

Ecography

**ECOG-04906**

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**Supplementary material**

## Appendix 1

**Table A1** Overview of the microclimatic measurements throughout the study. Gr: grassland; Po: poplar forest; Ro: *Robinia* forest; Pi: pine forest; ✓: operational microclimate station; ×: malfunctioning or damaged microclimate station. There were two grassland stations in each locality, which is indicated by two functionality symbols in respective cells. If both grassland stations of a locality were compromised, we could not use otherwise operational forest stations of the same locality (also indicated with “×” sign), as we could not standardize them.

Month	Fülőpháza				Ágasegyháza				Méntelek				Izsák			
	Gr	Po	Ro	Pi	Gr	Po	Ro	Pi	Gr	Po	Ro	Pi	Gr	Po	Ro	Pi
March	✓✓	✓	✓	✓	✓✓	✓	✓	✓	✓✓	✓	✓	×	××	×	×	×
April	✓✓	✓	×	✓	××	×	×	×	✓✓	✓	✓	✓	✓×	✓	✓	✓
May	✓✓	✓	✓	✓	✓✓	✓	✓	✓	✓✓	✓	×	✓	××	×	×	×
July	××	×	×	×	✓✓	✓	×	✓	✓✓	✓	✓	✓	✓✓	✓	✓	✓
August	✓✓	✓	✓	✓	✓×	✓	✓	✓	✓✓	✓	✓	✓	××	×	×	×
October	✓✓	✓	✓	✓	✓×	✓	✓	✓	✓✓	✓	✓	✓	××	×	×	×
December	✓✓	✓	✓	✓	✓×	✓	✓	✓	✓✓	✓	✓	✓	××	×	×	×

**Table A2** Results of the linear mixed-effects models prepared for the canopy cover of poplar, *Robinia* and pine forests. Pairwise comparisons were considered only if the full models explained a significant proportion of the variation of the data. Pairwise p-values were adjusted with the fdr method. \*p<0.05.

	March		April		May		June	
Forest type	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Forest type	109.46	<0.001*	96.69	<0.001*	1.80	0.204	5.95	0.010*
	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
Poplar - <i>Robinia</i>	-5.17	<0.001*	-12.72	<0.001*	.	.	2.79	0.018*
Poplar - Pine	9.41	<0.001*	-1.49	0.153	.	.	-0.37	0.718
<i>Robinia</i> - Pine	14.59	<0.001*	11.22	<0.001*	.	.	-3.15	0.018*
	August		October		December		January	
Forest type	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Forest type	15.14	<0.001*	4.87	0.013*	141.64	<0.001	107.52	<0.001*
	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
Poplar - <i>Robinia</i>	3.05	0.005*	0.51	0.608	-5.21	<0.001	-2.60	0.014*
Poplar - Pine	-2.44	0.017*	-2.41	0.032*	11.25	<0.001	11.20	<0.001
<i>Robinia</i> - Pine	-5.49	<0.001*	-2.92	0.018*	16.46	<0.001	13.80	<0.001

**Table A3** Results of the linear models prepared for the effect of canopy cover on microclimatic variables in *Robinia* and poplar forests, and the one-sample t-tests on the effect of pine forests on microclimate as compared to adjacent open grasslands. \*p<0.05.

<i>Robinia</i>	<i>Estimate</i>	<i>t</i>	<i>p</i>	<i>R</i> <sup>2</sup>
DT TD	-0.14	-4.17	0.001*	0.52
NT TD	0.04	2.77	0.014*	0.32
DT HD	0.35	3.45	0.003*	0.43
NT HD	0.12	2.35	0.032*	0.26
<i>Poplar</i>	<i>Estimate</i>	<i>t</i>	<i>p</i>	<i>R</i> <sup>2</sup>
DT TD	-0.14	-2.20	0.041*	0.21
NT TD	0.01	0.26	0.795	0.01
DT HD	0.55	3.33	0.004*	0.38
NT HD	0.23	2.18	0.042*	0.21
<i>Pine</i>	<i>Mean</i>	<i>t</i>	<i>p</i>	
DT TD	-8.17	-8.64	0.001*	
NT TD	1.38	3.53	0.003*	
DT HD	14.05	5.96	<0.001*	
NT HD	0.79	0.39	0.703	

**Table A4** Results of the linear mixed-effects models prepared for carbon and nitrogen contents of the soil of grasslands and poplar, Robinia and pine forests. Pairwise comparisons of habitat types were considered only within depth layers. Pairwise p-values were adjusted with the *fdr* method. \* $p < 0.05$ .

