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Some notes on forest ruderalisation

Poznámky o ruderalizaci lesních porostů

Hana Rambousková

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Forest monocultures near Prague, esp. spruce stands, are compared with forests of more or less natural species composition growing at the adjacent ecologically similar habitat. Ecological demands of shrub and herb layer species of these stands are judged on the basis of Ellenberg's indicator values. Spruce monocultures at unnatural habitats are presumed to encourage ruderalisation while natural forests at the same habitat have a certain buffer capacity balancing the penetration of ruderals to the stands.

Institute of Landscape Ecology, Czechoslovak Academy of Sciences, 170 00 Praha 7, Malá plynární 2, Czechoslovakia

INTRODUCTION

In the last decades our cultural forests of lowlands and even highlands have been floaded with *Sambucus nigra* L. or *S. racemosa* L. and other common ruderal species indicating increasing supply of nutrients esp. nitrogen in the soil. The impact of agriculture, changes in forest cultivation and recreation are the most frequent causes of this phenomenon.

Tüxen et Ellenberg (1947, cf. Hadač et Sofron 1980) were the first who stated that the main criteria of cultural forests are the artificial dominance of foreign tree species, the lability of the community and the absence of their characteristic species.

The cultural forest communities, however, even if not so common in our landscape, have not been given attention enough. There are still discrepancies in views of phytocoenologists whether to classify them at all, and if so how to classify them. Successful attempts have been done with the classification of *Robinia* communities and with some types of spruce and pine communities (Hadač et Sofron 1980, Kontriš et Jurko 1982).

METHODS

Relevés were taken by Braun-Blanquet's method using Domin's 11-grade scale modified by Hadač (cf. Hadač 1978).

Ellenberg's indicator values (Ellenberg 1974) were used for evaluation of the occurrence of species in shrub and herb layer in relation to relative light intensity (L), temperature (T), and nitrogen supply (N). In order to take into account the coverage of single species the total indices for L (I_L), T (I_T) resp. N (I_N) were calculated by summing partial multiples of coverage and appropriate indicator value and by dividing this sum by the number of species (the sign "+" was considered to be equal to 0.5; indifferent species were omitted).

Tab. 1. — Spruce monoculture (excepting 5) near Prague from places used for recreation

Relevé	1a	2a	2b	3a	3b	3c				
Exposition	—	NE	NNE	SE	SE	W	W	W	—	—
Slope (°)	0	15	15	3	0–1	3–5	3	0–2	0	0
Area (m^2)	150	150	150	200	150	200	200	200	150	200
Number of species	20	13	11	17	17	8	16	22	14	12
Coverage (%) E_3	70	80	75	75	80	75	75	85	85	70
E_2	75	60	60	70	65	20	80	30	40	80
E_1	40	15	50	95	75	45	70	45	75	70
E_0	3	10	15	5	3	—	3	—	—	—
E_3										
Carpinus betulus L.	.	.	.	.	.	.	.	3	.	.
Larix decidua MILL.	.	.	.	.	.	.	.	1	.	.
Picea excelsa (LAMK.) LK.	7	8	8	8	9	8	9	9	9	.
Pinus sylvestris L.	.	.	.	.	.	.	.	.	.	8
Quercus petraea (MATT.) LIEBL.	.	.	.	3	.	.	.	1	1	.
Sambucus nigra L.	.	.	.	6	.	.	3	.	.	.
Tilia cordata MILL.	.	.	.	.	.	.	3	1	.	.
E_2										
Acer platanoides L.	.	.	.	.	.	.	.	.	1	.
Acer pseudoplatanus L.	1	.	.	1	.	.	.	.	.	.
Betula pendula ROTH	.	.	.	.	.	.	.	.	1	.
Cerasus avium (L.) MOENCH.	.	.	1	.	.	.	.	.	.	.
Corylus avellana L.	.	.	.	.	.	.	.	.	1	.
Fagus sylvatica L.	.	.	.	.	.	.	.	1	.	.
Quercus robur L.	.	.	.	.	.	.	.	.	.	1
Ribes alpinum L.	.	2	.	1	.	.	.	.	.	.
Ribes grossularia L.	.	1	.	.	.	.	.	.	.	1
Rubus idaeus L.	.	1	3	.	.	.	.	3	3	.
Sambucus nigra L.	8	7	7	8	8	5	5	6	6	9
Sorbus aucuparia L.	.	3	4	.	.	1	3	3	4	.
Tilia cordata MILL.	.	.	.	.	.	.	1	4	.	.
E_1										
Acer pseudoplatanus L. (juv.)	3	1	.	1	.	.	.	.	.	.
Aegopodium podagraria L.	3	.	.	.	1	.	.	.	.	.
Anemone nemorosa L.	.	.	.	.	.	.	.	1	.	.
Arctium lappa L.	.	.	.	+	.	.	.	.	.	.
Avenella flexuosa (L.) DREJER	.	.	.	.	.	.	1	3	.	.
Calamagrostis villosa (CHAIX.) J. F. GMEL.	.	.	.	.	.	.	3	3	1	1
Carex sylvatica HUDS.	.	.	.	.	1	.	.	.	.	.
Carpinus betulus L. (juv.)	.	.	.	.	.	.	.	1	.	.
Dryopteris filix-mas SCHOTT	1	1	2	1	.	1	2	.	.	.
Epilobium angustifolium L.	.	+	1	.	.	7	.	.	3	1
Galium aparine L.	.	.	.	3	.	.	.	.	.	.
Galium sylvaticum L.	1	.	.	.	.	.	.	.	.	.
Geranium robertianum L.	3	.	.	1	.	.	.	.	.	.
Geum urbanum L.	.	.	.	.	1	.	.	.	.	.
Glechoma hederacea L.	.	.	.	.	1	.	.	.	.	.
Hieracium sylvaticum (L.) L.	.	.	.	.	.	.	1	.	.	1
Hypericum perforatum L.	.	.	.	.	.	.	1	.	.	.
Impatiens parviflora DC.	2	3	3	7	7	5	.	3	.	6
Lamium luteum HUDS.	4	.	.	.	.	.	.	.	.	.
Lathyrus niger BERNH.	.	.	.	.	1	.	.	.	.	.
Lysimachia nummularia L.	.	.	.	.	1	.	.	.	.	.
Maianthemum bifolium (L.) F. W. SCHMIDT	.	.	.	.	.	.	.	1	.	.
Moehringia trinervia (L.) CLAIRV.	3	1	.	3	1	1	1	2	.	3
Mycelis muralis (L.) DUM.	2	.	.	.	.	.	2	1	.	.
Oxalis acetosella L.	5	.	.	1	6	.	3	4	3	.
Poa nemoralis L.	.	.	.	3	.	.	1	1	.	.

