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Cone size in putative hybrid swarm populations of *Pinus sylvestris* L. and *Pinus mugo* Turra in northern Slovakia

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Abstract: Comparative study on cone size has been done involving four populations of the putative hybrid swarms of *Pinus sylvestris* × *P. mugo* in northern Slovakia and three control populations of the parental species of *P. sylvestris* and *P. mugo*. The hybrid swarm populations were characterized by a reduced size of their cones compared to parental species. The phenomenon is supposed to be due to the lower quality of seeds in hybrid swarms.

Keywords: *Pinus sylvestris*, *P. mugo*, hybrid swarms, cone size

Introduction

Extensive variation of the mountain dwarf pine komplex (*Pinus mugo* Turra) is believed to be due to profound differences in ecological factors prevailing on the habitats with natural distribution of the species. Except for the growth types and needles, the cones were also reported to vary considerably between individual

trees of a given population as well as between different populations of the mountain dwarf pine (STASZKIEWICZ & TYSZKIEWICZ 1975). Using morphometric traits of cones BOBOWICZ (1990) was able to screen the introgressive hybrids of *P. mugo* × *P. sylvestris* on the locality Bór on Czerwonem of the Now Targ valley in Poland. The hybrid nature of the neighbouring populations of the kind in northern Slovakia has also been postulated by VIEWEGH (1981). The author used the needle anatomic characteristics to distinguish the hybrid individuals from those of *P. sylvestris* and *P. mugo* growing on the locality Habovka. The same opinion regarding the genetic status of the population on this locality has been expressed by MUSIL (1977) who has however employed cones instead of needles. STASZKIEWICZ (1996) reported of the intermediate size of cones in the natural hybrids of *P. mugo* × *P. sylvestris* of the High Tatra Mountains. Our study revealed a slightly reduced size of the cones in the putative hybrid swarm populations of *P. sylvestris* × *P. mugo* in northern Slovakia as compared with the adjoining populations of the parental species (KORMUŤÁK et al. 2007). In continuation with this study a new collection of cones has been undertaken in 2009 to illustrate more completely this feature of the cone production in the putative hybrid swarm populations mentioned above.

Material and methods

Seven populations were involved into study representing four putative hybrid swarms of *P. sylvestris* × *P. mugo* in northern Slovakia, one neighbouring population of *P. sylvestris* and two adjoining populations of *P. mugo.* Their list and location are given in Tab. 1. Collection was made from individual trees in autumn 2009. The number of trees of individual populations ranged between 30 and 56, whereas the number of cones per tree within the range of 14–31 in Hruštín, 17–52 in Vratná valley, 12–41 in Roháče, 3–41 in Habovka, 4–28 in Obšívanka, 7–41 in Suchá Hora, and 2–23 in Tisovnica (Tab. 2). Compact cones were subjected to measurement of their length shortly after collection using sliding gauge. Obtained data were processed statistically by the variance analysis (ANOVA).

Tab. 1. List of populations and their location

Species/Hybrids	Locality	Altitude (m)	Latitude	Longitude
P. sylvestris	Hruštín	800	49°19' 52"	19°20' 53"
P.mugo	Vrátna valley	1230	49°13' 20"	19°02' 05"
P.mugo	Roháče	1600	49°12' 27"	19°44' 30"
Hybrid swarm	Habovka	815	49°16' 25"	19°37' 14"
Hybrid swarm	Obšívanka	1172	49°14' 45"	19°01' 24"
Hybrid swarm	Suchá Hora	765	49°23' 20"	19°47' 11"
Hybrid swarm	Tisovnica	810	49°20' 32"	19°45' 51"

Tab. 2. Number of trees and cones used in study

Species/ Hybrids	Locality	Number of trees analyzed	Total number of cones analyzed
P. sylvestris	Hruštín	32	658
P.mugo	Vrátna valley	33	1088
P.mugo	Roháče	40	1065
Hybrid swarm	Habovka	30	503
Hybrid swarm	Obšívanka	56	940
Hybrid swarm	Suchá Hora	48	1111
Hybrid swarm	Tisovnica	30	219

