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THE INFLUENCE OF HABITAT CONDITIONS ON ANATOMICAL STRUCTURE OF *IMPATIENS PARVIFLORA* DC. (BALSAMINACEAE)

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ABSTRACT. The paper presents the results of the investigations on the anatomical structure of vegetative organs (stems and leaves) of five samples of *Impatiens parviflora* DC. from the Wielkopolski National Park. Samples varied in terms of light conditions and came from different phytocenoses. It was found that plants coming from an anthropogenic locality are characterised by the thickest stems, the thickest layer of the sclerenchymatous sheath, thick angular collenchyma and the biggest vascular bundles. Plants from a strongly shaded locality had the thinnest layer of collenchyma, a thin layer of the sclerenchymatous sheath at the thickest layer of mesophyll. Analyses showed a significant effect of habitat conditions on variation in anatomical traits. The biggest variability in stem traits was observed for the thickness of the sclerenchymatous sheath between bundles, while the smallest – for the thickness of epidermisis and the number of vascular bundles. The biggest variability in leaf traits was found for the number of idioblasts with rafides, while the smallest – for the width of stomata.

KEY WORDS: *Impatiens parviflora* DC., phenotype plasticity, different habitats, anatomy, stem, leaf

INTRODUCTION

Flora of every region comprises native species as well as alien species, either accidentally or purposefully introduced by man (Stace 1993). The group of plants spreading thanks to humans includes a species coming from Central Asia, *Impatiens parviflora* DC. It belongs to the family Balsaminaceae, comprising over 850 species. It is an anthropophyte and at the same time a holoagriophyte – naturalized in natural habitats (Podbielkowski 1995). At present it may be found throughout Poland (Atlas... 2001), in particular abundance in forested areas (Chmura 2004). It is characterised by a wide ecological amplitude, which has contributed to its high invasiveness (Chmura et al. 2007). Production of generative organs (frequently not used in reproduction) in this species is very high, strongly modified by environmental conditions (Piskorz and Klimko 2002, Piskorz 2005), while the mechanism of seed dispersal results in an extension of its range area. Within phytocenoses it avoids strongly shaded sites (Chmura and Sierka 2006), occupying empty and disturbed microhabitats (Piskorz and Klimko 2001). It effectively displaces a native species *Impatiens noli-tangere* L. (Faliński 1969).

Response of plants to environmental conditions may be manifested in the variation of morphological, anatomical and physiological traits, reproduction potential, as well as lability of development cycles (Falińska 1997, Stace 1993). *Impatiens parviflora*, despite slight genetic differences between populations (Komosińska et al. 2006), inhabits highly varied habitats, exhibiting extreme morphological elasticity (Eliáš 1999), manifested e.g. by variation in plant habit (Piskorz 2004). Phenotypic elasticity of specimens in a given species indicates its potential capacity to live under different conditions (Falińska 1997). Daubenmire (1973) claimed that it is of ecological importance, since it extends the range of habitats which a given species may occupy and that individual representatives of the species may adapt to more than one habitat.

Light preferences of *Impatiens parviflora* are not precisely defined. It is found both in insolated and shaded positions (Maj and Bednarek 1977, Piskorz and Klimko 2001, 2007). Studies conducted to date have concerned primarily the mesophyll structure in leaves. Under conditions of poor insolation the palisade parenchyma is most frequently one-layered, while in spongy parenchyma an increased number of intercellular spaces is observed in comparison to plants from well-insolated positions, where palisade parenchyma may have more layers, whereas spongy parenchyma is more compact (Ryerson and Dengler 1994). However, there are no such data on the anatomical structure of stems.

The aim of the study was to compare variation in the anatomical structure of leaves and stems of *Impatiens parviflora* found under different light conditions in the Wielkopolski National Park.

MATERIAL AND METHODS

Impatiens parviflora is a component of meso- and eutrophic broad-leaved forests, which are represented by one class *Querco-Fagetea* (Wysocki and Sikorski 2000). It occupies very different areas, irrespective of the physical and chemical properties of soils (Chmura et al. 2007). Localities of five samples were located in the Wielkopolski National Park (Fig. 1), which composition of flora comprises almost 25% alien species (Żukowski et al. 1995).

Biometric analyses were conducted on samples composed of 25 plants from each investigated locality, which differed in light conditions and they occurred in different phytocenoses (Fig. 1, Table 1). These plants were characterised in terms of eight anatomical characteristics of stems and three anatomical traits of leaves (Table 2).

Fragments of stems and leaves were fixed in a 3:1 alcohol and glycerin solution. In order to leach chlorophyll from leaves microsections were placed in chloral hydrate with water and glycerol (5:3:1). Anatomical analysis was conducted on cross-sections. Material was collected from central parts of plants. Diameters of stem cross-sections were measured using the Brinell scope, biometric analyses of the other traits were performed with the use of an ocular scale in a Studar microscope. Microphotographs were taken using the MultiScan v.11.06 CSS Scan: Advanced System of Image Laogding and Analyses software. For all quantitative traits the following characteristic values were calculated: X – arithmetic mean, MAX – the highest value of a given trait,

