

Rodna Mountains National Park - an endemogenetic alpine centre in Carpathians

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Abstract

Rodna Mountains are isolated from the other mountain units surrounding it (Maramures, Suhard, Tibles), being the only area from the Eastern Carpathians with an alpine level. This could have contributed possibly to favorable conditions for speciation to occur and newly formed taxa to emerge. In the conclusion, we can conclude that Rodna Mountains is playing a role of alpine refuge for many endemic species (212), being considered as an endemogenetic centre at Carpathian level.

Keywords: endemic, endemogenetic, alpine, Carpathians

Description of the area

Carpathian Mountain range is part of the European alpine system, representing a major orographic unit, well individualized by orogenetic, geomorphological and floristic characteristics. Extending over 1600 km, the Carpathians are the longest unit of the EAS (compared with the Alps – 1200 km, Dinaric Mountains – 800 km or the Balkans – 500 km, Mihăilescu, 1963).

Rodna Mountains National Park is the largest one in the north of the Eastern Carpathians and stretches over 47.000 hectares, of which 3.300 hectares have been declared Biosphere Reserve since 1979. The importance of this protected area relies on geology, geomorphology, and numerous endemic or glacial relicts of flora and fauna. Rodna Mountains boost the highest peaks of Eastern Carpathians (Pietrosu Mare, 2.303 m) and they are placed in north of Romania. They belong to the Northern Carpathian group, known as Maramureș and Bucovina Carpathians, and dominate the boundary region, the highest altitude gap being recorded towards Maramureș Depression, which is placed in north of Romania, Eastern Carpathians, counties of Maramureș, Bistrița-Năsăud and Suceava.

Rodna Mountains appear as a horst of crystalline layers delimited by deep faults: Dragoș Vodă (to north) and Rodna (to south). There are three crystalline layers: Bretila, Repedea and Rebra. To south, some new volcanic rocks are to be found into the high hills, placed along the Someșul Mare River. Sedimentary rocks (Cretaceous and Paleocene) surrounding the massif have been affected by tectonic movements and stamped the landscape with some particular features. The mountain chain keeps the best traces of Quaternary glaciers. Glacial landscape is well developed on the northern slope where some glacial cirques can be found (Pietrosu, Buhăescu, Negoescu and so on). On the southern slope, the glacial landscape is less impressive: some suspended glacial cirques and snow niches. On south, the

limestone bedrock has made up a karst landscape, with some remarkable caves: Izvorul Tăușoarelor (18 km), Jgheabul lui Zalion, Baia lui Schneider, Cobășel, Grota Zânelor, Izbucul Albastru al Izei etc. The high diversity of habitats spread from 500 to 2.303 m is correlated with huge biodiversity of flora and fauna, being recorded more than 7.000 species until now, some of them being glacial relicts, endemic and very rare species.

Material and methods

The database of The Rodna Mountains National Park was compiled using a vast literature source published between 1866 and 2013. This database of biodiversity was used as a tool for identifying endemic species and subspecies of flora and fauna which occur in Rodna Mountains.

The endemic species or subspecies are representing biogeographic elements having the highest degree of particularity, are often used as criteria in delimiting and individualizing biogeographic areas. By analyzing the model of endemism and in identifying the centers of endemism (endemogenetic centre), there can be done assessments on both their evolutionary role for the flora and fauna of the Carpathians and their conservation status.

The areas of endemism or endemogenetic centers are fundamental units in biogeography, indicate exactly those geographic regions bearing information on the areal dynamics and evolutionary processes of speciation. Clearly establishing the extent of these units is the initial condition necessary for any other type of biogeographic inference.

Discussions and results

According to the biodiversity database of the Rodna Mountains National Park, there are X endemic species and subspecies in the list mentioned below. We will note with EC - endemic species for Carpathians, EEC - endemic species for Eastern Carpathians and ER - endemic species for Rodna Mountains:

