BIOLOGICA NYSSANA
1 (1-2) • December 2010: 123-130 10th SFSES • 17-20 June 2010, Vlasina lake

Original Article

Contribution to understanding the origin and the genesis of the Nišava riverside valley fauna

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***Abstract*:**
Jakšić, P., Momirović, M.: *Contribution to understanding the origin and the genesis of the Nišava riverside valley fauna. Biologica Nyssana, 1 (1-2), December 2010: 123-130.*

The fact that very early biologists registered an extraordinary faunistic richnes in the greater area of Niš (Nišava's riverside) is pointed out. The conditions that contributed to this variety are analyzed. The importance of geological history of this region is explained, from the ancient lake phase trough the glacial epochs including the present state. The dilemma about lake terraces and the water level of the Neogene lake system is discussed. A list of gorges, speleological objects, springs, mountain tops as habitats of endemic and relict species is given. All the endemic and relict species in these habitats are listed.

Key words: Fauna Origin, Fauna Genesis, Nišava Riverside, Serbia

Introduction

The area of the Nišava river valley attracted the attention of geographers and biologists very early. As early as 1891 Đ. J o v a n o v i ć wrote about the caves in the gorge and in 1909 P. J a n k o v i ć devoted a comprehensive monograph to the development Nišavska valley. Among botanists S. P e t r o v i ć researched the flora of this region on two occasions (in 1882 and 1885, respectively).

At the very early stages of research of the Ponišavlje fauna, both botanists and zoologists noticed the diversity and large numbers of endemic and relic species. Thus, for example, P a v l o v i ć (1912) in his monograph on the land snails in Serbia pointed out the presence of numerous endemic species, and based on this data he produced one of the first zoogeographic maps in Serbia, where the Nišava valley was tagged as an area in which tertiary relics existed. Subsequent studies of many botanists and zoologists had this view only updated and confirmed.

The reason for this abundance is explained using geological and tectonic history of the area, its central position in the Balkan Peninsula and the topographic disposition of the terrain. From the valley of Niš, through the surrounding hills and cliffs of numerous rivers, the Suva Planina Mt., the Vidlič Mt. and other mountains of the wider area and geological complexity orographical areas offer good macroclimatic and microclimate conditions, and the significant complexity of habitat necessary for the existence of various elements of the flora and the fauna. Besides the gorges, which serve as an excellent refuge, there are also wells and springs, numerous caves, forest litter (bedding) and xerothermal habitats on the tops of the surrounding mountains. The central position of this area in the Balkan Peninsula, in turn, allowed the presence of various elements of the fauna: Central-European, Pannonian, Dacian, Pontic, East Asian, etc.

Material and methods

The area considered includes the headwaters of the Svrljig Timok, the Reka river valley, the Nišava valley from Bela Palanka to Niš (Gorge), the corresponding slopes of the Svrljiška and Suva Planina Mt., the Jelašnica and Prvokutinska gorges, caves and springs in the area. In the basin of Svrljig Timok, taken into consideration are Okapina 1, Okapina 2, Tor, Bezimena okapina, Great okapina, Small okapina, Okapina at Ostenjak, the church ruins okapina 1, the church ruins okapina 2, the church ruins okapina 3, the Ripaljka Cave, Tunnel Cave; in Nišava basin, the objects considered are the okapina on the Jecava, the Eagle gap, Mečija duvka, Celenkina duvka, Golema duvka, Ladarova duvka, Goveda duvka, Great okapina 1, Great okapina 2, okapina near the tunnel , Small okapina, Popova duvka (Savnjak) Paramanska okapina, Ogorelička cave, the cave at Zavrte, Jovina duvka, Great Balanica, Small Balanica, Popova duvka (Brljevski stone), Svinjarska duvka, Radonjino konopljište, Tunnel Cave. Wells and springs taken into consideration include Bojanine Vode and Vrelo on the Suva Planina Mt. Finally, mountain peaks of xerothermic character taken into consideration are Ramnište 951m, Crni Vrh 1164 m, Mečji Vrh 1184 m and Golemi Vrh 1535 m, all on the Suva Planina Mt.

