# SPECIES SPECTRUM OF VEGETATION ON SELECTED SECTIONS OF RAILWAY

**CERVENKOVA JANA, WINKLER JAN**
Department of Plant Biology
Mendel University in Brno
Zemedelska 1, 613 00 Brno
CZECH REPUBLIC

xcerven3@node.mendelu.cz

*Abstract:* This paper focuses on the evaluation of weed species composition on the selected railway sections between the cities Chrudim and Úhřetice. Weed species spectrum was evaluated according to phytocoenology relevé. Eleven phytocoenology relevé were carried out in two periods, the first in July and the second in August 2013. The obtained data were processed by multivariate analysis of ecological data, segment analysis DCA (Detrended Correspondence Analysis) and Canonical Correspondence Analysis (CCA). 85 species of plants were found on the railway. The highest coverage had species as: *Potentilla reptans*, *Urtica dioica*, *Equisetum arvense*, *Convolvulus arvensis*. The highest coverage on utilized railway had species *Equisetum arvense*, *Urtica dioica*, *Potentilla reptans*, *Convolvulus arvensis*. Species as *Potentilla reptans*, *Clematis vitalba*, *Linaria vulgaris*, *Senecio vulgaris*, *Geum urbanum* had the highest coverage on unused railway.

*Key Words:* weeds, railway, phytocoenology relevé

## INTRODUCTION

Czech and Slovak Republic are countries with a dense railway network, which is used for personal transport as well as for domestic and transit freight. Generally speaking, the largest number of expansive weeds is found in large railway spots (Jehlík 1998). Due to the problems that may be caused by the presence of weeds in the rail bed, it is necessary to remove weeds from railways (Schweinsberg et al. 1999). Railway lines are sites that provide less favorable conditions for the vegetation growth. However, certain species meet these conditions, such as mugwort, quinoa and many others (Dvořák, Smutný 2008). Foreign weeds, spreading by rail and shipping transport with various commodities (grain, agricultural products etc.), are another problem. *Ambrosia artemisiifolia* belongs between these species, which already had domesticated and are very dangerous for agricultural land. The problem with the introduction of invasive weeds is significant and growing (Mikulka, Kneifelova 2005). Too high vegetation impairs visibility during transport. Weeds make more difficult moving for trains and increase workplace hazards. Growing weed in the tracks prevents visual check of railway. These all influences increase risk of accident. It can also cause disturbances of signalling safety devices. In addition, some weeds grow through the insulating film and reduce their effectiveness (Dvořák, Smutný 2008). According to Jehlík (1998) habitat conditions of railway lands are very specific. The chemistry of rail soils is affected by brown coal, which often has fertilizing effect. Three major types of soils can be distinguished on the rail body by mechanical and chemical composition. These are cinder soils, which are composed from almost pure cinder, soils with a predominance of sand and soils. Soils are affected by the use of total herbicides against weeds. Herbicides on railways are used in order to maintain the quality of the track and safe working environment for railway employees (Torstensson 2001).

The aim of this work was to evaluate the species composition of growing vegetation on the selected railway sections and compare the differences in species spectrum on sections of utilized and unused railway.

## MATERIAL AND METHODS

### Characteristics of the area

Section Chrudim-Úhřetice on the line Chrudim-Borohrádek was selected for mapping. The length of the monitored section is approximately 7 km. The climate of monitored area is within the Czech Republic possible characterized as exceptionally warm with average total precipitation. The average temperature is 7°C in the city. July belongs between the warmest month and has an average temperature 17.5°C. City belongs to areas with high groundwater reserves and is situated at an altitude of 243–300 meters asl.

The total length of the line is 36 km, run by the Railway Infrastructure Administration. The maximum inclination is 17 ‰, the maximum speed in the section Chrudim-Hrochův Týnec reaches 45 $km.h^{-1}$ and in the section Hrochův Týnec-Borohrádek 60 $km.h^{-1}$. Chrudim-Borohrádek railway line connects Chrudim, Moravany, Holice and Borohrádek. The line was put into operation on September 26, 1899.

