How climatic change could treat honey bee food resources

Among the various threats affecting honey bees, climate change plays an important role in many respects. Rising temperatures can alter the life cycle of colonies, lead to extreme drought conditions, and promote the development and spread of parasites and diseases.

Honey bee collecting pollen on Cistus sp. *flower in Mediterranean area (Photo by Matteo Giusti)*

A recent European study sought to assess and predict the effects that ongoing climate change may have on honey bee food resources, particularly pollen sources. The study was published in Nature Communications (Quaresma et al., 2025 https://www.nature.com/articles/s41467-025-68085-6) and it was a result of the Europena project INSIGNIA-EU (https://www.insignia-bee.eu/) The research was carried out by analyzing pollen samples collected from 310 apiaries distributed across the 27 countries of the European Union, through a comprehensive effort involving in aeach country volunteer beekeepers as citizen scientists. In total, 2,500 pollen samples were analyzed. These were collected every two weeks at the various apiaries from May to August 2023, and their botanical origin was determined using ITS2 metabarcoding. For each plant taxon identified in the pollen samples, the researchers characterized its climatic niche, meaninghow its occurrence relates to temperature and precipitation gradients.

Linking species distributions to climatic variables (e.g., mean temperature and precipitation gradients) it was possible to produce response curves that describe the range of climate conditions under which each plant species reliably occurs. Using these cli-

matic response curves, the study modelled future climatic suitability for the floral resources thatbees rely on under projected climate change scenarios. The study found that increasing temperatures and reduced precipitation significantly threaten the diversity of floral resources available to honey bees.

Many plant species that bees commonly forage on are projected to be pushed beyond their climatic tolerance limits, reducing the range of available forage throughout the season. This effect is particularly pronounced when warming and drying trends coincide. A key outcome was the demonstration that climatic stressors do not act uniformly: in regions where temperatures rise but moisture remains sufficient, some resource diversity may persist; however, under scenarios combining high heat and low rainfall, ecosystem resilience collapses. This shows clearly that honey bees may lack alternative forage either through temporal shifts, related to changes in flowering times, or spatial shifts, because plant populations are moving to new areas.

Southern and Mediterranean climates, which are already warmer and more prone to summer droughts, emerge as particularly vulnerable zones for floral resource loss. In contrast, cooler northern regions are somewhat buffered but still show risks under projected warming trends. The loss of diverse floral resources could have several effects. First of all, a bee nutrition declines when foraging options narrow, reducing access to a balanced array of pollen (and nectar) sources. This can impair bee health, colony growth, and overwintering success, because bees rely on a variety of plant species for essential nutrients. In addition, plant - pollinator interactions could be disrupted when flowering times no longer align with bee foraging activity. Climatic changes can decouple phenological schedules, making honey bees forage when flowers are not at bloom peak, further diminishing available resources.By modelling exceedance risk, the study quantified the likelihood that specific plant - bee interactions will fail under future climate conditions. These risk assessments suggest that a substantial portion of interactions could be lost or severely weakened.

In summary this study shows that climate change threatens the diversity of honey bee floral resources across Europe, leading to potential nutrient shortfalls for bees and cascading effects on extrapolated to other types of bees or pollinators.