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Variability of quantity and location of pitchy channel in different species of genus *Pinus* L. in the left-bank Forest-Steppe and Steppe zone of Ukraine

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The variability of quantity and location of pitchy channel in pine-needle of different species of genus *Pinus* are investigated in two areas of introduction: in the left-bank Forest Steppe (10 species) and left-bank Steppe zone (16 species) of Ukraine.

The largest quantity of pitchy channel was identified in pine-needle of *P. thunbergiana* Franco – 9.30 ± 0.15, *P. funebris* Kom. – 8.50 ± 0.18, *P. nigra (n.)* Arnold. – 7.30 ± 0.10, *Pinus nigra (n.)* Arnold. subsp. *pallasiana* Lamb. Holmboe – 5.80 ± 0.16; the lowest quantity – in pine-needle of *P. peuce* Grisseb. – 2.00 ± 0.00, *P. pumila* (Pall.) Regel – 2.00 ± 0.00, *P. strobus* L. – 2.00 ± 0.00 and *P. sibirica* Mayr – 3.10 ± 0.03 in the left-bank Forest-Steppe. Maximum level of variability of characteristic was found in *P. nigra* subsp. *pallasiana* – 17.8%, *P. densiflora* Siebold et Zucc. – 3.4%, *P. funebris* – 13.3%, minimum level – *P. peuce, P. pumila* and *P. koraiensis* Siebold. et Zucc – 0% in this region.

In the left-bank Steppe zone the largest quantity of pitchy channel was identified in pine-needle of *P. laricio* Poiv. – 7.40 ± 0.22, *P. funebris* – 6.80 ± 0.22, *P. densiflora* – 5.90 ± 0.38, *P. mugo* Turra – 5.10 ± 0.20; the lowest – in pine-needle of *P. strobus* – 1.80 ± 0.06, *P. banksiana* Lamb. – 1.80 ± 0.08, *P. excelsa* Wall. – 1.90 ± 0.06, *P. flexilis* James. – 1.90 ± 0.04, *P. monticola* Dougl. – 1.90 ± 0.12. Maximum level of variability of characteristic was found in *P. ponderosa* var. *scopulorum* Lemm. – 48.4%, *P. ponderosa* Dougl. – 37.8%, *P. mugo* – 27.0%, *P. nigra* – 26.7%, *P. monticola* – 26.0%, *P. banksiana* – 23.5%, *P. densiflora* – 22.6%, average level – *P. wallichiana* – 14.6%, *P. strobus* – 16.0%, *P. funebris* – 16.1%, *P. koraiensis* – 17.6%, *P. laricio* – 17.3%, *P. mugo* Turra "Winter Gold" – 17.5%, minimum level – *P. cembra* L. – 0%, *P. peuce* – 0% and *P. flexilis* – 8.1% in the left-bank Steppe zone of Ukraine.

Key words: species of genus *Pinus*, pine-needle, quantity and location of pitchy channel, variability, coefficient of variation

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INTRODUCTION

Quantity and location of pitchy channel is original genotype of anatomical organization of pine-needle species of genus *Pinus*. This significant mark is used for evaluation of interspecies variation of pines in natural area and area of introduction. Individual variability quantity and location of pitchy channel of *Pinus silvestris* L. was investigated in Russia and Ukraine (Pravdin, 1964; Patlai, 1984). Variability in needle traits of *Pinus mugo* Turra, *P. kochiana* Klotzsch ex Koch, *Pinus nigra* Arnold. subsp. *pallasiana* Lamb. Holmboe and *P. pityusa* Steven was studied by Pashkevich (Pashkevich et al., 2001; Pashkevich, 2005). One of the authors of this article had started the observation of variability quantity and location of pitchy channel of other species of genus *Pinus* which was introduced in the left-bank Forest-Steppe of Ukraine in 2006 (Mazhula, 2006). The variability quantity and location of pitchy channel of species of genus *Pinus* which was introduced in the left-bank Steppe of Ukraine has not been studied to the present day.

MATERIALS AND METHODS

Plant material

The object in this study was pine-needles of different species of genus *Pinus* in two areas of introduction: in the left-bank Forest-Steppe – Zmievskiy forest enterprise – 10 species: *Pinus nigra (n.)* subsp. *pallasiana, P. nigra (n.), P. thunbergiana, P. funebris, P. peuce, P. sibirica, P. densiflora, P. pumila, P. koraiensis, P. strobus* and left-bank Steppe zone – Donetskiy Botanical Garden – 16 (15 species and 1 ornamental form): *P. banksiana, P. cembra, P. densiflora, P. wallichiana, P. flexilis, P. funebris, P. koraiensis, P. nigra, P. n.* var. *laricio, P. monticola, P. mugo, P. m.* "Winter Gold", *P. peuce, P. ponderosa, P. ponderosa* var. *scopulorum, P. strobus*. 40 pine-needles were prepared in the same part of the limb of trees of species.

