APIS

Original Research

Analysis of Pollen Samples from Hungary Based on the INSIGNIA 2023 Programme

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ABSTRACT

In 2023, under the INSIGNIA-EU project, pollen samples were collected across 315 locations in 27 European Union countries over nine sampling rounds. In Hungary, 15 apiaries from different geographic regions participated in the nine sampling rounds. However, two apiaries were unable to collect samples during certain rounds, resulting in a total of 133 domestic samples being analysed and evaluated. The Hungarian baseline data allows for further and more detailed analyses at both the national level and by individual apiary, sampling period, and plant species. Apiaries from more than half of Hungary's 19 counties—specifically, from 10 counties and the capital—contributed to the INSIGNIA 2023 programme.

Across the 15 apiaries and nine sampling rounds, 173 plant species were identified in the samples collected by bees. The number of species ranged from 36–60 per apiary and 22–69 per sampling round. A smaller proportion of these species were common across multiple apiaries. The maximum number of shared species per apiary was 13–16, and the minimum was 3–7. Similarly, during sampling periods, the maximum number of shared species was 10–16, and the minimum was 3–11. Of the 173 plant species identified, 133 provided nectar and 40 were nectarless species producing only pollen. Bees predominantly collected from nectariferous plants. In total, 31 species were common to all the apiaries, of which 19 provided nectar and 12 were nectarless.

The most frequently occurring species across all 15 apiaries included nectariferous cultivated agricultural plants such as *Brassica napus*, *Brassica rapa*, *Helianthus annuus*, and the nectarless herbaceous wild plant *Plantago lanceolata* (NN). These plant species included both short- and long-blooming varieties. By sampling period, the most frequently visited species were *Chelidonium majus* (NN), *Plantago lanceolata* (NN), *Trifolium repens*, and *Papaver rhoeas* (NN). Within specific sampling periods, the highest quantities were observed for *Brassica napus*, *Anthriscus cerefolium*, *Helianthus annuus*, *Papaver rhoeas* (NN), *Plantago lanceolata* (NN), *Robinia pseudoacacia*, and *Clematis vitalba* (NN).

The plant species collected in the largest quantities varied by apiary:

- *Raphanus raphanistrum* (Békéscsaba)
- *Phacelia tanacetifolia* (Nagykovácsi)
- *Plantago lanceolata* (NN) (Budafok, Újszentmargita, Drávafok, Nemesvita)
- *Papaver rhoeas* (NN) (Zámoly, Pannonhalma, Páhi, Fertőendréd)
- *Papaver somniferum* (NN) (Mezőfalva)
- *Brassica napus* (NN) (Vizsoly, Murakeresztúr)
- *Helianthus annuus* (Szalánta)
- *Ononis spinosa* (Kiskunmajsa).

Significant plant species included *Brassica napus*, *Plantago lanceolata* (NN), *Helianthus annuus*, *Papaver rhoeas* (NN), *Clematis vitalba* (NN), *Anthriscus cerefolium*, *Ononis spinosa*, *Phacelia tanacetifolia*, *Solidago gigantea*, and *Trifolium repens*. Among species occurring in only one apiary, some were specific indicators of local regions, while others were cultivated agricultural plants potentially grown elsewhere, such as *Amorpha fruticosa*, *Ballota nigra*, *Castanea sativa*, *Centaurea cyanus*, *Chelidonium majus* (NN), *Crepis setosa*, *Hypericum perforatum* (NN), *Lythrum salicaria*, *Melilotus albus*, *Papaver rhoeas* (NN), *Pisum sativum*, *Raphanus sativus var. oleifera*, *Sanguisorba officinalis* (NN),

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Sinapis alba, and *Tripleurospermum maritimum* (likely *Matricaria chamomilla*).

Regionally, in 2023, the Southern Great Plain (Dél-Alföld) region's three apiaries recorded the lowest number of plant species, while the highest diversity was observed in the apiaries of the Northern Hungary (Észak-Magyarország) region.

INTRODUCTION

As part of the INSIGNIA-EU project, pollen samples were collected in 2023 across 315 locations in 27 European Union countries during nine sampling rounds. A total of 2,525 viable samples were sent to the designated laboratory in Portugal for evaluation. In Hungary, 15 apiaries from various geographic regions participated in the nine sampling rounds. However, two apiaries were unable to collect samples during certain periods, resulting in a total of 133 samples being submitted for analysis. Each pollen sample contained different coloured pollen pellets, which were brushed off the bees' legs using a pollen trap.

Samples were collected by volunteer beekeepers (citizen scientists, referred to as "CS") according to the detailed guidelines of the monitoring plan, under the leadership of the national coordinator, Dr. János Körmendy Rácz. The samples were collected using pollen traps attached to two hives per apiary. After combining the pollen from the two hives, approximately two teaspoons of the mixture were placed in a sample container with silica gel and an identification label before being sent for analysis.

The botanical identification of the pollen samples submitted by each apiary was carried out using ITS2 metabarcoding at the EU-designated laboratory. According to the INSIGNIA-2023 summary report, the molecular ITS2 metabarcoding method—developed in previous years—was used to identify the botanical composition of the pollen samples. The key steps of this procedure included homogenising a specific portion of the sample, extracting DNA, and amplifying the ITS2 region of nuclear DNA using polymerase chain reaction (PCR). The PCR product was sequenced using the high-throughput Illumina MiSeq sequencing platform. The sequences obtained were compared to a reference ITS2 sequence database developed by INSIGNIA-EU for use by researchers in different countries [1].

For each mixed pollen sample, the laboratory determined the number of plant species present and estimated their relative abundance, which was converted into percentages for ease of interpretation. A purpose-built automated computational analysis system was used to evaluate the sequence data, compare it to the reference database, and calculate the relative abundance of each species.

The number of samples submitted from Hungary was 133, from which the relative abundance values for 1,259 plant taxa were determined. The data were grouped and aggregated at both the national and apiary levels. Tables provided the relative abundance of plant species by apiary and sampling round, while charts illustrated trends, occurrences, and temporal changes in abundance at the plant genus level.

For each sampling round, the relative abundance values did not exceed 1,00. A threshold of 1% (0.01) was applied to filter out genera that appeared only rarely in the samples.

The baseline data for Hungary allow for further and more detailed analysis at the national level, as well as by apiary, sampling period, and plant species. The following section presents the evaluation of the Hungarian data.

SAMPLING LOCATIONS IN HUNGARY

In 2023, 15 apiaries from 11 shires and the capital participated in the INSIGNIA program, representing more than half of Hungary's 19 shires. The pollen samples were collected from apiaries located in the following regions:

- Southern Great Plain (Dél-Alföld): 3 samples
- Northern Great Plain (Észak-Alföld): 1 sample
- Northern Hungary (Észak-Magyarország): 1 sample
- Central Hungary (Közép-Magyarország), including Pest shire: 1 sample
- Central Transdanubia (Közép-Dunántúl): 3 samples
- Western Transdanubia (Nyugat-Dunántúl): 3 samples
- Southern Transdanubia (Dél-Dunántúl): 2 samples
- Budapest (the capital): 1 sample

The distribution of sampling locations is summarised in Table 1, and their geographic locations are visualised in Figure 1 (map created using resources from www.terkepek.net).

SAMPLING PERIODS

In 2023, pollen samples were collected biweekly from early May to the end of August. The collection occurred on a designated day within each specified period, and if the pollen sample was insufficient, additional days were utilised for collection.

SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
may 4-8	may 18-22	june 1-4	june 15-18	june 29-july 2	july 13-16	july 27-30	august 10-13	august 24-27

Table 2: Sampling periods / Sampling rounds

Sampling location	Region	Shire	Geographical area
HU 13 Kiskunmajsa	Southern Great Plain	Bács-Kiskun	Great Plain (Alföld)
HU 14 Páhi	Southern Great Plain	Bács-Kiskun	Great Plain (Alföld)
HU 01 Békéscsaba	Southern Great Plain	Békés	Great Plain (Alföld)
HU 04 Újszentmargita	Northern Great Plain	Hajdu-Bihar	Great Plain (Alföld)
HU 07 Vizsoly	Northern Hungary	Borsod-Abaúj-Zemplén	Great Plain (Alföld)
HU 09 Drávafok	Southern Transdanubia	Baranya	Transdanubia (Dunántúl)
HU 10 Szalánta	Southern Transdanubia	Baranya	Transdanubia (Dunántúl)
HU 05 Zámoly	Central Transdanubia	Fejér	Transdanubia (Dunántúl)
HU 06 Mezőfalva	Central Transdanubia	Fejér	Transdanubia (Dunántúl)
HU 11 Nemesvita	Central Transdanubia	Veszprém	Transdanubia (Dunántúl)
HU 02 Nagykovácsi	Central Hungary	Pest	Transdanubia (Dunántúl)
HU 12 Pannonhalma	Western Transdanubia	Győr-Moson-Sopron	Transdanubia (Dunántúl)
HU 15 Fertőendréd	Western Transdanubia	Győr-Moson-Sopron	Transdanubia (Dunántúl)
HU 08 Murakeresztúr	Western Transdanubia	Zala	Transdanubia (Dunántúl)
HU 03 Budafok	Central Hungary	Pest	Capital/Budapest
All apiaries	7 regions	11 shires	2 geographical areas and the capital city

Table 1: Sampling locations in Hungary

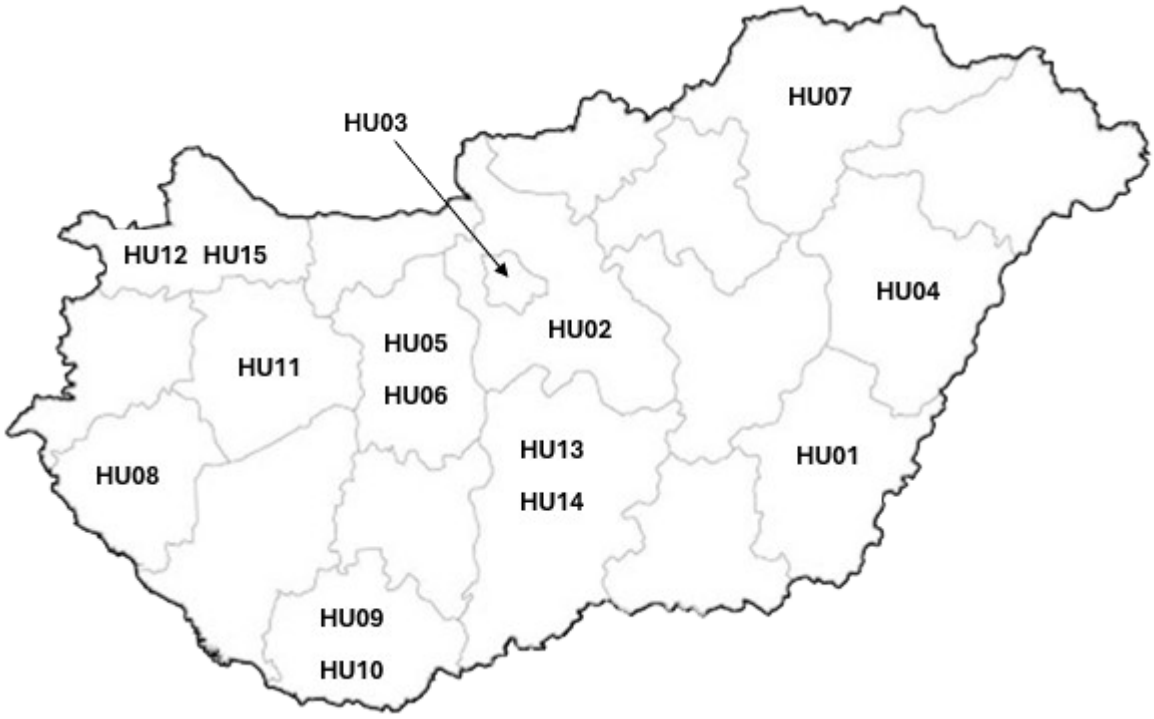

Figure 1: Geographic locations of the apieries in the Shires

HU01: Békéscsaba/Békés Shire
HU02: Nagykovácsi/Pest Shire
HU03: Budafok/Budapest XXII. district
HU04: Újszentmargita/Hajdú-Bihar Shire
HU05: Zámoly/Fejér Shire
HU06: Mezőfalva/Fejér Shire
HU07: Vizsoly/Borsod-Abaúj-Zemplén Shire
HU08: Murakeresztúr/Zala Shire
HU09: Drávafok/Baranya Shire
HU10: Szalánta/Baranya Shire
HU11: Nemesvita/Veszprém Shire
HU12: Pannonhalma/Győr-Moson-Sopron Shire
HU13: Kiskunmajsa/Bács-Kiskun Shire
HU14: Páhi/Bács-Kiskun Shire
HU15: Fertőendréd/Győr-Moson-Sopron Shire

OCCURRENCE OF PLANT SPECIES BY APIARY AND SAMPLING PERIOD

A total of 133 pollen samples from Hungary were analysed for plant origin. The study provided relative frequency values for the plant species found in each apiary during each sampling period. Altogether, 1,259 data points were generated. The analysis below presents the results organised by apiary and sampling period.