- **Amphibians:** *Triturus montandoni* (EC).
- **Lepidoptera:** *Erebia epiphron transsylvanica* (EC), *Erebia pharte carpatica* (EC), *Erebia pharte carpatica* (EC), *Erebia sudetica radnaensis* (EC), *Limenitis populi bucovinensis* (EC), *Parnassius mnemosyne transsylvanica* (EC), *Pieris bryoniae carpathensis* (EC), *Apamea maillardi carpathobrunnea* (EC).
- **Orthoptera:** *Isophya pienensis* (EC), *Miramella ebneri carpathica* (EC), *Pholidoptera transsylvanica* (EC).
- **Coleoptera:** *Carabus morio carpathicus* (EC), *Carabus arvensis carpathus* (EC), *Carabus fabricii malachitus* (EC), *Carabus silvestris transylvanicus* (EC), *Duvalius proceorides* (EC), *Pseudogaurotina excellens* (EC), *Carabus hampei* (EC), *Bembidion transsylvanicus* (EC), *Bembidion glaciale dacicum* (EC), *Trechus carpathicus* (EC), *Duvalius ruthenus* (EEC), *Poecilus szeptigetii* (EC), *Pterostichus szeptigetii radnensis* (EC), *Deltomerus carpathicus* (EC), *Nebria transsylvanica* (EC), *Nebria fuscipes*

(EC), *Bryodaemon hanakii* (EEC), *Otiorrhynchus carpathicus* (EC), *Otiorrhynchus deubeli* (EC), *Otiorrhynchus peneckianus* (EEC), *Otiorrhynchus schaumii* (EEC), *Carpathobyrrhulus transsilvanicus* (EC), *Cryptophagus transsilvanicus* (EC), *Sphaerosoma transsilvanicus* (EC), *Sphaerosoma carpathicum* (EC), *Niphetodes redtenbacheri* (EEC), *Niphetodes spaethi* (EEC), *Niphetodes eppelsheimi* (EEC), *Niphetodes deubeli* (EEC), *Leptusa alpicola* (EEC), *Leptusa carpathica* (EEC), *Leptusa eximia* (EEC), *Leptusa koronensis* (EEC), *Stenus carpathicus* (EC), *Stenus obscuripes* (EEC), *Stenus reitteri* (EEC), *Stenus transsilvanicus* (EC), *Paederidus rubrothoracicus carpathicola* (EC), *Othius transsylvanicus* (EC), *Quedius transsylvanicus* (EEC), *Ocypus ormayi* (EEC), *Neocrepidodera transsilvanica* (EC), *Psylliodes frivaldszkyi* (EC), *Sclerophaedon carpathicus* (EC), *Minota carpathica* (EC), *Asiorestia transsilvanica* (EC), *Chrysolina weisei* (EC), *Alpinia carpathica* (EC).

• **Diptera:** *Typula alpha* (EC), *Typula excisa carpatica* (EC).

• **Efemeroptera:** *Rhithrogena gorganica* (EC), *Ecdyonurus carpathicus* (EC).

• **Plecoptera:** *Taeniopteryx schoenemundi* (EEC), *Rhabdiopteryx alpina* (EC), *Leuctra armata* (EC), *Leuctra carpathica* (EC), *Choroperla kisi* (EC), *Siphonoperla torrentium transsylvanica* (EC), *Nemoura carpathica* (EC), *Nemoura fusca* (EC), *Nemoura ovoidalis* (EC), *Nemoura hamata* (EC), *Protonemura pseudonimborum* (EC).

• **Trichoptera:** *Drusus brunneus* (EC), *Drusus carpathicus* (EC), *Chionophylax mindszentyi* (EC).

• **Homoptera:** *Diplocolenus beresi* (EEC), *Dicranotropis carpathica* (EC), *Verdanus quadrivirgatus* (EEC).

• **Opiliona:** *Nemastoma transsylvanicum* (EC), *Paranemastoma kochi* (EC), *Paranemastoma silli* (EC), *Platybunus decui* (EC), *Ischyropsalis manicata* (EC).

• **Isopoda:** *Ligidium intermedium* (EC), *Hyloniscus transsilvanicus* (EC).

• **Molusca:** *Semilimax semilimax* (EC), *Carpathica calophana* (EC), *Vitraea transsylvanica* (EC), *Deroceras rodnae* (EEC), *Deroceras moldavicum* (EC), *Macrogastra latestriata* (EC), *Lozekia transsilvanica* (EC), *Arianta picea* (EEC), *Drobacia banatica* (EC), *Alinda fallax* (EC), *Oxychilus orientalis* (EC), *Perforatella dibothrion* (EC), *Trichia bielzii* (EC).

• **Nematoda:** *Aporcelaimus romanicus* (EC).

• **Chilopoda:** *Clinopodes rodnaensis* (EC), *Lithobius luteus* (EC), *Lithobius matici* (ER), *Lithobius silvivagus* (EC), *Lithobius cyrthopus* (EC), *Lithobius curtipes* (EC), *Lithobius inexpectatus* (EC), *Monotarsobius burzenlandicus* (EC), *Clinopodes rodnaensis* (EC), *Strigamia transsilvanica* (EC).

