zahl der Besuchung registriert.

**Résumé.** L'article est basé sur les résultats d'une série d'observations faites dans la région karstique d'Aggtelek (nord de la Hongrie), étalées sur plusieurs années. Les espèces végétales de la région étudiée, les espèces de papillons visitant ces plantes et le nombre de visites sont enregistrés.

Key words: Butterflies, plants, flower visits, nectar supply, pollination, Hungary.

### Introduction

Observations during several years can generate an important information about the plants of a given survey area, the composition of its butterfly fauna, as well as diversity and changes in diversity within the area. Every population is part of a community. Regarding the population of pollinators and the plants visited by them, the quality and quantity of resources (i.e. nectar producing plants) used is determined by the presence of nectar producing plants (Gonseth, 1992). Flowering plants should ensure the energy requirements of visitors. Visitors search for the most suitable sources, and their choice for a flower is dependent on many factors, such as:

- The size of the population of flowering plants. If this is not large enough there will not exist a stable pollination system (Vogel & Westerkamp, 1991);
- The colour, smell, shape etc. of the flower (Harborne, 1982);
- The position of nectary, thus the accessibility of nectar.

#### Methods

The study area is the Aggtelek-Karst (northern Hungary, 48° 28' 36" N, 20° 33' 38" E). The surveys were carried out between 1990 and 1994, during each July, every day between 8 a.m. and 6 p.m., because flower visitors are most active during this time (Gonseth, 1992; Olesen & Warncke, 1989). The flora of the area can be described as Polygalo-Brachypodetum and Caricetum humilis in the group of Cirsio-Brachypodion association. Dominant species in this area are for example: Dorycnium germanicum, Coronilla varia, Teucrium chamaedrys, T. montanum, Salvia verticillata, Stachys recta, Centaurea scabiosa, Inula salicina, I. ensifolia, Carex humilis etc. With the strating bordering, rimming (Versaumung), Brachypodium pinnatum, Carex montana and sprouting dicotyledons covering as much as 50% in patchwork. There are several important and protected species, such as Dracocephalum austriacum, Adonis vernalis, Centaurea triumfetti, Polygala major, Cirsium pannonicum, Cytisus procumbens etc. The original climax vegetation here must have been Querco-Carpinetum and Corno-Quercetum, and larger or smaller areas of these plant associations can still be found in many places in similar situations.

#### **Results and discussion**

Table 1 gives a list of selected plant species visited by butterflies in the Aggtelek-Karst. Visited plants are arranged in 5 columns by the number of contacts: the first four contain the species of the main four families while the fifth gives plant families, some species of which were rarely visited. We have examined, regarding all of the contacts, if there were annual differences in the visits to the different plant families and in the number of butterfly visits. The results show that there are significant differences in both. (Plant families: ANOVA,  $F_{[4,20]} = 4.43$ , p = 0,01; butterfly families: ANOVA,  $F_{[4,20]} = 2.87$ , p = 0,01).

Forty-one plant species were used by the butterflies in the Aggtelek-Karst. Table 2 shows the 10 most frequently visited plant species in decreasing order. At the same time these plants are the most abundant in the study area, especially the first four

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Thymelicus lineola (Ochsenheimer, 1808)	Inula ensifolia 6 Achillea millefolium 1 Cerchus accompation 1	Cytisus albus 2	Knautia arvensis 1		Linum hirsutum 6
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<i>Hesperia comma</i> (Linnaeus, 1758)	Centaurea scabiosa 2 Inula ensifolia 9 I. hirta 7 Carduus acanthoides 26		Knautia arvensis 4	Betonica officinalis 3	
Ochlodes venata (Bremer & Grey, 1853)	Centaurea scaptosa 1 Anthemis tinctoria 1 Cartaura acanthoides 21 Cartaurea scarbiosa 7	Cytisus albus 3 Medicago lupulina 1	scapiosa ochroleuca 4 Knautia arvensis 5 Scabiosa ochroleuca 9	Betonica officinalis 4	Convolvulus arvensis l
	Critatarca scarosa 1 Chrysanthemum corymbosum 1 Cirsium arvense 1 Inua ensifolia 23				
Iphiclides podalirius (Linnaeus, 1758)	L. nuta 5 Carduus acanthoides 25 Cantairea continea 1				Echium vulgare 1 Somburne abrilie 3
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Pieris brassicae (Linnaeus, 1758)	Cirsium arvense 2 Carduus acanthoides 8		Scabiosa ochroleuca 2	Salvia officinalis 1	Chenopodium vulgare 1
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Origanum vulgare 5	Mentha aquatica 3 Origanum vulgare 1	Betonica officinalis 2 Origanum vulgare 7		Salvia verticillata 1	Origanum vulgare 1	Origanum vulgare 1	Salvia verticillata 1	Origanum vulgare 3	Saambucus ebulus 30
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P. rapae (Linnacus, 1758)	Pontia dapildice (Linnaeus, 1758) Lycaena dispar (Haworth, 1802) L. virgaureae (Linnaeus, 1758)	L. tityrus (Poda, 1761) Callophrys rubi (Linnaeus, 1758) Satyrium w-album (Knoch, 1782) S. spini ([Denis & Schiffermüller], 1775)	S. acaciae (Fabricius, 1787)	Cupido minimus (Fuessly, 1775) C. argiades (Pallas, 1771) C. alcetas (Hoffmannsegg, 1804) Plebeius argus (Linnaeus, 1758)	P. idas (Linnaeus, 1761)	P. argyrognomon (Bergsträsser, 1779) Aricia artaxerxes (Fabricius, 1793) Polyommatus icarus (Rottemburg, 1775)	Meleageria bellargus (Rottemburg, 1775)	M. coridon (Poda, 1761)	Argynnis paphia (Linnaeus, 1758)