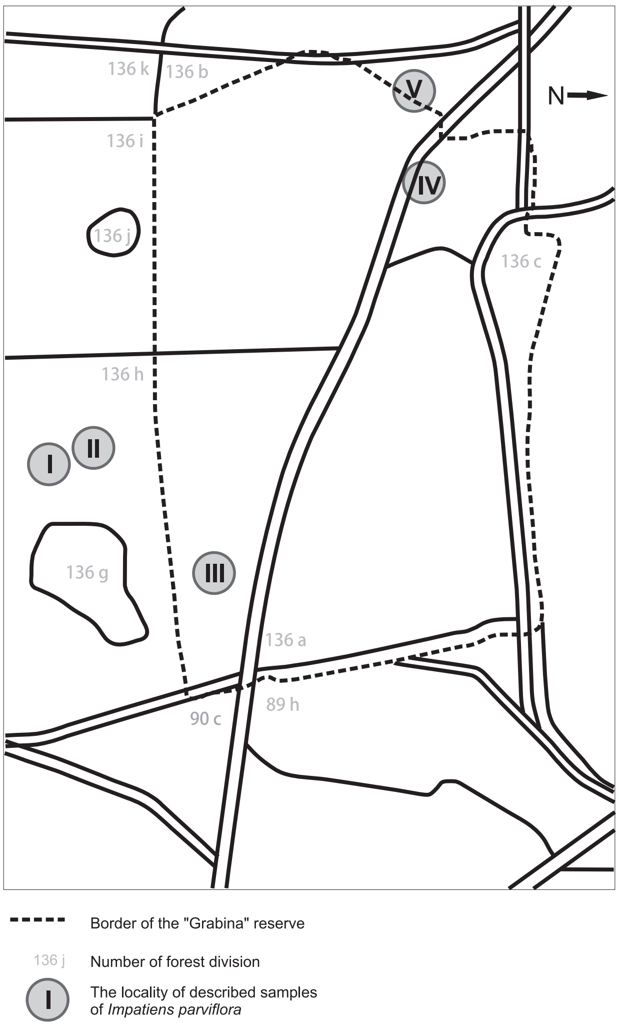

Fig. 1. Localization of studies samples of *Impatiens parviflora*

Table 1. Localization of studied samples of *Impatiens parviflora*

Sample I	Partial protection area in the patch of central oak-hornbeam forest characterised by two-layer tree stand. The first tree stand consists of *Quercus petraea* and *Pinus sylvestris* while the second is characterised by frequent occurrence of *Corylus avellana*. The sample was taken from shadowed places under the canopy.
II	The same area. The sample was taken from a strongly exposed to sun tree gap.
III	Within nature reserve area "Grabina", which represents regeneration form of typical oak-hornbeam forest, while high density of tree and bush stands leads to overshadowing of the tree floor.
IV	On the border of sun-lit forest road in the *Impatientetum parviflorae* stand (antropogenic stand).
V	Ecotone (transitionary) system between phytocoenosis *Galio sylvatici-Carpinetum* and *Calamagrostio-Quercetum* (sun exposed). Transitionary character of sun-exposed patch is evidenced by the presence of species passing from Scots pine forest and acidophilous oak forest. Simultaneously the tree layer is less dense than in a typical broadleaved forest.

Table 2. Analysed characters of the stems and leaves of *Impatiens parviflora*

No.	Characters	Units of measurement
	Stem	
1	Stem diameter	mm
2	Epidermis thickness	μm
3	Collenchyma thickness	μm
4	Cortex thickness	μm
5	Number of vascular bundles	μm
6	Vascular bundles thickness	μm
7	Vascular bundles width	μm
8	Sheath of sclerenchyma thickness	μm
	Leaf	
9	Length of stoma	μm
10	Width of stoma	μm
11	Number of idioblasts	mm^2

MIN – the lowest value of a given trait, SD – standard deviation as a measure of absolute variation, and V – coefficient of variation in a given sample. Numerical data were subjected to statistical analysis, calculating correlations and Pearson's coefficient of determination, as well as agglomerative clustering using the nearest neighbour method, which graphic image is a dendrogram (Karoński and Caliński 1973, Sokal and Rohlf 1997, Statistica... 2002).

RESULTS

Stems

Stems of *Impatiens parviflora* at the cross-section is circular in outline (Fig. 2 A). The diameter ranged from 2.06 mm (sample III) to 3.77 mm (sample IV). The biggest similarity was found for plants from samples I, II and V. The degree of variation for this trait in investigated plants of five samples was high, as it is manifested by coefficients of variation, ranging from 15.66% in sample I to 18.04% in sample IV, respectively (Table 3).

The cuticle layer is very thin. Stem epidermisis is single-layered, smooth, composed of rectangular cells, devoid of chloroplasts (Fig. 2 B). Mean thickness of the epidermis ranged from 14.83 μm (I) to 16.66 μm (IV). Plants from samples I and II in terms of this trait varied slightly, similarly as it was the case for samples IV and V. The intermediate character in terms of epidermis thickness was found for sample III, where mean thickness was 15.86 μm (Table 3). Thickness of the epidermis needs to be considered a character of limited variability, as it is reflected in low values of standard deviation (SD) and the coefficient of variation (V), which ranged from 7.63% (sample III) to 13.37% (sample II).

In the outer sections of the cortex immediately below the epidermis the angular collenchyma is found (Fig. 1). Most frequently it is two-layered, diverse in terms of thickness. Thickness of the collenchyma ranged from 27.58 μm (sample III) to 47.78 μm (sample IV). The biggest similarity in this trait was observed for plants from samples I and II as well as IV and V. Variation in this character was high, as it is evidenced by high coefficients of variation, ranging from 17.31% (sample IV) to 36.04% (sample III).

The layer of parenchyma in the cortex is relatively thin, most commonly three- or four-layered, while considerable spaces in the stem are filled by the parenchyma together with retort cells. The thickest parenchyma was observed in plants from sample III (232.08 μm), while the thinnest in plants from sample II (134.52 μm). Plants from samples I, IV and V in terms of this trait differed slightly. The coefficient of variation was relatively high, falling within the range from 18.56% (sample I) to 30.66% (sample III).

A one-layered endodermis, containing starch grains, is adjacent to the parenchymal layer of the cortex. The outer part of the pith has smaller dimensions of cells and thicker walls, which are found between vascular bundles as the sclerenchymatous sheath (Fig. 3), which thickness exhibited relatively considerable variability (Table 3). Moreover, plants were observed, particularly in sample III, in which the sclerenchymatous sheath was not detected. The thickest sclerenchymatous sheath was recorded in sample IV – 85.01 μm (Fig. 3), while the thinnest in sample III – 21.34 μm (Fig. 3). Plants from samples I and III differed slightly. Thickness of the sclerenchymatous sheath is one of the most variable characters (Table 3), while light conditions have a significant effect on the above characteristic.

