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ANOMALOUS NEEDLE NUMBERS OF *PINUS MUGO* TURRA IN THE TATRA MTS.

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Abstract. Needles from abnormal dwarf shoots of *Pinus mugo* are described. The three-, five- and seven-needle dwarf shoots were found in the Dolina Pięciu Stawów in the East Tatra Mts. The needles were measured and documented by photographing. Abnormal needles were shorter, thinner and narrower than those of two-needle shoots. The shape of cross-section of these needles was different, nearly triangular, semicircular, circular or irregular – difficult to describe.

Key words: abnormal dwarf shoots, mountain pine, needle, East Tatra Mts.

INTRODUCTION

The individuals of *Pinus mugo* with abnormal dwarf shoots were found in the Dolina Pięciu Stawów at altitude 1680-1710 m in the Tatra National Park during field works in 2005. Three-needle dwarf shoots were the most common, but also five-needle and seven-needle dwarf shoots were observed. The dwarf shoot of such great number of needles has not been described on *P. mugo* till now [Boratyńska and Boratyński 2003, 2005]. More than two-needle dwarf shoots of *Pinus mugo* were described several times [Schneider 1913, Györffy 1932, Debazac 1962, Jähring 1962, Skawiński 1975, Klaus and Zetter 1978, Christensen 1987 b, Boratyńska and Boratyński 2003, 2006]. The three-needle dwarf shoots are the most frequent anomalous forms, but four-, five- and even six-needle ones have also been described.

The dwarf shoots with more than two needles were observed within the whole area of *P. mugo*, the most frequently at the northern and upper species line, among other in the Tatra and Sudety mountains [Boratyńska and Boratyński 2003, 2005, Piórkowska 2004]. The abnormal dwarf shoots occur also on *P. uncinata*, while on the other European species of two-needle pines are extremely rare [Penzig 1922, Szymański 1958, Giertych 1968, Król 1983/84, Christensen 1987 b, Boratyńska and Boratyński 2003, 2006].

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Pinus mugo and *P. uncinata* populations contained in average 24 and 20% individuals with at least one abnormal dwarf shoot, respectively [Boratyńska and Boratyński 2003, 2006]. The frequency of such individuals varied between 8 and 50% in particular populations. The majority of investigated individuals had one three-needle dwarf shoots, but a few specimens with more than 50% participation of abnormal dwarf shoots were also found [Boratyńska and Boratyński 2003].

The aim of the present work was to verify the hypothesis on the connection between the number of needles on dwarf shoot and morphological and anatomical characters of the needle. The direct impulse was founding the dwarf shoot with seven needles, not described earlier.

MATERIAL AND METHODS

The length of needles of randomly chosen three-needle (Fig. 1), five-needle (Fig. 2) and seven-needle (Fig. 3) dwarf shoots was measured. Then the cross-section preparations of the needles of every dwarf shoot were done, according to the methods used in earlier studies [Boratyńska and Bobowicz 2001]. The width (along the vascular bundle) and thickness of the needle, the width and thickness of the stela (vascular vagina) and distance between vascular bundles were measured and the number of resin canals was counted. The occurrence of sclerenchymatic cells between vascular bundles and around the resin canals was analysed, according to Szweykowski [1969] method. The Jenamed II microscope was used in the anatomical measurements and verifications. The arrangement of needles on three types of dwarf shoots was analysed and photographically documented (Fig. 1, 2, 3).

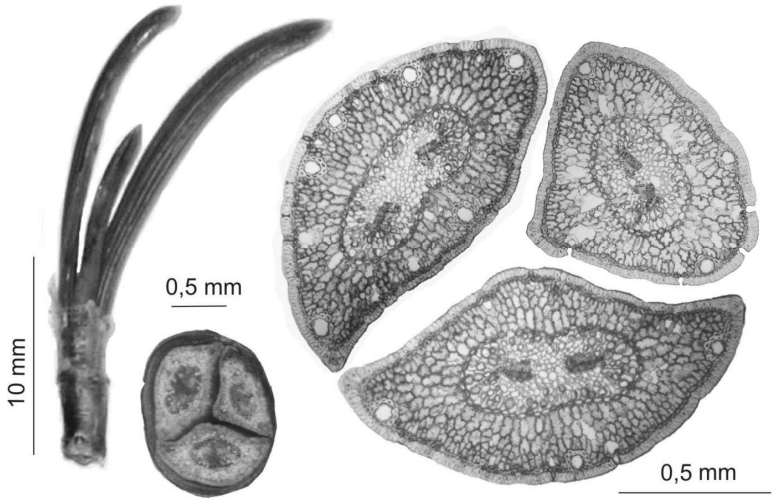

Fig. 1. 3-needle dwarf shoot, traverse section through needles and position of needle in bottom part
Rys. 1. Krótkopęd 3-igłowy, przekrój poprzeczny przez igły i ułożenie igieł w części nasadowej

