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BIOGEOGRAPHICAL PROVINCES, SUBPROVINCES AND BIOREGIONS OF THE CZECH REPUBLIC

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ABSTRACT

Presented biogeographical division of the Czech Republic was elaborated initially for purposes of national and supra-national Ecological Networks. This division has its own hierarchy, consisting of both individual and typological biogeographical units. Higher units (biogeographical province, subprovince, and bioregion) are of individual character. Within the territory of the Czech Republic, two biogeographical provinces, four biogeographical subprovinces and 91 biogeographical regions have been distinguished. Hierarchically lower biogeographical units (biochora, group of geobiocoene types) have typological character; their characteristics in English are intended to be published later. All of the biogeographical units - with the exception of the group of geobiocoene types - are elaborated in maps of scale 1:50 000.

Key words: Ecological Network, biogeographical province, Hercynian, West-Carpathian, North-Pannonian subprovince, biogeographical region

INTRODUCTION

Within the last decades of the 20th century, nature conservation was increasingly led by the biodiversity protection concept. This direction resulted in proposals of the Territorial Systems of Ecological Stability of Landscape in former Czechoslovakia (Buček, Lacina 1984, Buček, Lacina, Míchal 1996) and of Ecological Networks in the Netherlands, as published by Ministry of Agriculture, Nature Management and Fisheries (1990), Bennett (1991) and in the EU (Jongman 1996, Bennett 1999). All of these networks were based on a biogeographical division of the respective territory. Biogeographical division of a country is also considered to be an important part of scientific development, and often has an impact on the practise (Buček, Lacina 1979). The presented biogeographical division of the Czech Republic was elaborated as a project for Czech Ministry of Environment. The aim was to create a biogeographical background for proposals of the Territorial Systems of Ecological Stability of Landscape, i.e. National Ecological Network (NECONET). NECONET should enable a non-degenerative persistence and further development of populations of the natural and semi-natural biocoenoses. For this goal the preservation of these biocoenoses, and their ecotopes, is necessary. It is important to know distribution of flag-ship species, all types of biocoenoses and ecotopes, so that detailed biogeographical

division can be carried out. This division should have its global, regional, choric (district) and elementary (local) level.

Presented biogeographical division of the Czech Republic is based on potential biota and its ecotopes. It also takes into consideration the chorological aspect, i.e. the spread of various geoelements of biota. During the elaboration a need for international cooperation was considered important, especially in the regions along the state border.

HIERARCHICAL LEVELS OF THE BIOGEOGRAPHICAL UNITS USED FOR ECOLOGICAL NETWORK IN THE CZECH REPUBLIC

Biogeographical unites are ordered from highest level to the elementary one:

1. Biogeographical province

2. Biogeographical subprovince

3. Biogeographical region (bioregion)

4. Biochora (Culek 1989, 2005)

5. Group of geobiocoene type (Zlatník 1976)

Biogeographical provinces, subprovinces and bioregions have individual (unique) character, whereas biochoras and groups of geobiocoene types have a typological one. Biochora is a unit of potential biota of specific catenas and ecotope combinations, for instance submontane valleys on limestone, lowland floodplains with warm-lowing biota. Group o geobiocoene types is an unite of potential biota approximately on level of phytocoenological association, being more detailed in division of "average" potential forest vegetation and less detailed in division of vegetation on extreme ecotopes. This article focuses only on the individual units.

DISTINGUISHING OF THE BIOGEOGRAPHICAL PROVINCES, SUBPROVINCES AND BIOGEOGRAPHICAL REGIONS

Biogeographical provinces

Biogeographical province is an individual biogeographical unit. Its territory has its own sequence of altitudinal vegetation tiers. From surrounding provinces it differs in decisive geoelements. The area of the biogeographical province in Central Europe is usually larger than 5.10^5 km^2.

Biogeographical provinces were elaborated on the basis of the Udvardy's division (Udvardy 1975). It is in good correlation with Biogeographical Regions (Bennett 1999), biogeographical-political division, currently used in the EU for the NATURA 2000 Programme. These Regions mostly fulfil demands on biogeographical provinces.