Results

The results of comparative study on cone length are summarized in Tab. 3. It follows from it that populations of the parental species *P. sylvestris* from Hruštín and *P. mugo* from Vrátna valley possess the largest cones. Both populations are mutually differentiated in this respect as evidenced by Duncan grouping. The control population of *P. mugo* in Roháče deviates conspicuously from the parental populations mentioned above possessing cones of smaller size. The population is comparable in this trait with the putative hybrid swarms all of which exhibit reduced size of their cones. Most profound reduction was registered in the hybrid swarms from Obšívanka and Tisovnica, less conspicuous in hybrid swarms from Habovka and Suchá Hora. Duncan test indicates that except for the hybrid swarms in Obšívanka and Tisovnica all the populations under study differ significantly by their cones. Variance analysis has in addition confirmed significant differences in cone size between individual trees of a given population (Tab. 4). Deviating nature of the putative hybrid swarms becomes more apparent when the pooled data on cone size of both the hybrid swarms and parental populations are taken into account. The decrease in cone size followed in this case the order *P. sylvestris*, *P. mugo* and hybrid swarms with all the three types of populations being profoundly differentiated (Tab. 5–6).

Tab. 3. Cone length in *P. sylvestris*, *P. mugo* and in their putative hybrid swarms

Species/Hybrids	Population	N	Average ± st. d. (cm)	Minimum	Maximum	Duncan grouping
P. sylvestris	Hruštín	658	4.38±0.70	2.4	6.4	A
P.mugo	Vrátna valley	1088	4.14±0.48	2.4	6.0	B
P.mugo	Roháče	1065	3.51±0.54	1.5	5.9	E
Hybrid swarm	Habovka	503	3.74±0.82	1.7	7.3	C
Hybrid swarm	Obšívanka	940	3.16±0.56	1.7	4.8	F
Hybrid swarm	Suchá Hora	1111	3.57±0.63	1.5	6.0	D
Hybrid swarm	Tisovnica	219	3.12±0.54	1.5	4.4	F

Tab. 4. Analysis of variance of cone length in *P. sylvestris*, *P. mugo* and in their hybrid swarms

Source	DF	Sum of squares	Mean square	F- value	Probability
Populations	6	745.84	124.30	29.94	0.0001***
Indiv./Popul.	266	1104.58	4.15	23.04	0.0001**
Error	5311	957.15	0.18		

Tab. 5. Pooled data on cone length in *P. sylvestris*, *P. mugo* and in their putative hybrid swarms

Species/Hybrids	N	Average ± st. d. (cm)	Duncan grouping
P. sylvestris	658	4.38	A
P.mugo	2153	3.83	B
Hybrid swarm	2773	3.43	C

Tab. 6. Analysis of variance on pooled data of cone length in *P. sylvestris*, *P. mugo* and in their putative hybrid swarms

Source	DF	Sum of squares	Mean square	F- value	Probability
Species	2	492.89	246.44	52.79	0.0001**
Species/ Indiv.	126	588.27	4.66	13.78	0.0001**
Error	5455	1848.30	0.33		

Discussion

There exist two opinions relative morphometric traits of *P. mugo* cones. According to LUKÁČIK (1993, 1997) individual variation of this character is governed by genotypic constitution of each tree. Consequently, the genotype is offered as the most probable explanation of individual variation in cone size observed within each of the populations compared. Still other reason for this type of variation is the quality of seeds. It was shown by SARVAS (1962) that there exists a close relationships between developmental potential of Scots pine cones and number of their seeds. In case of fertilization failure, the conelets of Scots pine containing only unfertilized ovules desiccate and drop completely. Therefore, a certain number of fertilized ovules is necessary for a conelet to continue its development into cone. The final size of a mature cone is in a decisive way influenced by the number of its seeds. This is another reason for the cone size variation within a given tree as well as between individual trees. Of course, at the species level, there exist the species-specific limits for cone size which are extensively utilized in systematic classification of pines. With special reference to the investigated hybrid swarm populations of *P. sylvestris* × *P. mugo*, the reduced size of their cones in comparison with the populations of *P. sylvestris* in Hruštín and *P. mugo* in Vrátna valley is obviously due to the hybrid nature of these swarms.STEBBINS (1950) postulates either partial or complete sterility for the interspecific hybrids of plants. Taxonomically related species *P. sylvestris* and *P. mugo* were proved to intercross partially producing only a certain amount of viable seeds (WACHOWIAK et al. 2005). Also, our data indicate a lower production of seeds per cone, including the filled seeds, in hybrid swarm populations of these species (KORMUŤÁK et al. 2009). We suppose that this is the main reason of reduced size of cones in hybrid swarm individuals. As such, this trait of cones may serve as a supplementary criterion only in diagnosing hybrid individuals of a swarm.

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