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Characteristic morphotype distribution predicts the extended range of the "Transylvanian" smooth newt, *Lissotriton vulgaris ampelensis* Fuhn 1951, in Romania

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Abstract. The endemic smooth newt *Lissotriton vulgaris ampelensis* Fuhn, 1951 is listed in Annex II of the EU Habitats Directive, and thus its conservation requires designation of Special Areas of Conservation (SACs). The limited designation of protected areas for the subspecies results from the partly unknown distribution of this variant, the consequence of its imperfect recognition in the field. Summarizing the qualitative morphological traits of 65 males examined, we conclude that the smooth waved to straight, relatively low dorsal crest, its consistent starting point from the occipital region, and the accentuated steepness of the dorsal crest in larger crested newts, are the most reliable characteristics to distinguish *L. v. ampelensis*. On the basis of our morphological description, we report an extended distribution range of the subspecies. We confirm a high congruence between the distribution of the morphotypes of the subspecies and the molecular data reported in the literature.

Key words: *Lissotriton vulgaris ampelensis*, extended distribution, morphotype, morphological traits, Transylvania, Romania.

Introduction

The endemic smooth newt subspecies, *Lissotriton vulgaris ampelensis* Fuhn, 1951, which inhabits exclusively the Transylvanian region of Romania, was described based on a specimen from Valea Dosului (= Izvoru Ampoiului, Alba County) situated in the Ampoi River Valley, in the Apuseni Mountains region. *L. v. ampelensis* is one of seven (Raxworthy 1990, Schmidtler & Franzen 2004) or six subspecies recognized in the smooth newt, based on external and internal morphological traits (Olgun et al. 1999, Ivanović et al. 2011), later also confirmed genetically (Rafiński et al. 2001, Babik et al. 2005). In Romania, the nominate *L. v. vulgaris* Linnaeus 1758 was also reported (Fuhn 1960a,b). This is widely distributed in Eurasia, ranging from western Europe, with the exception of Iberia, to western Siberia, where it occupies much of the species range (Schmidtler & Franzen 2004, Babik et al. 2005). The distribution of *L. v. ampelensis* lies in an area relatively central with regard to the distribution of the species – and is surrounded by *L. v. vulgaris* (Cogălniceanu et al. 2000, Rafiński et al. 2001, Babik et al. 2005). *L. v. ampelensis* is considered to be the result of *in situ* survival of the species in the Apuseni Mountains area during several glacial cycles, an evolutionary history that confers its distinctive status (Cogălniceanu & Venczel 1992, Rafiński et al. 2001), although some significant discrepancies between morphological data versus allozyme and molecular data have also been reported (Babik et al. 2005).

Nevertheless, the morphological subspecific differentiation of the smooth newt is based almost exclusively on secondary sexual characters of the males, i.e. the male epigamic integumental traits (Fuhn, 1960b, Raxworthy 1990, but see Ivanović et al. 2011). *L. v. ampelensis* is considered to be morphologically similar to the other southern subspecies (Raxworthy 1990, Rafiński et al. 2001) sharing several characters such as low and straight to smooth-edged dorsal crests, well-developed dorso-lateral ridges and tail filaments, compared to the denticulate dorsal crest and the lack of the dorso-lateral ridges and tail filaments in the nominate subspecies (Fuhn 1951, 1960a,b, Cogălniceanu 1994, Cogălniceanu et al. 2000, Cogălniceanu & Venczel 1992). However, in the case of *L. v. ampelensis*, all these sometimes ambiguous and mismatched characters exhibit high variability.

According to this uncertainty of identification the distribution of the subspecies in Romania is still imperfectly known. Most faunistic works report only the presence of the species unregarding the subspecies status of populations, but see Cogălniceanu et al. (2013) and Iftime & Iftime (2013). This deficiency strongly affects the protection of *L. v. ampelensis* in the country, as this subspecies is

listed in Annex II of the EU Habitats Directive and there is a possibility for designation of Natura 2000 sites for the taxon – designation which is still ongoing in Romania. Here, based on the analysis of our preliminary morphological data and the available literature, we try to synthesize a reliable character group, which could be used in the identification of the subspecies, and to draw a preliminary up-to-date distribution map of the subspecies.