Number of species in apiaries by period										Plants identified	SR01-09
Apiary/Period	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09	Per apiary	Species
HU 01 Békéscsaba	7	9	7	4	8	13	11	13	0	72	**43**
HU 02 Nagykovácsi	10	9	4	11	12	10	13	12	11	92	**56**
HU 03 Budafok	6	6	8	6	9	8	13	11	11	78	**46**
HU 04 Újszentmargita	5	8	9	0	12	9	15	15	14	87	**47**
HU 05 Zámoly	7	10	6	6	16	7	9	13	15	89	**52**
HU 06 Mezőfalva	5	4	4	5	10	12	10	16	12	78	**41**
HU 07 Vizsoly	7	10	10	10	10	10	15	16	16	104	**60**
HU 08 Murak-eresztúr	7	7	11	7	13	9	10	8	13	85	**45**
HU 09 Drávafok	9	6	7	12	14	11	9	14	13	95	**57**
HU 10 Szalánta	9	5	9	7	9	9	11	11	13	83	**45**
HU 11 Nemes-vita	4	14	11	9	11	12	10	12	14	97	**51**
HU 12 Pannonhalma	7	6	12	7	8	12	11	15	12	90	**46**
HU 13 Kiskunmajsa	6	7	5	5	4	10	13	9	11	70	**38**
HU 14 Páhi	4	9	5	5	4	3	6	8	13	57	**36**
HU 15 Fertőendréd	10	8	6	6	8	11	6	11	16	82	**45**
Identified plants	103	118	114	100	148	146	162	184	184	1259	
species	**22**	**44**	**38**	**42**	**48**	**46**	**62**	**69**	**69**		

Table 3: Occurrence of plant species in apiaries and periods;
Number of apiaries: 15; number of samples: 133; Total species count: 173
During each sampling period, we marked the apiary showcasing the highest number of species by highlighting its background.

IDENTIFIED PLANT SPECIES AND VARIATIONS BY APIARY AND SAMPLING PERIOD

The number of identified plant species varied by apiary and sampling period, as summarised in Table 3, and visual representation Figure 2 and Figure 3.

Figure 2 shows the number of identified plants and species per apiary. Both values are the lowest in the Páhi apiary and the highest in the Vizsoly apiary.

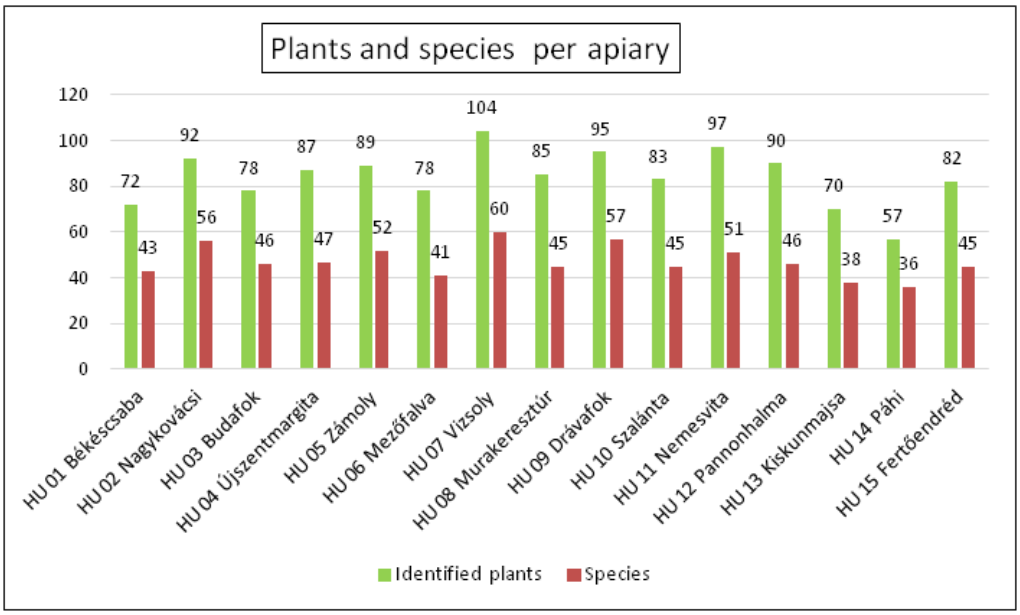

Figure 2: Number of identified plants and species per period (a visual representation of the last two columns of Table 3).

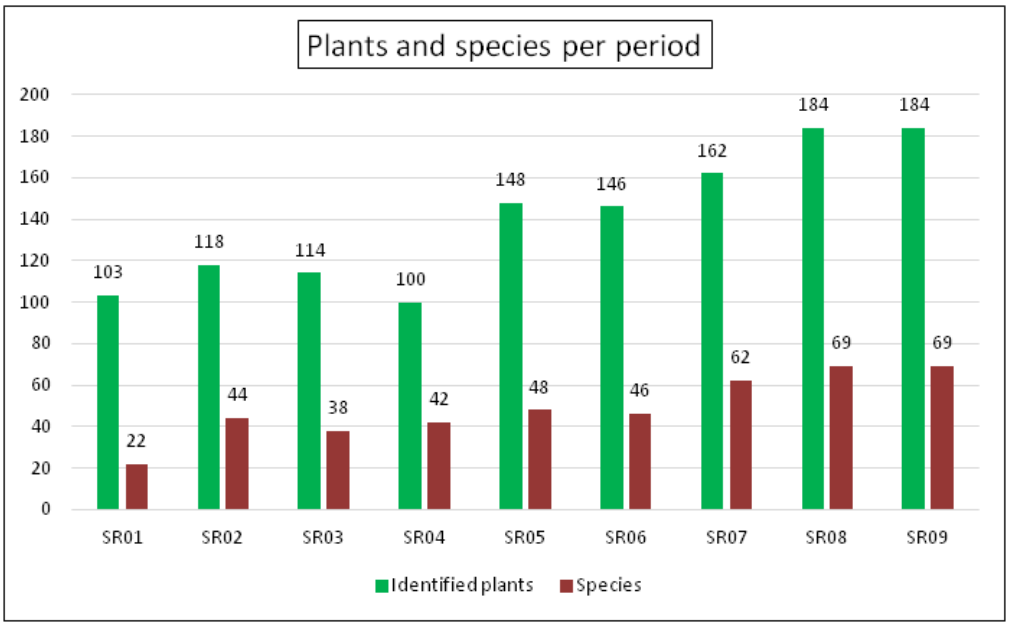

Figure 3: The number of plants and species identified per period (A visual representation of the last two rows of Table 3)

The number of identified plants per apiary is the simple sum of the plants identified during each sampling period for that particular apiary. However, the same plant species may appear in multiple sampling periods for a given apiary. Therefore, the number of species represents the total number of different plant species from which bees collected pollen during sampling periods 1–9.

In each sampling column (SR01–SR09), we highlighted the apiary where the highest number of species was identified during that specific sampling period. It is noteworthy that Vizsoly ranked at the top in three samplings, with 15 and 16 identified species, respectively.

Certain plant species were present in one or more periods within the individual apiaries, resulting in a total of 173 species identified in the Hungarian samples. The number of plant species per apiary varied, ranging between 36 and 60 /Figure 4/.

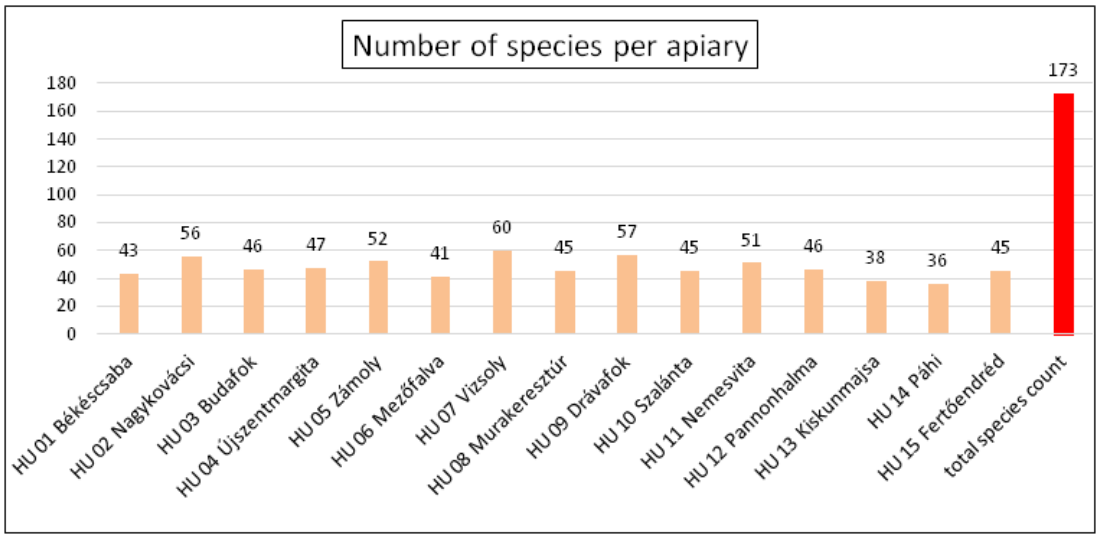

Figure 4: Number of plant species per apiary and the total species count.

The number of plant species during the sampling periods was lowest in the first period of May, with 22 species, and highest in the late summer–early autumn periods, exceeding 60 species /Figure 5/.

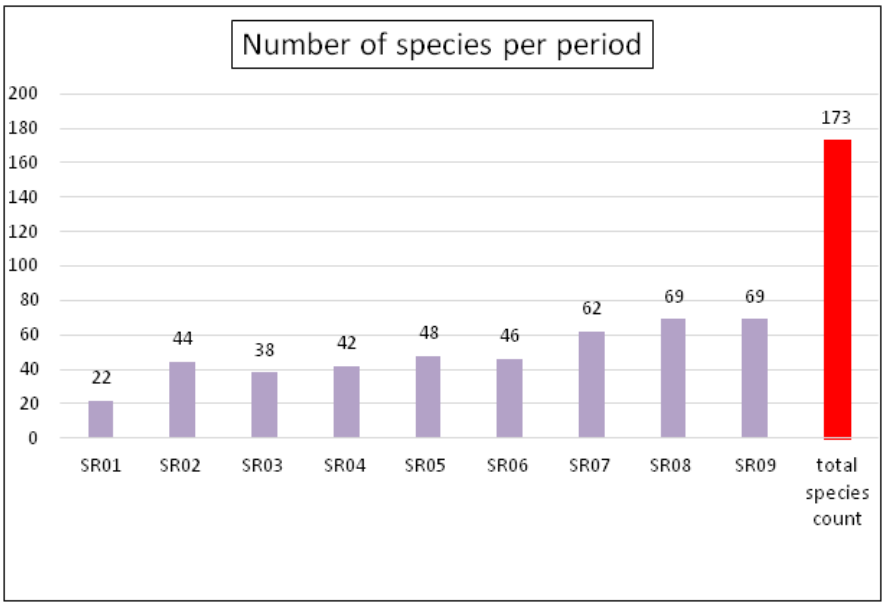

Figure 5: Number of plant species per period and the total species count.

