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DISTRIBUTION OF ENDANGERED *GENTIANA CLUSII* E. M. PERRIER & SONGEON IN THE ROMANIAN CARPATHIANS – A CRITICAL OVERVIEW

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Abstract: This study makes a critical analysis of the distribution of the rare plant species *Gentiana clusii* E. M. Perrier & Songeon in the Romanian Carpathians. This species was previously considered as sporadically distributed in the Romanian Carpathians. By reviewing the herbarium collections from Romania and Hungary, we were unable to find any valid specimens of *Gentiana clusii* collected outside the range of Apuseni Mountains. Additionally, we analysed the available botanical literature, which brought us to the same conclusion: the presence of *Gentiana clusii* in all previously mentioned localities from the Romanian Carpathians outside the Apuseni Mountains cannot be supported by any solid data and is, therefore, considered doubtful.

Our paper reconfirms the presence of *G. clusii* on Pietrele Negre limestone cliffs (Bihor Mts, Apuseni Mountains), providing also a description of the coenotic context in which the population grows.

The authors propose the inclusion of *Gentiana clusii* in the next edition of the Romanian Red Book of Vascular Plants as Endangered (EN), due to its regional rarity and existence at the margin of the distribution area of the species.

Keywords: Chorology; *Gentiana clusii*; Apuseni Mountains; threatened species; Red Book.

Introduction

Gentiana sect. *Ciminalis* (Adans.) Dumort. consists of seven ecological or geographical vicariant and closely related species (*Gentiana acaulis* L., *Gentiana ligustica* R.Vilm. & Chopinet, *Gentiana occidentalis* Jakow., *Gentiana angustifolia* Vill., *Gentiana dinarica* Beck, *Gentiana alpina* Vill. and *Gentiana clusii* E.M. Perrier & Songeon), which are distributed throughout the European high mountain ranges [6].

In the Romanian Carpathians, only two representatives of sect. *Ciminalis* are encountered: *Gentiana acaulis* and *G. clusii*. These ecological vicariant species are differentiated through subtle morphological traits and their ecological preferences towards substrate.

The ecological differences are expressed in the nutrients availability, as *G. clusii* prefers base-rich soils, while *G. acaulis* usually occurs on base-poor soils [90]. Morphologically, the two species are quite similar, this being one of the reasons for past misidentifications, the few differences being noticeable in the colour of the corolla, calyx lobes and shape of the leaves (Table 1) [90].

Table 1: Morpho-ecological differentiation between *Gentiana clusii* and *Gentiana acaulis*

Compared data	*G. clusii*	*G. acaulis*
Corolla	Dark blue, without olive-green vertical stripes.	Dark blue with olive-green vertical stripes inside.
Calyx lobes	At least half as long as the calyx; not connected by white membranous stripes.	Least than half of calyx's length; connected by white membranous stripes.
Leaves	Elliptical to oblong-lanceolate. Tough.	Lanceolate, elliptical or less frequently obovate. Soft.
Ecology	Prefers base-rich soils (with limestone bedrock).	Prefers base-poor soils (with acidic bedrock).

Both species are endemic to Europe [90]. *Gentiana acaulis* has a range partially sympatric with *G. clusii*, the former having a wider distribution, one that spans from the Pyrenees in Western Europe all the way to the mountains of the Balkan Peninsula (Stara Planina). The general distribution of *Gentiana clusii* includes the Alps, Carpathians and Dinaric Alps or Dinarides, situated in the westernmost part of the Balkan Peninsula (Croatia). The species inhabits calcareous rocky habitats and grasslands of the upper montane and subalpine zones [71].

In recent Romanian botanical literature [12, 57, 73] *Gentiana clusii* has been mentioned as sporadically distributed in the Romanian Carpathians: Maramureşului Mts., Rodna Mts., Obcina Mestecănişului Mt., Rarău Mts., Giumalău Mts., Căliman Mts., Ceahlău Mts., Hăşmaş Mts., Postăvaru Massif, Bucegi Mts., Piatra Craiului Mts., Iezer-Păpuşa Mts., Făgăraş Mts., Cindrel Mts., Parâng Mts., Retezat Mts., Gilău-Muntele Mare Mts., Trascăului Mts., Vlădeasa Mts. and Bihor Mts.

In the Romanian Carpathians, *Gentiana clusii* is considered a rare species [28], recorded also in the Red List of vascular plants of Romania as Rare (R) [56]. The species was not included in the Red Book of Vascular Plants of Romania [29].

Materials and Methods

Our investigations build upon extensive field studies, inspection of herbarium collections in CL, BP, BUC, BUCA, BVS, SIB, I, IAGB, IASI, CRAI (acronyms according to Thiers 2015 [89]), as well as literature surveys.

All existing herbarium material was revised and all available information from the botanical literature was critically compiled in order to clarify the distribution of *Gentiana clusii* in the Romanian Carpathians. Several field surveys were carried out by the authors between 2003 and 2015 in the Eastern Carpathians: Maramureşului Mts., Rodna Mts., Rarău Mts., Giumalău Mts., Căliman Mts., Ceahlău Mts., Hăşmaş Mts.; Southern Carpathians: Postăvaru Massif, Bucegi Mts., Piatra Craiului Mts., Iezer-Păpuşa Mts., Făgăraş Mts., Cindrel Mts., Parâng Mts., Retezat Mts.; Apuseni Mts.: Gilău-Muntele Mare Mts., Vlădeasa Mts., Bihor Mts. (Apuseni Mountains), covering the areas where the species was previously reported. Identification of specimens was carried out using several floristic monographs [90, 73, 92, 12].

Results and Discussion

1. Distribution of *Gentiana clusii* in the Romanian Carpathians

1.1. **Munţii Maramureşului** (Maramureşului Mts, Eastern Carpathians)

Resmeriţă was the first and only author to mention Clusius's Gentian in this mountain range, from Cearcănul Mt. [69]. A single herbarium specimen was found in CL (no. 561157), with this information on the voucher's label: "*Gentiana clusii*, Cearcănul Mt., Maramureş, leg. I. Resmeriţă, 16 Jun 1972". The herbarium material collected by Resmeriţă does not represent *Gentiana clusii*, but *Gentiana acaulis* (the herbarium specimen was revised by Mihai Puşcaş, 7 Mar 2011). Additionally, we could not identify any herbarium specimen of *Gentiana clusii* from the Romanian part of Maramureşului Mountains in none of the consulted herbarium collections.