Materials and methods

We were able to compare qualitative morphological traits of 65 male smooth newts, from 30 localities around the Transylvanian depression and surrounding mountains and their depressions (Fig. 1.A.), which we photographed in a water-filled aquarium. The newts were captured with a dip net and released at the point of capture. We consider that these specimens were encountered in the peak of their nuptial activities, being captured between March and May 2007–2011. Differences between subspecies of *L. vulgaris* have largely been drawn on the following characters: crest height and shape, dorso-lateral ridges, tail-fin height and shape, presence/absence of tail filament and of toe flaps and details of nuptial coloration (Raxworthy 1990). Thus in each specimen, if distinguishable, the following characters were summarized: the type of dorsal crest (denticulate, as in case of *L. v. vulgaris*, smooth-edged or straight), the starting point of the dorsal crest (between the eyes or from the occipital region), the dorsal crest height at mid-body [quantified by the proportions of the dorsal crest height and the body height measured at mid-body, as following: small (four times smaller), medium (three times smaller), large (two times smaller)], the steepness of the dorsal crest [quantified as the proportion between the dorsal crest height measured above the forelimb and the hindlimb (one, two or three or more times smaller)], the type of inferior edge of the tail (smooth-edged or straight), the presence of the dorso-lateral folds, the type of tail tip [with filament, with filament and borders – thus obviously differentiated from the tail as listed by Fuhn (1960b), probably the type *d* of Raxworthy (1990) – or without filament]. The toe flaps type was not considered, as in that character reliable categories were difficult to find.

Results

According to our data, 10 (15.3%) newts displayed denticulate, 35 (53.8%) smooth-edged and 20 (30.7%) straight dorsal crests. In only two individuals (3%) the dorsal crest started from between the eyes, and in the other 63 (96.9%) the dorsal crest started from the occipital region; 20 (31.2%) of the newts displayed small, 21 (61.7%) medium and 23 (35.9%) large dorsal crests. The dorsal crest above the forelimb was in 5 newts (4.6%) once, in 33 newts (51.5%) twice, and in 27 newts (40.6%) three or more times smaller than the dorsal crest above the hindlimb. In 5 cases (8%) the inferior edge of the tail was smooth-edged, while in 57 cases (91.9%) the inferior edge was straight. In 3 newts (4.76%) the dorso-lateral folds were missing, while in 60 newts (95.2%) they were present, although at a different level of development. With regard to tail tips, 24 newts (40.6%) were counted with a classic tail filament, 22 (37.2%) presented the second type of filament with tegument edges, and in 13 newts (22%) it was missing, the tip ending in a blunt point.

Discussion

Different morphotypes could be displayed in the same population or region, although a higher percentage of specimens with a large dorsal crest, as in newts from Lake Iezer-Ighiel, or small dorsal crest, as in newts from the Bogății Forest populations, could characterize local populations. The height of the dorsal crest in *L. v. ampelensis* was defined as 2–4 mm (Fuhn 1960, Cogălniceanu et al. 2000) or 1–3 mm (Cogălniceanu & Venczel 1992) – although Fuhn (1960*b*) noticed the possibility of a higher dorsal crest. Regarding the dorsal crest height the male *L. v. ampelensis* encountered are grouped almost equally. The dorsal crest in *L. v. ampelensis* is generally smooth-edged to straight as described previously (Fuhn 1960b, Cogălniceanu et al. 2000), although deeply denticulate specimens could appear. In general, in these specimens – and in the smooth-edged ones too – the denticulation starts from the mid-body region and continues along the tail crest, contrary to the assertion of Raxworthy (1990) that denticulation usually does not extend along the tail past the cloaca. According to Fuhn (1960a,b) in *L. v. ampelensis*, the dorsal crest starts in the occipital region and reaches its highest point above the cloaca. We consider that the starting point of the dorsal crest could have a strong taxonomic value, as in most cases the dorsal crest started from the occipital region. Olgun et al. (1999) found that in *L. v. vulgaris* (i.e. *L. v. schmidtlerorum*, an invalid taxon included within the synonimy of *L. v. vulgaris*) in a sample of 97 males the dorsal crest started from just behind the eyes, an observation we confirmed also in Romanian *L. v. vulgaris*. We found that this character

