

LOISELEURIA PROCUMBENS (ERICACEAE) IN THE SPANISH PYRENEES

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ABSTRACT

The paper analyses the distribution and occurrence conditions of *Loiseleuria procumbens* in the Spanish Pyrenees. The species represents a typical arctic-alpine element in the flora of Europe. In the Pyrenees it reaches its southernmost European localities. The Pyrenean populations of the species are not numerous in the majority of the localities. *L. procumbens* occurs most frequently in the alpine and subalpine zones, at altitudes between 2100 and 2650 m, with a minimum at 1750 m and a maximum at 2900 m. It has been reported nearly exclusively in the siliceous substrata, and predominantly on the north-facing slopes, on the regosols and/or on flat tops of rocks. It forms its own communities, mostly included into the *Loiseleurio-Vaccinion* alliance, and rarely enters associations of the *Festucion airoidis* and *Rhododendro-Vaccinion* alliances. Its typical community, *Cetrario-Loiseleurietum procumbentis*, is found only in the eastern and central parts of the Spanish Pyrenees.

KEY WORDS: plant geography, chorology, ecology, arctic-alpine plants, phytocoenology.

INTRODUCTION

The Alpine azalea [*Loiseleuria procumbens* (L.) Desv.] is a rare species in Spain, found in the Pyrenees. Its populations in this mountain range are the southernmost in Europe and are isolated from the other parts of the species range (Dupont 1990; Villar and Lazare 1991; Villar 1993). The position and isolation of the Pyrenean populations of *L. procumbens* make them highly vulnerable to unfavourable changes, particularly to global warming (Wada et al. 2002). For that reason the distribution of the species and its occurrence conditions in the Pyrenees are very interesting and should be recognized in detail. The fluctuations of the Alpine azalea altitudinal range could be used as an indicator of climatic changes in this region.

We had an opportunity to observe this interesting species in more than 100 locations in the Pyrenees in 1994-2002. This allowed us to show the actual distribution and ecological conditions of occurrence of *L. procumbens* in the Spanish and Andorran Pyrenees, which is the aim of this paper.

GENERAL DISTRIBUTION

Loiseleuria procumbens has a Holarctic, circumpolar range with a large gap in North-West Asia. The range is di-

vided into several isolated parts (Hultén and Fries 1986). One of them covers Europe (Fig. 1), where the species has an arctic-montane (and ampho-Atlantic) character. Even in northern Europe *L. procumbens* grows mostly in mountainous regions (Hultén 1950, Perring and Walters 1962). In the central part of the continent it occurs only in the highest mountain ranges of the Alps, Carpathians and Pyrenees, where its localities have a relict, postglacial character (Szafer 1949, 1975: 203, Meusel et al. 1978, Hultén and Fries 1986; Ellenberg 1988).

The largest part of the range of *L. procumbens* in Central Europe covers the Alps. The species occurs there at altitudes 1500-3000 m, with a minimum at 900 m in Switzerland and a maximum at 3100 m in France (Hess et al. 1970; Meusel et al. 1978; Welten and Sutter 1982; Haeupler and Schönfelder 1989). In the other mountains of Central Europe, *L. procumbens* does not cover such large areas as in the Alps and its populations are not so numerous (Villar and Lazare 1991; Villar 1993; Boratyński and Didukh 2002). In the Carpathians, populations of Alpine azalea are scattered only in the highest mountain ridges (Fig. 1). The most elevated locations were reported from an altitude of 2100 m (Boratyński and Didukh 2002). In the Pyrenees the species is also strongly dispersed and is the most frequent in the central and eastern parts of the mountains, at elevations of 2100-2650 (2900) m (Villar and Lazare 1991; Villar 1993).

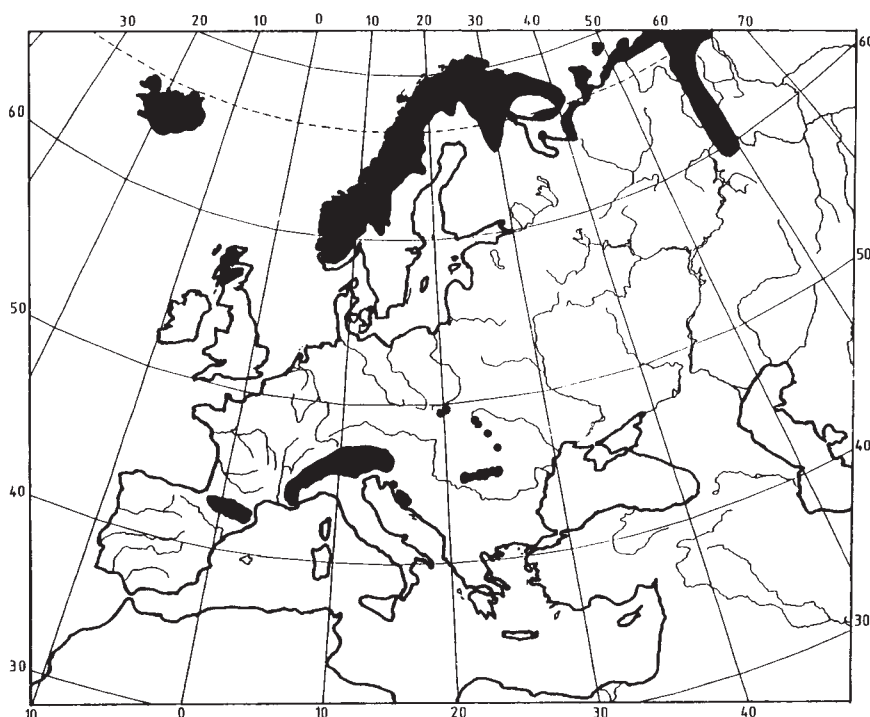


Fig. 1. Range of *Loiseleuria procumbens* in Europe (after Perring and Walters 1962; Hultén 1971; Meusel et al. 1978; Welten and Sutter 1982; Sokolov et al. 1986; Haeupler and Schönenfelder 1989; Dupont 1992; supplemented).

Loiseleuria procumbens in the mountains of Central Europe is a component of high-mountain communities, mostly alpine and sub-alpine ones, as *Cetrario-Loiseleurietum procumbentis* Br.-Bl. 1926, *Cetrarietum curvulae* Kerner 1963 and *Empetro-Vaccinietum* Br.-Bl. 1926 (Braun-Blanquet 1926, 1948; Hess et al. 1970; Villar and Lazare 1991; Boratyński and Didukh 2002).

