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Research Article

# Representatives of genus *Sempervivum* in mountain flora of eastern Alps

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**Abstract**

This article is aimed at mapping plants from the genus *Sempervivum* in the area of the eastern Alps, in the mountain pass Passo Stelvio. In august 2012, several expeditions visited Passo Stelvio. They focused on monitoring the houseleeks that naturally occur in this area. The results of the mapping were founding of four species, *S. arachnoideum* L., *S. montanum* L., *S. tectorum* L., *S. wulfenii* Hoppe ex Mert. et Koch., and also six natural hybrids between these species were found and documented.

**Key words:** *Sempervivum*, eastern Alps, mountain flora, houseleek

## INTRODUCTION

*Sempervivum* (houseleeks) is a plant genera with flat, hairy or bold leaves with a rigid tip. Leaves grow in a thick rosette. Flowering stem grows once in a life time, which ranks these plants to monocarpic plants. Flowers are symmetric, androgynous, with 9-20 petals, in pink, red, yellow or white colours. They are best reproduced by young rosettes. The genus contains around 30 species which are naturally spread in south and middle Europe, north Turkey, in Kuakas Mountains, in northern parts of Iran and in northern part of Africa [1]

Significance of the *Sempervivum* family is in their medicinal usage, in chemicals which occur in their parts naturally. *Sempervivum tectorum* L. has a long tradition of using in folk medicine in Alpine regions. Its properties are similar to the properties of aloe plant, and within the whole Europe, *S. tectorum* L. is used as a cure to shingles, dysentery and headaches. It was used with the burns, scald wounds, stings and skin diseases and also for the ear and eye wounds. It should heal corns and warts. The leaves of houseleeks are chewed as a remedy against the toothache. Nowadays, it is used for the burn wounds treatment or for the insect stings. [2, 3] The researches of several authors within the years 1993−2003 mentioned positive effect of *Sempervivum tectorum* L. on healing of liver, its usage as a painkiller and also its stabilizing effect to the cell membranes. [4, 5, 6] This effect is primarily connected with antioxidants and phenolic compounds. The research work of KEKESI et al. (2003) proved that application of *Sempervivum tectorum* L. extract to laboratory rats treated by intraperitorial medicines helped to mitigate the effect of treatment and increased resistance to pain (about 15%) after administration of the extract.

Phytochemical analysis of the plant extract proved the presence of the antioxidative compounds including polyphenols 4,2 w/w% (percent of contents from weight), flavonoids 0,7 w/w% (containing more than 20 different flavones) and polysaccharides 11,2 w/w%. Significant is also the content of the ions for example $Ca^{2+}$ (76.2 mg/g), $K^{+}$ (40.47 mg/g) and $Mg^{2+}$ (17.85 mg/g). [8] Chemical studies of *S. tectorum* L. investigated by ALBERTI et al. (2008), contend in 100 g of sample 0.94 ± 0.07 g of flavones (recount for content of hyperosid), 0.56 ± 0.08 g of polyphenols (recount for content of pyrogallol) and 0.26 ± 0.03 g of procyanidins (recount for content of cyanidin chloride).

Research in 2003, done in vitro and in vivo conditions on the laboratory rats proves that natural polyphenolic compounds and flavonoids in the extract of *Sempervivum tectorum* L. have in rats

proven influence on the intestine diseases caused by the intake of high amounts of cholesterol and triglycerides, mostly on those influenced by the ileum and jejunum. An advantage of the houseleek extract was also its low toxicity. Toxic amount was higher than 2 000 mg per one kilogram of live weight; that is a value which highly excesses the medicinal dose. [7]

## MATERIAL AND METHODS

Passo Stevio(Figure 1) is the highest mountain pass of the eastern Alps. It is situated in the altitude 2 757 meters above sea level, in the area of province Sondrio in the north part of Italy.

Mapping of the Sempervivum species in eastern Alps consisted of four separate trips to the location Passo Stevio in first half of August. During each trip were made several mapping excursions to the different parts of mountain pass during which was all discovered *Sempervivum* plants were photographed (whole plant, leaf detail, flowers if plant was blooming) and determined. The obtained results were also verified by literature and botany researchers in Czech Republic.

## RESULTS AND DISCUSSION

In mapped area we find all three typical Alpine *Sempervivum* species (*S. arachnoideum* L., *S. montanum* L. and *S. tectorum* L.) and besides them we also found and identified *S. wulfenii* Hoppe ex Mert. et Koch and six interspecies hybrids.