Extraction

Pine-needles were immersed in a mixture of ethanol of 96% concentration with glycerin pro rata 1:1. Razor-blade was used to slice sections

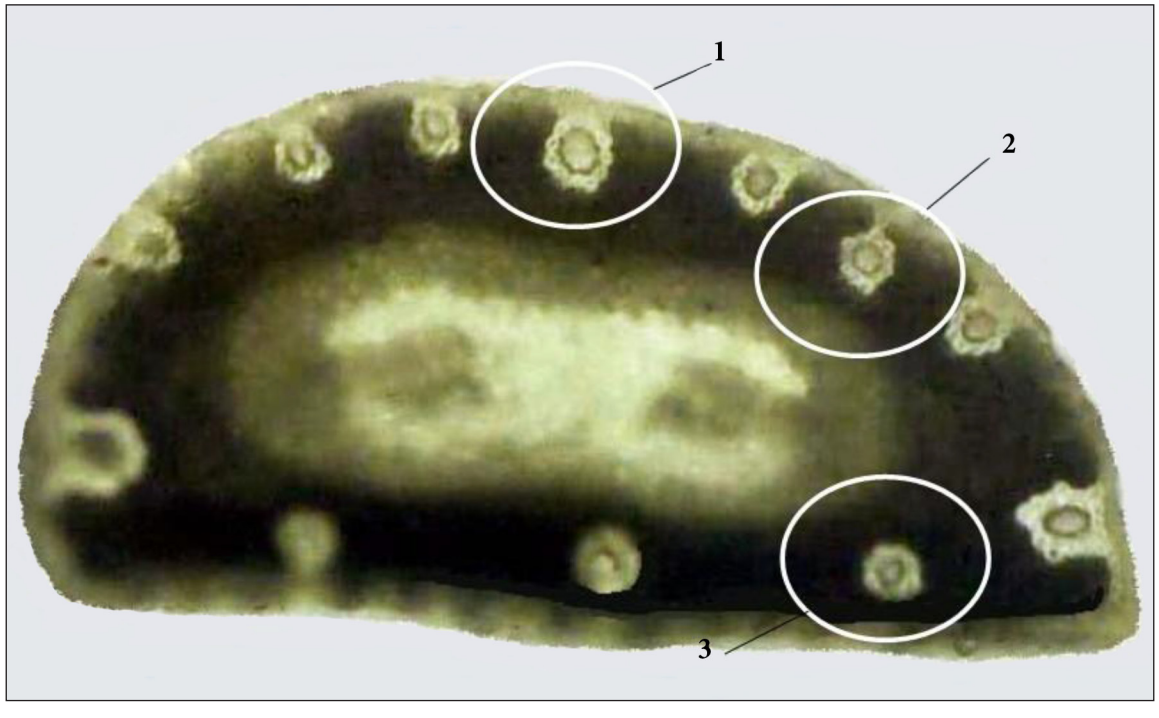

Figure. Location of pitchy channel in pine-needles of species of genus *Pinus*

of pine-needles for light microscopy. These sections were prepared in the middle part of pine-needles.

We determined the following indexes: a) quantity of pitchy channel; b) location of pitchy channel as follows: 1 – marginal resin-ducts, 2 – internal resin-ducts, 3 – medial resin-ducts (Figure).

RESULTS AND DISCUSSION

The results are set out in Table 1 for ten species of genus *Pinus* in the left-bank Forest-Steppe of Ukraine. The largest quantity of pitchy channel was identified in pine-needle of *P. thunbergiana* – 9.30 ± 0.15, *P. funebris* – 8.50 ± 0.18, *P. Nigra (n.)* – 7.30 ± 0.10, *Pinus nigra* (*n.) pallasiana* – 5.80 ± 0.16; the lowest – in pine-needle of *P. peuce* – 2.00 ± 0.00, *P. pumila* – 2.00 ± 0.00, *P. strobus* – 2.00 ± 0.00 and *P. sibirica* – 3.10 ± 0.03.

Four species of *Pinus* had only marginal resin-ducts, three – only medial resin-ducts, *Pinus nigra (n.)* subsp. *pallasiana* – internal and medial resin-ducts, *P. thunbergiana* and *P. densiflora* – marginal and medial resin-ducts.