MATERIAL AND METHODS

Data used in this study come from herbarium labels, literature and author's field investigations. The herbarium materials of ARAN¹, BC, BCC, BCF, G, JACA, KOR, MA, MAF and VIT were reviewed. The data base of phytosociologic surveys (<http://biodiver.bio.ub.es/biocat/homepage.html>) were used as additional source of information. Totally 430 records were analyzed. All data were used to prepare the map of geographical distribution, the profile of altitudinal distribution and analysis of occurrence conditions, such as aspect, soil requirements and phytosociologic role in plant communities. The full list of localities is attached as an appendix at the end of the work.

OCCURRENCE IN THE SPANISH PYRENEES

Loiseleuria procumbens was reported from the Pyrenees in the early 19th century by Lapeyrouse (1813), who described the first localities of the species in the French and Spanish parts of the mountains. Afterwards, in the 19th century, it was reported several times, mostly from the Ea-

stern and Central Pyrenees (Zetterstedt 1857; Costa 1877, Willkomm and Lange 1870; Willkomm 1893; Gauthier 1898; Bubani 1900; Soulié 1907-1914; Llenas 1912; Coste and Soulié 1913). Modern floras of the particular mountain ranges of the Pyrenees (Losa and Montserrat 1951; Farreny 1978; Bouchard 1981; Vigo 1983, Loscos 1986; Carrillo and Ninot 1992, Carreras 1993, Carreras et al. 1993, Villar 1993; Zamora and Escutia 1993; Romo and Panareda 1999) give a lot of new data concerning the distribution of *L. procumbens* and make it possible to prepare general maps of its distribution (Dupont 1990, Villar and Lazare 1991, Bolòs and Vigo 1995; Bolòs 1998; Bolòs et al. 2001).

Synthetic description of the Pyrenean range of *Loiseleuria procumbens* emphasizes that it occurs mostly in the northern (French) part of the mountains (Villar et al. 2001). The westernmost localities of the species are reported in the West Pyrenees in France (Villar and Lazare 1993).

Inside the Spanish frontiers, *Loiseleuria procumbens* occurs mostly in the East and Central Pyrenees. Their occurrence depends on the distribution of the highest mountain ridges formed of siliceous rocks, as the species generally avoids calcareous massifs. The largest populations of *L. procumbens* are reported from the mountains surrounding the Vall de Nuria in the Eastern Pyrenees, from upper regions of the Vall de Valira in Andorra and also from the mountains around the Vall d'Espot. Local populations of the species cover, as a rule, restricted areas, not bigger than 20-30 m². More extensive occurrence and more numerous populations of Alpine azalea were found only on several localities, in the mentioned above regions. The largest of them cover up to 200-300 m², as for example at the various places near the Port d'Envalira and Coma de Tristaina in Andorra.

¹ Herbaria acronyms after Holmgren et al. 1990

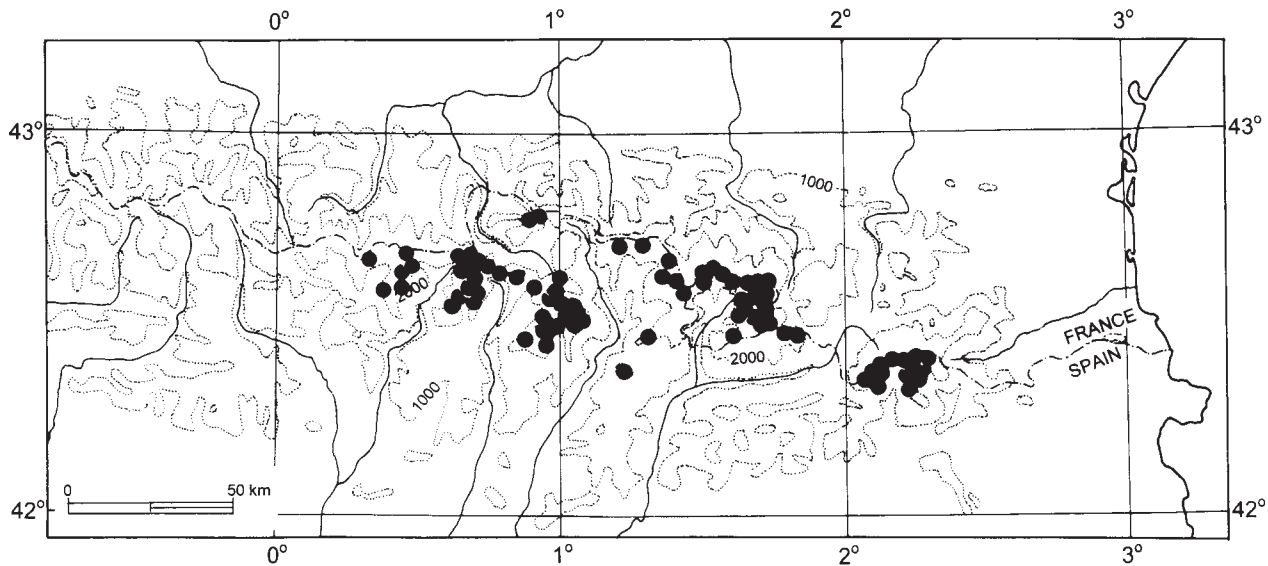


Fig. 2. Geographic distribution of *Loiseleuria procumbens* in the Spanish Pyrenees.

Loiseleuria procumbens has a great ability of vegetative propagation. The most restricted populations of the species can be formed by ramets, which come from small number of individuals erased in sexual reproduction. The genetic differentiation of such populations can be at low level with all disadvantageous effects (see for example Mitka 1997).

Loiseleuria procumbens is rarer in the western part of the Central Pyrenees, in the Maladeta – Aneto and Posets massifs (Fig. 2). It was also reported from two localities in the pre-pyrenean massifs (Bolòs et al. 2001) south of the main mountain ridge, but these information should be confirmed in the field (UTM CG95 and DG18).

Most of *Loiseleuria procumbens* stands spread out from 2100 to 2650 m, with the altitudinal minimum at 1750 m in Pla del Sorteny in Andorra and maximum at about 2900 m on the Puigmal above Nuria and at Coma Pedrosa in Andorra (Fig. 3).

