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CHOROLOGICAL DATA REGARDING THE PRESENCE OF THE SPECIES *CORYLUS AVELLANA* IN SOUTHWESTERN ROMANIA

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ABSTRACT. *The article aims to analyze scientific information in the scientific literature, data provided by the main herbaria in the country, and information collected from the spontaneous flora regarding the presence of the C. avellana species on the territory of Romania. Also, the distribution of C. avellana species has been analyzed according to the average annual temperature and the amount of average annual precipitations in Romania. The presence of the species on the territory of Romania was reported approximately 125 years ago in the "Conspectus of Romanian Flora" paper. In southwestern Romania, the species has been identified in different locations, for example, dendrological parks and natural parks. The practical value of this species is given by its edible fruits, which are valuable both for food and medicinal point of view or due to their agronomic characteristics. A primary objective for biodiversity conservation regarding this species should be protecting forested areas.*

KEYWORDS*: chorological data, C. avellana, distribution, Romania, temperature, precipitation*

INTRODUCTION

The *Corylus* genus is a group of useful woody plants ranging from small, multi-stemmed shrubs to tall, imposing trees, all producing edible nuts (Molnar 2011). The *Corylus* genus belongs to the *Corylaceae* family (Dihoru 1975, Beldie 1977, Ciocârlan 2000, 2009) or the *Betulaceae* family (Prodan 1939, Georgescu 1952, Prodan & Buia 1966, Resmeriță 1970, Houshyarfard

2020, Hicks 2022, Allegrini et al. 2022). The *Corylus* genus is widespread throughout the northern hemisphere, including 18 known species. *Corylus avellana* is a plant that appeared in the Tertiary period, especially in the Oligocene, between 33 and 23 million years ago. Its differentiation began in the Miocene period, counting two distinct types of hazel: one with narrow leaves (*Corylus insignis* Herr.) and the other one with large leaves (*Corylus mac-quarry* Herr.), which might be considered the ancestor of *C. avellana* L. (Holstein et al. 2018). Originally from Asia Minor, *C. avellana* grows spontaneously over a vast territory, ranging from Portugal to the Ural Mountains in the East and passing through the Italian and Balkan peninsulas, the Caucasus, and Kazakhstan (Browicz & Zielinski 1982). In the North, it goes up to 68° latitude along the Norwegian coasts, whereas in the South, it is found as far as Lebanon and Syria (Enescu et al. 2016). The *Corylus* genusis is widely distributed in the temperate regions of the Northern Hemisphere, with species found in Japan, Korea, and China, through Tibet, India, Northern Iran, Turkey, Caucus, Europe, and North America (Molnar 2011). The species is distributed mainly in Turkey (Black Sea coastal region), Italy, Spain, Portugal, France, and some parts of the United States (Oregon and Washington), but also in New Zealand, China, Azerbaijan, Chile, Iran, and Georgia (Alasalvar & Shahidi 2008). *C. colurna* (Turkish hazel) and *C. avellana* (common hazel) are the most common hazel species in Europe (Romisondo 1976, Riethmueller et al. 2014), but *C. avellana* has a wide distribution, whereas *C. colurna* is limited to the Balkans, Romania and northern Turkey (Thompson et al. 1996, Răduțoiu & Cosmulescu, 2020). *C. avellana* is widely distributed in Europe, in natural stands ranging from Scandinavia to the south of the continent (Palmé & Vendramin 2002, Enescu et al. 2016). In the North, it can be found in Norway up to 67°N, although its Northern limit decreases more Eastwards (Deacon 1974). It is the first species to colonize the European continent since the last Ice Age, as evidenced by pollen and chloroplast studies (Palmé & Vendramin 2002, Boccacci & Botta 2009). *C. avellana* is a significant species of food interest (Torello et al. 2018). In addition to scientific information, herbarium collections also provide valuable information about the presence of certain species in some ecological regions. Plant collections have a scientific, didactic, educational, and informative value. The collection of plants began in the 16th century. Later, J.P. Tourefort (around 1700, France) used the term "herbar" for plants (Bridson & Forman 1999). One of the oldest herbaria in

Southeastern Europe, a pre-Linnean herbarium dating from 1734, is in the botanical collection of the Natural History Museum within the Brukenthal Museum (Sibiu, Romania). The purpose of herbaria is important because it provides information about plants and their distribution area over long periods that help to carry out studies of taxonomy, biodiversity, ecology, anatomy, morphology, etc. (Vechiu & Dinca 2019). The information presented in different herbaria is evidence of the spread of hazel species. This article aims to analyze the scientific data and the main herbaria and spontaneous flora regarding the presence of *C. avellana* species in the southwestern part of Romania.

