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Abstract

A new two short needle hard pine species of Genus Pinus (*P. microphylla* Blada) is described. It occurs in the Romanian Pietrosul Rodnei Massif, between 1646 to 1890 m elevation. It has been found only at high elevations, always associated with mugo pine, most frequently on rocky ledges and on shallow soils on steep subalpine slopes. The species occurs in shrub-like form with stems lying on the ground then up-arching given rise to several crown shapes. Crown diameter, 2 (0.2-4.5) m, normal crown height 1.1 (0.2-2.5) m, and longest extended stem in crown 1.5 (0.3-3.2) m long, i. e. 193.3 % shorter than mugo pine. Annual twig height growth 4.0 (2.0-7.5) cm long, i. e. 167.5 % slower growing than mugo pine.

The species has two needles in each bundle, slightly curved, somewhat twisted and pointed. The needles are 1.5 (1.2-1.8) cm long, 293.3 % shorter than those of mugo pine; the foliage is blackish compared to the dark green foliage of mugo pine. Bundle-sheath hyaline to slightly rose, 7.4 (5.3-9.5) mm long in early first season; beneath the fascicle-sheath, a darkish brown color lanceolate sharp-pointed bract is present. Buds are darkish brown to blackish-brown, ovoid sharp-pointed, 7.2 (6.1-8.3) mm long, 62.5 % shorter than mugo pine. Male strobili are cherry-variegated color, irregular or cylindrical shape, 2.1 (2.0-2.3) cm long, 57.1 % shorter than mugo pine. Female strobili are purplish to reddish-tan color before pollination, but dark bluish to blackish color and spherical shape after pollination, 8.7 (8.5-8.8) mm long, 19.5 % shorter than mugo pine. Seed cones are light shiny brown during the vegetative period, darkish brown to maturity, globular ovoid, 2.3 (2.2-2.4) cm long, 1.7 (1.6-1.8) cm diameter, very short-stalked, borne single or two in cluster, rhombic apophysis, dark brown raised umbo with a short central tiny prickle at the tip; on lowest scales the tips turn downward. Seed cone length and seed cone diameter were 52.2 % and 23.5 %, respectively, shorter than those of mugo pine.

Key words: *Pinus mugo, P. uncinata, P. microphylla* sp. nova, hard pine, high elevation habitat, short-blackish needles, blackish crown, slow growing.

1. INTRODUCTION

The natural variation of the *Pinus mugo* Turra complex, including *P. uncinata* Ramond ex DC. has given rise to many species, subspecies and varieties being named by successive generations of botanists in an attempt to impose taxonomic order. Due to its high variability, this complicated group has not been taxonomically resolved yet. Most problems have been caused by some previously described which often more or less overlap or are based on insufficiently researched and unsuitably interpreted characters. In order to make the information available and useful, the information has been compiled (Hamernik & Musil 2007) with the most frequent names used in the past and sorted in a tabular manner, into a convenient synoptic schedule, respecting the present concepts of the complex and assigned them with the present most commonly used names.

A morphometric study of the *P. mugo* complex and its natural hybridization with *P. sylvestris* was published by Christiansen (1987b). Subsequently, a detailed paper discussing the mugo pine complex, including hybrids with *P. sylvestris* L. and an informative distribution map of the various taxa has been published by Businsky & Kirschner (2010).

Most authors, including Farjon (2010), now accept two species i. e. *P. uncinata* Ramond ex D.C. and *P. mugo* Turra with two subspecies: ssp. *mugo* Turra and ssp. *rotundata* (Link) Janch. & H. Neumayer).

Previously *P. uncinata* was treated either as a subspecies i. e. *P. mugo* ssp. *uncinata* (Ramond) Domin, or as a separate species i.e *P. uncinata*.

Pinus uncinata is distributed in the Alps (mainly in Switzerland), the Massif Central, and the Pyrenees, between 1000-2300 m, occasionally as low as 200 m, in frost hollows and pit bog habitats from NE Germany, but it is absent from SE Europe. It is a tree to 12-20 m tall, with bright to dark green leaves (23-75 mm long), persistent bundle sheaths (15-18 mm long), male strobili length of 10 mm, seed cones 25-60 mm long, 20-40 mm wide; apophyses thick, strongly pyramidal on outer side of cone, 6-10 mm wide, outer scale apophyses 4-9 mm thick, inner apophyses 3-4 mm thick; umbo at apex of apophyses, with a pronounced 1 mm prickle. The foliage characters of the *P. uncinata* are identical to those from ssp. *mugo*; the two taxa being separable only on habit and cone characters (Christensen, 1987 b).

Pinus mugo ssp. mugo is native to central and southeastern Europe, ranging from the Swiss-Austrian border in the Alps to the Erzgebirge (eastern Germany,

Czech Republic), the Tatra and Carpathian Mountains (Slovakia, Poland, west of Ukraine) and southeast through Croatia and Romania to Bulgaria, with western outliers to the Vosges and French Alps and an isolated population in the central Italian Apennines (Richardson 1998). It grows mostly in subalpine regions between 1400 and 2700 m, but also at lower altitudes in peat bogs and frost hollows down to 200 m in southeastern Germany and southern Poland (Christensen 1987 b), while in the Swiss National Park, the species ranges from 1400 to 3173 m above sea level (Bigler 2016). It occurs on granitic and limestone slopes and ridges (Auders & Spicer 2014). It is a shrub 3 (1-5) m tall, with branches base laying on the ground but ascending up to 10 m. The buds are ovoid-conic, 6-9 mm long, red-brown and very resinous. Needles occur in bundles of two, and are bright to dark green, straight to slightly twisted, 23-75 mm long, with a persistent grey leaf sheath, 15-18 mm long. Male cones color can be yellow or red. Female cones are purple ripening to matte dark brown in late September to October, and 18-55 mm long; apophysis thin, flat, flexible, 6-10 mm wide, rhomboidal, rarely pyramidal; umbo central, 3-4 mm wide. The seed are black, 3-4 mm long, with a 7-12 mm wing buff with darker streaks (Jovanovic 1986, Christensen 1987 b).

The *P mugo* ssp. *rotundata* ((Syns. P. *pseudopumilio* (Wilk.) Beck; *P. uncinata* Ramond ex DC.; *P. uncinata* Ramond ex DC. ssp. *uliginosa* (Neuman ex Wimm.) Businsky; *P. uliginosa* Neuman ex Wimm)) occurs in Pyrenees, Auvergne Mts., Alps, Erzgebirge, Bohmerwald, Sudeten and northwest Carpathians (Tatra). It is exclusively restricted to small upland peat bogs which are small lakes or ponds filled in with sphagnum peat since the last Ice Age. It is mostly found in peat bogs and on moorland from 450 to 750 m elevations (Auders & Spicer 2014).

According to Farjon (2010), the ssp. *rotundata* is native to Austria, Czech Republic, France (mainland), Germany, Italy (mainland), Poland, Switzerland. This subspecies is a low shrub when occurs on wet soil, but tall tree when grows on dry soil; confined to middle elevations in the mountains of central Europe, in Poland down to 180 m above sea level (Rehder 1960, 1986) reported that the ssp. *rotundata* is a shrub or small tree, differing from ssp. mugo in being a taller tree type, usually up to 10 m.

There have been many horticultural cultivars named over the years, mostly dwarf derived from seed or witches' brooms (Auders & Spicer 2014), but they will not be taken into consideration here.

So far, in the Romanian Carpathians, the *P. mugo* (syn. *P. montana* Mill., P. *mughus* Scop., *P. pumilio* Haenke) was reported as:

- ssp. *mughus* (Scop.) Willk. in Carpathians and ssp. *pumilio* (Haenke)

Zenary in the Dofteana Arboretum (Dumitriu-Tătăranu 1960);

- var. *mughusand* var. *pumilio* (Haenke) Zenary, but no location indicated (Beldie 1952);

- ssp. *mughus* distributed in all Carpathians between 1000 m in the Oaş Mts. and 2300 m elevation in Southern Carpathians (Negulescu & Săvulescu 1957).

- *P. mugo* occurs in all Carpathians but, var. *pumilio* (Scop.) Zenary with doubtful occurrence in the Maramureş Mts. (Beldie 1952, Stănescu et al. 1997); but, Farjon (2010) agrees that the *P. pumilio* Haenke and *P. mugo* var. *pumilio* are synonyms of the ssp. *mugo* (Scop.) Zenary.

- var. *mughus* (Scop.) Zenary spread in all Romanian Carpathians (Şofletea & Curtu 2007).

- Stănescu et al. (1997) have reported that the *P. mugo* ssp. mugo covers the whole Romanian Carpathians range, and Farjon (2010) and Auders & Spicer (2014) support that all the other previously reported taxa are synonyms.

According to the Romanian literature investigated and to our field explorations, as well, the *P. mugo* ssp. *rotundata* and the *P. uncinata*, do not occur in the Romanian Carpathians.

The aim of this paper was:

(i) to present the results of the field exploration concerning the species nova shrubs identification, their geographic coordinates by GIS methodology estimation, field observations and measurements of the identified shrubs, lab observations and measurements on the biological materials (twigs with needles and buds, and flowers, seed cones) collected from the field;

(ii) to describe and illustrate, via pictures, the quantitative and qualitative traits of the analyzed species nova and mugo pine shrub samples;

(iii) to estimate the statistical parameters of the quantitative traits of the species nova and mugo pine species shrub samples, which occur in the same environment, and to calculate the differences (%) between them;

(iv) based on the acquired field and lab results, a general description of the species nova will be done.

2. MATERIALS AND METHODS

2.1 Field exploration

The mugo pine populations from the six geographic components of the Pietrosul Rodnei Massif (Fig. 1) were investigated and within them, several species nova shrubs were identified and described.

