BIODIVERSITY
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BIORÓŻNORODNOŚĆ W ROLNICTWIE

International Conference

BIODIVERSITY IN AGRICULTURE

Abstracts

Międzynarodowa Konferencja

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Streszczenia

Lublin, 12–13 October 2023

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Drivers and conservation of farmland biodiversity and its ecosystem services

Eva Knop

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Due to changes in agricultural practices farmland biodiversity has declined in many parts of the world over the past decades. In fact, due to farmland being a habitat for numerous organisms, these changes are considered to be a main driver of the ongoing worldwide loss of biodiversity. This brings about many concerns, of which one is a reduced resilience of the system towards diseases or environmental changes, such as climate change. Also, due to the positive relationship between biodiversity and ecosystem functioning, it leads to reduced provisioning of important ecosystem services, such as pollination. I will begin with a short overview on the current status of farmland biodiversity and its ecosystem services, and then focus on major biotic and abiotic factors that drive changes of farmland biodiversity and ecosystem services. Doing so, I will consider the different spatial scales at which those drivers affect farmland biodiversity and ecosystem services. Finally, I will show how farmland biodiversity might be restored and conserved in an effective way, and I will show where more work needs to be done in near future.

The importance of biodiversity in agriculture

Ben Woodcock

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At its heart arable agriculture needs to support food production and maintain profitable farming systems vital to peoples livelihoods. Increased mechanisation, conversion of semi-natural habitats to production land and the wide spread use of agrochemicals have been critical to achieving these goals, but they have come at a cost to biodiversity that a century ago would have been a common feature of agricultural land. While there has been a wide scale acknowledgement that biodiversity declines are attributable to the impacts of farming at the same time there has also been an increased understanding that some of this biodiversity support production. This includes invertebrates that enhance pollination, natural pest control and soil biological processes. In this talk I will discuss research undertaken over the last 10 years in the UK looking at how agriculture can be modified to support greater levels of biodiversity, maximising those components of invertebrate fauna that provide critical ecosystem services while maintaining production and so feeding into sustainable agriculture. While agriculture will arguably always have a detrimental effect on biodiversity this talk will consider where and how the can be minimised and so benefit multiple stakeholders, from the farmers to the general public.

The future of biodiversity and associated ecosystem services in agricultural landscapes in Europe

Klaus Birkhofer

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Biodiversity in agricultural landscapes benefits humans, for example through the contribution of insects and spiders to the control of crop pests or through improved nutrient cycling by soil organisms in arable soils. A loss of species therefore directly threatens human well-being through negative effects on the provision of associated ecosystem services. Land-use and climate change both contribute to an unprecedented rate of biodiversity loss in human history. The related loss of ecosystem services in agricultural landscapes is mainly compensated by the application of agrochemicals such as synthetic pesticides or NPK fertilizer, with both practices accelerating the loss of biodiversity further. To break this vicious circle, agroecological research needs to contribute to the development of alternative, less harmful practises that provide opportunities for farmers to manage their land more sustainable. In this respect, both fundamental research to understand how and which biodiversity relates to the provision of ecosystems services and applied research about potentially beneficial practices are crucial. In regards to climate change, managing arable soils to improve their water holding capacity and simultaneously protect soil biodiversity to maintain soil functioning is a major aim facing more severe summer droughts in parts of Europe. The use of organic instead of synthetic fertilizers creates major benefits in regards to soil organic carbon content, water holding capacity and soil biodiversity and also makes soil communities more resilient towards summer drought events. Regarding land-use change, biodiversity will benefit from more diverse agricultural landscapes with a mixture of different crops and non-agricultural areas. Together with non-agricultural habitats, like fallows or grassy field margins, a mosaic of different crops across the landscape creates sustainable conditions to produce food and fodder while also protecting biodiversity. The ongoing conventional intensification of agricultural production in a “business as usual” manner is environmentally unsustainable and will affect human health negatively. The current state of knowledge already allows us to create a more sustainable future for agricultural production by creating a win-win situation that benefits farmers, the public and biodiversity. Research further identifies new opportunities to create additional value chains for farmers that at the same time contribute to biodiversity conservation, such as agroforestry strips or biodiversity-friendly photovoltaic parks. It is time now to join forces to implement economically and environmentally sustainable agricultural systems at the regional, national and European scale to stop the dramatic biodiversity loss.

Ground beetles (Carabidae, Coleoptera) in the agricultural landscape – a fading hope

Paweł Sienkiewicz

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Ground beetles are one of the most numerous groups of beetles found in and around croplands. They are insects considered to be beneficial, helping to regulate the abundance of invertebrates that are among other crop pests. However, these are not all the functions they perform as some of them feed on plant food at the same time. Some are even phytophagous. Therefore, the range of ecosystem services provided by this group of insects may be broader than traditionally described in acgroecology textbooks, although a few species may be pests. The agricultural landscape has become simplified, with high levels of chemisation. This, and agrotechnical methods, is causing a decline in ground beetle species living in intensively managed landscapes. It is therefore worth considering methods to protect the biodiversity of agricultural landscapes based on existing knowledge and to strengthen conservation efforts substantively. Ground beetles could also be a group of insects supporting the monitoring of biodiversity support programmes, as with other terrestrial ecosystems. However, this requires further scientific research, especially at the interface between biodiversity and estimating the value of ecosystem services derived from it.

Pollinators and pollination. Effects of climate change, pesticides and other drivers

Anders Nielsen

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Pollinators, and the ecosystem service they provide, is under threat from several anthropogenic drivers, including land-use change, climate change, pesticides, and invasive alien species. Land-use is seen as the main driver and is happening all over the world. Urbanisation and agricultural intensification, but also abandonment of marginal agricultural land affect ecosystems and the biodiversity they contain. Climate change alters species phenologies and distributions potentially affecting their interactions. The mutual relationship between plants and their pollinators is particularly prone to changes in interaction patterns, as negative effects on one mutualistic partner ultimately also affect the other. Insecticides are used to kill insects in agricultural productions. Over the last decades their effect on non-target organisms have received attention. Pesticides might kill wild bees and other pollinators, but more likely induced subtle and sub-lethal effects reducing survival and reproduction. Invasive species might directly compete with native species, over space or common resources (e.g., food), but they can also bring with them novel pathogens and parasites that might spill over to the native pollinator fauna. In this talk I will present several studies we have conducted in Norway, and beyond, and show how different drivers affect pollinators and pollination, separately, and in concert.