***Sempervivum montanum subsp. montanum*** L. Solons thin. Leaves in rosettes are usually 10 x 3 mm (exceptionally can be bigger). Leaves are egg shaped, sharply ended, hairy on both sides. Hairs are short, green and flexible. Flower stem is 50-100 (200) mm high and caries 2-8 (13) flowers, frequently with 11 or 13 petals. Petals are 12-20 x 2 mm big. Flowers are reddish, sometimes yellow flowers occur. Typical signs of subspecies *montanum* is a small rosette (not bigger than 20 mm in diameter), and hairs on the flower stem are longer than those on leaves. It naturally grows in Corsica, Italy, France, Spain (Pyrenees, Alps, north Apennines). It grows in altitudes from 1 700 to 3 000 meters above sea level. [10] 2n = 42. [11]

***Sempervivum tectorum*** L.**,** syn. *Sempervivum assimile* Schott. Perennial herb making clumps of compact, dark green, sometime reddish rosettes of fleshy leaves. Sterile rosettes are 30-80 mm in diameter. Rosettes are open, the ends of leaves pointed out from the centre. Leaves are ovoid, 20-40 mm long and 10-15 sometimes even 20 mm wide. The surface is glabrous, just on the edges ciliate. Ends of the leaves are reddish or red-purple. Flower stem grows from the centre of rosette and is 200-500 mm high. After flowering the whole flower stem dies. Inflorescence is made from 5-15 flowers each on short 3 mm long stem. Flowers have 12-16 petals. Seeds prolonged obpyriform or obovoid, flattish, apex rounded, base with or without wing or tail, 0.9-1.2 x 0.4-0.6 mm. Surface longitudinal ribbed, ribs faint crenate, interspaces with indistinct transverse ribs, orange-brown. [12] Naturally grown in France, Italy, Spain (Pyrenees, Alps, Apennines), and in northern parts of Balkans [10] 2n = 36, 72. [11]

***Sempervivum wulfenii*** Hoppe ex Mert. et Koch.
Slowly growing herbal perennial, making 2-3 rosettes in one growing period which are around 100 mm in diameter. Leaves are grey-green, on the basis purple. Flowers are yellow with purple coloured basis. This species naturally grow in west Alps (Italy, Switzerland and Austria). **[10]** 2n =36 **[11]**

***Sempervivum arachnoideum*** L**.** Small species which makes rosettes just around 25 mm in diameter. Leaves have on tips white, spider web like woolly hair. Flowers are pink. Seeds prolonged obovoid, with a small wing on the apex, base narrowed with hilum, 0.7-0.8 x 0.2-0.3 mm. Surface with longitudinal ribs, lustrous, yellowish-brown [12]. This species naturally occurs in France, Italy, Spain (Pyrenees, Alps, Apennines) [10] 2n = 32 [11]

Beside these four botanical species, we found several natural hybrids. Natural hybridization is common in the genus *Sempervivum*. Research SMITH (1981) done in the Pyrenees on 2 926 plants shows that species as *S. arachnoideum*, *S. montanum* and *S. tectorum* often make mutual hybrids. In the research done in 1971 and 1972, out of 224 plants collected in their natural environment, 138 were determined as natural hybrids of *S. tectorum* and 84 as natural hybrids of *S. arachnoideum*.

In the chosen locality, we found and identified hybrids between *S. tectorum* x *S. arachnoideum* (or between *S. wulfenii* x *S. arachnoideum*), hybrids between *S. montanum* x *S. arachnoideum* (Figure 2), hybrids between *S. arachnoideum* x *S. tectorum* (but this could also be hybrid between *S. montanum* x *S. arachnoideum*), hybrids between *S. tectorum* x *S. arachnoideum*, hybrids between *S. tectorum* x *S. montanum.* Exact identification must be determined by AFLP method (Amplified fragment length polymorphism). This method on the basis of DNA fingerprinting is able to determinate relationships between plant species or cultivars on the molecular level.

In literature it is mentioned that in the eastern Alps are native three species of houseleeks *S. arachnoideum* L., *S. montanum* L. a *S. tectorum* L.