The variability in the number of identified plant species across apiaries and sampling periods is illustrated in the graph below. In 2023, the pollen collection showed the least variability in Páhi, located in Bács-Kiskun Shire, while the highest variability was observed in Vizsoly, located in Borsod-Abaúj-Zemplén Shire. Additionally, pollen collection was highly variable in nine other apiary areas, while it showed lower variability in four locations /Figure 6/.

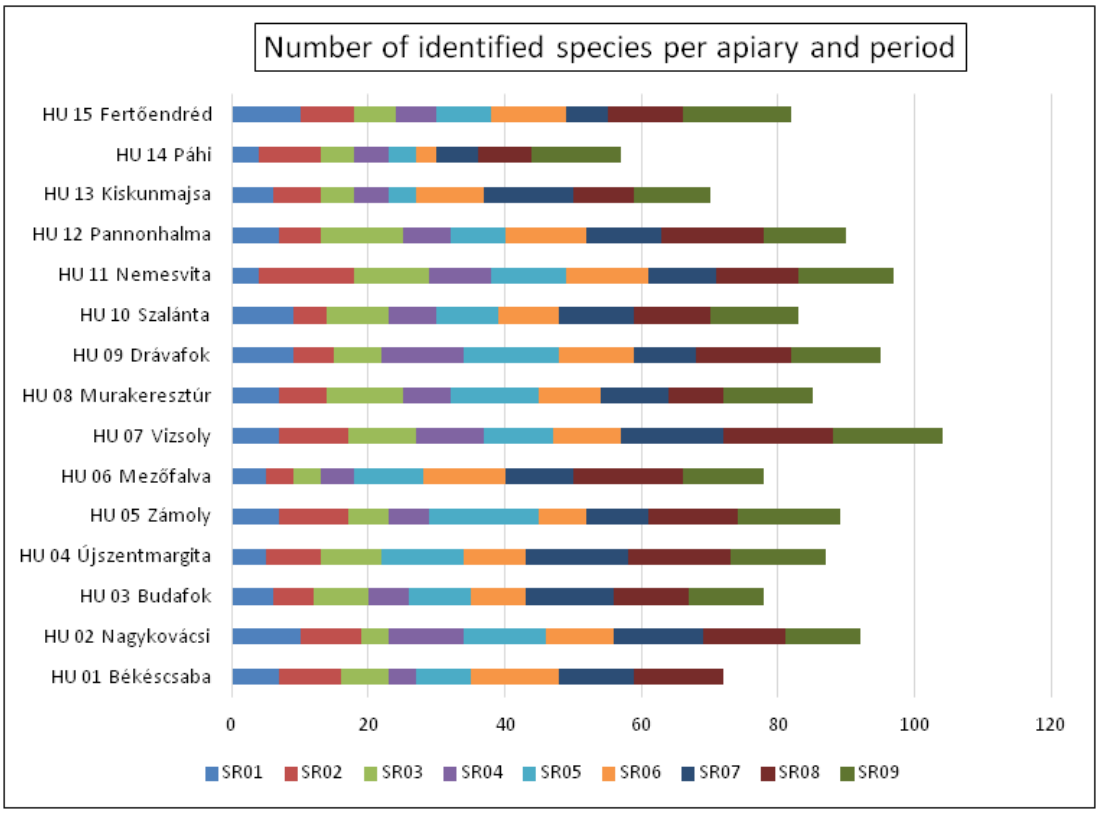

Figure 6: Number of identified species per apiary and sampling period

FREQUENCY OF PLANT SPECIES OCCURRENCE

The 1,259 identified plants from all sampling periods and apiaries represent 173 species. The number of species is inversely proportional to their frequency of occurrence. As the number of species increases, the occurrences within the apiaries decrease. The most frequently occurring species was *Plantago lanceolata* (NN), recorded 68 times, while 35 species were recorded only once. The graph illustrates the frequency of plant occurrences across all samples /Figure 7/.

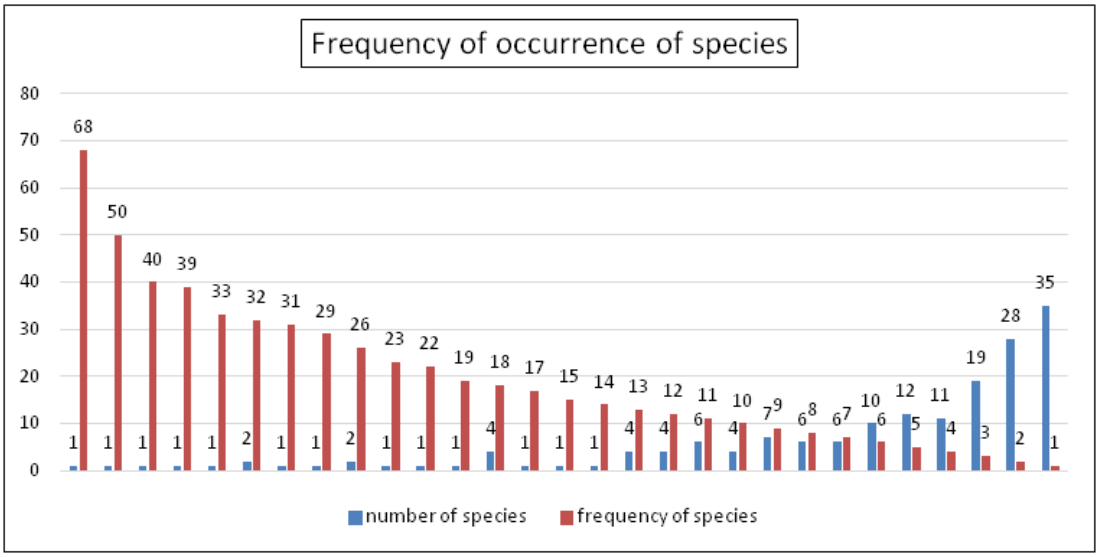

Figure 7: Frequency of species occurrence.

OCCURRENCE OF PLANT SPECIES BY APIARY

In the apiaries, bees collected pollen from a minimum of 3–7 and a maximum of 13–16 plant species /Figure 8/.

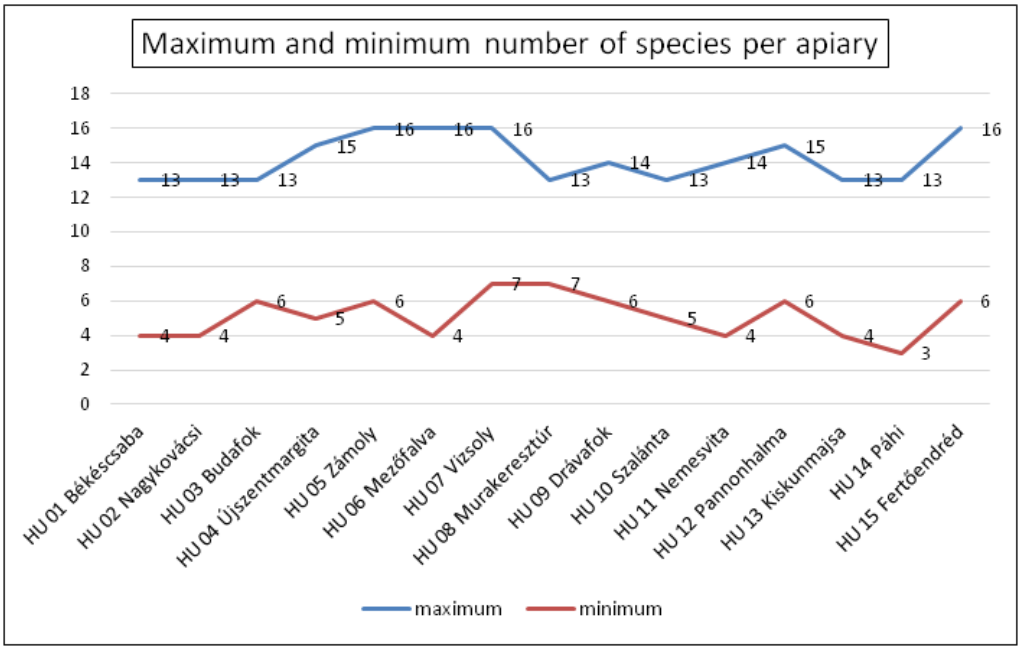

Figure 8: Maximum and minimum number of species per apiary

NUMBER OF PLANT SPECIES OCCURRING ACROSS APIARIES

The distribution of the 173 plant species found in the apiaries is illustrated in the following figure. The number of species shared by multiple apiaries is relatively low, while the number of species found in fewer apiaries increases. Seven shared species were identified across seven apiaries, and as the number of apiaries decreases, the number of shared plant species increases. Notably, the number of species occurring in only one or two apiaries is particularly high /Figure 9/.

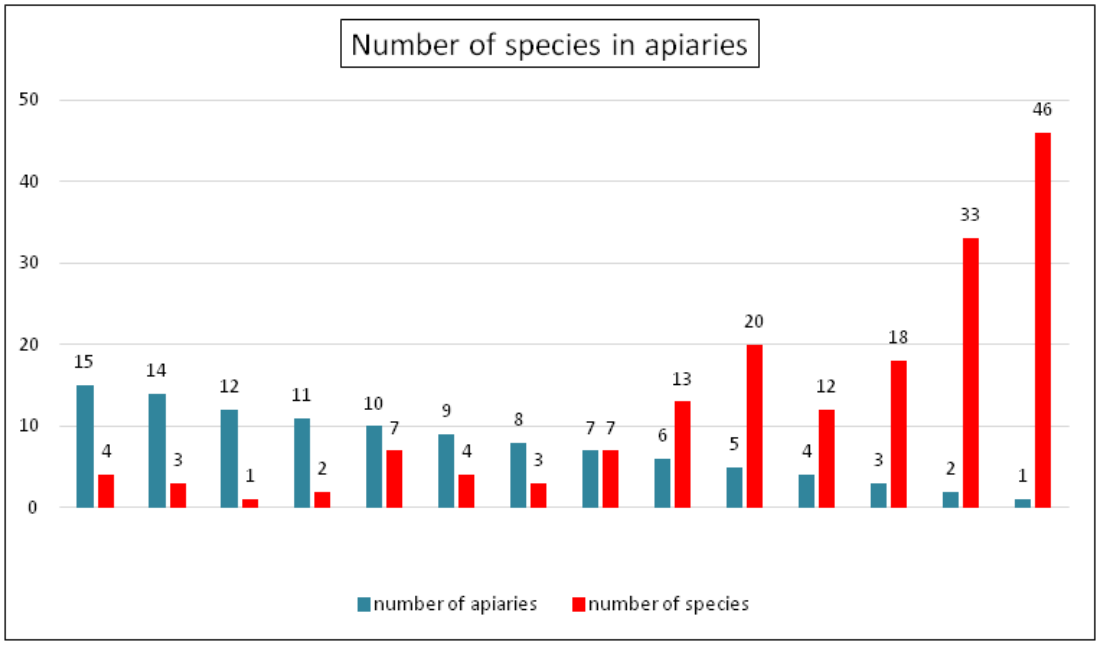

Figure 9: Number of species occurring in apiaries

During pollen collection, bees gathered plant species that provided either both nectar and pollen (nectariferous) or only pollen (nectarless). Among the 173 plant species, 133 were nectariferous, while 40 were nectarless (Figure 10)