shows pertinence even in specimens with transitional crest height. One of the newts, where the dorsal crest started between the eyes, was encountered in Lower Mureş Valley (Pojoga, Hunedoara Country), where a known contact zone exists with the nominate variant, and newts with intermediate characters have been found (Cogălniceanu et al. 2000, and our own data), the second newt was captured in the Bogății Forest (Braşov), where interestingly in general the small-crested morphotype occurs. Note that even here, the low anterior part of the dorsal crest misses its abrupt start as in *L. v. vulgaris*. However, Fuhn (1960b) noted that the dorsal crest in the nominate morph could start also from the occipital region, an extent which must be further investigated (see also Iftime & Iftime 2008). Dorsal crest steepness shows an obvious tendency towards a higher crest in the posterior part of the body, a characteristic also described but not quantified by Fuhn (1960a,b), as this tendency occurs also in *L. v. vulgaris*, although to a significantly lower extent. Grouping the two characters, the dorsal crest height and steepness, on the basis of frequencies encountered, we found five morphotypes, which could comprise the morphology of *L. v. ampelensis* (Fig. 2). The inferior tail edge is mostly straight, as related by Fuhn (1960b), although even the denticulation of the nominate morph is moderately waved. The presence of dorso-lateral edges confine a slightly square-shaped dorsal in *L. v. ampelensis* and rounded shape in the nominal subspecies (e.g. in Fuhn 1960b). In the specimens examined the folds are in general present. The different development state supports the high variability of this character even between individuals from one population. If one considers the classic tail filament only, then slightly more than a third of the specimens showed this character, and summing the two filament types three-quarters of the newts were diagnosed with tail filaments. Fuhn (1960b) considered both filament types as characteristic of the subspecies; although the second filament type is characteristic also of *L. v. vulgaris* (Cogălniceanu et al. 2000, our own observations). Raxworthy (1990) pointed out the absence of the classic tail filament, although he listed the presence of the second type. The inconsistent presence of the tail filament and its shape have made this supposedly diagnostic character problematic.

We must emphasize, that each description represents the extreme states of the morphological traits used in identification, i.e. when the male was in the culmination of its nuptial characters development, and thus we must agree that these characters are characterised by large variation in traits. Body size and shape change greatly in an allometric fashion with the net input of material resources of the individual during ontogeny (Geist 1987). Thus individual variation in secondary sexual characters depends also on fitness of males (Raxworthy 1990). According to Green (1991) crest height correlates with male condition in the field and even with recent food intake. The time spent in reproductive activities relates to different crest height and development states (Verrell et al. 1986, Griffiths & Mylotte 1989). The crest and all the secondary sexual characters are more developed in the middle of the reproductive period than in the initial and terminal periods. The observed pattern of phenotypic variation might be driven also by local environmental factors (Raxworthy 1990, Ivanović et al. 2011). The short aquatic phase in ephemeral habitats induced by drought could result in weaker development of the sexual characters. The physical characteristics of the water body, e.g. its depth, could result in lower crest height in males (our own observations). Additionally, on a larger scale, sexual selection or genetic drift could induce different resulting phenotypic variations even between populations of the same subspecies (Green 1991, Ivanović et al. 2011). In spite of this inconsistency and considering our results, the smooth waved to straight, relatively low dorsal crest, the more or less consistent starting point at the occipital region and the accentuated steepness of the dorsal crest in the larger crested newts proved to be the most reliable characteristics of *L. v. ampelensis*.

On the basis of our conclusions we can indicate an extended distribution of the subspecies (Fig. 1.A., new localities listed in Appendix 1.). According to our data, *L. v. ampelensis* reaches the Eastern Carpathians and is present in the Gurghiu, Ciuc and Braşov Depressions and the Southern Carpathians in the Sibiu and Făgăraş Depressions (but see Fuhn 1960a,b, Cogălniceanu et al. 2000). In the north, the Gutin-Igniş Mountains appear to be the northernmost distribution limit of this subspecies (Török 1997), although more data are needed. The subspecies reaches higher altitudes, considered to be the limits of its ecological optimum (Cogălniceanu & Venczel 1992), in the eastern area of its distribution as well. The morphotype was found at 1184 m altitude at Câmpu Cetății (Mureş County), in the Călimani Mountains.