On this geographic terrain the presence of tertiary relict species and postglacial xerothermic steppe species is analyzed. In this work the method of causal induction method was used (JS Mill) in which the conclusion is based on the search for causes. This method has many variations, and we applied the mode of agreement and difference, a method of reasoning where cause and effect correlate. Geological-tectonic history and the history of climate change in the area are observed as a cause and the abundance of the species as a result.

Results

Representatives of Nišava valley flora and fauna of preglacial age and xerothermic relics

a) **Representatives of the flora.** Among tertiary relics we can cite the following species: *Juglans regia*, *Syringa vulgaris*, *Corylus colurna*, *Acer intermedium*, *Staphylea pinnata*, *Daphne laureola*, *Dictamnus albus*, *Edraianthus serbicus* and, especially, endemorelict species *Micromeria cristata*, *Parietaria serbica*, *Ramonda serbica* and *Ramonda nathaliae*. From the period of the relatively warm and dry interglacial (xerothermal) remained the steppe relics: *Adonis vernalis*, *Prunus fruticosa*, *Prunus tenela*, *Asparagus tenuifolius*, *Sternbergia colchiciflora*, *Hyacinthella leucophea*, *Ranunculus illyricus*, *Cachrys alpina* et al. (Lazarević et al., 2007).

b) **Representatives of the fauna.** A survey of the fauna is limited to two groups of invertebrates: Mollusca and Arthropoda. Significant contribution to the knowledge of Mollusca in this area was given by Pavlovic (1912). The author cites the following relict and endemic species in the gorge: *Cabinet annularis* Stud, *Hyaline nitens* Michaud., was also found near the village Prekonoge, *Zonitoides nitidus* Müll., *Patula solaria* Mke., *Eulota fruticum* Müll., *Vallonia pulchella* Müll., *Fruticicola (Monache) incarnata* Müll., *Campylaea trizon* ZGL., *Carthusian carthusian* Müll., *Buliminus (Zebra) detritus* Müll., *Buliminus (Ena) obscura* Müll., *Chondrula tridens* Müll., *Chondrula (Mastus) venerabilis* Ziege., *Caecilianella acicula* Müll., *Orcula doliolum* Brug, *Pupa frumentum* DRP., *Modicella avenacea* Brug., *Pupilla muscorum* L., *Isthmia minutissima* Hartm., *Isthmia salurensis* Reinhardt, *Clausiliastra laminate* Mont., *Alinda plicata* DRP., *Alinda biplicata* Mont., *Herilla frauenfeldi* Zelebor, *Carinigera eximia* Mollendo . The last one listed is an endemic species growing on the bare and sun-exposed limestone and found in Bela Palanka at Vrelo in the gorge on the road village Mokro, above the Modro spring, near the village of Krupac and also in Pleš on Nišavska side. Finally, there are also types of *Carychium minimum* Müll., In both Sićevo and Jelašnička gorge *Acme serbica* Clessin was found, and *Ericia costulata* (Zgl.) Rossmore. Species *Uncinaria petrovici* Pavlović was found on Vidlič above Visočke Ržane. Species *Kuzmićia pygmaea* Mollendo. is distributed only in southern and southeastern Serbia, in the analyzed area it was found on a Suva Planina Mt., in the Jelašnička and Sićevo gorges, on Pleš Mt. and the village of Prekonoge.

