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Spruce and broadleaved trees pollen percentages and PAR values in the European part of Russia: 9 years of pollen trap monitoring implemented to the fossil data

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Abstract. 9-years results of modern pollen monitoring in the Central European Russia are presented. We discuss some implementations of modern pollen data to the interpretation of fossil distribution for *Picea* and broadleaved trees pollen.

Keywords: modern pollen deposition, pollen monitoring, Tauber traps, Holocene, *Picea*, broadleaved trees

1. Introduction

Picea abies s.l. and broadleaved trees (*Quercus robur, Tilia cordata, Ulmus glabra, U. scabra, Acer platanoides* and *Fraxinus excelsior*) are the important forest-forming taxa in the Central and North-Western part of the European Russia (NW ER). Complex forests consisting of spruce and broadleaved species in various combinations (and succession series) represented primary vegetation (before the beginning of large-scale human-caused deforestation) of that area during all over Middle and Late Holocene. The maximum percentages and PARs for North-West European Russia (Polistovsky National Reserve – Nosova et al. 2017) and Central European Russia (Central Forest Reserve – Novenko et al. 2009) are presented in the Table 1.

Extremely high PAR-values for *Picea* pollen were recorded in Middle and Late Holocene and then there was relatively late decline of primary forests. Thus, the challenge in search of modern analogues and examination of possible threshold values for the presence or absence of spruce trees in vegetation has been raised.

2. Study area

This study presents 9-year results of modern pollen data obtained from 23 Tauber pollen traps, operating in frame

Figure 1. PMP-sites within the European part of Russia

of the Pollen Monitoring Programme (Hicks et al. 1996; www.pollentrapping.org), located on 6 model territories in 4 regions in the European part of Russia (Fig. 1):

1. RU-PL – Polistovsky Natural Reserve (north-western European Russia, Pskov Region, coniferous-broadleaved forest zone). **2. RU-TR – Biological Station "Chisty Les"** (Tver region, sand-soil type of coniferous-broadleaved forest zone) **3. RU-CF – Central Forest State Natural Biosphere Reserve** (Tver Region, south slope of Valdai Hills, taiga-faced, low disturbed forests in the coniferous-broadleaved forest zone. **4. RU-ZV – Zvenigorod Biological Station of Moscow State University** (Moscow Region, south variant of coniferous-broadleaved forests located in the suburban belt of Moscow). **5. RU-TU –** Tulskie Zaseki (surroundings of Tula town, broadleaved forest zone). **6. RU-KP –** Military History and Natural Reserve "Kulikovo Field" (Tula region, forest-steppe ecotone).

Vegetation maps based on satellite images were created for all territories within a 5 km radius from the trap locations. In addition, data from forest surveys were used for the interpretation of remote sensing data.

3. Results and conclusions

Preliminary results indicate the absence of appropriate modern analogues for primary forests among the investigated sites as vegetation and landscapes of all these regions has been transformed by humans significantly with maximum of deforestation in 1700th – 1900th.

Broadleaved trees PARs and percentages (Figure 2, Table 2) increase from the north to the south right up to broadleaved forest belt and then decrease in the forest-steppe ecotone. The lower values observed for the sites RU-TR (there are sand soils and a lot of *Pinus*) and RU-CF (that site controlled by specifically cold microclimatic conditions).

Table 1. Maximum fossil pollen percentages and PARs (pollen grains*yrs^{-1}*cm^{-2}) for two sites in the European Russia.

Site/Region	*Picea*		*Quercus*		*Tilia*		*Ulmus*		*Fraxinus*	
	%	PAR	%	PAR	%	PAR	%	PAR	%	PAR
Polistovsky National Reserve (Nosova et al., in press)	25	56000	11.9	8500	4.7	6300	13.5	24000	4.2	2700
Central Forest Reserve (Novenko et al., 2009)	40	47000	5.7	3500	4.8	9500	11	13000	1.6	2300

Picea and broadleaved trees show maximum modern PARs ~10 times less than the fossil PARs (Table 1).

Table 2. Average PAR-values (pollen grains*yrs^{-1}*cm^{-2}) and pollen percentages (based on total terrestrial pollen sum – P) for six trap-sites in European Russia.