• **Collembola:** *Tetrachantella transsylvanica* (EC), *Tetrachantella borsa* (EC), *Heteraphorura carpathica* (EC), *Onichiurus carpathicus* (EC).

• **Diplopoda:** *Chromatoiulus silvaticus* (EC), *Tracysphaera acutula transsylvanica* (EEC), *Polydesmus montanus* (EC), *Polydesmus polonicus* (EC), *Polydesmus dadayi* (EEC), *Polydesmus tetranus radnaensis* (EEC), *Karpatophyllon polinskii* (EC), *Leptoiolus baconiensis pruticus* (EEC), *Leptoiolus corongisius* (EC), *Romanosoma birtei* (ER), *Romanosoma cavernicola* (EC), *Romanosoma odici* (ER), *Cylindroiolus burzenlandicus* (EC), *Leptophyllum transsylvanicum* (EC), *Unciger transsilvanicus* (EC), *Polyzonium transsilvanicum* (EC), *Enantiulus transsilvanicus* (EC), *Xestoiulus imbecillus* (EEC), *Mastigona transsilvanica* (EC), *Stenophyllum hermannimuelleri* (EC), *Mastigophorophyllum penicilligerum* (EC), *Mastigophorophyllum serrulatum* (EC).

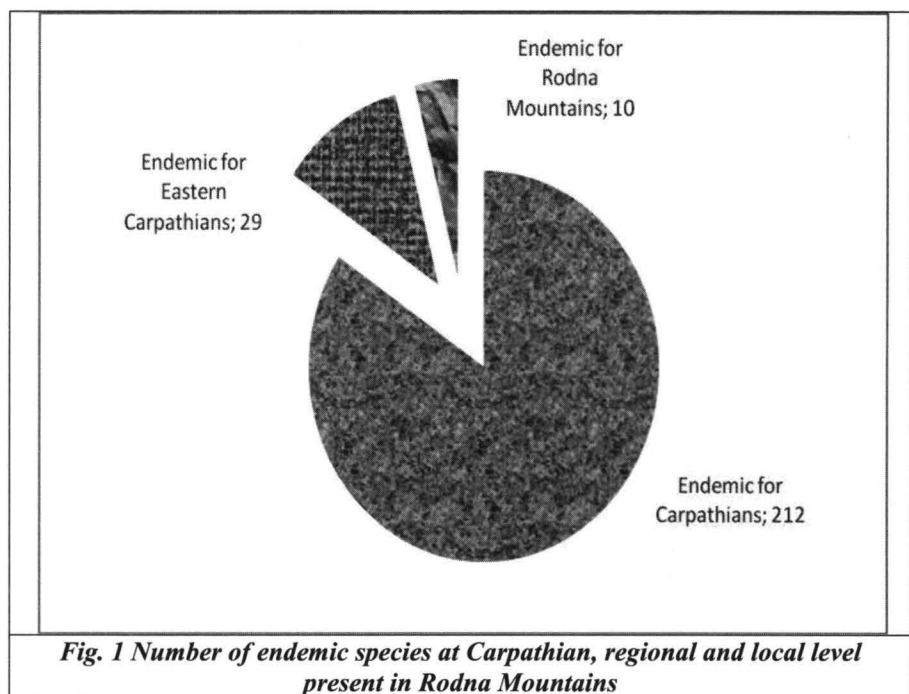
• **Lumbricida:** *Allolobophora carpathica* (EC), *Allolobophora dacica* (EC), *Allolobophora prosellodacica* (EC), *Allolobophora sturanyi dacidoides* (EEC), *Dendrobaena alpina alteclitellata* (EEC), *Octodrilus exacystis* (EC), *Octodrilus compromissus* (EC), *Octodrilus robustus* (EEC), *Aporrectodea carpathica* (EC).

• **Lichens:** *Amphoroblastia erumpens* (ER), *Amphoroblastia rodnensis* (ER), *Involucrothele gyelnikii* (ER), *Involucrothele transsylvanica* (ER), *Thelidium gibbosum* (EC), *Verrucaria marmorosica* (EC), *Lecanora carpathica* (EC).

