Opusc. Zool. Budapest, 2013, 44 (suppl. 1): 5–10

The role of the Balkan Peninsula in the origin and genesis of the soil fauna of the Carpathian Basin: history, aims and results

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Abstract. The history, aims and the results are summarized of the project "The role of the Balkan Peninsula in the origin and genesis of the soil fauna of the Carpathian Basin", supported by the Hungarian Scientific Research Found (OTKA *No*. K72744) and led by the late Prof. Sándor Mahunka are communicated. During the project 48 species new to science were discovered belonging to different groups of soil animals (Lumbricina, Oribatida, Uropodina, Zerconida, Opilionida and Collembola). The "Illyric-Dacian pincer" theory was affirmed and the close connections between Balkanic and Carpathian Basin's pedofauna were also demonstrated.

Keywords. Soil fauna, faunagenesis, Carpathians, Balkan Peninsula

INTRODUCTION

The Balkan Peninsula is one of the characteristic and well demarcated regions of Europe; its Western, Southern, and Eastern borders are delimited by the Mediterranean and the Black Sea, but the Northern border is more problematic. Most scientists agree that the North-Eastern limit of the Balkan Peninsula is the Danube River however there are some views suggesting that the North-Eastern Border is the Southern fringe of the Carpathian Arc, which means that Dobrudja can be part of the Balkan as well. Similarly to the North-Eastern border of the Balkan Peninsula there are several conceptions on its North-Western border as well. One regards the Drava River delimiting the Balkans, placing several Slavonian mountains such as the Papuk Mts., Psunj Mts. etc., and even more the Fruska Gora, and all of Slovenia as part of the Balkan Peninsula. Another hypothesis places the border to the Sava River and consequently relegates all of the previously mentioned regions to the Carpathian Basin or to the Alps. Either of the views is valid it is clear that there is no sharp limit between the Carpathian basin and the Balkans and this is true not only for the geography of the region but also for its fauna as well.

HISTORY

Hungarians zoologists have paid always especial attention to the Balkan Peninsula, and a number have contributed in its zoological exploration as well. Although the zoological research had begun as early as the eighteen century the systematic exploration of the Balkan started – with more or less intensity depending on the actual political situations – at the beginning of the twenties century.

The first Hungarian zoological research was launched by Imre Frivaldszky (1799–1780). He organized and led expeditions to Macedonia, Bulgaria, and Turkey. From the material collected a number of beetle, butterfly, and mollusc species

urn:lsid:zoobank.org:pub:8EAC56AE-98D6-4C4F-916A-D74AA0B70683
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

new to science were described. He authored also the description of the now widely distributed collared dove (*Sterptopelia decaocto* Frivaldszky, 1838).

Károly Brancsik (a physician and zoologist 1842–1915) director of the Tencsény County Museum (now in Slovakia) led three expeditions to the Balkan collecting in Dalmatia and Bosnia however, the most intensive research of this period was carried out by Ernő Csíki (1875–1954) who even before the First World War made collections in Bosnia and Dalmatia. During the War he followed the Austro-Hungarian army and collected all around in the occupied territories and brought home an extremely rich material just before collapsing the front. His first scientific results were published by the Hungarian Academy of Sciences in a two volumes book entitled "A Magyar Balkán Kutatás Eredményei I-II,, (Results of the Hungarian Balkan Researches I-II.).

After a long silence in the seventies and eighties the Balkan research started again but mainly with expeditions to the "available" countries (i.e. the former Eastern Bloc countries). This research, although restricted in scope, resulted in the publication of remarkable scientific results (Pintér 1968, 1978, Varga 1978, 1984). However, the intensive Balkan research was re-launched only around the new millennium. Since then the staff of the Hungarian Natural History Museum organized several collecting trips to Albania and the former Yugoslav countries collecting soil samples, plants, molluscs and other invertebrate material (Subai & Fehér 2006).

The scientific elaboration of these and other samples confirmed that the Balkan refuge and the Balkan Peninsula itself might have played an important role in the postglacial faunagenesis of the Carpathian Basin (Mahunka 1991a, 1991b, 1993).

After the long project of the Zoology Department of the Hungarian Natural History Museum (Faunagenesis of the Carpathian Basin [see: Mahunka 2007]) a new, research was organized by Professor Sándor Mahunka (1937–2012).

The aim of this project was to study the role of the Balkan Peninsula in the faunagenesis of the Carpathian Basin.

The postglacial colonization of the Carpathian basin from the Balkan refuges is quite well documented for both the vertebrate (Seddon *et al.* 2001, 2002, Marmi *et al.* 2006) and invertebrate taxa (Cooper *et al.* 1995, Horn *et al.* 2006, Schmitt *et al.* 2006, Varga 1995). However, the majority of these studies focused on vagile, easily dispersing animals. But our knowledge on the low-dispersing, almost sedentary animals such as the members of the soil fauna is rather scant. In this manner we know almost nothing about the repopulation of the Carpathian basin by the members of the soil mega- macro and meso-fauna except a few cases for the oribatid mites (Acari: Oribatida) where the "Illyric-Dacian pincer" theory was established (Mahunka & Mahunka–Papp 2004). According to this theory the humid and sub-humid Illyric species were spread along the eastern fringe of the Alps up to the Őrség, Szigetköz, Fertő regions and the xeric species towards the southern side of the Bakony, Vértes, and Pilis mountains. The other stalk of the pincer is represented by the South-Eastern (Moesian) species spreading up to the North-Eastern part of Hungary (Aggteleki Mts. Szatmár-Beregi plain) mostly via the Transylvanian Island Mountains (Apuseni) and/or the western slopes of the Eastern-Carpathian Arc.