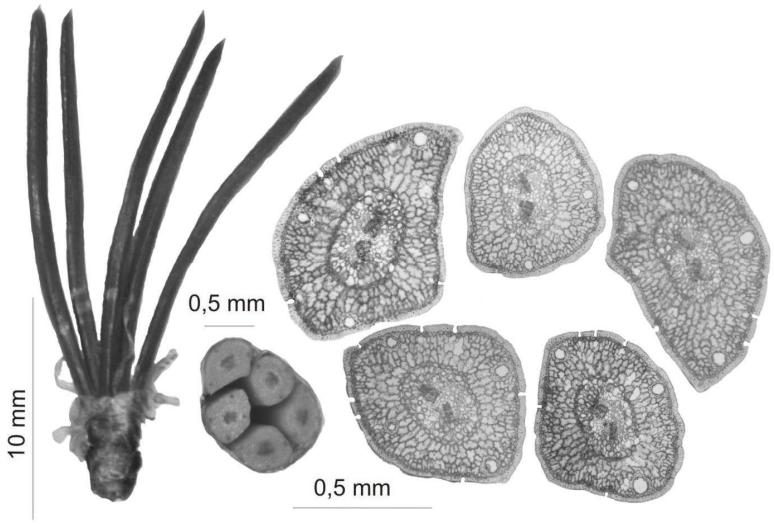

Fig. 2. 5-needle dwarf shoot, traverse section by needles and position of needle in bottom part
Rys. 2. Igły z krótkopędu 5-igłowego, przekrój poprzeczny przez igły i ułożenie igieł w części nasadowej

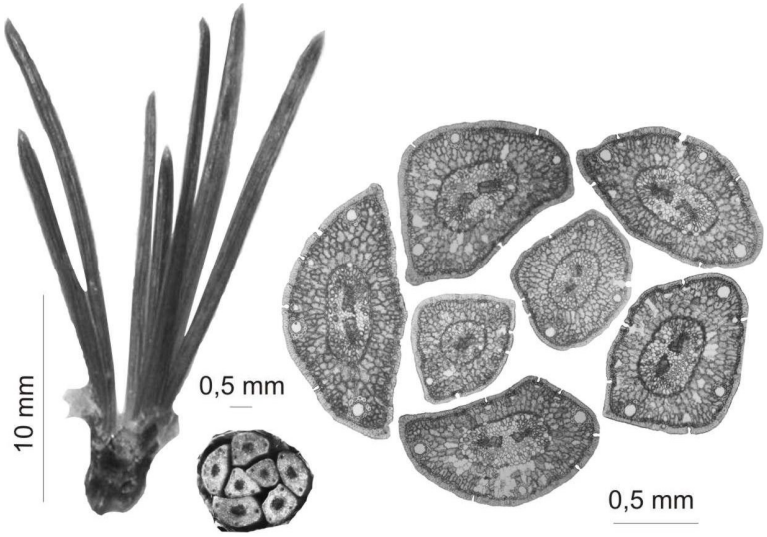

Fig. 3. 7-needle dwarf shoot, traverse section by needles and position of needle in bottom part
Rys. 3. Igły z krótkopędu 7-igłowego, przekrój poprzeczny przez igły i ułożenie igieł w części nasadowej

RESULTS AND DISCUSSION

The needles from abnormal dwarf shoots differed morphologically of needles from two-needle dwarf shoots. It concerns mostly of the length, width and thickness of the needles (Table 1). The needles of three-needle dwarf shoot were shorter than from two-needle ones. Needles from typical dwarf shoots collected in the population of *Pinus mugo* in Dolina Pięciu Stawów had average length slightly above 45 mm [Boratyńska et al. 2004]. However, the examinations on the abundant material from *P. mugo* and *P. uncinata* did not confirm the differences between length of needles from two- and three-needle dwarf shoots [Boratyńska and Boratyński 2003].