LEPIDOPTERA	ASTERACEAE	FABACEAE	DIPSACACEAE	LABIATAE	OTHER
A. adippe ([Denis & Schiffermüller], 1775)	Carduus acanthoides 13			Mentha aquatica 11	Sambucus ebulus 11
A. niobe (Linnaeus, 1758)	Centaurea scabiosa 3 Carduus acanthoides 23 Centaurea scabiosa 1 Cirsium arvense 1				
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Boloria dia (Linnaeus, 1767)	Inula ensifolia 5		Knautia arvensis 3 Scahiosa ochroleuca 2		
Meliaea didyma (Esper, 1778)	Anthemis tinctoria 1 Carduus acanthoides 2 Centaurea scabiosa 22 Greium arvense Inula ensifolia 28	Dorycnium germanicum 1	Krautia arvensis 1 Scabiosa ochroleuca 4	Salvia verticillata 3	Dianthus pontederae 4 Erystum odoratum 1 Teucrium chamaedris 1
<i>M. aurelia</i> Nickerl, 1850	Achiller millefolium 1 Centaurea scabiosa 6 Chrysanthemum corymbosum 2 Inula estifolia 64	Coronilla varia 3 Dorycnium germanicum 20 Trifolium pannonicum 9	Knautia arvensis 11	Salvia verticillata 5 Dianthus pontederae 2	Cynanchum vincetoxicum 6
M. britomartis Assmann, 1847	Achillea millefolium 1 Centaurea scabiosa 6 Chrysanthemun corymbosum 3 Girsium arvense 2 Imule artifolia 47	Dorycnium germanicum 12 Trijolium rubens 1	Krautia arvensis 9 Scabiosa ochroleuca 1		Cynanchum vincetoxicum 1 Dianthus pontederae 1
M. athalia (Rottemburg, 1775)	Achillea millefolium 3 Achillea millefolium 3 Anthemis tinctoria 4 Centaurea scabiosa 11 Cirsium arverse 3 Inula essiyolia 78	Coronila coronata 4 Dorycnium germanicum 1 Trifolium pannonicum 10	Krautia arvensis 16 Scabiosa ochroleuca 1	Origanum vulgare 4 Salvia verticillata 3	Cynanchum vincetoxicum 2
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		Dianthus pontederae 2	Convolvulus arvensis 1 Dianthus pontederae 8 Helianthemum ovatum 1 Sambucus ebulus 25	Cynanchum vincetoxicun 1 Dianthus pontederae 9	Sambucus ebulus 2		Dianthus pontederae 1			Dianthus pontederae 1	Dianthus pontederae 1
Betonica officinalis 3 Mentha aquatica 9	Salvia verticillata 1	Betonica officinalis 2	Betonica officinalis 5 Mentha aquatica 15 Origanum vukgare 9 Salvia verticillata 1	Veronica officinalis 1	Mentha aquatica 1	Origanum vulgare l	Origanum vulgare 1	Salvia verticillata 2	Salvia verticillata 1	Betonica officinalis 2 Origanum vulgare 2	Betonica officinalis 3
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Coenonympha arcania (Linnaeus, 1761)	C. glycerion (Borkhausen, 1788)	Coenonympha sp. C. pamphilus (Linnaeus, 1758) Aphantopus hyperantus (Linnaeus, 1758)	Maniola jurtina (Limiaeus, 1758)	Melanargia galathea (Linnacus, 1758)	Minois dryas (Scopoli, 1763)	Amata phegea (Linnaeus, 1758)	Zygaena purpuralis (Brünnich, 1763)	Z. carniolica (Scopoli, 1763)	Z. viciae ([Denis & Schiffermüller], 1775)	Z. filipendulae (Linnacus, 1758)	Z. lonicerae (Scheven, 1777)

Table 2. Relative frequencies of visit	its on the different plant species (prf) and	
number of visiting butterfly species /	visits on the different plant species (pv/vp)	

