

附表 1 红皮云杉林的乔木层数量特征表

Appendix table 1 Quantity characteristics of tree stratum in *Picea koraiensis* Forest Alliance

Latin name	Frequency (%)	Density (Plant/600 m ²)	DBH (cm)	Height (m)	Importance value (%)
<i>Picea koraiensis</i>	100	19	25	17	11.7
<i>Larix gmelinii</i>	45	16	23	18	8.0
<i>Abies nephrolepis</i>	61	13	19	16	6.6
<i>Betula platyphylla</i>	80	12	16	16	6.5
<i>Larix olgensis</i>	12	12	21	18	4.9
<i>Pinus koraiensis</i>	57	6	20	13	4.3
<i>Juglans mandshurica</i>	12	10	21	17	4.3
<i>Pinus sylvestris</i> var. <i>mongolica</i>	10	5	29	18	3.9
<i>Fraxinus mandshurica</i>	16	5	25	20	3.4
<i>Populus davidiana</i>	24	5	20	19	3.4
<i>Tilia amurensis</i>	45	4	16	12	3.2
<i>Ulmus davidiana</i> var. <i>japonica</i>	27	5	18	13	2.9
<i>Betula costata</i>	20	5	16	14	2.6
<i>Alnus hirsuta</i>	27	5	13	11	2.6
<i>Acer pictum</i>	24	5	15	11	2.5
<i>Acer tegmentosum</i>	27	5	9	9	2.3
<i>Chosenia arbutifolia</i>	10	2	23	21	2.2
<i>Picea jezoensis</i> var. <i>microsperma</i>	4	2	31	23	2.2
<i>Populus maximowiczii</i>	16	2	20	17	2.0
<i>Tilia mandshurica</i>	4	8	11	10	2.0
<i>Alnus mandshurica</i>	4	4	16	14	1.8
<i>Syringa reticulata</i> subsp. <i>amurensis</i>	6	8	6	7	1.7
<i>Betula ermanii</i>	4	4	16	14	1.7
<i>Ulmus laciniata</i>	14	3	12	10	1.7
<i>Acer ukurunduense</i>	10	5	9	7	1.6
<i>Fraxinus chinensis</i> subsp. <i>rhynchophylla</i>	8	4	12	8	1.5
<i>Quercus mongolica</i>	12	2	12	12	1.5
<i>Padus avium</i>	18	2	8	7	1.4
<i>Acer pseudosieboldianum</i>	4	5	7	5	1.2
<i>Sorbus pohuashanensis</i>	8	2	7	7	1.0
<i>Picea jezoensis</i> var. <i>komarovii</i>	2	1	13	11	0.9
<i>Salix raddeana</i>	2	1	11	8	0.7
<i>Acer barbinerve</i>	2	2	6	6	0.7
<i>Rhamnus davurica</i>	2	1	6	7	0.6
<i>Maackia amurensis</i>	2	1	3	5	0.4

附表 2 红皮云杉林群丛尺度上气候因子的主成分分析

Appendix table 2 The principal component analysis of climatic factors of *Picea koraiensis* Forest Alliance

Climatic factor	Principal component (PC) Loading value	
	PC1	PC2
Mean annual temperature (°C)	0.99	0.16
Mean temperature of the coldest month (°C)	0.79	0.56
Mean temperature of the warmest month (°C)	0.91	-0.39
Growing degree days on a 5°C basis (°C·d)	0.96	-0.27
Growing degree days on a 0°C basis (°C·d)	0.98	-0.21
Mean annual precipitation (mm)	0.80	0.56
Actual evapotranspiration (mm)	0.99	-0.08
Potential evapotranspiration (mm)	0.99	0.13
Moisture index	0.95	-0.29
Eigenvalue	7.80	1.03
Information amount (%)	86.62	11.46

附表 3 红皮云杉林物种与环境因子的冗余分析结果

Appendix table 3 Redundancy analysis (RDA) of species composition in relation to environment variables of *Picea koraiensis* Forest Alliance

Parameters	Axis 1	Axis 2	Axis 3	Axis 4
Eigenvalues	0.16	0.05	0.04	0.02
Species-environment correlations	0.95	0.97	0.83	0.85
Cumulative % variation of species data (%)	15.91	21.03	24.78	27.13
Cumulative % variation species-environment relations (%)	44.42	58.72	69.18	75.74
Sum of all eigenvalues				1.00
Sum of all canonical eigenvalues				0.36

