

# Conservation status of some rare plant species on the watershed of the middle section of river Devoll (South Central Albania) and their distribution in Albania

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**Abstract.** In this study, the conservation status was estimated for six important rare and endemic plant taxa from the watershed of the middle section of river Devoll. It was assessed by the Geospatial Conservation Assessment Tool (GeoCAT). The GeoCAT method is a standardized method for determination of the conservation status of the Red List species. As a result, *Bubon albanicum* and *Echium maculatum* were estimated for the first time as Endangered, while *Bornmuellera baldaccii* subsp. *baldaccii* and subsp. *rechingeri*, respectively, were estimated as Endangered and Critically Endangered. The conservation status of Endangered was confirmed for *Campanula hawkinsiana*, while *Festucopsis serpentini* and *Cistus sintenisii* were proposed to be included in the IUCN Red List of species as Vulnerable and Endangered, respectively. Comments on the species distribution were also included.

**Key words:** Albania, GeoCAT, river Devoll, watershed

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## Introduction

The geographical position, relief, geological composition and climatic condition of Albania have created different habitats and ecological niches with appropriate conditions for a large variety of plants. Floristic studies have shown that Albanian flora comprises about 3629 species belonging to 960 genera and 175 families (Meço & Mullaj 2015), thus constituting nearly 30% of the European flora. The *Excursion Flora of Albania* (Vangjeli 2015), which covers also the cultivated plants of the country, lists 4560 taxa. Of these, 25 species and about 150 subspecies are endemic to Albania. About 160 other plant taxa share the distribution area between

Albania and the neighboring countries, such as Greece, Macedonia, Kosovo, and Montenegro, and are considered subendemic taxa (Paparisto & al. 1988).

The watershed of the middle section of river Devoll is located in the South Central Albania and has characteristically diverse climate and geological conditions. The main characteristics of the climate are dry summers and wet winters. The average annual temperatures vary from 7.5°C upstream of the river to 14.7°C downstream. Geological composition is dominated by flysch, a string of sedimentary rocks, and ophiolite, mostly of different magmatic rock types, while soils vary from shallow soils with low calcium content (in the upper part of the basin), to deep soils with higher

content of calcium in the lower parts and alluvial deposits, where intensive agriculture is practiced (Kabo 1990, 1991; Norconsult 2010).

Dominance of the serpentine substrate is a particularly important factor in the formation of highly diverse and unique flora in the study area. The area of the watershed of the middle section of river Devoll is about 6500 km<sup>2</sup> (5 % of total area of the Albanian territory), but it hosts about 700 plant taxa which represent 19.3% of the Albanian flora. Eighteen habitat types are also identified and classified according to the Habitats Directive (Council Directive 92/43/EEC, 1992) and EUNIS habitat classification, 2007. The first floristic studies in this area have been undertaken by foreign botanists like Markgraf in 1924, and subsequently by Meyer in 1959–1961 (TIR database). There are very few phytogeographical studies undertaken only within the framework of different projects, but still many data remain unpublished.

In general, the conservation of rare species and their habitats in Albania is focused mainly on the high mountains and little attention is paid to the areas at low altitudes (between *ca* 100 m and 1500 m), even though they host a high number of important plant taxa of Albania threatened to a various degree by the human impact. The *Albanian Red List*, approved by the Council of Ministers in 2013, lists 368 taxa of vascular plants which represent about 10.1 % of the entire Albanian flora. However, the conservation status of these taxa has been determined by unclear and indistinct methodology. Thus, in addition to reporting for the first time six important taxa (endemic, sub-endemic and rare) in the watershed of the middle section of river Devoll and their distribution across the Albanian territory (Fig. 1), we have aimed in our study to assess the conservation status of these taxa according to the Geospatial Conservation Assessment Tool (GeoCAT) (Bachman & al. 2011) and suggest the usage of GeoCAT as a standardized method for determination of the conservation status of all species already included in the *Albanian Red List*, or to be included in the future.

## Material and methods

The study of rare and endemic species in the watershed of the middle section of river Devoll, their conservation status and distribution, was carried out

during the period 2015-2016. Conservation status of the plant taxa was determined by the Geospatial Conservation Assessment Tool (GeoCAT). This version of GeoCAT automatically generates a conservation assessment based solely on EOO (Extent of Occurrence) and AOO (Area of Occupancy) values. These metrics contribute to the IUCN Red List of categories and criteria, as a tool that deals with the geospatial aspect of Red Listing. Thus, all data taken from TIR and from the already published literature about distribution of the six analyzed species in Albania, as well as their new location recorded in the watershed of the middle section of river Devoll (Table 1), were used as inputs for calculation in GeoCAT.