Fig. 1 The general view of the Pietrosul Rodnei Massif (2303 m elevation) and its surrounding geographic components (from the left to the right): Zănoaga Iezer Cirque Glacier, Piciorul Moşului Mt. Ridge, Zănoaga Mare Cirque Glacier; here the species nova occurs (Photo: P. Zaharia)

2.2 Plant material sampled for study

Six species nova shrubs, of different ages, were sampled to be described as representatives of this species. Similarly, in the close proximity of each of the species nova sampled shrub, six mugo pine shrubs were sampled and described as representatives of this species. Using the two sets of the sampled shrubs, a comparison study between the two species was done. The geographic locations of the six paired samples are shown in Table 1.

Table 1 Geographical coordinates of the *P. microphylla* sampled shrubs from the Pietrosul Rodnei Massif

Row	The sampled shrubs places	Shrub	Age	Geographic coordinates			Slope	Aspect
		#	Years	Latitude	Longitude	Alt.(m)	(°)	
0	1	2	3	4	5	6	7	8
1	Zănoaga Mare Cirque Glacier	1	42	47°36'22"	24°38'31"	1,646	20	N
2	Zănoaga Mare Cirque Glacier	2	38	47°36'23"	24°38'31"	1,647	20	N
3	Zănoaga Iezer Cirque Glacier	3	65	47°36'08"	24°38'43"	1,877	41	NNE
4	Piciorul Moşului Mt. Ridge1	4	51	47°36'12"	24°38'44"	1,890	38	NNE
5	Piciorul Moşului Mt. Ridge 2	5	16	47°36' 11"	24°38'45"	1,879	35	NNE
6	Piciorul Moşului Mt. Ridge 3	6	10	47°36' 11.3"	24°38'46"	1,877	32	NNE

Legend: N = North; E = East

2.3 Field measurement and observations

The following data were collected from each selected shrub of the two species:

- the shape and color of the crown;
- the longest extended stem from the crown;
- the number of branches per whorl counted on the longest extended stem;
- the length of each internode (annual twig height growth) was measured across the longest extended stem.

The shrub age was estimated according to the number of nodes on the longest extended stem. It should be taken into account that we believe this method of age evaluation proved to be enough accurate, across the whole longest extended stem, except on about 10 cm fragment from the thicker, i.e. oldest extremity of the measured stem. According to our experience, a mugo pine seedling usually reach such a length in about 3-4 years. Therefore, the potential age error, is negligible.

2.4 Botanical material collection

Two categories of materials were collected.

The first category consisted of twigs with needles and buds and mature seed cones from species nova and mugo pine species, to be used for herbarium archiving. Two herbarium sheets were created and distributed to two institutions, i.e. to the Academy Institute of Biology from Bucharest.

The second category consisted of material to be used for lab measurements and observations, collected from each pair of the six sample shrubs of the two species, such as: needles, buds, male and female strobili and mature seed cones. Note: at the collection year, the species nova shrubs number 3; 5 and 6 were not bearing male and female strobili and seed cones.

In order to get realistic averages for needles length, the needles were collected from the last three internodes i.e. 2015, 2014 and 2013 year twigs. However, for needle fascicle sheath length measurements and bract observations, needles were collected early June 2015, from one year old twigs, only.

2.5 Lab measurements and observations

The following measurements and observations were made for each shrub for each set of collected materials for the two species:

- needle or bundle length, shape, and color;
- bundle sheath length, shape, and color;
- bud length and diameter, shape, and color;
- male strobili length, shape, and color;
- female strobili length and diameter, shape, and color;
- seed cone length and diameter, shape, and color;

A total of 15 quantitative traits were measured (Table 2) of which 11 were statistically analyzed.

Table 2 The measured quantitative traits of the sampled shrubs

Nr	Traits	Unit	Symbol
	Non-statistically analyzed		
1	Shrub age	Years	SA
2	Average crown diameter	m	ACD
3	Normal crown height	m	NCH
4	Longest extended stem in crown	m	LESC
	Statistically analyzed		
5	Branches per whorl	#	BW
6	Annual twig height growth	cm	ATHG
7	Needle length	cm	NL
8	Bundle-sheath length	mm	FSL
9	Bud length	mm	BL
10	Bud diameter	mm	BD
11	Male strobili length	cm	MSL
12	Female strobili length	mm	FSL
13	Female strobili diameter	mm	FSD
14	Seed cone length	cm	SCL
15	Seed cone diameter	cm	SCD

2.6 Statistical parameters of the quantitative traits

Using the data collected from the six sampled shrubs of the two species, a statistical row variation data for each trait was obtained; based on row variation data, six statistical parameters (trait mean, interval of variation (minimum and maximum values), amplitude of variation, coefficient of variation, variance, standard deviation) were estimated (Ceapoiu 1968) for each of the 11quantitative traits.

The average differences (D %) between each pair traits of the two species were calculated according to the Hallauer & Miranda (1981) formula, adapted to this case:

$$D_{\%} = ((S_1-S_2)/S_2)*100$$

where: S_1 and S_2 are the average traits of the *P. mugo* and the *P. microphylla* species, respectively.

3. RESULTS

3.1 Native habitat of the species

The short needle stone pine (*P. microphylla*), a new native multi-stem dwarf two needle hard pine species was found and described in this paper.

This shrub occurs naturally in the Pietrosul Rodnei Massif, namely in some of its geographic components, such as: Zănoaga Mare Cirque Glacier, Zănoaga Iezer Cirque Glacier and Piciorul Moşului Mt. Ridge (Fig. 1). So far, the species has been found on north-eastern, north and north-western oriented slopes between 47°36' 08" and 47°36'23" North latitude, 24°38'31" and 24°38' 46" East longitudes and between 1646 to 1890 m altitudes (Table 1).

The species grows rarely on humic and relatively deep loamy soils, but is more frequent found on rocky ledge sand debris shallow soils from sub alpine steep slopes. Habitually, it occurs mixed with mugo pine, but it also is found associated scattered single or clumps of other tree species, like cembra pine (*Pinus cembra* L.), spruce (Picea abies (L.) Karst., juniper (*Juniperus communis* L. ssp. *nana* (Willd.) Syme, rowan (*Sorbus aucuparia* L.), willow (*Salix capraea* L), green alder (*Alnus viridis* (Chaix) DC, hind berry (*Rubus idaeus* L.), red elderberry (*Sambucus racemosa* L.), as well as some sub-shrubs, like alpenrose (*Rhododendron myrtifolium* Schott et Kots.), blueberry (*Vaccinium myrtillus* L.) and cowberry (*Vaccinium vitis-idaea* L.). It should be pointed out that Coldea (1990) has published a comprehensive geo-botanic study from the Rodnei Mountains, including the Pietrosul Massif.

Based on the multiple field explorations and literature investigations, it should be stressed that neither *P. uncinata* and *P. sylvestris* L. species, nor *P rotundata* subspecies have been found or reported in both Pietrosul Rodnei Massif and in its surrounding areas, so that any hybridization among these taxons was possible; consequently, the hybrid origin of the species nova has to be excluded.

3.2 Habitat, size and form of the sampled species nova shrubs

Shrub 1

Habitat - Occurs on gentle slope from the bottom of the Zănoaga Mare Cirque Glacier, on a relatively deep humic-loamy fertile soil, at the geographic coordinates and gradients indicated in Table 1 (row 1).

Size and form – The spreading ascending multi-stems and their branches have given rise to a dense round shape blackish color crown. At age 42, its average diameter crown measured 3.2 m, normal crown height 2.5 m, while the longest extended stem from crown has reached 3.2 m (Table 3, rows 1 to 4, col. 3).

Shrub 1 was the tallest found, not only among the six sampled shrubs, but among any other individual of the species found during the exploration period. Its blackish color crown is highly contrasting with the green mugo pine crown. Frequently, it produces flowers and seed cones (Fig. 2a, 2b), and seeds with endosperm and embryo but, no viability testing of the seed has been done.

Fig. 2a The species nova Shrub 1, blackish crown with seed cones on it (right-back-side); mugo pine, green crown (left-front-side) (October, 2015) (Photo I. Blada)

Fig. 2b The species nova Shrub 1 in full blossom (early June, 2015 year) (Photo I. Blada)

Table 3 Quantitative traits and statistical parameters [1)] of the individual six sampled shrubs of *P. microphylla* and their average performances, as compared to the average performances of *P. mugo* samples (Research data based on the sampled shrubs from the Pietrosul Massif)