We could not find *G. clusii* in any area of this mountain that was investigated during our field campaigns (A. Bartók, pers. obs. 2009, 2012, 2014, 2015; Hurdu, pers. obs. 2008, 2009).

Moreover, we highlight that from the Ukrainian part of Maramureşului Mountains various literature sources concerning the flora of Ukraine reported *G. clusii* (Wisjulina, Fodor, Tzvelev, Mosyakin & Fedoronchuk [93, 35, 91, 52]). Nevertheless, a recent study could not confirm the presence of this species in the Ukrainian Carpathians [71].

Therefore, the occurrence of Clusius's Gentian in this mountain range could not be confirmed through any specimen.

1.2. **Munţii Rodnei** (Rodna Mts, Eastern Carpathians)

This important hotspot for the alpine flora in the Carpathians was thoroughly covered by botanical studies. *Gentiana clusii* was mentioned in the flora of this mountain group, by Jávorka [42], Resmeriţă [68] and Ghişa & Resmeriţă [36]. Jávorka cited the presence of Clusius's Gentian in Pietrosul Mare Mt., while Resmeriţă & Ghişa mentioned the species from Izvorul Cailor and Pietrosul Mare Mt.

Nevertheless, the species was not mentioned in other botanical monographs of famous botanists such as Schur [74], Porcius [65], Simonkai [78], Soó [82] or Coldea [13].

Probably the erroneous mention of the species from Pietrosul Mare Mt. by Jávorka [42] was based on the herbarium material of Frivaldszky and Jávorka which is deposited in CL collection (specimen no. 523619), with this note on the voucher's label: "*Gentiana clusii*, in herbidis montis Nagy Pietrosz, comit. Máramaros, leg. N. Filarszky & S. Jávorka, 5 Jul 1907". The collected material does not represent *G. clusii*, but *G. acaulis* (the herbarium sheet was revised by Mihai Puşcaş, 20 Oct 2015).

We also analyzed one herbarium specimen from BP herbarium collection, indicated from Pietrosul Mare Mt. labelled: BP (no. 697719), "*Gentiana clusii*, Marmaros, Pietrosz leg. J. Wagner, Jul 1909". The aspect of the basal leaves indicates *G. acaulis*, but not *G. clusii*.

Another mention from Izvorul Cailor [36] was also proven erroneous, probably based on confusion with *G. acaulis*. Olos [55] does not report the presence of *G. clusii* in Piatra Rea Mt. (which also includes Izvorul Cailor waterfall).

Also, based on our field surveys, we could not find Clusius's Gentian in the Rodna Mountains (A. Bartók, pers. obs. 2004, 2005, 2009, 2010, 2012–2015; Hurdu, pers. obs. 2007, 2008, 2014). Moreover, we were unable to identify any herbarium specimens belonging to this taxon from the mountain range in any public herbaria.

Thus, it can be concluded that the presence of *G. clusii* in the Rodna Mountains is based on erroneous identification and it is very unlikely that Clusius's Gentian occurs in this mountain range. By contrast, *G. acaulis* from Rodna Mts. is well-documented in Romanian herbaria.

1.3. **Munţii Obcina Mestecănişului** (Obcina Mestecănişului Mts, Eastern Carpathians)

This mountain range is poorly covered by floristic surveys. Raclaru & Barbu [67], Pop *et al*. [61] and Ştefan & Oprea [87] published botanical studies without mentioning *G. clusii*. However, Ţopa [92] mentions the presence of *G. clusii* in the Obcina Mestecănişului Mountains at Lucina. We do not know the primary source of this data.

We could not find any herbarium voucher of this species from this mountain range. Similar to other parts of Eastern Carpathians, it is very likely that the Clusius's Gentian does not occur in these mountains; it was probably confused with *G. acaulis*.

1.4. **Munţii Rarău** (Rarău Mts, Eastern Carpathians)

Pietrele Doamnei (Lady's Stones) and its surroundings might represent the most intensively investigated region by botanists, considering the whole range of Rarău Mountains.

The presence of *G. clusii* in this mountain range was reported by some authors: Morariu [51], Raclaru [66], Mititelu *et al.* [49], Oprea & Sârbu [58, 59] from Pietrele Doamnei. Older botanists, Herbich [39] or Knapp [44], reported only the presence of *G. acaulis* in this location.

A single herbarium specimen from the Rarău Mts. was found in BUC (no. 272262), with the voucher's label: "*Gentiana clusii* var. *tenella* nova var., Câmpulung, Bucovina, mountain meadows, on Măgura, leg. I. Morariu, 21 May 1950". The material collected by Morariu from Măgura peak does not represent *Gentiana clusii*, but some form or variety of *G. acaulis.*

During our field surveys, the species was not found near Pietrele Doamnei or in any other part of this mountain group (A. Bartók, pers. obs. 2004, 2007, 2010, 2011, 2014, 2015; Hurdu, pers. obs. 2009). Furthermore, we were unable to identify herbarium specimens of this taxon from the mountain range in any public herbaria. The species remains doubtful in the flora of Rarău Mountains.

1.5. **Munţii Giumalău** (Giumalău Mts, Eastern Carpathians)

This mountain group has been poorly covered by botanical studies, although Dobrescu *et al.* published articles regarding the flora and vegetation of the Giumalău Mountains [30, 31].

Though Ţopa [92] mentions the presence of *G. clusii* in this mountain range, it is probably based on confusion with *G. acaulis*. We do not know the primary source for his data.

We could not find any herbarium specimen of Clusius's Gentian from this area. Also we could not identify *G. clusii* near Giumalău, nor at Stegile peaks, or in any other parts of this mountain range (A. Bartók, pers. obs. 2007, 2014, 2015; Hurdu, pers. obs. 2009).

Therefore, the occurrence of Clusius's Gentian in the Giumalău Mountains remains unproven by clear data.

1.6. **Munţii Bistriţei** (Bistriţei Mts, Eastern Carpathians)

This mountain range was not properly investigated, only the area of Neagra Şarului, Neagra, Negrişoara, Grinţieş and Neagra Broştenilor having a better botanical coverage.

G. clusii was mentioned in the flora of this mountain group by Chifu *et al*. [11] (from Grinţieşu Mare Mt.) and Oprea [57] (from Măgura Bistricioarei Mt., erroneously mentioned because according to the quoted source [11] the species grows in Grinţieşu Mare Mt.).