What do we need to know about pollination effectiveness – an ecological and economic perspective

Bożena Denisow

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Globally, ca. 87% of wild angiosperm plant species need animal pollination services (mainly insects) for effective reproduction (Ollerton et al., 2011). Insect pollination is also critical for human nutrition stability, as it provides a varied diet (fruits, grains, vegetables) which deliver minerals, vitamins, antioxidants, and other substances essential for metabolism. Pollination has also an impact on human economic stability, as 75% of the world's leading food crops show increased fruit or seed set with animal pollination.

The approach to pollination has evolved. In the 1970s, the prevailing view was that the goal of evolution was the morphological adaptation of flowers for the most effective pollinator and the frequency of insects on flowers was accepted as a measure of pollinator effectiveness. The rapid progress of the research on pollination effectiveness has brought ample evidence that the plant-pollinator relationship goes beyond the morphological flower characteristics. For example, the plant-pollinator relationship is also based on the biology of flowering (seasonal and diurnal dynamics of flowering) and the biochemistry of floral reward (changes in the sugar composition between floral phases). Currently, the measures of pollination effectiveness include (i) the pollen load carried by insects, (ii) the insect frequency in the female phase of the flower, and (iii) the number of pollen grains deposited on the stigma (e.g. Antoń and Denisow, 2018).

Considering the pollinator taxa, although honey bees are still regarded as important pollinators (mainly due to the colony size and their frequency in entomophilous crops), they turned out to be less effective than wild bees. There is evidence that the pollination of diverse plants (both in terrestrial ecosystems and crops) will benefit from conservation of non-honeybee taxa.

Ollerton, J., Winfree, R., Tarrant, S. (2011). How many flowering plants are pollinated by animals? Oikos, 120(3), 321–326.
Antoń, S., Denisow, B. (2018). Pollination biology and breeding system in five nocturnal species of Oenothera (Onagraceae): reproductive assurance and opportunities for outcrossing. Plant Systematics and Evolution, 304, 1231–1243.

The conservation of wild bees in modern agricultural landscapes

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Wild bees are essential pollinators, not only for plants in natural ecosystems but also for many of our crops. However, habitat fragmentation and agricultural intensification has led to the loss of many of the species that provide this ecosystem service. In order to reverse the loss of species and decline of wild bee diversity and abundance it is vital to understand what these species need in order to live in modern agricultural landscapes.

For this, we need to know which species, and in extension, which functional traits are affected most by agricultural intensification and which species and traits are filtered out. What can we learn from species that survive or even thrive in agricultural ecosystems and how can we reintroduce the species that have gone regionally extinct?

We will explore this question based on recent data and by making use of indicator species and functional groups, which help shed light on trait combinations that are beneficial or detrimental and we will focus on the two most important factors for bees, namely the presence of host plants and the availability of nest sites. Since neither of these factors are present inside the fields themselves, we must protect the natural habitat fragments surrounding the fields to protect the species that remain, as well as create new suitable habitats to attract the species that have been lost. This in addition with agroecological practises and an increase of land use heterogeneity will ensure a future for our most important pollinators.

Taxonomic and biochemical diversity of microalgae as resources for biotechnological applications

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The diversity of microalgal species plays an important role in global aquatic and terrestrial ecosystems. The Chlorophyta clade is very diverse and includes freshwater, marine, and terrestrial microalgae. Scenedesmus and Chlorella are the most abundant freshwater algal genera. Identification of these microalgae is difficult and requires the development of DNA barcoding to confirm their affiliation at various taxonomic levels, in addition to analyses of structural and phylogenetic traits. The effectiveness of barcoding is determined by the following genes: 18S, 28S rRNA, ITS1-5.8S-ITS2, 18S rDNA, rbcL, 16S rDNA and 16S, 23S rDNA (ITS), 18S V4, and rbcL, which identify the genera of the families Scenedesmaceae and Chlorellaceae. Microalgae are rich in primary and secondary metabolites, e.g. pigments (astaxanthin lutein, β-carotene, chlorophyll a, b, c), which are used as food, pharmaceutical, and cosmetics products. With their high concentration of polysaccharides, lipids, bioactive peptides, amino acids, PUFAs, and enzymes, microalgae can be used as a component of healthy foods, nutraceuticals, and cosmetics.

In addition, sustainable agriculture and climate change require the development of new methods for the production of environmentally beneficial crops. One of these products is algal extracts that exert an impact on the transcription of genes involved in the synthesis of growth hormones: auxin, cytokinin, and abscisin, which are responsible for plant growth and crop yields. Microalgae can also potentially be used as a source of bioenergy. Additionally, they are suitable for wastewater treatment and provide nutrient-rich biomass as they utilize inorganic N and P for growth and remove heavy metals and toxic organic compounds, preventing secondary pollution. The role of microalgae in the future development of sustainable agriculture and in the process of global carbon neutrality should be emphasized. Furthermore, health-promoting products derived from microalgae should be widely promoted and research on the safety of their use should be continued.

Diversity of microbiomes of cultivated and non-cultivated Fluvisols

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Human agricultural activity affects the quality of soil, which plays an important role in the context of crop quality and food security. The aim of this study was to compare the composition of the bacterial community in river silt used for blackcurrant cultivation and not used for agricultural purposes.