According to Udvardy's division, the prevailing part of the Czech territory belongs to the Biogeographical province of the Central-European deciduous forests. It corresponds to the Continental Region of NATURA 2000. Only a part of Southern Moravia belongs to the Pannonian province. It was distinguished mainly on the basis of newly recognised phytocoenological taxons of thermophilous oak forests on loess plains (*Aceri tatarici-Quercion*), Pannonian oak-hornbeam forests (*Primulo veris-Carpinetum* Neuhäusl et

Neuhäuslová ex Neuhäuslová-Novotná 1964) and sub-mediterranean floodplain association (*Fraxino pannonicae-Carpinetum* Soó et Borhidi in Soó 1962) in the Czech Republic (Chytrý 1997). In sections of unclear potential vegetation in borderlands, mostly totally used as arable land, Pannonian province embodies an area of tchernozems soils matrix, in contrast to the Hercynian or West-Carpathian subprovinces, that embodies matrix of cambisols or luvic soils.

Biogeographical subprovinces

Biogeographical subprovince is an individual biogeographical unit. Its biota has typical diversity, combination of the geoelements and has its own endemic species. Its territory has its specific modification of altitudinal vegetation tiers. From surrounding subprovinces it differs in edificators of one or more vegetation tiers. In the scope of the biogeographical subprovince, specific geological and geomorphologic structures are usually visible. The area of a biogeographical subprovince is in Central Europe typically more than 5.10^4 km^2.

Biogeographical subprovinces are important for proposals of Ecological Networks in large territories (Bínová, Culek, Kopecká, Míchal, Plesník 1995). The division of European flora conducted by Meusel (1965) was taken as the starting point, as according to author's experience Meusel's subprovinces of the Central Europe often meet the demands on biogeographical subprovinces. Nevertheless his opinion on the position of Hercynian – Pannonian border was not accepted (see Discussion).

Division of biota in the Czech Republic to Hercynian and Carpathian areas has been known for a long time (Drude 1902). The terrain bordering Hercynian and West-Carpathian subprovinces is typified by a broad transition zone – in contrast to the geological border of the Bohemian massif and the Carpathians. Some Carpathian species or migrants have invaded the eastern margin of the Bohemian massif to the "depth" from 30 km to 100 km. Nevertheless the greatest gradient between Hercynian and Carpathian biota is to be located in Outer Carpathian depressions. These depressions are mostly converted to arable land. The solution was found in form of floodplains of rivers originated in Hercynicum and adjacent plains being part of the Hercynian subprovince and those originating in the Carpathians and adjacent plains belong to the West-Carpathian subprovince.

Distinguishing of the Polonian subprovince on the North of the Czech Republic was complex. Biota associated with the small Czech part of the North European lowlands (south of the Baltic Sea) has transitional character among Hercynian, West Carpathian and semi-boreal territories of the eastern Baltics. There are only a few species that could be considered indicative of Polonian subprovince, but cenotaxonomically it is more obvious. Large areas are potentially covered by oak forests on pseudogley soils (*Molinio arundinaceae-Quercetum*), only slightly moister soils with lime oak-hornbeam forests with natural presence of *Abies alba* (*Tilio-Carpinetum*) and especially by oak-beech forests (*Carici-Quercetum*) on nutrient medium rich waterlogged soils (Neuhäuslová et al. 1997, 2001). Delineation of the borderline in unclear transitional territories follows the accumulations of Riss (Saalian) glacial sediments. They are mostly of loamy to clay character and support the above-mentioned phytocoenological associations. For areas close to border of Poland geobotanical publications by Pawlowski & Szafer (1978) and Matuszkiewicz (1993, 2008) were taken in account (see Discussion). Position of West-Carpathian/Pannonian border in Slovakia was possible with geobotanical regions (Plesník 2002) and simple zoogeographical map (Jedlička, Kalivodová 2002) to compare.

For evaluation of fauna distribution Zoogeographical division of former Czechoslovakia was used (Mařan 1958) and Atlases of distribution of fauna taxa group, for instance from

Atlas of distribution of Fishes, Amphibians and Reptiles (Dungel & Řehák 2005), or Atlas of breading sites of birds (Šťastný, Bejček & Hudec 2006).

According to abovementioned approach, the Central-European deciduous forests province in Czechia is divided into three subprovinces – Hercynian, West-Carpathian and Polonian ones (see Fig. 1). Biogeographical subprovinces were refined (Culek, Grulich 2009) and thoroughly characterized (Culek [ed.] 1996, Culek et al. in print).