	Carbon content		Nitrogen content	
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Habitat	9.60	<0.001*	23.65	<0.001*
Depth	71.61	<0.001*	26.70	<0.001*
10–20 cm	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
Poplar - <i>Robinia</i>	-2.41	0.048*	7.11	<0.001*
Poplar - Pine	-3.52	0.004*	-1.19	0.324
Poplar - Grassland	-2.95	0.018*	0.74	0.506
<i>Robinia</i> - Pine	-1.11	0.329	-8.30	<0.001*
<i>Robinia</i> - Grassland	-0.17	0.865	-7.47	<0.001*
Pine - Grassland	1.11	0.329	2.11	0.072
70–80 cm	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
Poplar - <i>Robinia</i>	-2.37	0.048*	3.09	0.008*
Poplar - Pine	-4.13	0.001*	-1.05	0.361
Poplar - Grassland	-3.59	0.004*	-0.02	0.981
<i>Robinia</i> - Pine	-1.76	0.151	-4.14	<0.001*
<i>Robinia</i> - Grassland	-0.85	0.436	-3.59	0.002*
Pine - Grassland	1.18	0.329	1.19	0.324

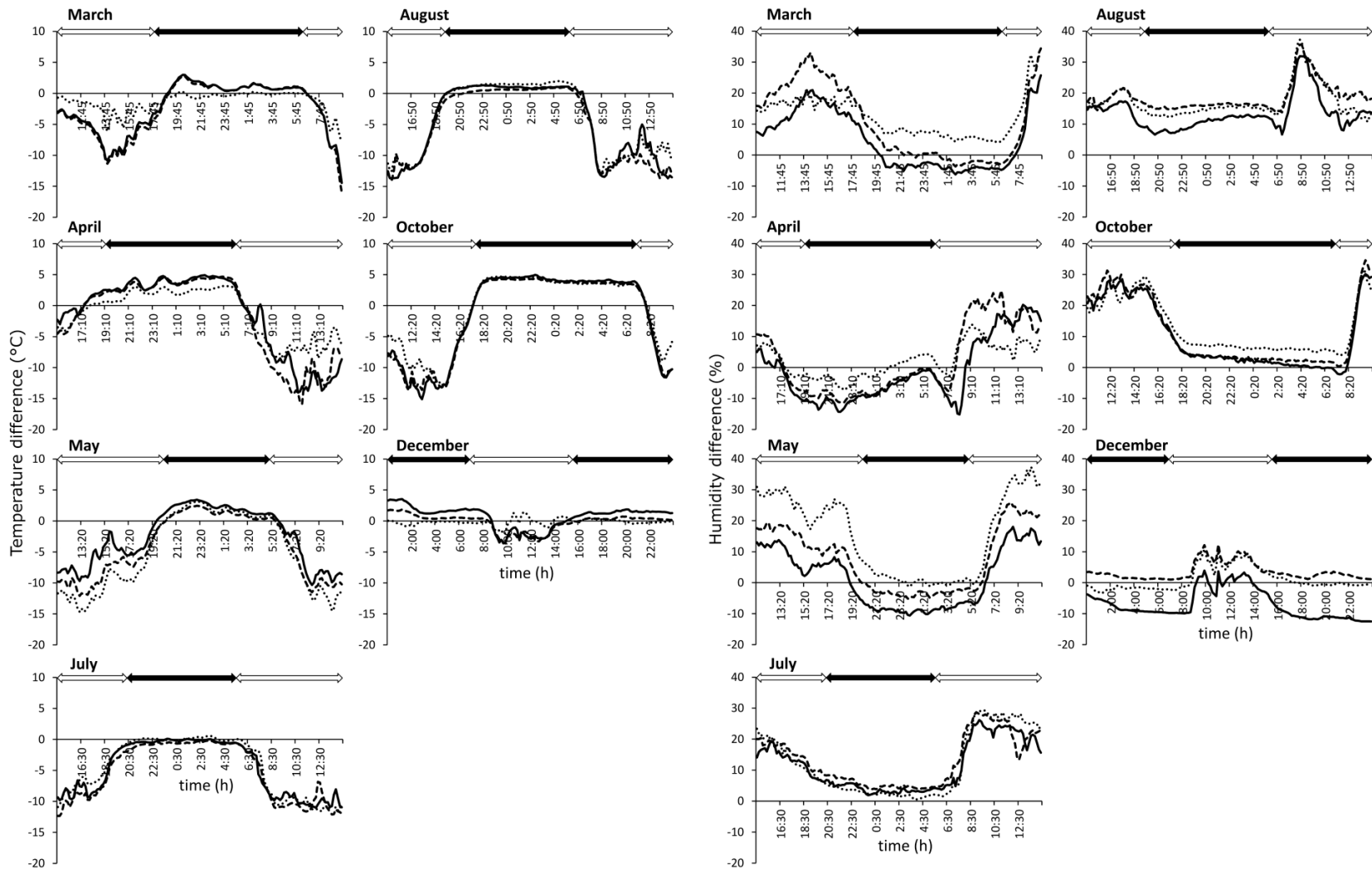
**Table A5** Results of the linear mixed-effects models prepared for the soil moisture content of grasslands and poplar, Robinia and pine forests over the course of a year. Centimetres from 20 till 120 denote depth layers. Pairwise p-values were adjusted with the fdr method. \*p<0.05.