The research material was the medium river muds, Fluvisols, collected in Opatkowice, in the Vistula River valley, in the Lublin Voivodeship (51°27'44.9"N 21°52'14.1"E). This area is a natural floodplain of the river, and the classification was made on the basis of an agricultural map. Soil was collected from the blackcurrant cultivation (agriculture – A) and from the neighboring meadow (M). Samples were taken with a sterile probe from a depth of 0–20 cm in August 2022. DNA was isolated using a commercial kit followed by Next Generation Sequencing (NGS) by Miseq, Illumina.

The analysis showed that Proteobacteria were the dominant phylum in agricultural soil, and Acidobacteria in meadow soil. At the genus level, both variants were dominated by an unidentified taxon from the class Acidobacteria_Gp6 (16.27% – M and 11.73% – A). Among the identified genera, Sphingomonas spp. dominated in both cases (1.55% – M and 2.53% – A).

The Shannon index was higher in the soil from the blackcurrant cultivation and amounted to 4.41, and in the soil from the meadow 4.01. The value of the Chao1 index was also higher in the cultivated soil (254) compared to the meadow (159). Interestingly, both soils had 141 ASVs in common, but as many as 107 were found only in the blackcurrant soil, while there were only 13 unique taxa in the meadow soil. Among the bacteria found only in arable soil, it is worth paying attention to the genus Massila (0.61%), whose representatives have the ability to degrade cellulose and chitin, and some species are referred to as plant growth promoting bacteria.

The obtained results indicate that both soils have a common microbiome and the same bacteria dominate in both. In addition, the soil under blackcurrant cultivation is characterized by a more diverse microbiome, which may result from the applied fertilization.

The research was carried out within the framework of project No. 2019/35/N/NZ9/00830 entitled: "The search for bacteria adapting to extreme soil moisture conditions and the assessment of the effects of hydric stress on the quality of the soil environment" funded by the National Science Centre Poland (NCN).

Comparison of metabolic profiles (Biolog GenIII test) of *Azotobacter chroococcum* strains

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Characterization of the metabolic profile of 13 strains belonging to the genus Azotobacter was performed with the use of the Biolog system using GenIII plates. Genetically identified (based on the analysis of the 16S rRNA gene sequence) strains of Azotobacter spp. belonging to one species of Azotobacter *chroococcum* showed metabolic differentiation in relation to the substrates of all analyzed groups: carbohydrates, amino acids, carboxylic acids and other substrates. The A2684 strain was characterized by the highest metabolic activity among the tested (AWCD = 95.007), while the lowest value of this indicator (AWCD = 59.628) was obtained for the A819 strain. The differences in the catabolism of individual groups of substrates between the compared strains probably result from their intraspecific diversity and the specificity of the soil from which they were isolated.

Development of innovative technology for producing microbially enriched bio-fertilisers supporting sustainable crop production and its adaptation to climate change

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The main objective of the project is to develop technology of biofertiliser production based on biodegradable waste and microorganisms, supporting development of sustainable crop production, especially to counteract drought conditions, as support for waste circular management and adaptation and mitigation to climate change. The technologies for producing three types of biofertilizers based on liquid digestate compost and biochar and containing high level of phytohormones will be developed. Biofertilizers will be carriers of microorganisms supporting plant growth in drought conditions. In the first phase, the microorganisms most effective in drought conditions will be selected. They will be used to develop the optimal composition of a consortium of microorganisms supporting crops under rainfall deficiency. The reactors faithfully reflecting the conditions of fermentation, composting and torrification on an industrial scale will be used to produce substrates maximally rich in phytohormones and serving as carriers of consortia of dedicated microorganisms. In the next phase of the project, digestate, compost and biochar inoculation technologies will be developed, taking into account their physical form. In the final phase, the effectiveness of developed innovative bio-fertilizers in supporting drought resistance of plants will be tested in greenhouse and plot experiments simulating real conditions. The main result of the project will be the development of innovative technologies combining three different strategies aimed at increasing drought resistance of plants and reducing crop losses in seasons with insufficient rainfall, i.e. using the potential of drought-resistant microorganisms, introducing phytohormones and increasing soil water holding capacity by introducing exogenous organic matter to soil.

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The rhizosphere bacteria– genetic identification of potential biofertilizers components

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Agricultural crops are exposed to abiotic and biotic stresses that can constrain crop productivity. Global climate changes are a problem of high priority as they increases the frequency of extreme weather events and influences crop production worldwide. Drought stress is one of the main factors negatively affecting plant growth and production. Drought causes numerous physical damages, physiological and biochemical disturbances and molecular changes in plant tissues leading to a decrease in yield. There is thus a need to seek ways of reducing this risk by improving plant growth under drought stress conditions. One of the key ways to reduce this risk is the use of microbiologically enriched biofertilizers. The purpose of this study was the genetic identification of potential biofertilizer components, i.e. isolated bacterial strains from the rhizosphere of plants growing on metallurgical waste landfills heavily polluted with heavy metals with extremely difficult water conditions. For this purpose, the genetic material of selected bacterial isolates was isolated and a fragment of the 16S rRNA gene was amplified. Sanger sequencing was commissioned by the Genomed SA laboratory in Warsaw. Among the potential microbiological components of biofertilizers, strains of bacteria classified to the genus: Burkholderia, Pseudomonas, Rhizobium and Mesorhizobium have been identified.

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The functional diversity of fungi associated with *Triticum aestivum* L.

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Wheat, as the most important cereal cultivated worldwide, is inhabited by numerous microorganisms whose mutual interactions influence its health, growth and development, grain yield and quality. Among Polish organic farmers, spring wheat is more popular than winter wheat, due to its lower susceptibility to frost damage and lower pressure of crop-reducing factors, i.e. pathogens, pests and weeds.

The rhizosphere is the area around a plant root that is inhabited by a unique population of microorganisms influenced by the plant roots exudates. The constant supply of organic matter in the root zone during the vegetation period causes that the number of fungal communities occurring near the roots and on their surface is much greater than in the soil beyond the reach of the roots. Although rhizosphere fungi that positively interact with plant roots play a key role in agricultural crops and are a promising factor in terms of their potential use in organic farming, knowledge about their communities in agricultural soils and the rhizosphere zone is still limited.