OCCURRENCE CONDITIONS

The southern (Spanish) part of the Pyrenees offers smaller area characterized by more favourable growth conditions

for *Loiseleuria procumbens* than the northern (French) one. The majority of the species localities in Spain were reported from siliceous substrata, mostly granites, granodiorites, quartzites or metamorphic slates. Only a few records of occurrence of the species on limestone were found among the studied materials, mostly in close proximity to siliceous rocks. Anyway, each of the gathered notes concerning its occurrence shows a low pH level in the substratum (Losa and Montserrat P. 1951; Villar and Lazare 1991; Villar 1993; Carrillo and Ninot 1992; Carreras 1993; Carreras et al. 1993; Romo and Panareda 1999; Villar et al. 2001).

Alpine azalea in the Pyrenees grows predominantly in locations with a very thin layer of undeveloped soil (regosol) or even in the fissures on the tops of the solid rocks, in places without or only with a thin humus stratum. A thicker layer of humus is accumulated below the prostrate branches of *L. procumbens*, protected there against wind erosion, similarly as inside the cushions formed by other species characteristic for the high-mountain and arctic communities. The pH_{H_2O} of humus stratum is also low, and is not higher than 3.8-4.5 in average. Exceptionally it reaches 5.0-5.1 in the East Pyrenees (Braun-Blanquet 1948: 280; Negre 1971: 62). Only a few localities of the species were

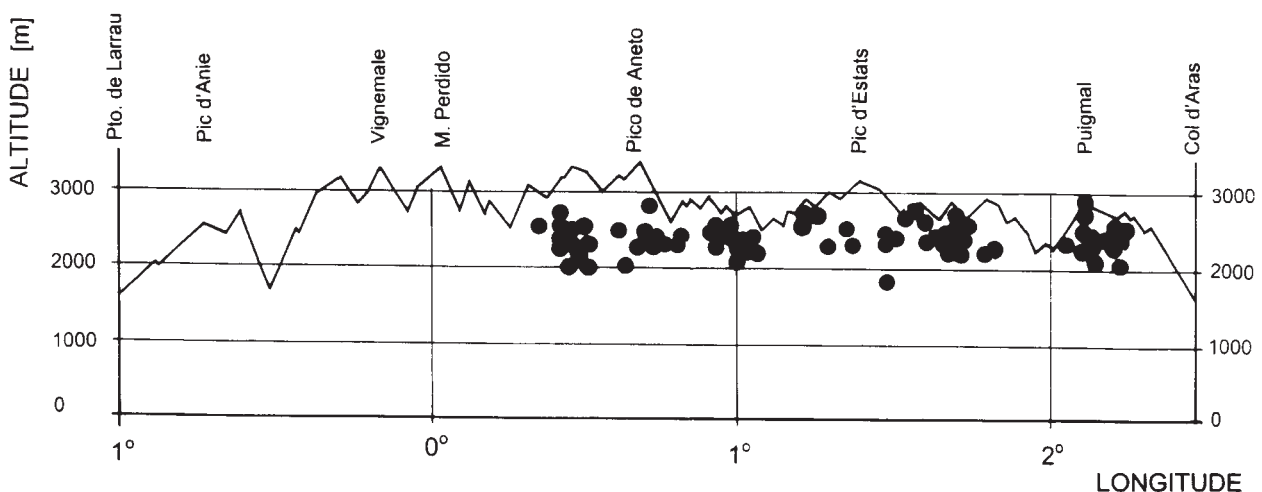


Fig. 3. Vertical distribution of *Loiseleuria procumbens* in the Spanish Pyrenees.

TABLE 1. *Loiseleuria procumbens* as component of plant associations in the Spanish Pyrenees.

Source of data	Braun-Blanquet 1948, <i>Loiseleurio- -Vaccinietum</i>	Carrillo, Ninot 1992, <i>Cetrario- -Loiseleurietum</i>	Carreras 1993, <i>Cetrario- -Loiseleurietum</i>	Gruber 1978, <i>Cetrario- -Loiseleurietum</i>	Braun-Blanquet 1948, <i>Empetro- -Vaccinietum</i>
Region	Andorra	Aigues i Tortes	San Joan de l'Erm	Aigues i Tortes	Andorra 5
Number of releves	4	4	5	10	
Characteristic of allinace (<i>Loiseleurio-Vaccin</i>), ordo (<i>Vaccinio-Piceetalia</i>) and class (<i>Vaccinio-Piceetaea</i>)					
<i>Loiseleuria procumbens</i> *	V 4 ⁵	V 5 ⁴	IV 5	V 2 ³	IV 1 ³
<i>Vaccinium uliginosum</i> subsp. <i>microphyllum</i>	V + ²	V 1 ²	V 2 ⁴	V + ³	V 2 ⁵
<i>Rhododendron ferrugineum</i>		II +	II +	IV + ¹	III +
<i>Huperzia selago</i>		II +		III + ¹	II +
<i>Juniperus communis</i> subsp. <i>alpina</i>		II +		II +	II +
<i>Astrantia minor</i>		II 1		II +	I +
<i>Deschampsia flexuosa</i>	III +		II +		III + ²
<i>Homogyne alpina</i>			I +	III + ¹	II +
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>				II + ¹	III 1 ⁴
<i>Vaccinium myrtillus</i>				II +	III + ⁴
<i>Cetraria nivalis</i> *	IV + ²	II +	III 1 ²	V + ²	
<i>Cetraria islandica</i>	III + ²	IV + ²	V 1 ²		IV 1 ³
<i>Cladonia uncialis</i>	III +				II + ¹
<i>Cladonia rangiferina</i>	III +				I +
<i>Cladonia arbuscula</i>	IV 1 ²				IV + ²
<i>Cetraria ericetorum</i>	V 2 ³				II + ¹
<i>Cetraria cucullata</i>	V + ²				I +
<i>Thamnolia vermicularis</i>	V 1 ²	IV +			
<i>Alectoria ochroleuca</i>	III 1 ²				
Accompanying species					
<i>Primula integrifolia</i>	IV +	V + ²	II + ¹	IV + ¹	III +
<i>Gentiana alpina</i>	III +	III + ¹	II + ¹	III + ¹	I +
<i>Luzula lutea</i>	III 1	III + ¹	IV + ²	II + ¹	III + ¹
<i>Juncus trifidus</i>	IV + ²	III +	V + ¹	III + ¹	II +
<i>Phyteuma hemisphaericum</i>	III + ¹	III +	V +	II +	II +
<i>Leontodon pyrenaicus</i>		IV + ¹	III + ¹	IV + ¹	IV + ¹
<i>Jasione crispa</i> subsp. <i>crispa</i>		IV +	IV + ²	III + ¹	I +
<i>Polygonum viviparum</i>	II +	III 1 ²		I +	I +
<i>Euphrasia minima</i>	II +	III + ²	III +		I +
<i>Avenula versicolor</i>	III + ²	III + ¹		II +	V + ¹
<i>Luzula spicata</i>		III +	II +	II +	I +
<i>Festuca airoides</i>	III +	II +	IV + ²		I +
<i>Carex curvula</i>		IV 1	I +	III +	
<i>Salix herbacea</i>		III + ¹		I +	I +
<i>Silene acaulis</i>	III +	III +		II + ¹	
<i>Pulsatilla vernalis</i>		III +	I +		I +
<i>Leucanthemopsis alpina</i>		II 1		II + ¹	II +
<i>Agrostis rupestris</i>		II +	IV + ¹	II +	
<i>Antennaria carpatica</i>		II +	I +	II +	
<i>Carex sempervirens</i> subsp. <i>pseudotrística</i>		II +	I +	II +	
<i>Minuartia recurva</i>		II +	I +	I +	
<i>Lotus corniculatus</i>		II +	II +		II +
<i>Pedicularis pyrenaica</i>			IV + ¹	III +	I +
<i>Minuartia sedoides</i>	II +		I +	I +	
<i>Trifolium alpinum</i>			I +	I +	I +
<i>Antennaria dioica</i>		III + ¹	II +		I +
<i>Plantago monosperma</i>		II 1	III + ¹		
<i>Kobresia myosuroides</i>		II 1	II + ¹		
<i>Agrostis alpina</i>		II 1	I +		
<i>Carex caryophyllea</i>		II 1	I +		
<i>Thymus nervosus</i>		II +	II +		
<i>Oxytropis campestris</i>		II +	I +		
<i>Calluna vulgaris</i>			I +	III +	
<i>Alchemilla flabellata</i>			II +	I +	
<i>Bartsia alpina</i>				I +	I +
<i>Silene ciliata</i>	IV +		II + ¹		
<i>Helictotrichon sedenense</i>			II 1		I +
<i>Androsace laggeri</i>			II +		II +