	20 cm		40 cm		60 cm		80 cm		100 cm		120 cm	
MARCH	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	8.81	<0.001	13.76	<0.001	15.48	<0.001	2.93	0.075	0.18	0.912	0.40	0.751
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	4.53	<0.001*	2.77	0.011*	0.46	0.903	.	.	.	.	.	.
Grassland - <i>Robinia</i>	3.66	0.003*	1.57	0.144	0.10	0.923	.	.	.	.	.	.
Grassland - Pine	1.32	0.227	-4.17	<0.001*	-6.07	<0.001*	.	.	.	.	.	.
Poplar - <i>Robinia</i>	-0.75	0.451	-1.03	0.305	-0.32	0.903	.	.	.	.	.	.
Poplar - Pine	-2.78	0.014*	-6.01	<0.001*	-5.65	<0.001*	.	.	.	.	.	.
<i>Robinia</i> - Pine	-2.02	0.071	-4.98	<0.001*	-5.34	<0.001*	.	.	.	.	.	.
APRIL	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	27.37	<0.001	10.43	<0.001	32.78	<0.001	85.26	<0.001	18.86	<0.001	13.99	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	7.9	<0.001*	3.76	<0.001*	0.15	0.880	-1.72	0.108	-3.51	0.002*	-3.77	<0.001*
Grassland - <i>Robinia</i>	6.80	<0.001*	1.63	0.107	-2.45	0.024*	-2.80	0.010*	-0.11	0.916	0.21	0.838
Grassland - Pine	3.31	0.002*	-2.41	0.027*	-9.30	<0.001*	-12.90	<0.001*	-6.89	<0.001*	-5.49	<0.001*
Poplar - <i>Robinia</i>	-0.96	0.340	-1.84	0.083	-2.25	0.033*	-0.94	0.352	2.95	0.006*	3.44	0.002*
Poplar - Pine	-3.98	<0.001*	-5.35	<0.001*	-8.18	<0.001*	-9.68	<0.001*	-2.93	0.006*	-1.49	0.168
<i>Robinia</i> - Pine	-3.02	0.004*	-3.50	0.002*	-5.93	<0.001*	-8.75	<0.001*	-5.87	<0.001*	-4.93	<0.001*
MAY	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	10.63	<0.001	33.85	<0.001	50.95	<0.001	52.92	<0.001	27.06	<0.001	31.91	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	3.81	<0.001*	-4.55	<0.001*	-6.23	<0.001*	-6.48	<0.001*	-5.60	<0.001*	-7.55	<0.001*
Grassland - <i>Robinia</i>	2.88	0.008*	-6.03	<0.001*	-7.35	<0.001*	-6.30	<0.001*	-5.00	<0.001*	-5.90	<0.001*
Grassland - Pine	-1.70	0.111	-9.60	<0.001*	-11.70	<0.001*	-12.21	<0.001*	-8.33	<0.001*	-8.01	<0.001*
Poplar - <i>Robinia</i>	-0.81	0.422	-1.28	0.206	-0.97	0.336	0.15	0.883	0.53	0.599	1.43	0.188
Poplar - Pine	-4.77	<0.001*	-4.37	<0.001*	-4.74	<0.001*	-4.96	<0.001*	-2.36	0.025*	-0.40	0.692
<i>Robinia</i> - Pine	-3.97	<0.001*	-3.09	0.003*	-3.77	<0.001*	-5.11	<0.001*	-2.89	0.008*	-1.83	0.107

