Influence of selected meteorological factors on the development of varroasis in honey bees

Ľubomír Korený[1], Michaela Korená Hillayová[1], Peter Borsányi[3], Jaroslav Škvarenina[1, 2]
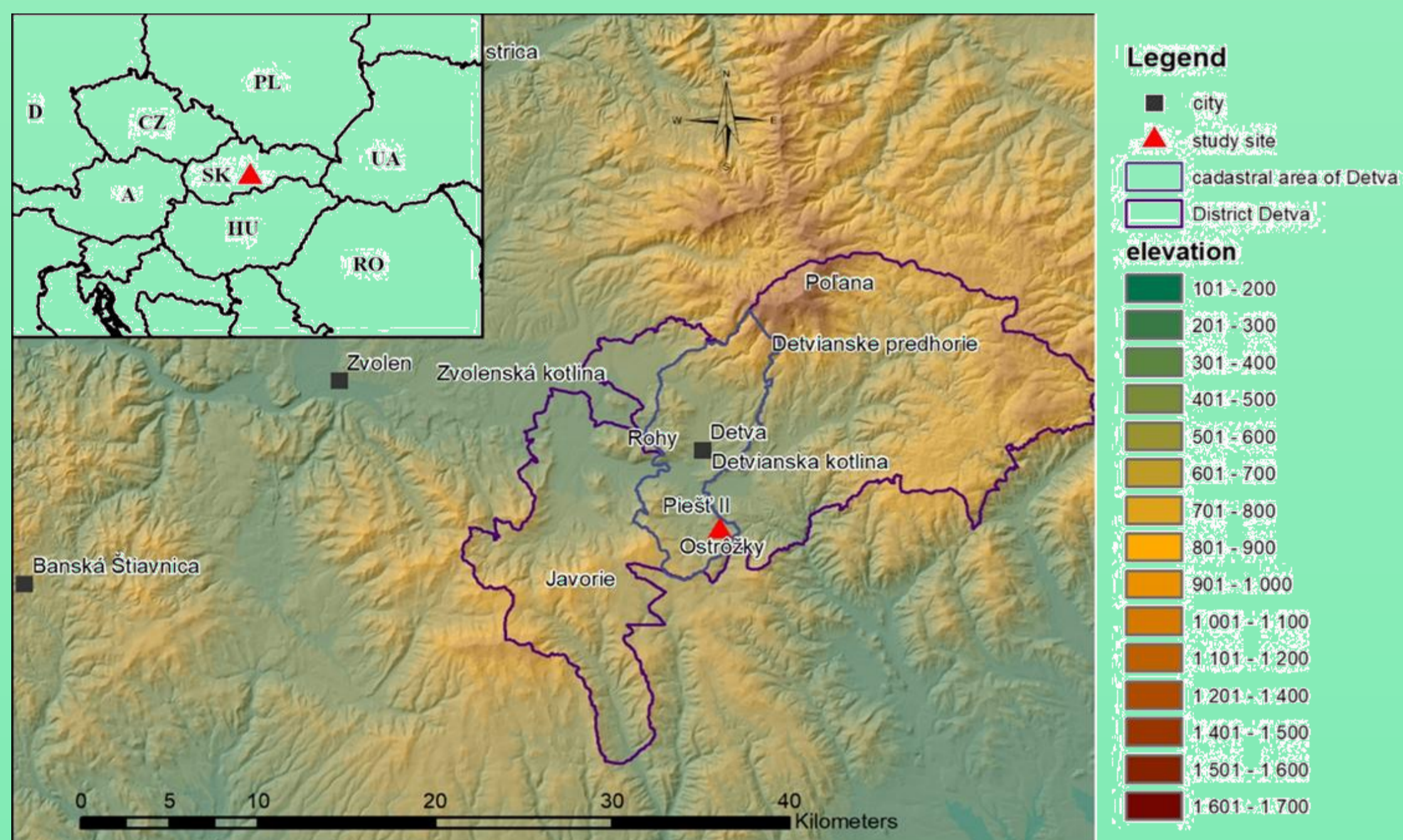
[1] Department of Natural Environment, Faculty of Forestry, Technical University in Zvolen, T. G. Masaryka 24, 960 01 Zvolen, Slovak Republic.