The results are set out in Table 2 for sixteen species (15 species and 1 ornamental form) of genus *Pinus* in the left-bank Steppe of Ukraine. The largest quantity of pitchy channel was identified in pine-needle of *P. laricio* – 7.40 ± 0.22, *P. funebris* – 6.80 ± 0.22, *P. densiflora* – 5.90 ± 0.38, *P. mugo* – 5.10 ± 0.20; the lowest – in pine-needle of *P. strobus* – 1.80 ± 0.06, *P. banksiana* – 1.80 ± 0.08, *P. wallichiana* – 1.90 ± 0.06, *P. flexilis* – 1.90 ± 0.04, *P. monticola* – 1.90 ± 0.12.

Five species of *Pinus* had only marginal resin-ducts, 3 – only medial resin-ducts, *Pinus nigra* var. *laricio, P. ponderosa* and *P. ponderosa* var. *scopulorum* – internal and medial resin-ducts, *P. funebris, P. mugo* and *P. mugo* "Winter Gold" – marginal and medial resin-ducts. Two species of *Pinus* (*P. wallichiana* and *P. nigra*) had three diversities of resin-ducts in one.

The results show that significantly more variability not only location of pitchy channel (Tables 1 and 2), but also quantity of resin-ducts (Table 3) was found in different species of genus *Pinus* in left-bank Steppe zone (Donetskiy Botanical Garden). In the left-bank Forest-Steppe (Zmievskiy forest enterprise) the studied species of *Pinus* had lower-lying individual variation of test characteristics, coefficients of variation significantly lower compared to those in Steppe zone (Table 3).

According to the scale of Mamaev (Mamayev, 1973), the level of variability shall be interpreted very low for V < 7%, low for V = 8–12%, middle for V = 13–20%, high for V = 21–40% and very-high for V > 40%. The results of our research confirm that very high level of variability of characteristic was found

Table 1. Quantity of pitchy channel: marginal, internal, medial and total quantity in pine-needle of different species of genus *Pinus* in the left-bank Forest-Steppe of Ukraine

Species	Quantity of resin-ducts, piece			
	marginal	internal	medial	total
Pinus nigra (n.) subsp. *pallasiana*	–	0.03 ± 0.03	5.77 ± 0.17	5.80 ± 0.17
P. nigra (n.)	–	–	7.30 ± 0.10	7.30 ± 0.10
P. thunbergiana	0.80 ± 0.12	–	8.50 ± 0.15	9.30 ± 0.15
P. funebris	8.50 ± 0.18	–	–	8.50 ± 0.18
P. peuce	2.00 ± 0.00	–	–	2.00 ± 0.00
P. sibirica	–	–	3.10 ± 0.03	3.10 ± 0.03
P. densiflora	0.40 ± 0.08	–	3.80 ± 0.09	4.20 ± 0.09
P. pumila	2.00 ± 0.00	–	–	2.00 ± 0.00
P. koraiensis	–	–	3.00 ± 0.00	3.00 ± 0.00
P. strobus	2.00 ± 0.02	–	–	2.00 ± 0.02

Table 2. Quantity of pitchy channel: marginal, internal, medial and total quantity in pine-needle of different species of genus *Pinus* in the left-bank Steppe zone

Species	Quantity of resin-ducts, piece			
	marginal	internal	medial	total
P. banksiana	–	–	1.80 ± 0.08	1.80 ± 0.08
P. cembra	–	–	3.00 ± 0.00	3.00 ± 0.00
P. densiflora	5.90 ± 0.38	–	–	5.90 ± 0.38
P. wallichiana	1.82 ± 0.06	0.04 ± 0.04	0.04 ± 0.04	1.90 ± 0.06
P. flexilis	1.90 ± 0.04	–	–	1.90 ± 0.04
P. funebris	6.74 ± 0.22		0.06 ± 0.06	6.80 ± 0.22
P. koraiensis	–	–	2.70 ± 0.08	2.70 ± 0.08
*P. n.*var. *laricio*	–	0.05 ± 0.04	7.35 ± 0.22	7.40 ± 0.22
P. monticola	1.90 ± 0.12	–	–	1.90 ± 0.12
P. mugo	5.08 ± 0.2	–	0.02 ± 0.02	5.10 ± 0.2
P. mugo "Winter Gold"	4.18 ± 0.22	–	0.02 ± 0.02	4.20 ± 0.22
P. nigra	0.02 ± 0.02	0.05 ± 0.04	4.03 ± 0.18	4.10 ± 0.18
P. peuce	2.00 ± 0.00	–	–	2.00 ± 0.00
P. ponderosa	–	0.01 ± 0.01	4.29 ± 0.38	4.30 ± 0.38
P. ponderosa var. *scopulorum*	–	0.01 ± 0.01	3.49 ± 0.4	3.50 ± 0.4
P. strobus	1.80 ± 0.06	–	–	1.80 ± 0.06

Table 3. The variability of quantity of pitchy channel in two areas of introduction: in the left-bank Forest Steppe and left-bank Steppe zone of Ukraine