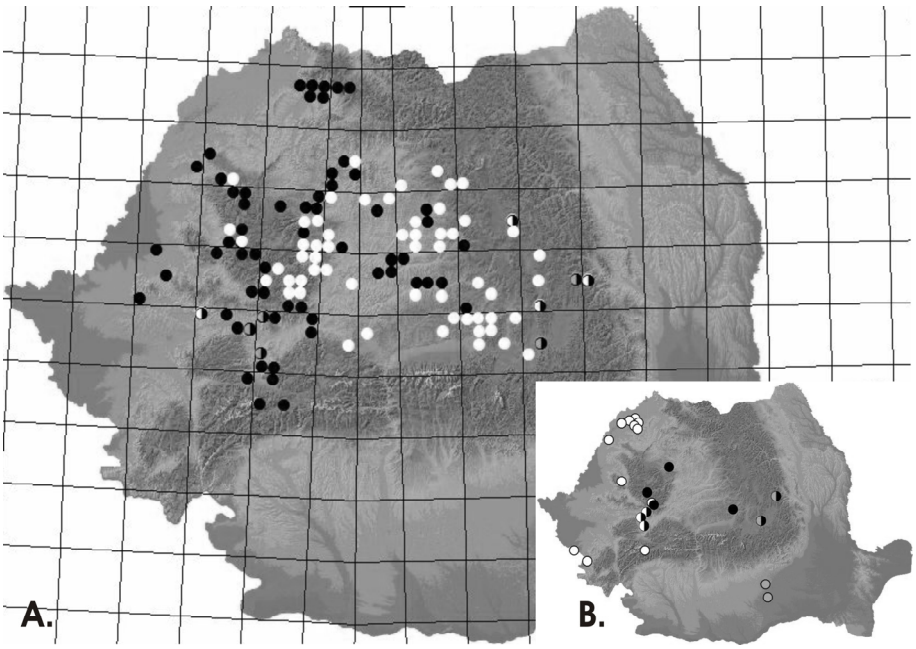

Figure 1.A. New data on the distribution of *L. v. ampelensis* in Romania. The presence of *L. v. ampelensis* in 10 x 10 km UTM squares according to literature (black dots; Fuhn 1960b, Török 1997, Török 1999, Rafiński et al. 2001, Babik et al. 2005, Iftime & Iftime 2013) and based on our data (white dots). The presence of morphologically intermediate individuals is denoted by half-white, half-black dots (Cogălniceanu et al. 2000, Iftime & Iftime 2013, own data from the lower Mureş Valley), where the presence of at least two clades is indicated by half-grey, half-black dotes (Babik et al. 2005). **B.** The distribution of *L. vulgaris* F (white dots), J (black dots) and G (grey dots) clades in Romania according to Babik et al. (2005). The presence of two clades in one location is represented by the half-coloured dots.

