

***In situ* evaluation of a *Pisum sativum* subsp. *elatius* population from the valley of the river Pcinja in southeast Serbia**

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Introduction

There is a taxon within the genus *Pisum* L. colloquially called *elatius*, commonly considered a subspecies within common pea (*P. sativum* L.), namely *P. sativum* L. subsp. *elatius* (Steven ex M. Bieb.) Asch. & Graebn. (1). In further text referred to as *P. elatius*, it is regarded as a direct progenitor of cultivated pea (2), although with not satisfactorily described process of domestication yet. In a wider sense from an ecological viewpoint, *P. elatius* is a Mediterranean element with native distribution in Albania, Algeria, Azerbaijan, Bulgaria, Croatia, Cyprus, Egypt, France, FYR of Macedonia, Georgia, Greece, Iran, Israel, Italy, Lebanon, Libya, Montenegro, Morocco, Portugal, Russia, Romania, Serbia, Spain, Syria, Tunisia, Turkey and the Ukraine (3).

The first records on the presence of *P. elatius* in the flora of Serbia come from the second half of nineteenth century by the father of modern Serbian biology and ecology, Josif Pancic (4). This species is known to be distributed in several regions of the country and most abundantly in the south. Also, there are reports of a white-flowered variety (var. *albiflorum*) unlike the usual violet-flowered ones (5). However, existing information on the distribution of *P. elatius* in Serbia is incomplete. Recently, this pea taxon has been rediscovered in the southeastmost regions of Serbia, namely in the area of the upper Pcinja river and quite close to the modern border between Serbia and Former Yugoslav Republic of Macedonia (Figure 1). In that area, *P. elatius* inhabits the lower zone of northerly exposed slopes of Mount Kozjak, on the left side of the valley, amidst the slopes covered by termophilous submediterranean forests and scattered scrub vegetation on siliceous rocky soil (6).

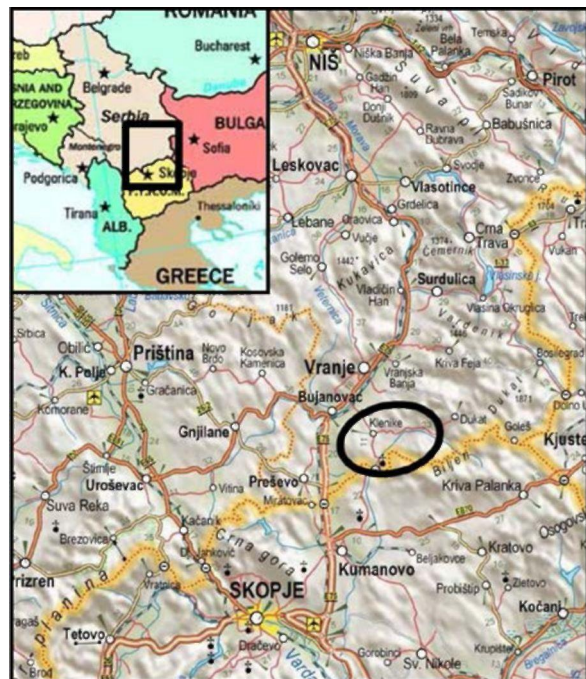


Figure 1. The upper flow of the river Pcinja where *P. elatius* was re-discovered.

The aim of this preliminary research was to carry out an initial *in situ* evaluation of the population of *P. elatius* growing in the upper Pcinja River.

Materials and methods

Two expeditions were made in 2011 with an ultimate goal of collecting samples for a more detailed *in situ* evaluation of the *P. elatius* population from the region of the Pcinja River (Fig. 1), with emphasis on agronomic characteristics, such as yield components, and chemical composition, stressing the nutritive value.

The first expedition was performed on 28 May 2011, targeting the same area where *P. elatius* was re-discovered in 2009. A group of several plants was found on the edge between the foothills of the Mount Kozjak, between the forest and the meadow in the very vicinity of the Pcinja River and the monastery of Saint Prohor Pcinjski from 11th century. The plants were in the full bloom stage and forming the first pods (Figure 2), in further text referred to as Stage 1. Not far from this group, up the slopes of the Mount Kozjak and amidst the dense canopy of trees and shrubs, another population was found in the same stage, with plants either creeping over the rocky ground or climbing up and hanging from branches. By several plants growing on inaccessible slopes between these two

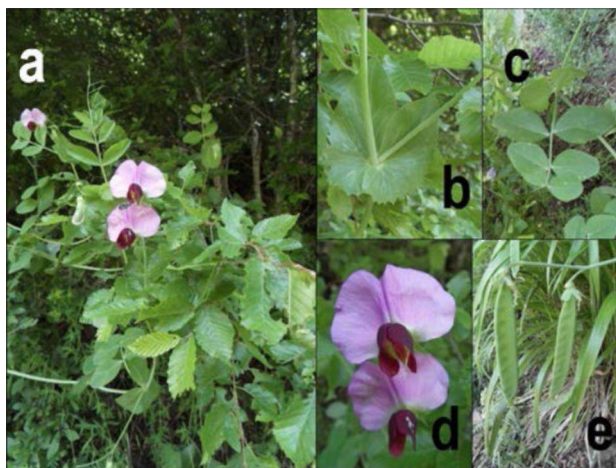


Figure 2. Some features of the *P. elatius* population from the upper flow of the

groups, it may be assumed that the first group is a progeny of the second one, developing from the seeds that gradually rolled downwards, although this must remain speculative until a comparative research of these two populations is done with molecular markers. Fourteen plants were sampled in total from both groups and used for the analysis of agronomic characteristics and chemical composition related to forage.

