



## MORPHO-ANATOMICAL STRUCTURE OF THE LEAVES OF *FESTUCA TRACHYPHYLLA* (HACK.) KRAJINA IN THE ECOLOGICAL ASPECT

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**Abstract.** *Festuca trachyphylla* (Hack.) Krajina is a morphologically variable species common in warm and dry habitats in various communities: xerothermic grasslands, dry meadows, sand dunes, scrub and well-lighted forest. The aim of this study was to determine the limits of morphological and anatomical trait variability of *F. trachyphylla* leaves. The study was conducted in 24 sub-populations (N-432 individuals) in the Lublin Upland, southeastern Poland. Plants in two localities were investigated: in calcium carbonate-rich xerothermic grasslands and on sand dunes. Variability of the *F. trachyphylla* leaf blades was demonstrated to be dependent on the habitat type. The following morphological and anatomical traits: the length of the leaf, width of the cauline leaf, number of ribs in the leaf, length of the cauline leaf, length of hair in the leaf, colour of the leaf, hairiness of the upper part leaf, cross-section of the leaf, and distribution of the sclerenchymatous tissue in the leaf blade exhibited high variability.

**Key words:** morphology, anatomy, leaf, variability, *Festuca trachyphylla*

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### Introduction

*Festuca trachyphylla* (Hack.) Krajina belongs to the group *F. ovina* agg. (HACKEL 1882; MARKGRAF-DANNENBERG 1980; PAWLUS 1983-1985; WILKINSON & STACE 1991; DENGLER 1996, 1998). Its geographical range is limited to the temperate climate zone in the northern hemisphere and cool subtropical regions. It occurs in diverse communities: insolated hill slopes, steep slopes of calcareous or loess valleys, dry meadows and mid-field sand dunes, as well as scrub and well-lighted forest (FIJAŁKOWSKI & WARMIŃSKA 1972; MEDWECKA-KORNAŚ & KORNAŚ 1977; FALKOWSKI 1982; ŁUSZCZYŃSKA 2001). It is a co-dominant or dominant component of xerothermic grasslands from the associations *Seslerio-Festucion duriusculae* and *Cirsio-Brachypodion pinnati* (MATUSZKIEWICZ 2007). It often occurs in anthropogenic habitats. *F. trachyphylla* is a morphologically variable species of the group *F. ovina* agg. and it thus poses problems to systematicians. Its variability is manifested mainly in the morphological and anatomical structure of the leaf blade of sterile shoots (PAWLUS 1983-1985; CONERT 1996; SZCZĘŚNIAK 2005).

The aim of the paper was to identify the variability of morphological and anatomical traits in *F. trachyphylla* leaves in the southeastern part of Poland.

### Material and methods

The plant material included samples of *F. trachyphylla* (Hack.) Krajina from 24 sub-populations (432 individuals) collected from different habitats in the southeastern part of Poland (Tab. 1). Thirteen of the sub-populations originated from calcium carbonate-rich xerothermic grassland habitats, while the others grew on sand dunes. The studies involved thirteen traits: 9 quantitative and 4 qualitative (Tab. 2 and 3), and consisted mainly of biometric measurements of the traits that were variable in this species. Some observations of traits, for example the length of leaf and cauline leaf or leaf colour, were carried out directly on living plant specimens in their natural habitats. The other characters that demanded precise observation of leaf elements were counted or measured with a ruler or an Opta-Tech stereoscopic zoom microscope. The anatomical analysis was performed with the use of a Nikon light microscope. Differences among the means of the characters were tested using a one-way ANOVA version 7.1 of the STATISTICA programme (StatSoft Inc. 2007).

### Results and discussion

#### Quantitative characters

The results of the ANOVA analysis showed a significant variability ( $p < 0.05$ ) of morphological and anatomical traits of *F. trachyphylla* (Tab. 1).

