



Original Article

Rhododendron luteum Sweet. and *Rhododendron hirsutum* L. in Habitats from Central Europe

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Abstract

This paper presents results of research conducted in the field in three different habitats edified by two species of *Rhododendron* specific to Central Europe (*Rhododendron hirsutum* and *Rhododendron luteum*). It presents their spread, the ecological requirements of each habitat, typical plant association, enlightening and characteristic species composition. Also the names of the same habitats found on different classifications are mentioned for better correlation and recognition. Specified codes are EUNIS, Emerald, Natura 2000, Palearctic habitats and European forest types. Also debating on how *Rhododendron* species spread and survived in Europe during the last glacial period. Vegetation types are described in the Julian Alps in Slovenia, the Austrian Alps and pine forests in Poland, where a certain species of *Rhododendron* prevails. Vegetation was observed following the research in the field.

Keywords: rhododendrons species areas, plant communities, Central Europe.

Introduction

Most species of rhododendrons are endangered due to human activities, some of which are almost extinct. Thus, knowing and identifying habitats that they form is a key objective in their protection. Also these habitats are home to many rare and interesting species. To ensure their perpetuation and understanding the ecosystems they live in, habitat conservation is required.

The genus *Rhododendron* L. falls within the *Ericaceae* family, *Rhodoreae* tribe from *Ericoideae* subfamily, which includes the *Erica*, *Bruckenthalia* and *Calluna* genus, which grow in similar conditions.

This is a highly complex genus, totaling over 1000 species worldwide with the center of spread in the Himalayas and Southeast Asia, where it's approximated that live over 700 species [7]. Rhododendrons are typical to cold and temperate regions of the Northern Hemisphere (East Asia, North America, Europe) [9].

Rhododendrons are woody species, some of which are evergreen, others deciduous, because of unfavorable conditions, such as the winter period. There are also tropical rhododendrons (generically called "Vireya" [9], that grow at high altitudes in Southeast Asia (Indochina), to the south in Indonesia, Philippine and northern parts of Australia, with over 200 species only in the island of New Guinea [4]. As a very broad genre, that varies in terms of shapes and colors, from species of just few centimeters to 30 meters high [14]. Some species may also be epiphytic on tropical tree branches.

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Rhododendron flowers can be single or grouped in racemes, with a wide range of colors. Flowering period can be from a few weeks, throughout the year (representatives from tropical regions). The fruit is usually a woody capsule, with many seeds, sometimes wearing wings and appendages to facilitate air transport [9].

Many species of rhododendrons are cultivated in parks and gardens, and because of their flowers beauty, over 28000 varieties and hybrids were created [8].

Rhododendrons in Europe (about 10 species) occupy mostly mountain areas from almost every major mountain chains and Arctic areas of Fennoscandia or subtropical in the Caucasus and the Iberian Peninsula [25].

***Rhododendron hirsutum* L.**

Small shrub 30 - 80 ((20 - 100) cm) evergreens, with elliptical leaves filled with long hairs (as the name suggests) and reddish pink

flowers (Fig. 1) [1]. Unlike its close relative (*Rhododendron ferrugineum*) *Rhododendron hirsutum* grows exclusively on limestone rock substrate, on soils with basic pH. It is found in both open forests as well on rocky slopes of the upper mountain floors, where it forms large thickets [18]. It prefers sunny and semishaded areas [23].

Geographical distribution includes the central and eastern Alps (France, Switzerland, Italy, Austria, Germany, Liechtenstein, Slovenia) and northwestern Dinaric Mountains (Croatia, Slovenia, Bosnia-Herzegovina, Montenegro) [18, 23, 19]. In western Croatia, it can be found mainly in Velebit Mountains, Risnjak, Velika Kapela, Gorski Kotar, Pljesevica and in Bosnia-Herzegovina it is found isolated in Vranica Mountains and Maglie, the last being on the border with Montenegro. In Montenegro, *Rhododendron hirsutum* was discovered only in recent years [19]. It was planted in the Jura Mountains and the Western Carpathians (Tatra Mountains - Slovakia)[18].



