



Biogeographical Analysis of the Butterfly Fauna of the Eastern and Southern Carpathians

Ph. D. Thesis

Biology Ph.D. School, Biodiversity Programme

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Debrecen, 2002

ZOOGEOGRAPHICAL ANALYSIS OF THE BUTTERFLY FAUNA OF THE EASTERN AND SOUTHERN CARPATHIANS

(Abstract of the thesis)

1. In the Eastern and Southern Carpathians 169 species of butterflies occur altogether, as opposed to the complete list of butterflies of Romania, consisting of 185 species. In the Eastern Carpathians 152 species occur, while in the Southern Carpathians 151 species. The number of common species is 149, the numbers of differential species are 18 and 17 species, respectively. It means that nearly one-fourth of the whole set of species (35 species) consists of species, which exclusively occur either in the Eastern or in the Southern Carpathians. Thus, these can be used for zoogeographical characterisation of the regions. The bulk of the differential species of the Eastern Carpathians belongs to the families Lycaenidae (7 spp.) and Nymphalidae, excl. Satyrinae (5 spp.), while most differential species of the Southern Carpathians belong to the Satyrinae (9 spp.).
2. Following the biogeographical subdivision of European butterflies of VARGA (1977), I have taken 12 faunal types into consideration. I have calculated the relative frequencies of species numbers belonging to each faunal type in the whole area, and in the Eastern Carpathians and in the Southern Carpathians, respectively.
 - The fauna of both areas is formed in the greatest proportion by the widespread polycentric Palaearctic-Holarctic species. Their number and percentage distribution in both areas are nearly the same (44 resp. 42 species or 28,95% resp. 27,81 %). There are no significant differences in the basic fauna, either in the widespread polycentric (see above) or in the Holo-Mediterranean and North-Mediterranean species which can be found in slightly larger number in the Southern Carpathians (30 resp. 34 spp., or 19,74 resp. 22,52 %). Nearly the half of the total species number consists of species belonging to these widespread faunal type (Carpathians: 47,34%, Eastern Carpathians: 48,69%, Southern Carpathians: 50.33 %).
 - The other most important faunal type is the Siberian faunal type in the whole area. There is a striking difference between the two regions in number and proportion of the Siberian species. Here there is a significant surplus to the advantage of the Eastern Carpathians: 26 resp. 17 species, or 17,11 resp. 11,26 %, which underlines well the fact that in the Eastern Carpathians there is a stronger continental influence in connection with the Boreal coniferous woodland and moorland.
 - As opposed to the former faunal type, the frequency of the Ponto-Mediterranean faunal elements shows an obvious surplus in the Southern Carpathians as compared to the Eastern Carpathians, 22 resp. 14 species or 14,57 resp. 9,21 %. 8 Ponto-Mediterranean species (*Spialia orbifer*, *Pyrgus*

sidae, *Pieris mannii*, *P. balcana*, *P. ergane*, *Hipparchia syriaca*, *Coenonympha leander*, *Kirinia roxelana*), widespread in the Balkan peninsula, reach the north-western limit of their range in the south-western part of the Southern Carpathians. These belong to the most important zoogeographical colouring elements of the Southern Carpathians.