Since the early zoological investigations on the Balkan Peninsula started two hundred years ago, did not focus on the soil dwelling animals new collection trips were planned and organized to the Balkan Peninsula in the framework of the project "*The role of the Balkan Peninsula in the origin and genesis of the soil fauna of the Carpathian Basin*" supported by the Hungarian Scientific Research Found (OTKA 72744). The focus groups were the most important representatives of the pedofauna such earthworms, mites, springtails and Opiliones. The collections covered the whole area of the Balkan Peninsula and the material collected was elaborated from faunistical and taxonomical and also biogeographical point of view.

RESULTS

Analyzing the huge material collected in the Carpathians, the Carpathian Basin, and the Balkans we successfully demonstrated that the earthworm fauna of the Carpathians and the Carpathian Basin is highly endemic. The 40.12% endemism ratio is extraordinary in continental faunas, that is due to the insular-like isolation of the region and the fact that the Carpathian Basin was always ice-free during the last glaciations (Pop *et al*. 2010, Csuzdi *et al.* 2011). The earthworm fauna is enriched with West- and East Balkanic (Illyric and Moesian respectively) elements of which the Illyric species spread along the Eastern fringe of the Alps up to Lower Austria. The true Moesian elements enter the Carpathian Basin along the Danube River and the Cerna Valley, however they do not cross the Mures River (Csuzdi *et al.* 2011, Pop *et al.* 2012).

The investigated mite groups show different types of connections between the Carpathians, the Carpathian Basin, and the Balkan. Several oribatid species confirm the "Illyric-Dacian pincer" hypothesis. Illyric species [e.g. *Allosuctobelba grandis grandis* (Paoli, 1908) or *Cultroribula juncta* (Michael, 1885)] collected in several countries of the western Balkans (*e.g.* Albania, Croatia, Slovenia) were also found along the western border of Hungary up to the Kőszegi Mts. On the contrary, the Moesian elements (e.g. *Zygoribatula undulata* (Berlese, 1916), which was described from the Danube Delta) are distributed in the eastern part of Hungary, in several cases from the Eastern part of the Hungarian Great Plain to the Hungarian Northern Mountains.

Occurrences of the other mites can show a circum-pannonic distribution, which can mean an existing connection among the Balkanic Mountains, the Carpathians and the Alps. This distribution type relates to the Uropodina species *Trachytes irenae* Pecina, 1970 and *Trachytes carpathicus* Kontschán, 2007, but this distribution type can be observed in the largest European springtail species [*Tetrodontophora bielanensis* (Waga, 1842)] as well. According to our results, we can conclude that the mountainous regions of the Balkan Peninsula have played a key role in the formation of the soil mesofauna of the Carpathians and the Carpathian Basin.

Regarding the arachnid order Opiliones and the insect order Dermaptera, shared fauna of the Carpathian Basin and the Balkan is limited to widespread, mostly Central European taxa. These are distributed in areas of continental or montane climate, and lacking in the coastal areas and the Southern Balkan (Murányi 2013b: Figs. 33–34), but some cosmopolitan species like *Forficula auricularia* Linnaeus, 1758 inhabit the whole Balkanic mainland and some of the isles (Murányi 2013b: Fig. 35). The few known, strictly Carpathian montane species are not yet found even in the connected Stara Planina, whereas some Alpine taxa distributed also in the Western Balkan like the genus *Megabunus* Meade, 1855 (Murányi 2013a: Fig. 63) relating to an Illyric type of distribution.

Distribution of Balkan endemic species in the arachnid order Opiliones delimitate three distinct areas: the Illyric (with some species distributed southwards to Epirus), the Moesian and the South Aegean centres (Murányi 2013a: Figs. 63-64).

During the term of our project (2007-2012) six papers on earthworms (Csuzdi & Pop 2008; Csuzdi *et al.* 2011, Szederjesi & Csuzdi 2012a, 2012b, Szederjesi 2013a, 2013b), 15 papers on mites (Kontschán 2008, 2009, 2010, 2011a, 2011b, Kontschán & Gyuris 2010, Kontschán & Ujvári 2008, Mahunka 2008a, 2008b, Mahunka & Mahunka-Papp 2008, 2010 Ujvári 2009, 2010a, 2010b, 2011, Ujvári & Călugăr 2010), four on springtails (Dányi 2010, Dányi & Traser 2008, Traser & Dányi 2008, Dányi *et al.* 2010) and one paper on Opiliones (Murányi 2008) were published in different journals. So far 48 species new to science were discovered in this region and several dozen new records for the different countries of the Balkan Peninsula were reported.

Acknowledgements – This research was supported by the Hungarian Scientific Research Found (OTKA No. K72744). Our thanks are due to Ms. Emma Sherlock (NHM, London) for polishing the English of the text.

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