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ESTIMATION OF POLLINATORS COMMUNITIES IN THE AREAS OF INDUSTRIAL IMPACT

In recent decades, the European Union has issued several strategies to promote the efficient use of resources, the circular economy and to address biodiversity loss and climate change. On the basis of the strategy of the European Union, during 2023, in the premises of the company Wienerberger s.r.o. carried out biomonitoring of insecta with a focus on pollinators. We conducted the research in 4 study areas representing the meadow biotope. We used the following methods for catching insects: Yellow Sticky Traps, insect traps and entomological nets. In total, we recorded 267 individuals belonging to 44 species and 12 families. There was one eudominant species, namely *Apis mellifera*. We recorded the highest value of diversity in study area 1 (H'=2.931) and equitability in study area 2 (E=0.9118). Through Principal Component Analysis (PCA) analysis, we noted a greater binding of species to the meadow biotope with partial planting of grass mixtures that attract butterflies and bees.

Keywords: Insecta; pollinators; bioindicator; Slovakia.

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Introduction

The diversity of life on Earth is dramatically affected by human changes in ecosystems (Baillie et al., 2004). Many activities necessary for human existence lead to the reduction and gradual loss of biodiversity. This trend will probably continue in the future. Biodiversity impacts occur across countries and regions and span a given area over long distances. Mineral supply chains can have extensive, but often hidden, impacts on biodiversity (Lambin et al., 2018; Díaz et al., 2019).

On the one hand, industry is a key element of the economy, but on the other hand, it is also a major source of pollution. It has a major effecton the environment and biodiversity around the world. The risks associated with the negative impact on biodiversity are mainly made up of sectors focused on mining, forestry and agriculture. In these industries that uncontrolled business practices can cause environmental deterioration (Bao et al., 2019). Even the construction of industrial areas, occupying vast areas, is a simple example of an adverse impact on local biodiversity (Sonter et al., 2018). Extractive industries play a significant role in the global loss of biodiversity. This type of business is the main source of large industrial operations that often come to remote and undeveloped areas, potentially disrupting habitats and degrading the local environment (Moldalieva, 2021). The mining industry hasa special position among industries, because its activity provides raw materials for other industries. It is at the beginning of the chain of industries and mining itself represents serious and highly specific threats to biodiversity (Chovancová, Adamišin, 2016).

The European Union's biodiversity strategy highlights the importance of the private sector and its significant role as a potential destroyer and at the same time protector of biodiversity (Marco-Fondevila, Álvarez-Etxeberría, 2023; Tregidga, 2013). The European Union has committed itself to an ambitious biodiversity restoration plan in its 2030 Biodiversity Strategy and Green Deal. The aim is to halt the loss of biodiversity and move towards sustainable development, focusing on restoring degraded habitats, expanding the network of protected areas and improving the efficiency of management, administration and financing (Hermoso, 2022; Paleari 2024).

The goal of our biomonitoring is to evaluate the state of pollinators in the industrial area of Wienerberger s.r.o., which also participates in the restoration of habitats for pollinators and the increase of overall biodiversity, according to European Union regulations.

Material and methods

During 2023, we collected insects with a focus on pollinators in the industrial area of the brick factory (Zlaté Moravce, Slovakia) of Wienerberger s.r.o. We had 4 study areas on the company premises,

Fig. 1. Industrial area of company Wienerberger s.r.o.
Note: study area 1, 2, 3, 4.

representing meadow biotopes (fig. 1):

1) study area, mowed meadow next to the administrative building, area 15 m^2, (48°23'30.3"N, 18°22'39.7"E). On the area, we noticed the predominance of the following types of plants: *Vicia hirsuta*, *Leucanthemum vulgare*, *Plantago lanceolata*, *Elymus repens*, *Taraxacum officinale*, *Salvia nemorosa*, *Trifolium pratense*, *Papaver rhoeas*, *Calystegia sepium*. The planted mix of pollinator-attracting herbs contained the following species: *Pimpinella major*, *Betonica officinalis*, *Allium angulosum*, *Securigera varia*, *Helianthemum grandiflorum*, *Verbascum nigrum*, *Origanum vulgare*, *Echium vulgare*, *Lathyrus pratensis*, *Aster amellus*, *Dianthus carthusianorum*, *Dianthus deltoides*, *Pilosella aurantiaca*, *Knautia arvensis*, *Centaurea jacea* and *Trifolium montanum*;