* The names of vascular plant taxa after Villar et al. (1997, 2001), the lichen species after Llimona & Hladun (2001).

found on the thin peat stratum with $\text{pH}_{\text{H}_2\text{O}}$ of about 4.4-5.4 (Casanovas 1992).

The majority of *L. procumbens* localities have been reported on the north-facing slopes (Fig. 4). Only a few, not numerous populations of the species were found on the southern, slightly inclined slopes. The number of localities with the northern exposure is strongly positively correlated with the altitude ($r = 0.9893$). According this, the most elevated localities are, surprisingly, connected with the N-facing slopes. The climate conditions of these exposures are more humid, but with lower temperatures in the summer and lower amplitude between day and night temperatures (Rivas-Martínez and Costa 1998; Gottfried et al. 1998).

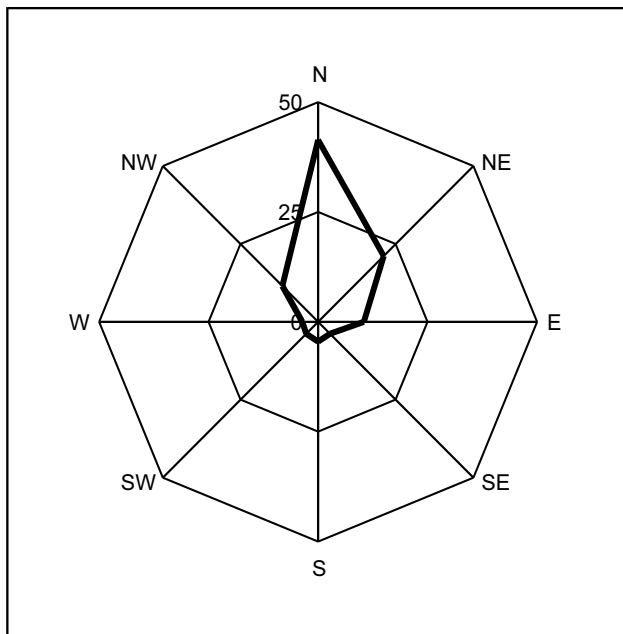


Fig. 4. Exposure of localities of *Loiseleuria procumbens* in the Spanish Pyrenees (on the base of 106 data).

Eastern and southern exposures show strong negative correlations between the number of localities and the altitude ($r = -0.8740$ and $r = -0.9980$, respectively), while the number of localities on western slopes is practically independent of the altitude ($r = -0.2244$). The southern and eastern exposures in the high mountain are characterized with the most continental climate conditions (Gottfried et al. 1998). The occurrence of *Loiseleuria procumbens* is most strongly connected with the northern, rocky, convex slopes in the upper parts of its natural range and with the concave forms of relief in the lower parts. The lowest localities were reported from rocks among peat bogs and/or slopes, mostly on the routes of cool air flow in the time of inversion of temperatures. This can be observed, for example, in the lowest localities of *L. procumbens* in the Vall de Nuria (see data of Vigo 1983 and Romo and Panareda 1999).

The majority of *Loiseleuria procumbens* localities are found on convex slopes, characterized by strong snow drifting processes, reducing the snow cover in winter (Vigo 1976; Saule 1991; Villar and Lazare 1991; Carrillo and Ninot 1992). This is similar to other mountainous localities of the species (see, for example, Ellenberg 1988; Boratyński and Didukh 2002; Wada et al. 2002), but differs from the conditions occurrence in the Arctic zone, where *L. procumbens* enters also snowbed vegetation (Razhivin 1994).

PHYTOCOENOTIC POSITION

In the Spanish Pyrenees *Loiseleuria procumbens* forms its own, very characteristic communities. It dominates in the *Cetrario-Loiseleurietum* association (*Loiseleurio-Vaccinion* alliance), described from the Alps (Braun-Blanquet 1926), and reported several times in the East and Central Pyrenees (Braun-Blanquet 1948; Chouard 1949; Losa and Montserrat 1951; Claustres 1966; Rivas-Martínez 1968; Baudière and Serve 1973; Vigo 1976; Fromard 1982; Carrillo and Ninot 1992; Carreras 1993; and Baudière 2001). This community is dominated by prostrate chamaephytes forming dense heath. *L. procumbens* grows there as a dominant or co-dominant with *Vaccinium uliginosum*, and with participation of *Huperzia selago*, *Rhododendron ferrugineum*, *Homogyne alpina*, *Vaccinium myrtillus* from *Vaccinio-Piceetalia* and other (accompanying) species, most frequently with *Primula integrifolia*, *Luzula lutea*, *Gentiana alpina*, *Jasione crispa*, *Festuca airoides*. Very characteristic for *Cetrario-Loiseleurietum* is the significant participation of lichen species from the genera *Cetraria*, *Cladonia*, *Thamnolia* and *Alectoria* (Table 1).