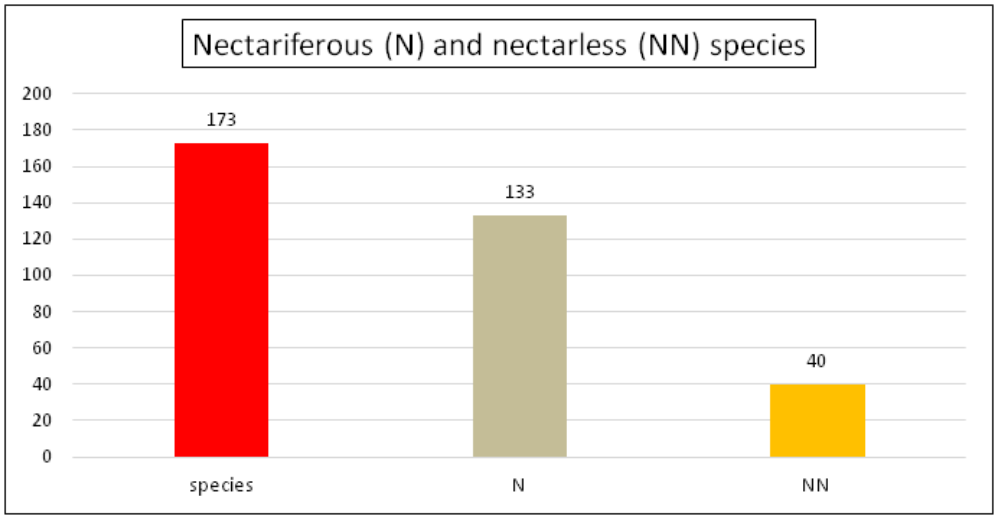

Figure 10: Number of nectariferous and nectarless species

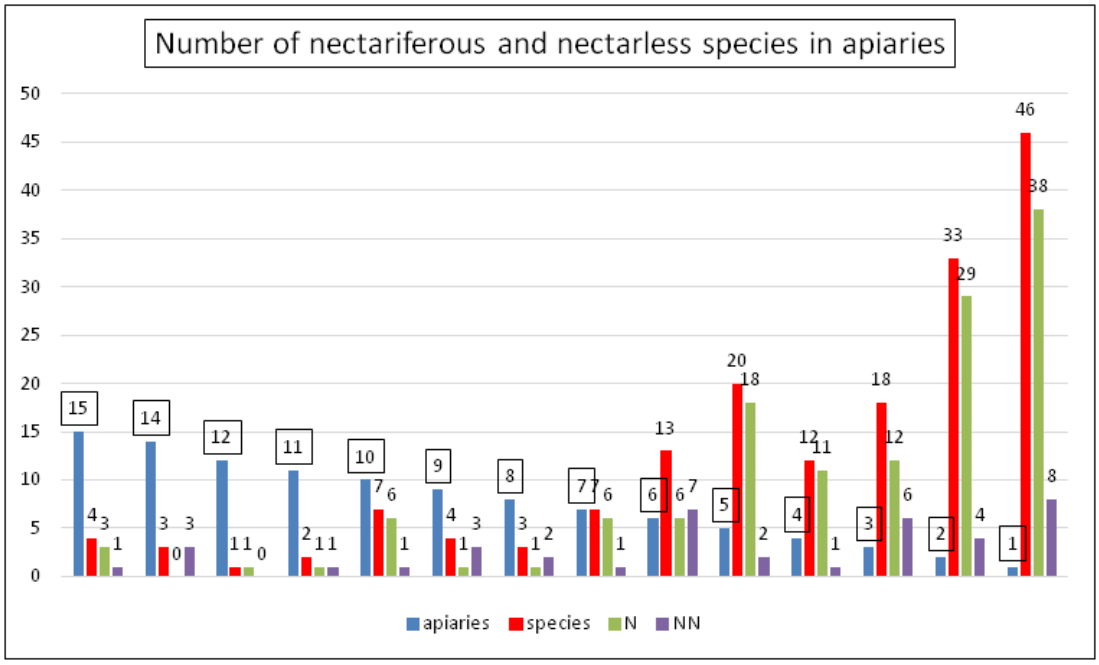

Figure 11: Number of nectariferous and nectarless species occurring in apiaries

The data reflect that bees typically collect pollen to a greater extent from plants that also provide nectar. The occurrence frequency of plant species in more than seven apiaries is still low. The number of species occurring in fewer than six apiaries has increased sharply, and among the identical plant species found in fewer than six apiaries, the number of nectariferous plant species is significantly higher than that of nectarless ones (Figure 11).

OCCURRENCE OF PLANT SPECIES BY PERIOD

Bees collected pollen from a minimum of 3-11 and a maximum of 10-16 plant species per period. The spring period is characterized by a low number of plant species visited, while from mid-summer to autumn, the number of plant species visited gradually increases (Figure 12).

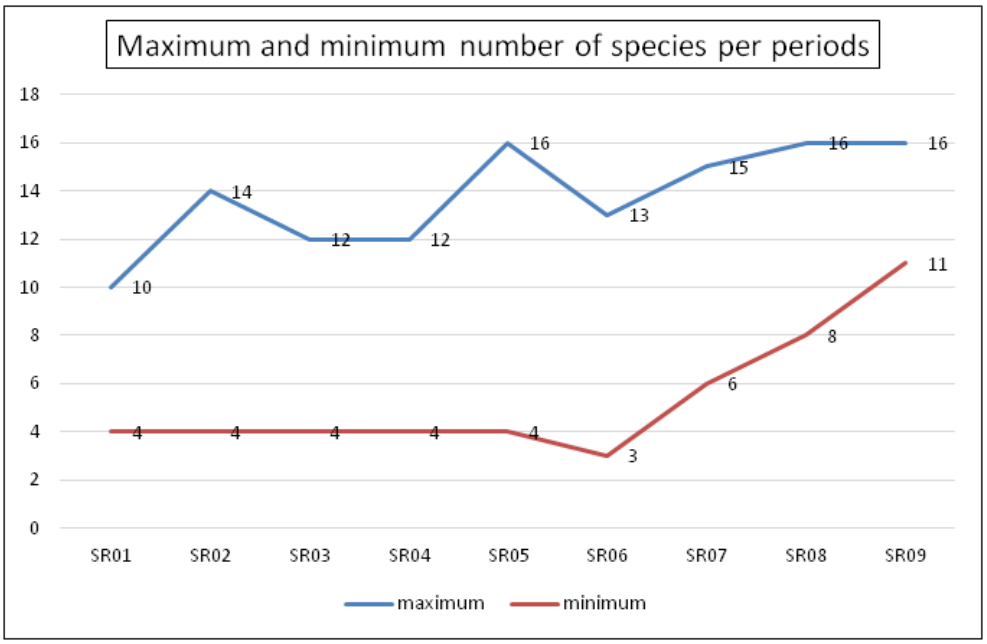

Figure 12: Maximum and minimum number of species per period

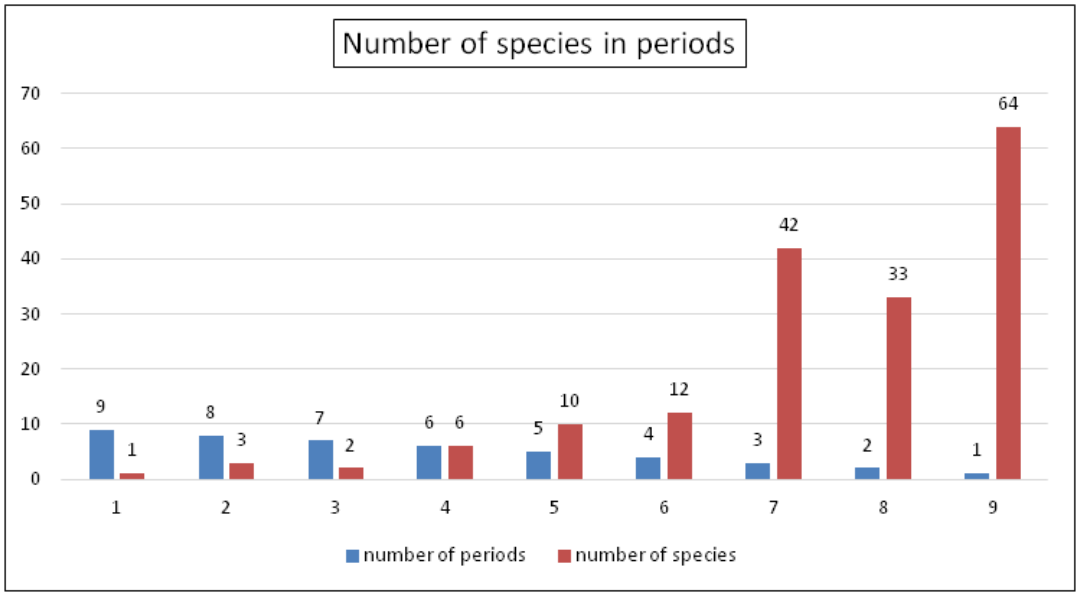

Figure 13: Number of species occurring in different periods

Only one plant species was collected in all nine periods, the nectarless *Chelidonium majus*. Regarding the pollen-collecting period, the nectarless *Papaver rhoeas* and *Plantago lanceolata*, along with the nectariferous T*rifolium repens*, were collected in eight periods. In seven periods, bees collected pollen from the nectariferous *Brassica napus* and *Melilotus albus*. In six periods, pollen was collected from the nectarless *Cannabis sativa*, *Clematis vitalba*, and *Hypericum perforatum*, as well as the nectariferous *Raphanus sativus var. oleiferus*, *Reseda lutea*, and *Verbascum thapsus*. The number of plant species increases significantly when considering the other periods, with most species (64) occurring in only one period (Figure 13).

In the various periods, pollen was typically collected in greater quantities from nectariferous plant species (Figure 14).

The most characteristic species of the spring pollen-collecting period, *Chelidonium majus* (NN), was not present in all apiaries.

Among plants flowering for several months, *Plantago lanceolata* (NN) occurred in the highest quantity (abundance 1066) across eight periods, from May to the end of August, though in May it was present in only one apiary.

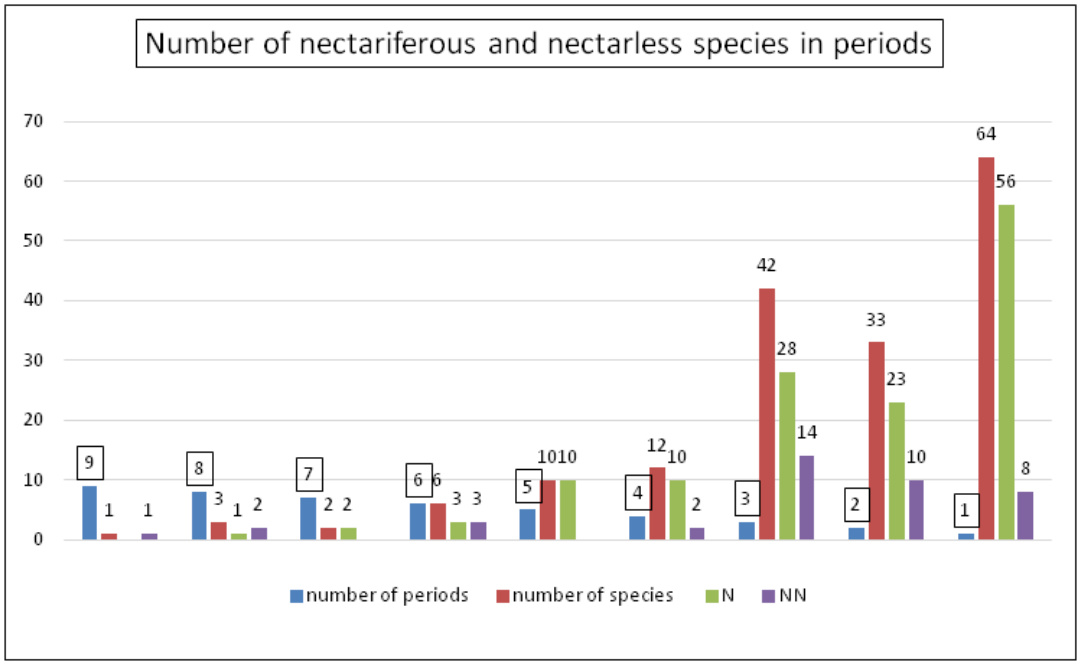

Figure 14: Number of nectariferous and nectarless species occurring in different periods

SPECTRUM CLASSIFICATION

Bees were able to collect pollen from certain plant species across varying numbers of periods.