Different groups of Arthropod fauna have also been the subject of intensive research by many authors. Thus Pljakić (1977) in this area identified the presence of many primitive species of lower crustaceans from Oniscoidea: *Hyloniscus riparius* (CL Koch, 1838) in the Sićevo Gorge, *Hyloniscus transsylvanicus* Verhoeff, 1901 in the spring at Ostrovica, *Hyloniscus kopaonicensis* Buturović, 1960 in the upper and lower Dušnik, *Trichoniscus naissensis* Pljakić, 1977 in the three caves (Donja cave in refuge, Great Belanica and Kojina cave) and *Trichoniscus bononensis* Sotirova Pljakić, 1977 in the cave Kravljansko pester. The summation of known Diplopoda in this area was given by Makarov et al. (2004). The authors cite several cavernlike species: *Dorypetalum degenerans* (Latzel, 1884) and *Megaphyllum austriacum* (Latzel, 1884) from a cave in the Barski reed, *Svarogosoma bozidarcurcici* Makarov, 2003 from a cave in Sava's fall (Trem), *Nopoiulius kochii* (Gervais, 1847) from the great Belanica and *Typhloiulus (Typhloiulus) nevo* Makarov, Mitić & Curcio, 2002 from the Great cave. The Opilionida identified are *Paranemastoma (Buresiolla) bureschi* (Roewer, 1926) and *Cyphophthalmus serbicus* (Hadži, 1973) in Cerjanska caves. In the Pseudoscorpiones group Ćurčić et al. (2004) found the species *Roncus remesianensis* Ćurčić, 1981, *Roncus timacensis* Ćurčić, 1981 and *Roncus jelasnicae* Ćurčić and Dimitrijevic, 2009. The recognized species of Spiders (Araneae) include *Pholcomma gibbum* (Westring, 1851), *Steatoda triangulus* (Walckenaer, 1802) and *Lepthyphantes leprosus* (Ohlert, 1865) in Košuća cave (Kravlje), *Lepthyphantes trnovensis* (Drensky, 1931) in the Cave near Niš and *Mettelina merianae* (Scopoli, 1763) in Jelašnička cave. Among Ticks (Ixodidae), the species found include *Eschatocephalus vespertilionis* CL Koch, 1844 at Ogorelačkoj cave.

The presence of numerous representatives of Insecta has been determined. The representatives of the species Staphylinidae are *Bisnius cephalotes* (Gravenhorst, 1802) and *Aleochara (Xenochara) funebris* Wollaston, 1864 from the Ogorelačka cave, and the species *Quedius (Microsaurus) mesomelinus skoraszewskyi* Korge, 1961 and *Atheta (Alaobia) caving* Erichson, 1839 from both Belanica and the Ogorelačka cave. The representatives of the beetles (Carabidae) are the species *Duvalius (Paraduvalius) winkler* (Jeannel, 1923) from the Ogorelačka cave, and Straight Prekonoga oven and *Laemostenus (Pristonychus) terricola punctatus* (Dejean, 1828) from the Ogorelačka cave, and the species *Trechus (Trechus) irenis* Csik, 1912 from the Cerjanska cave. Finally, the Orthoptera (Raphidophoridae) species observed are *Troglophilus neglectus vlasinensis* Maran, 1958 in the Belanica and Ogorelačka cave.

The Ogorelačka cave has long been known for existence of the Cave Bear (Djordjević, 1891). Jovanović (1891) established its presence in the Prekonoška cave. Herak (1947) proved that the cave bear in the Balkan Peninsula is not indigenous but has in fact come from the region of the Alps at a later date Diluvium.

Discussion

From the description it is evident that the presence of the glacial elements in the analyzed region is reduced to a minimum. In association with the pine (*Sorbet-Mughetum* Jn.) on the steep, cold northern slopes of the highest part of the Suva Planina Mt. at about 1400 m above sea level, all the way to the highest peaks, some of the glacial relics can be found, such as eg. *Dryas octopetala*. This means that the glaciation in this region has significantly disrupted the starting wildlife.

If the climatic factor was not crucial, then it can be assumed that the proper interpretation of the geological history is the key to understanding the origin and genesis of the recent flora and fauna in the Nišava riverside valley.