附表 4 红皮云杉林群落分类简表

Appendix table 4 Synoptic table of *Picea koraiensis* Forest Alliance

附表 4a 群丛组分类简表

Appendix table 4a Synoptic table for association group

Association group number		I	II	III	IV	V
Number of plots	L	6	19	15	6	3
<i>Trigonotis radicans</i>	7	50	0	0	0	0
<i>Rubia sylvatica</i>	7	47	0	0	0	0
<i>Amphicarpaea edgeworthii</i>	7	47	0	0	0	0
<i>Galium dahuricum</i> var. <i>lasiocarpum</i>	7	34	0	0	0	0
<i>Deyeuxia purpurea</i>	7	0	62	0	0	0
<i>Larix gmelinii</i>	1	0	61	0	0	0
<i>Pyrola asarifolia</i> subsp. <i>incarnata</i>	7	0	57	0	0	0
<i>Betula fruticosa</i>	4	0	56	0	0	0
<i>Potentilla chinensis</i>	7	0	52	0	0	0
<i>Adenophora tetraphylla</i>	7	0	52	0	0	0
<i>Vaccinium vitis-idaea</i>	4	0	52	0	0	0
<i>Clematis sibirica</i> var. <i>ochotensis</i>	4	0	47	0	0	0
<i>Larix gmelinii</i>	4	0	47	0	0	0
<i>Pinus sylvestris</i> var. <i>mongolica</i>	1	0	47	0	0	0
<i>Vaccinium uliginosum</i>	4	0	47	0	0	0
<i>Sanguisorba officinalis</i>	7	0	47	0	0	0
<i>Rosa acicularis</i>	4	0	44	0	0	0
<i>Geranium erianthum</i>	7	0	42	0	0	0
<i>Geranium soboliferum</i>	7	0	42	0	0	0
<i>Hieracium umbellatum</i>	7	0	40	0	0	0
<i>Geranium maximowiczii</i>	7	0	38	0	0	0
<i>Trientalis europaea</i>	7	0	38	0	0	0
<i>Rubus saxatilis</i>	7	0	33	0	0	0
<i>Adenophora pereskiifolia</i>	7	0	31	0	0	0
<i>Convallaria majalis</i>	7	0	30	0	0	0
<i>Fragaria orientalis</i>	7	0	27	0	0	0
<i>Picea koraiensis</i>	4	0	27	0	0	0
<i>Fraxinus mandshurica</i>	1	0	0	69	0	0
<i>Acer pictum</i>	1	0	0	58	0	0
<i>Fraxinus mandshurica</i>	4	0	0	51	0	0
<i>Eleutherococcus senticosus</i>	4	0	0	48	0	0
<i>Aconitum umbrosum</i>	7	0	0	48	0	0
<i>Impatiens noli-tangere</i>	7	0	0	46	0	0
<i>Ulmus laciniata</i>	1	0	0	45	0	0
<i>Dryopteris crassirhizoma</i>	7	0	0	44	0	0
<i>Ulmus davidiana</i> var. <i>japonica</i>	1	0	0	44	0	0
<i>Philadelphus schrenkii</i>	4	0	0	44	0	0
<i>Adiantum pedatum</i>	7	0	0	42	0	0
<i>Aster scaber</i>	7	0	0	41	0	0
<i>Viburnum burejaeticum</i>	4	0	0	41	0	0
<i>Phryma leptostachya</i>	7	0	0	40	0	0
<i>Chrysosplenium sinicum</i>	7	0	0	39	0	0
<i>Juglans mandshurica</i>	1	0	0	39	0	0

