Proposed topics for research projects 2024/2025 in the *biological sciences discipline*

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Taxonomic and geographical differentiation of Pinus L. (Pinaceae) species in the Mediterranean area as the effect of plant migrations.

The genus Pinus L. is the most numerous among the gymnosperms, with approximately 120 accepted species and several uncertain species and synonyms. The systematic relationships between some taxa remain undetermined. The Mediterranean Basin is the second largest biodiversity hotspot in the world. Its species richness is the effect, among others, of the role of a refugium it played during the glaciations and the earlier Tertiary migrations of species, including during the complete drying of the Mediterranean Sea.

Almost all pine species from the *Pinaster* subsection of the *Pinus* section grow in this area, i.e. six out of seven, as well as *P. nigra* with an undetermined number of intraspecific taxa. The systematic position of some species from section *Pinaster* also remains unclear.

The aim of the research will be to determine the differentiation and systematic relationships between related taxa from the *Pinaster* section or within species with wider ranges, such as *P. nigra*. The likely impact of migration on the current differenttiation of the studied taxa will also be analyzed. Taxometric methods and genetic analyzes will be used. The basis of the research will be material collected from possibly the entire range of the selected species (some of the material has already been collected). The assumption is that the modern diversity of taxa is related to geographical location and is the result of migration of plants in different periods.

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The importance of free-living bee colonies for the protection of local subspecies and populations of honey bees

Free-living populations of various subspecies of honey bees (*Apis mellifera* L.) are key pollinators, but their numbers and conservation status are insufficiently studied. Popular opinion suggests that introducing the parasitic mite *Varroa destructor* from East Asia to Europe led to the disappearance of free-living bees because they cannot survive the parasite's invasion without human intervention. Despite this, observations indicate the existence of such families in various European countries such as Ireland, Poland, Germany, and Spain. Free-living bees, inhabiting mainly tree cavities, can play an essential role in protecting local subspecies. However, knowledge about their occurrence and density is limited. The research project aims to investigate the demography and genetic diversity of free-living bee colonies in Poland to better understand their demographics and conservation needs. It is also important to examine the impact of bees managed by humans on gene pools and the adaptation of free-living colonies.

Bee colonies are routinely treated with chemicals to combat parasites and disease, suggesting that free-living bees cannot survive without similar treatment. Major bee diseases and pathogens such as *Varroa destructor*, American foulbrood, and *Nosema* spp. are of concern regarding the role of free-living colonies in their spread. Microbiomes and parasite loads in free-living colonies are poorly documented, but preliminary data suggest differences between apiary and free-living colonies. Understanding these differences may be key to developing a bee conservation strategy.

The project aims to investigate what mechanisms enable honey bees to survive in natural environments, such as tree cavities. We expect that honey bees that can survive without human intervention have a specific genetic composition, which may indicate their adaptability. The research will cover the impact of climate, the availability of nesting sites, and the intensity of beekeeping on the distribution and survival of free-living colonies. An important element of the project will be the analysis of genetic introgression from commercial breeds, which may affect the genetic integrity of free-living populations. We will also analyze adaptation to natural environments and genetic selection in the context of survival in the wild. The project's ultimate goal is to improve honey bee conservation, promote sustainable beekeeping practices, and protect local bee biodiversity.

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