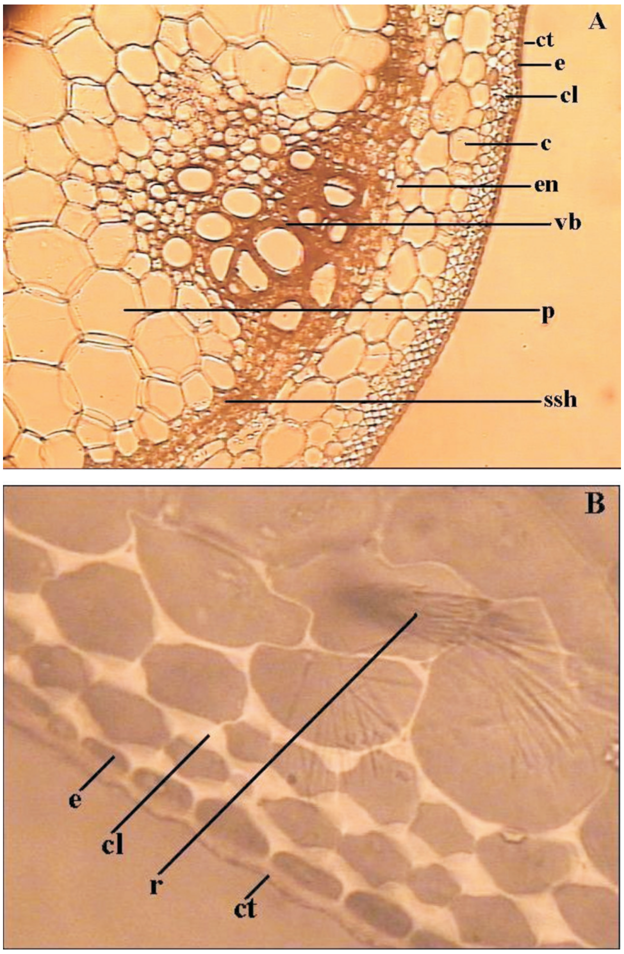

Fig. 2. Cross-section of *Impatiens parviflora* stem; e – epidermis, cl – collenchyma, c – cortex, e – endodermis, vb – vascular bundle, p – parenchym, ssh – sheath of sclerenchyma, r – raphids, ct – cuticle; sample II; A – ×100, B – ×400

The primary elements of the central cylinder are collateral vascular bundles, arranged around the pith formed from the primary parenchyma, in which also idioblasts with crystals of calcium oxalate are found. The mean thickness of a vascular bundle ranged from 152.33 μm in sample III to 395.95 μm in sample IV. The highest similarity in terms of this character was found for plants from samples II and V, which differed only slightly. The situation was analogous in case of their width. The thinnest vascular bundles were observed in plants from sample III, while the widest in sample IV. These characters need to be considered to be rather variable, as it is manifested in the high values of standard deviation and the coefficient of variation (Table 3). Single vascular bundles are arranged at more or less identical distances, but they were also observed two one next to the other, with either well- or poorly developed xylem and phloem in all samples (Figs 2 A, 3). In stems at the cross-section a total of four to 10 vascular bundles were

Table 3. Statistical descriptions of the analysed anatomical characters of stem

Descriptive statistics	STEM Characters							
	1*	2	3	4	5	6	7	8
I**								
X	2.81	14.83	38.23	151.54	7.80	215.52	162.53	24.14
SD	0.44	1.86	8.30	28.12	0.41	42.97	25.86	12.15
V	15.66	12.54	21.71	18.56	5.26	19.94	15.91	53.24
MAX	3.70	19.20	52.80	226.20	8.00	315.00	201.00	53.40
MIN	1.90	12.00	19.20	102.60	7.00	145.20	105.60	0.00
II								
X	2.37	14.88	39.47	134.52	7.80	263.06	177.91	53.78
SD	0.41	1.99	8.65	34.46	0.82	61.39	48.93	28.97
V	17.30	13.37	21.91	25.62	10.51	23.34	27.61	53.87
MAX	3.30	17.40	54.00	267.00	8.00	411.00	272.40	133.20
MIN	1.75	10.80	18.60	90.00	4.00	167.40	90.00	20.40
III								
X	2.06	15.86	27.58	232.08	7.24	152.33	138.58	21.34
SD	0.36	1.21	9.94	71.15	0.94	31.54	27.14	11.67
V	17.56	7.63	36.04	30.66	13.4	20.71	19.58	97.41
MAX	3.00	18.00	51.60	379.80	8.00	234.00	187.80	31.20
MIN	1.45	13.80	18.00	118.20	5.00	111.60	93.00	0.00
IV								
X	3.77	16.66	47.78	157.20	8.36	395.95	256.98	85.01
SD	0.68	1.67	8.27	37.16	0.70	100.67	91.96	38.13
V	18.04	10.02	17.31	23.64	8.37	25.42	36.35	44.86
MAX	5.50	19.80	70.80	231.00	10.00	660.00	501.00	226.80
MIN	2.40	14.40	31.80	83.40	7.00	220.20	123.00	31.20
V								
X	2.53	16.25	45.53	160.39	7.84	243.62	174.98	30.83
SD	0.44	1.91	11.43	48.67	0.94	56.14	33.93	13.00
V	17.39	11.75	25.10	30.34	11.99	23.04	19.39	45.79
MAX	3.35	19.80	83.40	331.20	9.00	336.00	237.60	49.80
MIN	1.60	12.60	20.40	118.80	4.00	126.00	111.00	0.00
NIR α = 0.05	**0.525**	**1.972**	**7.277**	**56.552**	**0.863**	**50.286**	**39.215**	**26.192**

*See Table 2; **See Table 1.

found. On average the biggest number of vascular bundles (8.36) was observed in sample IV, while the lowest (7.24) in sample III. Samples I and II in terms of this trait did not exhibit differences, while in sample V this number was slightly higher (Table 3).

Between the eight anatomical traits of stems correlations and coefficients of determination were calculated for significant correlations (α = 0.05) in each sample (Table 4).