Most frequently visited plants	prf	pv/vp
<ol> <li>Inula ensifolia</li> <li>Centaurea scabiosa</li> <li>Carduus acanthoides</li> <li>Knautia arvensis</li> <li>Cirsium arvense</li> <li>Inula hirta</li> <li>Sambucus ebulus</li> <li>Scabiosa ochroleuca</li> <li>Mentha aqutica</li> <li>Dorycnium germanicum</li> </ol>	$\begin{array}{c} 0.33\\ 0.257\\ 0.129\\ 0.0826\\ 0.0375\\ 0.0342\\ 0.0334\\ 0.0297\\ 0.026\\ 0.0252\end{array}$	$\begin{array}{c} 0.045\\ 0.058\\ 0.075\\ 0.133\\ 0.206\\ 0.155\\ 0.097\\ 0.26\\ 0.109\\ 0.177\\ \end{array}$

(Inula ensifolia, Centaurea scabiosa, Carduus acanthoides, Knautia arvensis). This fact has a significant effect on food searching behaviour of butterflies. Colours of the plants mentioned above are mostly lilac or purple and, more rarely, yellow or white. These data agree with our knowledge concerning the colour selectivity of insects (Harborne, 1982; Jolivet, 1986). Besides, these plants are robust and tall, which could also have importance for foodrecognition of insects (Porter et al., 1992). Table 2 shows the relative frequencies of visits on the different plant species (prf) and the ratio of the number of the visiting butterflies to the number of the visits on the different plant species. These values (pv/vp) show how many butterfly species were responsible for the contacts. Thus, for example, on Cirsium arvense and Scabiosa ochroleuca fewer visits were paid by more butterfly species, and on the first three plant species more visits were paid by fewer butterfly species.

The family Asteraceae dominated throughout the survey period (over 50% in every year), especially in 1991 (87.4%) and 1994 (79.46%). This is the most species-rich plant group — they are present on almost all continents and habitats. Thus, they provide enough food for numerous flower visitors. Their lack or decrease in the area would substantially affect species composition of the insects.

Changes in flower visits were identified at family level between 1990 and 1994. In 1990, species of Nymphalinae were the main flower visitors while in 1994, by a gradual process, the Satyrinae had become main visitors. Regarding the vegetation of the study area the main feature is the expansion of Brachypodium pinnatum, which surpasses that of important nectar-producing plants. This phenomenon can provide explanation for the dominance changes in flower visits mentioned above. Butterflyindication shows clearly the absence or decrease in those plant species that are their main nectar sources. With some exceptions, nectar plant specialisation is not characteristic for butterflies. Although the Asteraceae are the preferred plant family among butterflies, this does not mean that other plant families are not visited by them. The preference for Asteraceae lies in the shape of their inflorescence. The heads of their flowers serve as an appropriate roost for butterflies, and after landing they only have to reach out for nectar. As flower heads (capitulum) of the Asteraceae contain many flowers, the amount of nectar is enough to satisfy the appetite of visitors. Nectary is usually present at the base of the flower, at the base of the style or between the pistil and stamen. The shape of butterflies prevents them from climbing into the flower as in the case of bees.

Regarding the butterfly species, the main visitor was Maniola jurtina (on 21 plant species 726 contacts were registered). Its food plant list observed by us is more or less the same as previously indicated in the literature (Gonseth, 1992; Weidemann, 1995). Ebert & Rennwald (1991) have listed 65 out of 164 plant species known to occur in Baden-Württemberg. In contrast to the Meadow Brown, the Lycaenidae pay the fewest visits. This supports, on one hand, a hypothesis that the quality of the vegetation in the study area has an influence on the presence of butterflies. On the other hand, it is well known that the Lycaenidae prefer fewer nectar-producing plants. Most species of this butterfly family occupy a large range and can be found in many kinds of plant associations. In contrast to this, there are many species among the Lycaenidae and Nymphalinae that are more confined to plant associations. Thus, the disappearance of important food sources could affect their distribution pattern. Choice of food plants by butterflies depends on different factors. Thus, for example, Melanargia galathea chooses plants with lilac or purple flowers, species of Papilionidae (Iphiclides podalirius) and Nymphalinae (Argynnis paphia, A. adippe, A. niobe, Issoria *lathonia*) prefer robust plants overhanging the vegetation cover in their habitat (*Centaurea scabiosa, Carduus acanthoides*, etc.).

#### Conclusions

Several plant species can be ranked as food plants (nectar sources) of butterflies. An important factor is the availability of plants in a given area. The continuous — year by year — presence of these plant species also has certain effects on the pollinatorpopulation. We cannot find a unified methodology to explain the food plant choice of butterflies. Depending on the circumstances, these insects prefer the different food sources. That is why it is so important to take into consideration their indicative role, they can be pollinators only when the food plant is present.

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