Usage of GeoCAT can quickly and easily combine data from multiple sources, such as GBIF, Flickr, etc. Analysis is visualized providing an indication of the Red List threat rating subject to meeting the full requirements of the criteria. Outputs including the results, data and parameters used for analysis are stored in a GeoCAT file that can be easily reloaded or shared with collaborators (Bachman & al. 2011). The distribution maps are prepared in ArcMap 10.1.

The *Red List of Albanian Vascular Plants* (Decision of Council of Ministers, 2013), IUCN Red List of Threatened Species (IUCN 2016), Bern Convention (Appendix I) (Council of Europe 1979) and Habitats Directive (Annex II, IV) (Council Directive 92/43/EEC, 1992) were checked out for the conservation status of the plant taxa. Data about distribution of the species in Albania are based on the information included in the database of the National Herbarium in Tirana (TIR). This database is in a hard copy format, like a register, in the herbarium of TIR, where all data about the species deposited in the National Herbarium are recorded, namely, collection date, location, collector, substrate, etc., including also data about locations where the species has been observed but was not collected. Data about the nomenclature and area of distribution of the analyzed taxa was consulted with the Euro+Med Plantbase (<http://ww2.bgbm.org/euroPlusMed/query.asp>).

## Results and discussion

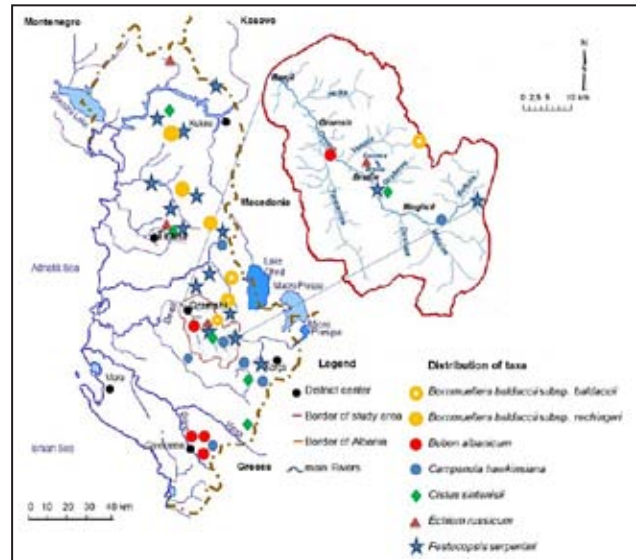
As a result of our study in the watershed of the middle section of river Devoll (South Central Albania), the conservation status was evaluated for the Albanian

**Table 1.** New chorological data of the analyzed taxa from the watershed of the middle section of river Devoll.

No.	Species	New chorological data
1.	<i>Bubon albanicum</i>	SC Albania. Devoll valley: along the stream banks of Skënderbegas village, at 310 m a.s.l., in eroded places, on flysch substrate, 40°47'47" N, 20°14'04" E, 20.03.2016, coll. <i>M. Meço</i> (MM/Gr/2016/00058).
2.	<i>Echium maculatum</i>	SC Albania. Devoll valley, above Bulçar village, at 900 m a.s.l., on serpentine substrate, 40°48'15" N, 20°17'45" E, 20.05.2016, coll. <i>M. Meço &amp; D. Pavlova</i> (MM/Gr/2016/00243; SO 107718).
3.	<i>Bornmuellera baldaccii</i> subsp. <i>baldaccii</i>	SC Albania. Devoll watershed: in the swamps of Grabovë e Sipërme village, on serpentine substrate, 1150 m a.s.l., 40°48'06" N, 20°25'30" E, 18.07.2016, coll. <i>M. Meço</i> (MM/Gr/00347).
4.	<i>Campanula hawkinsiana</i>	SC Albania. Devoll valley: near the bridge of Lozhan village, on serpentine scree, at 652 m a.s.l., 40°42'02" N, 20°30'55" E, 20.10.2015, coll. <i>M. Meço &amp; A. Mullaj</i> (MM/Gr/2015/00052).
5.	<i>Cistus sintenisii</i>	SC Albania. Devoll valley: at Kokël village, at 350 m a.s.l., 40°47'06" N, 20°17'34" E and at the Molla e Grabovës, at 490 m a.s.l., on serpentine substrate, 40°44'59" N, 20°20'11" E, 04.05.2016, coll. <i>M. Meço</i> (MM/Gr/2016/00219).
6.	<i>Festucopsis serpentini</i>	SC Albania. Devoll valley: Molla e Grabovës, on serpentine rocks, at 380 m a.s.l., 40°45'02" N, 20°20'07" E, 20.10.2015 coll. <i>M. Meço</i> , (TIR, herb. <i>Meço</i> MM/Gr/2015/00051); near Lozhan, at the bridge of Lozhan village (Korça district), at 690 m a.s.l., along the road from Gramsh to Korçë 40°43'22" N, 20°32'40" E, 16.07.2016 coll. <i>M. Meço</i> (MM/Gr/2016/00206).