Figure 1. *Rhododendron hirsutum* L. in the Alps

***Rhododendron luteum* Sweet**

Shrub 1 - 4 m tall, deciduous who acquires a red, orange or purple color in fall. Fragrant yellow flowers, funnel-shaped, appear in spring before or at the same time as the leaves, and produce a toxic nectar (Fig. 2). The plant is toxic, but also has medicinal uses [2, 11].

Rhododendron luteum geographical distribution is quite large, but with small and disjunct areals (Fig. 3). It is considered an East

European species - Caucasus, more precisely a Pontic species [5]. The main area of distribution is in the Pontic area (Pontic Mountains of northern Turkey and some points south of the Marmara Sea, Taurus Mountains in the southeast) and the Caucasus. Here it grows in mountain forests, especially conifers, on oligotrophic soils. It is also found at several points in Poland, Belarus, Ukraine, Austria, Slovenia, Greece [18]. In these areas the species

behaves different, grows in open, rare woods, especially at their edge, on sandy, peat or other oligotrophic soils.

It is protected in Poland, Slovenia, Ukraine, Russia, Azerbaijan, Belarus and by the European network Natura 2000 network as in Slovenia [24, 22].

It was planted in many parts of Europe where in optimum conditions it gets wild (central Poland, Tatra Mountains in Slovakia)[3]. Likewise, a well known population is found in the eastern Alps (Carinthia, Austria), which proved to be introduced since Roman times [15].



Figure 2. *Rhododendron luteum* Sweet

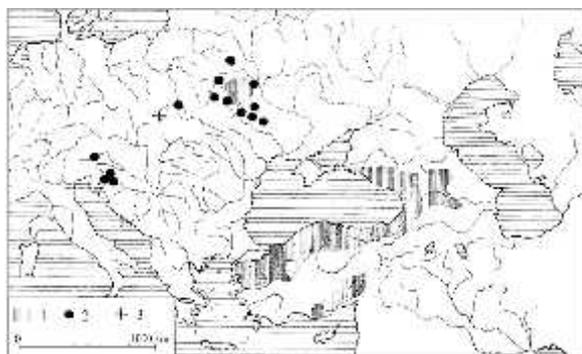


Figure 3. Natural distribution of *Rhododendron luteum* Sweet; 1 – main range, 2 – small “islands”, 3 – paleobotanical localities [12]

The species was widespread in Tertiary period through most of Europe, the proof stands not only by the insular relict populations from Eastern and Central Europe and Balkans, but also the paleobotanical remains from different regions like Carpathians [16] and Alps [12]. Palynological tests confirm that not only the Caucasus, but also the Alps, Balkans and Carpathians were populated on the last period of the Tertiary (Pleistocene) by *Rhododendron luteum* [17]. Isolated populations besides Sava River (Slovenia) confirm this theory. Glaciation

did not arrive there and *Rhododendron luteum* populations survived, being a true relict of the Tertiary [15], just as *Rhododendron ponticum* populations escaped in Bulgaria.

Leaves can be attacked by various pathogenic fungi, most common being *Microsphaera azaleae* (*Erysiphe azaleae*) found on plants from Poland as well as those from Slovenia [21, 10].

2. Material and Method

The methods used in the study of plant communities from mountain areas are based on: observation, description, collecting material for genetic and structural laboratory tests. Analysis of floristic composition and structure phytocoenosis was made through field and laboratory activities. For the determination of species several papers were used: Flora Europaea, vol. I – IV (1964 - 1980), Flora Alpina – Aeschmann 2004. Research methods were based on criteria developed by Braun-Blanquet (1964) using the surveys conducted in the summer months in the Alps and in Poland.

Rhododendron habitats researched in this paper

Habitat description was made for each species of *Rhododendron* depending on the geographic area it occupies. Habitats addressed in the paper are filled with official denomination of the habitats found under different names but with the same species and ecological requirements, from many scientific studies published over the years, greatly helping identification and correlation between them. The paper also presents phytocenologic surveys on plants identified in each habitat.