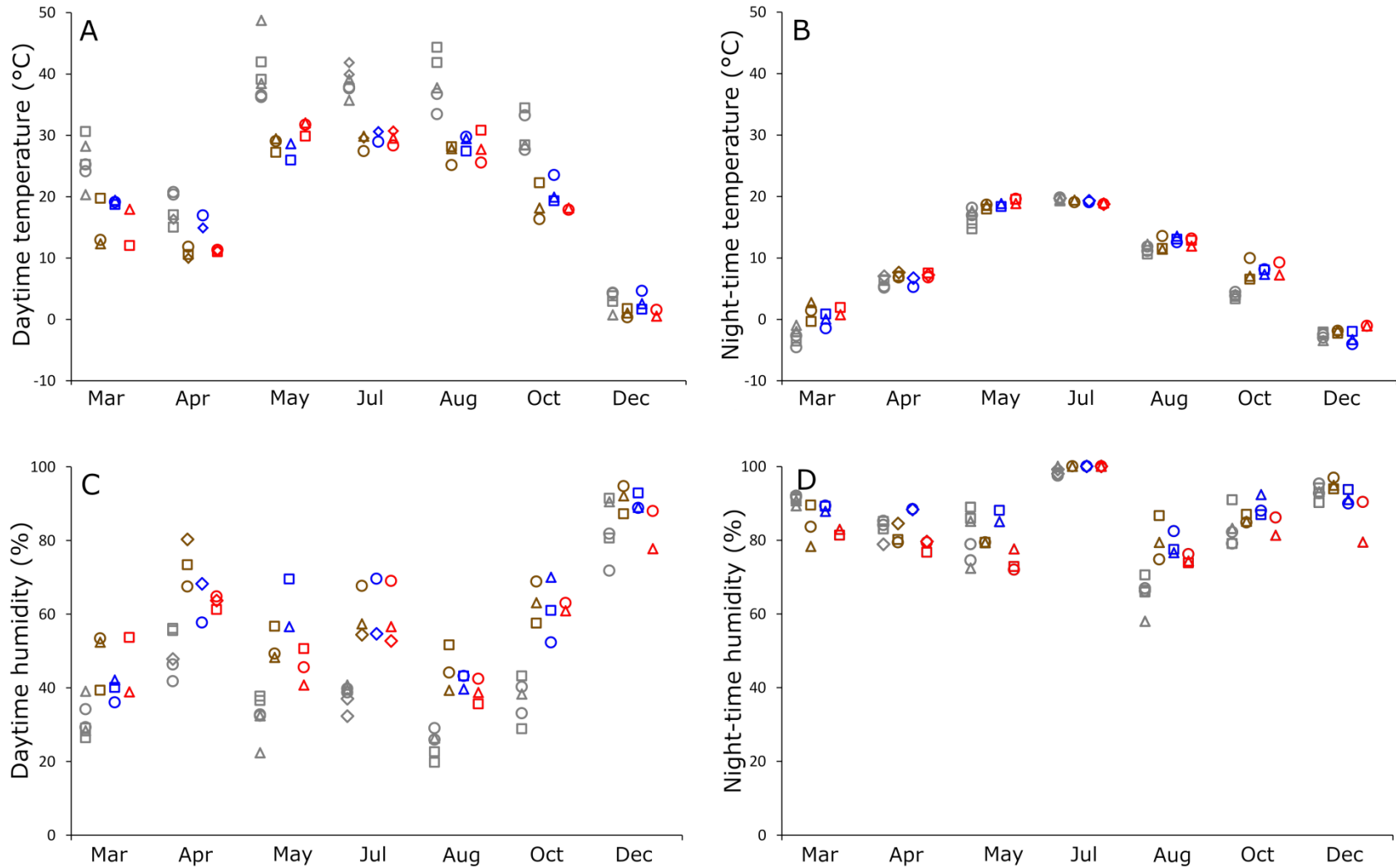
	20 cm		40 cm		60 cm		80 cm		100 cm		120 cm	
JULY	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	22.89	<0.001	74.96	<0.001	96.20	<0.001	137.35	<0.001	171.61	<0.001	64.25	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	-0.78	0.436	-10.92	<0.001*	-12.23	<0.001*	-15.51	<0.001*	-17.99	<0.001*	-10.82	<0.001*
Grassland - <i>Robinia</i>	5.23	<0.001*	-2.06	0.051*	-7.59	<0.001*	-11.29	<0.001*	-13.66	<0.001*	-8.88	<0.001*
Grassland - Pine	-4.22	<0.001*	-12.50	<0.001*	-15.17	<0.001*	-17.08	<0.001*	-18.12	<0.001*	-11.00	<0.001*
Poplar - <i>Robinia</i>	5.21	<0.001*	7.67	<0.001*	4.02	<0.001*	3.66	0.001*	3.75	<0.001*	1.68	0.117
Poplar - Pine	-2.98	0.005*	-1.37	0.174	-2.54	0.013*	-1.36	0.179	-0.11	0.910	-0.15	0.879
<i>Robinia</i> - Pine	-8.19	<0.001*	-9.04	<0.001*	-6.56	<0.001*	-5.02	<0.001*	-3.87	<0.001*	-1.83	0.106
AUGUST	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	9.20	<0.001	55.57	<0.001	62.03	<0.001	50.69	<0.001	38.49	<0.001	64.86	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	1.35	0.180	-9.10	<0.001*	-9.57	<0.001*	-9.13	<0.001*	-7.95	<0.001*	-10.47	<0.001*
Grassland - <i>Robinia</i>	3.97	<0.001*	-3.83	<0.001*	-3.83	<0.001*	-7.84	<0.001*	-7.64	<0.001*	-9.78	<0.001*