Row	Traits and statistical parameters	Unit	*Pinus microphylla*								*P. mugo*[2)]	
			Shrub 1	Shrub 2	Shrub 3	Shrub 4	Shrub 5	Shrub 6	**Average**	**Range[2)]**	**Average**	**Range**
0	1	2	3	4	5	6	7	8	9	10	11	12
1	Shrub age (SA)	Years	42	38	65	51	16	10	**37**	**10.. 65**	**41**	**37-47**
2	Average crown diameter (ACD)	m	3.2	1.8	4.5	2.1	0.35	0.15	**2.0**	**0.2-4.5**	**5.8**	**2.3-7.6**
3	Normal crown height (NCH)	m	2.5	1.1	0.7	1.6	0.24	0.19	**1.1**	**0.2-2.5**	**3.6**	**2.5-4.6**
4	Longest extended stem LESC)	m	3.2	1.8	1.3	2.2	0.40	0.30	**1.5**	**0.2-3.2**	**4.4**	**3.9-4.7**
5	**Branches per whorl (BW)**											
	a. Average	#	2.2	2.0	1.5	2.2	1.5	1.5	**1.8**	**1.5-2.2**	**3.0**	**2.6-3.2**
	b. Range	#	1.0-5.0	1.0-3.0	1.0-2.0	1.0-5.0	1.0-3.0	1.0-3.0	**1.0-3.5**	**1.0-5.0**	**1.3-4.5**	**1.0-5.0**
	c Amplitude of variation	#	4.0	2.0	1.0	4.0	2.0	2.0	**2.5**	**1.0-4.0**	**3.25**	**3.0-4.0**
	d Coefficient of variation	%	53.3	31.4	33.7	46.2	43.2	43.2	**41.8**	**31.4-53.3**	**30.2**	**22.0-43.7**
	e Variance	-	1.318	0.393	0.25	1.078	0.420	0.420	**0.647**	**0.250-1.318**	**0.882**	**0.447-1.830**
	f. Standard deviation	-	1.148	0.627	0.5	1.038	0.648	0.648	**0.768**	**0.500-1.148**	**0.901**	**0.669-1.353**
6	**Annual twig growth (ATHG)**											
	a. Average	cm	7.5	4.7	2.0	4.3	2.3	3.0	**4.0**	**2.0-7.5**	**10.7**	**9.7-12.7**
	b. Range	cm	2.0-12.0	2.0-7.7	1.0-4.1	1.2-8.5	1.5-3.5	2.0-3.6	**1.5-6.4**	**1.0-12.0**	**2.9-19.5**	**1.5-27.0**
	c. Amplitude of variation	cm	10.0	5.7	3.0	7.3	2.0	1.6	**4.9**	**1.6-10.0**	**16.625**	**12.0-23.0**
	d. Coefficient of variation	%	38.4	33.6	33.6	50.6	27.2	16.4	**33.3**	**16.4-50.6**	**41.381**	**31.4-52.1**
	e. Variance	-	8.309	2.532	0.445	4.677	0.373	0.236	**2.762**	**0.236-8.309**	**22.201**	**10.1-43.6**
	f. Standard deviation	-	2.883	1.591	0.667	2.163	0.611	0.486	**1.400**	**0.486-2.883**	**4.509**	**3.181-6.604**
7	**Needle length (NL)**											
	a. Average	cm	1.7	1.2	1.7	1.8	1.3	1.3	**1.5**	**1.2-1.8**	**5.9**	**5.4-6.4**
	b. Range	cm	1.0-2.1	0.9-1.6	1.1-2.9	1.1-2.7	0.9-2.2	1.0-1.6	**1.0-2.2**	**0.9-2.9**	**4.6-7.4**	**4.0-7.7**
	c. Amplitude of variation	cm	1.1	0.7	1.8	1.6	1.3	0.6	**1.2**	**0.6-1.8**	**2.825**	**1.6-3.5**
	d. Coefficient of variation	%	12.3	13.2	18.1	19	22.2	13.9	**16.5**	**12.3-22.2**	**12.4**	**6.4-16.3**
	e. Variance	-	0.042	0.026	0.093	0.111	0.083	0.030	**0.064**	**0.026-0.111**	**0.578**	**0.150-0.939**
	f. Standard deviation	-	0.205	0.160	0.306	0.334	0.289	0.175	**0.245**	**0.160-0.334**	**0.730**	**0.388-0.969**
8	**Bundle-sheath length (BSL)**											
	a. Average	mm	8.7	6.7	8.0	9.5	6.0	5.3	**7.4**	**5.3-9.5**	**14.4**	**13.3-15.3**
	b. Range	mm	5.0-13.0	5.0-10.	5.0-11.0	7.0-12.0	5.0-8.0	4.0-7.0	**5.2-10.2**	**4.0-13.0**	10.5-17.8	**10.0-19.0**
	c. Amplitude of variation	mm	8.0	5.0	6.0	5.0	3.0	3.0	**5.0**	**3.0-8.0**	**7.25**	**7.0-8.0**
	d. Coefficient of variation	%	18.9	16.8	16.9	11.2	15.1	14.4	**15.6**	**11.2-16.9**	**12.1**	**10.7-13.6**
	e. Variance	-	2.676	1.270	1.836	1.126	0.824	0.588	**1.387**	**0.588-2.676**	**3.030**	**2.271-3.818**
	f. Standard deviation	-	1.636	1.127	1.355	1.061	0.907	0.767	**1.142**	**0.767-1.636**	**1.733**	**1.507-1.954**

Table 3 (cont.inued)

Row	Traits and statistical parameters	Unit	*Pinus microphylla*								*P. mugo*[2)]	
			Shrub 1	Shrub 2	Shrub 3	Shrub 4	Shrub 5	Shrub 6	**Average**	**Range[2)]**	**Average**	**Range**
0	1	2	3	4	5	6	7	8	**9**	**10**	**11**	**12**
9	**Bud length (BL)**											
	a. Average	mm	8.1	6.7	6.1	6.5	8.3	7.5	**7.2**	**6.1-8.3**	**11.7**	**9.0-14.1**
	b. Range	mm	4.0-11.0	5.0-9.0	4.5-8.0	5.0-9.0	7.0-10.0	7.0-9.0	**5.4-9.3**	**4.0-11.0**	**9.0-14.8**	**6.0-18.0**
	c. Amplitude of variation	mm	7.0	4.0	3.5	4.0	3.0	3.0	**4.1**	**3.0-7.0**	**5.75**	**5.0-7.0**
	d. Coefficient of variation	%	22.0	14.7	14.8	16.3	12.5	12.3	**15.4**	**12.3-22.0**	**13.5**	**12.4-14.6**
	e. Variance		3.164	0.957	0.819	1.125	1.071	0.857	**1.332**	**0.819-3.164**	**2.505**	**1.709-3.775**
	f. Standard deviation		1.779	0.978	0.905	1.061	1.035	0.926	**1.114**	**0.905-1.779**	**1.566**	**1.307-1.943**
10	**Bud diameter (BD)**											
	a. Average	mm	4.8	3.8	3.5	3.6	3.8	3.5	**3.8**	**3.5-4.8**	**5.6**	**4.6-6.0**
	b. Range	mm	2.0-6.0	2.5-5.0	3.0-4.5	3.0-5.0	3.0-4.0	3.0-4.0	**2.8-4.8**	**2.0-6.0**	**3.8-7.9**	**3.0-9.0**
	c. Amplitude of variation	mm	4.0	2.5	1.5	2.0	1.0	1.0	**2.0**	**1.0-4.0**	**4.1**	**3.0-5.0**
	d Coefficient of variation	%	32.5	17.9	13.3	17.1	12.3	15.3	**18.1**	**12.3-32.5**	**19.2**	**14.9-22.5**
	e Variance	-	2.478	0.453	0.223	0.371	0.214	0.286	**0.671**	**0.214-2.478**	**1.212**	**0.657-1.752**
	f. Standard deviation	-	1.574	0.673	0.472	0.609	0.463	0.535	**0.721**	**0.463-1.574**	**1.077**	**0.811-1.323**
11	**Male strobili length (MSL)[3)]**											
	a. Average	cm	2.2	2.0	0	2.3	0	0	**2.1**	**2.0-2.3**	**3.3**	**3.0-3.6**
	b. Range	cm	1.2-4.7	1.2-3.5	0	1.2-3.5	0	0	**1.2-3.9**	**1.2-4.7**	**1.8-4.8**	**1.3-5.8**
	c Amplitude of variation	cm	3.5	2.3	0	2.3	0	0	**2.7**	**2.3-3.5**	**3.0**	**2.1-4.5**
	d Coefficient of variation	%	34.8	33.3	0	33.7	0	0	**33.9**	**33.3-34.8**	**23.3**	**17.7-31.3**
	e Variance	-	0.606	0.439	0	0.576	0	0	**0.540**	**0.439-0.606**	**0.656**	**0.336-1.238**
	f. Standard deviation	-	0.779	0.663	0	0.759	0	0	**0.734**	**0.663-0.779**	**0.782**	**0.580-1.113**
12	**Female strobili length (FSL)**											
	a. Average	mm	8.8	8.5	0	8.7	0	0	**8.7**	**8.5-8.8**	**10.4**	**8.9-11.3**
	b. Range	mm	7.0-11.0	7.0-10.0	0	7.0-10.0	0	0	**7.0-10.3**	**7.0-11.0**	**8.5-12.3**	**7.0-13.0**
	c Amplitude of variation	mm	4	3	0	3	0	0	**3.3**	**3.0-4.0**	**3.75**	**3.0-5.0**
	d Coefficient of variation	%	12.619	12.423	0	12.075	0	0	**12.4**	**12.1-12.6**	**9.7**	**8.4-12.7**
	e Variance	-	1.242	1.124	0	1.095	0	0	**1.154**	**1.095-1.242**	**0.986**	**0.861-1.271**
	f. Standard deviation	-	1.115	1.060	0	1.047	0	0	**1.074**	**1.047-1.115**	**0.990**	**0.928-1.127**
13	**Female strobili diameter(FSD)**											
	a. Average	mm	7.9	7.7	0	7.8	0	0	**7.8**	**7.7-7.9**	**8.3**	**6.9-9.0**
	b. Range	mm	6.0-10.0	6.0-9.0	0	6.0-9.0	0	0	**6.0-9.0**	**6.0-10.0**	**7.5-9.8**	**6.0-10.0**
	c. Amplitude of variation	mm	4.0	3.0	0	2.0	0	0	**3.0**	**2.0-4.0**	**2.3**	**1.0-3.0**
	d Coefficient of variation	%	14.7	12.7	0	11.0	0	0	**12.8**	**11.0-14.7**	**8.4**	**5.1-12.0**
	e Variance	-	1.356	0.952	0	0.743	0	0	**1.017**	**0.743-1.356**	**0.470**	**0.207-0.674**
	f. Standard deviation	-	1.165	0.976	0	0.862	0	0	**1.001**	**0.862-1.165**	**0.669**	**0.455-0.821**

Table 3 (continued)