- Basic spectrum: Includes species occurring in 75-100% of the periods.
- Supplementary I spectrum: Includes species present in 50-74% of the periods.
- Supplementary II spectrum: Includes species present in 25-49% of the periods.
- Remainder spectrum: Includes species present in fewer than 25% of the periods.

During the 2023 study, six species were classified into the Basic spectrum, 16 species into the Supplementary I spectrum, 54 species into the Supplementary II spectrum, and 97 species into the Remainder spectrum.

The species occurring in 5-9 periods indicate plants with longer pollen-collecting periods. Among these, cultivated plants were present alongside a significant number of wild plants. It was also observed that, during these periods, nectarless plants that provide only pollen were present in considerable numbers.

Spectrum	Periods number	Species Names
Basic spectrum	9	*Chelidonium majus* (NN)
	8	*Papaver rhoeas* (NN); *Plantago lanceolata* (NN); *Trifolium repens*
	7	*Brassica napus*; *Melilotus albus*
Supplementary I spectrum	6	*Cannabis sativa* (NN); *Clematis vitalba* (NN); *Hypericum perforatum* (NN); *Raphanus sativus var. oleiferus*; *Reseda lutea*; *Verbascum thapsus*
	5	*Ballota nigra*; *Brassica rapa*; *Carduus acanthoides*; *Convolvulus arvensis*; *Delosperma cooperi*; *Helianthus annuus*; *Lythrum salicaria*; *Ononis spinosa*; *Rubus ulmifolius x Rubus caesius*; *Sinapis alba*
Supplementary II spectrum	4	.....; *Phacelia tanacetifolia*; *Sorghum bicolor* (NN); *Zea mays* (NN)
	3	.....; *Ambrosia artemisifolia* (NN); *Ambrosia coronopifolia* (NN); *Artemisia vulgaris* (NN); *Papaver somniferum* (NN); *Rosa canina* (NN)
Remainder spectrum	2	.....; *Amorpha fruticosa*; *Anthriscus cerefolium*; *Castanea sativa*; *Crataegus monogyna x. C. punctata*
	1	.....; *Elaeagnus angustifolia*; *Fagopyrum esculentum*; *Hedera helix*; *Juglans regia* (NN); ***Malus sylvestris; Prunus serotina***; *Quercus frainetto* (NN); *Quercus pubescens* (NN); *Quercus rubra* (NN); *Rumex patientia* (NN); ***Salix triandra***; *Robinia pseudoacacia*; *Solidago canadensis*; ***Taraxacum officinale; Tilia cordata, Tilia tomentosa***; *Trifolium alexandrinum*; *Urtica dioica* (NN)

Table 4: Spectrum classification of key plant species

In the Supplementary II and Remainder spectra, certain species—such as nectarless plants *Zea mays*, *Sorghum bicolor*, *Ambrosia artemisiifolia*, and nectariferous plant *Solidago gigantea*—were particularly important to bees during specific periods.

It is noteworthy that among the species found in only one period (bolded in the table), several provided abundant pollen-collecting opportunities for bees even before the first May period in certain regions during the 2023 study in Hungary (Table 4).

OCCURRENCE OF PLANT SPECIES IN APIARIES AND PERIODS

FREQUENCY OF PLANT SPECIES BY APIARY

The number of plant species occurring varies across the different apiaries (Figure 15).

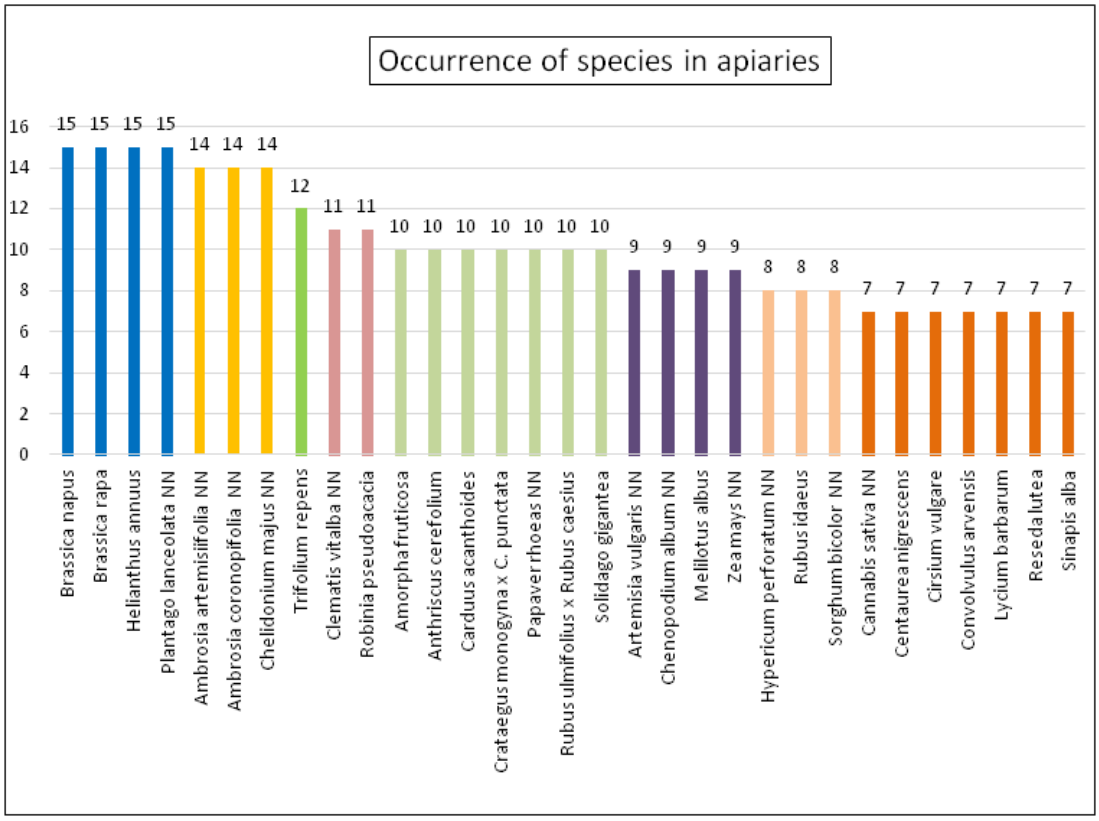

Figure 15: Occurrence of species in the apiaries

Among the same species, four species were found in all fifteen apiaries: the nectariferous *Brassica napus*, *Brassica rapa*, *Helianthus annuus*, and the nectarless *Plantago lanceolata*. In fourteen apiaries, three nectarless species, *Ambrosia artemisiifolia*, *Ambrosia coronopifolia*, and *Chelidonium majus*, were present. Additionally, in twelve apiaries, one nectariferous species, *Trifolium repens*, was recorded. Eleven apiaries contained two species: the nectarless *Clematis vitalba* and the nectariferous *Robinia pseudoacacia*.

In ten apiaries, seven species occurred: the nectariferous *Amorpha fruticosa*, *Anthriscus cerefolium*, *Carduus acanthoides*, *Crataegus monogyna x C. punctata*, *Rubus ulmifolius x Rubus caesius*, *Solidago gigantea*, and the nectarless *Papaver rhoeas*.

In nine apiaries, four species were found: the nectarless *Artemisia vulgaris*, *Chenopodium album*, *Zea mays*, and the nectariferous *Melilotus albus*. Eight apiaries recorded three species: the nectariferous *Rubus idaeus* and the nectarless *Hypericum perforatum* and *Sorghum bicolor*.

Seven apiaries contained seven species: the nectarless *Cannabis sativa* and the nectariferous *Centaurea nigrescens*, *Cirsium vulgare*, *Convolvulus arvensis*, *Lycium barbarum*, *Reseda lutea*, and *Sinapis alba*.

Pollen collection occurred most frequently from cultivated agricultural plants, wild plants, and less often from trees and shrubs. The species occurring in 15–7 apiaries that are more significant in terms of frequency, along with the number of occurrence periods, are summarized in the table below (Table 5).

Number of Apiaries	Number of Sampling rounds	Species
15	8	*Plantago lanceolata (NN)*
	7	*Brassica napus*
	5	*Helianthus annuus; Brassica rapa*
14	9	*Chelidonium majus (NN)*
	3	*Ambrosia coronopifolia (NN); Ambrosia artemisiifolia (NN)*
12	8	*Trifolium repens*
11	6	*Clematis vitalba (NN)*
	1	*Robinia pseudoacacia*
10	8	*Papaver rhoeas (NN)*
	5	*Rubus ulmifolius x Rubus caesius; Carduus acanthoides*
	3	*Solidago gigantea*
	2	*Anthriscus cerefolium; Amorpha fruticosa; Crataegus monogyna x C. punctata*
9	7	*Melilotus albus*
	4	*Zea mays (NN)*
	3	*Artemisia vulgaris (NN); Chenopodium album(NN)*
8	6	*Hypericum perforatum(NN)*
	4	*Sorghum bicolor (NN)*
	3	*Rubus idaeus*
7	6	*Reseda lutea; Cannabis sativa (NN)*
	5	*Sinapis alba; Convolvulus arvensis*
	3	*Centaurea nigrescens; Lycium barbarum; Cirsium vulgare*

Table 5: Occurrence of plant species in apiaries and periods

THE OCCURRENCE FREQUENCY OF PLANT SPECIES BY PERIOD

Only one species, the nectarless *Chelidonium majus*, appeared in every period. Three species occurred in eight periods (Figure 16), but in different numbers of apiaries: the nectarless *Plantago lanceolata* was found in 15 apiaries, *Papaver rhoeas* in 10 apiaries, and the nectariferous cultivated agricultural plant *Trifolium repens* in 12 apiaries (Table 5).

Species that occur in multiple periods and simultaneously in several apiaries, as well as those found in more than 10 apiaries—regardless of their presence in only a few periods—represent important pollen sources (Table 6).