Grassland - Pine	-1.80	0.090	-11.56	<0.001*	-11.56	<0.001*	-10.22	<0.001*	-8.39	<0.001*	-10.87	<0.001*
Poplar - <i>Robinia</i>	2.27	0.039*	1.46	<0.001*	4.56	0.147	1.12	0.321	0.27	0.786	0.59	0.665
Poplar - Pine	-2.74	0.016*	-2.14	0.036*	-2.14	0.048*	-0.94	0.351	-0.38	0.786	-0.35	0.728
<i>Robinia</i> - Pine	-5.00	<0.001*	-3.55	<0.001*	-6.69	0.001*	-2.06	0.065	-0.65	0.776	-0.94	0.523
OCTOBER	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	16.90	<0.001	72.25	<0.001	50.59	<0.001	18.67	<0.001	16.42	<0.001	16.26	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	2.59	0.017*	-7.91	<0.001*	-9.40	<0.001*	-6.42	<0.001*	-5.71	<0.001*	-5.71	<0.001*
Grassland - <i>Robinia</i>	5.44	<0.001*	1.41	0.163	-3.14	0.003*	-2.43	0.021*	-1.05	0.354	-1.94	0.068
Grassland - Pine	-2.12	0.038*	-12.26	<0.001*	-10.41	<0.001*	-5.71	<0.001*	-5.32	<0.001*	-5.58	<0.001*
Poplar - <i>Robinia</i>	2.47	0.019*	8.07	<0.001*	5.42	<0.001*	3.46	0.002*	4.03	<0.001*	3.27	0.003*
Poplar - Pine	-4.08	<0.001*	-3.76	<0.001*	-0.87	0.386	0.62	0.538	0.34	0.736	0.12	0.908
<i>Robinia</i> - Pine	-6.55	<0.001*	-11.84	<0.001*	-6.29	<0.001*	-2.84	0.009*	-3.70	<0.001*	-3.15	0.003*

