Hibernation peculiarities of cave-dwelling bats from Bulgaria in the context of Global Climate Change

PhD THESIS SUMMARY

Nia Lyubenova Toshkova

Institute of Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences

Supervisor: Prof. Vasil Popov, PhD

Sofia, 2025

This thesis aims to identify and analyse the wintering characteristics of cave-dwelling bat species in Bulgaria in relation to the impacts of climate change. Limited data exist on winter bat activity in the country, posing challenges for monitoring potential behavioural deviations associated with a warming climate. To address this, winter activity was investigated in some of Europe's largest hibernacula. The findings reveal cave- and species-specific activity patterns. Bat activity was recorded during each month of the survey, with distinct peaks on particular days. At one high-elevation site, activity was restricted to a single night, whereas the highest overall activity was observed at the highest elevation site (1325 m). The most active species was *Myotis capaccinii* (Bonaparte, 1837). While bats were predominantly active shortly after sunset, following their typical circadian rhythm, daytime activity was also recorded, including emergence at temperatures as low as –8°C. At sites with sufficient data, external temperature emerged as a significant positive predictor of bat activity, with higher temperatures associated with increased activity levels. The data suggest that winter foraging near roost entrances is rare. The variability in activity levels across sites highlights the importance of high-resolution, site-specific data, rather than broad generalisations.

Next, to examine the winter foraging activity, the diet of *Miniopterus schreibersii* from Razhishkata Cave (Balkan Mountains, Bulgaria) was analysed. The species was found to feed actively outside the cave, without reliance on cave fauna. Dietary shifts were observed throughout the study period. Although *Diptera* was the most abundant insect order during the two sampling periods, the bats primarily preyed on *Lepidoptera* and *Hymenoptera*. Metabarcoding results also confirmed the presence of insects with diurnal activity in the diet. The internal cave temperature showed a strong correlation with the outside temperatures, likely influencing bat activity patterns.

Furthermore, to fill the gap in knowledge regarding the health status of bats in Bulgaria, targeted assessments were conducted at the studied hibernacula. A total of 728 bats were examined: 326 pre-hibernation and 402 post-hibernation, revealing significant post-hibernation declines in body mass index (BMI) in *Myotis blythii*, *Myotis capaccinii*, and *Myotis myotis*, particularly at high-elevation sites. *M. blythii* from Ivanova Voda exhibited the most substantial BMI loss. *M. schreibersii* populations showed variable BMI changes, including slight decreases, increases, or no change. Wing damage increased post-hibernation, particularly in *M. schreibersii*, while ectoparasite prevalence declined across all species. Bats with higher pre-hibernation BMI were less likely to host ectoparasites. Dental wear correlated with plaque levels, but hibernation did not lead to increased plaque accumulation. Despite prolonged inactivity, lipid peroxidation remained stable, DNA damage decreased, and antioxidant levels increased, suggesting that hibernation may contribute to the mitigation of oxidative damage.

These findings provide insight into the complex physiological responses of bats during hibernation and their resilience to environmental stressors. Long-term monitoring of these parameters is essential for understanding how climate change affects bat health and survival during this vulnerable period.

Additionally, the pre- and post-hibernation wing inspections led to the identification of the skin mite *Psorergatoides kerivoulae* (Fain, 1959), which causes cutaneous lesions on the wing membranes of *M. myotis* and *M. blythii*. This represents the first record of the lesser mouse-eared bat (*M. blythii*) as a host for this parasite, as well as the first histopathological description of the infection in both species. It is also the southernmost record of this parasite and the first documentation of the genus *Psorergatoides* in the Balkans.

Finally, as a direct conservation outcome of this dissertation, Bulgaria's existing national monitoring programme for cave-dwelling bats was updated with supplementary guidelines. These guidelines include a review of current challenges and propose measures to support local conservationists in collecting more consistent and comprehensive data on bat populations and climate-related threats. This structured approach is intended to enhance understanding of the conservation status of bats at both national and European levels and to inform more effective conservation strategies. Ultimately, these efforts may contribute to a better understanding of the long-term effects of climate change on bat populations in Bulgaria.

Although it is challenging to capture the full complexity of climate change–driven processes within a single dissertation period, especially in the absence of baseline data, this study provides an essential foundation for future long-term research. The insights gained here can significantly contribute to both understanding changes in bat populations and informing effective conservation strategies.