• **Plants:** *Achillea lingulata* (EC), *Aconitum hosteanum* (EC), *Aconitum lasiocarpum* (EC), *Aconitum moldavicum* (EC), *Alopecurus laguriformis* (EC), *Anthemys macrantha* (EC), *Allysum repens* (EC), *Aquilegia transsylvanica* (EC), *Asperula capitata* (EC), *Campanula carpatica* (EC), *Campanula transsilvanica* (EC), *Cardamine rivularis* (EC), *Cardaminopsis neglecta* (EC), *Carduus kernerii* (EC), *Carex limosa* (EC), *Carex loliacea* (EC), *Carex pauciflora* (EC), *Carex paupercula* (EC), *Centaurea pinnatifida* (EC), *Centaurea phrygia carpatica* (EC), *Centaurea mollis* (EC), *Cerastium lerchenfeldianum* (EC), *Chrysosplenium alpinum* (EC), *Crocus banaticus* (EC), *Cryptogramma crispa* (EC), *Dentaria glandulosa* (EC), *Dianthus tenuifolius* (EC), *Doronicum carpaticum* (EC), *Draba fladnizensis* (EC), *Draba kotschyii* (EC), *Empetrum nigrum* (EC), *Erigeron macrophyllus* (EC), *Erysimum witmannii* (EC), *Euphorbia villosa* (EC), *Euprasia tatrae* (EC), *Festuca carpatica* (EC), *Festuca rupicola saxatilis* (EC), *Festuca porcii* (EC), *Festuca versicolor* (EC), *Heracleum carpaticum* (EC), *Heracleum palmatum* (EC), *Heracleum sphondylium transilvanicum* (EC), *Hesperis oblongifolia* (EC), *Hieracium pseudovagneri* (EC), *Hypericum richeri grisebachii* (EC), *Hieracium borsanum* (ER), *Hieracium pietroszense* (ER), *Jovibarba heuffeli* (EC), *Juncus castaneus* (EC), *Lathyrus hallersteinii* (EC), *Leontodon pseudotaraxaci* (EC), *Leucanthemum waldsteini* (EC), *Linum extraaxillare* (EC), *Silene nivalis* (ER), *Melampyrum saxosum* (EC), *Melampyrum bihariense* (EC), *Oxytropis carpatica* (EC), *Papaver alpinum corona sancti-stephani* (EC), *Petasites kablikianus* (EC), *Phyteuma tetramerum* (EC), *Phyteuma wagneri* (EC),

Pinguicula alpina (EC), *Poa deylii* (EC), *Poa media* (EC), *Poa rehmanii* (EC), *Primula officinalis carpathica* (EC), *Pulmonaria filarszkyana* (EC), *Ranunculus carpathicus* (EC), *Ranunculus alpestris* (EC), *Ranunculus glacialis* (EC), *Ranunculus crenatus* (EC), *Salix bicolor* (EC), *Salix retusa kitaibeliana* (EC), *Saussurea porcii* (EC), *Saxifraga carpathica* (EC), *Saxifraga luteoviridis* (EC), *Saxifraga heucherifolia* (EC), *Scabiosa lucida barbata* (EC), *Scheuchzeria palustris* (EC), *Scutellaria alpina* (EC), *Sempervivum marmoreum* (EC), *Senecio abrotanifolius carpathicus* (EC), *Sesleria heuffleriana* (EC), *Sesleria bielzii* (EC), *Sesleria rigida haynaldiana* (EC), *Silene acaulis* (EC), *Silene dubia* (EC), *Silene heuffeli* (EC), *Silene zawadskii* (EC), *Soldanella hungarica hungarica* (EC), *Symphytum cordatum* (EC), *Swertia punctata* (EC), *Thlaspi dacicum* (EC), *Thlaspi kovatsii* (EC), *Thymus bihoriensis* (EC), *Thymus comosus* (EC), *Thymus pulcherrimus* (EC), *Trisetum fuscum* (EC), *Trisetum macrotrichum* (EC), *Veronica baumgartenii* (EC), *Viola dacica* (EC), *Viola declinata* (EC).

There are 212 endemic species of flora and fauna for Carpathians (EC), 29 endemic species for Eastern Carpathians (EEC) and 10 endemic species for Rodna Mountains (ER), fig. 1, 2. Most of them are from group of plants (58) and coleopteran (48), well represented in the massif.