endemic species *Festucopsis serpentini*, of four sub-endemic species, namely, *Bubon albanicum*, *Bornmuellera baldaccii*, *Campanula hawkinsiana*, and *Cistus sintenisii*, and of the rare species for Albania, *Echium maculatum*. *Echium maculatum* is included even in the Annexes II and IV of the Habitats Directives and in the IUCN Red List of Europe.

A conservation status of *B. albanicum* and *E. maculatum* was determined for the first time on the basis of GeoCAT, and they were suggested to be included in the *Albanian Red List*. The conservation status of *B. baldaccii* subsp. *baldaccii* and *B. baldaccii* subsp. *rechingeri* was assessed also for the first time. *Bornmuellera baldaccii* subsp. *rechingeri* has been reported so far as a local Greek endemic, but in this study we have observed and confirmed its presence in Albania. Also, we reconfirmed the conservation status for *C. hawkinsiana*, so far defined according to the *Albanian Red List*. After reevaluation of the conservation status of *Festucopsis serpentini* and *Cistus sintenisii* on the basis of distribution of these species, we suggest their inclusion in the IUCN Red List. Distribution of the studied taxa in Albania and in the study area is shown in Fig. 1.

**Fig. 1.** Hydrographic map of Albania (Miho & al. 2013) with the middle section of river Devoll and distribution of all described taxa in Albania and in the study area.

The analyzed plant taxa, accompanied with detailed data about their distribution across Albania, as well as across their area are given below.

## Apiaceae

### *Bubon albanicum* (Alston & Sandwith) Hand

*Bubon albanicum* is a subendemic species with a very limited distribution area. It is not included in the *Albanian Red List*, which features only *Athamanta macedonica* (L.) Spreng as Endangered A1b (with fast decrease > 50 % within 10 years). In the *Flora of Albania* (Qosja & al. 1992) and *Flora Europaea* (Tutin 1968), *B. albanicum* is recorded as *Athamanta macedonica* subsp. *albanica* (Alston & Sandwith) Tutin. On the basis of the fact that *B. albanicum* is accepted as species, with a very limited distribution area, and in line with the results from GeoCAT, with AOO of 16 km<sup>2</sup> and EOO of 357.8 km<sup>2</sup>, we suggest its inclusion in the *Albanian Red List* as Endangered (EN). All data about the distribution of this species in Albania were taken from TIR and from the published literature (Malo & Shuka 2008; Mahmutaj & al. 2015). According to our investigation in the field, the decrease of its population determined by the indicator A1b (more than 50 % for 10 years) is not realistic even for the coming next 10 years. True, its habitat is limited but no great threats exist for the extinction of this taxon so fast.

This species shares a distribution area between Albania and Greece (Strid 1986). The authors of *Flora of*

Albania (Qosja & al. 1992) and *Flora Europaea* (Tutin 1968) reported the distribution of *Athamanta macedonica* subsp. *albanica* in S Albania (near Gjirokastrë) and considered it an endemic of Albania. However, in the *Mountain Flora of Greece* (Strid 1986), *Athamanta albanica* Alston & Sandwith is reported in NW Greece, in Mt. Gramos and Mt. Avgo, as a synonym of *Athamanta macedonica* subsp. *albanica*. Although *Flora of Albania* was published later than *Mountain Flora of Greece*, its authors have based their data only on *Flora Europaea* and have considered *Athamanta macedonica* subsp. *albanica* an endemic taxon. According to Hand (2011), these taxa are synonyms of *Bubon albanicum*, a subendemic species of Albania and Greece.