MATERIALS AND METHODS

The material used for this paper consisted of specialized sections that included the *C. avellana* species in the floristic list or the composition of some phytocoenoses, according to herbarium data in the main herbaria in the country (Bucharest and Craiova). Still, it is also based on the data analysis obtained following the trips made in different resorts where they grow in the spontaneous flora. The acronyms used for the consulted herbaria are BUCA (Herbarium of the Biology Institute of the Romanian Academy) and CRA (Herbarium of the University of Craiova). A database was created for *C. avellana*, focusing on the following data: plate number; Herbarium/Botanical Collection/Institution; species name; harvest date; place of harvest; the person who collected the plant; degree of preservation, coded with numbers from 1 to 4 (1 = plant well preserved, 2 = plant with parts detached from the plate but still present, 3 = plant detached from the plate with missing parts and 4 = plant detached and fragmented, with over 50% of its pieces missing) (Vechiu & Dinca 2019). To map the localities, the UTM Code was used, according to Lehrer & Lehrer (1990), and the Stereo 70 coordinates corresponding to the points in the spontaneous flora where *C. avellana* was identified were used. The species distribution maps were obtained with the help of the Corolog 2010 Program, made at the Institute of Biology in Bucharest. The program uses an access database with information from the literature, herbarium, and spontaneous flora and two maps: the average annual temperature map and the precipitation map of Romania.

RESULTS AND DISCUSSION

Prodan (1939), in his work entitled "Flora for the Determination and Description of Plants that Grow in Romania" states that in the Romanian

flora, there are three species of *Corylus* (*C. avellana, C. colurna,* and *C. maxima*). In the Flora of Romania (volume I, 1952, p. 197-202), Georgescu (1952) mentions the same three species: *C. avellana, C. colurna* and *C. maxima*. Prodan & Buia (1966), in "The Small Illustrated Flora of Romania" mention three species in the *Corylus* genus. For each species, the main morphological characteristics, flowering and fruiting period, and ecology are presented, and for *C. avellana,* the cenotic affiliation is also given. Data on the chorology of *Corylus* species can be found in various synthesis papers with the flora and vegetation of a particular territory as their object of study. There is a lot of information about the spread of *C. avellana*, having a good representation in the literature, being mentioned in Câmpia Crișurilor by Pop (1968); in the Vlădeasa Massif by Resmeriță (1970); in the Eastern Carpathians by Oprea & Sîrbu (2009); in the Rodnei Mountains by Coldea (1990) etc. It was mentioned by Cârțu (1969) in the Amaradia river basin, by Cârțu (1972) in the area between Jiu-Desnățui-Craiova and the Danube, by Năstase (1982) in the Bucovăț forest, by Karácsonyi (1995) in Satu-Mare, by Oroian (1998) in the Mureș Gorge, between Toplița and Deda, by Negrean et al. (2017) in Sălaj county. Iordănescu et al. (2014) claim that, in Romania, *C. avellana* is part of the spontaneous flora found in people's gardens. Still, in the last ten years, hazelnut plantations for both Romanian and Italian varieties have been established in different regions of the country: Timiș, Alba, Cluj, and Mureș. Posta et al. (2022) reported a large number of shrubs of the *C. avellana* species in the spontaneous flora in Timiș county: Moșnița Veche (45°44′4″N 21°19′48″E), Timișoara (45°47′58″N 21°17′38″E), Sanmihaiu German (45°42′51″N 21°22′23″E), Topolovați (45°46′32″N 21°37′44″E) and Lugoj (45°41′10″N 21°54′2″E). Table 1 presents a short inventory of the *C. avellana* species in the spontaneous flora of Romania. It is mainly found in Banat and Oltenia. In Caraș Severin County, *C. avellana* is located at Băile Herculane, Mount Domogled, on Sirinei Valley, Beul sec Valley, Cernei Valley, Şușcului Summit. In Mehedinți county, it is found in the forest on Marcopriciu, towards Vârciorova and on Comăneștilor Hill, Cazanele Mari, Ciucarul Mare Summit. The species was also identified in Gorj County, Tismana, Dolj County, Nicolae Romanescu Park, and Cluj County, Borșa. *C. avellana* has a wide distribution (Thompson et al. 1996). Hazel grows naturally in forests, and the cultivation of hazelnut bushes is not done intensively – they are found spontaneously or rarely planted on fragmented lands or private properties (Posta et al. 2022).