In the geological-tectonic history of the area the most important event was the lake stage. From the point of view of modern science, it is surprising that as early as 1909, 100 years ago, Janković published an extensive study of the history of the development of the Nišavska valley. The author of this work claims: "The Niška valley is a drained pool of a large neogen lake, which existed probably until the end of the Pliocene." In the same paragraph, the author presents another observation: "The Niška valley with its configuration and its main plastic lines independent of the Nišava valley and its actions, because the river formed only after the runoff Neogen lake"; also extremely important is that we note that the author of this work gives the original drawings of the land and sea during the three phases of the Neogen. The Suva Planina Mountain, the Pleš, the Vidlič Mt. and other ranges are presented in these maps as islands. Janković in summarizing his results highlighted the existence of two systems of terraces: the high abrasion (lake) and a system of low (fluvial, river) terraces and that by them we can see that the great lakes declined successively and in breaks. The assessed absolute levels and relative levels of lake shores in stages are also determined. Cvijić (1913) in his study of the Rtanj Mountain pays attention to Rtanj lake plasticity. Cvijić found the presence of lake terraces at 940-830 m, then at 680-670 m, and at the level of 600 m, he also links these terraces to Pont. Writing about the Prvokutinska gorge, which was cut by Kutina, a left tributary of Nišava, Martinović (1976) linked its genesis with the lake stage, the end of the Miocene and stated that the area of today's gorge was the lake narrow of the Niš lake basin. By analyzing the formation of dolomite in Neogen lake sediments in the Niš area of the Morava riverside, Nikolić & Janjić (1986) came to the conclusion that in certain phases of the existence of the lake there occurred the salinisation of the water environment, an increased salinity, higher temperatures and evaporation, causing a deposit of dolomite. By analyzing the Neogen series of the litostratigraphic column, the authors established the first cycle of sedimentation in the lower Miocene, the second cycle of sedimentation taking place during the middle Miocene, the third cycle of sedimentation proceeding during the Mio-Pliocene, and after that the last phase was implemented in the genesis of Neogen sedimentation. A similar view was proposed by A n d j e l k o v i ć et al. (1991), who pointed out that during the Pontian the marine environment had been reduced to remnants of Paratethys in the Pannonian and Dacian areas, while in other parts of the former sea came to a loss of salinity and the formation of wetlands covered by dense vegetation Taxodium forests. During the Dacian era, the complete withdrawal of Paratethys from Serbia occurred, this territory, therefore, existing as a land mass from 12 (12.5) million years ago until the present day.

M a r t i n o v i ć (1968) compiled a very detailed survey of the genesis of the Sićevo Gorge. He singled out six lake levels, i.e. six lake terrace: the highest abrasive track at the level of 1020 - 1000 m; the second terrace is at 860 m, the third terrace at 830-820 m; the next level of 760 - 750 m has been developed in the Sićevo Gorge and on the outskirts of the Niš Valley; the fifth level is a distinct riparian terraces in the gorge at a height of 720-700; the last level was at an altitude of 680-660 m; this level is also present along the perimeter of the Niš Valley (where it is represented at two levels due to intense tectonics of the terrain). Martinović says that up to a height of 720 m terrace is of Pannonian age (Upper Miocene, about 12-13 million years), lower than 460 m of Pontus (Pliocene, about 11 to 11.5 million years) and below this level are the Diluvial ones; the last lowest terrace is recent.

The Pontic era climate in Serbia is characterized by relatively high temperature and high humidity, as evidenced by the sediments and deposits of tacsodium. During the Dacian era, the climate did not significantly change, which is proven by the process of paleocrustification (A n d j e l k o v i ć et al., 1991).

In the debate about the level of Neogen lakes in the south of Serbia, M i l i ć (1982) showed that there was no communication between Pannonian Lake and Aegean Lake through Grdelica Gorge or other possible locations. But the author also pointed out that such communication was possible in the upper Miocene and that the link extended west of the mount Kukavica to the Preševo-Kumanovo Basin. The author specifieds that this connection had existed during the Pannonian.