### Boraginaceae

#### *Echium maculatum* L.

This species is included in the Annexes II and IV of the Habitats Directive and in the IUCN Red List of Europe with a category of Least Concern (LC). In Albania, this is a rare plant but its conservation status has not been assessed yet. On the basis of the locations recorded in the database of the TIR Herbarium, and the new location described in Table 1 resulting from the applied GeoCAT method, with AOO of 12 km<sup>2</sup> and EOO of 1835 km<sup>2</sup>, it seems reasonable to include *E. maculatum* in the *Albanian Red List* as Endangered (EN). This result is supported by the fact that the observed populations of the species were represented by few individuals and sparsely.

This species is distributed in EC & SE Europe and extends northwards to c. 55° N in C Russia (Gibbs 1972). In the *Flora of Albania*, it is mentioned with a very wide distribution, in areas with Mediterranean climate (Qosja & al. 1996). In the database of the National Herbarium (TIR), *E. maculatum* was reported many years ago from Mt. Dajti (Tiranë, C. Albania) by Louis in 1924 and from Bajram Curri (Tropojë, N Albania) by Demiri & Palikuqi in 1960.

The new locality in the watershed of the middle section represents the southernmost point of this species' distribution in Albania and a first record of the species on serpentine substrate (Fig. 1). Further efforts are needed for evaluation of the distribution of *E. maculatum* in Albania and for studying the conditions of its populations. At least some of the species' localities should be included in the natural protected areas.

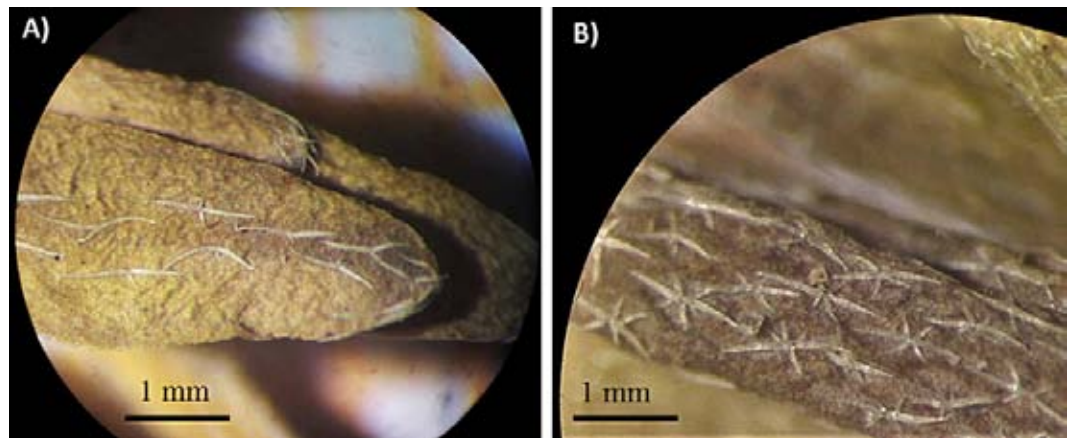
### Brassicaceae

#### *Bornmuellera baldaccii* (Degen) Heywood

According to the *Albanian Red List*, the conservation status of *B. baldaccii* is EN A1b (Endangered, with a fast decrease of population or habitat destruction exceeding 50% within 10 years). According to the IUCN Red List, this species has not been assessed yet. After examination and determination of all specimens in the TIR Herbarium and the new chorological data (Table 1), we have confirmed the distribution of both subspecies *baldaccii* and subsp. *rechingeri* Greuter for the flora of Albania. The conservation status of both subspecies according to the GeoCAT was evaluated. On the basis of the results, with AOO of 24 km<sup>2</sup> and EOO of 1027 km<sup>2</sup>, we suggest the conservation status of Endangered (EN) for *B. baldaccii* subsp. *baldaccii*. On the basis of a value of 4 km<sup>2</sup> for AOO and no value for Extent of Occurrence (EOO), we suggest the inclusion of *B. baldaccii* subsp. *rechingeri*, a new taxon for the Albanian flora, in the *Albanian Red List* as Critically Endangered (CR). According to the *Albanian Red List*, the indicator A1b that accompanies the conservation status EN of the taxon shows a faster decrease of the population and habitat destruction of more than 50% within 10 years. According to our field investigations, this assessment seems unrealistic because of the habitat of this taxon, which lies predominantly in humid mountainous meadows, at altitudes above 1000 m where no such high threats (as determined by the indicator A1b) are present.