It was found that the biggest number of significant correlations was observed for plants from sample I (including the biggest number of positive correlations), while the lowest number – in sample II. The biggest number of negative correlations was recorded for plants in sample III. In sample I eight positive correlations were found for the following characteristics: stem diameter with the thickness of vascular bundles (also in samples III, IV and V) and the thickness of the sclerenchymatous sheath (also in sample III), the thickness of the collenchyma with that of the cortical parenchyma as well as the thickness of vascular bundles (also in sample III) and their width, the thickness of the cortical parenchyma with the width of vascular bundles and the thickness of vascular bundles with their width (also in samples II, IV and V) and the thickness of the sclerenchymatous sheath between them (also in samples I and V). A negative correlation was obtained only for one pair of traits, i.e. the number of vascular bundles with the

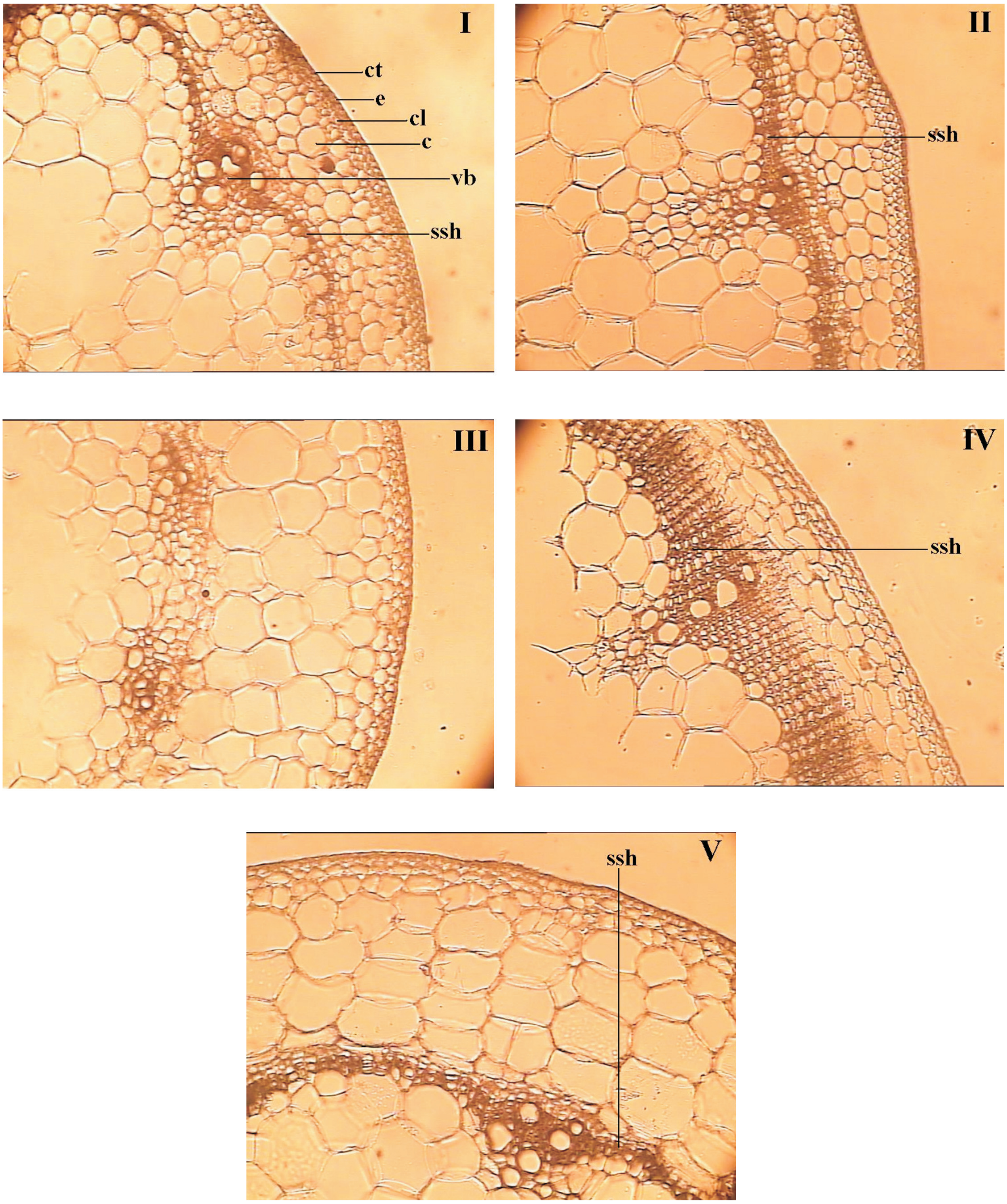

FIG. 3. Cross-section of *Impatiens parviflora* stem; ct – cuticle, e – epidermis, cl – collenchyma, c – cortex, vb – vascular bundle, ssh – sheath of sclerenchyma (samples I-V, see Table 1)

thickness of the sclerenchymatous sheath. In sample II only two positive correlations were observed, i.e. the thickness of the collenchyma with the thickness of the sclerenchymatous sheath and the thickness of vascular bundles with their width, as well as one negative correlation, i.e. the thickness of the cortical parenchyma with the number of vascular bundles (also in sample V). In sample III three positive and three negative correlations were obtained. Positive correlations were found for the following traits: stem diameter with the thickness of vascular bundles and the thickness of the sclerenchymatous sheath as well as the thickness of the collenchyma with the thickness of vascular bundles. Negative correlations were observed for the diameter of the stems and the thickness of the cortical parenchyma, the thickness of the collenchyma and the thickness of the parenchyma as well as the thickness of the parenchyma with the thickness of vascular bundles (also in sample V). In sample IV five positive correlations were recorded for the following traits: stem diameter with the thickness of the collenchyma and the thickness of vascular bundles, the thickness of bundles with their

Table 4. Correlations and determination coefficients between characters of stem of *Impatiens parviflora*