[2] Ústav vied o Zemi SAV, v.v.i., Dúbravská cesta 9, Bratislava, SK-84005, Slovak Republic.

[3] Slovak Hydrometeorological Institute, Zelená 5, Banská Bystrica, SK 97404, Slovak Republic.

Correspondece: michaela.hillayova@tuzvo.sk

Disease varroosis (caused by the overgrowth of the parasite *Varroa destructor*) is currently the most serious global problem in the field of honeybee survival. This study investigated the impact of local environmental factors on *V. destructor* mite infestation in honey bee (*Apis mellifera carnica*) colonies. The research explored the relationship between natural mite fall and biotic factors (bee queen line – Singer and Sklenár) and abiotic factors (daily maximum, minimum, average temperature and relative humidity, and hive location – open space vs. Apihouse). Four bee colonies were established, two with Singer queens and two with Sklenár queens, with two hives of each line located in the open and two in the Apihouse. Mites falling onto oiled monitoring boards were counted. Meteorological data (temperature and humidity) were collected every 5 minutes using an automatic meteorological station. Statistical analyses, including correlation/regression analysis and Mann-Whitney U tests, were performed to assess the relationships between mite fall and the measured factors. Results revealed a significant temperature dependence of Varroa mite fall. Increased mite fall was observed when daily maximum temperatures ranged from 25.1 to 31.7°C and minimum temperatures were above 5.5°C. The highest mite fall occurred in open-air hives when temperatures increased between 13.9 and 28.7°C and humidity decreased between 47.2 and 22.7%. Overall, mite falls in the open-air hives were 46.57% higher than in the Apihouse hives, indicating that hive location significantly affected mite fall. The Sklenár bee line exhibited a 26.27% higher mite fall than the Singer line, suggesting a role for bee line characteristics in mite infestation levels. All colonies were treated with a natural veterinary product (wormwood, thyme, and mint oils) when natural mite fall exceeded three mites, and all colonies survived the winter. This study demonstrates the combined influence of temperature, humidity, hive location, and bee line on *V. destructor* infestation, providing valuable insights for beekeepers in developing effective and environmentally friendly management strategies for varroosis.