Tab. 1. — Continued

Prenanthes purpurea L.	2	.	.	.	.	.	.	.	.	.
Quercus petraea (MATT.) LIEBL. (juv.)	.	.	.	.	.	.	.	1	1	.
Quercus robur L. (juv.)	.	.	.	.	.	.	.	.	.	1
Ranunculus repens L.	3	.	.	.	.	.	.	.	.	.
Ribes alpinum L.	.	.	.	.	1	.	.	.	1	.
Rosa sp. L.	.	+	1	.	.	.	1	.	.	1
Rubus fruticosus agg.	3	.	.	3	.	3	8	7	7	7
Rubus idaeus L.	.	2	2	.	2	.	.	2	3	.
Sambucus nigra L. (juv.)	3	3	1	4	4	4	3	3	3	3
Senecio nemorensis L.	.	1	7	.	.	.	.	3	.	.
Silene dioica (L.) CLAIRV.	2	.	.	.	.	.	.	.	.	.
Sorbus aucuparia L. (juv.)	3	.	1	.	+	1	3	3	1	.
Stachys sylvatica L.	1	.	.	1	.	.	.	.	.	.
Urtica dioica L.	2	.	.	6	1	.	.	.	3	3
Vaccinium myrtillus L.	.	.	.	.	.	.	.	1	1	.
Veronica hederifolia L.	.	.	.	5	.	.	.	.	.	.
Viola sylvestris LAMK.	4	.	1	.	3	.	.	1	.	.

Mean values:	E_2	E_1
I_L	25.2	11.9
I_T	20.9	11.7
I_N	42.3	16.5

Localities:

1a — the Kokořín Valley, near Kokořín, N. of Prague, the camping site, 5. 8. 1980
2a, 2b — the Drahäň Valley, Prague, 20. 5. 1981
3a, 3b, 3c — the Krč Forest, Prague, 28. 5. 1981
4a, 4b, 4c — the Říčany Forest, 2. 6. 1981
5a — the forest Borky between Stratov and Ostrá, E. of Prague, 12. 6. 1981

I_L — the total index for light intensity
I_T — the total index for temperature
I_N — the total index for nitrogen supply

RESULTS AND DISCUSSION

Relevés in cultural forests (mostly spruce monocultures) near Prague (the Kokořín Valley, the Drahäň Valley, the Říčany Forest, the Krč Forest, the forest Borky between Stratov and Ostrá) were taken (Tab. 1) and compared with these of more or less natural species composition at the same localities (Tab. 2).