- On the other hand, the faunal composition of the Eastern Carpathians shows a strong continental influence. Some differential species of this mountain range belong to the Siberian faunal type (*Parnassius apollo*, *Lycaena helle*, *Lycaena hippothoe*, *Arícia eumedon*, *Coenonympha tullia*, *Argynnis laodice*, *Brenthis ino*, *Boloria aquilonaris*, *Clossiana titania*, *Euphydryas aurinia*). The proportion of the Southern-Siberian and Southern-Siberian-Manchurian species also shows a little surplus in favor of the Eastern Carpathians: 10 resp. 9 species, or 6,58 resp. 5,96 %. The proportion of the Ponto-Caspian – South-Siberian species (South-Continental) show also a slight difference in favour of the Eastern Carpathians: 9 resp. 8 species, or 5,92 resp. 5,30 %. The sum of the proportion of the continental faunal types reaches 29,61% in the Eastern Carpathians, as opposed to the figure 22,82% in the Southern Carpathians.
 - The Mediterranean influence proved to be much stronger in the Southern Carpathians. The sum of the proportion of the Mediterranean faunal types reaches here 36,25%, as opposed to the 28,95% in the Eastern Carpathians. Also most of the differential species of the Southern Carpathians belong to the Holo- and Ponto-Mediterranean faunal types, respectively (*Hipparchia statilinus*, *Brintesia circe*, *Hyponphele lupina*, *Pyronia tithonus*, *Lybithea celtis*, *Limenitis reducta* and *Spialia orbifer*, *Pyrgus sidae*, *Pieris mannii*, *P. balcana*, *P. ergane*, *Hipparchia syriaca*, *Coenonympha leander*, *Kirinia roxelana*).
 - ***Thus, the butterfly fauna of the Eastern and Southern Carpathians shows a rather expressed territorial differentiation, both in the taxonomical composition and in the proportion of the faunal types.***
3. We have mapped and analysed the distribution of 52 species in details, according to the following points of view: the shape, the geographical and taxonomical structure of the area (disjunctions, subspecific differentiation), barriers, corridors and important limits of distribution etc. We have studied the taxonomical subdivision of 36 species. In 11 cases we could constate that the Carpathian populations are subdivided into 2 or more subspecies, furthermore in 16 cases we have found that the Carpathian populations are represented by endemic/sub-endemic subspecies. The species of limited distribution have been subdivided into four main groups as follows.
- Siberian species, which occur only in the Eastern Carpathians, in not very high altitudes, in humid or wet biotopes. Some of these species are restricted to peat-bogs (*Boloria aquilonaris aquilonaris*, *Coenonympha*

tullia tiphon), but the bulk of the species is connected to marshy or wet meadows (*Lycaena helle*, *L. hippothoe eurydice*, *Maculinea teleius*, *Brenthis ino*, *Euphydryas aurinia aurinia*) or to the humid mountain-subalpine meadows (*Aricia eumedon*, *Boloria titania transsylvanica*). Their habitats are confined to the cool-humid intermontane basins and valley systems of the Eastern Carpathians. The distribution of one part of these species reaches the southern part of the Eastern Carpathians (*L. helle*, *A. eumedon*, *B. ino*, *M. teleius*, *A. laodice*), other species occur exclusively in the northern part of the Eastern Carpathians (*L. hippothoe eurydice*, *Boloria aquilonaris*, *E. aurinia aurinia*, *C. tullia tiphon*).

- Ponto-Mediterranean species showing Balkanic biogeographical connections, which are restricted to the western part of the Southern Carpathians (Iron Gate area). This region can be biogeographically separated from the other parts of the Southern Carpathians. They are connected either to xerothermic, rocky habitats (*Pyrgus sidae*, *Pieris mannii*, *P. ergane*, *Hyponephele lupina*, *Erebia melas melas*) or to white oak scrub forests of Balkanic type (*Pieris balcana*, *Hipparchia syriaca rebeli*, *Pyronia tithonus*, *Coenonympha leander*).
- In the distribution of the alpine and arctic-alpine species the elevation of the habitats above the sea level proved to be the most important limiting factor. Most of these species occur locally both in the Eastern and Southern Carpathians: *Erebia sudetica sudetica*, *Erebia pharte carpathina*, *E. manto trajanus*, *E. epiphron transsylvanica*, *E. gorge fridericikoenigi*, *E. pandrose cibiniaca*. We suppose that during the last glaciation they have had a larger, nearly continuous range of distribution in the Carpathians, which only quite recently has been restricted and dissected by the expanding postglacial re-forestation, because the isolation could not cause a subspecific differentiation of these species in the given region. The species, characteristic for some highest mountain regions, are concentrated either to the Retezat massif, with own differential species showing Balkanic connections (*Erebia cassioides neleus*) or to the Făgăraș-Bucegi-Piatra Craiului-„triangle” (*Pyrgus cacaliae*, *Boloria pales carpathomeridionalis*, *Erebia pronee regalis*).
- Balkanic, Ponto-Mediterranean oreol species occur only two species (and three subspecies, respectively) in the Carpathians: *Erebia melas carpathicola* in the Eastern, *E. melas melas* and *E. melas melas f. koenigiella*, *Coenonympha rhodopensis schmidtii* in the Southern Carpathians. Their strongly disjuncted distribution and also the subspecific differentiation suggest that the distribution of the Carpathian and Balkanic population had been earlier disconnected than the last glaciations (Upper Pleistocene).