Seghedin, in his PhD thesis and in the floristic synthesis of Suceava County [75, 76], does not mention Clusius's Gentian, but Koch's Gentian from Grinţieşu Mare Mt. and Pietrosul

Bistriţei Mt. Also, Mardari, in a floristic survey of Bistriţei Mountains [45], could not confirm the presence of *G. clusii* in this area, only *G. acaulis*. On Grinţieşu Mare Mt. schists are dominant, so there would be no ecological conditions for Clusius's Gentian (which prefers base-rich soils, with limestone bedrock).

We could not find any herbarium specimen from the Bistriţei Mountains in all the verified herbaria. Similar as in other mountain ranges in the Eastern Carpathians, *G. clusii* was probably confused with *G. acaulis*; we assume that Clusius's Gentian is not present in these mountains.

1.7. **Munţii Căliman** (Căliman Mts, Eastern Carpathians)

G. clusii was mentioned once in the flora of this mountain group, by Şerbănescu [86] from Izvorul Căliman Mt., more accurately from a place named "Faţa Gardului".

Neither Csűrös [17, 18], nor Höhn [40, 41] or Mititelu *et al.* [50] mentioned Clusius's Gentian in the Căliman Mountains. The most recent floristic checklist covering Căliman National Park [94] does not indicate any occurrence of *G. clusii* in this mountain range either, but it mentions *G. acaulis* instead.

We could not find Clusius's Gentian in Căliman Mountains (A. Bartók, pers. obs. 2007, 2010, 2011, 2015; Hurdu, pers. obs. 2007, 2009, 2014) and we were also unable to identify herbarium specimens belonging to this taxon from the mountain range in any public herbaria.

Considering that Şerbănescu's citation of *G. clusii* in Căliman Mountains [86] is based on the paper of Csűrös [17] (where *G. clusii* was not included), we conclude that it is highly unlikely that Clusius's Gentian occurs in this mountain range.

1.8. **Munţii Ceahlău** (Ceahlău Mts, Eastern Carpathians)

Ceahlău Mountains represent maybe the region most intensively investigated by botanists, considering the whole range of the Eastern Carpathians. The first mention of *G. clusii* in this massif dates back to the beginning of the 20th century, when Grecescu [37] cited the species from the upper part of Ceahlău, but without any exact locality. Interestingly, he mentioned both species in the same place: *G. clusii* and *G. acaulis*. More curiously there is also a note, which explains the morphological difference between the two taxa.

Mititelu [48] and Chifu *et al.* [11] mentioned the presence of Clusius's Gentian in this mountain range, but also without any clear locality.

The presence of *G. clusii* in this mountain group was never confirmed through herbarium material. We could not find any herbarium specimen of Clusius's Gentian from the Ceahlău Mountains. Moreover, we could not find *G. clusii* in this mountain range during the field surveys (A. Bartók, pers. obs. 2003–2007, 2009, 2015; Hurdu, pers. obs. 2009). We believe that Koch's Gentian was mistaken for Clusius's Gentian since this species is frequently encountered in subalpine and alpine parts of the Ceahlău Mountains.

1.9. **Munţii Hăşmaş** (Hăşmaş Mts, Eastern Carpathians)

This mountain range has been thoroughly investigated from a botanical perspective, but there is no reference related to Clusius's Gentian in this mountain unit. Neither Soó [80, 81], nor Nechita [53] mentioned *G. clusii* from this mountain range.

Two herbarium specimens were found in the herbaria investigated, with the vouchers' labels: "*Gentiana clusii*, Transsilvania, Csíki-havasok, Nagyhagymás, leg. G. Lengyel, 12 Jul 1911" and "*Gentiana clusii*, Transsilvania, Csíki-havasok, m. Öcsém, leg. G. Lengyel, 10 Jul

1911". Nevertheless, the herbarium specimens collected by Lengyel do not represent *G. clusii*, but *G. acaulis*.

Nor could we find Clusius's Gentian in any part of this mountain range that was covered by field surveys (A. Bartók, pers. obs. 2004–2009, 2011, 2013–2015; Hurdu, pers. obs. 2009).

Similar to other mountain ranges from the Eastern Carpathians, we assume that *Gentiana clusii* does not occur in this mountain group.

1.10. **Munţii Postăvaru** (Postăvaru Mts, Southern Carpathians)

Postăvaru Mts. represents one of the most intensively investigated mountain units, considering the whole range of the Southern Carpathians, but *G. clusii* was not mentioned in any subsequent monographs regarding the flora of this area (Römer [70], Fink [33, 34]).

Two herbarium specimens were found in the herbaria consulted. The first is in BP (no. 307666), with this information on the voucher's label: "*Gentiana clusii*, Transsilvania, in prate pojana supra oppidum Brassó, leg. E. Radó, 1 May 1906". The herbarium material collected by Radó does not represent *G. clusii*, but *G. acaulis*. The second specimen we found in BP (no. 133358), labelled: "*Gentiana clusii*, Brassó vidéke, Schüler-havas, leg. I. Györffy, 30 May 1900". The aspect of the basal leaves indicates *G. acaulis*, but not *G. clusii*.

Also, we could not find *G. clusii* in this mountain group during our field trips (A. Bartók, pers. obs. 2004–2008, 2011–2015; Hurdu, pers. obs. 2009, 2013). We believe that it was confused with *G. acaulis*, since this species is sporadically encountered in this region.

1.11. **Munţii Bucegi** (Bucegi Mts, Southern Carpathians)

In the botanical literature there is no reference related to Clusius's Gentian from this mountain range. A single herbarium specimen was found in IAGB (no. 2324), with the voucher label: "*Gentiana clusii*, Munţii Bucegi, near Vârful cu Dor, leg. & det. C. Papp, 25 Jun 1956". The herbarium material collected by Papp does not represent *Gentiana clusii*, but *G. acaulis*.

We could not find Clusius's Gentian in any part of this mountain range during the field research (A. Bartók, pers. obs. 2003-2015, Hurdu, pers. obs. 2009, 2013).

Similar to other mountain ranges in the Eastern or Southern Carpathians, presumably Clusius's Gentian is not present in this massif.

1.12. **Munţii Piatra Craiului** (Piatra Craiului Mts, Southern Carpathians)

Piatra Craiului (Királykő, Königstein, King's Rock) is a 20-km long compact ridge made of calcareous rock, with a maximum altitude of 2238 m (Piscul Baciului peak). This mountain range is renowned among others for its endemic species *Dianthus callizonus* Schott & Kotschy.