Loiseleuria procumbens enters also other plant communities of the alpine zone of the Pyrenees. The species grows in the eastern and central parts of the Spanish Pyrenees in the association *Empetro-Vaccinietum uliginosi* (*Rhododendro Vaccinion* alliance) (Braun-Blanquet 1948; Nègre 1971; Gruber 1978). The subassociation *Empetro-Vaccinietum uliginosi loiseleurietosum* has been described as an intermediate between the typical *Empetro-Vaccinietum* and *Cetrario-Loiseleurietum* (Rivas-Martínez 1968).

In the Central Pyrenees *Loiseleuria procumbens* was found as a rare component of the grassland community *Hieracio-Festucetum airoidis* (*Festucion airoidis* alliance) (Farreny 1978; Carreras et al. 1993). The species was also reported as very rare from communities of *Arctostaphylos alpina* and *Dryas octopetala* on limestone rocks (Fromard 1982; Soriano 1998).

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LOISELEURIA PROCUMBENS (ERICACEAE)
W HISZPAŃSKICH PIRENEJACH

STRESZCZENIE

Zbadano rozmieszczenie geograficzne oraz warunki występowania *Loiseleuria procumbens* w hiszpańskiej części Pirenejów. Naskałka rozeszłana jest we florze Europy typowym przedstawicielem elementu arktyczno-alpejskiego. W Pirenejach osiąga krańcowe, najdalej na południowy zachód wysunięte stanowiska w obrębie swojego europejskiego zasięgu. Występujące tam populacje tego gatunku w większości liczą niewiele osobników. *L. procumbens* notowana była najczęściej w strefie alpejskiej i subalpejskiej Pirenejów, najliczniej na wysokościach pomiędzy 2100 i 2650 m n.p.m., z minimum na 1750 m i maksimum na około 2900 m n.p.m. Gatunek ten rośnie prawie wyłącznie na podłożu kwaśnym i wyraźnie preferuje północne ekspozycje. Gleby na stanowiskach naskałki są słabo wykształcone, bądź też rośnie ona w szczelinach na płaskich wierzchołkach skalnych całkowicie pozbawionych gleb. Omawiany gatunek tworzy własne zbiorowiska roślinne zaliczane do związku *Loiseleurio-Vaccinion* lub wkracza do zespołów roślinnych ze związków *Festucion airoidis* i *Rhododendro-Vaccinion*. Najbardziej typowym zbiorowiskiem naskałki jest zespół *Cetrario-Loiseleurietum procumbentis*, który występuje we wschodniej i środkowej części hiszpańskich Pirenejów.

SŁOWA KLUCZOWE: geografia roślin, chorologia, ekologia, fitocenologia, element arktyczno-alpejski.

APPENDIX:
LIST OF LOCALITIES

Spain:

Macizo de Posets: San Juan de Plan, Valle de Millares, 31TBH8623, 2400-2520 m, pastos higroturbosos y pedregales, leg. Ferrández & Sesé, 1993 (JACA168493); Sahún, Aigüeta de la Vall, 31TBH8919, 2250-2400 m, Lago Pardinias, pastos pedregosos y humedales, leg. Sesé & Ferrández, 1992 (JACA359292); *ibidem*, 31TBH8919, 2500-2730 m, Collado de la Ribereta, comunidades iniciales en crestas, leg. Sesé & Ferrández, (JACA366392); *ibidem*, 31TBH8920, 2040-2250 m, Pleta de la Vall, pastos y humedales sobre sustrato silíceo, leg. Sesé & Ferrández, 1992 (JACA355992); *ibidem*, 31TBH8921, 2290-2470, Valle de Bagöena, bajo de Ibón Alto, rocas silíceas, leg. Ferrández, 1993 (JACA257993); Eriste, entre refugio Forcan y cima Posets, 31TBH92, 2350 m, roca granítica, suelo ácido, leg. Castroviejo *et al.*, 1987 (MA391231); Lago Eristé (Hu) 2500 m, orillas del lago Eriste, leg. Capell, 1947 (BC101376); *ibidem*, Ibon Alto, 31TBH9225, 2000-2600 m, Ferrández, Sesé, 22.08.1989, JACA276890; Benasque. Valle de Estós, BH9227, ca Lago Bardamina, umbría, leg. Montserrat P., 1955 (JACA784); *ibidem*, 31TBH9227, 2200-2400 m, Aguja de la Paul, leg. Pedrizas, Villar, Sesé & Benito, 1992 (JACA383192); *ibidem*, 31TBH9327, 1800-2200 m. Barranco de Estós, arroyo, prado, leg. Villar, Sesé

& Benito, 1992 (JACA386792); *ibidem*, 31TCH9227, 2305-2360 m, bajo el ibón de Bardamina, leg. Ferrández, 1995 (JACA626195); Benasque, 31TCH0825, 2460 m, Ibón del Salterillo, orillas y cercanías, leg. Ferrández & Sesé, 1994 (JACA207594);

Valle de Benasque. Vall de Gurgutes, 31TCH0330, 2100-2480 m, pastos, roquedos, arroyos, leg. Sesé & Benito, 17.07.1992, JACA259992

Macizo de Maladeta: Benasque, 31TCH9226, 2280-2380 m, brezal bajo *Rhododendron ferrugineum*, leg. Ferrández, 1995 (JACA634995); Port de Benasque, 2100 m, E slopes (Braun-Blanquets 1948); Tuca de Vargas – Pt. de la Picada, 31TCH0828, 2400-2500 m, leg. Sesé, 1991 (JACA143391); Ibones de Paderna, 31TCH0626, 2100-2500 m, calizas, leg. Ferrández, 1993 (JACA260793); La Renclusa, leg. Amich, Rico & Sánchez, 1979, (MA249345; BCF); Pico de Renclusa, 31TCH02, 2350 m, roquedo granítico, fisuras y repisos, N, leg. Alejandro, Icaya & Morante, 1984 (VIT.1949.84); Pico de Aneto, 31TCH0818, 2330-2800 m, gleras i neveros al E i NE del Vallibierna; rellano entre granitos, leg. Montserrat G., 1984 (JACA184684); *ibidem*, Entre Estany Gelat y Estany de Botornás, 31TCH0718 2500 m, orillas de un lago, leg. Gómez, 1984 (JACA170284); Estany de Botornas, NE, 2480 m (Carreras *et al.* 1993); Valle de Llauset, 30TCH11-CH01,