Row	Traits and statistical parameters	Unit	*Pinus microphylla*								*P. mugo*[2)]	
			Shrub 1	Shrub 2	Shrub 3	Shrub 4	Shrub 5	Shrub 6	**Average**	**Range[2)]**	**Average**	**Range**
0	1	2	3	4	5	6	7	8	9	10	11	12
14	**Seed cone length (SCL)**											
	a. Average	cm	2.4	2.2	0	2.3	0	0	**2.3**	**2.2-2.4**	**3.5**	**3.2-3.9**
	b. Range	cm	2.1-2.9	2.0-2.6	0	2.0-2.6	0	0	**2.0-2.7**	**2.0-2.9**	**2.4-4.8**	**2.2-5.8**
	c. Amplitude of variation	cm	0.8	0.6	0	0.6	0	0	**0.7**	**0.6-0.8**	**2.4**	**1.7-3.6**
	d Coefficient of variation	%	8.4	8.9	0	9.2	0	0	**8.8**	**8.4-9.2**	**15.5**	**12.2-17.4**
	e Variance	-	0.042	0.040	0	0.043	0	0	**0.042**	**0.040-0.043**	**0.301**	**0.161-0.459**
	f. Standard deviation	-	0.205	0.200	0	0.208	0	0	**0.204**	**0.200-0.208**	**0.540**	**0.402-0.677**
15	**Seed cone diameter (SCD)**											
	a. Average	cm	1.8	1.6	0	1.7	0	0	**1.7**	**1.6-1.8**	**2.1**	**2.0-2.2**
	b. Range	cm	1.6-2.0	1.5-2.0	0	1.5-2.0	0	0	**1.5-2.0**	**1.5-2.0**	**1.7-2.4**	**1.5-2.6**
	c. Amplitude of variation	cm	0.4	0.5	0	0.5	0	0	**0.5**	**0.4-0.5**	**0.775**	**0.5-1.0**
	d Coefficient of variation	%	13.2	9.427	0	9.3	0	0	**10.6**	**9.3-13.2**	**8.6**	**6.2-10.2**
	e Variance	-	0.018	0.024	0	0.024	0	0	**0.022**	**0.018-0.024**	**0.035**	**0.016-0.052**
	f. Standard deviation	-	0.132	0.155	0	0.154	0	1	**0.147**	**0.132-0.155**	**0.183**	**0.127-0.228**

[1)] Some statistical parameters like coefficient of variation, variance and standard deviations were not detailed in the paper but, if necessary, the reader is kindly encouraged to perform himself the respective analysis.

[2)] Average of the six sampled *P. mugo* shrubs growing in the vicinity of each of the six *P. microphylla* ones.

[3)] During the exploration period, the shrubs 3; 5; and 6 were not in blossom, so that they had not seed cones;

Shrub 2

Habitat – It grows in a relatively open space, between two stones, on rocky ledge soil, on a gentle slope from the bottom of the Zănoaga Mare Cirque Glacier, at the geographic coordinates and gradients inserted in Table 1 (row 2).

Size and form - The spreading ascending multi-stems and their branches have given rise to a short tree with round - shape-crown, in late autumn blackish color, highly contrasting with the light green of the mugo pine behind it (Fig. 3).

At age 38, its average crown diameter measured 1.8 m, normal crown height 1.1 m, while the longest extended stem in crown has reached 1.8 m length (Table 3, rows 1 to 4, col. 4). Frequently and abundantly it produces seed cones.

Fig. 3 The species nova Shrub 2 in front, with a mugo pine shrub behind it (both in late autumn color) (Photo I. Blada)

Shrub 3

Habitat - Open grown shrub, growing between two massive mugo pine shrubs, on a rocky ledge soil of steep slope from the Zănoaga Iezer Cirque Glacier, at the geographic coordinates and gradients indicated in Table 1 (row 3).

Size and form – At age 65, resulted a huge bush, with a wide flat-topped rhombic crown of 4.5 m average diameter, 0.7 m average normal crown height and the longest extended stem only 1.3 m (Table 3, rows 1 to 4, col. 5). The crown color is dark green in growing season and blackish in late autumn, sharply contrasting with the light green mugo pine shrub left of it (Fig. 4).

No male and female strobili and seed cones bearing in the last five years was noted.

Fig. 4 The unusually large dark green to blackish crown of the species nova Shrub 3 (right side) growing near a mugo pine bush (left side), in the upper part of the Zănoaga Iezer Cirque Glacier (Photo I. Blada)

Shrub 4

Habitat - The shrub is growing on a rocky ledge soil, just on the ridge of the Piciorul Moşului Mt., at the geographic coordinates and gradients indicated in Table 1 (row 4).

Size and form - It is a medium low in stature bush, which was almost entirely suppressed by a massive neighboring much faster growing mugo pine bush (already removed); the stems are lying low across the ground, then up-arching, given rise to a irregular distorted semicircular crown, in late autumn blackish color (Fig. 5). At age 51, its crown average diameter measured 2.1 m, 1.6 m crown height, while the longest extended stem was 2.2 m in length (Table 3, rows 1 to 4, col. 6).

Fig. 5 The species nova Shrub 4, with its distorted up-arched crown. This bush was almost completely dominated by a neighboring large mugo pine bush (Photo I. Blada)

It currently produces flowers, cones and seeds with endosperm and embryo present.

Shrub 5

Habitat – A very small shrub which is growing close to a small mugo pine seedling, on debris shallow soil from a sub alpine lawn, on the ridge of the Piciorul Moşului Mt., at the geographic coordinates and gradients given in Table 1 (row 5).

Size and form – At age 16, its rectangular shape crown measured only 0.35 m in diameter, 0.24 m in crown height and the longest extended stem 0.40 m (Table 3, rows 1 to 4, col. 7). Its blackish autumn color crown contrasts with the light green crown of the neighboring small mugo pine (right side) (Fig. 6)

Fig. 6 The species nova Shrub 5 (left side) alongside a young mugo pine seedling (Photo I. Blada)

Shrub 6

Habitat - The shrub is growing on poor debris thin soil, in a subalpine lawn, not too far from the ridge of the Piciorul Moşului Mt., at the geographic coordinates and gradients presented in Table 1 (row 6).

Size and form – A very small shrub or young seedling, growing singly among alpine blueberry and cowberry sub-shrubs. It has ascending branches giving rise to a relatively round shape crown. It has an intense green summer color crown (Fig. 7). At age 10, its average crown diameter measured 0.15 m, crown height 0.19 m, while the longest extended stem in the crown reached 0.30 m (Table 3, rows 1 to 4, col. 8).

Fig. 7 The species nova Shrub 6 growing in active competition with the blueberry and lingo berry plants. (Photo I. Blada)

3.3 Average differences between the species nova and mugo pine

The species nova and mugo pine occur in the same natural habitat, and because they appear strikingly different, a comparison of the major quantitative and qualitative traits of the sampled shrubs of the two species will be given.

Age. The species nova average age was 37 years with a range between 10 in Shrub 6 and 65 in Shrub 3 (Table 3, row 1, col. 3 to 10). The occurrence of such an array of age clearly suggests that natural regeneration in the species nova is underway.

The average age of the mugo pine sampled shrubs was 41 years, with a variation interval between 37 and 47 years (Table 3, row 1, col. 11, 12). The reason why the mugo pine and the species nova sampled shrubs, as well, were so young is explain with the Discussion chapter.

Multi-stems habit. The species nova shrubs displayed up-arching or upright multi-stems with simple or multi-ramifications, light to dark grayish bark with small prominent ridges and grooves after the needles fall off (Fig. 8a, 8b).

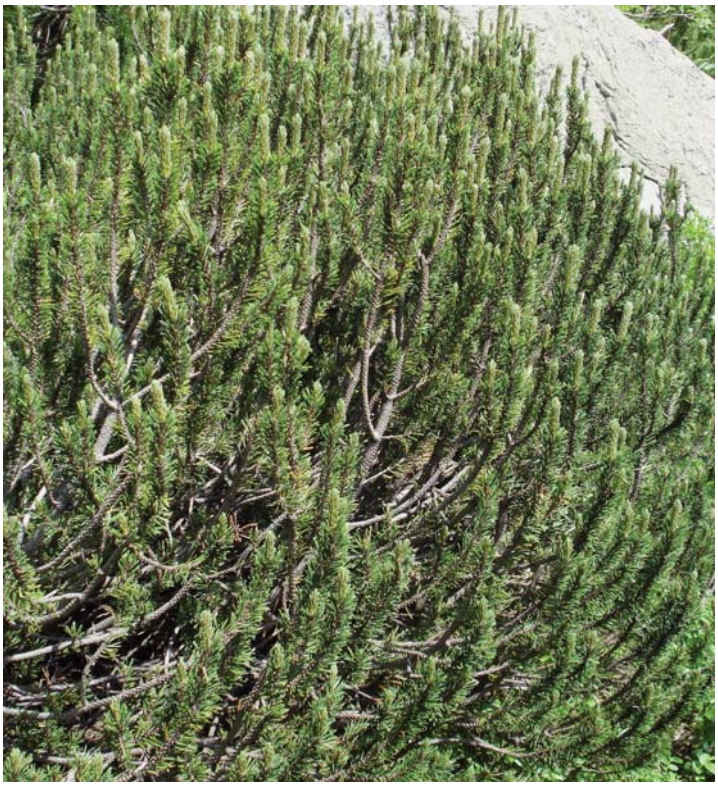

Fig. 8a Two types of multi-stems and second ary branching of the species nova bush up arching (Photo I. Blada)

Fig. 8b Two types of multi-stems and secondary branching of the species nova bush- upright (8b) (Photo I. Blada)

The average longest extended stem in the crown of the species nova measured 1.5 m with a range between 0.3 m in Shrub 6 to 3.2 m in Shrub 1 (Table 3, row 4, col. 3 to 10).

The average longest extended stem in crown of the mugo pine was 4.4 m with a range between 3.9 and 4.7 m (Table 3, row 4, col. 11, 12).

The average difference in the longest extended stem between the two species was 193.3 % (Table 4, row 3, col. 2); thus, the data demonstrate that the species nova grows much slower than mugo pine.

The average stem number of branches per whorl of the species nova was 1.8 with a range between 1.5 and 2.2 (Table 3, row 5a, col. 3 to 10).

The mugo pine average stem number of branches per whorl was 3.0 with a range of 2.6 to 3.2 (Table 3, row 5a col. 11, 12).