The aim of the presented research was to analyze the functional diversity of fungal communities inhabiting roots and the soil rhizosphere of six varieties of spring wheat grown in the ecological system, using BIOLOG FF plates.

The presented research was completed in the frame of the research project no. 1.08 entitled "Characteristics of fungal endophytes from selected spring wheat cultivars and determination of their potential in plant growth promotion and the limitation of plant pathogens development", financed from the statutory subsidy of IUNG – PIB, Puławy (2022–2025).

The importance of bees for biodiversity, their problems and methods to counteract their depopulation

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One way to preserve biodiversity is to pollinate plants. Bees play a key role in this process. They are particularly useful in agriculture by carrying pollen within the ecosystem, increasing the number and quality of crops. Thanks to their hard work, we can enjoy the gifts of nature in the form of vegetables, fruits, grains and admire the beauty of flowers. They are part of the food chain for at least several dozen species of birds, spiders and insects. Wild animals benefit from the activity of bees, for which fruits from pollinated plants are a natural source of food. The loss of even one element of the natural environment may prove crucial for the functioning of the entire ecosystem.

The decline in the number of pollinating insects, especially bees, is becoming a common problem known all over the world. In part independent of humans, it is due to diseases caused by invasive parasite species. On the other hand, one of the biggest problem of modern beekeeping is the chemization of agriculture, which directly and indirectly threatens bees. Its direct impact is manifested by poisoning of bee colonies. However, indirect is the weakening of immunity due to the penetration of toxic compounds into the hemolymph, which disrupt immune protein synthesis pathways. In addition, widespread use of herbicides leads to depletion of the food base, resulting in nutritional deficiencies. Protein deficiencies necessary for the smooth functioning of the immune system and the accumulation of adequate fat body reserves can be particularly acute. Another reason for the decline in bees' immunity are modern apiary management methods, including migratory beekeeping, which exposes bees to stress and a mono-diet. Concentrating too many colonies on one apiary may result in the rapid depletion of pollen resources in the environment, a source of very valuable protein.

Under such conditions, only high efficiency of immunity mechanisms determines the survival of bees. The key in research on bee immunity is the study of the proteolytic and antioxidant systems in functionally related bee tissues: fat body, hemolymph and cuticle, which are handled by our Team in the Department of Invertebrate Ecophysiology and Experimental Biology at the University of Life Sciences in Lublin, Poland.

The problems can be solved through small but massive actions. One of them is to provide insects with space to live in every possible place. Nectar-producing and different species of plants should be planted. Supporting bees' immunity by administering appropriate biostimulators. Artificial plant protection products should be replaced with compost and no grass burning.

Invasive species as a threat to the biodiversity of pollinating insects

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An invasive species is defined as an organism that poses a threat to the native flora and fauna of the ecosystem and is characterized by significant expansiveness. These species have a negative impact on biodiversity by competitively displacing native species (predation as well as transmission of pathogens or changing ecosystem conditions). Invasive alien species can also pose a threat to pollinating insects. Thanks to their activities, pollinators are organisms that stabilize the ecosystem and create biodiversity in the environment. They are of key importance in agricultural and livestock production. Research conducted in Poland indicates that one of the invasive plants that has a negative impact on the biodiversity of pollinating insects is Canadian goldenrod (Solidago canadensis). While displacing native species of meadow plants, goldenrod is also the reason for reducing the diversity of bees and butterflies. It disturbs the cycle of bees entering hibernation due to the continuity of access also in autumn periods. In addition, Canadian goldenrod does not produce nectar that is good enough for pollinators both qualitatively and quantitatively. As a result, pollinators such as bees and butterflies leave sites dominated by this species. Canadian goldenrod has a particularly negative effect on day butterflies. Due to the often close connection with specific plant species in different periods of the life cycle, their biodiversity decreases when these species are displaced by the invasive goldenrod. Another example of an invasive species with a negative impact on pollinators is the Asian hornet (Vespa velutina nigrithorax). Its wide range of impacts on native pollinator species has not yet been sufficiently documented. However, it is possible to say that due to the similar food base of the European hornet (*Vespa crabro*) to the native species, it is a serious competition for this species. In addition, the Asian hornet eagerly hunts not only representatives of the honey bee (*Apis melifera*), but also other wasps and flies. This seriously disturbs the biodiversity of existing ecosystems. Many aspects of the impact of alien invasive species on the biology of pollinating insects are still at an early stage of research, but they provide important information that will enable effective protection of native species in the future.

The impact of pollinating insect biodiversity on biodiversity in agriculture

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Pollinators are a key link in creating biodiversity among the flora and fauna of the environment. A large part of plants that require pollination is the basis of agricultural production (e.g. rapeseed) and thus are an essential element of animal production and human nutrition.

The most popular pollinators associated with agriculture are bees and are responsible for about 90% of pollination carried out by insects, of which honey bees, bumblebees and other wild pollinators (e.g. solitary bee, Osmia) participate in pollination.

Contrary to popular belief, honey bees are worth breeding not only for honey, but also because of the value of the crops they pollinate, which far exceeds the value of the honey they produce. The advantage of honey bees is also the possibility of overwintering colonies.

Bumblebees fly over many plant species, including those that cannot be pollinated by honeybee workers, or are insufficiently pollinated by the specific structure of their flowers, such as deeply hidden nectar, inaccessible due to the short tongues of the workers (about 7 mm). Bumblebees are efficient pollinators, flying within 1 minute, e.g. up to 30 red clover flowers. The size and thick hair of bumblebees make them work at lower temperatures (in summer at about 10°C), while the honey bee starts working above 15°C.