Pannonian province in Czechia is represented only by the North-Pannonian subprovince.

Biogeographical regions (bioregions)

Biogeographical region (bioregion) is an individual, unique unit of the biogeographical division on the regional level (in geographical sense). Bioregion is mostly heterogeneous on the elementary and mostly on the sub-regional level too. A bioregion consists of a characteristic mosaic of elementary biogeographical unites, in our case of groups of geobiocoene types (Zlatník 1976) and a typical combination of biochoras (Culek et al. 2005). The geobiocoenoses of a bioregion are determined by a bioregion's location and have characteristic chorological features; these are the result of a specific postglacial development. In the scope of a bioregion other differences in composition of potential biota shouldn't exist, than differences caused by a different ecotope. The bioregion is also mostly characterised by a specific type, and a certain intensity of an anthropogenic influence, i.e. by specific present-day biocoenoses. A bioregion in Central Europe has typically an area of 100 – 5000 km^2. Bioregions are important for the National Ecological Network project.

The following criteria for the proposal and the delineation of a bioregion are ordered according to their importance:

1. The area is larger than 100 km^2, with a width exceeding 2.5 km. Differences in species composition from the surrounding landscape should increase, as bioregion size decreases. That means, smaller bioregion was delineated only in case of very different biota.
2. The connectivity of the territory. The bioregion must be coherent and should not be formed by areas connected only by a narrow stripe.
3. The relative homogeneity in spreading of geoelements and migrants.
4. "The recurrent pattern" - a recurrent of ecotopes, typical combinations of biota and soil catenas.
5. The catchment area of the same sea (except of mountainous regions).

Map analysis of geoelements, such as perialpine, alpine, carpathian, subatlantic, pontic and pannonic, sub-mediterranean, boreal and subarctic (Skalický 1988) was a starting point. Help in delineation was provided by Regional phytogeographic division of the Czech Republic (Skalický 1988). Map of Natural potential vegetation (Neuhäuslová et al. 1997) and characteristics of its unites (Neuhäuslová et al. 2001) were also taken into consideration, the same as older geobotanical (Mikyška 1968) and phytogeographical maps (Dostál 1966). The map of so-called Natural forest regions (ÚHÚL 1985) was important too, because these regions respect other features of vegetation. For evaluation of fauna distribution the same publications as for delineation of biogeographical subprovinces were used (see above). Information and comments of approximately thirty consultants were useful help.

For areas close to Germany regionalisation of natural environment by Meynen et al. (1959-1962) and Ssymank (1994) were taken in account. For territory close to Poland geobotanical regions by Matuszkiewicz (1993, 2008) and along Slovak border geobotanical regions (Plesník 2002) were used, but not always accepted. As the aim of presented Biogeographical division was to support the proposal of National Ecological Network, thus

fragments of probable bioregions that core is situated in neighbouring countries, were added to bioregions in Czechia. Which were this case, see Discussion.

The "sum" of the differences between various territories in potential biota, modifications of altitudinal vegetation tiers, distribution of geoelements, distribution of biogeographically important fauna species, moisture and soil nutrient conditions was evaluated. When the "sum" of these differences was higher than an accepted level, a new bioregion was proposed. This work was done by a committee of experts.

The map of Biogeographical division of the Czech Republic was elaborated in the scale 1:200 000 and generalised to 1:500 000 (Culek 1994, 1996). Later it was refined to the scale 1:50 000 (Culek et al. 2005).