G. clusii was mentioned in the flora of Piatra Craiului by Halda [38] and Sanda *et al*. [72]. Halda cited the presence of Clusius's Gentian without clear indication of its locality. He mentioned only "in lower rocky parts of the mountain". Sanda noticed the species near Piatra Craiului Mică above Gura Râului chalet, in one relevé, in the association *Nardetum alpigenum - austro carpaticum* Borza 1959.

Beldie [5] or Mihăilescu [46] in their floristic monographs did not report *G. clusii* from any area of this mountain range. However Mihăilescu included Clusius's Gentian on the list of protected plant species of the Piatra Craiului Massif [47].

Two herbarium materials were found in the Romanian herbaria. The first is in BVS (no. 20484), with this information on the voucher's label: "*Gentiana clusii* f. *albiflora*, Piatra Craiului, Padina Popii valley, leg. O. Tontsch, det. I. Morariu, 7 May 1959". The herbarium material collected by Tontsch is a form of *Gentiana acaulis* with white flowers, but not *G. clusii*.

The second specimen we found in BUCA (no. 141346), with the voucher's label: "*Gentiana clusii*, Piatra Craiului, mountain meadows, towards Zărneşti, leg. O. Popescu & V. Sanda, 5 Jun 1976". The herbarium material is not complete, basal leaves are totally missing, and the plant is relatively damaged, but the aspect of the calyx-teeth indicates *G. acaulis* rather than *G. clusii*.

Also, Clusius's Gentian could not be found in this mountain group during our field surveys (A. Bartók, pers. obs. 2003–2005, 2007, 2008, 2013–2015; Hurdu, pers. obs. 2008, 2009, 2013, 2014). We assume that previous mentions of the species were based on confusion with *G. acaulis*, since this species occurs sporadically in Piatra Craiului.

1.13. **Munţii Iezer-Păpuşa** (Iezer-Păpuşa Mts, Southern Carpathians)

Clusius's Gentian was first listed from these mountains by Ţopa [93] on Păpuşa and Oticu Mt., but it was not confirmed through any herbarium specimen. Later Alexiu [1, 2, 3] mentioned *G. clusii* from Păpuşa and Oticu Mt., based on old literature data, but not on field research.

We could not find any proof of this species' existence in the massif, neither in the herbarium collections, nor during the field surveys (A. Bartók, pers. obs. 2003–2005, 2008, 2010, 2013, 2014; Hurdu, pers. obs. 2009). Similar to other areas from the Eastern or Southern Carpathians, it is very unlikely that the plant occurs in the Iezer-Păpuşa Mts.

1.14. **Munţii Făgăraş** (Făgăraş Mts, Southern Carpathians)

As in Iezer-Păpuşa Mountains, *Gentiana clusii* was first reported in this mountain range by Ţopa [92] from Negoiu and Podeanu Mts. Alexiu [1, 2, 3] mentioned the species from Negoiu and Podeanu Mt., but without actual field data.

Neither Buia & Todor [9, 10] nor Stancu [83] mentioned Clusius's Gentian from the dolomite-covered areas of this mountain range (e.g. Râiosu and Buda Mt.), where the species could find a more typical habitat. Moreover, during our field surveys we found specimens resembling the variety described by Morariu from the Rarău Mts, growing on limestone (Piatra Caprei limestone cliffs, Sâmbăta Valley, *c*. 1800 m. alt), but which without any doubt belonged to *G. acaulis* (Hurdu, 2014, 2015), vouchers being deposited also in the CL herbarium. This is an interesting situation, as both specimens (Rarău and Făgăraş) occur in a different habitat than that known for *G. acaulis*, but retain its typical morphological characters.

We could not trace any herbarium specimen from the Făgăraş Mountains in all the herbaria investigated. Moreover we could not find *G. clusii* in this mountain group during our field surveys (A. Bartók, pers. obs. 2003–2006, 2008, 2009, 2011, 2013–2015; Hurdu, pers. obs. 2009, 2010, 2013, 2014). Thus we assume that Clusius's Gentian was erroneously reported from the Făgăraş Mts., without any strong support from existing data.

1.15. **Munţii Cindrel** (Cindrel Mts, Southern Carpathians)

G. clusii was mentioned once in the flora of the Cindrel Mountains by Machner from Ardeiu Mt. In his botanical monograph of Sibiu County, Drăgulescu stated that the species is reported erroneously from this mountain range, based on a misidentification of *G. acaulis* [32].

There are no herbarium specimens from the Cindrel Mountains in any of the herbaria verified. Similar to other parts in the Eastern or Southern Carpathians, it is very likely that the plant does not grow in that massif.

1.16. **Munţii Parâng** (Parâng Mts, Southern Carpathians)

Ploaie (2006) recorded for the first time [60] *G. clusii* from Parâng Mountains, but without any exact locality. Moreover, Clusius's Gentian is listed in the most recent Management

Plan of Parâng Sit Natura 2000 [96], but still without any exact data. Pócs [64] didn't mention *G. clusii* from this mountain range.

A single herbarium specimen was found in BP (no. 133359), with the voucher's label: "*Gentiana clusii*, Páreng havasok, Parengul oldala, leg. S. Jávorka". The herbarium material collected by Jávorka does not represent *Gentiana clusii*, but *G. acaulis*.

Nor could we find *G. clusii* in this mountain range during our field surveys (A. Bartók, pers. obs. 2003, 2004, 2007, 2008, 2012–2015; Hurdu, pers. obs. 2014). Therefore, the occurrence of Clusius's Gentian in Parâng Mountains cannot be proven through firm data.

1.17. **Munţii Retezat** (Retezat Mts, Southern Carpathians)

This mountain range is well-studied from a botanical point of view, but no botanist has cited this species from the Retezat Mountains (e.g. Csűrös [21]; Nyárády [54]; Csűrös [25]).

A single herbarium specimen was found in BP (no. 133359), with the voucher's label: "*Gentiana clusii*, Retyezát hegység, "Pelaga" Havas (Peleaga Mts.), leg. I. Győrffy, 26 Jun 1901". Nevertheless, the material collected by Győrffy is not *Gentiana clusii*, but *G. acaulis*.