Table 1. Inventory of *Corylus avellana* species in the spontaneous flora of Romania

Harvesting place	COD_UTM	Stereo 70	
		X (N)	Y (E)
Dolj, Craiova, Romanescu Park	GQ21	404569.4953	311780.9795
Caraș Severin, Mount Domogled, forest	FQ28	297836.6474	377959.5701
Caraș Severin, Băile Herculane, on Mount Domogled, wooded calcareous rocks	FQ18	296893.0355	378553.3915
Caraș Severin, Berzeasca, on the Sirina valley	EQ74	258778.9364	355521.1017
Caraș Severin, Silvam formans in Mount Domogled, altitude approximately 700-900 m	FQ18	296893.0355	378553.3915
Timiș, “Culta in horto Muhle oppidi” Timişoara, the hazel trees being at 12 m altitude	ER16	206586.4622	478873.4057
Caraș Severin, Băile Herculane, in “Crucea Albă” Forest	FQ17	297012.6274	379327.0347
Cluj, Borșa	GS09	397770.7925	604459.5031
România, Mehedinți district	FQ16	331161.1417	385725.9944
Oltenia Region, Tr. Severin County, Forest South-East from Ilovita, Northern Vârciorova	FQ15	300683.1994	363968.9998
Mehedinți district, in the forest, on Marcopriciu Hill, towards Vârciorova	FQ15	312713.0338	391274.319
Hunedoara Region, Simeria Dendrological Park	FR57	346196.3421	486659.6678
Romania, Banat, Mehedinți District, Cazanele Mari, Ciucarul Mare Summit	FQ04	282570.2909	348429.2714
Banat, Caraș Severin district, Mount Domogled, in the forest above Baile Herculane	FQ17	296345.3594	380056.3988
Oltenia, Gorj county, chestnut forest at Tismana	FQ59	337669.2452	400170.29
Cazane	FQ04	284783.8028	352200.8366
Caraș Severin County, Băile Herculane, calcareous rocks on Şușcu summit	FQ17	296345.3528	380056.3952
Banat, Caraș Severin county, in the Beiul Sec Valley	FQ06	246161.9903	385618.3098
Cerna Valley	FQ39	302949.8893	391210.8189
Mehedinți, Comăneștilor Hill	FQ47	331161.1437	385725.9954

Since herbaria provide information about plants and their distribution area over long periods that help to carry out studies of taxonomy, biodiversity, ecology, anatomy, and morphology, in Table 2, an inventory of the *C. avellana* species in herbarium data is presented, using information from two herbaria in the country, Bucharest and Craiova, in the collection of which this species exists. In the Herbarium of Biology Institute of the Romanian Academy (BUCA) collection, the oldest specimen was collected in 1931 by Grințescu from the Domogled area, Băile Herculane. Also, according to the data provided by the Herbarium of Biology Institute of the Romanian Academy (BUCA), the species is mentioned in Gorj county, in Polovragi, Novaci, Runcu, Gilort; in Mehedinți county, towards Vîrciorova, to the West of Păunești Village, descending into Valea Topolniței; in Dolj county, in Nicolae Romanescu Park in Craiova. The plants in the Romanian Academy Biology Institute Herbarium (BUCA) were collected and determined by Grințescu, Anton, Nyazady, Cîrțu, Georgescu, and Sanda.

