

For the climate, bees, and people

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Currently, many scientists are alarming that climate changes and fluctuations are affecting and will continue to significantly influence all spheres of human activity in the future. The preservation of biodiversity and bees is becoming a serious problem, and ecology as a way of thinking is becoming a necessity. This article briefly discusses bees, their role in sustainable agricultural production, and the influence of meteorological conditions and climate changes on their activity and distribution.

Briefly about the origin, biology, and activity of bees

It is believed that the disappearance of bees will lead to the demise of humanity. This incredible insect was declared the most important animal on the planet by the Earthwatch Institute after a debate at the Royal

Geographical Society in London in 2019. European honey bees (*Apis mellifera*) are social insects used by humans since ancient times. Ancient Egypt is the place where modern science apiculture (Fr. apiculture from Lat. apis „bee“ and cultura „cultivation“)" originated.

A characteristic feature of the family is sexual dimorphism. The species has two female forms – worker bee and queen bee, depending on the feeding of the larva after the 3rd day with honey and royal jelly. In the queen, the stinging apparatus is modified into an ovipositor. They reproduce by laying eggs from early spring to late autumn – fertilized (worker bees), and during the active period, unfertilized (male form). Another type of reproduction for entire families is through division (swarming). When a young queen is present, the old one, along with some of the workers, leaves the hive and forms a new social unit. They are distinguished by strict organization and distribution of activities, according to the age of the bees. Beekeeping results in valuable products such as honey, beeswax, propolis, royal jelly, bee venom, and pollen. The food products they produce contain the essential amino acids indispensable for humans. Honey, propolis, and bee venom are widely used in the pharmaceutical industry.

In recent years, biodiversity in nature has been threatened and has become the focus of scientific research related to climate and climate change. There is a two-way relationship between the vital activity of bees and vegetation: they ensure the species diversity of plants, but also rely on them for foraging – for collecting nectar and pollen, and plants are also their natural habitat.

The role of bees in sustainable agriculture

Entomophilous pollination (pollination by insects) plays a leading role in sustainable agricultural production; it determines the quality and productivity of field crops, fruit species, vineyards, and is important for forest vegetation. Among all insects, bees are best adapted for cross-pollination and possess the unique property of *florospecialization* (bees visit the same plant species for a prolonged period when nectar, pollen, or honeydew is secreted). Literature indicates that between 74% and 90% of pollination is their responsibility. And here it is important to note the role not only of the European honey bee (*Apis mellifera*) but also of wild species. Of all 20,000 bee species, only 11 are honey-producing.

The big question here is: are bee populations declining, and is this related to climate change? It has been proven that for all insects, solar radiation is a key factor responsible for their biological development. Among the main meteorological elements whose average values determine the climate of a given place, solar radiation is considered the most conservative and least variable factor. Entomologists link the start of egg-laying by the queen bee in honey bees, for example, not so much to air temperature but to the increase in day length.

Orientation in space and during honey collection occurs thanks to light. Temperature changes are also responsible for the behavior of bees and their distribution areas. Variations in humidity, droughts, and aridity directly affect vegetation and nectar secretion, with an emphasis in our country to be placed on the regions of the Upper Thracian Plain and Southeast Bulgaria. All abiotic factors exert a complex influence on the development and behavior of bees.

The last two decades of the previous century and the beginning of the current one show an increase in the average air temperature. In our country, scientists have found an increase of up to 0.8°C compared to the period 1961 – 1990. Different climate models show an increase in the average value by 2050 of between 1.6°C and 3.1 °C. For the Struma region and Southeast Bulgaria, the annual temperature is expected to rise by between 0.9°C and 1.3 °C by 2025, distributed by seasons as follows: winter – 0.6 °C; spring – 1.2 °C; summer – 0.9 °C and autumn – 1.2 °C. Some models expect an increase in solar radiation during the cold half of the year by no more than 10%. Precipitation shows a decreasing trend at the end of the last century and an increase after the mid-1990s in many regions of the country. Model expectations for the annual precipitation sum by 2025 are for a decrease of between 2% and 5%, with a tendency to increase to 10% by the end of the 21st century.

Why are bees so sensitive to climate change?