Nor could we find Clusius's Gentian in the field, in any of the surveyed areas of this mountain range (A. Bartók, pers. obs. 2004–2007, 2009–2015; Hurdu, pers. obs. 2006–2008, 2011, 2013). Similar to other parts of the Southern Carpathians, it is very likely that the plant does not grow in this massif.

1.18. **Munţii Trascău** (Trascău Mts, Apuseni Mountains)

Oprea [57] erroneously mentioned Clusius's Gentian from this mountain group from the Turului Gorges. In Csűrös-Káptalan's paper [16] regarding vegetation aspects of the Turului Gorges, the author highlighted that in the *Seslerietum rigidae praebiharicum* sub-association some montane-subalpine species (e.g. *Gentiana clusii*) are missing from the studied area, species that occur in a similar coenotic context in other limestone areas throughout Apuseni Mountains.

We could not find any herbarium specimen of Clusius's Gentian from this area. Therefore, the occurrence of Clusius's Gentian in the Trascău Mountains remains unsupported by currently known data.

1.19. **Munţii Gilău-Muntele Mare** (Gilău-Muntele Mare Mts, Apuseni Mountains)

Undoubtedly, Scăriţa-Belioara Mt. is one of the most botanically interesting areas of the Apuseni Mountains, representing a famous refugium for different types of relics. The flora and vegetation of this area was studied by many botanists, including: Freyn, Simkovics (Simonkai), Wolff, Borbás, Borza, Csűrös and Pop. These limestone cliffs harbour a great variety of geo-elements, species of different temporal and geographical origin often coexisting within the same community [8]. The geo-botanical reserve of Şesul Craiului – Scăriţa-Belioara, situated at a relatively low altitude (*c.* 1350 m) preserves numerous Carpathian endemic elements, glacial relicts, thermophilous sub-Mediterranean or threatened plant species: *Aquilegia nigricans* Baumg. subsp. *Subscaposa* (Borbás) Soó, *Sorbus dacica* Borbás, *Astragalus roemeri* Simonk., *Arctostaphylos uva-ursi* (L.) Spreng., *Dryas octopetala* L., *Saponaria bellidifolia* Sm., *Gentiana clusii* E. M. Perrier & Songeon, *Alyssum montanum* L., etc. [29, 4].

Clusius's Gentian was mentioned several times in the botanical literature from this area: Simkovics [77], Csűrös [19, 22], Csűrös & Spîrchez [27], Pop & al. [62], Csűrös & Pop [26], Csűrös & Csűrös-Káptalan [23, 24]. Floristic or phytosociological studies repeatedly reported the presence of this Alpine-Carpathian element in the following locations: Scăriţa-Belioara plateau, Runcului Gorges, Şesul Craiului, "La Comandă", Vulturese and Pinet peak.

The occurrence of *G. clusii* in the Gilău-Muntele Mare Mts. is also well-documented in the herbarium collections of CL, BP, BUC, BUCA, I, SIB or BVS and thus we can clearly state that this is one of the few certain occurrences of *Gentiana clusii* in the Romanian Carpathians.

1.20. **Munţii Vlădeasa** (Vlădeasa Mts, Apuseni Mountains)

Considering the whole range of Vlădeasa Mountains, Pietrele Albe (White Stones) stand out as a limestone island, this being the place where *Gentiana clusii* was cited by Ghişa & Resmeriţă [36].

In 1963 Csűrös published a paper [20] concerning geo-botanical aspects from Pietrele Albe, with the proposal of a new sub-association named *"Seslerietum rigidae biharicum*" which included subalpine-alpine elements, such as *Carex rupestris* All., *Gentiana clusii* E.M. Perrier & Songeon, *Saxifraga adscendens* L., *Campanula kladniana* (Schur) Witasek, *Carex sempervirens* Vill., *Kernera saxatilis* (L.) Rchb. and *Euphrasia salisburgensis* Funck.

The distribution of *G. clusii* in the Vlădeasa Mts. is also well-documented in the CL herbarium, certifying this species' presence in the area.

1.21. **Munţii Bihor** (Bihor Mts, Apuseni Mountains)

G. clusii was mentioned in the flora of this mountain unit by Kerner [43], Simonkai [78], Jávorka [42], Pop & Hodişan [63] and Togor & Burescu [89] from three localities: Piatra Boghii, Piatra Muncelului (Pietrele Negre) and the Ordâncuşei Gorges.

It is worth mentioning that Clusius's Gentian was first mentioned for the Romanian Carpathians by Kerner [43], when he described it as a new species (*Gentiana firma* A.Kern, syn. *G. acaulis* ß Linné) growing on the limestone cliffs of Pietrele Bogii and Piatra Muncelului. Later, *G. firma* would be subsumed within with *G. clusii* E. M. Perrier & Songeon.

In the Ordâncuşii Gorges, Clusius's Gentian was published for the first time by Simkovics [77], later by Pop & Hodişan [63]. A recent study by Togor & Burescu [89], concerning also the vegetation from Pietrele Negre, mentioned *G. clusii* in a relevé belonging to the association *Taxo-Fagetum* Etter 1947.

Most recent research of Hurdu *et al.* (*pers.com.*) reconfirms Clusius's Gentian presence in the area of Piatra Muncelului (Pietrele Negre) (Fig. 1). The collected specimens were deposited in the „A. Borza" Botanical Garden Herbarium, Cluj-Napoca (CL no. 665397). Thus, we can state that *Gentiana clusii* is certainly distributed in the Bihor Mountains.

Based on the present study, which includes our field research, the analysis of regional herbarium collections and literature data, we can state that *Gentiana clusii* E. M. Perrier & Songeon occurs in the Romanian Carpathians only in the Apuseni Mountains. (Fig. 2).

Nevertheless, we have to make an observation on the known ecological vicariance that was described between these two species. Several herbarium specimens, as well as the individuals found by us in the limestone cliffs from Piatra Caprei (Făgăraș Mountains, Southern Carpathians) hold most of the morphological characteristics of *Gentiana acaulis* (shape of the calyx lobes, shape of the leaves). On the other hand, we observed that these specimens had different traits compared to both species types: a single flower that had a long stem and at least one pair of stem leaves. It was probably based on these same considerations that Morariu named the specimens from Rarău as var. *tenella* nova var. Further studies involving molecular profiles of the populations would be required to elucidate this morphological and ecological inconsistency.



Fig. 1: Habit of *Gentiana clusii*, growing on limestone rocks, Piatra Muncelului (Pietrele Negre)
(photo: B.-I. Hurdu & P. M. Szatmari, 13 May 2015)

The validated *Gentiana clusii* specimens included in this study are listed in Appendix 1.