3. Results and Discussions

Subalpine scrubland with *Rhododendron hirsutum*

Biotope: *Rhododendron hirsutum* forms large scrublands, often compact in sub-alpine floor and higher boreal, between (350) 800 - (1800) 2400 m altitude. Can be found on rich limestone soils and thrives among trees. Habitats formed from short or tall, compact mesophilic bushes on limestone substrate continue from the trees limit to the sub-alpine floor and are usually drier and more exposed to sunlight than the ones with *Rhododendron ferrugineum*.

Synonyms used for this habitat:

- 4060 Alpine and Boreal heaths (EU Habitats Directive Annex 1)
- F2.2 Alpidic [*Rhododendron hirsutum*]
- [*Erica*] heaths (EUNIS)
- 31.48 Alpidic hairy alpenrose-erica heaths (Palearctic Habitats)

Plant associations: *Rhododendretum hirsuti* Lüdi 1921 [13].

Structure and floristic composition: The main dominant species are: *Rhododendron hirsutum*, *Rhododendron x intermedium*, *Rhodothamnus chamaecistus* and *Erica herbacea*.

In Slovenia, Alpine habitats with *Rhododendron hirsutum* include the following characteristic species: *Antennaria carpatica*, *Arctostaphylos alpinus*, *A. uva-ursi*, *Bartsia alpina*, *Daphne striata*, *Dryas octopetala*, *Empetrum hermaphroditum*, *Globularia nudicaulis*, *Hieracium alpinum*, *Homogyne discolor*, *Juncus trifidus*, *Loiseleuria procumbens*, *Rhodothamnus chamaecistus*, *Vaccinium gaultherioides* (Table 1).

In the *Rhododendretum hirsuti* Lüdi 1921 association from the Julian Alps, the main edifying species found are: *Rhododendron hirsutum*, *Rhodothamnus chamaecistus*, *Viola biflora*, *Homogyne alpina*, *Salix waldsteniana*, *Clematis alpina*, *Vaccinium myrtillus*, *Geranium sylvaticum*, *Solidago virgaurea*, *Rosa pendulina*, *Polystichum lonchitis*, *Daphne striata*, *Juniperus sibirica*, *Laserpitium peucedanoides*, *Ranunculus hybridus*, *Koeleria eriostachya*, *Pimpinella alpina*, *Aster bellidiastrum*, *Sesleria albicans*, *Carex sempervirens*, *Carex firma*, *Bartsia alpina*, *Dryas octopetala*, *Juncus monanthos*, *Gentiana clusii*, *Linum julicum*, *Pedicularis verticillata*, *P. rostrato-capitata*, *Arctostaphylos alpina*, *Biscutella laevigata*, *Ranunculus carinthiacus*, *Polygonum viviparum*, *Homogyne discolor*, *Salix retusa*, *Saxifraga aizoides*, *Selaginella selaginoides*, *Tofieldia calyculata*, *Vaccinium vitis-idaea*, *Parnassia palustris*, *Valeriana saxatilis*, *Pinguicula alpina*, *Carex ferruginea*.

Other species encountered: *Festuca laxa*, *Primula auricula*, *Rumex scutatus*, *Cystopteris regia*, *Thlaspi kernerii*, *Aconitum ranunculifolium*, *Alchemilla fallax*, *A. velebitica*, *Gymnocarpium robertianum*, *Laserpitium siler*, *Lotus corniculatus*, *Libanotis sibirica* ssp. *montana*, *Salix appendiculata*, *Trifolium repens*, *Veratrum album* ssp. *lobelianum*, *Veronica chamaedrys*, *Ranunculus traunfellneri*, *Salix*

serpyllifolia, *Sesleria sphaerocephala*, *Soldanella minima*, *Leontodon hispidus*, *Alnus viridis*, *Carex atrata*, *Huperzia selago*, *Lycopodium annotinum*, *Maianthemum bifolium*, *Pyrola rotundifolia*, *Ranunculus nemorosus*, *Rhodiola rosea*.