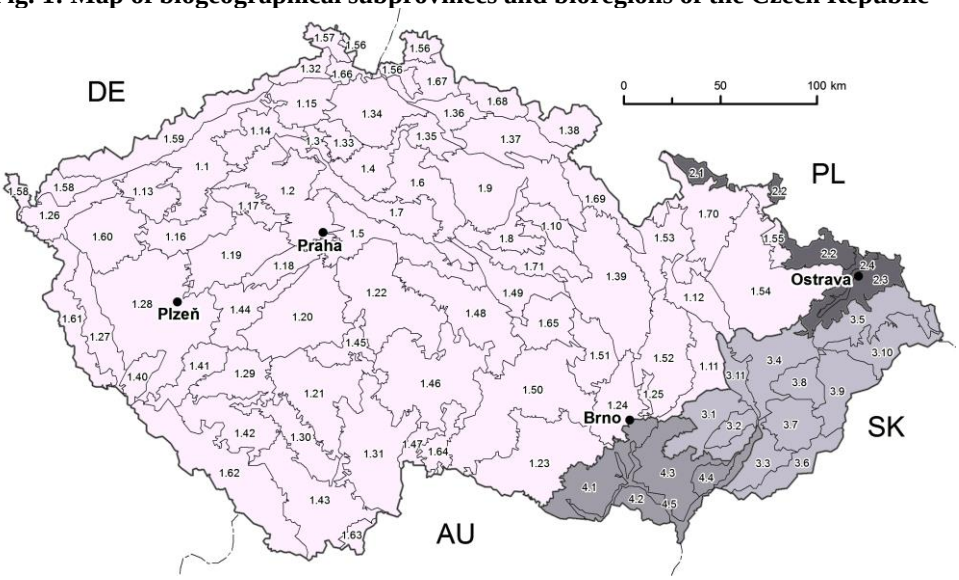
In the bioregions, so-called transition and non-representative zones were set up. Non-representative zones include ecotopes that are atypical to the bioregion and in more pronounced features and/or in larger areas they are present within surrounding bioregions. Transition zones include ecotopes that are on the border of two bioregions, and biota associated with these zones has no pronounced distinguishing features. These zones were presented in the more detailed map (Culek 1994, 1996). In this paper, due to the scale of map, had to be omitted.

RESULTS

The Czech Republic covers a territory of 78,867 km^2. The decisive part of it belongs to the biogeographical province of Central-European deciduous forests (95.9 %). A small area of the Pannonian province in South Moravia is part of the North Pannonian subprovince (3,265 km^2, i.e. 4.1 %). In the scope of Central-European deciduous forests province the Hercynian subprovince is the largest; it is situated in the western and central part of the country. The total area of the Hercynian subprovince is 66,805 km^2, i.e. 84.7 % of the country area. A small area in the north-east, mostly in Silesian lowlands, belongs to the Polonian subprovince with the area of 1,696 km^2, i.e. 2.2 % of the Czech Republic. In the south-eastern part of the Czech Republic the West Carpathian subprovince was delineated, with the area of 7,104 km^2, i.e. 9 % of the state territory. North-Pannonian subprovince in southern Moravia covers area of 3,265 km^2 that means 4.1 % of the country. Relatively detailed characteristics of respective subprovinces were elaborated through good cooperation with a team of botanists and zoologists of the Brno Universities. Results were published in the Czech language in a book titled Biogeographical division of the Czech Republic (Culek [ed.] 1996). Reworked and extended it will be published just now (Culek et al., in print).

In the aforementioned way, a total of 91 bioregions were distinguished within the Czech Republic: 71 in the Hercynian subprovince, 11 in the West-Carpathian subprovince, 4 in the Polonian subprovince and 5 in the North-Pannonian subprovince. The area of bioregions varies, from 84 km^2 in the Moravian Karst, up to 2,883 km^2 in Plzeňský bioregion (bioregion in the surroundings of the city of Pilsen).

Fig. 1: Map of biogeographical subprovinces and bioregions of the Czech Republic



Bioregions of the Hercynian subprovince are in light grey with their code beginning with figure 1. Bioregions of the Polonian subprovince are in dark grey with their code beginning with fig. 2. Bioregions of the West-Carpathian subprovince are in medium grey with their code beginning with fig. 3. Bioregions of the North-Pannonian subprovince are in medium dark grey with their code is beginning with fig. 4.

For every bioregion large characteristics were elaborated in cooperation with botanists and zoologists of the Brno Universities and regional specialists (Culek [ed.] 1996, Culek et al., in print). In each bioregion its area, position, geology, geomorphology, climate, soils, potential and actual/observed vegetation, specific and typical species of fauna, are characterized. Characteristics of landuse and nature protected areas and reserves are incorporated too.

A more detailed map of biogeographical provinces, subprovinces and biogeographical regions of the Czech Republic was published (Culek et al. 2005) and more recently in the Atlas of Landscape of the Czech Republic (Culek & Grulich 2009).