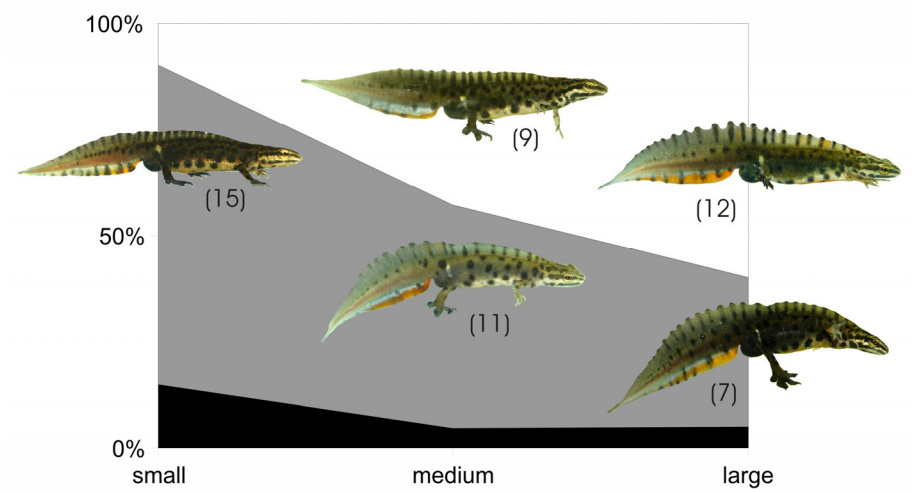

Figure 2. The frequencies of *L. v. ampelensis* morphotypes based on dorsal crest height (horizontal axis) and the extent of dorsal crest steepness from a low angle (black background) to a high angle of steepness (white background, vertical axis; for explanation see text). In brackets are the number of individuals in the group. Specimens showed are from Bistra Mureşului and Câmpul Cetății, Mureş county, and the last ones from Iezer-Ighiel Lake, Alba County (from left to right, up to down).

Another record of the morphotype from an area with average altitude of 1050 m, was listed from Mohoş Peat-bog (Harghita County) by Fuhn (1960a,b). In our opinion this newt (illustration 2.a. in Fuhn 1960a, which is the same as illustration 111.3. in Fuhn 1960b, although it is horizontally flipped and listed with a wrong locality) is only a morphotype of the *L. v. ampelensis* with large dorsal crest, similar to the newt found in the Bogăţii Forest. In the lower Mureş Valley the morphotype was found at an altitude of 172 m, lower than recorded up until now (300–1270 m, Fuhn 1960a; 300–1100, Fuhn 1960b; 300–1200, Cogălniceanu et al. 2000). In the south-western part of its distribution the subspecies reaches the Ţarcu Massif, where also the nominate and intermediate populations exist (Iftime & Iftime 2013).

Genetic studies confirmed the extended distribution of the subspecies substantially. According to Babik et al. (2005), Romania holds three major *L. vulgaris* clades: the F clade occupies a small area around the Iron Gates and in south-western Romania; the second, G clade, is found in the south of the Eastern Carpathians and within Romanian populations of *L. montandoni*, a closely related species; and lastly the J clade occurs almost exclusively in Transylvania. If we consider that the J clade resembles *L. v. ampelensis*, this variant occurs in the whole southern Transylvanian Basin, from the Apuseni Mountains to the Eastern Carpathians and its depressions (Fig. 1.B., Babik et al. 2005). Regarding the presence of clades outside the Transylvanian Basin, the western F clade and eastern G clade are obviously possessed by *L. v. vulgaris*. The presence of these clades in the lower Mureş Valley or in the Braşov depression was to be expected, as noted above. According to the distribution of the F clade, a deep and genetically distinct penetration is reported into the *L. v. ampelensis* territory (see Izvoru Ampoiului, the *terra typica* of the subspecies), although the morphological features of the populations examined from the neighbouring area showed clear *L. v. ampelensis* characteristics, which is supported by the presence of the J clade in the area (in Cărpiniş, Zlatna, Alba County). The distribution of the F clade makes questionable the taxonomic status of the populations assigned to *L. v. ampelensis* in the southern and western area of the Apuseni Mountains and surroundings (Cogălniceanu et al. 2000). In the Braşov Depression the secondary contact with *L. v. vulgaris* or even with *L. montandoni*, while both house the G clade, was also predicted. The contact with *L. montandoni* is confirmed in a population further to north – extending into the Ukrainian Carpathians – where the J clade appears as another distinct clade, resulting from introgression with *L. vulgaris*, and here probably with *L. v. ampelensis*. A hypothesis that the lack of the *L. v. vulgaris* characteristics even in specimens from the G clade could be the result of introgression with *L. montandoni*, a closely related species, and not with the nominate variant, could be predicted; although more morphological and genetic data are needed to draw a reliable conclusion. Nevertheless, Babik et al. (2005) indicated high inconsistency between subspecies denomination and the corresponding clades. The newts from the F clades were classified also as *L. v. ampelensis*, a view which appears also in Ivanović et al. (2011). Newts from the central distribution of *L. v. ampelensis*, listed in J clade (e.g. Rupea) were classified also as nominate subspecies. The F-J combination is listed as *L. v. ampelensis*, while G-J is listed as *L. v. vulgaris*, thus in contradictory ways. We consider that the genetic background shows high congruence with the distribution pattern of *L. vulgaris* subspecies in Romania, although the pattern was not recognized in Babik et al. (2005; Fig. 1A-B). However recently, Cogălniceanu et al. (2013) only report the presence of *L. v. ampelensis* from the Apuseni Mountains and some localities in the Intra-Carpathian area, in Transylvania.