Distribution of *B. baldaccii* encompasses NW Greece and Albania (Strid 1986). Strid (1986) clearly divided this species into *B. baldaccii* subsp. *baldaccii* and *B. baldaccii* subsp. *rechingeri* Greuter. The subsp. *baldaccii* differs from subsp. *rechingeri* by the hairs on the leaves, with 3–6-fid and lateral rays, often very short (Fig. 2), and very sparse bifid hairs. Subsp. *rechingeri* has one or two short lateral rays (Strid 1986). This taxon is not included either in *Flora Europaea* (Heywood 1993), or in the relevant volume of the *Albanian Flora* (Paparisto & al. 1988), where the subspecies rank has not been accepted. According to the database of the National Herbarium (TIR), *B. baldaccii* was reported for the first time in Albania by Markgraf in 1924, in Mt. Shebenik (Librazhd district, CE Albania), and subsequently in 1928 in Lura (Dibër district, NE Albania), Mokër and Guri i Topit (Pogradec district, E Albania). Later on, this species was recorded by the Albanian botanists Vangjeli and Xhulaj in 1975 in Lurë (Dibër, NE Albania), by

**Fig. 2.** A) Bifid hairs of *Borrmuelera baldaccii* subsp. *rechingeri* with one or two short lateral rays, and B) Hairs of leaves of *B. baldaccii* subsp. *baldaccii* with 3–6 fid (photos taken with stereomicroscope by M. Meço).



Vangjeli in 1976 in Mt. Valamarë (Pogradec, E Albania) and by Vinjoll (Mat, NC Albania). All these botanists have taken into consideration the determination key of the *Flora of Albania* and *Flora Europaea*, but not of Strid (1986). We have examined all specimens of *B. baldaccii* in the National Herbarium and in a collection of Vangjeli in 1975 from Lura (NE Albania) (TIR 03937) and the result was *B. baldaccii* subsp. *rechingeri* Greuter, a taxon which has been considered a local Greek endemic (Strid 1986; Hartvig 2002). After examination of all specimens in the National Herbarium, we noted that the distribution area of these subspecies was divided as follows: *B. baldaccii* subsp. *baldaccii* was recorded only in Mt. Valamara and around it (SE Albania) (TIR- 03924, 03925, 03926, 03927, 03929, 03930, 03931, 03933, 03934), whereas *B. baldaccii* subsp. *rechingeri* was only in Lurë (Dibër, NE Albania), (Fig. 1). The specimens with the serial numbers TIR- 03928, 03932, 03935, 03936, reflected some different morphological deviations and need further examination to confirm the subspecies rank.

### Campanulaceae

#### *Campanula hawkinsiana* Hausskn. & Heldr.

The conservation status of *C. hawkinsiana* in the *Albanian Red List* is EN A1b (Endangered, with fast decrease of population or habitat destruction exceeding 50 % within 10 years), while for the IUCN Red List this species has not been assessed yet. After GeoCAT calculations, with AOO of 24 km<sup>2</sup> and EOO of 1970 km<sup>2</sup>, we reconfirmed the conservation status for this species as Endangered (EN). However, no great threats exist that could decrease the populations of this species so fast, as according to the indicator A1b. According to GeoCAT calculations of the conservation

status of this species, the distribution data taken from the TIR database were taken into consideration, as well as its new locality in the watershed of the middle section of river Devoll (Table 1).

This species shares a distribution area between Greece and Albania (Fedorov & Kovanda 1976). It is found from the Pindus Mts (Smolika) in Greece, in Poliçan (Gjirokastrë, S Albania), Gjergjevicë (Korçë, SE Albania) and Shebenik (Librazhd, EC Albania), as reported by Shuka & Jahollari (2007). Markgraf recorded it for the first time in Albania in 1928 in Mt. Tomorri (S Albania), on calcareous substrate (data from TIR database), which is interesting because this species normally grows on serpentine substrate. Its location was reconfirmed by Mahmutaj & al. (2014). In July 2015, this species was recorded by Mahmutaj and Meço near Panarit village (SE Albania), in serpentine scree.

