

MORFOLOGICAL VARIABILITY, ECOLOGICAL, CHOROLOGIC AND PHENOLOGICAL CHARACTERISTICS OF THE POPULATIONS OF THE SPECIES *POTENTILLA* *TOMMASINIANA* F.W. SCHULTZ IN BOSNIA AND HERZEGOVINA

S. REDZIC

Department of Plant Ecology, Faculty of Science, University of Sarajevo. P.O. Box 207, 71000 Sarajevo, Bosnia and Herzegovina.

SUMMARY: Based on the morphological analysis of a larger quantity of populations of the species *Potentilla tommasiniana*, collected from different stands in ecological sense, it could be stated, that this species, is very variable. The level variability is the largest in the form and the size of rosette leaves and in the teeth number on the middle lobe of a leaf, in the length of the peduncle and in the width of the outer sepal. The species has a wide range of tolerance for phytocenosis. The most of its populations occur in the communities of submediterranean rocky balds of alliance *Chrysopogoni-Satureion subspicatae* Ht et H-ic 1934.

Keywords: *Potentilla tommasiniana*, flora, variability, ecology, chorology, phenology, Bosnia and Herzegovina.

INTRODUCTION

The species *Potentilla tommasiniana* has been described by F.W. SCHULTZ in 1858 (Arch. fl., 273 and in Jahresb. Pollichia). It belongs to Subgenus *Potentilla*, Sectio *Aurastrum* and Series *Grandiflorae*. The available literature about this species shows us that it has a rather complex taxonomic status. Many authors give it the status of variety within the widespread species *P. arenaria* Borkh. In the Flora Europea (BALL & al. 1968) it is assigned to the species *P. cinerea* Chaix, what is inadmissible, for, according to MEUSEL & al. (1965) *P. cinerea* develops out of the aureole of the species *P. tommasiniana* (Fig. 1).

The status of species has been given to it by HAYEK (1927), ROHLENA (1942), pointing to its similarity with *P. arenaria* «A simili *P. arenaria* Borkh.», MAYER (1952)



Figure 1. An area map of the species *Potentilla tommasiniana* F.W. Schultz (according to MEUSEL, 1965)

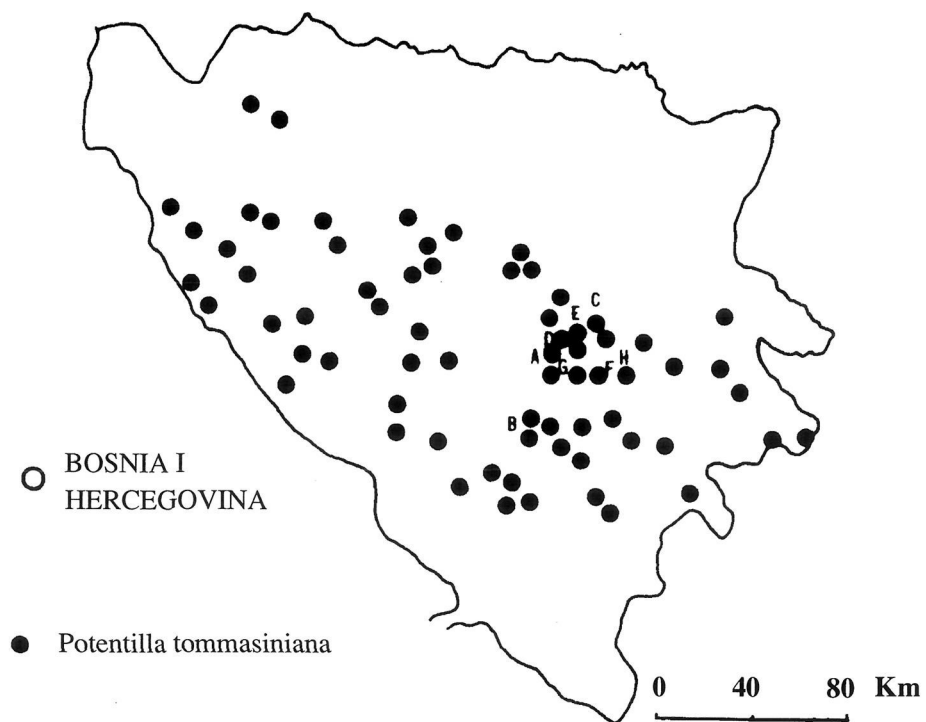


Figure 2. An area map of the species *Potentilla tommasiniana* F.W. Schultz in Bosnia and Herzegovina showing the locations from which the samples are collected in order to study morphological variability in detail (A - H)

The status of species has been given to it by HAYEK (1927), ROHLENA (1942), pointing to its similarity with *P. arenaria* «A simili *P. arenaria* Borkh.», MAYER (1952) and DOMAC (1973).

A great number of synonyms tell us about the different understanding of this form by many authors -*P. tommasiniana* F.W. Schultz 1858 Arch. Fl. 273; Hayek, 1927, Prodr. Fl. pen. Balc., 1: 687; Rohlena, 1942, Consp. Fl. Mont., 145; Mayer, 1952, Sezn. prapcvet. Sl. ozem., 112; Domac, 1973; Mala Fl. Hrv., 199 (Syn.: *P. arenaria* Borkh. var. *trifoliata* Borb., Fl. BHNP, 1927: 36; *P. subacaulis* Wulf. in Jacq., Coll. II, 145 et Ic. rar II, t. 491; Vis., Fl. Dalm., III, 252 non L., *P. grandiflora* Scop., Fl. Carn., ed. II, I, 363 t. 22 non L.; *P. cinerea* var. *trifoliata* Koch, Syn. Fl. Germ., 217 (1837), ed II, 242 p.p. ; *P. trifoliata* Murb., Beitr. Südbosn. in Lunds Univ. Ars. 27 (1891) 136; *P. subacaulis* Maly, 1848, Enum. pl. Austr.,: 341; *P. arenaria* subsp. *tommasiniana* Th. Wolf, 1903, Pot. Stud., 2: 53 pro subsp. vel. var.: vel subsp. Ciocirlan, Fl. Il. Rom., 1988: 306; *P. arenaria* Borkh var. *tommasiniana* (F.W. Schultz) Hegi 1922, Ill. F1. Mitt. - Eur., 4(2): 876 and F1. SR Srb., 1972: 112; *P. subacaulis* L., Fl. Knez. Srb., 1874: 274; *P. stellulata* David., MBL. I: 28).