2) study area, unmown meadow adjacent to the riparian vegetation of the pond, area 45 m^2, (48°23'39.1"N, 18°22'36.5"E). On the area, we noticed the predominance of the following types of plants: *Vicia hirsuta*, *Leucanthemum vulgare*, *Poa pratensis*, *Elymus repens*, *Plantago lanceolata*, *Taraxacum officinale*, *Trifolium pratense*;

3) study area, unmown meadow adjacent to the clay mine quarry, area 320 m^2, (48°23'41.3"N, 18°22'25.0"E). On the area, we recorded the predominance of the following types of plants: *Potentilla anserina*, *Vicia hirsuta*, *Leucanthemum vulgare*, *Elymus repens*, *Taraxacum officinale*, *Papaver rhoeas*;

4) study area, unmown meadow adjacent to the clay mine quarry, area 360 m^2, (48°23'36.7"N, 18°22'03.1"E). On the area, we noticed the predominance of the following types of plants: *Potentilla anserina*, *Vicia hirsuta*, *Leucanthemum vulgare*, *Calamagrostis arundinacea*, *Taraxacum officinale*, *Papaver rhoeas*, *Calystegia sepium*.

We caught insects using the following methods: Yellow Sticky Traps, insect traps and entomological nets at regular monthly intervals from May to September. For each study areas (1-4), we made a total of 5 of subscriptions insect sampling. The number of individuals during the months was as follows: May = 26 individuals, June = 90 individuals, July = 42 individuals, August = 38 individuals, September = 71 individuals. We determined the captured insect material according to (Macek et al., 2015, 2017).

Multivariate analysis (Principal Component Analysis – PCA) to determine the dependencies between objects (insecta and study areas) was used in the Canoco5 program (Ter Braak, Šmilauer, 2012).

We calculated Shannon's index of diversity and Equitability in the program Past 3.05 (Hammer, 2015).