Jeane Bodin in her PhD thesis 2010, in which she observes the changes in vegetation in the Alps in the 20th century, mentioned the *Sempervivum montanum* L. as a species which is stabile in the Alpine flora. This particular species is in her work tagged as one of the five species (in research were totally observed 125 plant species) found in the same locations within the years 1906, 1927, 1972, 1995 and 2003, and referred to as stabile species according to the altitude and number of colonized mountain peaks. [14]

These species are the common part of the Alpine flora, which was also confirmed in this article.

Puscas and Choler, in their research in 2012, were focused on the cluster analysis of the grasslands with dominant occurrence of *Carex curvula* All. They monitored 853 localities in the Alps in the altitudes from 2 200 to 2 700 meters. Their results shown that houseleek *Sempervivum montanum* L. was represented in 37% of all phytosociological maps, mostly in the maps that were made in the locations with shallow soils on the mountain peaks and in marginal habitats. [15]

The Alpian houseleeks grow in xerothermal sites and can survive 7-8 months of snow. So they belong to the group of semi chionophile plants. Main growing period of these plants is in spring (V-VI) and flowering period in summer (VII-IX). *S. montanum* L. occurs in the altitudes from 1 800 to 2 300 meters above sea level, Barun even mentions an altitude of 3 250 meters. *Sempervivum arachnoideum* L. and *Sempervivum tectorum* L. are common in habitats in altitudes from 600 to 2 800 meters. [16] This shows that houseleeks are plants extremely resistant to the climatic conditions, which is proved by many authors and their researches.

We find all three mentioned species in Passo Stevio location which altitude is referred as 2 757, what is close to the upper level for the *S. tectorum* L. and *S. arachnoideum* L., and above the upper limit for *S. montanum* L.

Larcher et al. in 2010 examined resistance of high mountains flora to the extreme temperatures. Their research was based on the assumption that mountain plants can during summer survive a short term swing which is higher than average temperatures in the summer months. In the clear and windless days, the leaf rosette in plants can be oriented to the south warm to the temperature 40 or even 50 °C. The experiment proved that *Sempervivum arachnoideum* L. and *S. tectorum* L. have the ability to survive, for the short period of time, temperatures around 62–64 °C. [16] This research was followed by ZAHARIA et al. (2010) by experiment, in which they examine the resistance of *S. montanum* L. and *S. tectorum* L. to the extreme conditions. Rosettes of these two species were exposed to a temperature of 50 °C, light intensity of 90 000 lux together with dry soil conditions. The results of experiment show that in 13 days the weight of rosettes decreased by 52 % in *S. tectorum* L. and for 63 % in *S. montanum* L. According to these results, both the species were evaluated as extremely resistant and it was proved that irreversible degradation of tissues began after 6−7 days from the start of the experiment.

Also resistance to the low temperatures is significant for the *Sempervivum* plants. When the leaves of *S. montanum* were exposed to the low temperatures during the summer growing period, they were damaged by a temperature -5 °C, at temperatures from -6 to -7 °C, half of the rosette died, by the temperatures from -8 to -9 °C the whole rosettes died. But when the plants were treated with zero temperatures for three days, the resistance of leaf rosettes increased by 5 degrees (the leaves started to die at -13 °C), when the cold period was even longer the lethal temperature was lowered again, to the -25 °C. [16] This shows that the resistance of houseleeks is connected to their metabolism.

Experiments with *Sempervivum montanum* L. from 1981 prove that when we change the light and temperature conditions, the plant is able to switch from CAM metabolism, typical for the *Crassulaceae* family, to the $C_3$ type of metabolism. [19] In *Crassulaceae* 99% of assimilation of $CO_2$ ongoing in the night, which stimulated hypothesis that this kind of metabolism is very adaptable to the outer conditions. [17] WAGNER and LARCHER (1981) experimentally proved that CAM metabolism is evolutionary adaptation useful not just for extremely dry conditions but also for climatic conditions of high mountains in which there are high swings in temperatures. The experiment proved the intake of $CO_2$ at temperatures from -2 °C to 45 °C, and $CO_2$ processing at temperatures from -2 °C to 35 °C.

## CONCLUSION

The area of Passo Stevio is, from the botanical point of view, a very interesting locality. Good accessibility by car makes it a perspective locality for a research of the alpine flora. Our research confirms information from the literature about the species' occurrence of genus *Sempervivum* plants. We confirm presence of all the three most common Alpine houseleeks and also found six natural hybrids, whose exact determination must be confirmed by molecular methods.

**Figure 1**
**The research area of Passo Stevio**

**Figure 2**
**Hybrid between S. montanum and S. arachnoideum**

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