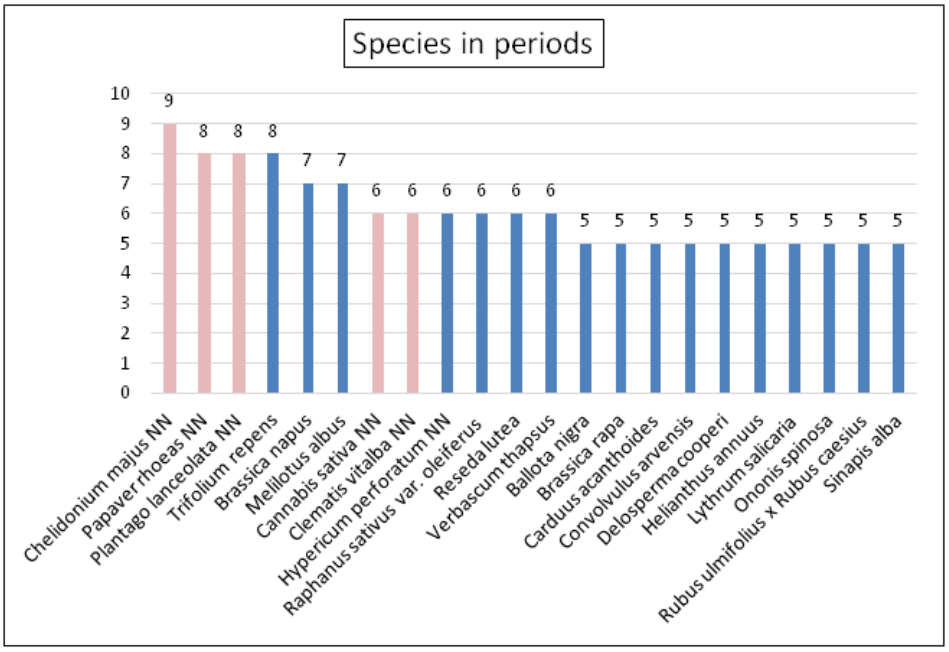

Figure 16: Occurrence of species across periods

Latin name	Number of Periods	Number of Apiaries
Chelidonium majus (NN)	9	14
Plantago lanceolata (NN)	8	15
Trifolium repens	8	12
Papaver rhoeas (NN)	8	10
Brassica napus	7	15
Clematis vitalba (NN)	6	11
Brassica rapa	5	15
Helianthus annuus	5	15
Carduus acanthoides	5	10
Rubus ulmifolius x Rubus caesius	5	10
Ambrosia artemisiifolia (NN)	3	14
Ambrosia coronopifolia (NN)	3	14
Solidago gigantea	3	10
Anthriscus cerefolium	2	11
Amorpha fruticosa	2	10
Crataegus monogyna x C. punctata	2	10
Robinia pseudoacacia	1	11

Table 6: Important pollen sources across periods and apiaries

SUM OF THE RELATIVE FREQUENCY BY PLANT SPECIES

The maximum abundance of plant species indicates the period in which bees collected the largest amount of pollen (Table 7).

Species name	Sum of abundance	Sampling Round / Period	Number of apiaries
Brassica napus	486	SR01	15
Anthriscus cerefolium	288	SR01	9
Helianthus annuus	288	SR06	14
Papaver rhoeas (NN)	260	SR04	8
Plantago lanceolata (NN)	246	SR08	10
Robinia pseudoacacia	233	SR02	11
Clematis vitalba (NN)	211	SR05	9
Brassica rapa	164	SR01	15
Chelidonium majus (NN)	164	SR01	12
Amorpha fruticosa	148	SR03	10
Solidago gigantea	141	SR08	9
Ononis spinosa	115	SR05	5
Phacelia tanacetifolia	106	SR03	3
Sorghum bicolor	100	SR07	7
20 species	50-99	...	...
27 species	30-49	...	...
60 species	10-29	...	...
52 species	2-9	...	...

Table 7: Sum of the relative frequencies by period in the apiaries

The bees collected the most pollen from Brassica napus across seven periods, with the highest amount observed in the first period and a significant amount in the second period. In the remaining periods, its presence was minimal (Figure 17).

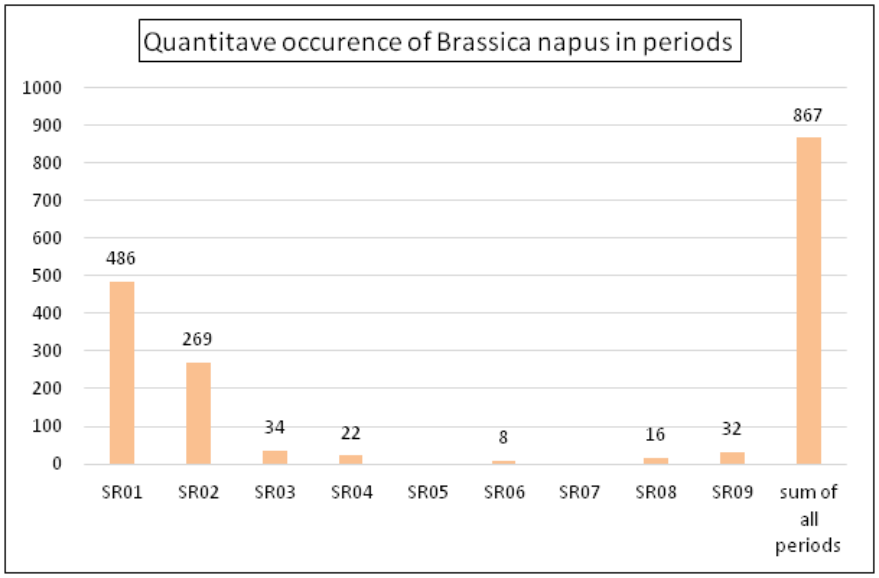

Figure 17: Quantitative occurrence of Brassica napus across periods

MAXIMUM OCCURRENCE OF PLANT SPECIES

The relative frequency percentages of plant species across various periods for each apiary are presented in Table 8. Two samples, HU01 SR09 and HU04 SR04, could not be evaluated.

Species name	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
HU01 BÉKÉSCSABA /BÉKÉS Shire									
Anthriscus cerefolium	40								
Brassica napus		30							
Chenopodium album (NN)								20	
Helianthus annuus						15	29		
Raphanus sativus var. oleiferus			40	63	30				
HU02 NAGYKOVÁCSI /PEST Shire									
Brassica napus	27								
Castanea sativa					26				
Clematis vitalba (NN)							25		
Fraxinus ornus (NN)		35							
Helianthus annuus						25			
Phacelia tanacetifolia			61	27					
Picris hieracioides								16	
Plantago media (NN)									23
HU03 BUDAFOK /BUDAPEST XXII.ker.									
Brassica napus	29								
Clematis vitalba (NN)				32			27		
Melilotus albus			40						
Plantago lanceolata (NN)					41	43		29	51
Robinia pseudoacacia		39							
HU04 ÚJSZENTMARGITA /HAJDÚ-BIHAR Shire									
Amorpha fruticosa			22						
Brassica napus	52								
Helianthus annuus					16				
Ononis spinosa						40			
Plantago lanceolata (NN)								26	

Species name	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
Robinia pseudoacacia		24							
Sinapis alba							27		30
HU05 ZÁMOLY /FEJÉR Shire									
Ballota nigra								21	
Brassica napus	32	37							
Papaver rhoeas (NN)				40	30		20		
Papaver somniferum (NN)			32						
Trifolium alexandrinum						42			
Zea mays (NN)									15
HU06 MEZŐFALVA /FEJÉR Shire									
Anthriscus cerefolium	53								
Artemisia vulgaris (NN)								25	
Hedera helix									22
Helianthus annuus						27			
Papaver rhoeas (NN)					25				
Papaver somniferum (NN)			40	46					
Plantago lanceolata (NN)							23		
Robinia pseudoacacia		32							
HU07 VIZSOLY /BORSOD-ABAÚJ-ZEMPLÉN Shire									
Brassica napus	38	44	34						
Clematis vitalba (NN)					32	26			
Helianthus annuus							26		
Papaver rhoeas (NN)				25					
Solidago gigantea								39	26
HU08 MURAKERESZTÚR /ZALA Shire									
Brassica napus		25							24
Chelidonium majus (NN)	34								
Helianthus annuus						26			
Ranunculus sardous			29						
Solidago gigantea								33	
Trifolium repens							24		
Tripleurospermum maritimum				36	26				
HU09 DRÁVAFOK /BARANYA Shire									
Amorpha fruticosa			35						
Chelidonium majus (NN)	23								
Crepis setosa					23				
Erigeron annuus (NN)				33					
Plantago lanceolata (NN)						18		29	18
Raphanus sativus var. oleiferus							26		
Robinia pseudoacacia		42							
HU10 SZALÁNTA /BARANYA Shire									
Anethum graveolens						22			
Anthriscus cerefolium	25								
Chenopodium album (NN)							24		
Clematis vitalba (NN)					29				

Species name	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
Papaver rhoeas (NN)			31						
Plantago lanceolata (NN)								25	
Raphanus sativus var. oleiferus									28
Robinia pseudoacacia		41							
Tripleurospermum maritimum				34					
HU11-NEMESVITA /VESZPRÉM Shire									
Amorpha fruticosa			27						
Brassica napus	53	26							
Castanea sativa				23	25				
Hedera helix									18
Hypericum perforatum (NN)						19			
Plantago lanceolata (NN)							26	25	
HU12-PANNONHALMA /GYŐR-MOSON-SOPRON Shire									
Brassica napus	41	35							
Onobrychis viciifolia						30			
Papaver rhoeas (NN)			30	43	32				
Plantago lanceolata (NN)							26	25	
Sinapis alba									17
HU13 KISKUNMAJSA /BÁCS-KISKUN Shire									
Anthriscus cerefolium	55								
Chenopodium album (NN)							19		
Helianthus annuus						38			
Ononis spinosa				37	43			25	35
Papaver rhoeas (NN)		38	40						
HU14 PÁHI /BÁCS-KISKUN Shire									
Anthriscus cerefolium	62								
Helianthus annuus						55			
Lythrum salicaria								30	
Ononis spinosa					42				
Papaver rhoeas (NN)		28	55	45					
Sanguisorba officinalis (NN)							42		22
HU15 FERTŐENDRÉD /GYŐR-MOSON-SOPRON Shire									
Brassica napus	42	35							
Helianthus annuus							34		
Hypericum perforatum (NN)									21
Papaver rhoeas (NN)			38	44	33				
Plantago lanceolata (NN)						40		35	

Table 8: Maximum relative frequency values of plant species per apiary and period.

The plant species with the highest maximum value is *Raphanus sativus var. oleiferus*, with 63% in the June 15-18 (SR04) period, which was found in the sample from the HU01 Békéscsaba/Békés Shire apiary. The species with the lowest maximum value is *Zea mays* (NN), with 15%, occurring in the August 24-27 (SR09) period from the HU05 Zámoly/Fejér Shire apiary (Figure 18)

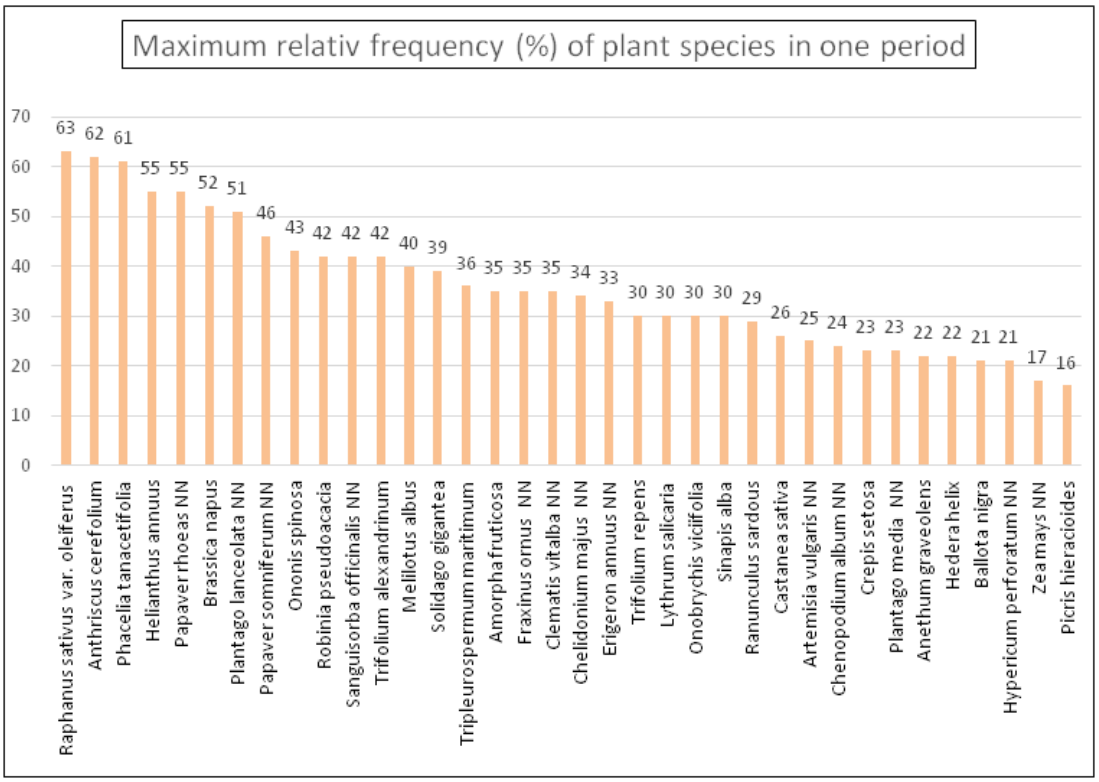

Figure 18: Maximum relative frequency values of plant species across periods.