Results and discussion

In the area of the brickyard, we recorded 267

Table 1. Systematic review of pollinator species of the study areas

Familia	Species	Study Area				Σ Individuals	%
		1	2	3	4		
Syrphidae	*Dasysyrphus albostriatus* (Fallén, 1817)	2				2	0.75
	Epistrophe grossulariae (Meigen, 1822)	2				2	0.75
	Episyrphus balteatus (De Geer, 1776)		1		2	3	1.12
	Eristalis similis (Fallén, 1817)				1	1	0.37
	Eupeodes corollae (Fabricius, 1794)	1	6	6	5	18	6.74
	Melanostoma scalare (Fabricius, 1794)	17	4			21	7.87
	Sphaerophoria fatarum Goeldlin, 1989	1				1	0.37
	Sphaerophoria scripta (Linné, 1758)	5		2	5	12	4.49
	Xanthandrus comtus (Harris, 1780)	3	1			4	1.50
Apidae	*Andrena minutula* (Kirby, 1802)	1		2	2	5	1.87
	Anthidium florentinum (Fabricius,1775)	1				1	0.37
	Apis mellifera Linné, 1758	22	4	6	14	46	17.23
	Bombus haematurus Kriechbaumer, 1870	1				1	0.37
	Bombus lapidarius Linneus, 1758	7	2	1	1	11	4.12
	Bombus terrestris Linné, 1758	12		1	1	14	5.24
	Halictus tumulorum (Linnaeus,1758)	3		1		4	1.50
	Chalicodoma ericetorum Lepeletier, 1841	2			1	3	1.12
	Xylocopa violacea Linnaeus, 1758	3	1	2		6	2.25
Vespidae	*Dolichovespula media* Retzius, 1783		7	6		13	4.87
	Polistes sulcifer Zimmermann, 1930			1	1	2	0.75
	Vespa crabro Linnaeus, 1758			1		1	0.37
	Vespula germanica (Fabricius, 1793)		3	6		9	3.37
Arctiidae	*Amata phegea* (Linnaeus, 1758)	2		1		3	1.12
Geometridae	*Alsophila aceraria* (Denis, Schiffermüller, 1775)			1		1	0.37
Lycaenidae	*Aricia agestis* (Denis, Schiffermüller, 1775)			1		1	0.37
	Glaucopsyche alexis (Poda, 1761)	1	2		7	10	3.75
	Lycaena tityrus Poda, 1761			1		1	0.37
	Polyommatus eroides (Frivaldszky, 1835)	4		1		5	1.87
Nymphalidae	*Boloria dia* Linnaeus, 1767	4			1	5	1.87
	Apatura ilia (Denis & Schiffermüller, 1775)	1				1	0.37
	Vanessa atalanta Linné, 1758	1				1	0.37
	Aglais io (Linnaeus, 1758)	1				1	0.37
Papilionidae	*Iphiclides podalirius* Linnaeus, 1758	3				3	1.12
	Papilio machaon Linnaeus, 1758	1				1	0.37
Pieridae	*Aporia crataegi* Linnaeus, 1758				1	1	0.37
	Leptidea sinapis (Linnaeus, 1758)		1	1	2	4	1.50
	Pieris brassicae (Linnaeus, 1758)	4	4	5	9	22	8.24
	Pieris rapae (Linnaeus, 1758)	6				6	2.25
	Pontia edusa Fabricius, 1777	1				1	0.37
	Colias hyale (Linnaeus, 1758)	1				1	0.37
Satyridae	*Coenonympha pamphilus* Linnaeus, 1758	1	1		8	10	3.75
	Melanargia galathea (Linné, 1758)	1		1	2	4	1.50
Sphingidae	*Hemaris tityus* Linné, 1758	3				3	1.12
Zygaenidae	*Zygaena filipendulae* Linnaeus, 1758				2	2	0.75
Σ individuals		**118**	**37**	**47**	**65**	**267**	**100**

Table 2. Diversity and equity of study areas

Study area	Shannon_H	Equitability
1	2.931	0.8458
2	2.339	0.9118
3	2.676	0.8931
4	2.482	0.8587

individuals belonging to 44 species and 12 families (tab. 2). We recorded a eudominant representation (D>10%) in the species *Apis mellifera*. In the species *Eupeodes corollae*, *Melanostoma scalare*, *Bombus terrestris*, *Pieris brassicae* we confirmed the dominant representation (D=5–9.9%). Subdominant (D=2–4.9%) species were *Sphaerophoria scripta*, *Bombus lapidarius*, *Dolichovespula media*, *Vespula germanica*, *Glaucopsyche alexis*, *Coenonympha pamphilus*. The other species had recessive or subrecessive representations.

We found the highest value of diversity in study area 1 (H'=2.931) and the lowest in study area 4 (H'=2.482). We found the highest value of equitability in study area 2 (E=0.9118) and the lowest in study area 1 (E=0.8458). The results of the values of diversity (H') and equitability (E) are summarized in table 2.

In study area 1, we recorded a higher species diversity, because a mixture of herbs attracting pollinators was planted on the site. In the other study areas (2–4), species biodiversity was lower due to mining. The decrease in biodiversity due to mining was also early confirmed (Turley et al., 2022; Bridge, 2004; Pascal et al., 2008; Edwards et al., 2014; Smith et al., 2004).

Principal Component Analysis (PCA, SD=1.9 on the first ordination axis) revealed the connection of species to study areas. The explained variability of taxonomic data values was 74.31% on the first ordination axis and 96.56% on the second cumulative ordination axis.

On the ordination graph (biplot) 3 clusters were recorded. The first was made up of species linked to study area 1. The second cluster wasrepresented by species preferring the conditions of study areas 2 and 3. The third cluster wasmade up of species linked to study area 4. From the analysis, we saw that the most suitable conditions were the species in study area 1, which wereinfluenced also by planting grass mixtures that attract butterflies and bees (fig. 2).