<i>Acer tegmentosum</i>	4	0	0	36	0	0
<i>Enemionraddeanum</i>	7	0	0	35	0	0
<i>Acer tegmentosum</i>	1	0	0	33	0	0
<i>Acer ukurunduense</i>	1	0	0	32	0	0
<i>Euonymus macropterus</i>	4	0	0	32	0	0
<i>Tilia amurensis</i>	1	0	0	32	0	0
<i>Padus avium</i>	1	0	0	29	0	0
<i>Athyrium spinulosum</i>	7	0	0	27	0	0
<i>Filipendula glaberrima</i>	7	0	0	26	0	0
<i>Larix olgensis</i>	1	0	0	0	100	0
<i>Rubus sachalinensis</i>	4	0	0	0	67	0
<i>Equisetum ramosissimum</i>	7	0	0	0	62	0
<i>Ribes triste</i>	4	0	0	0	57	0
<i>Crataegus maximowiczii</i>	4	0	0	0	55	0
<i>Acer ukurunduense</i>	4	0	0	0	54	0
<i>Syringa villosa</i> subsp. <i>wolfii</i>	4	0	0	0	54	0
<i>Viola sacchalinensis</i>	7	0	0	0	54	0
<i>Bupleurum chinense</i>	7	0	0	0	54	0
<i>Larix olgensis</i>	4	0	0	0	54	0
<i>Dryopteris woodsii</i>	7	0	0	0	54	0
<i>Phegopteris connectilis</i>	7	0	0	0	50	0
<i>Mitella nuda</i>	7	0	0	0	48	0
<i>Sorbus pohuashanensis</i>	4	0	0	0	48	0
<i>Lonicera ruprechtiana</i>	4	0	0	0	47	0
<i>Pinus koraiensis</i>	4	0	0	0	44	0
<i>Tilia mandshurica</i>	4	0	0	0	44	0
<i>Ribes mandshuricum</i>	4	0	0	0	33	0
<i>Lonicera caerulea</i>	4	0	0	0	31	0
<i>Spiraea media</i>	4	0	14	0	0	69
<i>Ostericum maximowiczii</i>	7	0	0	0	0	56
<i>Pinus koraiensis</i>	1	41	0	34	0	0
<i>Saussurea neoserrata</i>	7	0	25	0	0	0

附表 4b 群丛分类简表

Appendix table 4b Synoptic table for association

Association group number	I	II	II	II	III	III	IV	V
Association number	1	2	3	4	5	6	7	8
Number of plots	L 6	8	6	5	7	8	6	3
<i>Amphicarpaea edgeworthii</i>	7	45	0	0	0	0	0	0
<i>Rubia sylvatica</i>	7	44	0	0	0	0	0	0
<i>Carex quadriflora</i>	7	0	59	0	0	0	0	0
<i>Potentilla flagellaris</i>	7	0	48	0	0	0	0	0
<i>Rubus chamaemorus</i>	7	0	48	0	0	0	0	0
<i>Fragaria orientalis</i>	7	0	42	0	0	0	0	0
<i>Trientalis europaea</i>	7	0	41	0	0	0	0	0
<i>Pyrola dahurica</i>	7	0	38	0	0	0	0	0
<i>Ribes nigrum</i>	4	0	33	0	0	0	0	0
<i>Thalictrum minus</i> var. <i>hypoleucum</i>	7	0	31	0	0	0	0	0
<i>Adenophora tetraphylla</i>	7	0	30	0	0	0	0	0
<i>Saussurea manshurica</i>	7	0	30	0	0	0	0	0