KEY SPECIES ACROSS PERIODS

Among the key species (with a relative frequency abundance greater than 50) characteristic of each period, there are both plants that flowered for a longer and shorter duration (Table 9).

Primarily, the number of foraging periods increased with the length of the flowering period of the plants.

Species	Number of periods	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
Brassica napus	2	x	x							
Brassica rapa	2	x	x							
Chelidonium majus (NN)	2	x	x							
Anthriscus cerefolium	1	x								
Crataegus monogyna x C. punctata	1	x								
Papaver rhoeas (NN)	4		x	x	x	x				
Robinia pseudoacacia	1		x							
Papaver somniferum (NN)	2			x	x					
Phacelia tanacetifolia	2			x	x					
Amorpha fruticosa	1			x						
Melilotus albus	1			x						
Clematis vitalba (NN)	4				x	x	x		x	
Castanea sativa	1				x					
Raphanus sativus var. oleiferus	1				x					
Tripleurospermum maritimum	1				x					
Plantago lanceolata (NN)	5					x	x	x	x	x
Helianthus annuus	3					x	x	x		
Ononis spinosa	2					x				x
Sorghum bicolor (NN)	2						x	x		
Trifolium repens	2						x	x		
Chenopodium album (NN)	1							x		

Species	Number of periods	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	SR09
Rubus ulmifolius x R. caesius	1							x		
Solidago gigantea	2								x	x
Artemisia vulgaris (NN)	1								x	
Carduus acanthoides	1								x	
Chenopodium album (NN)	1								x	
Ambrosia artemisiifolia (NN)	1									x
Ambrosia coronopifolia (NN)	1									x
Sinapis alba	1									x

Table 9: Key species across periods

KEY SPECIES CHARACTERISTIC OF EACH APIARY

Among the key species (with a relative frequency abundance greater than 50) in each apiary, there are both nectariferous species and nectarless species, which provide only pollen. The most common nectariferous species in the apiaries were *Brassica napus* (found in nine apiaries), *Helianthus annuus* (found in six apiaries), as well as nectarless, pollen-only species such as *Plantago lanceolata* (found in eight apiaries), *Papaver rhoeas* (found in six apiaries), and *Clematis vitalba* (found in five apiaries) during the 2023 study year. Among the nectariferous species, *Anthriscus cerefolium* and *Ononis spinosa* were found in three apiaries, while *Phacelia tanacetifolia*, *Solidago gigantea*, and *Trifolium repens* were found in two apiaries. The other species listed in the table appeared in only one apiary (Table 10).

Species	Number of apiaries	HU01	HU02	HU03	HU04	HU05	HU06	HU07	HU08	HU09	HU10	HU11	HU12	HU13	HU14	HU15
Brassica napus	9	x			x	x		x	x		x	x	x			x
Plantago lanceolata (NN)	8			x	x		x			x	x	x	x			x
Helianthus annuus	6	x					x				x			x	x	x
Papaver rhoeas (NN)	6					x					x		x	x	x	x
Clematis vitalba (NN)	5		x	x				x			x	x				
Anthriscus cerefolium	3						x							x	x	
Ononis spinosa	3				x									x	x	
Phacelia tanacetifolia	2		x													x
Solidago gigantea	2							x	x							
Trifolium repens	2								x			x				
Amorpha fruticosa	1									x						
Ballota nigra	1					x										
Castanea sativa	1		x													
Centaurea cyanus	1						x									
Chelidonium majus (NN)	1								x							
Crepis setosa	1									x						
Hypericum perforatum (NN)	1															x
Lythrum salicaria	1														x	
Melilotus albus	1			x												
Papaver somniferum (NN)	1						x									
Pisum sativum	1	x														
Raphanus sativus var. oleiferus	1	x														
Sanguisorba officinalis (NN)	1														x	
Sinapis alba	1				x											
Tripleurospermum maritimum	1								x							

Table 10: Key species in the apiaries

KEY PLANT SPECIES IN THE APIARIES

KEY CHARACTERISTICS BY PLANT SPECIES

Based on the plant composition observed in the apiary samples, it is possible to identify which species are dominant in the area during a given period, i.e., the key species. Common key species include agricultural plants, as well as wildflowers. At maximum percentage values, alongside the mentioned plant groups, an invasive tree species, *Robinia pseudoacacia*, also appears. At minimum percentage values, in addition to agricultural plants and herbaceous wild plants, species such as the herb *Anethum graveolens* and the climbing ornamental plant *Hedera helix* were also found (Table 8).

KEY SPECIES (>45%) IN THE APIARIES (HUXX) AND THEIR PERIODIC OCCURRENCE (SR XX):

- HU01: *Raphanus raphanistrum* 63% (SR04) – Agricultural crop plant
- HU02: *Phacelia tanacetifolia* 61% (SR03) – Agricultural crop plant
- HU03: *Plantago lanceolata* (NN) 51% (SR09) – Herbaceous wild plant
- HU04: *Brassica napus* 52% (SR01) – Agricultural crop plant
- HU06: *Anthriscus cerefolium* 53% (SR01) – Herbaceous wild plant
- HU06: *Papaver somniferum* (NN) 46% (SR04) – Agricultural crop plant
- HU11: *Brassica napus* 53% (SR01) – Agricultural crop plant
- HU13: *Anthriscus cerefolium* 55% (SR01) – Herbaceous wild plant
- HU14: *Anthriscus cerefolium* 62% (SR01) – Herbaceous wild plant

MAXIMUM % IN THE APIARIES:

- HU01: *Raphanus raphanistrum* 63% (SR04) – Agricultural crop plant
- HU02: *Phacelia tanacetifolia* 61% (SR03) – Agricultural crop plant
- HU03: *Plantago lanceolata* (NN) 51% (SR09) – Herbaceous wild plant
- HU04: *Brassica napus* 52% (SR01) – Agricultural crop plant
- HU05: *Trifolium alexandrinum* 42% (SR06) – Agricultural crop plant
- HU06: *Anthriscus cerefolium* 53% (SR01) – Herbaceous wild plant
- HU07: *Brassica napus* 44% (SR02) – Agricultural crop plant
- HU08: *Tripleurospermum maritimum* 36% (SR04) – Matricaria chamomilla (herb)
- HU09: *Robinia pseudoacacia* 42% (SR02) – Forest tree species
- HU10: *Robinia pseudoacacia* 41% (SR02) – Forest tree species
- HU11: *Brassica napus* 53% (SR01) – Agricultural crop plant
- HU12: *Papaver rhoeas* (NN) 43% (SR04) – Herbaceous wild plant
- HU13: *Anthriscus cerefolium* 55% (SR01) – Herbaceous wild plant
- HU14: *Anthriscus cerefolium* 62% (SR01) – Herbaceous wild plant
- HU15: *Papaver rhoeas NN 44% (SR 04)* – Herbaceous wild plant

RESULTS

1. In the fifteen apiaries and nine periods, the number of plant species recorded in the bee-collected samples was 173, with 36-60 species per apiary and 22-69 species per period (Figures 4-5).
2. The occurrence frequency of species shows a notable trend reversal for species appearing fewer than 10 times, with a sharp increase in occurrences. Among the 173 plant species found in the apiaries, only a smaller number were common across multiple apiaries. From the sixth apiary onwards, as the number of apiaries decreased, the number of recurring species increased sharply (Figure 7).
3. In the apiaries, bees collected from a maximum of 13-16 and a minimum of 3-7 plant species (Figure 8).
4. In the periods, bees collected from a maximum of 10-16 and a minimum of 3-11 plant species (Figure 12).
5. Of the 173 plant species, 133 produced nectar and 40 were pollen-only species (Figure 10).
6. Bees collected significantly larger quantities from nectariferous species (Figures 11 and 14).
7. In the first period, the highest percentage of 62% was collected from *Anthriscus cerefolium* in Bács-Kiskun Shire/Páhi. In the second period, 44% was collected from *Brassica napus* in Borsod-Abaúj-Zemplén Shire/Vizsoly. In the third period, 61% was collected from *Phacelia tanacetifolia* in Pest Shire/Nagykovácsi. In the fourth period, 63% was collected from *Raphanus raphanistrum var. oleifera* in Békés Shire/Békéscsaba. In the fifth period, 43% was collected from *Ononis spinosa* in Bács-Kiskun Shire/Kiskunmajsa. In the sixth period, 55% was collected from *Helianthus annuus* in Bács-Kiskun Shire/Páhi. In the seventh period, 42% was collected from S*anguisorba officinalis* (NN) in Bács-Kiskun Shire/Páhi. In the eighth period, 39% was collected from *Solidago gigantea* in Borsod-Abaúj-Zemplén Shire/Vizsoly. In the ninth period, 51% was collected from *Plantago lanceolata* (NN) in Pest Shire/Budafok (Tables 8).
8. Common species typically appeared in more than seven apiaries. Of the 31 species, 19 were nectariferous, and 12 were pollen-only species. The most common species, appearing in fifteen apiaries, were the nectariferous agricultural plants *Brassica napus*, *Brassica rapa*, *Helianthus annuus*, and the pollen-only herbaceous wild plant *Plantago lanceolata* (Figure 15).

9. Among the plant species, there are both short-lived and longer-flowering species (Table 10).
10. The most frequently collected plant species by period:
    - o *Chelidonium majus* (NN) in nine periods/fourteen apiaries
    - o *Plantago lanceolata* (NN) in eight periods/fifteen apiaries
    - o *Trifolium repens* in eight periods/twelve apiaries
    - o *Papaver rhoeas* (NN) in eight periods/ten apiaries (Table 6).
11. The species collected in the largest quantities per period:
    - o *Brassica napus* 486/15 apiaries in SR01
    - o *Anthriscus cerefolium* 288/9 apiaries in SR01
    - o *Helianthus annuus* 288/14 apiaries in SR06
    - o *Papaver rhoeas* (NN) 260/8 apiaries in SR04
    - o *Plantago lanceolata* (NN) 248/10 apiaries in SR08
    - o *Robinia pseudoacacia* 233/11 apiaries in SR02
    - o *Clematis vitalba* (NN) 211/9 apiaries in SR05

    Further data can be found in Table 7.
12. The most abundant species collected from the apiaries:
    - o *Raphanus raphanistrum* /Békéscsaba
    - o *Phacelia tanacetifolia* /Nagykovácsi
    - o *Plantago lanceolata* (NN) /Budafok, Újszentmargita, Drávafok, Nemesvita
    - o *Papaver rhoeas* (NN) /Zámoly, Pannonhalma, Páhi, Fertőendréd
    - o *Papaver somniferum* (NN) /Mezőfalva
    - o *Brassica napus* (NN) /Vizsoly, Murakeresztúr
    - o *Helianthus annuus* /Szalánta
    - o *Ononis spinosa* /Kiskunmajsa (Table 8).
13. The most important plant species with greater than 50% relative frequency in the most apiaries:
    - o *Brassica napus* /9 apiaries
    - o *Plantago lanceolata* (NN) /8 apiaries
    - o *Helianthus annuus* and *Papaver rhoeas* (NN) /6 apiaries
    - o *Clematis vitalba* (NN) /5 apiaries
    - o *Anthriscus cerefolium* and Ononis spinosa /3 apiaries
    - o *Phacelia tanacetifolia*, *Solidago gigantea*, and *Trifolium repens* /2 apiaries. Some species were recorded in only one apiary (Table 10).
14. Among the important species recorded in only one apiary, some are specific to certain areas, while others are cultivated agricultural plants that could theoretically be grown elsewhere. These include *Amorpha fruticosa*, *Ballota nigra*, *Castanea sativa*, *Centaurea cyanus*, *Chelidonium majus* (NN), *Crepis setosa*, *Hypericum perforatum* (NN), *Lythrum salicaria*, *Melilotus albus*, *Papaver rhoeas* (NN), *Pisum sativum*, *Raphanus sativus var. oleifera*, *Sanguisorba officinalis* (NN), *Sinapis alba*, and *Tripleurospermum maritimum* (Table 10).