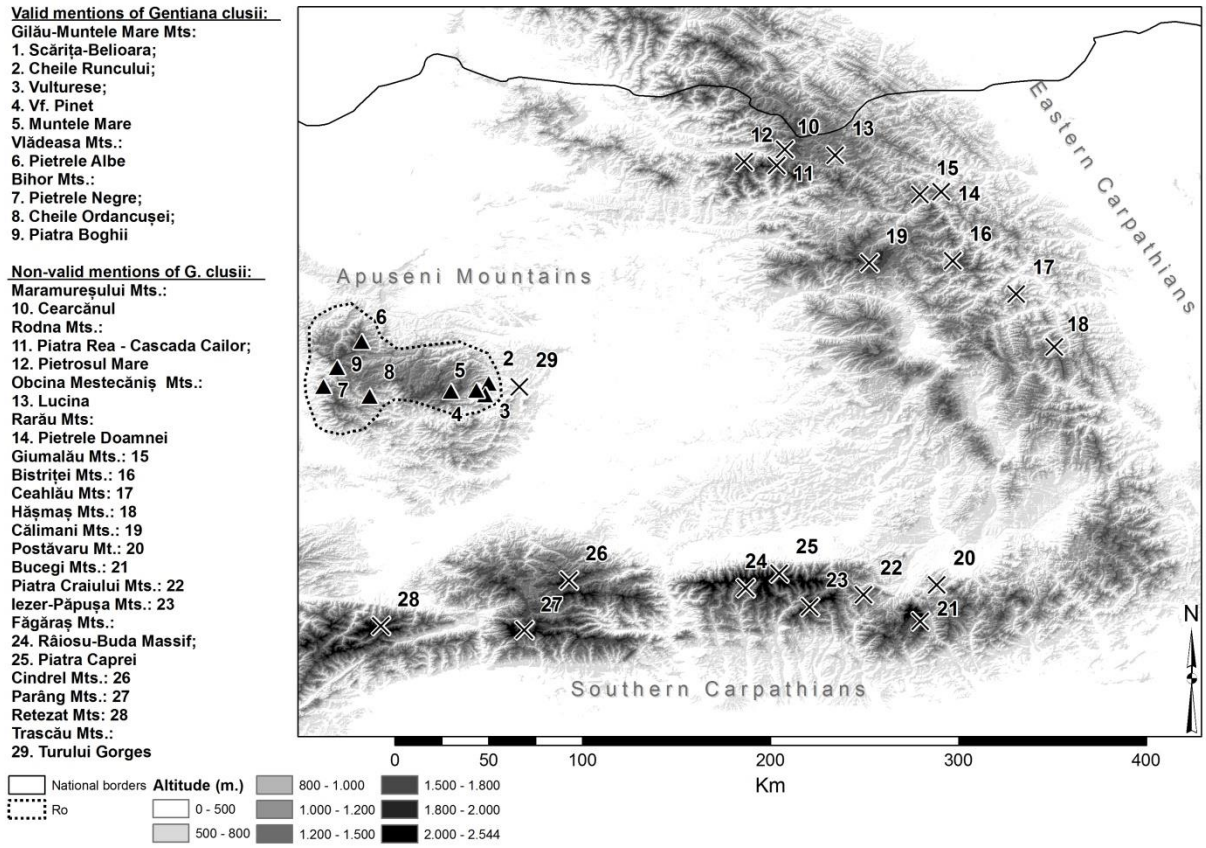


Fig. 2: Distribution of valid (▲) and non-valid (X) mentions of *Gentiana clusii* in the Romanian Carpathians

2. General distribution of *Gentiana clusii* in the Carpathian Mountain Range

An interesting aspect can be observed also in the general distribution of the species. The occurrences of *Gentiana clusii* in the Carpathian Mountains belong to the eastern part of its areal

(Fig. 3). In the Western Carpathians it is distributed in relation to the presence of limestone-covered areas, with only one occurrence in the Polish High Tatras [85], whereas in Slovakia it is found more frequently [7]. With regard to the South-Eastern Carpathians (including the Apuseni Mountains), it's non-occurrence in Ukraine was confirmed by a recent study that included analysis of all the herbarium specimens deposited in the herbarium collections from Ukraine (CAI, CHER, CSAU, CWU, DNZ, KRA, KRAM, KW, LE, LW, LWKS, LWS, MELIT, MSUD, PHEO, UU, YALT) [80]. The absence of this species from the mountains of the Balkan Peninsula, apart from the Dinaric Alps (Croatia [84]) emphasizes the populations from the Apuseni Mountains as being a marginal, isolated presence of the species, one that raises questions on its potential migration routes and post-glacial history.

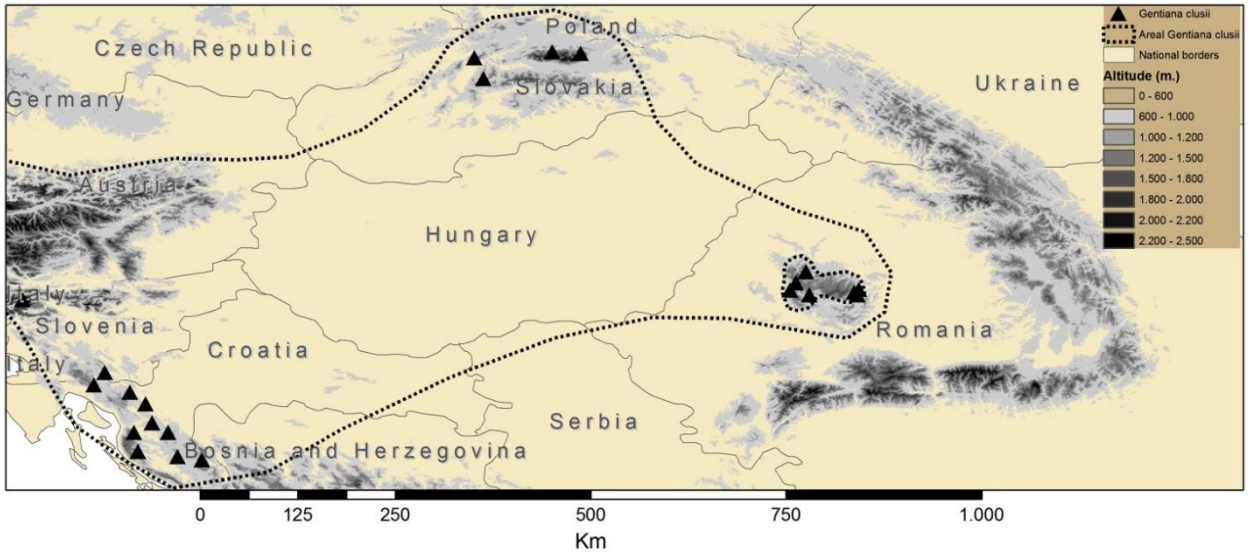


Fig. 3: *Gentiana clusii* at the eastern margin of its distribution

3. Habitat description in the Romanian Carpathians

In the Romanian botanical literature, *G. clusii* is ascribed to *Elyno-Seslerietea*, *Seslerion rigidae, Caricion davallianae* or *Molinion* syntaxa [73].