Potentilla tommasiniana is a very variable species, just like many mongreles what makes its relations more complex within its taxonomy.

In this supplement, morphological, chorological, ecological and some phenological characteristics of many populations of the species *P. tommasiniana* from different ecosystems of Bosnia and Herzegovina, are analyzed with more details, in order to establish its variability and to find its adequate taxonomic position in the genus *Potentilla* system.

MATERIAL AND METHOD

In order to study morphological variability of the species *P. tommasiniana* populations, the floristic material from many populations has been collected over the whole area of Bosnia and Herzegovina. At the same time, it has been tried to include as many populations as it can be found, from ecologically different conditions. For variationally statistical analyses it has been worked on eight populations, and for wider recognition of the morphological variability on considerably samples (Fig. 2).

All collected facts have been exposed to variationally statistical analyses. The following parameters have been calculated -arithmetic mean (\bar{X}), standard deviation (S), standard error (S_x), coefficient of variability (V%), difference of standard errors (S_{x₁}- x₂). The difference test between two arithmetical means has been done by Student (t - test). The calculation has been done according to PETZ (1974).

Review of the locations from which the samples were collected with general ecological characteristics

Locality: Zecija Glava (Crepoljsko mount), altitude cca 900 m, exposure SW, slope 20°, geological substratum limestone, type of soil calcomelanosol, community *Potentillo tommasinianae-Scabiosetum leucophyllae* Redz. 1991, date 2nd May 1988., mark of sample A - «Zecija Glava».

- Loc.: Ovcari - Konjic, alt cca 350 m, exp S-SW, slope 30°, geol substr dolomite, t of s rendzina, community *Scabiosetum graminifloiae* s. lat., date 14th May 1988., mark of sample B - «Ovcari».
- Loc.: Crepoljsko hill, alt 1510 m, exp S, slope 25-30°, geological substr limestone, t of s calcomelanosol, community *Diantho kitaibelii-Brometum erecti* Redz. 1991, date 18th May 1988, mark of sample C - «Crepoljsko».
- Loc.: Mrkovici, alt 800 m, exp W, slope 60°, geol substr limestone, t of s regosol, community *Edraiantho-Dianthetum kitaibelii* Lakusic 1975, date 28th April 1988., mark of sample D - «Mrkovici».
- Loc.: G. Mrkovici (Goropec), alt 1050 m, exp SE, slope 15°, geological substr limestone, t of s calcocambisol, community *Potentillo-Scabiosetum leucophyllae agrostietosum capillaris* Redz. 1991, date 28th April 1988., mark of sample E - «G. Mrkovici».
- Loc.: Celjugovici, alt 750 m, exp W, slope 20°, geol substr limestone, t of s calcomelanosol, community *Asperuletum purpureae* Redz. 1991, date: 4th May 1988., mark of sample F - «Celjugovici».
- Loc.: Kozija Cuprija, alt: 550 m, exp S-SW, slope 25°, geol substr limestone, t of s calcomelanosol, community *Stipo capillate-Dichanthietum ischaemi* Redz. 1991, mark of sample G - «Kozija Cuprija».
- Loc.: Bulozi, alt 750 m, exp W, slope 35°, geol substr limestone, t of s calcomelanosol, community *Asperuletum purpureae* Redz. 1991, date: 15th April 1988, mark of sample H - «Bulozi».
- Loc.: Rudo, valley of Lim river, alt cca 500 m, exp W, slope 20°, geol substr peridotit, t of s ranker, community *Euphorbio-Fumanetum bonapartei*, Rt 1970, date: 6th May 1988.
- Loc.: Sedrenik (Sarajevo), alt 800 m, exp W, slope 15°, geol substr limestone, t of s calcomelanosol, community *Achilleo nobilis-Genistetum januensis* Redz. 1991, date: 28th April 1988.
- Loc.: Kozija Cuprija, alt cca 560 m, exp SW, slope 20°, geol substr limestone, t of s calcomelanosol, community *Bromo-Plantaginetum mediae* Ht (1931) 1934, date: 15th April 1987.
- Loc.: Obhodza (Sarajevo), alt 650 m, exp S-SW, slope 15°, geol substr limestone, t of s calcomelanosol, community *Potentillo-Scabiosetum leucophyllae agrostietosum capillaris* Redz. 1991, date: 15th April 1987.
- Loc.: Obhodza (Borije), alt 850 m, exp SW, slope 20°, geol substr limestone, t of s calcomelanosol, community *Quercu-Ostryetum carpinifoliae* Ht 1938, date: 16th April 1987.
- Loc.: Hresa, alt 860 m, exp N-NW, slope 10°, geol substr limestone, t of s calcomelanosol, community *Bromo-Danthonietum alpinae* Sugar 1972, date 18th April 1986.
- Loc.: Gradina (Crepoljsko hill), alt 1100 m, exp S-SE, slope 20°, geol substr limestone, t of s calcomelanosol, community *Festuco-Koelerietum* s. lat., date: 20 April 1986.
- Loc.: G. Biosko (Crepoljsko hill), alt 970 m, exp S-SE, slope 25°, geol substr limestone, t of s calcomelanosol, community *Crataego-Juniperetum communis* Beus 1971, date: 17th April 1986.
- Loc.: Brus (Trebevic), alt 1200 m, exp E, slope 15°, geol substr limestone, t of s calcomelanosol, community *Bromo-Plantaginetum mediae* Ht (1931)1934, date: 10th May 1986.
- Loc.: Konjic (Suhi Do), alt 790 m, exp S-SE, slope 20°, geol substr dolomite, t of s rendzina, community *Alysetum moelendorfianii* Rt (1956)1967, date: 15th May 1987.
- Loc.: Kobjic (Suhi Do), alt 780 m, exp SW, slope 20°, geol substr dolomite, t of s rendzina, community *Quercu-Ostryetum carpinifoliae* Ht 1938, date: 15th May 1987.
- Loc.: Konjic - Zlatar, alt 550 m, exp SW, slope 20°, geol substr dolomite, t of s rendzina, community *Orchido zlatari-Pinetum nigrae* Rt 1967, date: 15th May 1987.
- Loc.: G. Faletici (Siljato hill), alt 1000 m, exp S, slope 10°, geol substr limestone, t of s calcomelanosol, community *Potentillo-Scabiosetum leucophyllae agrostietosum capillaris* Redz. 1991, date: 13th April 1989.
- Loc.: Konjic (Suhi Do), alt - 500 m, exp W, slope 25°, geol substr dolomite, t of s rendzina, community *Cephalario-Pinetum nigrae* Rt 1967, date: 15th April 1989.
- Loc.: Konjic (Zagorica), alt cca 800 m, exp E, slope 30-35°, geol substr dolomite, t of s rendzina, community *Fraxino orni-Quercetum pubescentis* Nomen prov., date: 15th April 1989.
- Loc.: Borci (Konjic), alt 900 m, exp SW, slope 15°, geol substr dolomite, t of s rendzina, community *Genisto dalmaticae-Scabiosetum graminifoliae* nom. prov., date 15th April 1989.
- Loc.: Borci (Konjic), alt 900 m, exp SW, slope 5-10° geol substr dolomite, t of s rendzina, community *Scabiosetum leucophyllae* s. lat., date: 15th April 1989.