***Rhododendron luteum* habitats**

Mixed forests of pines (*Pinus sylvestris*) and oak (*Quercus robur*)

Biotope: Habitats at the northern limit of the area usually are low plain areas, where survival of the species is primarily due to permanent swamps and very acid soil.

Main populations in Poland are on portion of a mound, over 100 m high, dominating the surroundings. At the western end it is bordered by a swampy forest with *Alnus glutinosa* and in the eastern end by a dry forest of *Pinus sylvestris*. Interestingly, the soil here is very poor in organic matter and quite dry compared to the rest of the sites.

Synonyms used for this habitat

- G4.7 Subcontinental nemoral [*Pinus*] - [*Quercus*] forests (EUNIS)
- G4.7 Continental nemoral [*Pinus*] - [*Quercus*] forests (EUNIS)
- 41.58 Subcontinental pine-oak forests (Palearctic Habitats)
- 43.6 Continental nemoral pine-oak forests (Palearctic Habitats)
- 6.2.6 Mixed Scots pine-pedunculate oak forest (EEA, 2007)

Plant associations: *Quercus robur* - Pinetum (W.Mat. 1981) J.Mat. 1988 [12].

Structure and floristic composition: In Poland, the most suitable habitats for *Rhododendron luteum* are mixed acidic, moist forests with pine and oak trees (*Pinus sylvestris*, *Quercus robur*) where the shrub layer dominates, as seen in Table 2.

Tree species common in this type of vegetation are: *Quercus petraea*, *Quercus robur*, *Carpinus betulus*, *Sorbus aucuparia*, *Betula pendula*, *Populus tremula*, *Picea abies*, rarely *Fagus sylvatica* and *Pinus sylvestris* is frequent, most likely as a result of forestry activities.

In the shrub layer appear: *Corylus avellana*, *Euonymus verrucosus*, *Frangula alnus*, *Prunus spinos* and in the undergrowth and grassy layer: *Vaccinium myrtillus*, *Pteridium aquilinum*, *Calamagrostis arundinacea*, *Molinia caerulea*, *Festuca ovina*, *Deschampsia flexuosa*, *Calluna*

vulgaris, *Carex digitata*, *Melampyrum nemorosum*, *Melica nutans*, *Viola reinchenbachiana*. In most of these forests, *Rhododendron luteum* was originally planted and optimal environmental conditions helped the

spread of this species. Rarely grows in the forests of linden (*Tilia cordata*) and hornbeam (*Carpinus betulus*) in more humid very acidic areas.

Table 1. *Rhododendron hirsutum* field surveys in the Alps (Slovenia - Triglav National Park)

Field survey number	1	2	3
Altitude	1655	1712	1680
Exposition	N	NV	N
Herb cover (%)	80	100	90
Sample area (m ²)	40	50	30
<i>Rhododendron hirsutum</i>	5	5	4
<i>Erica herbacea</i>	2	2	1
<i>Rhodothamnus chamaecistus</i>	2	2	1
<i>Vaccinium myrtillus</i>	+	1	+
<i>Solidago virgaurea</i>	+	+	-
<i>Juniperus sibirica</i>	+	+	-
<i>Homogyne alpina</i>	-	+	+
<i>Clematis alpina</i>	+	-	+
<i>Carex sempervirens</i>	-	+	+
<i>Bartsia alpina</i>	-	+	-
<i>Arctostaphylos alpinus</i>	+	-	-
<i>Daphne striata</i>	-	+	-
<i>Pinguicula alpina</i>	+	+	-
<i>Dryas octopetala</i>	+	+	+
<i>Pedicularis verticillata</i>	+	+	-
<i>Polygonum viviparum</i>	+	+	+
<i>Biscutella laevigata</i>	-	-	+
<i>Selaginella selaginoides</i>	-	+	+
<i>Vaccinium vitis-idaea</i>	-	+	+
<i>Lotus corniculatus</i>	+	-	+
<i>Carex atrata</i>	-	+	-
<i>Luzula luzuloides</i>	+	+	+
<i>Sesleria albicans</i>	-	-	+
<i>Juncus trifidus</i>	+	+	+
<i>Hieracium alpinum</i>	-	+	+
<i>Viola biflora</i>	+	-	-
<i>Aster bellidiastrum</i>	-	+	+
<i>Pedicularis rostrato-capitata</i>	-	+	-
<i>Homogyne discolor</i>	+	-	-
<i>Trifolium pallescens</i>	-	+	-
<i>Potentilla crantzii</i>	+	+	+
<i>Campanula scheuchzeri</i>	-	+	+
<i>Hedysarum hedysaroides</i>	+	-	-
<i>Trifolium repens</i>	+	+	-
<i>Cystopteris regia</i>	-	-	+
<i>Globularia nudicaulis</i>	-	+	+
<i>Vaccinium gaultherioides</i>	+	-	-
<i>Leontodon hispidus</i>	+	-	+
<i>Huperzia selago</i>	+	+	-
<i>Loiseleuria procumbens</i>	+	+	-