Site/Region-->		RU-PL	RU-TR	RU-CF	RU-ZV	RU-TU	RU-KP
Picea	**PAR**	897	934	690	2075	120	80
	%	1.7	2.1	1.7	3.5	0.2	0.3
Tilia	**PAR**	0	9	10	347	1622	61
	%	0.0	0.0	0.0	1.0	1.7	0.2
Ulmus	**PAR**	209	159	66	827	279	50
	%	0.3	0.5	0.2	0.5	0.8	0.1
Fraxinus	**PAR**	233	180	26	362	1058	125
	%	0.1	0.5	0.1	0.3	1.7	0.4
Acer	**PAR**	42	1	16	24	550	151
	%	0.1	0.0	0.1	0.0	0.7	0.3
Quercus	**PAR**	151	145	73	438	1345	251
	%	0.2	0.4	0.2	0.5	1.6	0.7
Corylus	**PAR**	267	101	154	206	1060	108
	%	0.5	0.4	0.6	0.4	1.7	0.3

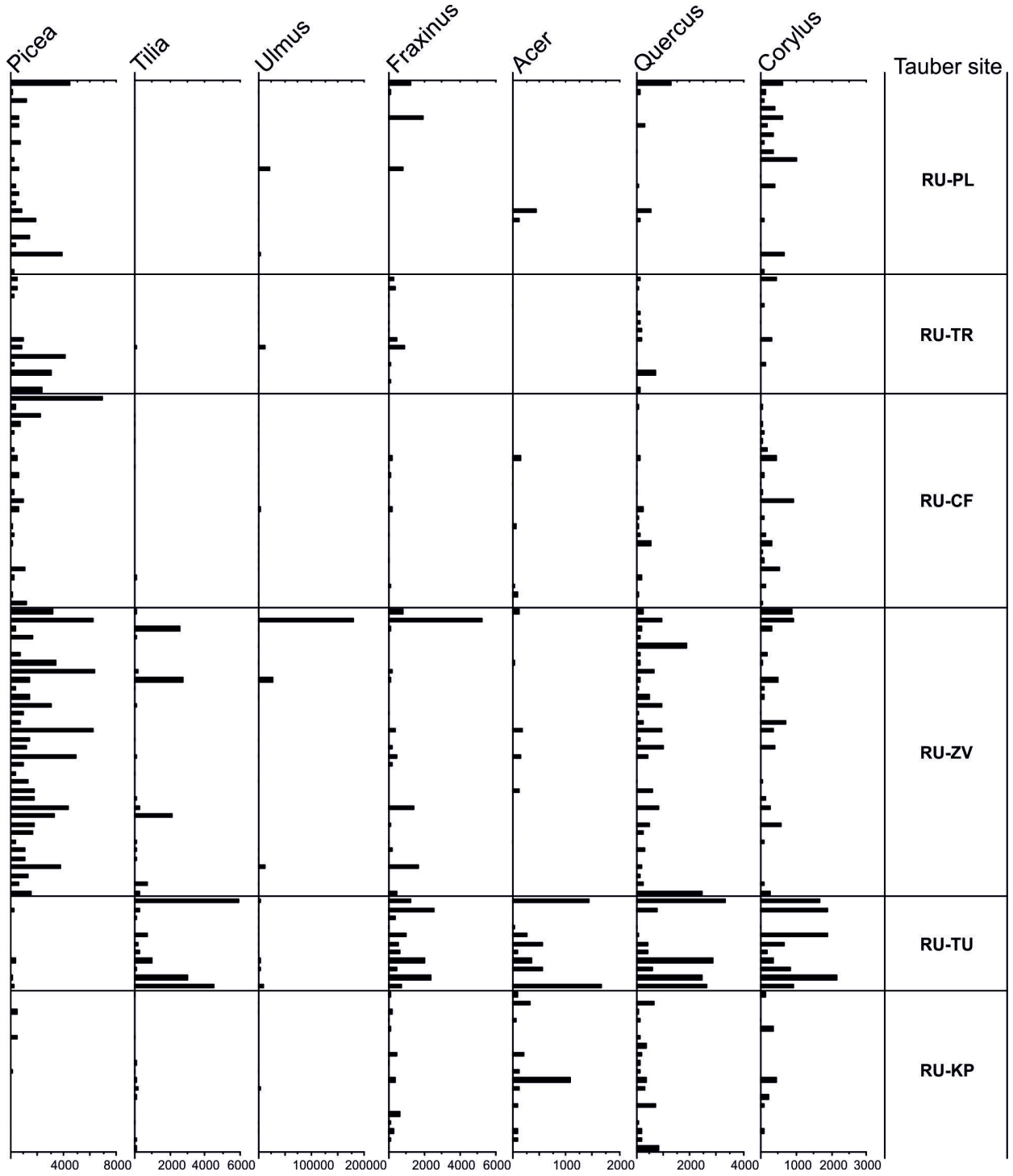

Figure 2. PAR diagram for 9 years of pollen monitoring (years are not specified, don't include the missed ones and increase from bottom to top)

We suggest to determine threshold values for *Picea* PAR ~100 p.g.*yrs^{-1}*cm^{-2} and less than 1%. For broad-leaved trees (except *Quercus*) we support the opinion of many authors (e.g. Lisitsyna et al. 2011) that threshold values are ~ 0,5% and suggest the <50 PAR as a criteria of absence or single trees of broadleaved species in the vegetation.

Three zones investigated (south taiga, mixed coniferous-broadleaved forests and broadleaved forests) are well detected by *Picea*/broadleaved pollen ratio even in modern modified state of vegetation.

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