				I**				
	1*	2	3	4	5	6	7	8
1*	1					*29.16*		*16.00*
2	0.40	1						
3	0.28	−0.14	1	*18.49*		*16.81*	*17.64*	
4	0.34	0.03	**0.43**	1			*18.49*	
5	−0.26	−0.05	0.19	0.17	1			*29.16*
6	**0.54**	0.19	**0.41**	0.20	−0.10	1	19.36	*22.09*
7	0.21	−0.10	**0.42**	**0.43**	−0.16	**0.44**	1	
8	**0.40**	0.18	−0.03	−0.13	**−0.54**	**0.47**	0.29	1
				II				
1	1							
2	−0.03	1						
3	−0.09	0.00	1					*16.00*
4	−0.17	−0.23	0.06	1	*70.56*			
5	0.06	0.15	0.15	**−0.84**	1			
6	−0.05	0.17	0.31	0.17	−0.06	1	*26.40*	
7	0.00	0.04	0.01	0.20	−0.16	**0.66**	1	
8	−0.17	0.30	**0.40**	**0.11**	0.06	0.38	−0.25	1
				III				
1	1			*19.36*		*16.81*		*16.00*
2	−0.28	1						
3	0.24	−0.09	1	*17.64*		*50.41*		
4	**−0.44**	0.36	**−0.42**	1		*20.25*		
5	0.33	−0.01	0.31	−0.37	1			
6	**0.41**	0.01	**0.71**	**−0.45**	0.22	1		
7	0.04	0.11	0.00	0.22	−0.12	0.05	1	
8	**0.40**	−0.35	0.30	−0.15	−0.03	0.28	0.05	1
				IV				
1	1		*19.36*			*16.81*		
2	−0.11	1	*16.00*					
3	**0.44**	**−0.40**	1					
4	−0.27	0.39	−0.08	1				
5	−0.25	−0.08	−0.38	0.02	1			
6	**0.41**	0.17	−0.08	0.03	−0.11	1	*77.44*	*62.41*
7	0.35	0.19	−0.20	0.07	0.01	**0.88**	1	*47.61*
8	0.38	0.06	−0.02	−0.02	−0.18	**0.79**	**0.69**	1
				V				
1	1					*26.01*	*26.52*	
2	−0.21	1						
3	−0.06	0.06	1					
4	−0.21	0.31	−0.11	1	*68.89*	*16.81*		
5	0.15	−0.11	−0.13	**−0.83**	1			
6	**0.51**	−0.39	0.27	**−0.41**	0.19	1	*34.81*	*29.16*
7	**0.52**	−0.25	0.05	0.02	−0.23	**0.59**	1	
8	0.38	−0.10	0.21	0.14	−0.17	**0.54**	0.28	1

Bolded – significant correlations ($\alpha = 0.05$).
Italicized – determination coefficients ($\alpha = 0.05$).
*See Table 2; ** See Table 1.

width and the thickness of the sclerenchymatous sheath as well as the width of bundles with the thickness of the sclerenchymatous sheath. A negative correlation was obtained for only one pair of traits, i.e. the thickness of the epidermis with that of the collenchyma. In turn, in sample V four positive and two negative correlations were observed, with the positive correlations being between stem diameter and the thickness and width of vascular bundles, as well as the thickness of bundles with their width and the thickness of the sclerenchymatous sheath, whereas negative correlations were found between the thickness of cortical parenchyma with the number of vascular bundles and their thickness.

The highest coefficients of determination (amounting to over 60%) were obtained for plants from samples II and IV. On the anthropogenic locality (IV) the coefficient of determination for the width and thickness of bundles was 77.44%, while for the thickness of the sclerenchymatous sheath and the length of vascular bundles it amounted to 62.41%. In sample II variation in the number of vascular bundles was explained by the variation of the thickness of cortical parenchyma in 70.56%.

Leaves

Leaves of small balsam are very thin and delicate. They are covered by a single-layered epidermis with single chloroplasts, evenly distributed along the undulate surface of walls. Leaves are amphistomatic and stomata are anisoocytic (Fig. 4).

In plants from four samples (II-V) the length of stomata in the underside epidermis was very uniform and on average it ranged from 30.04 μm (in sample III) to 32.74 μm (in sample II). The longest stomata were observed in sample I (39.58 μm) (Table 5). This characteristic need to be considered to be of limited variability, as evidenced by low values of the coefficient of variation, ranging from 10.49% (in sample III) to 12.81% (in sample I).

The width of stomata in plants from four samples (I-IV) was also very uniform and on average it ranged from 20.47 μm (sample III) to 21.59 μm (sample I). The thinnest stomata were observed in sample V, where the mean width was 18.80 μm. The coefficient of variation was low and ranged from 6.79% in sample IV to 12.29% in sample II, thus this trait needs to be considered to be of a limited variability.

Two types of parenchyma are distinguished, i.e. palisade and spongy. In leaves from shady locality samples (I, III) one layer of palisade parenchyma and four layers of very loose spongy parenchyma are found, while for insolated localities (samples II, IV, V) two layers of palisade parenchyma and four-five layers of spongy parenchyma were observed, with a markedly lower number of intercellular spaces. In spongy parenchyma single-shaped idioblasts with very thin cell walls were reported, containing calcium oxalate in the form of rafides (Fig. 5).

It was observed that the number of bundles of rafides in plants from sample I (2.12) was lower than that in sample V (3.36). Variation of this trait was high and the coefficient of variation ranged from 28.21% in sample IV to 47.62% in sample V (Table 5).

Based on the calculated correlations and coefficients of determination it was found that the length of stomata is correlated with their width in two samples: I and II. The coefficient of determination in sample I was 18.49%, while in sample II it was 40.96%, respectively (Table 6).

Based on numerical data for anatomical traits of stems and leaves the analysis of agglomerative clustering was conducted using the nearest neighbour method on Euclidean distances. Dendrograms are graphic representations of the analysis (Fig. 6).

When comparing dendrograms we may state a high similarity of specimens from samples II, IV and V, while for samples I and III the biggest variation was found. A dendrogram of sample I consists of specimens of one large group, divided in itself into numerous subgroups. The biggest similarity in the complex of analysed traits was found for specimens 5 and 19, 16 and 17 as well as 1 and 18 (the distance of linkages was 14, 16 and 17, respectively). An individual pair comprised specimens 9 and 12 as well as specimen 2, which showed the biggest difference. In the dendrogram of sample II the biggest similarity was observed for specimens 3 and 13 as well as 2, 19 and 4 (the distance of 24). A markedly individual character, at a considerable distance of the linkage (125), was shown by specimen 14, which distance was statistically significant. Sample III exhibited a relatively high variation. Eight pairs formed their own subgroups, at Euclidean distances from 25 (specimens 6 and 18) to 39 (specimens 9 and 25, as well as 2 and 23), while specimen 7 was most individual in character (distance 73). Sample IV comprises one large group, divided into several subgroups. The biggest similarity was found for specimens 1, 6, 7, 9 and 16 (distance 30) as well as specimens 17 and 24 (distance 40). A markedly individual character, at a considerable distance of linkage, was observed for specimen 10 (distance 250). In the dendrogram of sample V we may distinguish two subgroups with low values of Euclidean distances. The former includes six specimens, while the other – 17. The biggest statistically significant distance (121 and 104) was recorded for specimens eight and 12.