From the herbarium data provided by the Craiova University Herbarium (CRA), it can be seen that the oldest plate dates back from 1958, the *C. avellana* species being collected in Dolj county, between Sălcuta and Livezi, to the west northern part of the railway line, between Căprioarei Valley and Ursoaia Valley, at 120 m altitude. According to the data provided by the Craiova University Herbarium (CRA), the species was also identified in Vâlcea County, Cerna de Olteț Basin, on the Recea River Valley, at the level of the mountain region at an altitude between 700 and 1400 m, upstream from the town of Cerna, in the edges and rarefied areas of beech forests, near the river Cerna, at 700-800 m altitude, in Valea Bistriței, Folestii de Jos commune, between the Bîrloaga Forest and the Gogioman Coast, at about 300 m altitude, at 500 m altitude, in the same area, on the Bistriței Gorge, at Bulz, 1000 m altitude but also in Banat, Orșova county, Herculane, on Domogled, at 500-900 m altitude. The plants from the Herbarium of Craiova University (CRA) collection were collected and determined by Buia, Păun, Maloș, Olaru, Cîrțu, Popescu, Costache, Răduțoiu.

Hazel grows as an understory species in mixed deciduous forests (Kull & Niinemets 1993). Due to several leaf adaptations, it can grow in the sun and shade conditions (Catoni et al. 2015). It grows best on fertile and nutrient-rich, slightly acidic or neutral, or dry calcareous soils (Clinovschi 2005, Savill 2013). Hazel prefers a moderate climate with sufficiently high temperatures during growing but can withstand low temperatures or frosts (Savill 2013).

Table 2. *Corylus avellana* species inventory in herbarium/botanical collection data

Plate no	Herbarium/ Botanic collection/ Institution	Harvesting date	Harvesting place	Collected/ determinated by:	Conservation degree	COD_UTM
1	Herbarium of Craiova University (CRA)	02.08.2005	Oltenia, Vâlcea county, Cerna de Olteț Basin, on the Recea River Valley, at the level of the mountain region (700-1400 m altitude)	Costache I., Răduțoiu D.	1	GR20
1	Herbarium of Craiova University (CRA)	07.09.2001	Oltenia, Vâlcea county, Cerna de Olteț Basin, upstream from Cerna town, at the edges and in the glades of beech forests, near the Cerna river gravel (700-800 m altitude)	Răduțoiu D.	1	GR20
1	Herbarium of Craiova University (CRA)	13.05.1972	Oltenia, Vâlcea county, Bistrița Valley, Folestii de Jos Commune, between the Bîrloaga Forest and the Gogioman Coast (approx. 300 m alt.)	Popescu Ghe.	1	KK69
1	Herbarium of Craiova University (CRA)	15.05.1972	Oltenia, Vâlcea county, Bistrița Valley, Folestii de Jos Commune, between the Bîrloaga Forest and the Gogioman Coast (approx. 500 m alt.)	Popescu Ghe.	1	KK69
1	Herbarium of Craiova University (CRA)	19.08.1962	Banat region, Orșova district, Herculane, on Domogled (500-900 m alt.)	Buia Al., Păun M., Maloș C., Olaru M., Cîrțu D.	1	FQ05
1	Herbarium of Craiova University (CRA)	05.10.1958	Oltenia, Craiova Region, between Sălcuța and Livezi westnorthern railway line, Căprioarei Valley and Ursoaia Valley (120 m alt.)	Popescu Ghe.	1	GQ20
1	Herbarium of Craiova University (CRA)	05.10.1958	Oltenia, Craiova Region, Livezi	Popescu Ghe.	1	GP19
1	Herbarium of Craiova University (CRA)	19.07.1962	Banat region, Orșova district, Herculane, on Domogled, approx. 600 m altitude	Buia Al., Păun M., Maloș C., Olaru M., Cîrțu D.	1	FQ17

(Table 2 continued next page)

(Table 2 - continuation)

Plate no	Herbarium/ Botanic collection/ Institution	Harvesting date	Harvesting place	Collected/ determinated by:	Conservation degree	COD_UTM
1	Herbarium of Craiova University (CRA)	13.09.1968	Oltenia, Vîlcea county, Cheile Bistrița Gorge, at Bulz, 1000 m alt.	Popescu Ghe.	1	FS29
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	25.08.1981	Polovragi, Novaci		1	GR00
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	16.06.1919	Forest, under the Bulbucului Rock, Runcu, Gorj county	Grințescu G.	1	KL90
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	05.07.1949	Mehedinți District, to the west of Păunești Commune, descending into the Topolniței Valley	Anton I., Nyazady E.J	1	FQ26
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	16.07.1972	Oltenia, Gorj County, “In fructicetis Carpinion dclivibus saxosis ad rippam rivuli Gilort”, 950 m altitude	Cîrțu M.	1	FQ94
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	03.07.1931	Domogled, Băile Herculane	Grințescu G.	1	FQ17
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	26.09.1964	Oltenia, Ilovita Forest, Vîrciorova, Turnu Severin	-	1	FQ15
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	16.03.1948	Mehedinti, towards Vîrciorova	-	-	FR01
1	Herbarium of Biology Institute of the Romanian Academy (BUCA)	15.07.1961	Craiova, Nicolae Romanescu Park	Georgescu C., Sanda V.		GQ11