Species	Coefficient of variation of quantity of pitchy channel in two areas of introduction in the left-bank of Ukraine – V, %	
	Forest Steppe zone	Steppe zone
Pinus nigra (n.) subsp. *pallasiana*	17.8	–
P. nigra (n.)	8.4	26.7
P. thunbergiana	10.1	–
P. funebris	13.3	16.1
P. peuce	0.0	0.0
P. sibirica	8.8	–
P. densiflora	13.4	22.6
P. pumila	0.0	–
P. koraiensis	0.0	17.6
P. strobus	8.4	22.2
P. banksiana	–	23.5
P. cembra	–	0.0
P. n. var. *laricio*	–	17.3
P. wallichiana	–	14.6
P. flexilis	–	8.1
P. monticola	–	26.0
P. mugo	–	27.0
P. mugo "Winter Gold"	–	17.5
P. ponderosa	–	37.8
P. ponderosa var. *scopulorum*	–	48.4

only in *P. ponderosa* var. *scopulorum,* high level – only in 7 species in left-bank Steppe zone. The remaining species (8 – in Steppe zone and all 10 – in Forest Steppe zone) had middle, low and very low level of variability.

All data of the investigations point at impoverished biological diversity of species of *Pinus* which was introduced to Ukraine, especially in the left-bank Forest-Steppe. The seed propagation of species of *Pinus*, creation of provenance trial is the best method for enrichment of biological diversity.

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SKIRTINGŲ *PINUS* L. GENTIES RŪŠIŲ SAKOTAKIŲ KIEKIO IR PADĖTIES ĮVAIROVĖ KAIRIOJO KRANTO MIŠKASTEPIŲ IR STEPIŲ ZONOJE UKRAINOJE

Santrauka

Sakotakių kiekio ir padėties įvairovė skirtingų *Pinus* genties rūšių pušų spygliuose tirta dviejose introdukcijos vietose: kairiojo kranto miškastepės (10 rūšių) ir kairiojo kranto stepių zonoje (16 rūšių) Ukrainoje. Didžiausias sakotakių kiekis nustatytas *P. thunbergiana* Franco (9,30 ± 0,15), *P. funebris* Kom. (8,50 ± 0,18), *P. nigra (n.)* Arnold. (7,30 ± 0,10), *Pinus nigra (n.)* Arnold. subsp. *pallasiana* Lamb. Holmboe (5,80 ± 0,16) pušų spygliuose; mažiausias kiekis – *P. peuce* Grisseb. (2,00 ± 0,00), *P. pumila* (Pall.) Regel (2,00 ± 0,00), *P. strobus* L. (2,00 ± 0,00) ir *P. sibirica* Mayr (3,10 ± 0,03) pušų spygliuose kairiojo kranto miškastepėje. Didžiausia charakteristikos įvairove pasižymėjo *P. nigra* subsp. *pallasiana* – 17,8 %, *P. densiflora* Siebold et Zucc. – 13,4 %, *P. funebris* – 13,3 %, mažiausia – *P. peuce, P. pumila* ir *P. koraiensis* Siebold. et Zucc – 0 % šiame regione. Kairiojo kranto stepių zonoje didžiausias kiekis sakotakių nustatytas *P. laricio* Poiv. (7,40 ± 0,22), *P. funebris* (6,80 ± 0,22), *P. densiflora* (5,90 ± 0,38), *P. mugo* Turra (5,10 ± 0,20) pušų spygliuose; mažiausias – *P. strobus* (1,80 ± 0,06), *P. banksiana* Lamb. (1,80 ± 0,08), *P. excelsa* Wall. (1,90 ± 0,06), *P. flexilis* James. (1,90 ± 0,04), *P. monticola* Dougl. (1,90 ± 0,12) pušų spygliuose. Didžiausia charakteristikos įvairove pasižymėjo *P. ponderosa* var. *scopulorum* Lemm. – 48,4 %, *P. ponderosa* Dougl. – 37,8 %, *P. mugo* – 27,0 %, *P. nigra* – 26,7 %, *P. monticola* – 26,0 %, *P. banksiana* – 23,5 %, *P. densiflora* – 22,6 %, vidutine – *P. wallic hiana* – 14,6 %, *P. strobus* – 16,0 %, *P. funebris* – 16,1 %, *P. koraiensis* – 17,6 %, *P. laricio* – 17,3 %, *P. mugo* Turra „Winter Gold“ – 17,5 %, minimalia – *P. cembra* L. – 0 %, *P. peuce* – 0 % ir *P. flexilis* – 8,1 % kairiojo kranto stepių zonoje.

Raktažodžiai: *Pinus* genties rūšys, pušų spygliai, sakotakių kiekis ir padėtis, įvairovė, įvairovės koeficientas