Figure 1. This graphical abstract emphasizes the complex relationship between environmental factors, beekeeping practices and bee health. It is important to take all these factors into account in order to effectively fight against varroosis and protect bees.
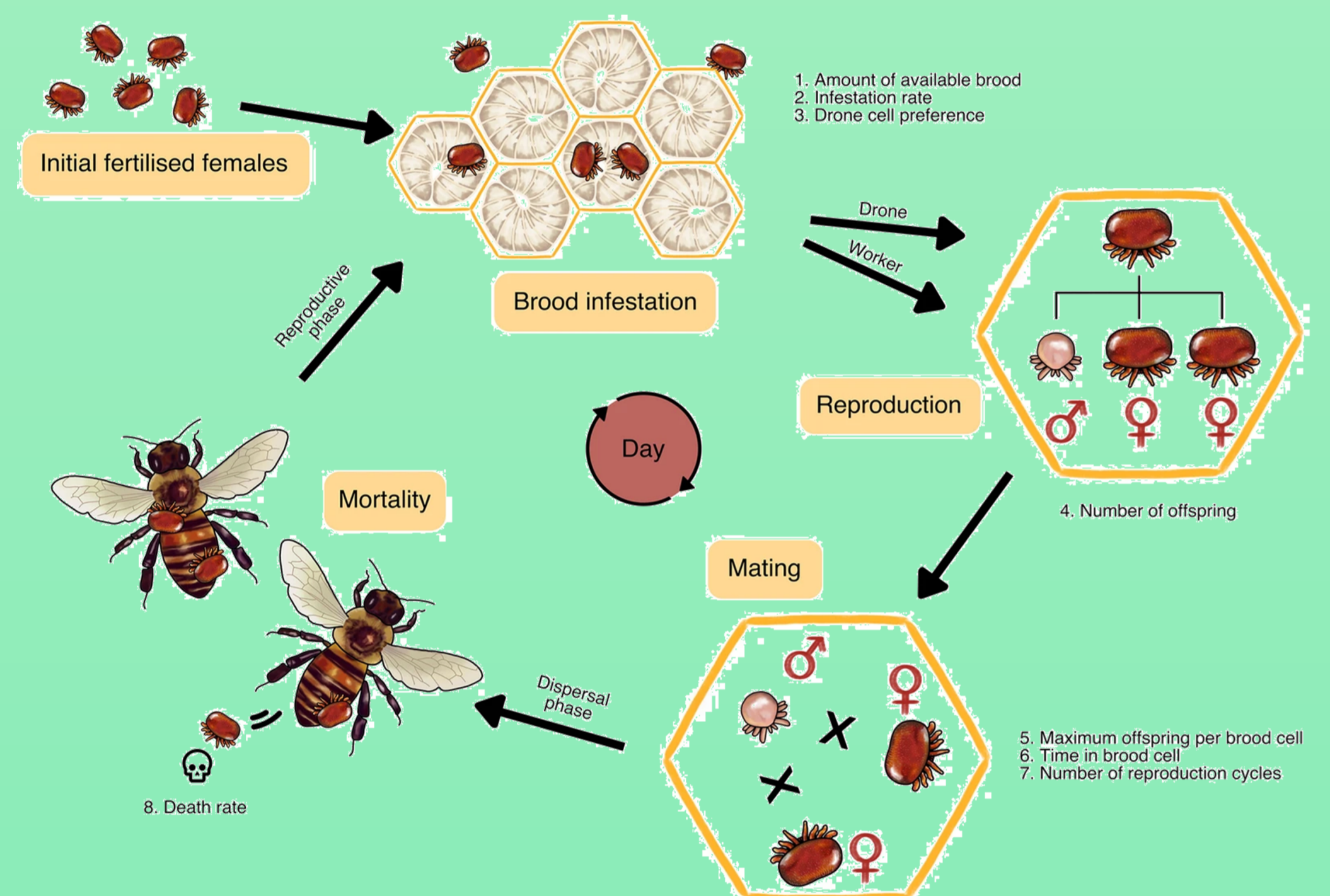
Figure 2. A gene drive in populations of the honey bee parasite *Varroa destructor* (*Source: Faber et al. 2021). Varroa destructor* is an insect parasite growing to an average size of 1.5 mm. Females are larger than males and have round, flat bodies of brown colour. Males have a longer and slimmer body. Both sexes have eight legs and are covered with fine hairs. It is known that meteorological conditions, such as temperature and humidity, can affect the reproduction of *V. destructor*. For example, higher temperatures can accelerate the development of mites and increase their reproductive rate. Humidity can also play a role, as mites need a humid environment to survive and reproduce.

Figure 3. The experimental area is situated at 48°30'32.9"N 19°25'59.0"E (48.509029, 19.433027) at an elevation of 535 m a.s.l. in the cadastral area of Detva town. The northern part is covered by the geomorphological unit of Poľana and Detvianske predhorie. The southern parts belong to Ostrôžky and Javorie. A major part of the Detva region is deforested. Continuous broadleaved, coniferous and mixed forests can be found on the north-west and the south-west. Forest covers approximately a quarter of the area, and two-thirds of the area is covered by permanent grassland and arable land. The most common soils are polymerised and gleyed soils (Šály, 2000; Geodesy, Cartography and Cadastre Authority of the Slovak Republic, 2022).