The layer in cultural coniferous forests is dominated by spruce resp. pine (Tab. 1 — relevé 5). The most frequent species in shrub layer (in 50 %relevés or more) are *Sambucus nigra* L. and *Sorbus aucuparia* L. In herb layer the most widespread species are *Sambucus nigra* L. juv., *Impatiens parviflora* DC., *Moehringia trinervia* (L.) CLAIRV., *Rubus fruticosus* agg., *Sorbus aucuparia* L. (juv.), *Dryopteris filix-mas* SCHOTT, *Oxalis acetosella* L., *Epilobium angustifolium* L., *Rubus idaeus* L., *Urtica dioica* L. i.e. especially synanthropophytes or species characteristic of a contact of spruce and beech forests (*Oxalis acetosella* L.) or of forest clearings (*Epilobium angustifolium* L., *Rubus idaeus* L.) the penetration of which is a result of a poor quality of tree stand. The rest of the species in shrub and herb layers belong to the natural composition of grove communities (al. *Carpinion betuli* (MAYER 1937) OBERDORFER 1953, *Luzulo-Fagion* LOHMEYER et TX. in TX. 1954, *Quercion robori-petraeae* BR.-BL. 1932).

Tab. 2. — Grove communities near Prague from places used for recreation

Relevé	1b	2c	2d	3d	3e	3f	3g	4d
Exposition	NNE	NE	N	—	—	—	—	W
Slope (°)	10	10	15–20	0	0	0	0	3
Area (m²)	100	150	150	200	150	150	200	200
Number of species	20	15	17	11	12	10	19	17
Coverage (%) E_3	60	40 (75)	40 (75)	75 (85)	60 (70)	50 (75)	60	80
							(with fulldeveloped leaves)	
E_2	0	45	5	3	2	0	0	15
E_1	85	40	90	80	20	65	55	85
E_0	0	0	0	0	0	0	0	0
E_3								
Betula pendula ROTH.	.	.	.	.	.	.	.	3
Carpinus betulus L.	7	.	.	3	.	.	1	1
Fagus sylvatica L.	.	.	.	.	.	.	.	1
Pinus nigra ARNOLD	.	.	1	.	.	.	.	.
Pinus sylvestris L.	.	.	.	.	.	.	5	3
Quercus petraea (MATT.) LIEBL.	3	7	6	8	8	7	7	8
Sorbus aucuparia L.	.	.	.	.	.	.	.	3
E_2								
Acer pseudoplatanus L.	.	2	.	.	.	.	.	.
Cerasus avium (L.) MOENCH.	.	3	.	.	.	.	.	.
Picea excelsa (LAMK.) LK.	.	.	.	.	.	.	.	1
Quercus petraea (MATT.) LIEBL.	.	.	.	.	3	.	.	.
Ribes grossularia L.	.	1	2	.	.	.	.	.
Rosa sp. L.	.	.	1	.	.	.	.	.
Rubus idaeus L.	.	6	.	.	.	.	.	.
Sambucus nigra L.	.	3	1	.	.	.	.	.
Sorbus aucuparia L.	.	5	.	.	.	.	.	4
Tilia cordata MILL.	.	.	.	1	.	.	.	.
E_1								
Acer platanoides L. (juv.)	.	1	.	.	.	.	.	.
Acer pseudoplatanus L. (juv.)	2	.	.	.	.	.	.	.
Anemone nemorosa L.	.	.	.	4	.	.	1	4
Anthriscus sylvestris (L.) HOFFM.	.	.	1	.	.	.	.	.
Avenella flexuosa (L.) DREJER	.	.	.	.	5	1	.	.
Campanula rapunculoides L.	.	.	1	.	.	.	.	.
Carex pilulifera L.	.	.	.	.	4	.	.	.
Carpinus betulus L. (juv.)	.	.	.	.	.	.	1	.
Cerasus avium (L.) MOENCH. (juv.)	.	2	1	.	.	.	.	.
Chaerophyllum temulum L.	.	.	3	.	.	.	.	.
Convallaria majalis L.	3	.	.	.	.	.	.	.
Dryopteris filix-mas SCHOTT	2	.	3	.	.	.	.	3
Epilobium angustifolium L.	.	3	.	1	.	.	.	.
Fagopyrum convolvulus GROSS	.	.	.	.	.	3	.	.
Festuca ovina L.	.	.	.	1	4	.	.	.
Fragaria vesca L.	.	2	.	.	.	.	2	.
Galium aparine L.	.	.	.	.	.	1	.	.
Galeopsis tetrahit L.	2	.	.	.	.	.	.	.
Geranium robertianum L.	.	.	1	.	.	.	.	.
Geum urbanum L.	.	.	1	.	.	.	1	.
Hedera helix L.	1	.	.	.	.	.	.	.
Hieracium sylvaticum (L.) L.	.	3	3	3	3	.	1	1
Hypericum perforatum L.	.	.	.	.	1	.	.	.
Impariens parviflora DC.	.	4	4	1	+	7	6	.
Lamium luteum HUDS.	7	.	4	.	.	.	.	.
Luzula campestris (L.) DC.	.	.	.	.	1	.	.	.
Luzula nemorosa (POLL.) E. MEY.	3	.	.	.	3	1	1	1