2100-2600 m, subiendo a coll de Vallibierna, *leg. Aizpuru & Catalan*, 1984 (ARAN); *ibidem*, 31TCH0918, 2490 m, Entre ibón de Cap de Llauset y los ibonets de cara E de Montanuy, *leg. Ferrández*, 1995 (JACA604095); *ibidem*, 31TCH01, 2500 m, zonas de neves, calizas y granitos, *leg. Uribe-Echebarría*, 1984 (VIT.2299.84);

Vall d'Aran: Sierra de la Grebosa, 31TCH1523, 2300 m, Valle del riu Nere, umbría, *leg. Ferrández*, 1988 (JACA453788); Vessants del Tuc de Sarraera (Viella), 2410 m, N (Carreras et. al. 1993); Port de Viella, 2350 m, Font-Quer, 07.07.1934, BC78620; Monludé, *leg. Llenas*, 1909 (BC40660); *ibidem*, 31TCH1639, 2355-2517 m, matorral alpino con *Loiseleuria*, *leg. Villar et al.*, 1995 (JACA247695); Picada, Montludé, La Picada, *leg. Llenas*, 1909 (BC40659; BC40660; BC82061 in CADEVALL); *ibidem*, 31TCH0829, 2400 m, suelos pedregosos ácidos, *leg. Luceño & Vogt*, 1985 (MA318644); Cap de Baqueira, 2490 m, Vigo, Masalles, 06.07.1973, BCC; BC618416; Puerto de la Bonaigua, 31TCH32, 2250 m, substrato ácido, *leg. López & Valdés*, 1975 (MA200950); *ibidem*, 31TCH3425, 2070 m, umbría granítica con matorral subalpino (*Empetro-Vaccinietum*), *leg. P. Montserrat & Villar*, 1986 (JACA529686);

Aigües Tortes: Espot. La Mosquera, 2200 m, La Mosquera in glareosis alpinis, *leg. Rothmaler*, 14.07.1934, BC74393; sota el Coll de Delluï, 2400 m (Carrillo & Ninot 1992); sota el Coll del Muntanyó de Llacs, N, 2550 m (Carrillo & Ninot, 1992); Estany de Monges, 2430 m (Carrillo & Ninot, 1992); Port de Ratera, 31TCH, 2480 m, granitos, estany, *leg. Carrillo & Ninot*, 1976 (JACA635391); Vall d'Espot, Llac Negre (Pallars Sobira) 2300 m, *leg. Carreras*, 1977 (BCC); Estany Tort, Vall Fosca, CH30, 2300 m, *leg. Pineda*, 1985 (BCC); *ibidem*, Vall de Felià, vers el Portarró, CH 3101, 2200 m, *leg. Romo*, 1984 (BC); *ibidem*, Estany Salat, CH30, 2350 m, *leg. Pineda*, 1985 (BCC); *ibidem*, E (Carrillo & Ninot 1992); Vessant N del Pui de Linya, CH41, N, 2370 m, granit, *Cetrario-Loiseleurietum*, *leg. Carrillo & Ninot*, 1981 (BCC; SEV114001; LEB29953; SANT13417); (Carrillo & Ninot 1992); "Estanyets" (Estanyetes) 2200 m, in rupestribus alpinis, *leg. Rothmaler*, 1934 (BC74392); *ibidem*, NE, 2150 m (Carrillo & Ninot 1992); *ibidem*, Pala d'Eixe, NE, 2300-2400 m (Carrillo & Ninot 1992); Cap a l'estany de la Coveta, CH31, 2400 m, granites, *leg. Carrillo & Ninot*, 1976, (BCC); *ibidem*, E, 2400 m (Carrillo & Ninot 1992); Creu de l'Eixol, CH41, 2220 m, pedrusca fixada, *leg. Carrillo & Ninot*, 1983 (BCC);

Vall de Cardós: cima del Pic Ventolao, 2850 m, *leg. Llensa*, 1957 (BC145538); del Port de Tavascan al llac Mariola, 2220 m, *leg. Llensa*, 1955 (BC136930); Coll de Sallente, 2500 m, *leg. Llensa*, 1956 (BC145203);

Vallferrera, 2200 m, sota els Estanys d'Aixens, *leg. Farreny*, 1979 (BC619994); Estany Romedo CH62, Barborte (Casanovas 1992);

Sant Joan de l'Erm: Bony de Trescul, CH60, 2330 m, N slopes (Carreras 1993); Rasos de Sabollera, 2410 m N slopes (Carreras 1993); Pic de l'Orri, 2250 m NW slopes (Carreras 1993);

Cerdagne: Crête du Puncho, DH00 (Braun-Blanquet 1948); Estany de Malniu, pr. Meranges, 31TDH0003, 2200 m, borde de lago, *leg. Aedo et al.*, 1993 (Iter Gerundense VII-1993, MA529339); Val de Planés, 2300 m, Sennen, 04.08.1916, BC 40650

Vall de Núria: Núria (Gerona), without *leg.*, 07.1849 (BC658197); *ibidem*, in rupestribus glareosisque apricis, 2000 m, *leg. Vayreda*, 1880 (VAYREDA-BC); *ibidem*, *leg. Llenas*, 1907 (BC40658); *ibidem*, *leg. Losa*, 1946 (BCF34646); *ibidem*, Vall de Núria, *leg. A. de Bolòs*, 1956 (BC145668); Puigmal, *leg. Puiggari*, 1868 (BC40645; 40644); *ibidem*, Montes de Núria, en los prados cespitosos, alt. 3000 m, *leg. Trèmols*, 1873 (CADEVALL-BC); *ibidem*, 2700 m, *leg. Sennen*, 1914 (BC40651); *ibidem*, 2700m, *leg. Cuatrecasas*, 1921 (BC40652); *ibidem*, piso supraforestal de Puigmal, 31TDG2894, 2200-2800 m, *leg. Villar*, (JA-