Table 1. Measurements of selected features of needles in abnormal dwarf shoots
Tabela 1. Pomiary wybranych cech igieł w nietypowych krótkopędach

Dwarf shoots Krótkopędy	Needle number Numer igły	Needle length Długość igły mm	Needle width Szerokość igły µm	Needle thickness Grubość igły µm	Number of resin canals Liczba kanałów żywicznych	Length of stele Długość steli µm	Width of stele Szerokość steli µm	Distance between vascular bundles Odległość wiązek µm	Number of layer of cells of type of fiber Liczba warstw komórek typu włókien
3-needle 3-igłowy	1	33	1 084	680	4	412	275	63	0
	2	32	1 020	744	4	495	282	33	1
	3	18	893	765	3	426	289	47	2
5-needle 5-igłowy	1	25	850	680	3	352	247	33	2
	2	25	808	659	4	344	240	20	2
	3	25	914	574	3	385	220	23	1
	4	24	870	638	3	357	227	10	1
	5	23	744	595	3	371	158	33	1
7-needle 7-igłowy	1	25	723	595	2	274	240	0	0
	2	24	786	638	3	398	268	47	2
	3	24	850	701	3	364	268	20	2
	4	23	893	595	4	412	247	33	2
	5	20	1 063	595	3	460	240	33	1
	6	18	1 060	553	2	392	206	13	2
	7	16	1 062	616	3	495	254	37	2

The needles from the five-needle dwarf shoot were shorter than the needles of two- and three-needle dwarf shoots. Similarly, the needles from seven-needle dwarf shoot were shorter than all the compared. On the seven-needle dwarf shoot two needles were significantly smaller than the others (Table 1). The similar differences in the needle length were also observed on the five- and four-needle dwarf shoots on *P. uncinata* in the Pyrenees and five-needle dwarf shoots of *P. mugo* from the Karkonosze Mts. [Boratyńska and Boratyński 2003].

The number of resin canals in one cross-section oscillated between 2 and 4 in all the needles from abnormal dwarf shoots. The average number of resin canals for population of *P. mugo* fro the Dolina Pięciu Stawów was found as above 4 [Boratyńska et al. 2004]. The canals in the needles from three-, five- and seven-needle dwarf shoots were predominantly marginal, closely adjacent to hypodermis. Only single medial canals were observed, placed in the parenchyma.

The shape and size of the vascular vagina, where the two vascular bundles are placed surrounded with transfusion tissue, were similar in the cross-sections of the needles from two-needle and abnormal dwarf shoots and only slightly connected with the shape of cross-section. The neddle shope depends on the number and arrangement of the needles on dwarf shoot. The needles on three-needle dwarf shoot are the most frequently triangle-shaped in cross-section, however, not always, while needles from four- and more-needle dwarf shoots had irregular cross-sections [Boratyńska and Boratyński 2003]. Above the vascular bundles from the phloem side (abaxial side), one or two layers of fibre-like cells with thick walls and restricted lumen are frequently observed. This type of sclerenchymatic cells is frequent in the needles of *P. sylvestris*, but rare in *P. mugo* [Szweykowski 1969]. The sclerenchymatic, fibrous cells were observed in the needles from abnormal dwarf shoots of *P. mugo* as forming one or two layers. In one needle from three- and one from seven-needle dwarf shoots we found only single fibrous cells dispersed among transfusion tissue, which did not form layers. The type of sclerenchyma cells was typical for *P. mugo*, as described by Boratyńska et al. [2004].

The distance and the type of cells between vascular bundles are characteristic for the pine species. The distance for *P. mugo* is shorter than for *P. sylvestris* [Boratyńska and Bobowicz 2001]. The distances between vascular bundles were significantly shorter on the cross-sections of the needles from abnormal dwarf shoots, than from the typical ones. The close connection of the vascular bundles was also found in the needle from seven-needle dwarf shoot.

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ANOMALIE IGŁOWE U SOSNY GÓRSKIEJ *PINUS MUGO* TURRA W TATRACH

Streszczenie. W artykule opisano nietypowe krótkopędy *Pinus mugo*. Podczas badań terenowych w październiku 2005 roku w Dolinie Pięciu Stawów na terenie Tatrzańskiego Parku Narodowego znaleziono wiele krzewów o 3-igłowych krótkopędach, a także pojedyncze okazy z pięcioma i siedmioma igłami. Igły z nietypowych krótkopędów są krótsze, mają mniejszą szerokość i grubość niż igły w typowych krótkopędach. Liczba igieł w krótkopędzie zdecydowanie determinuje kształt igieł: od prawie półokrągłych przez trójkątne, okrągłe do nieregularnych – trudnych do opisania. Zauważono niewielki związek pomiędzy liczbą igieł w krótkopędzie a badanymi cechami anatomicznymi.

Słowa kluczowe: nietypowe krótkopędy, *Pinus mugo*, kosodrzewina, igły, Tatry

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