RESULTS AND DISCUSSION

Ecological characteristics

Most populations of the species *P. tommasiniana* on the horizontal and vertical profile of Bosnia and Herzegovina live at altitudes from 300 to 1500 meters. The species generally speaking has a wide range of tolerance to geological substratum. Most populations occur on limestone geological substratum and a considerable number on dolomite one. The populations of this species reach considerable number and covering on serpentinous-peridotitic substratum. It occurs on shallow carbonate soils, on rendzina and calcomelanosol and sometimes on calcocambisol and rankers. Its presence is very significant on degraded already mentioned soils as well as on lithosolae and regosolae. The soils where this species grow are, in general, of dusty structure and very dry. The species has a wide range of tolerance for phytocenosis. The most of its populations occur in the communities of submediterranean rocky balds of alliance *Chrysopogoni-Satureion subspicatae* Ht et H-ic 1934 and those are: *Potentillo tommasinianae-Scabio-setum leucophyllae* Redzic 1991, *Stipo capillatae-Dichanthietum ischaemi* Redzic 1991, *Achilleo nobilis-Genistetum januensis* Redzic 1991, and some communities of the alliance *Bromion erecti* Br.-Bl. (1925) 1936.

It is a pronounced thermophilous and heliophilous species. Some populations are heliophilous to semisciophilous.

Morphological variability

On the basis of data on comparative morphological analyses of many samples of the species *P. tommasiniana* it results that a considerable number of characters, are more or less, variable (Fig. 3; Tab. 1 A-P; Tab. 2).

The shape and the size of the leaves is one of the most variable characters. Just the pronounced variability of this character has caused a rather complex situation considering taxonomic status of this species.

The length of the middle lobe of the leaf, averagely varies from 5,02 to 12,44 mm. The smallest values are from 3,5 to 7,5 mm, and the biggest from 4,5 to 17 mm (Fig. 4).

The length of the first lobe of the leaf, averagely varies in interval from 4,86 to 7,72 mm. The minimum values go from 2,5 to 5 mm, and the maximum from 7 - 12 mm (Fig. 4). The coefficient of variability for the first character varies from 16,51 - 26,35 %, and for the other one from 17,91 - 18,15 (Tab. 1C; 1E).

The width of the middle lobe of the leaf averagely varies from 4,27 to 6,45 mm, and the width of the first lobe of the leaf from 3,55 - 6,54 mm.

The biggest width values of the middle lobe of the leaf vary from 2,5 to 4,0 mm, and of the first lobe from 1,5 to 4,0 mm. The maximum values for already mentioned characters are 5,5 and 11 mm, and 5 and 9 mm (Tab. 1D; 1F).

The number of teeth on leaf lobes varies in a great deal. So, the number of teeth on the middle lobe of the leaf (from one side) averagely varies from 3,57 to 5,02 and on the