However, the views put forward by J a n k o v i ć (1909), C v i j i ć (1913) and others are opposed by the contemporary authors. Thus, P e t r o v i ć D. (1988) critically examined Cvijić's understanding that during the upper and lower Pliocene there existed a unique Aegean Lake that cut high terraces of 760-740 and 670 m. The shallow character of Pont sediments, as encountered in the Nišava riverside valley, and their low height exclude the possibility that the Pontic water in general could reach the height of the coastal line of 940 m and above, and cut the surface at a height of 850 m. The existence of epigenetic gorges excludes the possibility that under the height of their upper edges surface abrasions could be carved, because the central lake level had to be above them. If we take the contour line of 857 m as a reference point selected as the middle of the three phases that Janković presented on his maps [which is approximately equal to the highest correlated level terrace of 873 meters of the current sea levels, according to N i k o l i ć (1991)], then we come to the conclusion that the islands could not be used to maintain tertiary elements of flora and fauna (**Fig. 1**).

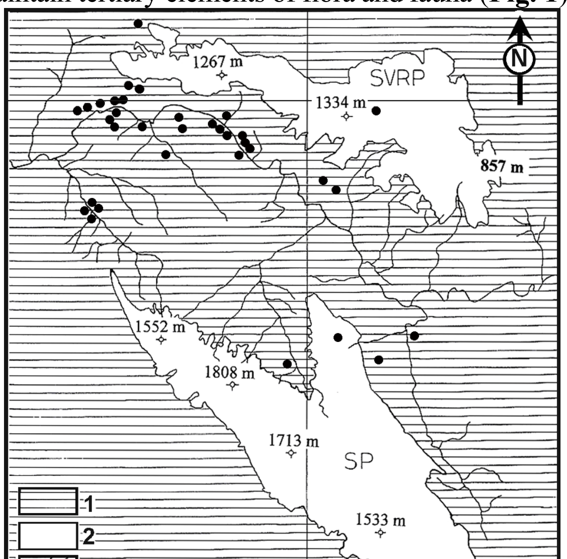

Fig. 1. A reconstruction of the land and sea on the contour line of 857 m, as understood by Janković (1909). The legend: 1 - sea, 2 - land, 3 - river network, 4 - caves analyzed in this paper, SVRP - the Svrljiške Planine Mt., SP - the Suva Planina Mt..

Such an image completely excludes the existence of gorges, caves and springs, all modern caves (represented by circles in the drawing) would in that time have been submerged. The abrasion and fluvial terraces seen in the field are real; their existence is not doubted by anyone. On the given maps of land and sea during the Sarmat, Pannonian and Pontian, Andjelković et al. (1991) specified the lines of the lake in that period, showing its successive reduction. These maps match well with the maps of Jovanović for the period of Pannon. However, substantial differences appear in the level - Andjelkovic et al. emphasize that this is a shallow lake, unlike Jovanović's view. Finally, Andjelkovic et al. pointed out that during the Pontian there occurred a positive epirogenesis, an upheaval of the land that led to the withdrawal of the sea and the transition of plain lands to hill lands. Now, we can set a theory that in this way the terraces were successively raised to the level seen today or that the level of the sea was more or less constant, and that the marking of terraces went successively, and that, due to positive epirogenesis after forming, they would be raised to this level.

Nikolić (2007), in a study of abrasive terraces, definitely confirmed this view. The author provided a precise series of successive levels of abrasion terrace for Serbia (especially in the catchment area of South Morava); according to the data, the altitude of the abrasion terrace showed these values: 60, 75, 100, 120, 140, 175, 200, 220, 240, 260 and 280 m. In the same article the author presented the data on a curve of eustatic fluctuations of the Mediterranean Sea in the Pleistocene, based on which it is shown that the sea level used to be between + 280 in the Gűnz 1 period - Gűnz 2 (560 thousand years ago), over - 120 in Wűrm 3 (about 30 thousand years), to the present level of 0 m.