Table 1: List of bioregions of the Hercynian subprovince and their area

No. of bio-region	Name and area of bioregion		No. of bio-region	Name and area of bioregion	
1.1	Mostecký	1 305 km^2	1.37	Podkrkonošský	968 km^2
1.2	Řipský	1 643 km^2	1.38	Broumovský	566 km^2
1.3	Úštěcký	136 km^2	1.39	Svitavský	2 106 km^2
1.4	Benátský	650 km^2	1.40	Branžovský	314 km^2
1.5	Českobrodský	1 171 km^2	1.41	Plánický	552 km^2
1.6	Mladoboleslavský	1 010 km^2	1.42	Sušický	998 km^2
1.7	Polabský	1 188 km^2	1.43	Českokrumlovský	1 653 km^2
1.8	Pardubický	578 km^2	1.44	Brdský	846 km^2
1.9	Cidlinský	1 985 km^2	1.45	Votický	422 km^2
1.10	Třebechovický	374 km^2	1.46	Pelhřimovský	2 124 km^2
1.11	Prostějovský	691 km^2	1.47	Novobystřický	229 km^2
1.12	Litovelský	641 km^2	1.48	Havlíčkobrodský	1 500 km^2
1.13	Doupovský	647 km^2	1.49	Železnohorský	735 km^2
1.14	Milešovský	658 km^2	1.50	Velkomeziříčský	2 542 km^2
1.15	Verneřický	673 km^2	1.51	Sýkořský	675 km^2
1.16	Rakovnicko-žlutický	762 km^2	1.52	Drahanský	1 309 km^2
1.17	Džbánský	420 km^2	1.53	Šumperský	912 km^2
1.18	Karlštejnský	447 km^2	1.54	Nízkojesenický	2 427 km^2
1.19	Křivoklátský	1 253 km^2	1.55	Krnovský	309 km^2
1.20	Slapský	1 716 km^2	1.56	Žitavský	454 km^2
1.21	Bechyňský	1 585 km^2	1.57	Šluknovský	232 km^2
1.22	Posázavský	1 911 km^2	1.58	Ašský	489 km^2
1.23	Jevišovický	1 819 km^2	1.59	Krušnohorský	1 261 km^2
1.24	Brněnský	807 km^2	1.60	Hornoslavkovský	1 109 km^2
1.25	Macošský	84 km^2	1.61	Českoleský	862 km^2
1.26	Chebsko-sokolovský	652 km^2	1.62	Šumavský	2 115 km^2
1.27	Tachovský	760 km^2	1.63	Novohradský	171 km^2
1.28	Plzeňský	2 883 km^2	1.64	Javořický	374 km^2
1.29	Blatenský	751 km^2	1.65	Žďárský	689 km^2
1.30	Českobudějovický	729 km^2	1.66	Lužickohorský	199 km^2
1.31	Třeboňský	1 752 km^2	1.67	Jizerskohorský	526 km^2
1.32	Děčínský	285 km^2	1.68	Krkonošský	426 km^2

1.33	Kokořínský	307 km^2	1.69	Orlickohorský	591 km^2
1.34	Ralský	1 097 km^2	1.70	Jesenický	1 254 km^2
1.35	Hruboskalský	372 km^2	1.71	Chrudimský	683 km^2
1.36	Železnobrodský	446 km^2			

Table 2: List of bioregions of the Polonian subprovince and their area

No. of bio-region	Name and area of bioregion		No. of bio-region	Name and area of bioregion	
2.1	Vidnavský	214 km^2	2.3	Ostravský	779 km^2
2.2	Opavský	563 km^2	2.4	Pooderský	141 km^2

Table 3: List of bioregions of the West-Carpathian subprovince and their area

No. of bio-region	Name and area of bioregion		No. of bio-region	Name and area of bioregion	
3.1	Ždánicko-Litenčický	917 km^2	3.7	Zlínský	631 km^2
3.2	Chřibský	259 km^2	3.8	Hostýnský	417 km^2
3.3	Hlucký	507 km^2	3.9	Vsetínský .	796 km^2
3.4	Hranický	1 042 km^2	3.10	Beskydský	827 km^2
3.5	Podbeskydský	873 km^2	3.11	Kojetínský	307 km^2
3.6	Bělokarpatský	530 km^2			

Table 4: List of bioregions of the North-Pannonian subprovince and their area

No. of bio-region	Name and area of bioregion		No. of bio-region	Name and area of bioregion	
4.1	Lechovický	1 116 km^2	4.4	Hodonínský	225 km^2
4.2	Mikulovský	289 km^2	4.5	Dyjsko-moravský	547 km^2
4.3	Hustopečský	1 088 km^2			

DISCUSSION

International cooperation is very important in biogeographical division elaboration. Some problems are impossible to be solved within a small area and at local level. Only some of them are possible to solve on the base of literature.