**Table 1.** Characteristics of the *Festuca trachyphylla* habitats investigated.

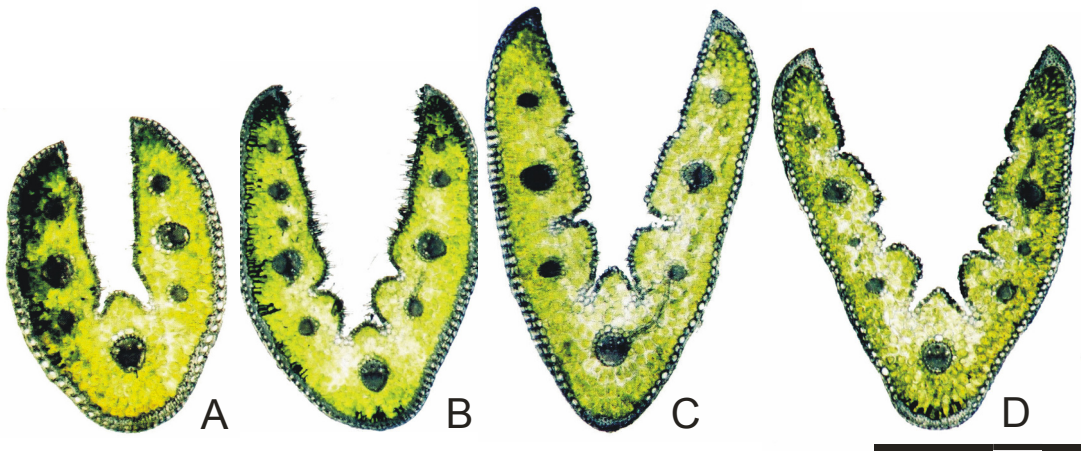
Habitat	Origion	Abbreviation	Geographical factors	
			latitude (°N)	longitude (°E)
xerothermic grassland	Opoka Duża	T-2	50°52' 42"	22°56' 62"
	Lublin	T-24	51°16' 52"	22°38' 93"
	Rudnik	T-25	51°17' 24"	22°36' 13"
	Ciechanki	T-27	51°17' 36"	22°52' 22"
	Iłowiec	T-30	50°50' 05"	23°24' 48"
	Kazimierz Dolny	T-41	51°19' 53"	21°55' 50"
	Bychawa	T-43	51°01' 21"	22°31' 37"
	Nałęczów	T-49	51°17' 26"	22°14' 53"
	Czumów	T-50	50°47' 49"	23°58' 18"
	Niedzieliska	T-51	50°42' 56"	23°04' 33"
	Tarnogóra	T-65	50°53' 47"	23°07' 21"
	Staw	T-96	51°12' 21 "	23°24' 50"
	Parchatka	T-131	51°22' 56"	21°49' 96"
sand dunes	Chotyłów	T-16	52°00' 46"	23°23' 49"
	Zwierzyniec	T-23	50°36' 19"	22°59' 56"
	Aleksandrów	T-26	51°54' 28"	22°29' 09"
	Konstantynów	T-28	51°12' 43"	23°05' 43"
	Puławy	T-29	51°28' 42"	21°55' 58"
	Orchówek	T-31	51°32' 16"	23°36' 38"
	Małaszewicze	T-32	51°01' 56'	23°32' 34"
	Sobibór	T-44	51°28' 46"	23°39' 46"
	Krężnica Jara	T-48	51°09' 49"	22°28' 25"
	Potok Wielki	T-61	50°47' 20"	22°13' 72"
	Stoczek	T-141	51°38' 45"	22°42' 53"

**Table 2.** The range for the nine quantitative characters and the results of ANOVA. (Differences traits were considered significant at the level of  $p < 0.05$ ).

Character	$F$ ( $p < 0.05$ )	<i>F. trachyphylla</i> range	xerothermic grasslands	sand dunes
length of leaf (mm)	31.52	132.0-309.0	130.0-195.0	184.0-309.0
width of cauline leaf (mm)	16.56	1.0-1.9	1.0-1.5	1.4-1.9
number of ribs in the leaf	13.31	3.0-9.0	3.0-5.0	6.0-9.0
length of cauline leaf (mm)	12.91	36.0-57.0	36.0-42.0	40.0-57.0
length of hair in the leaf (mm)	10.86	0.1-0.8	0.6-0.8	0.1-0.5
width of leaf (mm)	5.24	1.0-2.2	-	-
number of vascular bundles in the leaf	3.79	6.0-10.0	-	-
diameter of vascular bundle in the leaf ( $\mu\text{m}$ )	3.63	101.7-158.5	-	-
thickness of leaf (mm)	3.41	0.7-1.0	-	-

**Table 3.** Descriptions, abbreviations and attributes of qualitative characters and their frequencies in *Festuca trachyphylla*.

Descriptions of character	Abbreviation of character [attributes]	Frequency of <i>F. trachyphylla</i> (N=432)
leaf colour	[green/blue-green]	185/247
leaf: hairiness, lower part	[glabrous/hairy]	28/404
cross-section of leaf	[wedge-shape/ovoid-shape]	210/222
sclerenchyma	[1-layer /2-3-layer]	193/239

**Fig. 1.** Cross-sections of *Festuca trachyphylla* from different habitats: A-B xerothermic grasslands, C-D sand dunes. Scale bar=1 mm.

The highest variability was found for the length of the leaf, width of the cauline leaf, number of ribs in the leaf, length of cauline leaf, and length of hairs in the leaf. The other quantitative characters were permanent in this species and did not exhibit variability between the different types of habitats. The results revealed that the plants from xerothermic grasslands differed from the plants from sand dunes in terms of the following combination of characters: shorter leaf, narrower and shorter cauline leaf, and the leaf, which tends to have fewer ribs and longer hair on the upper surface of the leaf blade (Tab. 1).

#### Qualitative characters

All individuals of the *F. trachyphylla* species were studied for leaf colour, hairiness of the upper part leaf, cross-section of the leaf and distribution of the sclerenchymatous tissue in the leaf blade (Tab. 2). Plants growing in shallow and dry soil, full sun conditions, had filiform, blue-green, leaf blades with dense hairs on the lower part. In cross-section, the leaf blades were ovoid-shaped. Plants growing in sand dunes were characterized by green leaves, which had delicate pubescence on the lower part, or were hairless. In cross-section, the leaf blades were

wedge-shaped with convex sides and a rounded tip. Additionally, the plants growing on the sand habitats exhibited two or three rows of sclerenchymatous cell layer, clustered in three corner rows; in the plants from the calcareous soil in the xerothermic habitats, the single-row layer formed a separate ring. The cross-section diversity is presented in Fig. 1.

There are some morphological differences between plants of different habitats within *F. trachyphylla*; these differences, however, are too inconsistent and imprecise to allow recognition of two intraspecific taxa within *F. trachyphylla*. It could be expected that under such circumstances, a significant degree of morphological diversification would have occurred, making it possible to visually distinguish plants of different habitats. The results obtained in the present study are partly consistent with investigation data reported by other authors (MARKGRAF-DANNENBERG 1980; FALKOWSKI 1982; SZAFER *et al.* 1986; CONERT 1996) who found that the morphological and anatomical traits of the leaf blade in this species were considerably unstable and modified by the environmental effect.

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