Luzula pilosa (L.) WILLD.	2	.	.	.	.	.	.	1
Melica nutans L.	1	.	.	.	.	.	.	.
Milium effusum L.	4	.	.	.	.	.	.	.
Moehringia trinervia (L.) CLAIRV.	1	2	3	.	.	1	2	.
Oxalis acetosella L.	5	.	.	.	.	.	.	3
Poa compressa L.	1	.	.	.	.	.	.	.
Poa nemoralis L.	.	4	8	8	3	7	7	1
Polygonatum multiflorum (L.) ALL.	2	.	.	.	.	.	.	.
Prenanthes purpurea L.	3	.	.	.	.	.	.	.
Quercus petraea (MATT.) LIEBL. (juv.)	.	.	.	.	3	.	4	.
Rosa sp. L.	.	+	1	.	.	.	1	.
Rubus fruticosus agg.	.	.	.	1	.	.	3	8
Rubus idaeus L.	3	3	.	.	.	.	1	.
Sambucus nigra L. (juv.)	.	1	.	.	.	1	.	.
Scrophularia nodosa L.	.	.	.	.	.	3	1	.
Senecio nemorensis L.	.	.	.	.	.	.	.	1
Sorbus aucuparia L.	.	3	.	.	.	.	1	3
Stellaria holostea L.	3	.	.	3	.	.	.	.
Vaccinium myrtillus L.	.	.	.	.	+	.	.	1
Veronica chamaedrys L.	.	.	.	.	.	.	3	.
Veronica officinalis L.	.	.	.	.	1	.	1	.
Viola sylvestris LAMK.	3	.	.	.	.	.	1	.

Mean values:	E_2	E_1
I_L	7.9	11.2
I_T	5.7	11.1
I_N	6.3	12.6

(For explanation see Tab. 1)

Localities:

1b — the Kokořín Valley, near Kokořín, N. of Prague, the camping site, 5. 8. 1980
2c, 2d — the Draháň Valley, Prague, 20. 5. 1981
3d, 3e, 3f, 3g — the Krč Forest, Prague, 28. 5. 1981
4d — the Říčany Forest, E. of Prague, 2. 6. 1981

VĚTVIČKA (1978) having studied the structure and ecology of *Sambucus* sp. and having observed the number of contacts of *Sambucus nigra* L. with other plant species found the most frequent contacts with *Urtica dioica* L., *Impatiens parviflora* DC., *Mycelis muralis* (L.) DUM., *Geum urbanum* L., *Anthriscus sylvestris* (L.) HOFFM., *Chelidonium majus* L. and *Rubus idaeus* L. The most of these species occur in the above mentioned relevés as well.

In the parts of forest with grove character (Tab. 2) the prevailing species in tree layer are *Quercus petraea* (MATT.) LIEBL. and *Carpinus betulus* L., in shrub layer (which was generally not so dense compared with shrub layer in spruce forest) there is no specific dominant, in herb layer the most frequent species are *Poa nemoralis* L., *Hieracium sylvaticum* (L.) L., *Impatiens parviflora* DC., *Luzula nemorosa* (POLL.) E. MEY., *Moehringia trinervia* (L.) CLAIRV., i.e., with the exception of *Impatiens parviflora* DC., the species typical of poor grove communities of *Carpinion betuli* (MAYER 1937) OBERDORFER 1953 or *Quercion robori-petraeae* BR.-BL. 1932. The same concerns the remaining species or they are characteristic for the whole class *Querco-Fagetea* BR.-BL. et VLIEGER in VLIEGER 1937.