CA5322.74); *ibidem*, 31TDG2693, 2280-2440 m, *Saxifrago-Rhododendretum* con *Loiseleuria*, *leg. Montserrat P., Montserrat G. & Villar*, 1986 (JACA458986); Del Pas dels Lladres al Puigmal (Vigo 1983); Coma de Fontalba, abundant (Vigo 1983, 1996); Coma de Gombreny 2100 m, E (Vigo 1983, 1996); Coma de Fresers, molt abundant (Vigo 1983); torrent de les Barraques, 2600 m, NE (Vigo 1983, 1996); vessants del Balandrau 2200-2400, N (Vigo 1983, 1996); Costa Rubí, 2050 m, NW (Vigo 1983, 1996); Cap al Pic de l'àliga, 2300 m, *leg. Vigo & Anglada*, 7.07.1968, BC601516; *ibidem* (Vigo 1983, 1996); Roques Blanques, Costabona, *leg. Vayreda*, 1873 (VAYREDA BC); Coll de Lló, without *leg.*, 07.1893 (BC632897); Vall de Llo, à la Font del Segre, pâturages, vers 2450 m, *leg. Sennen*, 1919 (SENNEN BC); Vallée d'Eynes, *leg. Bordère*, 1871 (BC658198); Le Cambredase (Cambres d'Aze), 2400 m, pelouses, *leg. Sennen*, 1919 (SENNEN BC); Val d'Eyne, 2400 m, pelouses alpines, *leg. Sennen*, 1921 (BC40662); Ras de l'Ortigar, 2300 m, *leg. Vigo & Anglada*, 21.07.1968, BC601541; *ibidem* (Vigo 1983, 1996); Pic de Segre, 31TDG2894, 2500 m, NE slopes, on the siliceous rocks, *leg. Boratyński*, 1995 KOR; Noufonts, 2600, *leg. Sennen*, 1913 (SENNEN BC); Collado de Carença, without *leg.*, ex herbario *Barnades*, 1933 (BC603256);

Ull de Ter: Setcases, Pla de Camp Magre, *leg. Bolòs*, 1875 (MA89514); Pyrénées Orientales, pratis Ull de Ter, *leg. Vayreda*, 1873 (BC40646); *ibidem*, *leg. Trèmols*, 1875 (BC804694); *ibidem*, *leg. Bolòs*, 1875 (BC613510); *ibidem*, *leg. Codina*, 1921 (BCF34644); Coma del Orri, 2900 m, *leg. Font-Quer*, 1912 (BC40661); de Setcases subiendo a Núria y en otras partes de aquellos montes, without *leg.*, 18-22.07.1880 (BC40648);

ANDORRA:

Arinsal: Coma Pedrosa, 2900 m (Fromard 1982); NE slopes below Estany de les Truites, 31CTH728154, 2220 m (*Boratyński*, obs. 1995);

Ordino: El Serrat. Coma del Forat, 31TCH7521, 2400 m, rocas siliceas, cervunales con regaliz, *leg. Fillat & Villar*, 1978 (JACA314378); *ibidem*, 31TCH758204, 2450 m, NW slopes, in clumps of *Rhododendron* above the lake, *leg. Boratyński*, 1995 (KOR); Estanys de Tristaina, between two lowest lakes, 2320 m (*Boratyński*, obs. 1996); E slopes above the lowest lake, 31TCH755224, 2480 m (*Boratyński*, obs. 1996); *ibidem*, 2510 m (*Boratyński*, obs. 1996); NW slopes of Mt Arcalis, 2360 m. (*Boratyński*, obs. 1996); *ibidem*, 2440 m (*Boratyński*, obs. 1996); *ibidem*, N slopes, 2500 m (*Boratyński*, obs. 1996); *ibidem*, N slopes, 2600 m (*Boratyński*, obs. 1996); Pla del Sorteny, 1750m, *leg.?*, 1948 (BCF); Vall de Riu de Rialb, 2110 m, 31TCH813227 (*Boratyński*, obs. 1995); *ibidem*, 2200m, 31TCH810226 (*Boratyński*, obs. 1995); *ibidem*, 2290 m, 31TCH808225 (*Boratyński*, obs. 1995); *ibidem*, E of Portella de Rialb, 2380 m, 31TCH804222 (*Boratyński*, obs. 1995); Coma de Varilles below Portella de Rialb, 2390 m, 31TCH796218 (*Boratyński*, obs. 1995); *ibidem*, 2470 m, 31TCH802220, (*Boratyński*, obs. 1995); Estanyol, *leg. Losa & P. Montserrat*, 1949 (MA163863), *ibidem*, 2700 m (Losa & P. Montserrat, 1950); W slopes of l' Estanyó, 2470 m (*Boratyński*, obs. 1995); *ibidem*, N slopes at Apres de la Serreta, 2450 m (*Boratyński*, obs. 1995); El Serrat. Mont de Besalí, 31TCH795217, 2350 m, NW slopes, *Rhododendron ferrugineum* scrub, *leg. Boratyński*, 22.09.1995 (KOR); Sorteny, Roc del Relloge – Apres de la Serreta, 31CTH837193, 2450 m, N slopes, *leg. Boratyński*, 1995 (KOR), *ibidem*, 2250 m, 2380 m SW ans W slopes (*Boratyński*, obs. 1995);

Canillo: Vall de Ransol, E slopes below Estanys de Ransol, 2210 m (*Boratyński* obs. 1996); *ibidem*, N slopes, 2260 m (*Boratyński* obs. 1996); *ibidem*, NE slopes, 2300 m, commonly (*Boratyński* obs. 1996); *ibidem*, below Coll de la Mina, NE slopes, 2600 m, commonly (*Boratyński* obs. 1996); Vall de Riu de Juclar, N slopes of Pic de Sisqueró, above Estany de Juclar,