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+ Appendix I. – one page (one table)

Appendix 1. List of new Romanian localities for *L. v. ampelensis*. The information for each record is listed by the following, sequential categories: locality, county, GPS coordinates, altitude (a.s.l.). County abbreviations: AB – Alba, BN – Bistrița Năsăud, BV – Brașov, CJ – Cluj, CV – Covasna, HD – Hunedoara, HR – Harghita, MS – Mureș.

Locality	Coordinates	Altitude	Locality	Coordinates	Altitude
Bistra Mureşului (MS)	47° 1'25.31"N, 24°51'54.37"E	788 m	Poşaga de Sus (AB)	46°27'15.36"N, 23°24'3.03"E	519 m
Buru (CJ)	46°30'11.21"N, 23°36'15.62"E	366 m	Poşaga de Sus (AB)	46°27'12.75"N, 23°24'7.94"E	526 m
Buru (CJ)	46°30'8.86"N, 23°36'24.64"E	366 m	Prejmer (BV)	45°43'16.02"N, 25°46'25.39"E	518 m
Buru (CJ)	46°30'5.67"N, 23°35'34.95"E	403 m	Racoş (BV)	46° 1'13.43"N, 25°24'35.51"E	488 m
Câmpeneşti (CJ)	46°51'14.63"N 23°38'49.02"E	465 m	Răstolița (MS)	46°59'22.78"N, 25° 1'4.52"E	629 m
Câmpu Cetății (MS)	46°40'28.08"N, 25° 7'6.39"E	1184 m	Răstolița (MS)	46°59'27.73"N, 25° 1'22.82"E	655 m
„Cetățile Ponorului" (BH)	46°33'52.08"N, 22°42'39.91"E	1225 m	Reci (CV)	45°49'32.98"N, 25°56'15.29"E	530 m
„Cheile Turzii" (CJ)	46°34'1.70"N, 23°40'18.67"E	491 m	Roşia Montană (AB)	46°18'11.72"N, 23° 8'36.96"E	1014 m
„Cheile Vălişoarei" (AB)	46°22'37.52"N, 23°34'57.35"E	467 m	Roşia Montană (AB)	46°18'12.24"N, 23° 8'43.47"E	1038 m
Chinari (MS)	46°37'7.93"N, 24°36'11.27"E	320 m	Rotbav (BV)	45°51'48.15"N, 25°32'55.77"E	494 m
Chinari (MS)	46°37'21.00"N, 24°35'59.30"E	325 m	Rupea (BV)	46° 1'51.67"N, 25°13'46.92"E	498 m
Ciuguzel (AB)	46°16'30.20"N, 23°54'45.21"E	280 m	Rupea (BV)	46° 1'46.52"N, 25°12'8.35"E	489 m
Cluj-Napoca (CJ)	46°43'56.01"N, 23°33'10.42"E	426 m	Rupea (BV)	46° 0'46.02"N, 25°13'46.65"E	527 m
Comăna de Sus (BV)	45°54'18.67"N, 25°17'10.73"E	598 m	Săcădat (MS)	46°39'1.07"N, 25° 0'49.04"E	625 m
Comăna de Sus (BV)	45°53'12.85"N, 25°17'10.46"E	617 m	Săcădat (MS)	46°39'0.04"N, 24°59'38.05"E	590 m
Curteni (MS)	46°35'3.65"N, 24°35'14.91"E	313 m	Sălciua de Jos (AB)	46°24'9.05"N, 23°26'32.70"E	441 m
Dacia (BV)	46° 0'30.15"N, 25° 7'59.30"E	490 m	Sălicea (CJ)	46°41'30.10"N, 23°32'53.29"E	706 m