The average difference in stem number of branches per whorl between the two species was 66.7 % (Table 4, row 3, col. 3); that is, the number of branches per whorl of the species nova was fewer by 1.2 branches per whorl than that of mugo pine.

Table 4 The average trait performances of the two species and the differences [D (%)] between them (Research data based on the sampled shrubs from the Pietrosul Massif)

Row	Species	Traits / averages											
		LESC (m)	BW #	ATHG (cm)	NL (cm)	BSL (mm)	BL (mm)	BD (mm)	MSL (cm)	FSL (mm)	FSD (mm)	SCL (cm)	SCD (cm)
0	1	2	3	4	5	6	7	8	9	10	11	12	13
1	P. *mugo*	4.4	3.0	10.7	5.9	14.4	11.7	5.6	3.3	10.4	8.3	3.5	2.1
2	*P. microphylla*	1.5	1.8	4.0	1.5	7.4	7.2	3.8	2.1	8.7	7.8	2.3	1.7
3	D (%)	193.3	66.7	167.5	293.3	94.6	62.5	47.4	57.1	19.5	6.4	52.2	23.5

All data refer only to the average of the measured sampled shrubs.
Legend: LESC = longest extended stem in crown; BW = branches per whorl; ATHG = annual twig height growth; NL = needle length; BSL = bundle-sheath length; BL = bud length; BD = bud diameter; MSL = male strobili length; FSL = female strobili length; FSD = female strobili diameter; SCL = seed cone length; SCD = seed cone diameter;

Annual twigs height growth. The species nova annual twigs grows were usually very slow growing, hairless, light dark green in early summer and darkish to blackish in the late autumn and the next season; there is a striking difference, in both annual twig growth and color, between the species nova and mugo pine (Fig. 9).

Fig. 9 Note the striking difference between mugo pine (left) and the species nova (right) in twig shape, length and color and needle length and color (Photo I. Blada)

The species nova average annual twig height growth was 4.0 cm with variation interval between 2.0 cm in Shrub 3 and 7.5 cm in Shrub 1 (Tab. 3, row 6a, col. 3 to 10) while the mugo pine average annual twig growth was 10.7(9.7-12.7) cm (Table 3, row 6a, col. 11, 12).

The average difference in annual twig height growth between the two species was 167.5 % (Table 4, row 3; col. 4) demonstrating that the species nova grows much slower than mugo pine.

Needles. The species nova has two needles per bundle, slightly curved, somewhat twisted, sharp pointed, averaging 1.5 cm in length, with a range of 1.2 cm in Shrub 2 to 1.8 cm in Shrub 4 (Table 3, row 7a, col. 3 to 10). The mugo pine average needle length was 5.9 (5.4-6.4) cm (Table 3, row 7a, col. 11, 12). The average difference in needle length between the two species was 293.3 % (Table 4, row 3, col. 5);

The needles color in species nova was variable from light green in early spring (Fig. 10b, right side), to darkish green in the middle of the summer, becoming blackish in the late autumn of the first year and in the following years (Fig.10a, left side). In contrast, the needle color of mugo pine was a light to darkish green color (Fig. 10a, right side; Fig. 10b, left side).

The blackish short needles of the species nova appear very different, not only from those of *P. mugo* ssp. mugo and *P. mugo* ssp. rotundata, but from those of the *P. uncinata* species, as well.

Fig.10a Needle color in late autumn (species nova left- and mugo pine right side) (Photo I. Blada)

Fig. 10b Striking difference in needle length: mugo pine left- and species nova right side; the fascicle-sheaths and bracts were already degraded) (Photo I. Blada)

BUNDLE-SHEATH AND BRACTS. The species nova hyaline to hardy perceptible rose colored bundle-sheaths had an average length of 7.4 mm in the first year, with a range between 5.3 mm in Shrub 6 and 9.5 mm in shrub 4 (Table 3, row 8a, col. 3 to 10); beneath the bundle-sheath, a darkish brown color lanceolate sharp-pointed bract is present (Fig. 11, see the five embraced fascicles). The upper part of the bundle-sheath and the entirely bracts are persistent only in the first half summer of the year one, then they degrade (Fig. 11, see the two extremes fascicles).

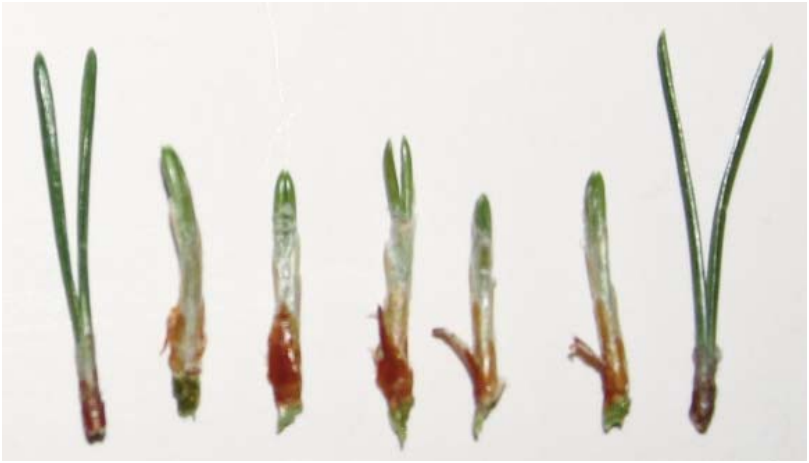

Fig. 11 Five species nova very young bundles (collected early June at their first season of vegetation with their non degraded sheaths and bracts), embraced by two species nova older bundles whose sheaths and bracts were degraded and lost (Photo I. Blada)

The mugo pine average bundle-sheath length was 14.4 in length, with a average variation interval of 13.3-15.3 mm (Table 3, row 8a, col. 11, 12).

The average difference in bundle-sheath-length, between the two species was 94.6 % (Table 4, row 3, col. 6). Clearly, the bundle sheath of the species nova is much shorter than that of mugo pine. This is another trait that differentiates the species nova from mugo pine.

Buds. The species nova apical buds were ovoid, sharp-pointed, slightly resinous and dark brown during the first half of the year one growing period, but blackish brown by autumn and the next season; with an average length of 7.2 mm, and a range between 6.1 mm in Shrub 3 and 8.3 mm in Shrub 5 (Tab. 3, rows 9a, col. 3 to 10); average diameter of 3.8 mm and a range between 3.5 mm in Shrubs 3 and 6, on one hand, and 4.8 mm in Shrub 1, on the other hand (Tab. 3, row 10a, col. 3 to 10) (Fig. 12, left side).

Longer apical buds were found in mugo pine species, i.e. 11.7(9.0-14.1) mm in length (Table 3, rows 9a, col. 11, 12) and 5.6 (4.6-6.0) mm in diameter (Table 3, row 10a, col. 11, 12) (Fig. 12, right side)

The average differences in bud length and bud diameter between the two species were 62.5 and 47.4 %, respectively (Table 4, row 3; col. 7, 8); the species nova buds were much shorter and thinner than those of mugo pine.

Fig. 12 The autumn season buds of the species nova (left side) and mugo pine (right side) (Photo I. Blada)

Male strobili. The species nova produces its yellowish to light brown or yellow-intense-cherry-variegated male strobili in clusters, borne erect in an irregular cylindrical shape in the upper part of the crown (Fig. 13a) with an average length of 2.1 (2.0-2.3) cm (Table 3, row 11a, col. 3 to 10).

The mugo pine male strobili are yellowish and less frequently yellow-cherry-variegated, borne erect in clusters of regular cylindrical shape (Fig. 13b), averaging 3.3 (3.0-3.6) cm long (Table 3, row 11a, col. 11, 12).

Fig. 13a Male strobili of the species nova (early June 2015) (Photo I. Blada)

Fig. 13b Male strobili of mugo pine species (middy June 2015) (Photo I. Blada)

Generally, the species nova male strobili releases pollen in early-June, while in mugo pine this phenomenon occurs mid June. However, part of the pollination period of the two species overlaps, but no hybrid progenies were found, so far.

The average difference between the two species, in male strobili length, was 57.1 % (Table 4, rows 3, col. 9); thus, the species nova average male strobili length is considerably shorter than the mugo pine ones.

Female strobili. The species nova average female strobili length was 8.7 (8.5-8.8) mm (Table 3, row 12a, col. 3 to 10), and 7.8 (7.7-7.9) mm in diameter (Table 3, row 13a, col. 3 to 10). Before pollination they displayed spherical shape and a purplish to reddish-tan color (Fig. 14a, right side), and after pollination, the strobili have enlarged and became dark bluish to blackish in color to maturity (Fig. 14b, left side).

Fig.14a Female strobili before pollination (June 2015): mugo pine (two twigs left side) and species nova (two twigs right side) (Photo I. Blada)

Fig. 14b Female strobili after pollination (August 2015): species nova (three twigs left side) and mugo pine (two twigs right side) (Photo I. Blada)

The average female strobili length of mugo pine was 10.4 (8.9-11.3) mm (Table 3, row 12a, col. 11, 12) and 8.3 (6.9-9.0) mm in diameter (Table 3, row 13a, col. 11, 12). Thus, the mugo pine female strobili displayed similar color and shape with those of the species nova one (Fig. 14a, 14b).

The average difference in female strobili length and diameter between the two species was 19.5 % (Table 4, rows 3, col. 10), and 6.4 %, respectively (Table 4, row 3, col. 11). The female strobili of the species nova were smaller than those of mugo pine, in both length and diameter.

Seed cones. The species nova seed cones relatively globular to ovoid, 2.3 (2.2-2.4) cm length, 1.7 (1.6-1.8) cm in diameter (Table 3, rows 14a, respective 15a, col. 3 to 10); light shiny brown to dark brown during the vegetative period (Fig. 15a, left side), rhombic apophysis, dark brown raised umbo with a very short tiny prickle at the tip and darkish brown to maturity, very short-stalked, single or two in clusters, scales relatively thick and woody, the lowest scales tips turning downward (Fig. 15b, right side).