Beech forests (*Fagus sylvatica*) on acidic substrate

Biotope: *Rhododendron luteum* biotope populations from the Eastern Alps (Carinthia) were regarded as relics of the Tertiary period.

Rhododendron ferrugineum populations found here at very low altitude are indeed relics, but from the glacial period, when vegetation floors lowered because of the glacier mountains.

The optimum soil conditions and moisture made *Rhododendron ferrugineum* persist here until today [6]. The altitude, where the two species occur together, is about 650 m on a northern slope [20].

Species from the warm Tertiary period, *Rhododendron luteum* had no way to survive in the

Alps, especially at this altitude, and no seeds from the relict populations in Northern Carpathians could not get here because of the distance and isolated biotope in Austria.

Table 2. *Rhododendron luteum* field surveys in Poland

Field survey number	1	2	3
Altitude	195	190	182
Exposition	N	S	SE
Herb cover (%)	100	90	100
Sample area (m ²)	50	40	50
<i>Pinus sylvestris</i>	5	5	4
<i>Quercus robur</i>	3	2	1
<i>Rhododendrum luteum</i>	1	3	1
<i>Quercus petraea</i>	+	+	+
<i>Carpinus betulus</i>	1	-	+
<i>Sorbus aucuparia</i>	-	+	+
<i>Betula pendula</i>	+	+	+
<i>Populus tremula</i>	+	+	+
<i>Fagus sylvatica</i>	+	-	-
<i>Corylus avellana</i>	+	+	-
<i>Euonymus verrucosus</i>	-	+	-
<i>Frangula alnus</i>	+	-	+
<i>Prunus spinosa</i>	+	+	+
<i>Vaccinium myrtillus</i>	+	+	1
<i>Pteridium aquilinum</i>	+	+	+
<i>Calamagrostis arundinacea</i>	-	+	+
<i>Molinia caerulea</i>	+	-	+
<i>Festuca ovina</i>	-	+	-
<i>Deschampsia flexuosa</i>	+	+	-
<i>Calluna vulgaris</i>	-	-	+
<i>Carex digitata</i>	+	+	+
<i>Melampyrum nemorosum</i>	+	+	-
<i>Melica nutans</i>	-	-	+
<i>Viola reinchenbachiana</i>	+	+	-
<i>Tilia cordata</i>	-	+	-

All the more, during the Quaternary deciduous forests were replaced by subalpine and alpine meadows at those altitudes. A migration of species from the shelter at the foot of the Julian Alps (Slovenia) during the Boreal period could be considered, but this species could not find optimal conditions for survival such as a rich soil in humus and didn't limit the spread to only a few square meters. Although sediments indicate the presence of the species during the Tertiary period, it could not survive because that valley (Drau) was a glacial valley. The only possibility of the species appearance was because it was brought here during the Roman occupation, where finding optimal conditions, survived [6]. Also, around the numerous castles and parks in Austria and Germany, *Rhododendron luteum* individuals, who escaped from culture by

seeds carried by the wind, were found naturalized in the forests around the area [20].

The soils are acidic and low in nutrients, therefore the vegetation is rather poor.