Comparing the indices for species occurrence in their relation to relative light intensity, temperature and ammonia or nitrate supply (tab. 1, 2) convincing and evident differences in I_L and I_T are not found in herb layer. There seems to be a slight difference in I_N. In spruce forest the indices indicate a higher mineral nitrogen supply than in deciduous forest.

As for shrub layer there are clearcut differences in all three observed indices. I_L and I_T are lower in a grove community, which means that shrub and herb layers have less light or temperature incomes there. The number of species indicating high nitrogen supply is lower as well.

Denaeyer-De Smet et Duvigneaud (1977) comparing the distribution of biogen macroelements into single above-ground organs of plant body in two forest ecosystems (one dominated by beech and the other by spruce) show that the total concentration of mineral nitrogen in *Piceetum* is roughly half the concentration in *Fagetum*. In my opinion the situation is similar to that with Ca, K and consumption when deciduous forest always consumed more than coniferous one (Rennie 1957 cf. Hadač 1977).

Introduction of spruce monocultures at unnatural habitats seems to be one of the keys to the solution of reasons why *Sambucus nigra* L. and other nitrophilous species have become such intruders into these forests. They can use nitrogen oversupply that is not used by a dominant spruce. On the other hand, the presence of spruce and resulting acid humus create unsuitable conditions for establishment and growth of original plant species but encourage ruderalisation of these forests and destruction of the biotope diversity. At the top of that, the economic effect these forests bring is doubtful, for wood production is low and these forests incline easily to insect calamities and wood diseases. From the point of view of recreation they are practically valueless, not only because of their aesthetic appearance, but walking through such a forest is not pleasant as well.

Of course the forest ruderalisation is not only the result of planting spruce monocultures. Ever-increasing amounts of fertilizers used in agriculture and the change in forest cultivation (using heavy mechanisation hurting the soil surface and leaving a lot of branches and second-hand wood at the spot in forest) are to blame. Particularly nitrate fertilizers applied in enormous amounts are washed off and fertilize our forests instead of bringing a supposed effect in a yield increase.

We can conclude that most spruce forests on unnatural habitats encourage the establishment and spreading of *Sambucus nigra* L. and other accompanying ruderal species. It seems that natural forests on the same habitat have a certain buffer capacity balancing the penetration of synanthrophyta to the stand.

This experience could be applied in forest cultivation. Even if coniferous and esp. spruce forests have been preferred up to now (because of economic reasons and poor experience with deciduous tree cultivation) the establishment of forest margins formed by deciduous trees (in our landscape mainly oak, hornbeam, lime) could serve well as a filter for catching superfluous nutrients from fields. These margins occur in some parts of our country playing mainly protective role against wind. Their filter function however cannot be neglected. It helps to increase both economic and aesthetical value of the forest itself, and that of the forest as a landscape element.

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SUMMARY

The article deals with some causes of forest ruderalisation, a common phenomenon of spruce monocultures introduced at unnatural habitats.

Spruce monocultures are compared with parts of forest at the adjacent ecologically similar habitat having more or less natural species composition. The given examples are taken from the close neighbourhood of Prague. The main causes of ruderalisation are suggested to be an introduction of unnatural species composition at the habitat, changes in forest cultivation, the impact of agriculture (i.e. an increasing application of fertilizers). Spruce is supposed not to use growing amounts of nitrogen in soil and this fact together with a negative influence of spruce on soil quality encourage the spreading of ruderals (esp. *Sambucus nigra* L.). Forests with natural species composition are supposed to have a certain buffer capacity preventing ruderals from penetrating to the stand.

SOUHRN

Článek se zabývá příčinami ruderalizace lesních porostů, tj. běžným jevem ve smrkových monokulturách, zavedených na nepřirozených stanovištích. Smrkové monokultury jsou srovnávány s částmi porostů o víceméně přirozeném druhovém složení na blízkých, ekologicky podobných stanovištích v okolí Prahy. Za hlavní příčiny ruderalizace se považuje introdukce druhů na stanovišti nepřirozených, změny v lesním hospodářství a vliv zemědělství (např. vzrůstající používání hnojiv). Je nutno předpokládat, že šíření ruderálních druhů (zvl. *Sambucus nigra* L.) je umožněno tím, že smrk nevyužívá zvýšeného množství dusíku v půdě a navíc negativně ovlivňuje kvalitu půdy. Lesy s přirozeným druhovým složením zřejmě mají určitou pufrační kapacitu, která zabraňuje ruderálním druhům pronikat na stanoviště.

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