Caves and species found in them can be the key to solving the dilemma presented here. According to the hypothesis of Janković (1909), as shown in Figure 1, all existing caves during the Neogen and until the end of the Pliocene were submerged; it is unlikely that they existed at all. Therefore, it follows that they were developed only after the runoff of the neogen lake, their maximum age being 11.5 million years. In speleology it is a common knowledge that in the Dinarides and Carpatho-Balkanides there are old cave systems of preglacial age. Most caves of the Alpine arc are of glacial age, some of them are only 40,000 to 50,000 years old. There is little data about caves in eastern Serbia. Gavrilovlć (1967) described the genesis of the Vlaška cave in the Resava spring. The cave was formed by water, its formation probably began in early Pleistocene and the formation of main channels in late Pleistocene. A similar view was expressed by Petrović (1977) in discussion about the genesis of the Bogovinska cave. The author concluded that the formation of the Bogovinska cave is related to the first half of the Pleistocene, it being the oldest stage in the formation of this cave. We also have reliable data for the Zlotska cave. The underground stream had built the channels of the Zlotska cave during the Late Pleistocene and the formation was completed in Holocene (Brown, 1957/58). In the relative proximity of the area that was analyzed in this paper is the Seselačka Pećura in Soko Banja. Petrović (1984) concluded that it was a younger object, formed at the turn of Pleistocene to Holocene. Bearing in mind the relative closeness of these caves with other speleological objects in the Nišava valley, as well as an exact geological-tectonic history and identical climatic conditions, we can conclude that the caves in the Nišava valley are also of Pleistocene age.

This viewpoint can serve as an explanation for significant differences in cavern-like fauna of cave systems in eastern Serbia (which are relatively poor in the fauna) and cave systems of Dinarides (who hold one of the richest fauna in the world). Cave systems in eastern Serbia were formed at the end of the glaciation, when most termophile species of the Tertiary age had already extinct.

Outside the context of this paper we present an interesting observation. Specifically, the caves of Eastern Serbia have developed as part of two carbonate platforms: "Kučajsko-tupižnička carbonate platform" and "Miročka carbonate platform". Both platforms were developed in the Mesozoic, in the upper Jurassic and lower Cretaceous (about 150 million years ago). "Overlaying" the map of distribution of carbonate rocks in Serbia with the map of Neogen basins in Serbia shows that limestone areas were not flooded by Neogen waters - they existed as dry land (Figure 2). So the question is: why are there no old cave systems to them? One possible explanation is that at the time the position of these masses was much closer to the equator, and in such circumstances, in the absence of cold waters the forming of caverns was difficult.

Ribera et al. (2010) analyzed the age of 57 species of cave-dwelling beetles from Leptodirini (Leiodidae, Cholevinae). The authors concluded that the colonization of cavern like habitat in the Pyrenees had begun shortly after their formation in the early Oligocene. So, today's abundance of species from this group is understandable having in mind that their evolution took 35 million years. The authors also concluded autochthony of this group; it has evolved in the same area where its ancestors used to be.

The Pyrenees are represented by another Tertiary relic - *Ramonda myconi* (Fam.