Solitary bees occur at certain times of the season, mainly in early spring and summer. The most popular bee is the mason bee, which is easy to breed. The larvae pupate and overwinter as adult insects in a cocoon in which they can be easily transported and, depending on the needs, cause their emergence to be used for pollination.

However, not all pollinating insects are Hymenoptera. Flies (e.g. hoverflies) are an important group of pollinating insects, mainly for wild plants. Beetles are an important pollinator for evolutionarily old plants. They pollinate plants with flat flowers, often emitting an intense and bland smell. In butterflies, the mouthparts in the form of a coiled sucker allow for obtaining nectar from very deep flowers. Wasps pollinate about 1,000 species of flowers, of which over 100 are pollinated only by them, e.g. some orchids. Contrary to appearances, flowers can also be pollinated to a lesser extent by other insects, such as mosquitoes.

Due to the poor spring condition of the honey bee, other pollinating insects are becoming an important alternative pollinator for orchards, gardens and field crops.

Effect of pesticides on the pollinators

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Pollinating insects are an important link in maintaining the biodiversity of flora and fauna. Bees pollinate up to 80% of plants that will became food for humans and livestock. Therefore, the amount of crop depends on the effectiveness of pollination and animal production depends on agricultural production. Due to many negative factors, in recent years we observe decline in the populations of pollinating insects and their biodiversity, especially those living in the wild. One of the factors affecting the organism of pollinators is the chemicalization of the environment, i.e. the improper use of plant protection products – pesticides. The use of pesticides currently involves guidelines that every user of chemicals should follow. Failure to comply with these guidelines results in a threat not only to pollinators but also to other living organisms.

Pesticides can act on pollinators in a contact and oral intake. Contact with the substance is usually associated with the perching of insects on the leaves on which the substance is located. As a result of cleaning, the bee will sooner or later introduce substances into its body and it will start to affect the systems inside the body. In addition, a bee in contact with the pesticide transfers it to the hive, which results in the health of the whole family and contamination of the honey (economic losses). Since bees are the most popular and testing insects, many scientific publications have confirmed the negative effects of a number of plant protection products on their bodies. Despite the huge number of pesticides for which the LD50 has been determined, neonicotinoids are an example of those that have been extensively tested. After using these substances, a number of changes in the immune profile of honeybees were noted. In addition to changes in the level of immunity, the following effects have been reported with the use of other pesticides: changes in metabolism and detoxification processes, impaired motor functions, behaviral changes and changes in reproductive functions. Of course, pesticides not only negatively affect the honey bee, but also other pollinators, such as bumblebees or wild solitary bees. The effect of these agents, regardless of the type or species of pollinator, causes a negative impact on the life processes of insects, often even leading to death. Nowadays, we are not able to prohibit plant protection products, but by/with good practice, we can protect crops and pollinators.

Physiological and anatomical insect adaptation for pollination

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Insects are the largest and most diverse group of organisms in the world. During the processes of differentiation and adaptation, they have developed a function necessary for life, but also crucial from the point of view of maintaining the stability of the environment. Some of the insects have specialized in ecological service – pollination, which nowadays has a significant impact on the creation of biodiversity of wild flora and crops. For example, it is estimated that bees (the most popular pollinators) are responsible for pollinating 2/3 of plants that will become our food. Due to the diversity of pollinated flora, insects had to adapt their biology to the appropriate structure of plants. The main types of adaptation to pollination are: the structure of the mouthparts, the presence of baskets, hairiness, the possibility of communication of individuals in the colony and the way of perceiving colors. Pollinators may have mouthparts of the main types (but not all): chewing-lapping (Apidae), siphoning (Lepidoptera) and sponging (Diptera). In addition, each type of appliance may have anatomical differences in the length of the tongue. The length of the tongue affects the possibility of pollinating appropriate plants, e.g. with deep flowers (in bumblebees, the tongue can measure up to 8 mm). Honey bees have a shorter tongue than bumblebees, but its length is also a species/breed/line feature. Baskets are an adaptation to the pollination of bees. Basket is a places on the last pair of legs with a modified structure of hairs around which pollen collects. In this way, the bees form pollen loads that allow you to collect as much pollen as possible into the hive during the flight. In collecting and transporting pollen, insects use hairs on which they can transfer additional amounts of pollen. In the case of social insects such as bees, individuals have developed a specific way of communicating called "dance of the bees" (moving, vibrating with the abdomen). They can also use pheromones and so-called trofalaxis. An additional adaptation may be the way of seeing colors in the environment. Bee worker bees have very poor eyesight, but they are great at finding the right plants thanks to the ability to see in ultraviolet. All these adaptations allow for effective pollination of many types/species of plants, which contributes to the creation of biodiversity in the environment and obtaining abundant agricultural crops.

Assessment of the stability of species composition and flowering activity of the flower strip in western Poland

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The interest in sustainable farming methods is systematically increasing. The optimistic results of current studies mean that farmers are increasingly encouraged to sow flower strips in order to counteract the decline in species diversity in the agrocenosis. In order to achieve satisfactory effects, the appropriate selection of species plants is crucial. The composition of the mixture intended for flower strips should take into account not only the food preferences of the desired arthropod species, but also long time of plant flowering, food for herbivorous arthropods and shelter. In perennial flower strips, the number and diversification of overwintering plant species are important.

This work is an assessment of the floristic effectiveness of a one from available mixture of seeds intended to establish flower strips. The study focused on changes in the species composition of plants derived from the seed mixture after overwintering and the intensity of additional wild plant species naturally occurring in the strip. Therefore, the aim of the study was to assess the species composition and floral activity of annual plants sown from a commercial seed mixture and wild plants present in the second year of the existence of the flower strip.

The observations showed that the species diversity observed in the second year of the strip's presence in western Poland composed of mostly annual plant species did not overlap in the next year. It has been found that not all seeds of species are able to survive the winter in a particular area, even if it is not severe. Wild species from the soil seed bank dominated in the flower strip. However, a large variety of spontaneously emerging species (considered as weeds) can successfully colonize existing gaps in the flower zone, ensuring an increase in biodiversity.