In Turkey, an average temperature of 13-16°C provides optimal conditions for hazelnut cultivation (Ustaoglu & Karaca 2014). The common hazelnut does not have high-temperature requirements. It withstands temperatures of -25°C and -10°C during flowering. Temperatures of 3-4°C are favorable for flowering, and those below 10°C are unfavorable for pollination. After starting vegetation, temperatures below -1°C cause the shoots to freeze and can compromise the harvest. The optimal temperature for hazelnut growth and fruiting is 23-27°C (Gonța 2021). Romania's geographical location and variable topography affect the distribution of ecological factors in the country, and these, in turn, have a unique influence on hazelnut growth and yield. Low temperatures (-30 to –33°C) during winter in central and eastern Transylvania and almost all of Moldova do not make intensive hazelnut cultivation possible in these areas (Botu & Turcu 2001). The hazelnut prefers subtropical climates with relatively high humidity (75-80%) and a cumulative temperature of 38-42.50ºC. It grows best in areas where the average annual temperature is 13-14ºC, the average temperature in the coldest month is not higher than 3.5-5.5ºC, the average temperature in the warmest month reaches 22-23ºC (Mirotadze et al. 2009).

Figure 1 shows the distribution of the *C. avellana* species correlated with the average annual temperature in Romania. This distribution results from both the herbarium data, red on the map, and from the data obtained from the spontaneous flora, blue on the map. The figure shows that the species is found in Oltenia and Banat, in areas with an average temperature between 9 and 11°C. The *Corylus* genus is widely spread in the temperate regions of the Northern Hemisphere, with species found in Japan, Korea, and China, through Tibet, India, Northern Iran, Turkey, Caucus, Europe, and North America (Molnar 2011).

The common hazelnut has high humidity requirements, needing a minimum of 700 mm of precipitation annually, especially during the growing months, with the highest requirements being between May and July. It requires irrigation during dry and hot periods to ensure fruiting (Gonța 2021). Annual precipitation is sufficient (700-900 mm) and well distributed in the Southern and Western Subcarpathian areas. However, rainfall is inadequate in the flat areas of the country's South and the Dobrogea region near the Black Sea; therefore, irrigation would be necessary. The Subcarpathian hill region (Oltenia, Muntenia, Banat, and Maramureș) and the Dobrogea region are considered the most favorable for intensive hazelnut cultivation (Botu & Turcu 2001). The necessary annual precipitation for good growth is 1500-

2000 mm, respectively 900-1200 mm during the growth period (Mirotadze et al. 2009). Figure 2 shows the distribution of the *C. avellana* species correlated with the average annual rainfall in Romania. The figure shows that in the distribution areas of Oltenia and Banat, the average annual precipitation is between 700 and 1000 mm. In Turkey, precipitation above 700 mm provides optimal conditions for hazelnut cultivation (Ustaoglu & Karaca 2014).