Warmer winters in recent years cause premature depletion of honey reserves. Colder periods and unfavorable phenomena in the pre-spring and spring periods signal the need for increased attention and additional care from beekeepers. On the other hand, all plant species are precise phenological indicators of temperature. Any change related to the phenological calendar and plant flowering is of great importance to bees. Climate changes and fluctuations alter the conditions for growth and development of melliferous vegetation. About 500 plant species in our flora are melliferous and a source of nectar and pollen. The family *Rosaceae* (mainly fruit species and shrubs) are among the most preferred; for apples, 87.4% of pollination is due to bees, for cherries and sour cherries – 85.7%, and for currants – about 98.9%. During the flowering period, which varies for different plant species, the most nectar is secreted at the beginning and during mass flowering, with the quantity decreasing towards the end of the phenological phase. The following factors influence bee foraging and honey collection:

- *Air temperature*: The optimal limits at which the secreted quantity is greatest are between 10 °C and 25 °C, and the maximum values – in the range of 26 °C – 29 °C.
- *Sunshine (cloud cover)*: More nectar is secreted on sunny days compared to cloudy ones, and yields are lower when crops are shaded.

- *Air humidity*: Optimal values for relative air humidity in percentage are between 60% and 80%. At high humidity, the collected nectar has less sugar content, while at lower values – it thickens.
- *Precipitation*: Frequent and light rainfall in warm weather favors nectar secretion. In areas with more and heavier rainfall, lower yields of honey and pollen are observed.

Many additional factors such as wind, crop density, varietal composition, and type also influence honey collection. The combination of high temperatures, low humidity, frequent, heavy rainfall, cloudy weather, and improper cultivation technology creates unfavorable conditions for bee activity and hinders nectar secretion.

Today, the frequency and intensity of weather phenomena, linked by experts to climate fluctuations and changes, pose a serious challenge to agriculture and the beekeeping sector.

Scientists have found a difference in the length of phytoclimatic seasons and the potential growing period in different parts of the world by up to two weeks. The shift in the beginning, end, and duration of the seasons is expected to directly affect honey collection and the life of bees. There are reports that in North America and Europe, bees are abandoning the southernmost and hottest parts of their habitats but are poorly adaptable to cooler climate conditions. Of course, with the honey bee *Apis mellifera*, the human factor largely manages to compensate for unfavorable meteorological elements through feeding with sugar syrup, forming swarms, migratory beekeeping, and selecting local races such as our *Apis mellifera macedonica*, *rodopica* type.

There are facts and prerequisites for climate fluctuations and changes to affect the species diversity of bees. We should also ask ourselves the question: **to what extent is the decline in populations and species diversity a natural process, and what is the role of the anthropogenic factor?**

In recent years, agriculture in our country has lost its diversity due to the lack of an effective irrigation system and the risk of losses when growing plants that require higher humidity. The cultivation of hybrid crops is becoming widespread both globally and in our country. As a result of uncontrolled transfer of biological material, there is a possibility of increased metisation (loss of pure bee races) and the introduction of diseases and pests in places where they had not been observed. The widespread and inappropriate use of pesticides, inconsistent with bee biology, is a significant problem. Bees are bioindicators of both climate and anthropogenic activity. Their decline threatens the stability and sustainability of both our food and animal food. And this is directly related to our future existence. Bees have no substitute, and this requires special attention and responsibility.

Investments in bee pollination are of great benefit. On the one hand, they can improve the quality and productivity of cultivated plants, and on the other – they are a source of nectar and pollen. The selection of

suitable varieties will help preserve the number of bee colonies and is a method for adapting agriculture to climate change.

Local bee races, in turn, have the best adaptability and plasticity, which is why they should be used rationally by professional beekeepers and hobbyists alike. Organic farming is also among the modern focuses due to the purity of its produce, the absence of pesticides, and higher resistance to climate fluctuations. Changes in vegetation cover and interference with the habitats of wild forms inevitably affect biodiversity. Everyone can contribute to the preservation of bees by creating suitable living conditions for them by growing continuously flowering plants in their garden and considering the timing and type of plant protection products used.

Source: Climateka