DISCUSSION

The stem of *Impatiens parviflora* is covered by a single-layered cortex, of similar thickness – irrespective of light conditions and the type of phytocenoses. Outer walls are thicker – covered by the epicuticular layer, which constitutes the boundary layer between the plant and the external environment. The cortex is adjacent to the epidermis, its primary elements being parenchymous cells and the central cylinder, which consists, among other things, of vascular bundles and the sclerenchymatous sheath. Metcalfe and Chalk (1957) reported that at the cross-section of stems in plants from genus *Impatiens* there are approx. 12 vascular bundles; however, this statement was based mainly on studies conduced on *Impatiens glandulifera*. Investigations conducted within this study showed that on average there are nine of them in *Impatiens parviflora*. In the opinion of Metcalfe and Chalk (1957) as well as Esau (1973), the pith is composed of parenchyma, which in many

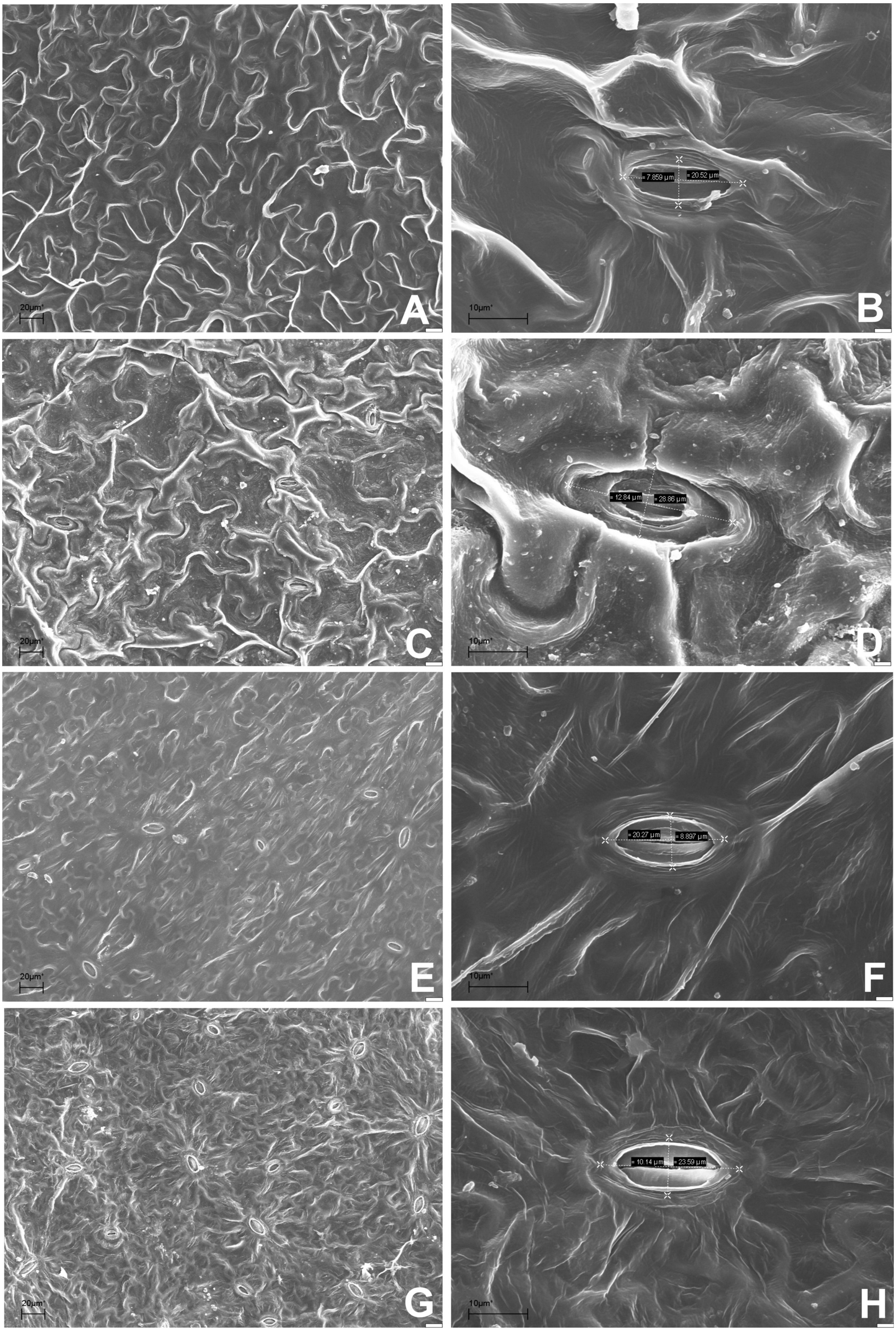

FIG. 4. SEM micrographs of adaxial (A-D) and abaxial (E-H) epidermis of leaf with stomata, cuticle and wax of *Impatiens parviflora* (note A, B, E, F – low light; C, D, G, H – high light)