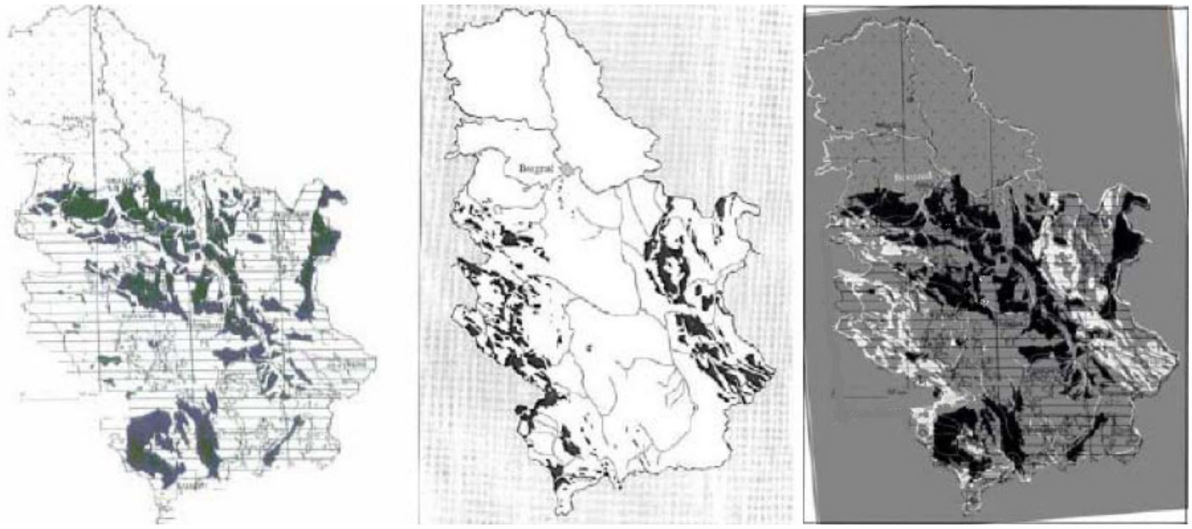

Fig. 2. Mutual spatial relationship – right, between the Neogene basins of Serbia (Jankovic, 1990) - left, and the range of karst (Gavrilovic, 1976) - in the middle.

Gesneriaeceae), this species makes it possible to make a complete parallel with the area that we have analyzed in this paper. As the species mentioned in the Pyrenees, our *Ramonda serbica and Ramonda nathaliae* are Tertiary relicts. But while in the caves of the Pyrenees there are 57 analyzed species from Leptodirini, to this time there are no species of this group in analyzed caves of Nišava valley. By this means, the opinions of Gavrilović (1967) and Petrović (1977) are confirmed about the pleistocenic age of caves in Eastern Serbia. The known Leptodirini are Leiodidae from Eastern Serbia, the representatives of the Endogean and not of the cavern-like fauna. (Curčić et al., 2009). Why did this group fail at adaptive radiation of cavern-like habitats? Probably because the continuous temperature stability of the region and the presence of optimum moisture content in litter and endogean conditions allowed a comfortable existence. The area of deciduous forests, which dominate the Carpatho-Balkan Mountains of Eastern Serbia, is characterized by the presence of a powerful layer of organo-mineral complexes; that is why the representatives of the endogean fauna did not have an ecophysiological need to retreat to cavern-like habitats. The areas affected by the influence of the Pleistocene climate, but which were not covered in ice, have a well-preserved terrestrial fauna. We conclude that the process of formation of cavern-like fauna in the Carpatho-Balkanides started, but has not yet been completed.

But, on the other hand, cavern-like Leptodirini of the Pyrenees have their analogues in Eastern Serbia. An analogy is found in the group Pseudoscorpiones - according to Curčić et al. (2004) out of 25 species from this group distributed in eastern Serbia, 20 of them live in caves, while only 5 species have been found outside the cave.

Conclusion

The fauna of the Nišava riverside valley is represented by species from different geochronologycal epochs: the species of Tertiary age as the oldest (represented by thermophile species), the species of the Pleistocene age (represented by glacial species) and species of the Holocene age, of postglacial character, as the youngest (represented by xerothermic relicts).

The opinion of Janković (1909) on the relationship between the land and the sea during the Neogen must be taken with caution. The opinion of Petrović (1988) is more likely, that in this area a shallow sea existed and the surrounding terrain upheaved successively. The current lake terraces explain the stages of ground upheaval, rather than the stages of the sea outflow.

Based on cavern-like fauna composition, and based on analogy of genesis of some caves in eastern Serbia, it is certain that the cavern-like objects in the Nišava riverside valley are of Pleistocene age.

The forming process of the cavern-like fauna has begun; in some groups it has advanced far (Pseudoscorpiones), in some groups it is still in its infancy (Leptodirini, Leiodidae), but it certainly has not yet reached the scale of what we encounter in the Dinarides.

On the other hand, the species of Tertiary age are abundantly represented in the gorges, springs and wells, especially in forest litter, in damp and shady habitats. Also, they can be found in high mountain habitats of oromediteranic thermophilic character.

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