<i>Picea koraiensis</i>	4	0	28	0	0	0	0	0	0
<i>Hemerocallis middendorffii</i>	7	0	0	68	0	0	0	0	0
<i>Polygonatum humile</i>	7	0	0	60	0	0	0	0	0
<i>Geranium erianthum</i>	7	0	0	59	0	0	0	0	0
<i>Astilbe chinensis</i>	7	0	0	57	0	0	0	0	0
<i>Abies nephrolepis</i>	4	0	0	55	0	0	0	0	0
<i>Heracleum moellendorffii</i>	7	0	0	54	0	0	0	0	0
<i>Moehringialateriflora</i>	7	0	0	53	0	0	0	0	0
<i>Lathyrus komarovii</i>	7	0	0	52	0	0	0	0	0
<i>Stellaria radians</i>	7	0	0	52	0	0	0	0	0
<i>Poa nemoralis</i>	7	0	0	50	0	0	0	0	0
<i>Lonicera chrysantha</i>	4	0	0	46	0	0	0	0	0
<i>Carex pilosa</i>	7	0	0	45	0	0	0	0	0
<i>Thalictrum aquilegifolium</i> var. <i>sibiricum</i>	7	0	0	44	0	0	0	0	0
<i>Convallaria majalis</i>	7	0	0	43	0	0	0	0	0
<i>Spiraea salicifolia</i>	4	0	0	42	0	0	0	0	0
<i>Saussurea neoserrata</i>	7	0	0	39	0	0	0	0	0
<i>Sorbaria sorbifolia</i>	4	0	0	36	0	0	0	0	0
<i>Corylus mandshurica</i>	4	0	0	31	0	0	0	0	0
<i>Valeriana officinalis</i>	7	0	0	31	0	0	0	0	0
<i>Equisetum arvense</i>	7	0	0	30	0	0	0	0	0
<i>Pinus sylvestris</i> var. <i>mongolica</i>	1	0	0	0	100	0	0	0	0
<i>Hieracium umbellatum</i>	7	0	0	0	93	0	0	0	0
<i>Betula fruticosa</i>	4	0	0	0	88	0	0	0	0
<i>Larix gmelinii</i>	4	0	0	0	81	0	0	0	0
<i>Rhododendron dauricum</i>	4	0	0	0	75	0	0	0	0
<i>Potentilla chinensis</i>	7	0	0	0	75	0	0	0	0
<i>Saussurea odontolepis</i>	7	0	0	0	71	0	0	0	0
<i>Geranium soboliferum</i>	7	0	0	0	67	0	0	0	0
<i>Sanguisorba officinalis</i>	7	0	0	0	66	0	0	0	0
<i>Asparagus dauricus</i>	7	0	0	0	61	0	0	0	0
<i>Ribes procumbens</i>	4	0	0	0	61	0	0	0	0
<i>Angelica amurensis</i>	7	0	0	0	61	0	0	0	0
<i>Clematis sibirica</i> var. <i>ochotensis</i>	4	0	0	0	61	0	0	0	0
<i>Vaccinium uliginosum</i>	4	0	0	0	61	0	0	0	0
<i>Rubus saxatilis</i>	7	0	0	0	58	0	0	0	0
<i>Carex lanceolata</i>	7	0	0	0	55	0	0	0	0
<i>Adenophora pereskiiifolia</i>	7	0	25	0	52	0	0	0	0
<i>Pyrola asarifolia</i> subsp. <i>incarnata</i>	7	0	0	0	52	0	0	0	0
<i>Ligularia fischeri</i>	7	0	0	0	51	0	0	0	0
<i>Ledum palustre</i>	4	0	0	0	51	0	0	0	0
<i>Peucedanum terebinthaceum</i>	7	0	0	0	51	0	0	0	0
<i>Lathyrus vaniotii</i>	7	0	0	0	51	0	0	0	0
<i>Carex pediformis</i>	7	0	0	0	50	0	0	0	0
<i>Galium boreale</i>	7	0	0	0	46	0	0	0	0
<i>Bupleurum longiradiatum</i>	7	0	0	0	40	0	0	0	0
<i>Fraxinus mandshurica</i>	4	0	0	0	0	62	0	0	0
<i>Sambucus williamsii</i>	4	0	0	0	0	51	0	0	0
<i>Carex siderosticta</i> var. <i>pilosa</i>	7	0	0	0	0	51	0	0	0

<i>Ostericum maximowiczii</i>	7	0	0	0	0	0	0	0	49
<i>Trigonotis radicans</i>	7	39	0	39	0	0	0	0	0
<i>Pinus koraiensis</i>	1	35	0	0	0	0	35	0	0
<i>Galium dahuricum</i> var. <i>lasiocarpum</i>	7	30	0	43	0	0	0	0	0
<i>Vaccinium vitis-idaea</i>	4	0	40	0	57	0	0	0	0
<i>Deyeuxia purpurea</i>	7	0	37	34	0	0	0	0	0
<i>Rosa acicularis</i>	4	0	27	0	36	0	0	0	0
<i>Geranium maximowiczii</i>	7	0	26	0	57	0	0	0	0
<i>Pinus koraiensis</i>	4	0	0	47	0	0	0	33	0
<i>Abies nephrolepis</i>	1	0	0	30	0	0	30	0	0
<i>Spiraea media</i>	4	0	0	0	52	0	0	0	52
<i>Eleutherococcus senticosus</i>	4	0	0	0	0	47	28	0	0
<i>Acer pictum</i>	1	0	0	0	0	47	39	0	0
<i>Philadelphus schrenkii</i>	4	0	0	0	0	38	30	0	0
<i>Mitella nuda</i>	7	0	0	0	0	0	43	43	0
<i>Larix gmelinii</i>	1	0	38	38	38	0	0	0	0

表中数据为物种特征值(%)。物种按特征值(Φ)递减的顺序排列。 $\Phi \geq 0.25$ 和 $\Phi \geq 0.5$ ($P < 0.05$)的物种为特征种,其特征值分别标记浅灰色和深灰色。表中 L 列为物种所在的群落层号, 1 表示乔木层, 4 表示灌木层, 7 表示草本层。

The numbers in the table are fidelity values. Species are sorted and ranked by decreasing fidelity (phi coefficient) within each association. Light and dark grey background indicates fidelity of $\Phi \geq 0.20$ and $\Phi \geq 0.50$ ($P < 0.05$), respectively. These species are considered as diagnostic species. The column marked with L is the code of community vertical layer. 1: Tree stratum; 4: Shrub stratum; 7: Herb stratum.