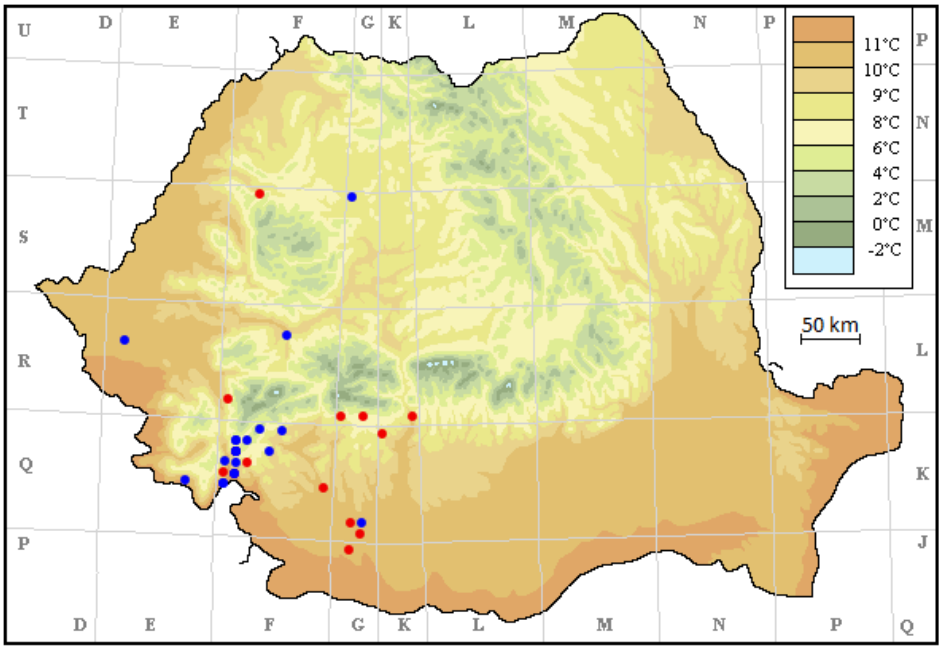

Figure 1. Distribution map of *C. avellana* according to the average annual temperature (red: herbarium data; blue: data from the spontaneous flora)

CONCLUSIONS

In conclusion, the presence of the *C. avellana* species on the territory of Romania was reported approximately 125 years ago in the "Conspectus of Romanian Flora" paper. Subsequent scientific information identifies the species in different locations, especially in Southwest Romania, dendrological, and natural parks. It is mainly found in Banat and Oltenia. Regarding the distribution of the species *C. avellana*, correlated with the

average annual temperature and the sum of the average annual precipitation in Romania, it was found that the average temperature is between 9 and 11°C in the distribution areas, and the sum of the average annual precipitation is between 700 and 1000 mm.

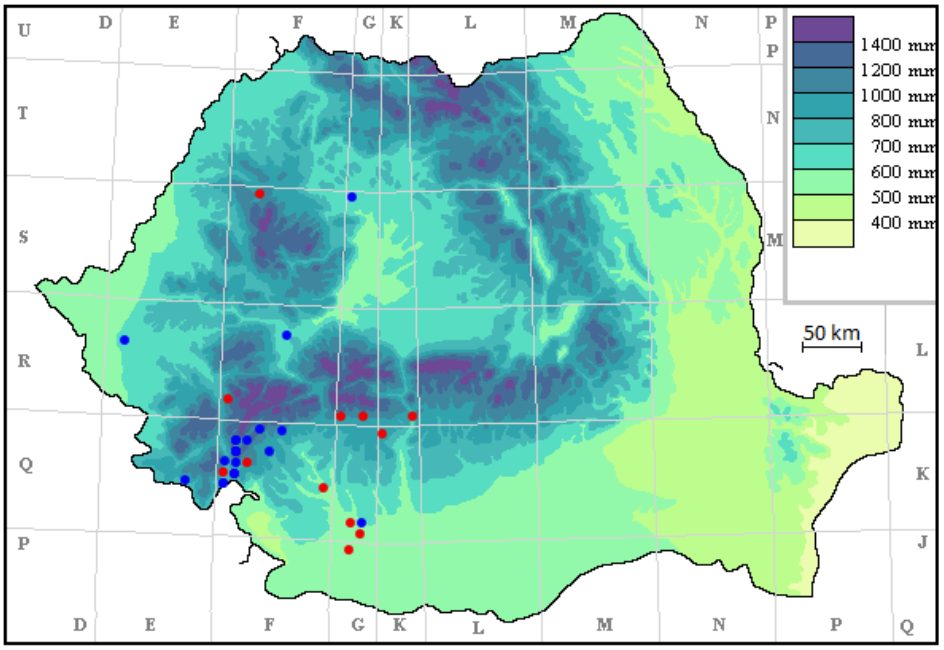

Figure 2. *C. avellana* distribution map according to the sum of average annual precipitation (red: herbarium data; blue: data from the spontaneous flora)

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