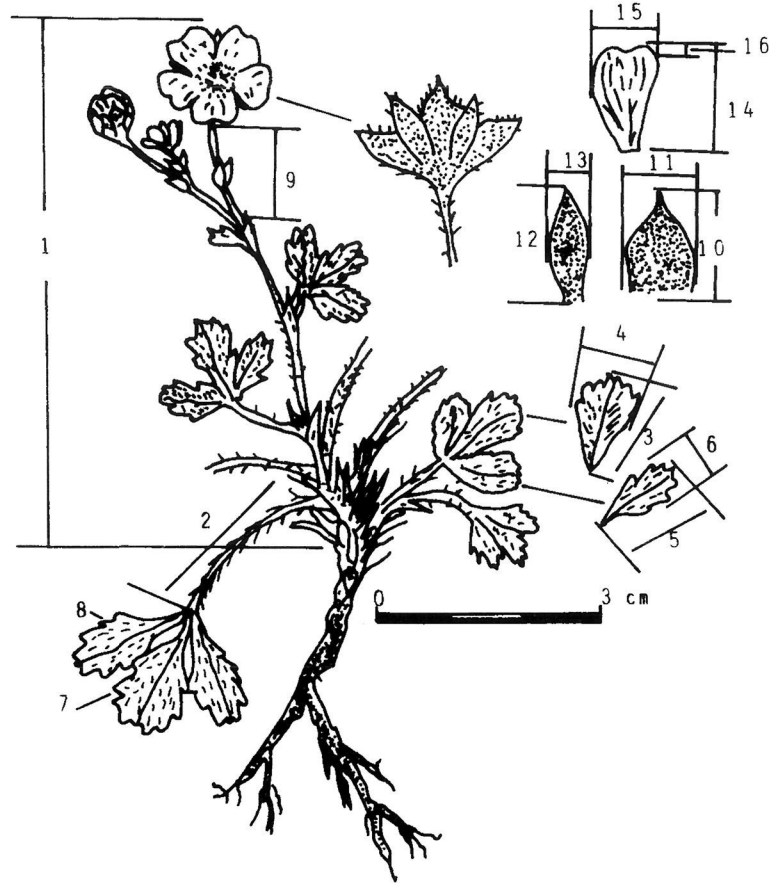


Figure 3. Analyzed morphological characters of the species *Potentilla tommasiniana* F.W. Schultz (1, The length of the plant; 2, The length of the leaf stalk; 3, The length of the middle most leaf lobe; 4, Maximal width of the middlemost leaf lobe; 5, The length of the first leaf lobe; 6, Maximal width of the first leaf lobe; 7, Number of teeth on the middlemost leaf lobe; 8, Number of teeth on the first leaf lobe; 9, The length of the peduncle; 10, The length of the interior sepal; 11, Maximal width of the interior sepal; 12, The length of the outer sepal; 13, Maximal width of the outer sepal; 14, The length of the petal; 15, Maximal width of the petal; 16, The depth of notch on the petal)

A.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	41	74	58.00	9.6106	2.0039	16.57
	B	40	<u>22</u>	112	68.10	19.1713	3.0699	28.15
	C	15	24	41	30.00	4.9769	1.3301	16.58
	D	37	45	<u>128</u>	78.91	23.6290	3.8846	29.94
	E	39	32	85	57.22	14.9096	2.3874	26.90
	F	23	43	116	80.70	21.7097	4.5268	26.90
	G	30	27	90	55.13	14.3808	2.6255	26.08
	H	22	31	98	46.60	15.0258	3.2035	32.24

Tab. 1A. The length of the plant

B.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	2.5	12.5	6.74	3.2782	0.6835	48.63
	B	40	4.0	36.0	13.14	6.6372	1.0628	50.51
	C	15	1.5	4.0	2.29	0.6385	0.1706	27.88
	D	37	8.0	19.0	13.83	4.2131	0.6926	30.46
	E	39	3.0	14.0	7.94	2.9586	0.4737	37.27
	F	23	3.0	21.0	8.00	5.0542	1.0538	63.17
	G	30	3.0	14.5	5.98	2.6440	0.4827	44.21
	H	22	2.0	8.0	5.02	2.1956	0.4681	43.73

Tab. 1B. The length of the leaf stalk

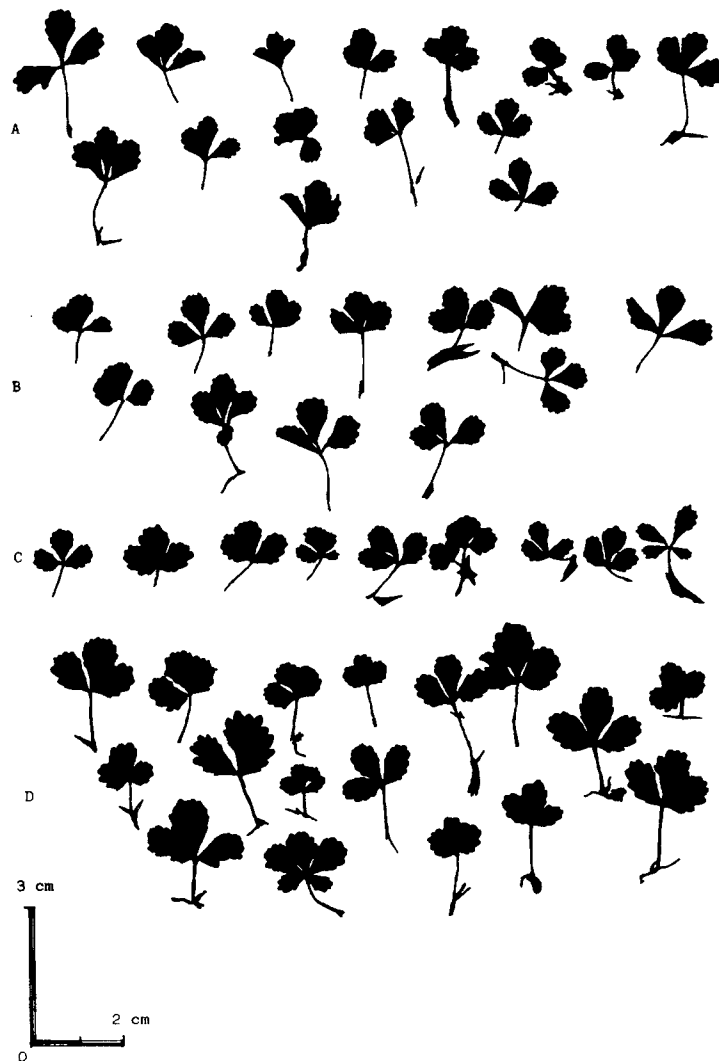


Figure 4. Variability of morphological characters of the leaf of species *Potentilla tommasiniana* F.W. Schultz at different populations

C.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	3.5	11.0	7.30	1.7437	0.3635	23.88
	B	40	7.5	17.0	12.44	3.0319	0.4855	24.37
	C	15	7.5	4.5	5.96	1.0455	0.2794	17.54
	D	37	6.0	13.0	8.54	1.9342	0.3179	22.64
	E	39	5.0	13.0	8.20	1.7907	0.2867	21.83
	F	23	6.0	12.5	8.83	1.4586	0.3042	16.51
	G	30	5.0	10.5	7.43	1.5128	0.2761	20.36
	H	22	4.0	9.0	5.02	1.6658	0.3551	26.35

Tab. 1C. The length of the middlemost leaf lobe

D.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	2.5	8.0	5.39	1.1866	0.2474	22.01
	B	40	4.0	11.0	6.45	1.5441	0.2472	23.93
	C	15	3.5	6.0	4.39	0.7152	0.1911	16.28
	D	37	4.0	11.0	5.81	1.4830	0.2438	25.52
	E	39	3.5	9.0	5.80	1.4124	0.2261	24.35
	F	23	4.0	8.5	6.16	1.0596	0.2209	17.20
	G	30	3.5	7.5	5.45	1.0451	0.1908	19.17
	H	22	3.0	5.5	4.27	0.7226	0.1668	18.32