The mugo pine seed-cones are ovoid or conic ovoid, sub-sessile, 3.5 (3.2-3.9) cm long and 2.1 (2.0-2.2) cm diameter (Table 3, rows 14a, respectively 15a, col. 11, 12), solitary or two to four in clusters, shiny yellowish-brown to dark brown, 2.5 x 1.5-2.5 cm, shining, subsessile, symmetrical, obtuse; apophyses flat, or convex above and concave below; umbo central or below the middle, with a small mucro (Fig. 15a, right side, and 15b, left side).

The average differences between the two species, in seed con length and seed cone diameter were 52.2 and 23.5 %, respectively (Table 4, row 3, col. 12, 13) i.e. the species nova cones were somewhat smaller in comparison to mugo pine ones.

Seeds. The species nova has light brown seeds, equally wide from tip to base wing while the mugo pine seeds were light brown color, narrow to the base, then enlarged to the middle and relatively sharp to the tip wing.

Fig. 15a Seed cones during the vegetation period (species nova left- and mugo pine, right side) (Photo I. Blada)

Fig. 15b Mature seed cones (mugo pine left- and species nova right side) (Photo I. Blada)

3.4 Brief characterization of the species nova

A new native two needle hard pine species of the Genus *Pinus* (*P. microphylla*) is described in this paper.

• The species occurs mostly on rocky ledges and debris shallow soils from subalpine rocky slopes, in the Pietrosul Rodnei Massif as part of the Romanian Northern Carpathians, between 1646 to 1890 m elevations, predominantly associated with mugo pine and other specific high elevation woody species, including several sub-shrubs.

• It is a bush which often displays lying across the ground multi-stems, then up-arching, given rise to variable blackish crown shapes, according to the site and competition with the neighboring species; crown diameter averages 2 (0.2-4.5) m, normal crown height 1.1 (0.2-2.5) m, and longest extended stem in crown 1.5 (0.3-3.2) m; the blackish color of the whole crown (needles, twigs) represent a major distinctive qualitative trait which, clearly, delineate the species nova from the *P. mugo* (ssp. *mugo* and ssp. *rotundata*) and *P. uncinata* species, as well.

• Number of branches per stem whorl 1.8 (1.5-2.2).

• Annual twig height growth 4.0 (2.0-7.5) cm long.

• The very short, slightly curved, somewhat twisted, pointed, 1.5 (1.2-1.8) cm long blackish needle, represent another complex trait that delineates the species nova from any other taxa of the *P. mugo* complex.

• Hyaline to hardy perceptible rose colored bundle-sheaths, with darkish brown triangular pointed shape bracts, both persistent only in the spring of the first year; 7.4(5.3-9.5) mm long in early first vegetation season.

• Buds ovoid sharp-pointed, dark brown during the first half of the year one growing period, but blackish brown by autumn and the next seasons; slightly resinous, 7.2(6.1-8.3) mm long and 3.8(3.5-4.8) mm in diameter.

• Male strobili cherry-variegated color, irregular or cylindrical shape, 2.1 (2.0-2.3) cm long.

• Female strobili purplish to reddish-tan color before pollination, but dark bluish to blackish color and spherical shape after pollination, 8.7 (8.5-8.8) mm long.

• Seed cones light shiny brown during the vegetation period, darkish brown to maturity, globular to ovoid, 2.3 (2.2-2.4) cm long, 1.7 (1.6-1.8) cm diameter, very short-stalked, single or two in clusters, rhombic apophysis, dark brown raised umbo with a short tiny prickle at the tip; on lowest scales, tips turning downward.

• Light brown or gray seeds, relatively equally wide from tip to base wing.

3.5 The *Pinus microphylla* species importance

The species nova, alongside the mugo pine, could be useful for stabilizing steep slopes, protecting soil against erosion; also, it could be used in urban plantings associated with natural rocks.

4. DISCUSSIONS

According to Christensen (1987a) *P. mugo* complex has 16 species, 91 varieties and 19 forms which have been described within the complex but, no taxa has been described at the subspecific level. On the other hand, most authors, including Farjon (2001, 2010), accept only two species, i.e. *P. mugo* with two subspecies (ssp. *mugo* and ssp. *rotundata*) and *P. uncinata.* Consequently, the *P. microphylla* will be compared only with the above mentioned three taxa. In addition, a short discussion about the natural hybridizations P. *sylvestris x P. mugo* and *Pinus mugo x P. sylvestris* hybrids will be done.

4.1 Major differences between the *P. microphylla* and *P. mugo* ssp. mugo

The *P. microphylla* cohabitates with the *P. mugo* ssp. *mugo* within the same natural habitat from the Pietrosul Rodnei Massif located between 1646 and 1890 m elevations, mostly on rocky ledges and debris shallow soils from subalpine steep slopes. Even though they cohabitate within the same habitat, there are large differences in most quantitative traits between the two species, such as: 293.3 % in needle length, 193.3 % in longest extended stem in crown, 167.5 % in annual twig height growth, 94.6 % in female strobili length. In addition, the *P. microphylla* blackish needles, twigs and the whole crown, compared to the *P. mugo* green ones, represents a strong qualitative trait that clearly delineates the two species.

4.2 Major differences between the *P. microphylla* and *P. mugo* ssp. *rotundata*

The *P. microphylla* is a multi-stems dwarf shrub native to the Pietrosul Rodnei Massif i.e. between 1646 to 1890 m elevations, mostly on dry rocky ledges and debris shallow soils from sub subalpine steep slopes.

The ssp. *rotundata* is native to the Pyrenees, the Auvergne Mountains, the Alps Erzgebirge, Böhmerwald, Sudeten and northwest Carpathians (Tatra Mts.), in Poland down to 180 m above sea level; it is almost exclusively limited to peat bogs (Farjon 2010). According to Amaral Franco (1986), the *P. mugo* ssp. *rotundata* is a10-15 m high single stem tree; in addition, the ssp. *rotundata* needle characteristics are mostly similar to those of the *P. mugo* ssp. *mugo*.

4.3 Major differences between the *P. microphylla* and *P. uncinata*

The *P. uncinata* is distributed at high elevations from Alps (mainly in Switzerland), Massif Central, and Pyrenees, between 1000-2300 m, occasionally as low as 200 m, in frost hollows and pit bog habitats from northeastern Germany, but absent from southeastern Europe. It is a 12-20 m tall tree, leaves bright to dark green, 23-75 mm long, bundle-sheaths persistent, 15-18 mm length, male strobili length 10 mm, female cons 25-60 mm long, 20-40 mm wide; apophyses thick, strongly pyramidal on outer side of cone, 6-10 mm wide, outer scale apophyses 4-9 mm thick, inner apophyses 3-4 mm thick; umbo at apex of apophyses, with a pronounced 1 mm prickle. The foliage characters of the *P. uncinata* are identical to those from ssp. mugo; the two taxa being separable only on habit and cone characters (Christensen, 1987b).

The natural hybridizations should also be discussed. Three putative hybrid swarm populations of *P. mugo x P. sylvestris* growing on peat-bogs from northern Slovakia, were subjected to molecular analysis. Data obtained from this study indicated a relatively extensive hybridization which takes place between *P. sylvestris* and *P. mugo* (Kormutak et al. 2008).

Spontaneous hybridization between the *P. mugo*, as exotic species in Lithuania and the native local *P. sylvestris* has been reported. The research objective, in this case, was to identify spontaneous hybrids, based on morphological traits, among the individuals naturally regenerating at the seaside zone. Thus, during the inventory completed over the entire Lithuanian part of the seaside, 200 individuals hybrids morphologically intermediate between *P. sylvestris* and *P. mugo* were identified. Based on a weighted trait index, the intermediate individual hybrids were grouped into two groups, one morphologically close to *P. sylvestris* and another group close to *P. mugo*. The needle micro-morphological traits of the putative hybrids were of intermediate values between the two species (Danusevicius, et al. 2012). Also, there was reported a widespread introgressive hybridization between *P. mugo* and *P. uncinata* giving rise, on one hand, to a variant *P. mugo* with erect branches, cone 4.5 x 2.5 cm, apophyses convex above and concave below, an ex-centric umbo, sometimes recognized as *P. mugo* var. *pumilio*, and on the other hand to a variant *P. uncinata* with shrubby habitat and rounded or hooded apophyses, sometimes recognized as *P. uncinata* var. *rotundata* (Link) Antoine (Gaussen, H. et al., 1964). It would have been interesting to study control pollinated F1 hybrids analyzed according to their genetic, but not phenotypic traits; this is because the hybrid assessment based on phenotypic traits might be misleading.

4.4 Major differences between the *P. microphylla* and *Pinus mugo x P. sylvestris* hybrid

According to Christensen, (1987a), the *Pinus mugo x P. sylvestris* hybrid is a tree, rarely a shrub, with bright green color crown; leaves glaucous green or bright green, 2.3- 5.8 cm long, very pungent; leaf sheaths persistent, up to 15 mm long, grey or dark brown; male strobili length up to 0.9 cm, yellow or scarlet; cones ovoid, ± oblique or symmetrical, 2.8-5.7 cm length, 1.7-3.4 cm diameter.

The *P. microphylla* is always a shrub with blackish color crown; blackish color laves, 1.5 (1.2-1.8) cm long, moderately pungent; leaf (fascicle) sheaths non persistent, 7.4 (5.3-9.5) mm, hyaline to hardy perceptible rose; male strobili length 2.1 (2.0-2.3) cm, yellowish to light brown or yellow-intense-cherry-variegated; seed cone ovoid, 2.3 (2.2-2.4) cm length, 1.7 (1.6-1.8) cm in diameter. Therefore, these big differences between the *P. microphylla* and *Pinus mugo x sylvestris* hybrid proved that the two taxa differs highly each other. In addition, the *P. sylvestris* and *P. uncinata* species have never occurred, neither in the Pietrosul Rodnei Massif nor in its surrounding areas, so that, their hybridization with *P. mugo* was not possible; consequently, a possible hybrid origin of the species nova in question, is rejected. No molecular work to examine *P. microphylla* relative to other species has been undertaken at this time.