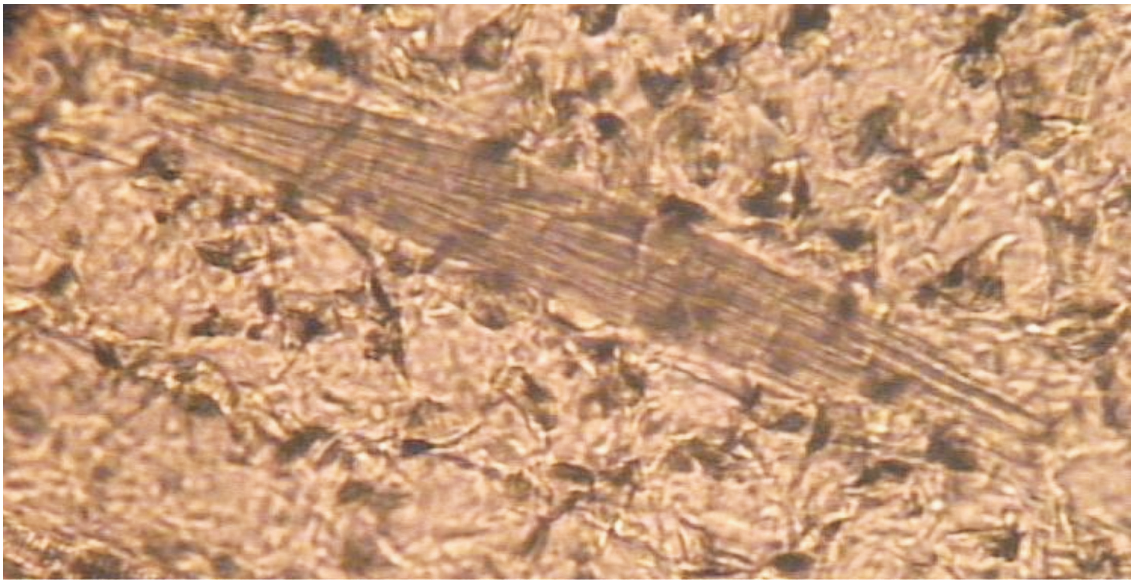

Fig. 5. Leaf; idioblasts with raphids, sample IV, ×400

Table 5. Statistical descriptions of the analysed anatomical characters of leaves

Descriptive statistics	LEAF		
	Characters		
	9*	10	11
I**			
X	39.58	21.59	2.12
SD	5.07	2.06	0.88
V	12.81	9.54	41.51
MAX	49.60	26.80	4.00
MIN	28.80	18.20	1.00
II			
X	32.74	20.66	2.96
SD	3.93	2.54	1.17
V	12.00	12.29	39.53
MAX	42.40	26.40	5.00
MIN	24.40	16.60	1.00
III			
X	30.04	20.47	2.32
SD	3.15	1.90	1.07
V	10.49	9.28	46.12
MAX	35.20	24.60	5.00
MIN	23.00	16.60	1.00
IV			
X	30.42	21.34	3.12
SD	3.77	1.45	0.88
V	12.39	6.79	28.21
MAX	39.20	24.40	5.00
MIN	24.40	18.00	1.00
V			
X	30.14	18.80	3.36
SD	3.20	1.91	1.60
V	10.62	10.52	47.62
MAX	36.20	22.00	8.00
MIN	23.00	15.80	1.00
NIR α = 0.05	**3.491**	**1.765**	**1.211**

*See Table 2; ** See Table 1.
Descriptive statistics: X – mean, SD – standard deviation, V – variance, MAX – maximum value, MIN – minimum value.

Table 6. Correlations and determination coefficients between characters of leaves of *Impatiens parviflora*

I**			
	9*	10	11
9*	1	*18.49*	
10	**0.43**	1	
11	0.28	0.29	1
II			
9	1	*40.96*	
10	**0.64**	1	
11	–0.48	–0.27	1
III			
9	1		
10	0.21	1	
11	–0.17	0.01	1
IV			
9	1		
10	0.31	1	
11	–0.35	–0.27	1
V			
9	1		
10	0.24	1	
11	0.07	0.1	1

Bolded – significant correlations (α = 0.05).
Italicized – determination coefficients (α = 0.05).
*See Table 2; ** See Table 1.

plants during growth becomes partly destroyed. Also in this study empty internodes were observed in many specimens. According to Gris 1872 (after Esau 1973), when the pith is preserved, its parenchymal cells may be diversified. In such a case the internal part may differ from the main part, as the former has cells of smaller dimensions and thicker, strongly lignified walls (Esau 1973). Such a morphologically separate external zone is the pith sheath (Esau 1973). It is composed of dead cells, which provide plant organs with strength to resist different types of deformations and at the same time prevent excessive damage to more delicate tissues. Thickness of the sclerenchymatous sheath layer between bundles varied, depending on light conditions. Some plants were devoid of the layer. According to Metcalfe and Chalk (1957) and the results presented in this study in case of the absence of the sclerenchyma layer stem rigidity is maintained thanks to the hydrated parenchyma. Primary parenchyma was formed of thin-walled cells, tightly packed and polyhedral in form, between which retort cells were frequently observed.

Leaves of *Impatiens parviflora* are very thin and delicate. Epidermal cells are irregular in shape and contain single chloroplasts evenly distributed along wall surfaces. Their presence indicates the hygrophytic character of a plant (Braune et al. 1975). Stomata are anomocytic in character, in contrast to *Impatiens sultani*, which leaves are hypostomatic (Metcalfe and Chalk 1957). Braune et al. (1975) reported that in leaves of *Impatiens parviflora* there are cells corresponding in shape and contents to typical idioblasts, which contain calcium oxalate in the form of delicate, long crystal needles – rafides. Metcalfe and Chalk (1957) claimed that they are the most characteristic, anatomical traits of family *Balsaminaceae*. The conducted studies confirmed the presence of three idioblasts in 1 mm^2 spongy parenchyma. Cheavin (1938) reported that they occur frequently in particularly large cells, easily filled with swelling slime, which in certain parts have thin cell walls, ruptured after swelling slime. Crystals are then expulsed outside