Synonyms used for this habitat

- 9110 Acidophilous (*Luzulo-Fagetum*) beech forests (EU Habitats Directive Annex 1)
- 9130 *Asperulo-Fagetum* beech forests (EU Habitats Directive Annex 1)
- 41.1 Beech forests (Emerald)
- G1.6 Medio-European acidophilous [*Fagus*] forests (EUNIS)
- 41.11 Medio-European acidophilous beech forests (Palearctic Habitats)
- 6.6.4 Central European submountainous beech forest (EEA, 2007)

Plant associations: *Asperulo - Fagetum*, *Luzulo - Fagion*, *Luzulo luzuloidis - Fagetum sylvaticae* Meusel 1937 [1].

Structure and floristic composition: The main dominant trees are: *Fagus sylvatica* in a mixture with *Quercus petraea* and at higher altitudes with *Abies alba* and *Picea abies*. Other species mixture: *Acer pseudoplatanus*, *Betula pendula*, *Sorbus aucuparia*, rarely *Quercus robur*.

Important species found: *Frangula alnus*, *Luzula pilosa*, *Luzula luzuloides*, *Deschampsia flexuosa*, *Melampyrum pratense*, *Hieracium sabaudum*, *Calluna vulgaris*, *Pteridium aquilinum*, *Carex umbrosa*, *Cytisus nigricans*, *Dryopteris dilatata*, *Polygonatum verticillatum*, *Festuca altissima*, *Oxalis acetosella*, *Senecio ovatus*, *Gymnocarpium dryopteris*, *Rubus idaeus*, *Vaccinium myrtillus* (Table 3).

Table 3. *Rhododendron luteum* field surveys in Lendorf (Austria)

Field survey number	1	2	3
Altitude	650 m	670	678
Exposition	N	NV	NE
Herb cover (%)	100	100	90
Sample area (m2)	20	20	10
<i>Fagus sylvatica</i>	5	5	5
<i>Quercus petraea</i>	1	+	1
<i>Rhododendrum luteum</i>	1	+	+
<i>Abies alba</i>	+	-	-
<i>Picea abies</i>	-	+	-
<i>Acer pseudoplatanus</i>	+	+	+
<i>Betula pendula</i>	+	+	+
<i>Sorbus aucuparia</i>	+	+	-
<i>Vaccinium myrtillus</i>	+	+	+
<i>Frangula alnus</i>	+	-	-
<i>Luzula pilosa</i>	+	+	-
<i>Luzula luzuloides</i>	-	+	+
<i>Deschampsia flexuosa</i>	+	-	+
<i>Melampyrum pratense</i>	-	+	-
<i>Hieracium sabaudum</i>	+	+	-
<i>Calluna vulgaris</i>	+	-	+
<i>Pteridium aquilinum</i>	-	+	+
<i>Carex umbrosa</i>	+	-	+
<i>Cytisus nigricans</i>	-	+	-
<i>Dryopteris dilatata</i>	+	+	-
<i>Polygonatum verticillatum</i>	-	-	+
<i>Festuca altissima</i>	+	-	+
<i>Oxalis acetosella</i>	+	+	-
<i>Senecio ovatus</i>	-	-	+
<i>Gymnocarpium dryopteris</i>	-	+	-
<i>Rubus idaeus</i>	+	+	-

4. Conclusions

Rhododendron hirsutum and *Rhododendron luteum* are two important species for the presented habitats. The habitats have a high conservative value and shelter numerous rare, endemic and endangered plants in areas where they are growing. *Rhododendron hirsutum* has a special ecological role by securing the coast and screes and limiting soil erosion in areas where it grows. *Rhododendron luteum* is declared a natural monument since 1937 in Austria.

The city Lendorf (Carinthia) is the only area where this species is growing at an altitude of 660m. In Poland the plant is on the Red List where it is considered threatened with extinction. *Rhododendron luteum* is also an ornamental plant which is greatly used in landscape design and improvement works in the genus *Rhododendron*. From observations made on the field result that those habitats have a fragile structure and can be easily affected by human activities such as excessive grazing and tourist activities.

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