Taking into account the striking differences between the *P. microphylla* on one hand, and the three above mentioned taxons (*P. mugo* ssp. *mugo*, *P. mugo* ssp. *rotundata*, *P. uncinata*), and the hybrids, the author of this paper is convinced that the *P. microphylla* meets the basic condition to be typified as a new species. But, the reader could ask, why a deeper insight analysis in the *P. mugo* variability was not done? The answer is, as follows: because the infra-taxons from the deeper insight variability of the *P. mugo* did not fulfill the requirements for a new species typification, while the *P. microphylla* did.

The ages of both *P. mugo* and *P. microphylla* is another item to be discussed. The *P. mugo* is a species which can reach several hundred of years. So, very recently, Timiş (2009) found a 155 year old mugo pine shrub in the Pietrosul Massif, while Bigler (2016) reported a 325 years old mugo pine in the Swiss National Park.

The ages of the sampled shrubs, from this study, varied between 10 and 65 (average 37) years in the species nova population and between 37 and 47 (average 41) years in the mugo pine one. The question is, why such big age difference between the mugo pine age reported by Timiş (2009) and our sampled shrubs for the present study. The explanation is given in what follows. With

proof at hand, the author of this paper declare that between 1960-1980 years, the *P. mugo*, and presumably *P. microphylla* population, as well, from the Pietrosul Massif were removed by the PLAFAR state enterprises, for turpentine extraction, to be used in the pharmaceutical industry. By chance, in some less accessible places, several older bushes have escaped from removing; this is the reason why the Timiş (2009) mugo pine bush has escaped. This explains why the Timiş (2009) mugo pine bush was older and why the sampled shrubs for study, of both species sampled shrubs, were younger.

5. CONCLUSIONS

• A new native multi-stem dwarf two needle hard pine species, i.e. the short needle pine (*P. microphylla*), was found and described in this paper. Twigs with needles and buds and mature seed cones from this species were collected and deposited to the BUCA Herbarium, Sheet # 158301, from the Bucharest Institute of Biology.

• The species occurs mostly on rocky ledges and debris shallow soils from sub alpine steep slopes, between 1646 to 1890 m elevations, in the Pietrosul Rodnei Massif, namely in its geographic components, such as: Zănoaga Mare Cirque Glacier, Zănoaga Iezer Cirque Glacier, and Piciorul Moşului Mt. Ridge.

• Habitually, the mugo pine occurs mixed with other specific high mountainous species, like *Picea abies, Pinus cembra, Sorbus aucuparia, Salix capraea, Alnus viridis, Rubus idaeus, Sambucus racemosa*, as well as some sub-shrubs.

• Because, neither *P. uncinata* nor *P. sylvestris* species, did occur in the last 70 years in the Pietrosul Rodnei Massif and in its surrounding areas, their hybridization with *P. mugo* was not possible; consequently, a possible hybrid origin of the species nova in question, is non-plausible.

• Taking into account the striking differences in quantitative and qualitative traits, and in habitat and distribution, as well, between the *P. microphylla*, on one hand, and the three above mentioned taxons (P. *mugo* ssp. *mugo*, *P. mugo* ssp. rotundata, and *P. uncinata*), the author of this paper is convinced that the *P. microphylla* meets the basic requirements to be considered a species nova taxon.

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JNEAPĂNUL CU ACE SCURTE (*PINUS MICROPHYLLA*), O NOUĂ SPECIE PENTRU ŞTIINȚĂ, ÎN FLORA MASIVULUI PIETROSUL RODNEI

Text prescurtat

În prezenta lucrare se descrie o nouă specie de jneapăn cu două ace într-o teacă, numită jneapăn cu ace scurte (*Pinus microphylla* Blada). Specia a fost găsită în masivul Pietrosul Rodnei, si anume în Zănoaga Iezer, Zănoaga Mare şi pe Piciorul Moşului (Fig. 1), la altitudini cuprinse între 1646 şi 1890 m. Creşte pe stâncăriile pantelor subalpine, pe soluri relativ superficiale cu multe fragmente de stâncă, cel mai frecvent în asociație cu jneapănul comun (*Pinus mugo* Turra ssp mugo Turra), dar şi cu arbori izolați de zâmbru (*Pinus cembra* L.), molid de altitudine (*Picea abies* (L.) Karst.), scoruş de munte (*Sorbus aucuparia* L.), salcie căprească (*Salix capraea* L.), anin verde (*Alnus viridis* (Chaix) DC), socul roşu (*Sambucus racemosa* L.). De asemenea, se mai asociază cu diferiți subarbuşti precum bujorul de munte (*Rhododendron myrtifolium* Schott et Kots.), afinul negru (*Vaccinium myrtillus* L.), merişorul (*Vaccinium vitis-idaea* L.).

Pe baza unui studiu comparativ a unor exemplare sau tufe perechi de - *P. microphylla* şi *P. mugo* ssp. *mugo* - de diferite vârste şi dimensiuni, situate în acelaşi loc, în continuare se prezintă principalele caractere ale celor două specii precum şi diferențele dintre ele, exprimate în procente.

Vârsta (SA, Tab. 2, rd. 1)

• Jneapănul cu ace scurte (*P. microphylla*) are media de vârstă 37 ani, cu intervalul de variație cuprins între 10 ani la Tufa 6 şi 65 ani la Tufa 3 (Table 3, row 1, col. 3-10). Această variabilitate de vârstă sugerează că specia nouă se regenerează natural.

• Jneapănul comun (*P. mugo* ssp. *mugo*) are media de vârstă 41 ani, cu intervalul de variație cuprins între 37 şi 47 ani (Table 3, row 1, col. 11 şi 12). Motivul pentru care ambele specii au avut vârste foarte mici, este pus pe seama defrişărilor masive a jnepenişurilor efectuate în perioada anilor 1960-1980, în toată zona Masivului Pietrosul Rodnei, de întreprinderea de stat PLAFAR. Extragerea terebentinei utilizată în industria farmaceutică, a fost principalul

motiv al defrişării jnepenişurilor, nu numai din Pietrosul Rodnei ci din aproape toți Carpații. Autorul acestui material a fost martorul ocular al acestui dezastru ecologic, dezastru patronat de Statul Comunist, în cadrul căruia au dispărut şi mare parte din pădurile de zâmbru din zona montană superioară.

Coroana (Tab. 3, rd. 2; 3; 4)

• Jneapănul cu ace scurte are coroana formată din multe tulpini târâtoare la început, apoi ascendente, dând naştere unor coroane de forme diferite (Fig. 3, 4, 6, 8a şi 8b). Media diametrului coroanei (ACD) la jneapănul cu ace scurte este de 2,0 m cu intervalul de variație cuprins între 0,2 şi 4,5 m (Tab. 3, rd. 2, col. 9 şi 10) iar media înălțimii normale a coroanei (NCH) a fost de 1,1 m având intervalul de variație cuprins între 0,2 şi 2,5 m (Tab. 3, rd. 3, col. 9 şi 10). Media lungimii celei mai lungi tulpini din coroană (LES) are 1,5 m cu intervalul de variație cuprins între 0,3 şi 3,2 m (Tab. 3, rd. 4, col. 9 şi 10).

• Jneapănul comun are media diametrului coroanei (ACD) 5,8 m cu intervalul de variație cuprins între 2,3 şi 7,6 m (Tab. 3, rd. 2, col. 11 şi 12) iar media înălțimii normale a coroanei (NCH) este de 3,6 m având intervalul de variație cuprins între 2,5 şi 4,6 m (Tab. 3, rd. 3, col. 11 şi 12). Media lungimii celei mai lungi tulpini din coroană (LES) este de 4,4 m cu intervalul de variație cuprins între 3,9 şi 4,7 m (Tab. 3, rd. 4, col. 11 şi 12).

• Cea mai lungă tulpină din coroana jneapănului cu ace scurte este cu 193,3 % mai scurtă în comparație cu ce mai lungă ramură a jneapănului comun (Tab. 4, rd. 3, col. 2).

Numărul ramurilor pe verticil (BW, Tab. 3, rd. 5)

• Jneapănul cu ace scurte are media numărului ramurilor pe verticil de 1,8 cu intervalul de variație cuprins între 1,5 la Tufele 3; 5 şi 6 şi 2,2 la Tufa 1 (Tab. 3, rd 5a, col. 3-10).

• Jneapănul comun are media numărului ramurilor pe verticil de 3,0 cu intervalul de variație cuprins între 2,6 şi 3,2 (Tab. 3, rd 5a, col. 11 şi 12).

Creşterea anuală în înălțime a lujerului (ATHG, Tab. 3, rd. 6).

• Jneapănul cu ace scurte are creşterea medie anuală în înălțime relativ înceată, adică 4,0 cm cu un interval de variație cuprins între 2,0 cm la Tufa 3 şi 7,5 la Tufa 1 (Tab. 3, rd 6a, col 3-10). Lujerii sunt glabri, primăvara au culoarea verde închis iar spre toamnă, şi în următorii ani, devin negricioşi, culoare prin care se deosebesc tranşant de verdele lujerilor de jneapăn comun (Fig. 9).

• Jneapănul comun are media de creştere de 10,7 cm cu intervalul de variație cuprins între 9,7 şi 12,7 cm (Tab. 3, rd.6a, col. 11 şi 12).

• Diferența de creştere anuală în înălțime dintre cele două specii este de 167,5 % (Tab. 4, rd. 3, col. 4), fapt care demonstrează că jneapănul cu ace scurte creşte mult mai încet comparativ cu jneapănul comun.