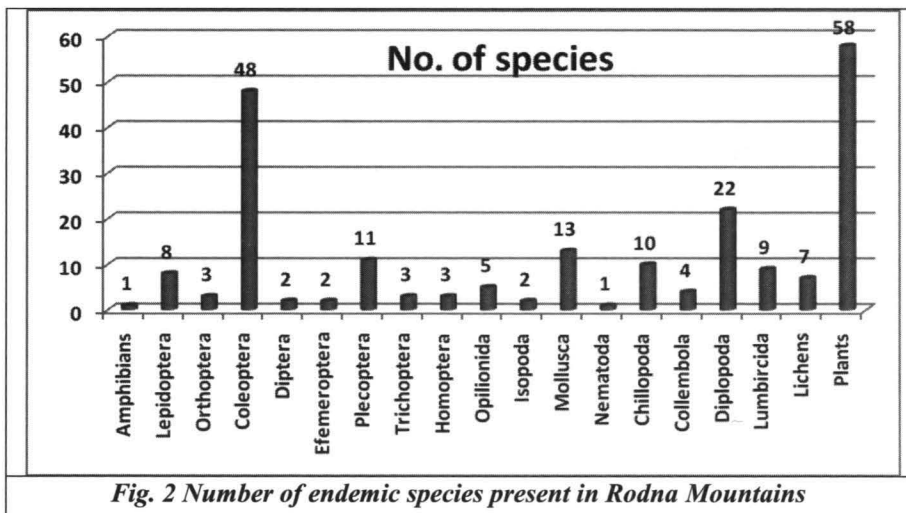


Fig. 2 Number of endemic species present in Rodna Mountains

Areas of concentration for endemic species have been considered centers of refugium and speciation. These hypotheses are being currently tested through the use of species distribution modeling and the involvement of paleoclimatic data obtained from different general climatic circulation models. A constant potential presence of species in certain areas indicates the stability of ecological conditions favorable for populations' resilience in time. Anyhow, these potential distribution models, projected in time, start from two important assumptions: ecological niche stability in time and species equilibrium with the environment. Accepting these assumptions as true, the results can reflect the stability (refugial) zones for species, as well as the spatial dynamics in the postglacial period (Hurdu B., 2012).

Endemics are taxonomical units of different ranks (subspecies, species, genus, family) limited in their distribution to a determined territory (province, region, district etc.). The endemic is in consequence a taxon with a restricted area to a certain natural region (Dihoru&Pârnu, 1987). Vischi et al. (2004) offer a more general definition of endemism: the phenomenon of endemism characterizes those taxa whose distribution is restricted to a certain area, more reduced than of other taxa of the same rank.

Endemics have been often considered biological entities with a rare distribution. Due to this cause, but also to evolutionary and biogeography importance, the endemics have been and still are utilized especially as a differentiation criteria for the identification of areas that require special protection. Areas of endemism have often been related to evolution and speciation centers for different groups of organisms, since the distribution of some taxa limited to these areas denotes isolation of the area, representing a geographical unit with a special evolution of biota. The congruence between areas of endemism and the network of protected areas has been often

considered as a good optimization criteria for conservation strategies (Dihoru&Pârvu, 1987).

Regarding all these aspects, namely the fundamental scientific importance (as evolutionary units and biogeography elements, areas of endemism identification and the analysis of areal dynamics in the context of climate change) but also practical (the role of endemic species in establishing conservation strategies), we can consider the study of endemism patterns as being a fundamental theme both to evolutionary and historical biogeography (Morrone, 2009), as well as to conservation oriented biology.

Pawłowski (1970) observed a richness latitudinal gradient for endemic taxa, the number of endemics increasing from Northern to Southern Europe. He also emphasized the relationship between the number of endemics residing in a certain area and the age of that area's flora (an older flora was subject to an increased number of areal fragmentation and isolation processes, due especially to orogenic and climatic factors, intensifying speciation). In the same time, glacial periods determined profound modifications of distribution extent for old species, this finding refuge in unglaciated areas. This is the case for the Balkans and the Carpathians, mountain ranges which were less affected by glaciations and still hold numerous paleoendemics in their flora, species which did not have the capacity of extending a recolonizing their former areal.

Endemic species are tightly linked to the emergence and various transformation suffered by the Carpathians, lowland adjacent areas having an incomparable smaller amount of endemics in their flora. This is the reason why endemism in Romania's flora and fauna is so highly connected to the development of this phenomenon in the Carpathian Mountains. Both Pax (1898 - 1908) and Prodan (1939) considered the Romanian Carpathian's flora and fauna to be the richest in Europe. Insufficient knowledge on the chorology and a clearer species concept entitled them to make such remarks.

