

Expansion, regression, phenological shifts, and voltinism in Romanian butterflies (opening presentation)

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Abstract: The phenomena of expansion, regression, phenological changes, and voltinism are followed with great interest not only by biologists, ecologists, and conservationists, but also by a wide range of people interested in changes in nature. In order to monitor and evaluate these complex biological processes, we need multi-annual data. Such data can be found and used in some countries where the monitoring of diurnal butterflies has a history of several decades and a large amount of data has been accumulated (Great Britain, Germany). But what can be done in countries where such data is lacking or scarce and more recent?

Romania is in such a situation. In order to highlight some trends, we used all existing data at national, regional, and local levels. We processed published data, mostly from museum collections, private collections, and the personal data of active lepidopterists. Author's experience of over 50 years and information obtained from the accounts of lepidopterists who are no longer with us were an important source of information. The analysis period covers 1920 to 2024. The 104 years of analysis were divided into three intervals: 1920-1969; 1970-1990; 1991-2024. For interpretations and explanations, we took into account the evolution over time of average precipitation, temperature, land use dynamics, and the quantities of pesticides used in agriculture at the national and regional levels.

Processing all this information, we illustrated the decline/expansion of certain species using distribution maps.

Zerynthia polyxena experienced a period of decline between 1961 and 1990 due to the widespread use of pesticides and the destruction of habitats with *Aristolochia clematitis*. After 1990, *Z. polyxena* slowly reoccupied the areas from which it had disappeared, so that by 2024 it had almost returned to its pre-1960 status.

Until 1980, *Zerynthia cerisy* occupied a very limited area in the southeast of the country. Between 1980 and 1995, there were no reports or only extremely sporadic ones. After 2000, the species appeared in the south-west of the country, where it had not been mentioned before, and spread northwards, returning vigorously to the south-east.

Aporia crataegi was widespread throughout Romania until the 1960s, being considered a pest. Between 1961 and 1985, it disappeared from the central part of the country. After 1985, the process of expansion began, with the species now occupying all the areas it occupied before 1960.

Pieris mannii had stable populations in the south-west of the country until 1970-1975, after which it began to expand north and east, significantly increasing its initial range. After 1980, it appeared in Transylvania and Dobrogea.

Colias erate spread between 1970-1995 from east to west across the entire country, reaching Hungary, Austria, eastern Germany and Poland. After 1995, there was a massive reduction in its range and a decline in population numbers.

Libythea celtis occupied a limited range in the southwest and west of the country before 1930. Between 1930 and 1980, its range was reduced to a small area in southwestern Romania, from where it spread southwest and northwest by about 200 km after 1980.

Aglais urticae was present throughout the country between 1930 and 1970, after which it declined until 2000 (remaining in mountainous areas). After 2000, it began to expand and reoccupy the areas from which it had disappeared.

The decline/expansion is also exemplified by other species: *Nymphalis xanthomelas*, *N. vau-album*, *Neptis rivularis*, *Leptotes pirithous*, *Melitaea arduina*, *Coenonympha leander*, *Pyronia tithonus*, *Arethusana arethusana*, *Brintesia circe*, *Chazara briseis*.

Causes of decline: agricultural intensification: insecticides, herbicides and fertilisers, abandonment of previously extensively farmed areas, soil acidification and eutrophication due to atmospheric deposition of SO₂, NO₂ and NH₂, destruction and fragmentation of habitats, climate change with natural and anthropogenic causes. The current decline could be the result of long-term environmental degradation processes associated with the Anthropocene

Causes of expansion: Combined effects of environmental factors, biotic interactions, human influences, and

the life history of species.

For the change in phenology between 1920 and 2023 around Cluj, examples are given for spring species that have brought forward their flight period by 25-30 days: *Pyrgus malvae*, *Leptidea sinapis*, *Pieris rapae*, *Pieris napi*, *Papilio machaon*, *Iphioides podalirius*. The shift in the flight period towards the end of autumn is exemplified by: *Colias croceus*, *C. hyale/alfacariensis*, *Polyommatus icarus*, *Coenonympha pamphilus*, *Pieris rapae*.

Changes in voltinism are exemplified by *Apatura ilia*, *Melitaea phoebe*, *Coenonympha pamphilus*. For *Vanessa atalanta*, the ability to overwinter in Transylvania is confirmed under the mild winter conditions of the last 10 years.

Conclusion: Climate change is happening too fast, organisms can't adapt to its speed, and so the decline of insects is really speeding up.

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