The observations have shown that 1) only in May and early June, the dominant species were those from the sown seed mixture: *Trifolium incarnatum* L. (over 70.5% of flowering plants) and *Phacelia tanacetifolia* Benth. (26.47%), which were recommended for sowing for flower strips in the conditions of western Poland, 2) from the beginning of June to the end of July, the share of flowering plants from the soil seed bank ranged from 42.59% to 88.19%, while among the originally intended plant species it was only 11.81–57.41%, 3) it was found that plants sown from a mixture of seeds in the previous year were characterized by a low level of flowering compared to plants sown spontaneously.

It should be taken into account that wild field plants may also enhance the attractiveness of the flower strip to beneficial arthropods, but must be maintained at an acceptable level to be a valuable addition.

Land abandonment in land sharing and land sparing concept

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Agricultural or urbanized land abandonment is a potential benefit for nature conservation because it allows for the natural succession of flora and settling areas by wild animals. Following land sharing and land sparing strategies is a modern method to establish new protected areas in nature conservation. Land sharing usually means extensive, nature-friendly land cultivation. Land sparing is separating land into a part of intensive agricultural use and pristine, intact land. Although benefits of the land sharing and land sparing have been described mostly for intact, pristine areas in tropics, they may be also considered for fully managed agricultural or urbanized land that has been changed by people's activity for centuries (e.g. Europe). In our review, we searched how many publications about land sharing and land sparing refer to land abandonment. We checked if land abandonment is treated more as land sharing or land sparing, from which regions were the studies, and how authors define and judge both strategies. We found 43 relevant articles and only 26 with original data. Usually, land abandonment was not specified as land sharing nor land sparing. However, studies that made classifications, treated land abandonment as land sparing. Study areas were usually agricultural fields or forests. We found inconsistency in definitions. In articles referring to land abandonment and land sharing/sparing, we identified synonyms used for those strategies. In general, the majority of studies suggest that a combination of both land sharing and land sparing is the best solution in agricultural areas. Recently, land sharing and land sparing strategies have been applied to fully managed or abandoned agricultural landscapes, not only pristine areas. Therefore, a clear definition of both and classification of abandoned land is important because the area of abandoned land has been growing in many parts of the World, mainly due to political changes.

Native pig breeds as a source of biodiversity

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In the European agriculture over the last decades was a tendency towards standardization of genotypes and mass rearing of high-yielding breeds. As a result of these changes, the number of pig breeds has drastically declined, with some of them becoming threatened with extinction. Additionally, the intensification of the animal production has led to the emergence of multiple problems that have a negative effect on not only the environment but also the performance and health of pigs. Equally alarming are such serious threats as disease epidemics and crisis situations (e.g. droughts, floods, armed conflicts). In many European countries, there is a large group of consumers who are guided by health, social, ethical, and animal welfare considerations when buying meat and its products. For several years, there has been a constantly growing consumer demand for products derived from animals kept in natural conditions and produced in a traditional way.

Although the pig industry is currently based on the use of several cosmopolitan breeds and lines, there are still a large number of local breeds in many regions of Europe. They have special traits, i.e. resistance to diseases, longevity, and high levels of maternal traits. Compared to conventional breeds, native breeds exhibit a slower growth rate. These pigs were found to digest fiber more efficiently than commercial breeds due to the greater richness of their cellulolytic and hemicellulolytic flora. Native breeds are characterized by higher adiposity and high meat quality. They are perfectly adapted to local environmental conditions, e.g. climate, soil, and available feed resources. They can be reared with poor feed resources available in permanent grassland, which contributes to development and protection of areas of high landscape value. Native breeds have been included in program for protection of genetic resources. An argument supporting the need to preserve the genetic variation between breeds is their potential future usefulness, as some of them have genes and unique combinations of alleles that are absent or rare in other breeds.

Preservation of the genetic diversity of native breeds may have key evolutionary applications e.g. in adaptation to climate change. The biodiversity of pig populations is essential for efficient and sustainable food production, sustainable improvement of food and nutrition security, and satisfaction of the highly diverse needs of human societies in the future.

Gene Bank – science beyond jars

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Plant genetic resources are key to crop adaptation to a changing climate. However, their actual use in crop improvement is limited and in stark contrast to their potential and value. The Polish gene bank, stores seeds of over 70,000 accessions.

Our main tasks are to collect, keep alive, and provide access to germplasm of plant genetic resources. In addition, we describe accessions for morphological, phenological, and agronomic traits and maintain the database. For some time now, molecular studies have complemented the activities of our gene bank.

We are interested both in the material collected and stored and in the changes related to the aging process of seeds stored for many years in a dry state.

We are carrying out molecular characterization of the stored collections. Based on the results of genotyping by sequencing, we assess intra- and inter-accession variation, and identify duplicates and outliers.

We also focus on natural seed aging. This is a complex and multi-component process that complicates the work of all seed banks. Loss of viability is inextricably linked to loss of biodiversity. We have focused on identifying changes in the transcriptome and miRNAome that have occurred in barley seeds during 45 years of dry storage.

We plan to expand our research into cryobiotechnology in the near future. We are interested in the response of biological systems to low temperatures, especially tolerance to deep freezing.

So the Polish gene bank is more than just priceless seeds sealed in jars.

Estimating the nutritional requirements of a honey bee colony

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Bee forage consists of nectar, honeydew and pollen. These are collected from plants and are the main source of natural food. Access to the forage is not constant, it is divided into dearth periods and foraging periods. These are determined by the pollen dusting and nectaring of individual plants at different times of the year.

During the dearth period, access to natural bee forage from the environment is significantly reduced or absent. At that time bee feed must be provided to the bee colony by beekeepers in order to keep its nutritional status at an appropriate level. The most commonly bee feeds are sugar syrups of various concentrations or sugar and honey cakes (with or without pollen).