Tab. 1D. Maximal width of the middlemost leaf lobe

E.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	2.5	9.0	6.17	1.2211	0.2546	19.79
	B	40	5.0	11.5	7.01	1.8875	0.3022	26.92
	C	15	3.5	7.0	5.12	0.9172	0.2451	17.91
	D	37	5.0	9.0	6.54	1.2296	0.2021	18.80
	E	39	3.0	7.0	4.86	1.1429	0.1854	23.51
	F	23	5.0	12.0	7.72	1.5644	0.3271	20.27
	G	30	4.5	8.5	6.17	1.2411	0.2265	20.11
	H	22	3.0	9.0	5.25	1.4780	0.3151	28.15

Tab. 1E. The length of the first leaf lobe

F.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	1.5	7.0	4.63	1.0596	0.2208	22.87
	B	40	3.0	9.0	4.49	0.8582	0.2033	28.27
	C	15	2.0	5.0	3.64	0.9899	0.2646	27.19
	D	37	3.0	6.0	6.54	1.0855	0.1784	23.64
	E	39	2.0	5.0	3.21	0.7590	0.1231	23.64
	F	23	4.0	9.0	5.48	1.0604	0.2211	19.35
	G	30	3.0	6.0	4.80	0.8452	0.1543	17.60
	H	22	1.5	6.0	3.55	0.9989	0.2129	28.13

Tab. 1F. Maximal width of the first leaf lobe

G.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	2.5	5.5	3.91	0.7232	0.1507	18.49
	B	40	2.5	8.5	4.95	1.3771	0.2205	27.81
	C	15	2.5	4.5	3.57	0.6114	0.1634	17.12
	D	37	3.0	5.0	3.95	0.7010	0.1152	17.71
	E	39	2.5	6.5	4.58	0.8950	0.1433	19.54
	F	23	3.5	7.5	5.02	0.9472	0.1975	18.86
	G	30	2.5	5.5	4.12	0.7591	0.1349	17.93
	H	22	2.5	5.0	3.64	0.6579	0.1403	18.67

Tab. 1G. Number of teeth on the middlemost leaf lobe

H.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	1.5	4.5	3.58	0.8958	0.1868	25.02
	B	40	1.5	5.5	3.54	1.0152	0.1605	28.67
	C	15	1.5	4.5	3.25	0.9743	0.2604	29.97
	D	37	1.5	6.0	3.72	0.9397	0.1545	25.26
	E	39	2.0	4.5	2.85	0.4808	0.0780	16.87
	F	23	3.5	6.5	4.59	0.8482	0.1765	18.47
	G	30	2.5	4.5	3.65	0.6841	0.1249	18.74
	H	22	2.5	4.5	3.55	0.6345	0.1353	17.87

Tab. 1H. Number of teeth on the first leaf lobe

I.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	4.0	16.0	8.98	2.3620	0.4925	26.30
	B	40	9.0	23.0	14.36	3.7028	0.7262	25.78
	C	15	2.0	11.0	8.21	2.7009	0.7210	32.88
	D	37	6.0	28.0	10.72	3.9002	0.6592	36.38
	E	39	6.0	16.0	9.61	2.3739	0.3801	24.70
	F	23	4.0	17.0	10.08	3.3293	0.6991	33.26
	G	30	5.5	16.0	10.90	2.7335	0.4990	25.07
	H	22	5.0	15.0	9.28	2.8309	0.6178	30.50

Tab. 1I. The length of the peduncle

J.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	2.0	4.0	3.24	0.4970	0.1036	15.34
	B	27	3.0	5.5	4.29	0.6171	0.1210	14.38
	C	15	2.5	4.0	3.14	0.4574	0.1222	14.56
	D	35	3.0	6.0	3.99	0.8333	0.1408	20.88
	E	39	3.0	4.5	3.61	0.5673	0.0908	15.71
	F	23	3.0	4.5	3.50	0.5838	0.1274	16.68
	G	30	2.5	4.5	3.36	0.5713	0.1043	17.00
	H	21	3.0	5.5	3.93	0.7791	0.1700	19.82

Tab. 1J. The length of the interior sepal

K.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	1.5	2.5	1.80	0.2915	0.0608	16.19
	B	27	2.0	4.0	2.42	0.5373	0.1075	22.20
	C	15	1.0	2.0	1.96	0.3461	0.0926	21.51
	D	35	1.0	3.0	1.90	0.5159	0.0872	27.15
	E	39	1.5	3.0	1.93	0.3835	0.0614	19.87
	F	23	1.5	2.5	2.05	0.2495	0.0520	12.17
	G	30	1.0	3.0	1.75	0.3884	0.0709	22.19
	H	21	1.5	3.0	2.09	0.4904	0.1070	23.46

Tab. 1K. Maximal width of the interior sepal

L.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	1.5	3.0	2.20	0.3612	0.0753	16.41
	B	27	2.0	4.0	2.77	0.4915	0.0964	17.74
	C	15	1.5	2.5	1.96	0.2369	0.0633	12.08
	D	35	2.0	3.0	2.46	0.4551	0.0769	18.50
	E	39	2.0	3.0	2.40	0.3713	0.0594	15.47
	F	23	2.0	3.0	2.47	0.4415	0.0920	17.87
	G	30	1.5	3.5	2.30	0.4842	0.0884	21.05
	H	21	1.0	4.0	2.55	0.6690	0.1459	26.23

Tab. 1L. The length of the outer sepal

M.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	23	1.0	1.5	1.02	0.1042	0.0217	10.22
	B	27	1.0	3.0	1.27	0.4266	0.0837	33.59
	C	15	0.5	1.0	0.93	0.1797	0.0480	19.32
	D	35	0.5	1.5	0.99	0.2232	0.0382	22.55
	E	39	0.5	1.5	1.10	0.2781	0.0445	25.28
	F	23	0.7	1.2	1.12	0.1663	0.0347	14.85
	G	30	0.7	1.5	1.00	0.1038	0.0189	10.38
	H	21	1.0	1.5	1.14	0.2315	0.0505	20.30