The second expedition on 25 June 2011 visited the same population of *P. elatius* near the Pcinja River. Intact, both groups were in full maturity of the oldest pods, with a few pods already shattering their seeds. This was referred to as Stage 2. The pods stood erect and followed the direction of their peduncles, unlike the hanging ones of cultivated pea. Another set of fourteen plants was sampled from both groups and for the analysis of agronomic characteristics and chemical composition of the seeds. At least a dozen plants were left for regeneration of the population.

The agronomic analysis comprised determining the main yield components including (Stage 1) stem length (cm), number of stems (plant⁻¹), stem mass (g plant⁻¹), leaf mass (g plant⁻¹), plant mass (g plant⁻¹), stem proportion (%) and leaf proportion (%), as well as (Stage 2) stem length (cm), number of stems (plant⁻¹), number of pods (plant⁻¹), number of grains (plant⁻¹), stem mass (g plant⁻¹), leaf mass (g plant⁻¹), pod mass (g plant⁻¹), seed mass (g plant⁻¹), plant mass (g plant⁻¹) and harvest index.

The analysis of chemical composition at both stages comprised determining the content (g kg⁻¹) of crude protein, crude fat, crude fiber, neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, crude ash and nitrogen-free compounds (NFC).

The data related to the agronomic characteristics in both stages are presented as minimum, maximum and average values. The results of the chemical composition and nutritive value in both stages were processed using Statistica 8.0 software, with analysis of variance (ANOVA) performed and a Fisher's Least Significant Difference (LSD) test used at $P = 0.05$.

Results and discussion

The analysis of agronomic characteristics of the *P. elatius* population that are of interest in its cultivated relatives revealed wide variation of certain morphological traits that are also important forage yield characteristics (Table 1). It is neither possible nor appropriate to compare these results with those obtained in related species under field conditions, although *P. elatius* grew together with many other plants, mostly grasses and legumes, such as vetches (*Vicia* spp.). At any rate, the average dry plant mass in the stage of full bloom and forming the first pods may provide a basis that this pea taxon has good potential for forage production. In addition, the leaf proportion was higher than 50%, indicating the potential for good forage quality.

Table 1. In situ forage related characteristics of the *P. elatius* population from the upper Pcinja River in southeast Serbia in 2010

(Stage 1).

	Stem length (cm)	Number of stems (plant ⁻¹)	Stem mass (g plant ⁻¹)	Leaf mass (g plant ⁻¹)	Plant mass (g plant ⁻¹)	Stem proportion	Leaf proportion
Minimum	31	1	4.48	7.70	12.18	0.13	0.48
Maximum	192	8	35.14	63.42	98.56	0.52	0.87
Average	68	3.8	11.04	22.44	33.48	0.33	0.67

Average stem length and stem number did not change significantly from Stage 1 to Stage 2 (Table 2). Average seed mass (5.60 g plant⁻¹) may be regarded as rather high, being perhaps another indicator of the domestication level of this pea taxon. Its harvest index, the ratio between the mass of mature seeds and the remainder of the mature and dry plant parts is also considerably high for a wild relative of a crop plant (0.38).

Table 2. In situ seed related characteristics of the *P. elatius* population from the upper Pcinja River in southeast Serbia in 2010

(Stage 2).

Stage 2	Stem length (cm)	Number of stems (plant ⁻¹)	Number of pods (plant ⁻¹)	Number of grains (plant ⁻¹)	Stem mass (g plant ⁻¹)	Leaf mass (g plant ⁻¹)	Pod mass (g plant ⁻¹)	Grain mass (g plant ⁻¹)	Plant mass (g plant ⁻¹)	Harvest index
Minimum	52	1	2	2	2.82	1.28	0.61	2.46	7.17	0.34
Maximum	168	7	11	74	14.34	5.25	2.35	15.71	37.65	0.42
Average	72	4.1	4.3	27.3	5.52	2.38	1.24	5.60	14.74	0.38

The average protein content (Table 3) in *P. elatius* forage dry matter (201 g kg⁻¹) is slightly higher than in typical forage pea cultivars (7) and is closer to those in vetches (8). The average crude protein content in grain dry matter (343 g kg⁻¹) is much higher than in dry pea cultivars or other important grain legume crops (9, 10) and close to another interesting legume crop wild relative (11), *Vavilovia formosa* (Stev.) Fed. As expected, crude protein content in Stage 1 is highest in leaf tissue. When combined with the already mentioned high leaf proportion in total plant mass, it may be interesting for forage pea breeders. On the other hand, the content of crude fiber, together with its fractions like ADF, NDF and lignin, was higher than in typical perennial forage legume crops (12).

Table 3. *In situ* nutritive value of the *P. elatius* population dry matter (g kg) from the upper Pcinja river in southeast Serbia

	Crude protein	Crude fat	Crude fiber	NDF	ADF	Lignin	Crude ash	NFC
				Stage 1				
Stem	115	8	483	619	532	136	61	333
Leaf	244	25	265	353	320	62	76	391
Plant	201	19	337	441	390	86	71	372
LSD05	32	6	123	45	35	15	6	29
				Stage 2				
Stem	69	12	528	674	587	128	88	303
Leaf	146	41	291	324	307	76	131	390
Pod	98	5	437	573	415	93	70	391
Grain	343	-	188	242	205	19	-	-
LSD05	67	11	211	69	55	27	33	31

Conclusions

This preliminary research will be continued on several levels. This newly found population of *P. elatius* will be maintained *ex situ* and further evaluated within the field collection of the Institute of Field and Vegetable Crops in Novi Sad. Also, this population will be monitored *in situ* and visited before the winter, to check if there is any fall growth of new plants, as well as in early spring next year, with the same purpose. In addition, more locations will be searched for *P. elatius*, thus verifying previous reports of its presence in the flora of Serbia.

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