Dâmbu Mare (CJ)	47° 9'10.74"N, 23°57'0.25"E	235 m	Sălicea (CJ)	46°41'2.69"N, 23°32'40.55"E	733 m
Dâmbu Mare (CJ)	47° 9'23.17"N, 23°57'30.12"E	233 m	Sălicea (CJ)	46°40'57.09"N, 23°32'39.35"E	738 m
„Dealul Turzunului" (BV)	46° 0'12.84"N, 25°21'4.85"E	453 m	Săvădisla (CJ)	46°40'2.22"N 23°27'36.21"E	553 m
„Dealul Turzunului" (BV)	46° 0'6.53"N, 25°20'52.47"E	449 m	Sâncrăieni (HR)	Mara, Gy., pers. comm.	
„Dealul Turzunului" (BV)	46° 0'34.93"N, 25°20'51.58"E	457 m	Sângeorgiu de Mureş (MS)	46°34'20.67"N, 24°36'6.82"E	335 m
Delniţa (HR)	Demeter L., pers. comm.		Senetea (HR)	46°37'22.66"N, 25°35'7.91"E	776 m
„Fânaţele Clujului" (CJ)	46°50'16.57"N, 23°37'55.94"E	551 m	Senetea (HR)	46°36'24.17"N, 25°34'13.60"E	828 m
„Fânaţele Clujului" (CJ)	46°50'2.93"N, 23°38'10.18"E	527 m	Senetea (HR)	46°36'21.22"N, 25°34'15.15"E	828 m
Fânaţele Mădăraşului (MS)	46°36'45.35"N, 24°24'31.97"E	324 m	Sfârcea (AB)	46°12'8.29"N, 23°19'3.26"E	1013 m
Gara Rupea (BV)	46° 0'36.12"N, 25°18'42.58"E	445 m	Slimnic (MS)	45°55'13.53"N, 24° 8'37.81"E	402 m
Gălăoaia (MS)	46°58'19.33"N, 24°56'0.77"E	526 m	Şoarş (BV)	45°55'23.09"N, 24°55'20.64"E	516 m
Glodeni (MS)	46°37'50.37"N, 24°36'12.21"E	353 m	Sucutard (CJ)	46°53'8.67"N, 24° 4'8.80"E	288 m
Glodeni (MS)	46°37'42.76"N, 24°36'2.33"E	366 m	Târgu Mureş (MS)	46°33'46.21"N, 24°33'53.64"E	309 m
Gornești (MS)	46°40'1.67"N, 24°38'1.20"E	332 m	Târgu Mureş (MS)	46°33'53.81"N, 24°34'4.67"E	312 m
Hodoşa (MS)	46°38'4.80"N, 24°49'33.76"E	412 m	Ţiptelnic (MS)	46°35'50.62"N, 24°24'42.88"E	377 m
Hodoşa (MS)	46°37'59.10"N, 24°49'31.93"E	412 m	Torba (MS)	46°33'3.89"N, 24°52'48.91"E	458 m
Hodoşa (MS)	46°38'1.51"N, 24°49'25.34"E	411 m	Ungra (BV)	45°58'37.94"N, 25°16'56.12"E	461 m
Hodoşa (MS)	46°38'40.93"N, 24°49'35.91"E	418 m	Valchid (SB)	46°10'10.86"N, 24°33'15.79"E	396 m
Hoghiz (BV)	45°59'33.05"N, 25°17'43.00"E	445 m	Valea Crişului (BH)	46°57'21.62"N, 22°39'56.49"E	555 m
Hoghiz (BV)	45°59'44.41"N, 25°18'31.73"E	456 m	Valea (MS):	46°34'10.63"N, 24°47'49.03"E	364 m
Ionești (BV)	46° 9'28.57"N, 25°19'43.98"E	500 m	„Valea Feneşului" (AB)	46°10'42.51"N, 23°17'30.97"E	820 m
Izvoarele (AB)	46°23'55.07"N, 23°32'37.99"E	572 m	„Valea Feneşului" (AB)	46°11'47.46"N, 23°16'32.10"E	853 m