Tab. 1M. Maximal width of the outer sepal

N.	Sample	N	Xmin	Xmax	X	S	Sx	V%
	A	17	3.0	5.5	4.30	0.9649	0.2496	20.11
	B	15	4.5	7.0	5.60	2.5787	1.1532	46.04
	C	15	2.5	6.5	4.07	1.4606	0.5521	35.88
	D	29	2.0	6.0	3.64	0.9645	0.1791	26.49
	E	37	2.5	6.5	4.82	0.8992	0.1478	18.65
	F	21	3.5	6.0	4.23	0.6842	0.1427	16.17
	G	30	3.5	6.5	4.68	0.8757	0.1598	18.71
	H	15	2.5	5.0	3.76	0.8837	0.2282	23.50

Tab. 1N. The length of the petal

O.	Sample	N	Xmin	Xmax	X	S	S _x	V%
	A	17	2.5	6.0	4.00	0.9170	0.2647	22.92
	B	15	4.0	6.0	5.00	0.7906	0.3535	15.81
	C	15	2.5	6.0	4.00	1.4142	0.5345	35.35
	D	29	2.0	6.5	3.82	0.8688	0.1613	22.74
	E	37	2.0	6.0	4.54	0.8281	0.1361	18.24
	F	19	3.5	6.0	4.14	0.5169	0.1186	12.48
	G	30	2.5	5.5	4.48	0.6357	0.1161	14.19
	H	15	3.0	6.0	3.93	0.8632	0.2289	21.96

Tab. 1O. Maximal width of the petal

P.	Sample	N	Xmin	Xmax	X	S	S _x	V%
	A	17	0.25	1.0	0.45	0.2089	0.0603	46.42
	B	15	0.25	2.0	0.85	0.6964	0.3114	81.92
	C	15	0.25	0.5	0.33	0.2489	0.1017	75.45
	D	29	0.30	1.0	0.49	0.3069	0.0587	62.65
	E	36	0.25	2.5	0.60	0.4199	0.0699	69.99
	F	18	0.25	1.5	0.46	0.3237	0.0763	70.36
	G	30	0.25	0.7	0.40	0.1727	0.0315	43.17
	H	14	0.25	1.0	0.70	0.2804	0.0749	40.06

Tab. 1P. The depth of notch on the petal

first lobe from 2,85 to 3,72. The minimum values vary between 2,5 and 3 on the middle lobe and between 1,5 and 3,5 on the first lobe and the maximum values from 4,5 to 8,5 and from 4,5 to 6,5. The coefficient of variation for the first parameter is from 17,12 to 27,81% and from 16,87 to 30% for the other one (Tab. 1G-H).

The flower stem of the most terminal flowers averagely varies from 8,21 to 14,36 mm. The coefficient of variation goes between 24,7 and 36,38%. The smallest flower stems are only 2 mm long and the biggest even 28 mm (Tab. 1I) .

The shape and the size of sepals varies differently from one sample to another. The inner sepals have somewhat more stable shape than the outer ones. The rang of variation of the inner sepals length goes from 2 to 6 mm, of the outer ones from 1 to 4 mm, of the inner sepals width from 1 - 4 and of the outer ones from 0,5 to 3 mm.

The coefficient of variation of the length of the inner sepals varies from 14,38 to 20,88%, and from 12,08 to 26,23% of the outer sepals. The coefficient of variation of the width of the sepals from 12,17 to 27,15 and from 10,22 to 33,59% (Tab. 1J-M).

The petal length, averagely varies from 3,64 to 5,6 mm, the width from 3,82 to 5 mm. The range of variation runs from 2 to 7 for the length, from 2 to 6,5 for the width. The coefficient is somewhat greater for the petal length (Tab. 1N-O).

The depth of the petal curves varies from 0,25 to 2,5 mm. The coefficient of variation for this character is great, from 40 to 82% (Tab. 1P).

Student's test has been applied for a comparison of the interpopulational differences means of some characters; every population has been compared with each other, for every single character and for all characters on the whole (Tab. 2; 3).

The length of the plant	22	128	59.33	16.65	32.24	25.42
The length of the leaf stalk	1.5	36	7.87	27.88	63.18	43.24
The length of the middle most leaf lobe	3.5	17	7.96	16.52	26.36	21.69
Maximal width of the middlemost leaf lobe	2.5	11	5.46	16.28	25.52	20.85
The length of the first leaf lobe	2.5	12	6.10	17.91	28.15	21.93
Maximal width of the first leaf lobe	1.5	9	4.54	17.61	28.27	23.84
Number of teeth on the middlemost leaf lobe	2.5	8.5	4.22	17.13	27.82	19.52
Number of teeth on the first leaf lobe	1.5	6.5	3.59	16.87	29.98	22.61
The length of the peduncle	2	28	10.27	24.70	36.38	29.36
The length of the interior sepal	2	6	5.46	14.38	20.89	16.80
Maximal width of the interior sepal	1	4	1.99	12.17	23.46	20.59
The length of the outer sepal	1	4	2.39	12.09	26.24	18.17
Maximal width of the outer sepal	0.5	3	1.07	10.22	33.59	19.55
The length of the petal	2	7	4.36	16.17	46.05	25.69
Maximal width of the petal	2	6.5	4.24	12.49	35.36	20.47
The depth of notch on the petal	0.25	2.5	0.53	40.06	81.93	61.26

Table 2. Comparative review of statistical data on the investigated characters of the species *Potentilla tommasiniana* F.W. Schultz

The facts which are presented in these tables, obviously reveal the existence of greater and smaller differences, which are significant from the statistical point of view. The greatest interpopulational differences are established for the samples A and B, that is population «Zecija glava» *Potentillo-Scabiosetum leucophyllae* and «Ovcari» *Scabiosetum graminifoliae*, then for the populations «Ovcari» and «Crepoljsko». In the 75% of the analyzed characters among already mentioned populations great, statistically significant differences have been established (Tab. 3).

In the interval from 60 to 70% of the observed characters many, statistically significant differences have been established between population pairs «Ovcari» and «Kozija Cuprija», and «Crepoljsko» and «Celjugovici».