    Tripleurospermum maritimum, known as sea mayweed, was kept as such in the evaluation, but it is likely that *Matricaria chamomilla*, also known as medicinal chamomile, is meant, which occurs in several places in Hungary.
15. Regarding the Hungarian regions, the lowest number of plant species collected was found in three apiaries in the Southern Great Plain region (HU01/43 species in Békés Shire; HU13/38 species and HU14/56 species in Bács-Kiskun Shire). Similarly, the Western Transdanubia region, with three apiaries (HU08/45 species in Zala Shire; HU12/46 species and HU15/45 species in Győr-Moson-Sopron Shire), had lower species counts. The highest number of species was recorded in the Northern Hungary region (HU07/60 species in Borsod-Abaúj-Zemplén Shire) (Table 3).
16. It is important to note that due to Hungary's natural conditions, intensive pollen collection begins as early as April, with the most frequently occurring species being *Salix caprea*, *Salix alba*, *Taraxacum officinale*, and *Prunus spp.* species.
17. The study results are from the year 2023, and the occurrence and quantity of species depend primarily on the ecological, local, and weather conditions as well as the sampling protocols. Species occurrence and abundance are primarily area- and weather-dependent, but can also be significantly influenced by changing agricultural activities.

COMMENTS:

1. For the nectarless, pollen-only plant species, the 'NN' designation was only included when confirmed by multiple sources. For species such as *Verbascum sp.*, there is no consistent evidence, therefore it was not marked.
2. The spelling of Hungarian plant names and the standardization of synonym names were based on [2].
3. Inconsistencies in Species Names in the INSIGNIA Basic Data

   Some species names in the INSIGNIA basic data differ from the officially recognized scientific names. This discrepancy may require correction to ensure consistency with accepted botanical nomenclature. It is important to cross-reference the data with the latest botanical references to update these species names accordingly.

INSIGNIA	**After correction**
Latin name	**Valid Latin name**
Brassica oleracea	= Brassica rapa subsp. oleifera = Brassica rapa
Brassica rapa	= Brassica rapa subsp. napus = Brassica napus subsp. napus = Brassica napus
Inula britannica (synonym name)	Pentanema britannicum
Lotus glaber (synonym name)	Lotus tenuis
Ambrosia psilostachya (synonym name)	Ambrosia coronopifolia

LEDLEGEND

Non-nectariferous plants (NN) are marked accordingly.

APPENDIX

Latin plant name	**Hungarian plant name**
Acer pseudoplatanus	hegyi juhar
Achillea millefolium	cickafark
Aegopodium podagraria	podagrafű
Aesculus hippocastanum	vadgesztenye
Agrimonia eupatoria	párlófű
Allium angulosum	gyíkhagyma
Allium cepa	vöröshagyma
Allium scorodoprasum	kígyóhagyma
Allium sphaerocephalon	bunkós hagyma
Allium stipitatum	termetes hagyma
Althaea officinalis	orvosi ziliz
Ambrosia artemisiifolia (NN)	ürömlevelű parlagfű (NN)
Ambrosia coronopifolia (NN)	évelő parlagfű (NN)
Amorpha fruticosa	cserjés gyalogakác
Anchusa officinalis	orvosi atracél
Anethum graveolens	kerti kapor
Angelica sylvestris	erdei angyalgyökér
Anthriscus cerefolium	zamatos turbolya
Anthriscus sylvestris	erdei turbolya
Artemisia vulgaris (NN)	fekete üröm (NN)
Atriplex tatarica (NN)	tatár laboda (NN)
Ballota nigra	fekete peszterce
Berteroa incana	fehér hamuka
Berula erecta	keskenylevelű békakorsó
Brassica napus	káposztarepce
Brassica rapa	réparepce
Buddleja davidii	illatos nyáriorgona
Cannabis sativa (NN)	vetési kender (NN)
Cardaria draba	útszéli zsázsa
Carduus acanthoides	útszéli bogáncs
Castanea sativa	szelídgesztenye
Centaurea cyanus	búzavirág
Centaurea nigrescens	feketés imola

Latin plant name	**Hungarian plant name**
Cerinthe minor	szeplőlapu
Chaerophyllum aureum	aranyos baraboly
Chelidonium majus (NN)	vérehulló fecskefű (NN)
Chenopodium album (NN)	fehér libatop (NN)
Chenopodium ficifolium (NN)	fügelevelű libatop (NN)
Chenopodium murale (NN)	kőfali libatop (NN)
Cichorium intybus	mezei katáng
Cirsium arvense	mezei aszat
Cirsium vulgare	lándzsás aszat
Clematis vitalba (NN)	erdei iszalag (NN)
Convolvulus arvensis	apró szulák
Cornus sanguinea	veresgyűrűsom
Crataegus monogyna x Crataegus punctata	galagonya hibrid
Crepis capillaris	vékony zörgőfű
Crepis foetida	nehézszagú zörgőfű
Crepis setosa	sertés zörgőfű
Cytisus scoparius	seprűzanót
Datura stramonium	csattanó maszlag
Delosperma cooperi	bíborvörös délvirág
Elaeagnus angustifolia	keskenylevelű ezüstfa
Erigeron annuus (NN)	egynyári seprence (NN)
Eupatorium cannabinum	sédkender
Fagopyrum esculentum	pohánka
Falcaria vulgaris	sarlófű
Filipendula vulgaris (NN)	koloncos legyezőfű (NN)
Fragaria vesca	erdei szamóca
Fraxinus ornus (NN)	virágos kőris (NN)
Galega officinalis	orvosi kecskeruta
Galium album	sziklai galaj
Galium mollugo	közönséges galaj
Genista tinctoria	festő rekettye
Glycine max	szója
Hedera helix	borostyán
Helianthus annuus	napraforgó
Hypericum perforatum (NN)	lyukaslevelű orbáncfű (NN)
Hypochoeris radicata	kacuros véreslapu
Impatiens balfourii	Matild-nebáncsvirág
Iris pseudacorus	mocsári nőszirom
Juglans regia (NN)	nemes dió (NN)
Knautia arvensis	mezei varfű
Koelreuteria paniculata	bugás csörgőfa
Lamium maculatum	foltos árvacsalán
Limonium hungaricum	magyar sóvirág
Lolium multiflorum (NN)	olaszperje (NN)
Lolium perenne (NN)	angolperje (NN)

Latin plant name	**Hungarian plant name**
Loranthus europaeus	sárgafagyöngy
Lotus corniculatus	szarvas kerep
Lotus glaber (=tenuis)	sziki kerep
Lycium barbarum	ördögcérna
Lycium chinense	kínai ördögcérna
Lythrum salicaria	réti füzény
Maclura pomifera	narancseperfa
Malus sylvestris	nemes alma
Melilotus albus	fehér somkóró
Mercurialis annua (NN)	egynyári szélfű (NN)
Morus alba (NN)	fehér eperfa (NN)
Odontites vulgaris	vörös fogfű
Oenanthe aquatica	vízi mételykóró
Onobrychis viciifolia	takarmánybaltacím
Ononis spinosa	tövises iglice
Onopordum acanthium	közönséges szamárbogáncs
Ornithogalum refractum	csilláros madártej
Papaver rhoeas (NN)	mezei pipacs (NN)
Papaver somniferum (NN)	termesztett mák (NN)
Pentanema britannicum	réti peremizs
Peucedanum cervaria	szarvaskocsord
Phacelia tanacetifolia	varádicslevelű mézontófű
Phytolacca americana	amerikai alkörmös
Picris hieracioides	közönséges keserűgyökér
Pisum sativum	veteményborsó
Plantago arenaria (NN)	homoki útifű (NN)
Plantago lanceolata (NN)	lándzsás útifű (NN)
Plantago major (NN)	nagy útifű (NN)
Plantago media (NN)	réti útifű (NN)
Portulaca grandiflora	porcsinrózsa
Portulaca oleracea	kövér porcsin
Potentilla argentea	ezüstös pimpó
Potentilla reptans	indás pimpó
Prunus serotina	kései zelnicemeggy
Pulicaria dysenterica	réti bolhafű
Pyracantha coccinea	közönséges tűztövis
Quercus frainetto (NN)	magyar tölgy (NN)
Quercus pubescens (NN)	molyhos tölgy (NN)
Quercus rubra (NN)	vörös tölgy (NN)
Ranunculus sardous	buborcs boglárka
Raphanus sativus var. oleiferus	olajretek
Reseda lutea	vadrezeda
Rhamnus cathartica x Rhamnus saxatilis	benge hibrid
Robinia pseudoacacia	fehér akác
Rorippa palustris	mocsári kányafű
Rosa canina (NN)	gyepürózsa (NN)

Latin plant name	**Hungarian plant name**
Rubus caesius	hamvas szeder
Rubus idaeus	erdei málna
Rubus radula	ráspolyos szeder
Rubus ulmifolius x Rubus caesius	hamvas tüskétlen szeder
Rumex patientia (NN)	paréjlórom (NN)
Salix alba	fehér fűz
Salix triandra	mandulalevelű fűz
Sambucus ebulus	gyalogbodza
Sambucus nigra (NN)	fekete bodza (NN)
Sanguisorba officinalis (NN)	őszi vérfű (NN)
Scabiosa lucida	fénylő ördögszem
Scorzonera parviflora	kisvirágú pozdor
Serratula tinctoria	festő zsoltina
Sinapis alba	fehér mustár
Sisymbrium orientale	hamvas zsombor
Sisymbrium strictissimum	magas zsombor
Solanum nigrum (NN)	fekete csucsor (NN)
Solanum villosum (NN)	sárga csucsor (NN)
Solidago canadensis	kanadai aranyvessző
Solidago gigantea	magas aranyvessző
Sonchus arvensis	mezei csorbóka
Sorghum bicolor (NN)	takarmánycirok (NN)
Sparganium erectum (NN)	ágas békabuzogány (NN)
Spiraea japonica	japán gyöngyvessző
Symphytum officinale	fekete nadálytő
Syringa josikaea	Jósika-orgona
Syringa vulgaris	kerti orgona
Tanacetum vulgare	gilisztaűző varádics
Taraxacum officinale	pongyola pitypang
Tetradium daniellii	koreai mézesfa
Tilia cordata	kislevelű hárs
Tilia tomentosa	ezüst hárs
Tragopogon pratensis	réti bakszakáll
Tribulus terrestris (NN)	földi királydinnye (NN)
Trifolium alexandrinum	egyiptomi here
Trifolium hybridum	korcs here
Trifolium incarnatum	bíbor here
Trifolium pratense	vörös here
Trifolium repens	fehér here
Trinia glauca	szürke nyúlkapor
Tripleurospermum maritimum	tengerparti ebszékfű
Urtica dioica (NN)	nagy csalán (NN)
Verbascum chaixii	déli ökörfarkkóró
Verbascum thapsus	molyhos ökörfarkkóró
Vicia faba	lóbab
Vicia villosa	szöszös bükköny

Latin plant name	**Hungarian plant name**
Vitis vinifera (NN)	bortermő szőlő (NN)
Xanthium strumarium	bojtorjánszerbtövis
Zea mays (NN)	kukorica (NN)

(NN) = non-nectariferous plant/nectarless

CONFLICT OF INTEREST

The author declares no conflicts of interest related to this research.

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