Jibert (BV)	46° 0'19.67"N, 25° 2'31.28"E	496 m	„Valea Feneşului" (AB)	46°12'28.50"N, 23°16'15.19"E	901 m
„Lacul Iezer-Ighiel" (AB)	46°10'44.85"N, 23°21'57.52"E	959 m	„Valea Feneşului" (AB)	46°12'51.98"N, 23°15'46.86"E	945 m
„Lacul Iezer-Ighiel" (AB)	46°10'54.81"N, 23°21'43.60"E	961 m	Vălişoara (AB)	46°23'22.05"N, 23°34'26.19"E	494 m
Lunca Bradului (MS)	46°56'49.26"N, 25° 3'26.93"E	594 m	Vălişoara (AB)	46°23'31.75"N, 23°34'12.77"E	501 m
Lunca Largă (AB)	46°31'5.00"N, 23°25'43.89"E	602 m	Vălişoara (AB)	46°23'53.24"N, 23°33'44.22"E	513 m
Lunca Meteşului (AB)	46° 8'30.59"N, 23°20'38.12"E	707 m	Vălişoara (AB)	46°23'54.87"N, 23°33'50.77"E	510 m
Mateiaş (BV)	46° 1'0.38"N, 25°22'37.41"E	464 m	Vălişoara (AB)	46°23'53.45"N, 23°33'51.82"E	510 m
Mateiaş (BV)	46° 0'22.21"N, 25°22'55.38"E	454 m	Vărgata (MS)	46°34'37.15"N, 24°47'28.57"E	370 m
Măgina (AB)	46°19'49.12"N, 23°38'44.41"E	393 m	Vărgata (MS)	46°34'36.37"N, 24°47'19.32"E	370 m
Mândra (SB)	45°54'26.47"N, 24° 4'58.09"E	373 m	Vărgata (MS)	46°34'35.74"N, 24°47'16.67"E	373 m
Miercurea Nirajului (MS)	46°32'29.16"N, 24°47'35.66"E	368 m	Vărgata (MS)	46°34'33.59"N, 24°47'14.99"E	373 m
Miercurea Nirajului (MS)	46°32'41.43"N, 24°48'22.47"E	352 m	„Vârful Băilesei" (BH)	46°35'22.74"N, 22°41'17.78"E	1188 m
Miercurea Nirajului (MS)	46°32'54.15"N, 24°47'43.72"E	369 m	Veneţia de Jos (BV)	45°52'6.57"N, 25°13'24.39"E	450 m
Mitreşti (MS)	46°35'4.35"N, 24°47'7.80"E	398 m	Veneţia de Sus (BV):	45°51'5.89"N, 25°15'41.41"E	560 m
Necrileşti (AB)	46°12'33.89"N, 23°21'40.61"E	892 m	Viile Tecii (BN)	46°55'45.45"N, 24°28'59.96"E	334 m
Odorheiu Secuiesc (HR)	46°17'52.51"N, 25°17'1.70"E	470 m	Visuia (BN)	46°50'24.49"N, 24°18'12.53"E	376 m
Orlat (SB)	45°45'26.76"N, 23°56'42.93"E	495 m	Vulcan (HD)	46°13'53.54"N, 22°57'54.76"E	826 m
„Pădurea Aiudului" (AB)	46°19'16.96"N, 23°35'51.56"E	678 m	Vulcan (MS)	46° 8'27.28"N, 24°51'6.29"E	470 m
„Pădurea Bogății" (BV)	45°56'15.26"N, 25°21'50.22"E	568 m	Vulcan (MS)	46° 8'21.40"N, 24°51'22.14"E	474 m
„Pădurea Bogății" (BV)	45°54'49.31"N, 25°24'32.96"E	651 m			
„Pădurea Bogății" (BV)	45°54'29.33"N, 25°25'23.22"E	637 m			
„Pădurea Mociar" (MS)	46°45'41.34"N, 24°49'4.49"E	444 m			
„Pădurea Mociar" (MS)	46°45'24.11"N, 24°49'0.33"E	449 m			
Pojoga (HD)	45°59'35.47"N, 22°20'40.38"E	172 m			