A little bit smaller statistically significant differences have been established for the populations «Ovcari» and «G. Mrkovici», «Ovcari» and «Bulozi», «G. Mrkovici» and «Sedrenik», «Sedrenik» and «G. Mrkovici» and some other ones (Tab. 3).

Differences in the interval from 50 to 60% of the analyzed characters have been established among these populations.

CHARACTERS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A:B	S	S	S	S	S		S	S	S	S	S	S	S			X
A:C	S	S	S	S	S	S	X					X				
A:D		S				S			X	S		X		X		
A:E			X		S	S	S	S		S						
A:F	S		S	X	S	S	S				S	X	X			
A:G									S							
A:H	S	X	S	S	X	S				S	X	X	X			X
B:C	S	S	S	S	S	X	S	S	S	S	S	S	S			
B:D	X		S			S	S	S	S		S	X	S		S	
B:E	S	S	S		S	S		X	S	S	S	S				
B:F	X	S	S			S		S	S	S	S	X			X	
B:G	S	S	S	S	X		S	S	S	S	S	S	S			
B:H	S	S	S	S	S	S	S	S	S		X				X	
C:D	S	S	S	S	S	S		S		S		S				
C:E	S	S	X	S			S			S		S	X			X
C:F	S	S	S	S	S	S	S	S		X		S	S			
C:G	S	S	S	S	S		X		S			S				
C:H	S	X	X							S		S	S			X
D:E	S	S			S	S	S	S		X				S	S	
D:F		S			S	S	S	S		X		X	X			
D:G	S	S				S	X			S				S	S	
D:H	S	S	S	S	S	S						X				X
E:F	S		S		S	S		S						S	X	
E:G		S			S	S		S	X				S			X
E:H	X	S	S	S			S	S						S	X	
F:G	S		S	X	S	X	S	S			S			X	X	
F:H	S	X	S	S	S	S	S	S		X						X
G:H	X		S	S	X	S	X		X	X	S		X	S	X	S

Table 3. Comparative review of the results of Student's test (t-test) for the investigated characters of the species *Potentilla tommasiniana* F.W. Schultz

S $p < 0.01$ X $p < 0.05$

Mutually the most similar populations, that is samples, are «Zecija Glava» from the community *Potentillo-Scabiosetum leucophyllae* and «Kozija Cuprija» from the community *Stipo capillatae-Dichantietum ischaemi*.

In just one feature (the length of the flower stem), these two populations have statistically significant difference. The most variable characters are the length of the plant,

the length of the leaf stem, the length of the middle lobe of leaf, the width of the first lobe of leaf and some other ones. These characters have morphologically significant differences in 60-68% of the analyzed populations. Statistically significant differences have been established for the teeth number on the first and on the middle lobe of leaf. It has been found out that 50-57% of the populations have statistically significant differences in these features. It is very interesting that 43% of the analyzed samples have statistically important difference in the length of the inner sepals. The smallest differences have been established between some populations, for the size of petals and the depth of notch. Statistically important differences, relative to the already mentioned features, have been recorded for a small number of populations, from 3 to 18% (Tab. 3).

The existence of statistically significant differences between analyzed samples can be partially attributed to the effect of the ecological factors. The high variability degree of some characters is probably affected by genetic factors. The possibilities of its hybridization with the closest species of this genus contribute to the great variability of this taxon. Today in our literature many of such forms have been mentioned (BECK, 1927).

Most of the samples develop in ecologically rather similar conditions, so many differences between some samples could not be brought into the more intimate connection, with the more significant effect of one of these factors on the variability degree of the observed characters. The obtained facts give better insight on the existing infraspecific forms on this species from one side, and more realistic definition of the new ones, from the other side. REDZIC (1988), beside previously mentioned authors, pointed to the important variability of many populations of these species on the area of Bosnia and Herzegovina's and he predicted the possibility of separation of new infraspecific forms within this taxa (REDZIC, 1989). Considering that the infraspecific differentiation means beside these and some other comparative-morphological, chorologic, phenological, ecological and some other analyses, we shall give more detailed results about definition of some infraspecific forms within this species, in one of the following supplements about this sort.

Phenological characteristics

The vegetational period of most populations of this species starts very early. Even in the middle of March, and sometimes even earlier, depending on general climate conditions during that year, the vegetative and soon after the generative organs of some individuals of this species develop intensively. In the second part of March, in submediterranean and in the lower parts of the hilly zone, the individuals of this sort start blooming. The phenophase of the full bloom in these areas lasts from the beginning to the end of April. The mountain and subalpine populations bloom fully at the end of April and in the first part of May. At optimal temperature most of the populations of these species also bloom at the second part of September and nearly to the first part of November but without strong frosts.

Chorological characteristics

According to HAYEK (1927) this species occurs in Albania and Bulgaria. CIOCIRLAN (1988) finds it also in the area of Rumania. In Bosnia and Herzegovina *P. tommasiniana* is widely spread (BECK, 1927). It exists on dry, shallow, mostly carbonate soils from submediterranean to subalpine zone, on vertical profile of Bosnia and Herzegovina (Fig. 2).

Bosnia: Kozara mt. (B.), Otasovac (Klekovaca mt. (B.), Pribelja (Sta.), Dubrava (Ha. Fa.), Kalin near Bugojno (Br. f. Th. Wolf), Hrblijina (Ha., Ja.), Kupres (F.), Marica Kosara on Dinara mt. (Ja. W.), Reckovac, Drvar, Marinkovci, Marino br. (Ja.), Grahovo, Preo dac, Rore, Branesci on Veliki Sator mt. (Ja.), between Glamoc et Rasticevo (Ha. Fa. f. Th. Wolf), Borova gl. near Livno (F., B.), Krug mt., Cincar (F.), Sehovci (Fo. f. Th. Wolf), between Jajce and Jezero (G.K.), Vlasic mt. around Travnik (Br.), Fojnica (Mu.), Krupac, around Sarajevo (H., B.), Trebevic mt. (B., M.), Miljacka (B., Fo.), Bakije, Debelo br. (Fo. f. Th. Wolf), Maglic, Mratinje (Roh.), Visegrad (Adam.), Kovanje (B.); Kamesnica (S.); (HERB. SARA !); Zecija gl. (R.S.) Crepoljsko br. (R.S.); Mrkovic (R.S.); Goropec (R.S.); Celjugovici (R.S.); Kozija Cuprija (R.S.); Bulozi (R.S.); around Rudo (R.S.); Sedrenik (R.S.); Obhodza (R.S.); Borije (R.S.); Hresa (R.S.); Gradina (R.S.); Brus near Trebevic (R.S.); D. Malovan (L., P., R.S.); Manjaca (R.S., M., O.); Strpci Una river (L., R.S.); Medeno polje (L., R.S.) (HERB. IBUS !).