31TCH951182, 2350-2400 m, *leg. Boratyński*, 1995 (KOR); *ibidem*, SW slopes, on the granite rocks below Estany de Juclar, 31TCH946183, 2290 m (Boratyński obs. 1995); *ibidem*, 31TCH943177, 2180-2200 m, small peat-bog on the granite rock, *leg. Boratyński*, 1995 (KOR); Estans de Sisqueró, 31TCH942158, 2400 m, thicket of *Juniperus nana*, *leg. Boratyński*, 1995 (KOR); *ibidem*, 31TCH946158, NW slopes, 2490 m (Boratyński obs. 1995); *ibidem*, N slopes below then upper lake, 31TCH943158, 2410 m (Boratyński obs. 1995); N slopes above Pletes de Sisqueró, 31TCH951182, 2380 m (Boratyński obs. 1995); Clots de l'Os W of Port Dret, 31TCH933147, 2450 m, NW slopes, together with *Vaccinium uliginosum* and *Salix herbacea*, *leg. Boratyński*, 1995, KOR; *ibidem*, 31TCH927152, 2350 m (Boratyński obs. 1995); Pic del Cap de Port Dret, 31TCH942152, 2750 m, N slopes, *Salix herbacea-Loiseleuria procumbens* community, *leg. Boratyński*, 1995 (KOR); Marrades Negres S of Port Dret, N slopes, 31TCH934143 (Boratyński obs. 1995); pass between Pic del Cap del Port Dret and Pic de la Font dels Isards, N slopes, 31TCH946154 (Boratyński obs. 1995); Below Portella Inferior de la Cabaneta, N slopes, 31TCH950157, 2550 m (Boratyński obs. 1995); *ibidem*, 31TCH951156, 2660m (Boratyński obs. 1995); Port d'Envalira, S slopes of Pic Maia 31TCH947177, 2500 m (Boratyński obs. 1995); *ibidem*, NE slopes above Costa Rodana, 2590 m (Boratyński obs. 1995); *ibidem*, N slopes, 31TCH947100, 2500 m, (Boratyński obs. 1995); *ibidem*, N slopes of Pic de Maia, 31TCH947128, 2560 m, with *Vaccinium uliginosum*, *leg. Boratyński*, 1995 (KOR); Collet d'Ortafa N of Maia, 31TCH944130, N slopes, 2550 m (Boratyński obs. 1995); Soldeu, between Els Espiolets and Tossal de la Llasada, 31TCH902130, N, 2350-2400 m, on the rocks and among alpine grassland, *leg. Boratyński*, 1995 (KOR); Tossal de la Llasada, NE slopes, 2450 m, 31TCH896126 (Boratyński obs. 1995);

Encamp: Pto. de Envalira (Coll d'Envalira), 31TCH9310, 2400 m, *leg. J. M. Montserrat*, 1978 (JACA171878); *ibidem*, 31TCH9410, 2420-2450 m, *leg. P. Montserrat*, 1992 (JACA048392); *ibidem*, 2450-2500 m, *Nardion y Caricion curvulae*, *leg. P. Montserrat, Benito et al.*, 1992 (JACA141592); *ibidem*, pastos psicroxerófilos en la cresta, *leg. Nieto Feliner, Davis & Izuzquiza*, 1992 (MA496580); *ibidem*, *leg. Navarro et al.*, 1992 (MA525668); *ibidem*, *leg. Navarro*, 1992 (Iter Andorrano-Aranense VII-1992, MA525668); *ibidem*, 2480 m, NE (Braun-Blanquet 1948); Coll Blanc above Pas de la Casa, N slopes, 2450 m (Boratyński obs. 1996); *ibidem*, E slopes, 2600 m (Boratyński obs. 1996);

ibidem, NW slopes, 2700 m (Boratyński obs. 1996); Pic Negre, 2600-2700 m, *leg. Losa & P. Montserrat*, 1949 (MA163863), (Losa & P. Montserrat, 1950); *ibidem*, N slopes, 2650 m (Boratyński obs. 1996); *ibidem*, NE slope, 2500 m (Boratyński obs. 1996); Port d'Envalira, N slopes above Estany d'en Gait, 31TCH943085, 2410 m, *leg. Boratyński*, 1995 (KOR); *ibidem*, NW slopes, 31TCH946091, 2450 m (Boratyński obs. 1995); Turbera, bajando de Gait als Esparvers, 2200 m, *leg. Losa & P. Montserrat*, 1950 (BCF); *ibidem*, 2300 m, *leg. Losa & P. Montserrat*, 1950 (BCF); stream valley below Estany de Montmalus toward Grau Roig, N slopes, 31TCH926088, 2310 m (Boratyński obs. 1995); *ibidem*, SE slope, 2350 m (Boratyński obs. 1996); *ibidem*, N slope, 31TCH927086, 2380 m (Boratyński obs. 1995); N slope above Estany de Montmalus, 31TCH927083, 2420 m (Boratyński obs. 1995); *ibidem*, E slope, 2480 m (Boratyński obs. 1995); *ibidem*, N slope of Coma Estremera, 2500 m (Boratyński obs. 1996); *ibidem*, NE slope, 2560 m (Boratyński obs. 1996); *ibidem*, N slope, 2620 m (Boratyński obs. 1996); Alt de Pessons, SE slope above Estany de Montmalus, 2620 m (Boratyński obs. 1996); Circo de Pessons, 31TCH9107, 2500 m, N laderas pedregosas, granitos, *leg. Almaraz, Álvarez & García*, 1996 (MA575780); *ibidem*, SE slope, 31TCH915087, 2380 m (Boratyński obs. 1995); *ibidem*, E slope, 31TCH910083, 2450 m (Boratyński obs. 1995); *ibidem*, NE slope, 31TCH905080, 2520 m (Boratyński obs. 1995); *ibidem*, NE slope below Portella de Pessons, 31TCH900075, 2600 m (Boratyński obs. 1995); *ibidem*, 31TCH900073, 2670 m (Boratyński obs. 1995); Portella de Pessons, N slope, 31TCH880075, 2750 m (Boratyński obs. 1995); Pic de Ensagents, 2600 m (Losa & P. Montserrat, 1950); N slope above Estany de Cubil E of Redort, 31TCH910103, 2350 m (Boratyński obs. 1995); *ibidem*, 31TCH920107, 2380 m (Boratyński obs. 1995); rocky ridge S of Collado d'Enradort, 31TCH903105, N, 2450 m, thicket of *Juniperus nana*, *leg. Boratyński*, 1995 (KOR); *ibidem*, to Tossal de la Llosada, N slopes, 31TCH904131, 2350 m (Boratyński obs. 1995); below Coll de Enradort, toward Encamp, 31TCH900105, NE slope, 2350 m (Boratyński obs. 1995); *ibidem*, N slope, 31TCH902105, 2450 m (Boratyński obs. 1995); N slope above Riu Deveses E of Encamp, 31TCH882106, 2100 m (Boratyński obs. 1995); *ibidem*, 31TCH894196, 2250 m (Boratyński obs. 1995); below Estany de l'Illa, S slope, 31TCH890054, 2360 m (Boratyński obs. 1995); NW slope above Estany de l'Illa, 31TCH897058, 2500 m (Boratyński obs. 1995); *ibidem*, 31TCH903063, 2560 m (Boratyński obs. 1995); SW slope of Pic de Ribus, 31TCH905064, 2610 m (Boratyński obs. 1995).