Figure 4. The collected 30-year-long mean (1981–2010) for the study area in the climate diagram. The hottest months in the region are July and August. On average, the most precipitation fell in June. The annual temperature is around 7.9 °C, the yearly mean precipitation total is approximately 745 mm, and the mean annual air humidity is 75.2% (Climate Atlas of the Slovak Republic, 2015).
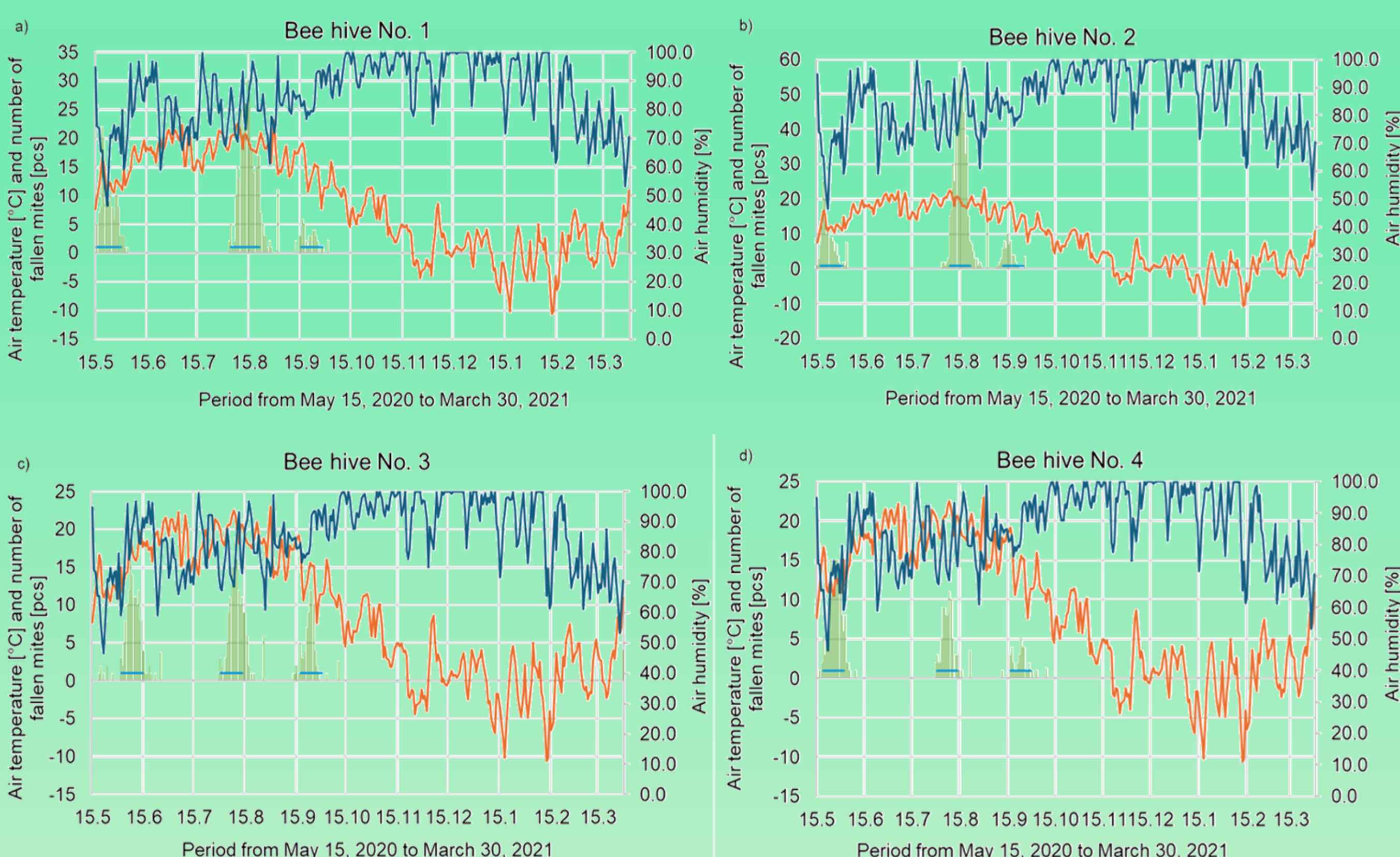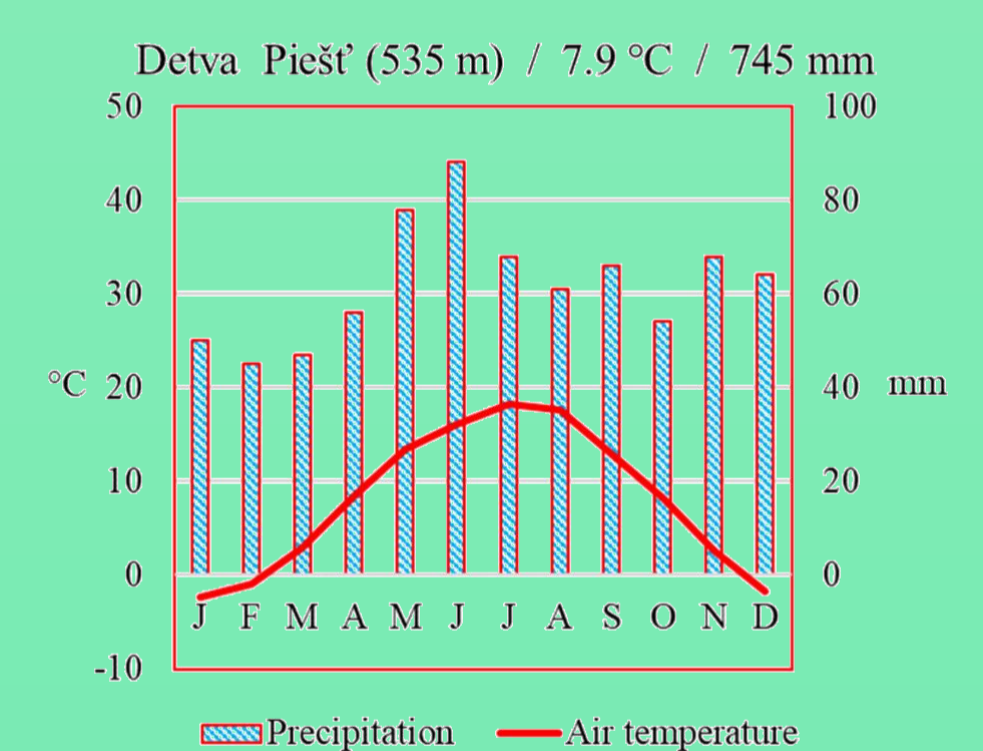
Figures 5 a) - d) showed the total number of Varroa destructor mites falling in four different bee colonies during the three monitoring periods. The colonies are divided by queen breed (Singer or Sklenár) and location (outdoor or Apihouse). The daily average temperature ranged from -11°C to 22 °C and the daily average relative humidity ranged from 46 % to 100 % during the monitoring period.
Bee hive 1 (Singer, outdoor): A total of 524 mites fell during the monitoring periods. In the first period (15 May - 5 June) there were 158 mites, in the second period (3 - 31 August) there were 323 mites and in the third period (11 - 30 September) there were 43 mites.
Bee hive 2 (Sklenár, outdoor): A total of 700 mites fell. In the first period (May 15 - June 2) there were 140 mites, in the second period (August 3 - 31) 496 mites, and in the third period (September 6 - 24) 64 mites.
Bee hive 3 (Sklenar, Apihouse): A total of 381 mites fell. In the first period (May 18 - June 24) there were 143 mites, in the second period (July 30 - August 25) 160 mites, and in the third period (September 10 - October 9) 78 mites.
Bee hive 4 (Singer, Apihouse): A total of 209 mites fell. In the first period (May 15 - June 15) there were 41 mites, in the second period (July 29 - August 20) 132 mites and in the third period (September 11 - October 7) there were 36 mites.
It is clear from the figures that the number of fallen mites varies between colonies and periods. Colonies placed in the outdoor environment generally had more fallen mites than colonies in the Apihouse. It also seems that the breed of the mother Sklenár may have an influence on the higher number of fallen mites compared to the Singer breed.

Legend:
- Number of natural fall mites per day
- daily mean temperature
- applied natural veterinary medicinal product (Ekopol)
- daily mean relative air humidity