Herzegovina: Ivan, Konjic, Jablanica, Mostar (Fo. sed a Th. Wolf non visa); Buna, Zitomislci, Velez, Crvanj mt., Bjelasica mt. near Gacko (Mu.), Plasa mt. (Pr.); Klinje near Gacko (R.S.), Ovcari (R.), (R.S.); Konjic - Suhi Do (R.S.); Zlatar near Konjic (R.S.), Borci near Konjic (R.S.); Ulog (R.S.); (HERB. SARA ! and HERB. IBUS).

Abbreviation: **Adam.** - Adamovic, L.; **B.** - Beck-Mannagetta, G.; **Br.** - Brandis, E.; **Fa.** - Faltis, F.; **Fo.** - Formanek, E.; **F.** - Fiala, F.; **G.K.** - Gross, L. et Kneucker, J.A.; **H.** - Hofmann, F.; **Ja.** - Janchen, E.; **KL.** - Lakusic, R.; **M.** - Maly, K.; **Mi.** - Misic, Lj.; **Mu.** - Murbeck, S.; **O.** - Omerovic, S.; **P.** - Pavlovic, D.; **Pr.** - Protic, G.; **R.** - Riter-Studnicka, H.; **R.S.** - Redzic, S.; **Roh.** - Rohlena, J.; **Sta.** - Stadlmann, J.; **S.** - Silic, C.; **Ha.** - Handel-Mazzetti, H.; **Ha.-Fa.** - Handel-Mazzetti, H., Stadlmann, J., Jannhen, E., Faltis, F.; **W.** - Wettstein, R.

CONCLUSIONS

On the basis of the studies about on morphological differentiation of many populations of the species *Potentilla tommasiniana*, on the horizontal and vertical profile of Bosnia and Herzegovina, it has been established that:

P. tommasiniana is a very variable species. The highest variability degree is in the length of the leaf stalk, the height of plant, shape and size of leaves, the length of flower stem, the depth of the notch on petals and the number of teeth on the first and on the middle lobe of leaf.

Statistically highly significant interpopulational differences have been established for the length of plants, the length of leaf stalk, the length of the first and middle lobe of

leaf, the width of the first lobe of leaf, and the number of teeth on the middle lobe. The 60-70% of the analyzed populations differ significantly on the mentioned features.

The most specific, from the morphological point of view, is the population «Ovcari» from the community *Scabiosetum graminifoliae*, which in the 70% of the analyzed features differs from the other populations. Considering the specific habitat of this population (dolomite geological substratum), the taxonomic differences, can be expected, relative to the other populations. The smallest differences in the morphology, considering the other populations, are established for the individuals from the population «Zecija Glava» from community *Potentillo-Scabiosetum leucophyllae*. In about 35% of the analyzed characters, this population differs from the others.

Considering the analyzed characters, this species considerably differs from the kindred and morphologically similar ones (*P. cinerea*, *P. arenaria*, etc.), so it should be treated entirely as a separate species.

The further investigations will be in the function of the affirmation of this species in a higher degree.

LITERATURE

- BALL, P.W., B. PAWLOVSKI & S.M. WALTERS (1968): *Potentilla* L. in *Fl. Europaea* (ed. Tutin, T.G.), Vol. 2: 36-47.
- BECK-MANAGETA, G. (1927): *Flora Bosne, Hercegovine i oblasti Novoga Pazara. Srpska kraljevska akademija, Prirodnjacki i matematicki spisi*, 15: 8-44, Sarajevo-Beograd.
- CIOCIRLAN, V. (1988): *Flora Illustrata a Romaniei*. Vol. I: 303. Editura Ceres, Bucuresti.
- DOMAC, R. (1973): *Mala flora Ervatske i susjednih podruca*. Skolska knjiga Zagreb.
- GAJIC, M. (1972): Rod *Potentilla* E. in *Flora Srbije*, tom IV: 80-118. (Ed. M Josifovic, M.). SANU Beograd.
- HAYEK, A. (1927): *Prodromus florae peninsulae Balcanicae*. Band I: 671-690, Berlin-Dahlem.
- MAYER, E. (1952): *Seznam praprotnic in cvetnic slovenskega ozemlja*. Ljubljana.
- MEUSEL, H., E. JAGER & E. WEINERT (1965): *Vergleichende Chorologie der Zentraleuropaischen Flora. (Karten)*. Gustav Fischer Verlag, Jena.
- PANCIC, J. (1874 repr. 1976): *Flora knezevine Srbije*. SANU, posebna izd., Odj. prir.-matem. nauka, knj. 47: 271-278. Beograd.
- PETZ, B. (1974): *Osnovne statisticke metode*. Izd. zavod JAZU, Zagreb.
- REDZIC, S. (1988): Ekolosko-morfoloska diferencijacija populacija vrste *Potentilla tommasiniana* F. Schultz. Naucni skup «Minerali, stijene, izumrli i zivi svijet Bosne i Hercegovine», povodom 100 godina postojanja Zemaljskog muzeja BiH u Sarajevu, Sarajevo.
- REDZIC, S. (1989): *Potentilla tommasiniana* F. Schultz u flori i vegetaciji Bosne i Eercegovine. II kongres biosistematikov Jugoslavije. Izvlaceki porocil, Gozd Martuljek, september 1989. godine, 59.
- ROHLENA, J. (1942): *Conspectus florae Montenegrinae. Preslia* 20-21: 141-146. Praha.

(Aceptado para su publicación el 1. Diciembre.1993)