

## Comparative phenology of two butterfly communities in Transylvania (Romania) during the period 2022–2024

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**Abstract:** Climate change is among the most pressing global issues humanity faces in the 21st century. In Romania, the past decades have witnessed a gradual increase in temperatures along with a decrease in annual precipitation. Local weather conditions influence the phenology and voltinism of butterflies, affecting both the onset and duration of the adult flight period.

Butterfly sighting data from Romania, collected and published on social media platforms, contribute to completing the national distribution records of species. These data show that the flight period of butterflies varies depending on the annual evolution of weather conditions. Empirically, an annual synchronization of flight periods can be detected, naturally influenced by the latitude and altitude of the sighting areas.

To test this hypothesis, we compared data collected during 2022–2024 from two butterfly communities in Transylvania. One dataset originates from citizen science activities published on the Facebook group *Insects of Romania and Europe* by Diana Buchilă. The species in this butterfly community were identified based on mobile phone images taken over an area of approximately 460 hectares in Valea Gârbăului, near Cluj-Napoca. The second dataset was collected in Harghita County over a larger area (approx. 130,000 hectares). In both regions, the date of the first annual sighting for each butterfly species was recorded each year. For every species and year, the number of days from January 1st to the first adult sighting was calculated.

During the study period, a total of 120 butterfly taxa were recorded, representing about 60% of Romania's butterfly fauna. Of these, 91 species were common to both regions, while 29 species differed (12 species exclusive to Cluj, 17 species exclusive to Harghita County).

At the community level, we identified a significant positive correlation ( $n = 91$ ,  $r = 0.72$ ,  $p < 0.0001$ ) between the average date of the first sighting of butterfly species shared between the two regions during this period. On average, during 2022–2024, the butterfly flight period began 6–7 days earlier in Cluj compared to Harghita County (mean days = 153.66,  $n = 103$  for Cluj; mean days = 160.00,  $n = 111$  for Harghita). In Cluj, the average number of days decreased gradually over the three years (2022: 162.42 days; 2024: 138.85 days), a similar trend also observed in Harghita (2022: 169.59 days; 2024: 143.64 days). Thus, between 2022 and 2024, butterflies began their flight period on average approximately 24 days earlier in Cluj and 26 days earlier in Harghita.

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