### Cistaceae

#### *Cistus sintenisii* Litard.

This is a subendemic species of Albania and Greece. It is included in the *Albanian Red List* with a conservation status of EN B2c (Endangered species, with a presence of less than 5000 km<sup>2</sup>, the decline in size and quality of habitat continues). Even according to GeoCAT, with AOO of 36 km<sup>2</sup> and EOO of 2510 km<sup>2</sup>, we have reconfirmed it as Endangered (EN). After inclusion in the calculations of GeoCAT of the location recorded in Greece and reported by Authier in Vladimirov & Tan (2014), with AOO of 40 km<sup>2</sup> and EOO of 2870 km<sup>2</sup>, we suggest for this species the same status as in the World Conservation Union (IUCN) Red List.

The name applied in the *Flora of Albania* (Paparisto & al. 1988) and *Flora Europaea* (Warburg 1968) for this

species is *C. albanicus* Heywood and it is mentioned as endemic to Albania. In 1987, Authier has recorded it also in NW Greece (Vladimirov & Tan 2014). Greuter (1996) has insisted on maintaining the binomial *C. albanicus*, while on behalf of the Committee for Spermatophyta, Brummitt (1999) recommended the use of *C. sintenisii*. In Albania, this species was recorded at 700 m a.s.l. at Lumbardhë (Pukë, N Albania) by Proko and Vangjeli in 1999, up to 1512 m in Martanesh (Tiranë, C Albania) by Markgraf in 1924, and by Ruci in 1999. In 1958, this species was recorded again by Markgraf in Bjeshkët e Kushnenit (Mirditë, N Albania). Vangjeli has reported it from Ballabanovë and Shelegurë (Korçë, SE Albania) in 1999 (TIR database). A location recorded by Meço in 2016 at 490 m a.s.l. (Table 1) represents the lower limit of the distribution range known for this species in Albania.

## Poaceae

### *Festucopsis serpentini* (C.E. Hubb.) Melderis

This is an endemic serpentine species of Albania included in the *Albanian Red List* (by Decision of the Council of Ministers, 2013), with conservation status of Vulnerable (VU). On the basis of the result taken from GeoCAT, with AOO of 76 km<sup>2</sup> and EOO of 8499 km<sup>2</sup>, the conservation status of this taxon could be Endangered (EN) or Vulnerable (VU). Considering the fact that this species is widespread in the serpentine formations of Albania, we recommend taking into consideration the Extent of Occurrence (EOO) and suggest to include it in the World Conservation Union (IUCN) Red List with a status of Vulnerable (VU).

This endemic species of Albania is widespread on serpentine formations, but these two localities are new records for the area of the Devoll valley. In the TIR database, it was reported from an altitude of 150 m at Shkopet by B. Ruci in 1999, and up to 1930 m at Mt. Allamani by Vangjeli in 1975. *F. serpentini* is a geographical and ecological vicariant of the endemic species *Peridiction sanctum* (Janka) Seberg (*Festucopsis sancta*) distributed in Mt. Slavyanka (Bulgaria) on calcareous terrains.

## Conclusions

In this study, the conservation status of six important taxa of the Albanian genofund was assessed by appli-

cation of GeoCAT: the Albanian endemic *Festucopsis serpentini*, the four subendemics *Bubon albanicum*, *Bornmuellera baldaccii*, *Campanula hawkinsiana*, and *Cistus sintenisii*, and the rare species for Albania *Echium maculatum*. Accordingly, for the first time the conservation status was determined for *Bubon albanicum* (EN), *Bornmuellera baldaccii* subsp. *baldaccii* (EN), *B. baldaccii* subsp. *rechingeri* (CR) and *Echium maculatum* (EN), and it was suggested to include them in the *Albanian Red List*. *B. baldaccii* subsp. *rechingeri* is reported as a new taxon for the Albanian flora in this paper.

The conservation status of Endangered (EN) was confirmed for *Campanula hawkinsiana*. *Cistus sintenisii* and *Festucopsis serpentini* were reassessed as Vulnerable (VU).

On the basis of the field investigations, in most cases the indicator that accompanies the conservation status of the taxon in the *Albanian Red List* does not show the real threats pressure. Most of these indicators are subjective, and the results are not achieved by a comprehensive assessment of the populations, as GeoCAT estimates. Thus, the use of GeoCAT as a standardized method is strongly recommended for updating the *Albanian Red List*, so as to avoid subjectivism in determination of the conservation status.

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