4. The species diversity of butterflies in the Carpathian mountains have been mostly influenced by the following factors: elevation above the sea level, extension of the areas above the timberline, geographical position, territorial connections (corridors), petrographic and edaphic factors, the diversity of flora and vegetation. The highest number of species have been constated in those areas, in which the interaction of these factors proved to be advantageous.
5. Based on the analysis of the distribution of the species mapped, I have outlined some important directions and corridors of dispersal, as follows:
 - The „archipelago” of moorlands and peat-bog habitats of the Eastern Carpathians are disconnected relicts of a former corridor for the boreal species which ends at the southern part of the Eastern Carpathians. The similarity of the faunal composition of these „islands” indicate that they should have been continuously connected since the last glaciations. Their disconnection has been resulted partly in climatic changes, but mostly in anthropogenic influences (logging, drainage, grazing).
 - The distribution of the Ponto-Mediterranean species with Balkanic connections has a sharp boundary both in northern and eastern direction. They do not show any continuous corridor into the inner parts of the Carpathian basin. Their occurrences in the Iron Gate region of the Southern Carpathians proved to be a northern limit of distribution in most cases. Only a smaller number of species have isolated occurrences in the inner parts of the Carpathian basin (*Pieris mannii*, *P. ergane*, *Maculinea arion ligurica*).
 - The Carpathians form recently a biogeographical barrier of dispersal for the steppicolous species. If they could cross this barrier, it has acted as factor of geographical isolation. We can suppose, that their dispersal has been occurred simultaneously in two or more directions (see: the very recent dispersal of *Colias erate*). Some species, which recently do not occur in the Carpathians, must have had crossed the Carpathians earlier than the last glaciation. They are the relict-like steppe species of the Transsylvanian basin (*Muschampia tessellum*, *M. cribrellum*, *Colias chrysotheme*, *Philotes bavius hungaricus*).
6. The Eastern and Southern Carpathians, as compared to the Northern Carpathians, display many similarities in the faunal composition of the montane and sub-alpine forested belts, and show also a rather slight differentiation in the faunal composition of the meadow and wetland habitats. The typical *Erebia* species of the humid meadows of the sub-alpine level (*Erebia epiphron*, *E. manto*, *E. sudetica*, *E. pharte*) have a scattered distribution both in the Northern, Eastern and Southern Carpathians. In the alpine level more differential species occur (e.g. *P.*

cacaliae, *E. cassioides*, species of *Geometridae*, *Arctiidae* and *Noctuidae*). It is important, that nearly all alpine species are represented in the Eastern/Southern Carpathians by other subspecies than in the Northern Carpathians (e.g. *Boloria pales*, *Erebia manto*, *E. gorge*, *E. pandrose*). It is also quite typical, that all ponto-mediterranean (Balkan) oreoal species which occur in the Eastern and Southern Carpathians, are lacking in the Northern Carpathians. Similarly, the number of the Mediterranean (Holo- and Ponto-Mediterranean) and Ponto-Caspian species is smaller in the Northern Carpathians, thus the diversity of the biogeographical composition is essentially smaller as either in the Eastern- or in the Southern Carpathians. The butterfly fauna of the West-Transsylvanian Island Mountains is less diverse, than in the Eastern and Southern Carpathians. The formation of endemic subspecies (*E. melas runcensis*) can be observed only in exceptional cases