Estimating the average nutritional requirements of a honey bee enables it to more easily determine the amount of bee feed to be provided to the bee colony during various periods of the season. It contributes to optimizing the amount of food consumed during nectar and pollen dearth periods. In order to make the entire feeding process as efficient as possible with the lowest possible costs, also taking into account the welfare of the honey bee.

Properly performed supplementary feeding makes it possible to obtain healthy, strong bee colonies with a very good condition. Which, in turn, translates into the amount of honey they produce and thus the sum of profits from running their own apiary as well as improving the operation of apiary management.

Beneficial effect of a diet based on rapeseed and phacelia pollen on selected morphological elements of the fat body in *Apis mellifera* L.

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The base of the honey bee's food pyramid is pollen, which provides protein, as well as nectar rich in simple carbohydrates. Important pollen in the bees' diet are those from rapeseed and phacelia. Rapeseed is an oil plant which is often a monodiet in early summer. The phacelia pollen is valuable in antioxidant compounds. The development of the fat body will depend on the availability of floral diversity near the apiary. The mentioned tissue is segmental and therefore performs various functions, e.g. production of proteins, hormones and plays an important role in the bees' immune system. Since diets, especially multi-floral diets, regulate fat body physiology, it is puzzling how these processes occur in monodiet terms. Therefore, the purpose of this study was to determine the metabolic activity of adipose body cells after bees consumed rapeseed or phacelia pollen.

One-day-old bees were divided into three groups and fed: 1 gr. – only sugar candy; 2 gr. – sugar candy with the addition of rapeseed pollen; 3 gr. – sugar candy with the addition of phacelia pollen.

On days 1, 7 and 14, bees were collected from each group and the fat bodies from tergites III, V and sternite were isolated under a stereoscopic microscope. Attention was focused on three locations due to the increased metabolic activity of these segments. In each segment, the length and width of trophocytes and the diameter of oenocyte nuclei were measured under an optical microscope using contrast DIC.

On day 7 of the experiment, both the length and width of trophocytes in tergite III, V and sternite were greater in the group of bees fed with rapeseed pollen compared to phacelia. On day 14, the trophocytes of bees from group 3 reached larger sizes. The diameters of the oenocyte nucleus present in tergite V and sternite were comparable in both groups fed with pollen, regardless of age, but larger than the control sample and was on average 15 μm.

It can be concluded that the addition of pollen to the bees' diet, even if it is a monodiet, affects the development of fat body cells. There is a need to continue research to select pollen with the most beneficial effect on the functioning of the bees' body.

Continuation of the research is planned as part of the research project "Preludium-21", No. 2022/45/N/NZ9/01333, entitled „Aging-related changes in the systems involved in bee defence responses in the context of the pollen monodiet as a key environmental stresor".

Shaping biodiversity in agroforestry ecosystems

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Agroforestry has been identified as important for reducing species loss in agricultural landscapes, but also for protecting endangered species. Agroforestry systems are complex systems combining elements of wild and domesticated plants, animals, fungi and microorganisms that interact to determine processes and emerging properties with beneficial consequences for both ecosystems and societies. The aim of the study was to assess the development of biodiversity in agro-forest ecosystems in the Rymanów commune. The research covered selected fields: arable fields, mid-field tree stands, and a forest area with perennial trees. The following were determined in the study: pH reaction, hydrolytic acidity, basic cations, total organic carbon content, total nitrogen content and the activity of three soil enzymes: dehydrogenases, phosphatase and urease. Studies of enzyme activity provide early evidence of subtle changes in the soil environment, long before changes in the chemical composition or physical properties of soils are observed. The results of our own research showed that changes in the activity of individual agroforestry systems differed depending on the research date. In the soil from the wooded area, the dehydrogenase value was the lowest in the first and second test dates, and the highest dehydrogenase values were recorded in the soil from the agricultural field, in the second test date. The highest acid phosphatase values were recorded in soils collected from under tree stands, during the first period of the study; in soil from agricultural fields, the activity of acid phosphatase was significantly lower than in soil samples from forests and tree stands. The activity of dehydrogenase, acid phosphatase and urease can be used to assess the shaping of biodiversity. Types of land use that combine production and conservation of biodiversity within a multifunctional landscape, such as agroforestry, are important to minimize biodiversity loss in agricultural landscapes.

Searching for resistance to crown rust in landraces of *Avena sativa* L.

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Oats (*Avena sativa* L.) is a cereal that can be grown successfully throughout Poland due to its low soil and climatic requirements. Its cultivation does not require as much financial investment as wheat, rape or maize. Its unique advantage is that it can be grown after other cereals, thus playing an important role in crop rotation. Spring varieties with yellow husks are grown in Poland. Despite the fact that oats are considered to be a very healthy crop, we are increasingly observing the appearance of diseases in oats, the severity of which is almost epidemic. This is the case of crown rust caused by the fungus Puccinia coronata, stem rust (*Puccinia graminis*) or powdery mildew (*Blumeria graminis*). As there are no fungicides dedicated to control fungal diseases in oats, the most effective form of protection is to grow genetically determined resistance – having resistance genes. In the case of crown rust, around 100 resistance genes to this pathogen have been identified in cultivated oats and wild species of the Avena genus. As they are used in breeding and introduced into new cultivars, these genes are gradually overcome by the evolving population of the pathogen. This forces us to constantly search for new resistance genes. The aim of this study was to search for resistance genes to *Puccinia coronata* in 50 local oat varieties obtained from the National Centre for Plant Genetic Resources (Radzików, Poland). Most of the varieties originated from Poland, but some were of very exotic origin, and among them genotypes with increased resistance to crown rust have been identified. The resistance of these accessions was uniform but limited to three or two of the *P. coronata* isolates used in the host-pathogen test. The identified genotypes can be used as a potential source of resistance to this pathogen after verification of the mode of inheritance.