The problems associated with the north-west border of the Pannonian biogeographical province are interesting. Meusel (1965) presents his opinion, that this province does not cross the hilly chain of Leitha berge in Austria and Malé Karpaty highland close to the city of Bratislava in Slovakia. Meusel delineated territory north-west of this border as part Hercynicum. In reality this territory - Vienna basin and south Moravian depressions - are transitional both in potential and actual biota. Nevertheless, patches of typical pannonian biota, including those on sandy soils and salty marshes and continental salt meadows, are present within this transitional territory. Also many species typical for the core of Pannonian province are present. As the presence of Pannonian biota in the depression among the Alps, the Bohemian massif and the Carpathians is commonly accepted, we proposed the North-Pannonian subprovince in this territory (Culek [ed.] 1996). Stronger influence of perialpine, hercynian and carpathian flora and fauna is its typical feature.

The borders of the Pannonian province in southern Moravia were devised according to the presence of thermophilous oak forests on loess plains (*Aceri tatarici-Quercion*) and Pannonian oak-hornbeam forests (*Primulo veris-Carpinetum*) and sub-mediterranean association of floodplain forests (*Fraxino pannonicae-Carpinetum*). In detail it was delineated so that matrix of soil type tchernozem was embodied in the Pannonian province. This is different from phytogeographical division (Skalický 1988), as so-called Thermophyticum in southern Moravia, presented in this map, is of a bigger extent. It also embodies patches of non-pannonian thermophilous flora on margins of Hercynian and Carpathian subprovinces and large patches of mesophilous vegetation. Abovementioned author failed to distinguish the Pannonian province. Almost the same problem is with so-called Phytogeographic-Vegetational division of Slovakia (Plesník 2002), that is in reality geobotanical regionalisation and failed to present chorological, regional aspects and thus unites like Pannonian province.

During consultations with representatives of The European Topic Centre for Nature Conservation in Paris, our delineation of the Pannonian province was accepted as Pannonian Region within the territory of the Czech Republic.

North-Pannonian subprovince in southern Moravia borders the territory of Austria and Slovakia and characteristics of this subprovince have to be revised through cooperation with Austrian and Slovak biologists and geographers.

Some problems of bordering bioregions could be solved only in neighbouring countries. Problem occur in the territory along the state frontier with Austria, as for Austria only topographical, geological and landcover maps was possible to obtain and some grid maps of flora species distribution.

In Germany, for purposes of NATURA 2000 and an Ecological network forming Main Nature Units (Naturräumlichen Haupteinheiten) were distinguished (Meynen et al. 1953-1962, Ssymank 1994). Although they were elaborated independently on the Czech bioregions, they continue fluently over the state border.

On Polish border the landscape is strongly divided by geology and geomorphology, thus also biogeographical unites corresponds to it. Nevertheless geobotanical regionalization done by Matuszkiewicz (1993, 2008) has no ambition to be a biogeographical division, so unites are obvious, but have different hierarchical levels from Czech ones. Also their

borders sometimes differ 1-5 km from Czech side ones. These problems need not to be fatal, anyway.

Relatively important differences are with recent Phytogeographic-Vegetational division of Slovakia. Main unites of this on the Czech-Slovak frontier have mostly character of altitudinal vegetation zones, so they are incompatible with biogeographical subprovinces and regions on Czech side. Also border dividing White Carpathians Mts. and Beskydy Mts. bioregions has on Czech side more southern position, respecting natural area of fir (*Abies alba*) and fir forests in Beskydy Mts. bioregion.

Fragments of probable bioregions that core is situated in neighbouring countries, were added to bioregions in Czechia. That is the case of southernmost part of bioregion 1.27, bordering mountain ranges and Kladská kotlina basin in bioregion 1.38 and 1.53. Silesian Beskydy Mts. in easternmost part of Czechia (bioregion 3.10) are probably part of other bioregion in Polish Beskydy Mts. Narrow stripe of hilly land on Austrian border south-east of town of Znojmo (Znaim) is part of a xerothermophilous biota bioregion with core in Austria, north-east of towns Maissau and Hollabrunn.

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