Mining companies are motivated to mitigate the loss of biodiversity caused by their activities, and various corporate sustainability strategies are increasingly being created to achieve the goals of sustainable development and biodiversity protection (Rainey et al., 2015). In our case, the Wienerberger s.r.o. company took the same approach and ensured the planting of grass mixtures that attract pollinators on the studied meadow areas. Industrial mining operators can improve the sustainability of their operations by implementing certain strategies (Swingland, 2013; Murguia et al., 2016). Sustainable mining requires companies to better understand and appreciate the value of biodiversity to their long-term operations as well as to local communities. Therefore, companies must not only reduce negative impacts on biodiversity, but must also contribute positively to the restoration of nature (Wickham et al., 2013; Littleboy et al., 2019). In our study, we also confirmed a higher number of species in study areas 1 and 4, where insect houses were installed for better conditions for insect reproduction.

Conclusions

Our results brought knowledge about biomonitoring of pollinators in the industrial area of Wienerberger s.r.o. During 2023, we recorded a total of 267 individuals belonging to 44 species and 12 families with the eudominant species *Apis mellifera*. We recorded the highest value of diversity in study area 1 (H'=2.931) and equitability in study area 2 (E=0.9118). PCArevealed that most species preferred study area 1, which was influenced by meadow management and partial planting of grass mixtures that attract butterflies and bees. In order to comply with the European Union's strategy for the restoration of biodiversity, it is necessary to carry out biomonitoring of industrial sites and subsequent management for the restoration of habitats after mining by attracting insects with an emphasis on pollinators.

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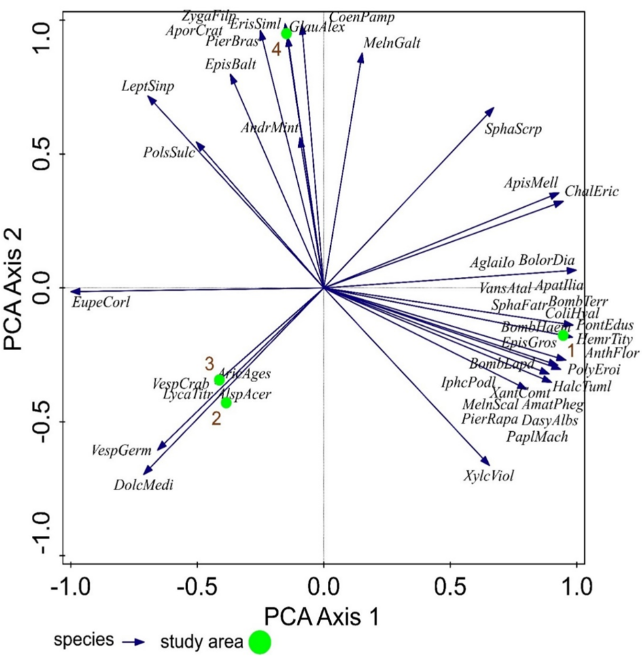

Fig. 2. PCA analysis of the attachment of insects to the study areas

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Ланграф В., Затковa М., Фабик М., Петровикова К. **Оценка сообществ опылителей в районах промышленного воздействия**.

За последние десятилетия Европейский Союз разработал несколько стратегий, направленных на содействие эффективному использованию ресурсов, циркулярной экономике и решению проблемы утраты биоразнообразия и изменения климата. В течение 2023 г. в импактной зоне предприятий компании Wienerberger s.r.o. проведен биомониторинг насекомых с акцентом на опылителей. Исследования проведены на 4-х участках, представляющих луговой биотоп. Для ловли насекомых использовали следующие методы: желтые липкие ловушки, ловушки для насекомых и энтомологические сети. Всего зарегистрировано

267 особей, принадлежащих к 44 видам и 12 семействам. Был один эвдоминантный вид – Apis mellifera. Наибольшее высокое значение разнообразия на участке 1 (H'=2.931) и коэффициента выровненности на участке 2 (E=0.9118). Методом главных компонен (PCA) выявлена привязку видов к луговому биотопу с подсевом травосмесей, привлекающих бабочек и пчел.

Ключевые слова: насекомые; опылители; биоиндикаторы; Словакия.

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