The potential of relay intercropping for enhancing field biodiversity

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Modern agricultural production is predominantly dominated by a few plant species, which are often cultivated in monoculture. Monoculture can be understood as either growing a single species in a field at the same time or cultivating the same species in consecutive years. This undeniably impacts the diversity of fields, but farmers adopt such practices primarily for economic reasons.

Among alternative production methods, relay intercropping stands out. It involves sowing a different species into an already growing crop. For a certain period, two species grow simultaneously in the field. After harvesting the main crop, the sown plant continues to grow until it's ready for harvest. Relay cropping allows for two harvests in a single year and increases the efficient use of resources such as water and the growing season.

Experiments with relay cropping technology were initiated in 2023 at the Gorzyń Experimental and Educational Facility. A standard winter wheat plantation was modified so that every 4 rows of growing wheat were interspersed with 4 rows without vegetation. In these prepared strips, 5 plant species were sown: buckwheat, soybean, sorghum, phacelia, and mustard. Control plots with pure sowing of each of these plants were also established. The planting took place in the third decade of May, and the plants grew together in the field until the wheat harvest (i.e., the end of July and the beginning of August). After the wheat harvest, the sown plants were left in the field until their own harvest.

The studied plants showed diverse responses to relay cropping, influenced by factors such as sowing time, initial shading, and water availability. The sown plants achieved varying biomass, height, and yield. Buckwheat, phacelia, and mustard were attractive to pollinators, whose presence was noted for most of their time in the field. Sorghum also exhibited some attractiveness to pollinators.

The simultaneous cultivation of these plants may have not only production but also ecological significance. Further research on concurrent crop cultivation in Polish conditions is necessary, especially given the ongoing climate changes and the need to protect biodiversity.

The impact of tree cover on the biodiversity of arable soil

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Sustainable systems of land use developed in world agriculture include agroforestry, which is the practice of integrating trees into agricultural landscape. Tree cover, as the so-called ecological functioning areas (EFA), play an important role in shaping the biodiversity and water management of arable soils. The purpose of the study was to investigate the impact of field shelterbelts of black locust on the biological diversity of the soil environment in an area particularly at risk of water erosion. A good indicator of changes in biodiversity occurring in the soil under the influence of natural and anthropogenic factors is the activity of soil enzymes. These enzymes are directly involved in the biogeochemical cycle of carbon (dehydrogenase), nitrogen (urease) and phosphorus (neutral phosphatase) in the environment. To this end, soil samples were collected along three transects situated within 25-year-old Robinia pseudacacia L. shelterbelts. The plantings were established in a loess micro-basin located on arable land. Three research points were designated in the area of each tree stand: in the middle of the tree stand and at distances of 2 and 20 m from the edge of the tree stand on arable land. The increase in soil organic carbon levels in the soil from the shelterbelts led to positive changes in the activity of the enzymes studied (dehydrogenases, neutral phosphatase and urease) catalyzing the most important processes of soil organic matter transformations. Compared to the arable soil, the soil under Robinia pseudacacia had higher enzyme activities decreasing significantly with distance from the tree strips. Biological activation and improvement of the chemical condition of soils indicate that tree cover has a beneficial effect on the natural environment and its biodiversity, including soil fertility and health.

Biodiversity and metabolic activity of fungi as an indicator of potential biological and soil-forming weathering

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The aim of the study was to assess the metabolic activity and biodiversity of fungi in tree root systems and how it can affect biological weathering. The area of interest is the Poprad gorge in the southern part of the Beskid Sądecki, Outer Western Carpathians. We used the following analyses: 1) to determine the structural diversity of fungi (ITS1) and 2) to assess the metabolic profile of soils (Biolog FFPlates). The most frequently used substrates by fungi were: glycyl-L-glutamic acids, L-ornithine, L-phenylalanine, L-proline, D-galacturonic acid, fumaric acids, D-saccharide acids, succinic acids and N-acetyl-D-glucosamine. Our study confirmed that the fungal community in the root zone is geochemically active, and organic acids secreted by plant roots in oligotrophic conditions and nutrient limitations significantly affect soil weathering.

Preliminary screening of *Avena sativa* L. landraces originated from the former Czechoslovakia for resistance to crown rust

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Cultivated oat is affected by a number of fungal diseases, among which crown rust caused by *Puccinia coronata* f. sp. avenae is the most widespread. The use of race-specific genes is the primary mean of control. Growing resistant varieties is not only an economical but also an ecological approach. Oat crown rust resistance which is expressed at all plant growing stages is usually monogenically inherited. So far, a number of Pc genes have been identified in oats, both in cultivated *A. sativa*, *A. byzantina* and wild *A. sterilis*, *A. strigosa*, *A occidentalis*, *A. barbata* species. The best source of resistance genes to *P. coronata*, with about 45 described, and about 10 introduced to common oats is *A. sterilis*. Unfortunately, current sources of resistance to crown rust rapidly lose their effectiveness due to the fast evolution of pathogen virulence therefore, recent efforts have focused on identifying new Pc genes. One of the main obstacles of using resistance genes derived from wild species is the number of non-desirable traits which are unintentionally introduced into breeding materials. Therefore, searching for resistance genes in local cultivars, which are populations selected by nature and the farmer, and not by a professional breeder, seems to be a good approach and a kind of compromise.

The aim of the presented studies was the identification of new potential sources of resistance to *P. coronata*. The level of resistance to crown rust of 18 *Avena sativa* landraces originated from the region of former Czechoslovakia and derived from Gene Bank of the Crop Research Institute, Ruzyne (Czech Republic) was analysed in detached leaf assay. To screen the resistance of the accessions 10 leaf fragments, each from a different seedling, were used to perform host-pathogen tests. Five highly virulent crown rust isolates were used to estimate the level of resistance in analyzed genotypes. Tested landraces were characterized by a moderate level of resistance, however, most of the genotypes were susceptible to isolates tested or showed an ununiform intermediate response.