7. The populations of the Siberian species, which occur in the Eastern and/or Southern Carpathians, have a marginal geographical position. Thus, in some cases they have formed peripheric subspecies (*Parnassius apollo transsylvanicus*, *Boloria titania transsylvanica*). In other cases, we could observe the occurrence of some rare mutations in such populations, e.g. the flavinistic male specimens of *Erebia ligea* („ab.” *huebneri*) in the Retezat Mts or the specimens of *Lycaena helle* in Mucedeni with distorted postdiscal and submarginal ocelli (E. Carpathians).
8. Compared the alpine and tundra-alpine species of the Carpathians and of the Balkan high mountains, we have observed some typical connections, but also some differences. The composition of the species, occurring in the highest regions, show essential similarities which is enhanced also by the close relationships of their endemic subspecies.

<i>Erebia pandrose cibiniaca</i>	<i>E. pandrose ambicolorata</i>
<i>Erebia gorge fridericikoenigi</i>	<i>E. gorge pirinica</i>
<i>Erebia cassioides neleus</i>	<i>E. cassioides macedonica</i>
<i>Erebia pronoe regalis</i>	<i>E. pronoe fruhstorferi</i>
<i>Boloria pales carpathomeridionalis</i>	<i>B. pales rilaensis</i>

9. Worth to mention that the zoogeographical significance of the Eastern Carpathians is increased by the fact, that more alpine species, e.g. *Erebia sudetica*, *E. pharte*, *E. epiphron*, *E. manto*, *E. pronoe*, *E. gorge*, *Boloria pales*, *Pyrgus cacaliae* and the Balkan-oreoal species: *Erebia melas* reach here the Eastern limit of their range of distribution in Europe. These species are generally lacking from the Caucasus Mts, but in some cases they are substituted by closely related, vicariant species, e.g. *Boloria caucasica* and *Erebia melancholica*. *Erebia cassioides* reaches its eastern limit of distribution in the Retezat Mts (*E. cassioides neleus*) and in the

Central Stara Planina (*E. cassioides kinoshitai*), showing close biogeographical connections to the Southern Carpathians. This species group is represented in the Caucasus-Transcaucasia area by more closely related species (*E. graucasica*, *E. iranica*).

10. Some relict-like populations have a high historical biogeographical importance, which are isolated and taxonomically differentiated from the populations of the main area of the species. Such cases have been found in the following biogeographical groups:

- Endemic Carpathian subspecies of alpine and arctic-alpine species (*Boloria pales carpathomeridionalis*, *Erebia manto trajanus*, *E. pharte carpathina*, *E. cassioides neleus*, *E. pandrose cibiniaca*).
- Endemic, relict-like Carpathian subspecies of Balkanic oreol species (*Erebia melas melas*, *E. melas carpathicola*, *Coenonympha rhodopensis schmidtii*).
- Endemic, relict like subspecies of Siberian species, isolated in the boggy intramontane basins of the Eastern Carpathians (*Clossiana titania transsylvanica*).

Worth to note, however, that the isolated and also taxonomically differentiated populations of Ponto-caspian steppe species (e.g. *Pseudophilotes bavius hungaricus*, some Geometrid and Noctuid moths) do not occur in the Carpathians. They are characteristic for the Transsylvanian basin („table-land”) which is geologically, climatically and also botanically rather different from the Carpathian areas.

On the other side, no taxonomic differentiation could be observed in the Ponto-Mediterranean species, restricted to the Iron Gate area of the Southern Carpathians. Thus, they cannot be considered as relict elements, but only as results of postglacial dispersal, followed by isolation.