Over time, *G. clusii* was included in several different coenotaxa (associations or sub-associations) (Table 2).

During our field surveys, we recently identified *G. clusii* in the Apuseni Natural Park near Arieşeni locality, on Piatra Muncelului (Pietrele Negre) limestone cliffs, reconfirming its mention in previous studies [43, 89]. Here it grows in communities on abrupt limestone rocks and rocky meadows, of east and north-east aspect, at an altitude of *c.* 1200 m. In the investigated phytocoenosis (ass. *Asperulo capitatae-Seslerietum rigidae* (Zólyomi 1939) Coldea 1991), *Sesleria rigida* Heuff. ex Rchb. was the dominant species, followed by *Asperula capitata* Kit. ex Schult., *Campanula kladniana* (Schur) Witasek and *Phyteuma orbiculare* L.

Other species occuring in the phytocoenosis are: *Sorbus graeca* (Spach) Kotschy, *Gentiana clusii*, *Silene nutans* L. subsp. *Dubia* (Herbich) Zapał., *Thymus bihoriensis* Jalas, *Erysimum odoratum* Ehrh., *Helictotrichon decorum* (Janka) Henrard, *Laserpitium latifolium* L., *Galium album* Mill., *Seseli libanotis* (L.) W.D.J.Koch, *Epipactis atrorubens* (Hoffm.) Besser, *Hieracium pilosum* Schleich. ex Froel., *Veronica urticifolia* Jacq., *Carex digitata* L., *Teucrium*

montanum L., *Campanula persicifolia* L., *Helianthemum nummularium* (L.) Mill. subsp. *Obscurum* (Čelak.) Holub and *Dianthus carthusianorum* L.

Table 2: Associations (sub-associations) in which *Gentiana clusii* was mentioned

Associations (sub-associations)	Mountains	Locations	References
Seslerietum rigidae praebiharicum Zólyomi 1939	Gilău-Muntele Mare	Scăriţa-Belioara	Csűrös, 1958 [19]
Pinetum sylvestris seslerietosum Csűrös & Spîrchez 1963	Gilău-Muntele Mare	Şesul Craiului	Csűrös & Spîrchez, 1963 [27]
Molinietum coeruleae calcicolum Pop *et al.* 1964	Gilău-Muntele Mare	Runc Gorges	Pop & al., 1964 [62]
Seslerietum rigidae biharicum Csűrös 1963	Vlădeasa	Pietrele Albe	Csűrös, 1963 [20]
	Bihor	Ordâncuşii Gorges	Pop & Hodişan, 1967 [63]
Nardetum alpigenum - austro carpaticum Borza 1959	Piatra Craiului	Piatra Craiului Mică	Sanda *et al.*, 1977 [72]
Alysso repentis- Seslerietum rigidae Csűrös *et al.* 1988	Gilău-Muntele Mare	"La Comandă"	Csűrös & Csűrös-Káptalan, 1997 [23]
Asperulo capitatae - Seslerietum rigidae alyssetosum repentis (Csűrös *et al.* 1988) Coldea 1991	Gilău-Muntele Mare	Scăriţa-Belioara	Coldea, 1997 [14]
Seslerio rigidae - Pinetum sylvestris (Csűrös & Spîrchez, 1963) Csűrös *et al.* 1968	Gilău-Muntele Mare	"La Comandă"	Csűrös & Csűrös-Káptalan, 1997 [23]
	Gilău-Muntele Mare	Scăriţa-Belioara	Csűrös & Csűrös-Káptalan, 1999 [24]
Thymo comosi - Caricetum humilis Morariu & Danciu 1974	Gilău-Muntele Mare	Scăriţa-Belioara	Csergő, 2009 [15]
Asperulo capitatae - Seslerietum rigidae (Zólyomi 1939) Coldea 1991	Gilău-Muntele Mare	Scăriţa-Belioara	Csergő, 2009 [15]
Taxo - Fagetum Etter 1947	Bihor	Pietrele Negre	Togor & Burescu, 2012 [89]

Notable in the phytocoenoses investigated is the presence of *Carex brachystachys* Schrank, a threatened species in the Romanian Carpathians, included in the Romanian Red Book of Vascular Plants. A similar coenotic structure, which includes also *Carex brachystachys* together with *Gentiana clusii*, was found by Pop & Hodișan, 1967 [63] on the limestone cliffs of the Ordâncușei Gorges (Bihor Mts.).

4. Recommended IUCN threat category

Only seven populations of *Gentiana clusii* are known with certainty from the Romanian Carpathians, in limited areas of the Gilău-Muntele Mare (Şesul Craiului – Scăriţa-Belioara, Runcului Gorges and Muntele Mare), Vlădeasa (Pietrele Albe) and Bihor Mountains (Piatra Boghii, Ordâncușii Gorges and Piatra Muncelului). The locations where the species occurs is included in the Şesul Craiului – Scăriţa-Belioara Natural Reserve and the Apuseni Natural Park.

On the basis of new chorological data and assessment of population condition, we can define Clusius's Gentian as IUCN EN B1bc (i, ii, iii) [95] in the Romanian Carpathians.

We therefore recommend the inclusion of *Gentiana clusii* in the next edition of the Romanian Red Book of Vascular Plants as Endangered (EN).