Bibliography

- Adamović, L. 1909, Die Vegetationsverhältnisse der Balkanländer (Mösische Länder) umfassend Serbien, Altserbien, Bulgarien, Ostrumelien, Nordthra kien und Nordmazedonien. In: Engler, A., Drude, O. (eds): Die Vegetation der Erde, Wilhelm Engelmann, Leipzig, 567 p.
- Antosyak, T.M., Voloschuk, M.I., Kozurak, A.V., 2009, Distribution of Endemic Species of Vascular Plants in the Carpathian Biosphere Reserve), Sci. Bull. Uzhgorod Univ. (Ser. Biol.), 25: 67-70.
- Beldie, A., 1967, Endemismele și elementele dacice din flora Carpatilor României, Com. Bot., SSNG: 113-130.
- Beldie, A., 1977, 1979, Flora României. Determinator ilustrat al plantelor vasculare, I, II, Ed. Acad. R.S.R., București, 414 p. + 407 p.

- Ciocârlan, V., 2009, Flora ilustrată a României - Pteridophyta et Spermatophyta, III ed., Ed. Ceres, București, 1141 p.
- Coldea, G., Stoica, I.-A., Pușcaș, M., Ursu, T., Oprea, A. & Intra Biodiv Consortium, 2008, Alpine-subalpine species richness of the Romanian Carpathians and the current conservation status of rare species, *Biodivers. Conserv.*, 18: 1441-1458.
- Crovello, T.J., 1981, Quantitative biogeography - an overview, *Taxon*, 30: 563-575. 33
- Didukha, I.P., 2009, Ukraine Red Data Book. Flora, 3 ed. National Academy of Science
- s of Ukraine, Kiev, 900 p.
- Dihoru, G., Pârveu, C., 1987, Plante endemice din flora României, Ed. Ceres, București, 183 p.
- Hausdorf, B., Hennig, C., 2003, Biotic Element Analysis in Biogeography, *Syst. Biol.*, 52 (5): 717-723.
- Holderegger, R., Thiel-Egenter, C., 2009, A discussion of different types of glacial refugia used in mountain biogeography and phylogeography. *J. Biogeogr.*, 36, 476-480.
- Hurdu, B.I., Pușcaș, M., Turtureanu, P.D., Niketić, M., Vonica, G., Coldea, G., 2012, A critical evaluation of Carpathian endemic plant taxa from the Romanian Carpathians, *Contrib. Bot.*
- Iușan C., 2011, Monografia Parcului Național Munții Rodnei (Rezervație a Biosferei), Editura Toderesco, pag. 335, Cluj Napoca.
- Jetz, W., Rahbek, C., Colwell, R.K., 2004, The coincidence of rarity and richness and the potential signature of history in centers of endemism, *Ecol. Lett.*, 7: 1180-1191.
- Morariu, I., Beldie, A., 1976, Endemismele din flora României, în: *Flora R.S.R.*, 13, (ed. de A. Beldie & Morariu), Ed. Acad. R.S.R., București, p. 97-105.
- Morrone, J.J., 1994, On the Identification of Areas of Endemism, *Syst. Biol.*, 43 (3): 438-441.
- Morrone, J.J., 2009, *Evolutionary Biogeography: an integrative approach with case studies*, Columbia University Press, 301 p.
- Oprea, A., 2005, Lista critică a plantelor vasculare din România, Ed. Univ. "Alexandru Ioan Cuza", Iași, 668 p.
- Pawłowski, B., 1970, Remarques sur l'endémisme dans la flore des Alpes et des Carpates, *Vegetatio*, 21: 181-243.
- Piekos-Mirkowa, H., Mirek, Z., 2003, Endemic taxa of vascular plants in the Polish Carpathians, *Acta Societatis Botanicorum Poloniae*, 72 (3): 235-242.
- Prodan, I., 1939, Flora pentru determinarea și descrierea plantelor ce cresc în România. (II) Noțiuni generale de fitogeografie, Tipografia "Cartea Românească", Cluj-Napoca, 713 p.

- Ronikier, M., 2011, Biogeography of high-mountain plants in the Carpathians: An emerging phylogeographical perspective, *Taxon*, 60: 373-389.
- Sanda, V., Popescu, A., Doltu, M., Doniță, N., 1983, Caracterizarea ecologică și fitocenologică a speciilor spontane din flora României, *Muz. Brukenthal. Studii și Comunic. Șt. Nat.*, 25: 5-126.
- Schur, J.F., 1866, *Enumeratio Plantarum Transsilvaniae*, Guilielmum Braumüller, Vindobonae, 984 p.
- Simonkai, L., 1887, *Enumeratio Florae Transsilvanicae Vasculosae Critica*, Kir. Magyar Természettudományi Társulat, Budapest, XLIX + 678 p.

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