Lungimea acelor (NL, Tab. 3, rd. 7)

• Jneapănul cu ace scurte are media lungimii acelor de 1,5 cm cu intervalul de variație cuprins între 1,2 la Tufa 2 şi 1,8 la Tufa 4 (Tab. 3, rd. 7a, col. 3-10). Culoarea acelor este variabilă de la verde deschis primăvara (Fig. 10b, dreapta) la verde închis în mijlocul verii, devenind negricioasă toamna târziu al primului an şi al anilor următori (Fig. 10a, stânga). În contrast, culoarea acelor la jneapănul comun este variabilă de la verde deschis la verde închis (Fig. 10a, dreapta; Fig. 10b, stânga).

• Jneapănul comun are media acelor de 5,9 cm cu intervalul de variație cuprins între 5,4 şi 6,4 cm (Tab. 3, rd. 7a, col. 11 şi 12).

• Diferența medie dintre lungimile acelor celor două specii este de 293,3 % (Tab. 4, rd. 3, col. 5); rezultă că lungimea acelor la specia nouă este de patru ori mai mică în comparație cu acele jneapănului comun. Acele negricioase şi scurte ale noii specii se deosebesc tranşant nu numai de specia *P. mugo* ssp. *mugo* ci şi de acelea ale speciilor *P. mugo* ssp. *rotundata* şi *P. uncinata*.

Teaca şi bracteea fascicolului de ace (BSL, Tab. 3, rd. 8)

• Teaca fascicolului de ace, la jnepănul cu ace scurte, are culoare hialină spre un roz deschis, iar lungimea medie (în primul an) de 7,4 mm cu intervalul de variație cuprins între 5,3 mm la Tufa 6 şi 9,5 mm la Tufa 4 (Tab. 3, rd. 8a, col. 3-10). La baza tecii fascicolului de ace se află o bractee ascuțit lanceolată de culoare brun negricioasă (Fig. 11, cele cinci ace situate între două fascicole mature). Partea superioară a tecii precum şi bracteea sunt persistente numai în prima parte a primului an de vegetație, după care se degradează şi dispar (Fig. 11, cele două fascicole extreme).

• Teaca fascicolului de ace, la jneapănul comun, are lungimea de 14,4 mm având intervalul de variație între valorile de 13,3 şi respectiv 15,3 mm (Tab. 3, rd. 8a, col. 11 şi 12).

• Diferența dintre lungimile medii ale tecilor celor două specii este de 94,6 % (Tab. 4, rd. 3, col. 6). Astfel, s-a demonstrat că teaca fascicolului de ace a noii specii, este mult mai scurtă decât teaca fascicolului de ace a jneapănului comun.

Mugurii (BL; BD, Tab. 3, rd. 9 şi 10)

• Jneapănul cu ace scurte are mugurele apical ovoid, pronunțat ascuțit, moderat răşinos; culoarea brună în prima jumătate a primului an de vegetație, devenind brun negricios spre toamnă şi în anii următori (Fig. 12, stânga);

lungimea medie de 7,2 mm, cu intervalul cuprins între 6,1 mm la Tufa 3 şi 8,3 mm la Tufa 5 (Tab. 3, rd. 9a, col. 3-10); media diametrului de 3,8 mm cu intervalul de variație între 3,5 mm la Tufele 3 şi 6, pe deoparte, şi 4,8 mm la Tufa 1, pe de-altă parte (Tab. 3, rd. 10a, col. 3-10).

• Jneapănul comun are mugurii bruni (Fig. 12, dreapta) şi lungi, adică 11,7 mm cu intervalul de variație cuprins între 9,0 şi 14,1 mm (Tab. 3, rd. 9a, col. 11 şi 12) iar diametrul de 5,6(4,6-6,0) mm (Tab. 3, rd. 10a, col. 11 şi 12).

• Diferențele medii dintre lungimile şi diametrele mugurilor celor două specii sunt de 62,5 şi respectiv 47 % (Tab. 4, rd. 3; col. 7 şi 8), ceea ce înseamnă că lungimile şi diametrele mugurilor apicali, la specia nouă, sunt mult mai mici comparativ cu dimensiunile mugurilor jneapănului comun.

Florile mascule (MSL, Tab.3, rd. 11)

• Jneapănul cu ace scurte are florile mascule grupate pe lujerul anului curent, de culoare gălbuie spre brună, uneori galben intens cu nuanțe multicolore, erecte, de formă cilindrică (Fig. 13a), cu lungimea medie de 2.1(2.0-2.3) cm (Tab. 3, rd. 11a, col. 9 şi 10). Obişnuit, răspândirea polenului are loc în prima parte a lunii iunie, în timp ce la jneapănul comun, răspândirea polenului are loc la mijlocul lunii iunie.

• Jneapănul comun are florile mascule de culoare galbenă, rareori galben intens cu nuanțe multicolore, erecte, de formă cilindrică (Fig. 13b), cu lungimea de 3.3(3.0-3.6) cm (Tab. 3, rd. 11a, col. 11 şi 12).

• Diferența medie dintre lungimea florilor mascule ale celor două specii este de 57,1 % (Tab. 4, rd. 3, col. 9); deci, lungimea florilor mascule la specia nouă este mult inferioară celor aparținând jneapănului comun.

Florile femele (FSL, Tab. 3, rd. 12)

• Jneapănul cu ace scurte are flori femele cu lungimea medie de 8,7 mm, cu intervalul de variație cuprins între 8,5 şi 8,8 mm (Tab. 3, rd. 12a, col. 3-10) şi cu diametrul mediu de 7,8 mm având intervalul de variație cuprins între 7,7 şi 7,9 mm (Tab. 3, rd. 13a, col. 3-10). Înainte de polenizare prezintă o formă sferică şi culoare purpurie care devine roşcat arămie (Fig. 14a, dreapta), iar după polenizare, spre maturație, îşi măresc dimensiunile schimbând culoarea în albăstruie spre negricioasă (Fig. 14b, stânga).

• Jneapănul comun are florile femele cu lungimea medie de 10,4 mm, cu intervalul de variație cuprins între 8,9 şi 11,3 mm (Tab. 3, rd 12a, col. 11, 12) şi diametrul de 8,3 mm cu intervalul de variație cuprins între 6,9 şi 9,0 (Tab. 3, rd 13a, col. 11, 12). Din Figurile 14a şi 14b se constată că florile femele ale ambelor specii etalează aceeaşi culoare.

• Diferențele medii dintre lungimile şi diametrele florilor femele ale celor două specii sunt de 19,5 % (Tab. 4, rd. 3, col. 10) şi respectiv 6,4 % (Table 4, row3, col. 11). Rezultă că atât lungimea cât şi diametrul florilor femele la specia nouă sunt mai mici comparativ cu dimensiunile florilor femele ale jneapănului comun.

Conurile (SCL; SCD, Tab. 3, rd. 14 şi 15)

• Jneapănul cu ace scurte are conurile relativ globular ovoide cu lungimea medie de 2,3 cm, şi intervalul de variație între 2,2 şi 2,4 cm (Tab. 3, rd. 14a, col. 9 şi 10) şi diametrul mediu de 1,7 cm, cu intervalul de variație între 1,6 şi 1,8 (Tab. 3, rd. 15a, col. 9 şi 10). Culoarea conurilor brun deschisă în perioada de vegetație (Fig. 15a, stânga), brun negricioasă la maturitate, scurt pedicelate, grupate câte unu sau două; apofiza rombică, umbelicul proeminent de culoare brun închisă, cu un minuscul ghimpe în vârf; solzi lemnoşi, relativ îngroşați (Fig. 15b, dreapta).

• Jneapănul comun are conuri ovoide sau conic ovoide, sub-sesile, 3,5 cm lungi cu intervalul de variație cuprins între valorile 3,2 şi 3,9 cm (Tab. 3, rd. 14a, col. 11 şi 12,), diametrul mediu de 2,1 cm cu intervalul de variație cuprins între valorile 2,0 şi 2,2 (Tab. 3, rd. 15a, col. 11 şi 12). Conurile sub-sesile, simetrice, obtuze, solitare sau grupate mai multe la un loc, de culoare brun gălbuie sau brun închisă, apofiza plată sau convexă în partea superioară şi concavă în cea inferioară; umbelicul central sau mai jos de mijloc (Fig. 15a, dreapta, şi 15b, stânga).

• Diferențele medii dintre cele două specii în privința lungimii şi diametrul conului sunt de 52,2 şi respectiv 23,5 % (Tab. 4, rd. 3, col. 12 şi 13), adică, dimensiunile conurilor ale noii specii sunt inferioare dimensiunilor conurilor aparținând jneapănului comun.

Semințele

Specia nouă are semințele de culoare brun deschisă, iar aripioarele au aceeaşi lățime de la vârf până la bază. Semințele jneapănului comun au culoare brun închisă; aripioara este îngustă la bază, mai lată la mijloc şi relativ ascuțită spre vârf.

CONCLUZII

• Din rezultatele anterior prezentate, se constată că jneapănul cu ace scurte (*P. microphylla*) se deosebeşte tranşant de jneapănul comun (*P. mugo* ssp. *mugo*).

• Potrivit textului prezentat în Limba engleză, între *P. microphylla*, pe de-o parte, şi speciile *P. mugo* ssp. *rotundata*, *P. uncinata*, pe de altă parte, există diferenţe clare atât în privinţa caracterelor cantitative şi calitative cât şi în ceea ce priveşte habitatul precum şi distribuţia geografică.

• Întrucât speciile *P. uncinata* şi *P. sylvestris* nu au fost niciodată semnalate nici în Masivul Pietrosul Rodnei şi nici zonele adiacente, hibridarea lor cu *P. mugo* ssp. *mugo* nu a fost posibilă; în consecinţă, o posibilă origine hibridă a speciei *P. microphylla* nu este plauzibilă.

• Pe baza tuturor rezultatelor prezentate în această lucrare (textul în L. engleză şi în L. română), autorul acestei lucrări este convins că *P. microphylla* întruneşte condiţiile necesare pentru a fi considerată specie nouă pentru ştiinţă.

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