Conclusions

Gentiana clusii was previously mentioned as sporadically distributed in the Romanian Carpathians, but without precise herbarium data to support this. Through our study, we found

that only herbarium specimens from the Apuseni Mountains corresponded to the morphological description of the species, while the rest of the material labelled as ”*G. clusii*” from other parts of the Romanian Carpathians belonged, in fact, exclusively to *Gentiana acaulis*. Additional to the study of herbarium specimens, a critical analysis of available botanical literature has brought us to the same conclusion: the presence of Clusius's Gentian in all previously mentioned localities in the Romanian Carpathians outside of the Apuseni Mountains cannot be supported by any solid data and, therefore, can be considered to be doubtful. Our study points also to the fact that *G. clusii* should be a more targeted species in conservation strategies, as it is not only rare in our country but also it is present at the eastern limit of its range. With the knowledge that such isolated populations hold valuable genetic information that could reveal strong support for explaining migration routes in the flora of the European Alpine System, we underline the importance of these populations occurring exclusively in the Apuseni Mountains.

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Appendix 1- List of validated *Gentiana clusii* specimens included in the study

- Cottus Torda-Aranyos [Turda-Arieş] (department of): in subalpe Skerisora ad pagum Podság [Poşaga de Sus], 21 Aug 1881, Simonkai (BP)
- Hungariae, Alpes Biharienses, in rupibus calcareis Ordenkusi ad Szkerisora [Scărişoara] et Petra Boghi ad Petrosz [Pietroasa], 28 Jul-3 Aug 1882, Simonkai (BP)
- Siebenbürgen, Scarisoara bei Posaga, kalkfelsen, 1380 m, 6 Aug 1915, Pax (BP)
- Torda-Aranyos [Turda-Arieş] (department of): in graminosis subalpinis montis Skerice, 16 Jun 1917, Győrffy & Péterfi (CL)
- Transsilvania, Turda-Arieş (department of): in pascuis subalpinis lapidosis "Șesul Craiului" montis Belioarae ad pagum Poşaga de Sus, solo calcareo, alt. 1250 m s.m., 6 May 1920, Borza (FRE no. 66: CL, SIB, BUC, BUCA, I, CRAI)
- Transsilvania occ., montes Gyalui havasok, in loc. calcareis montis Öreghavas, alt. 1600-1800 m, 8 May 1948, Szabó, det. Pócs (BP)
- Transsilvania, Alba (department of): in cacumine montis Scărița ad pagum Poşaga, alt. cca. 1300 m s.m., 8 May 1952, Rácz (CL)
- Transsilvania, Cluj (department of): in saxosis calcareis mt. Scărişoara-Belioara, Jun 1958, Raţiu (CL)
- Transsilvania, Cluj (department of): Mt. Scărişoara-Belioara, 11 Jun 1964, Csűrös (CL)
- Transsilvania, Alba (department of): Mt. Scărişoara-Belioara, prin pajişti, 16 Jul 1965, Hodişan (CL)
- Transsilvania, Alba (department of): Mt. Scărişoara-Belioara, pe stânci calcaroase, 6 Jun 1969, V. Hodişan (CL)
- Transsilvania, Alba (department of): Ocoliş, pe stâncile mai puţin abrupte de pe Vârful Pinet, 6 Jun 1969, V. Hodişan (CL)
- Munţii Gilăului la Scărişoara-Belioara, 30 Jul 1971, Morariu & Danciu (BVS)
- Transsilvania, Cluj (department of): in saxosis calcareis Scărița-Belioara, alt. cca. 1200 m s.m., 3 Jun 1974, Cristea (CL)
- Transsilvania, Alba (department of): in reserv. bot. Mt. Scărişoara-Belioara, solo calcareo, 21 Jun 1988, Groza (CL)

- Muntele Şesul Craiului, Scărița-Belioara, in Piceetum, 46°30'..N; 23°02'.E, 7 Jul 1993, Negrean (CL)
- Transsilvania, Alba (department of): Scărița-Belioara, calcare, pajişti, cca. 1250 m s.m., 28 May 1994, Groza (CL)
- Rezervaţia Şesul Craiului, Poşaga de Sus, 21 Jun 2003, Ularu & Gurean (BVS)
- Vulturese, Munţii Gilău-Muntele Mare, alt. aprox. 1200 m s.m., exp. S, stâncării calcaroase, 28 Jun 2004, Csergő (CL)
- Alba (department of): Montibus Gilău-Muntele Mare, in rupibus calcareis apertis et in pinetis montis "Muntele Belioara" loco "Scărița" dicto ad pagum Poşaga de Sus, 14 Jun 2013, Bartók, S. Bartók, Bartha (pers. herbarium A. Bartók).
- Vlădeasa, Pietrele Albe, la capătul nordic, pe calcare, 46.741093°; 22.80367°, alt. 1485 m, 25 May 2014, Turtureanu (CL)
- Munţii Bihor, Pietrele Negre (Piatra Muncelului): stâncării calcaroase semiumbrite, versant estic, N46.5179; E22.63133, alt. 1185 m, exp. E-NE, 19 Jun 2014, Hurdu, Ursu & Coldea (CL)
- Munţii Bihor, Pietrele Negre (Piatra Muncelului): stâncării calcaroase semiumbrite, versant estic, N46.5179; E22.63133, alt. 1185 m, exp. E-NE, 13 May 2015, Hurdu & Szatmari (CL)

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COROLOGIA SPECIEI PERICLITATE *GENTIANA CLUSII* E. M. PERRIER & SONGEON ÎN CARPAŢII ROMÂNEŞTI - STUDIU CRITIC

(Rezumat)

Studiul nostru propune o analiză critică a distribuţiei speciei rare *Gentiana clusii* in Carpaţii României.

În literatura botanică românească *G. clusii* este menţionată ca fiind sporadică, însă nu au fost găsite exemplare de herbar colectate din afara ariei Munţilor Apuseni în vederea susţinerii acestui argument.

O analiză critică a literaturii botanice disponibile ne conduce la aceeaşi concluzie: toate localităţile menţionate în Carpaţii Româneşti (în afară de Munţii Apuseni) nu sunt susţinute prin date concrete şi prin urmare prezenţa speciei *G. clusii* în aceste localităţi se consideră îndoielnică.

Se reconfirmă prezenţa *G. clusii* în Munţii Bihor, Piatra Muncelului (Pietrele Negre), respectiv se descrie mediul fitocenotic în care creşte această specie.

Autorii propun includerea speciei *G. clusii* în viitoarea ediţie a Cărţii Roşii a Plantelor Vasculare din România, cu statutul sozologic "Periclitat" (EN).

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