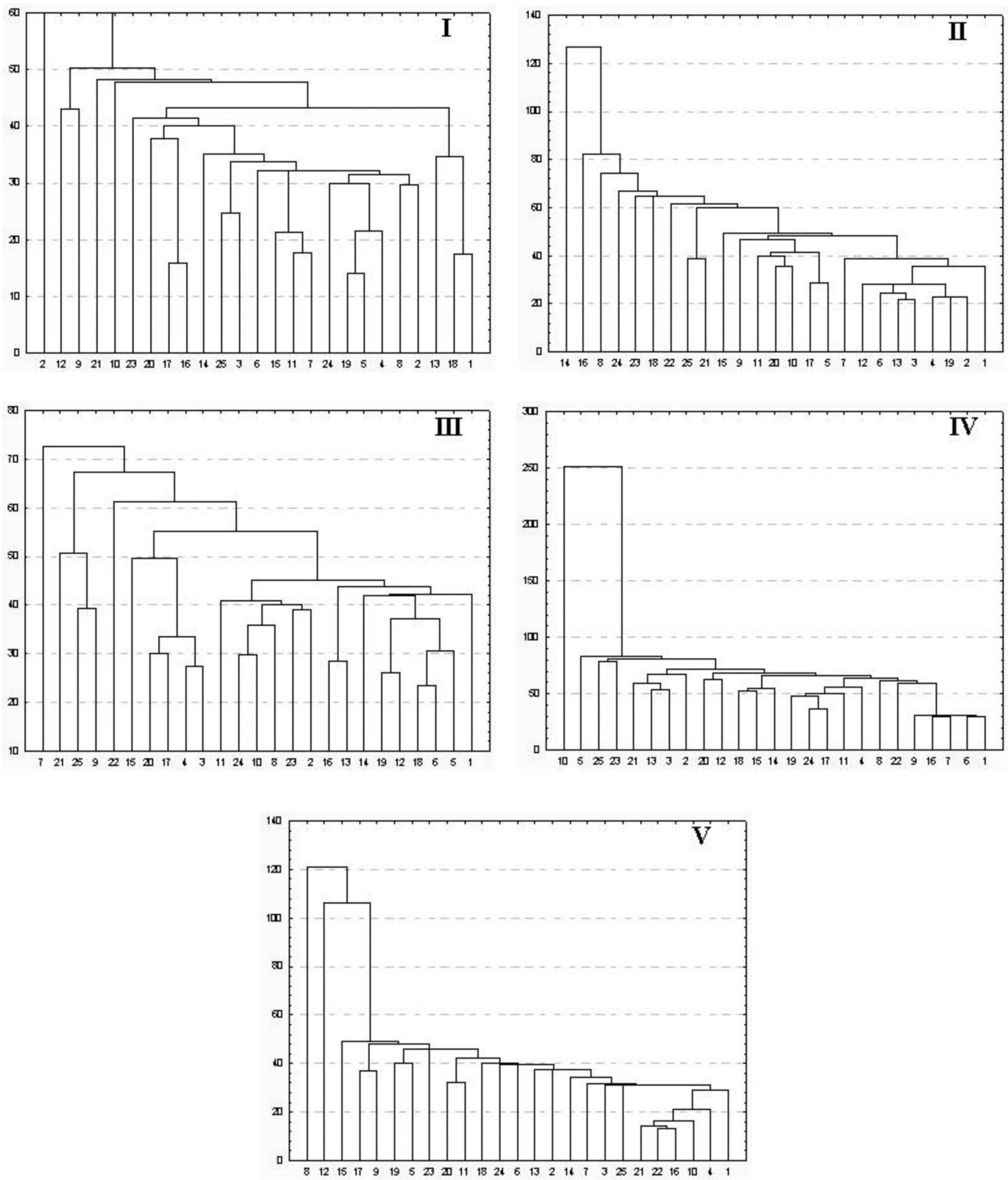

Fig. 6. Dendrogram of the cluster analysis with Euclidean distances of 25 samples of *Impatiens parviflora* constructed on the basis of anatomical characters of stems and leaves of *Impatiens parviflora* (I-V – samples, see Table 1)

(Esau 1973). Scattered needles of calcium oxalate were observed among parenchyma. According to Braune et al. (1975) the length of rafides falls within the wide ranges and not necessarily corresponds to cell length. These observations were confirmed in these investigations. In the longest idioblasts frequently the shortest bundles of rafides were observed, arranged along the main veins, on the leaf underside.

Based on the conducted anatomical analysis of stems, it was found that in specimens growing under strongly shaded conditions (samples I, III) there were fewer strengthening elements in the shoot structure than it was the case in the others. Stems of these plants had the thinnest layer of the collenchyma and a markedly thinner sclerenchymatous sheath in comparison to plants coming from well-insolated localities (II, IV, V). The number of vascular bundles was also smallest. In insolated plants from an anthropogenic locality (sample IV) the thickest layer of the sclerenchymatous sheath was found. Thickness of collenchyma was similar to that in plants from the ecotone (sample V), but at the same time it was definitely thicker than in plants from the other samples. Trepl (1984) indicated that *Impatiens parviflora* adapted to the environments, in which moderate, periodically predictable disturbances, but also they are capable to survive strong and irregular disturbances and stress. It is light conditions that are considered to be the main stressor (Piskorz 2004). According to Eliáš (1999), despite its low genetic variation, this species occupies highly diverse ecological niches, thus indicating morphological elasticity, as well as high variation in anatomical traits, as it was shown in this study.

CONCLUSIONS

On the basis of the conducted investigations it was found that habitat conditions, mainly the light factor, affect variation of anatomical traits in *Impatiens parviflora* DC. The biggest variation in anatomical characteristics of the stem are observed for the thickness of the sclerenchymatous sheath between vascular bundles, while the smallest – for the number of vascular bundles and thickness of the epidermis. The most variable characters in leaves include the number of idioblasts filled with rafides, containing calcium oxalate. Plants from the anthropogenic locality (sample IV) are characterised by traits typical of heliophilous plants. Stems in these plants are thickest, at the simultaneous thickest layer of the sclerenchymatous sheath. Thickness of collenchyma is similar, as in plants from the ecotone (sample V), but markedly thicker that in plants from the insolated locality (sample II) and a strongly shaded locality (sample III), while vascular bundles are biggest. In plants growing in strong shade (sample I) stems had the thinnest layer of collenchyma and a markedly thinner sclerenchymatous sheath than those from insolated, natural localities (sample II) and anthropogenic localities (sample IV). The number of vascular bundles was also smallest, at the thickest layer of parenchyma. In specimens from shaded localities less strengthening tissue was observed and a lower number of vascular bundles, while in leaves there was less palisade parenchyma.

Detailed anatomical analyses of stems and leaves, presented in this study, indicate that *Impatiens parviflora* exhibits not only elasticity in terms of its morphological, but also anatomical traits, which are considerably affected by light conditions both in natural and anthropogenic habitats.

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