	20 cm		40 cm		60 cm		80 cm		100 cm		120 cm	
DECEMBER	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	9.98	<0.001	4.56	0.006	9.05	<0.001	36.13	<0.001	25.78	<0.001	30.96	<0.001
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	3.26	0.003*	2.32	0.046*	1.09	0.338	1.24	0.220	-1.84	0.070	-4.61	<0.001*
Grassland - <i>Robinia</i>	4.94	<0.001*	1.23	0.267	-0.61	0.544	-2.81	0.008*	-5.14	<0.001*	-4.75	<0.001*
Grassland - Pine	3.52	0.002*	-1.70	0.140	-4.44	<0.001*	-9.30	<0.001*	-8.26	<0.001*	-9.41	<0.001*
Poplar - <i>Robinia</i>	1.46	0.225	-0.95	0.348	-1.47	0.220	-3.50	0.001*	-2.86	0.008*	-0.13	0.900
Poplar - Pine	0.23	0.821	-3.49	0.005*	-4.78	<0.001*	-9.12	<0.001*	-5.56	<0.001*	-4.16	<0.001*
<i>Robinia</i> - Pine	-1.23	0.268	-2.54	0.040*	-3.31	0.003*	5.62	<0.001*	-2.70	0.010*	-4.03	<0.001*
JANUARY	F	p	F	p	F	p	F	p	F	p	F	p
Habitat type	3.51	0.020	19.33	<0.001	9.80	<0.001	8.81	<0.001	1.59	0.200	3.72	0.015
	t	p	t	p	t	p	t	p	t	p	t	p
Grassland - Poplar	1.61	0.167	2.63	0.016*	-0.34	0.734	0.92	0.361	.	.	-2.37	0.062
Grassland - <i>Robinia</i>	-0.10	0.923	1.15	0.254	-1.56	0.185	-1.40	0.197	.	.	-2.97	0.024*
Grassland - Pine	-2.12	0.113	-5.58	<0.001*	-5.21	<0.001*	-4.43	<0.001*	.	.	-1.75	0.170
Poplar - <i>Robinia</i>	-1.48	0.172	-1.28	0.246	-1.05	0.355	-2.01	0.072	.	.	-0.52	0.605
Poplar - Pine	-3.23	0.011*	-7.10	<0.001*	-4.22	<0.001*	-4.64	<0.001*	.	.	0.54	0.605
<i>Robinia</i> - Pine	-1.75	0.167	-5.83	<0.001*	-3.16	0.005*	-2.62	0.021*	.	.	1.06	0.441





**Figure A1** Day-round microclimatic properties of poplar (dashed line), *Robinia* (dotted line) and pine forests (solid line) as compared to adjacent grasslands as base lines. Negative and positive values indicate that forests had respectively lower or higher values than grasslands at particular times of the day. Empty arrows: daytime (between sunrise and sunset), full arrows: night (between sunset and sunrise).



**Figure A2** Average non-standardized daytime (10 a.m. - 4 p.m.) and night-time (10 p.m. - 4 a.m.) temperature (A and B) and humidity (C and D) values of the sampling sites over the course of a year. Grey: grassland; brown: poplar forest; blue: Robinia forest; red: pine forest; circle: Mentelek; square: Fülöpháza; triangle: Ágasegyháza; diamond: Izsák.