### Methodology of evaluation

Eleven different stations spaced along the line were chosen for observation. Weeds were evaluated by using the phytocoenology relevé with the size 12 $m^2$. On a selected section of the railway is also part which is no longer used. Relevé were conducted at different sites such as: in the track, on embankment, next to the embankment. Observations took place in two periods, the first week in July and the second half of August 2013. Species composition of weeds and coverage were evaluated. Coverage was determined using the Braun-Blanquet scale (Moravec et al. 1994):

r – rarely (sometimes used symbol -)

+ – coverage is negligible, scattered

1 – cover of less than 5%, widely scattered

2 – coverage of from 5 to 25%

3 – coverage of 25 to 50%

4 – coverage of 50 to 75%

5 – coverage of 50 to 75%.

The obtained data was processed in Excel. Czech and Latin names of each weed species were used according to Kubát (2002).

The obtained data were processed by multivariate analysis of ecological data segment analysis DCA (Detrended Correspondence Analysis) and canonical correspondence analysis CCA. A total number of 499 permutations were calculated in Monte-Carlo test. Collected data were processed by a computer program called Canoco 4.0 (Ter Braak 1998).

## RESULTS AND DISCUSSION

A total of 85 plant species belonging to 33 plant families occurred in the monitored area. The average coverage is given in Table 1.

The obtained data about evaluation of weed infestation were initially processed by the DCA analysis which determined the length of the gradient, and it was 5.517. Based on this calculation for further processing was selected canonical correspondence analysis CCA. Analysis CCA defines the spatial arrangement of plant species and selected environmental factors. This is subsequently graphically expressed by the ordination diagram. Weed species and monitored factors are shown by points of different shape and color.

Influence railway use on the occurrence of weeds was according to the CCA analysis significant at the significance level $\alpha = 0.004$ for all canonical axes. The results are statistically highly significant. According to the ordination diagram (see Figure 1) plant species can be divided into three groups.

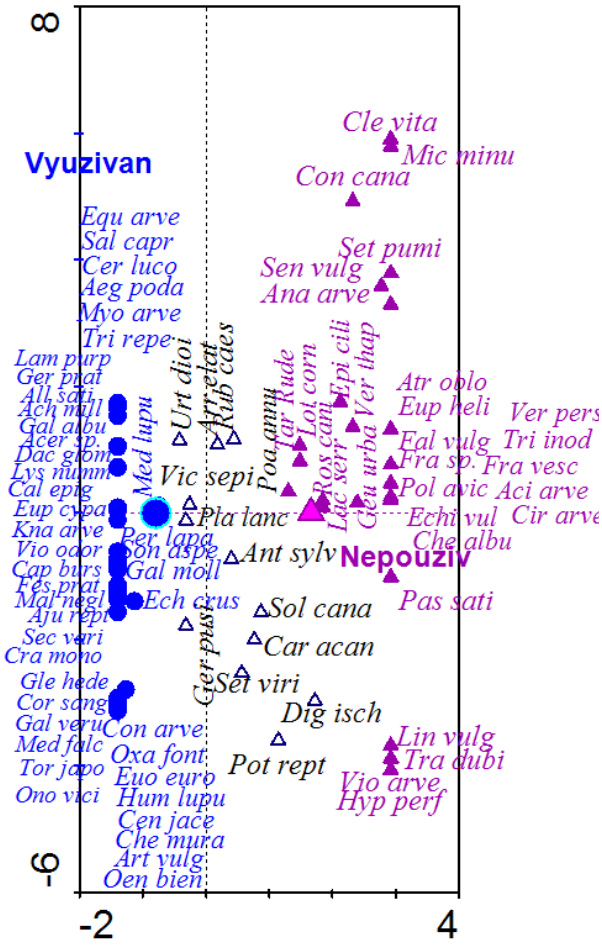
*Table 1 The average coverage of identified weed species (% coverage)*

| Species of plant | Type of railway and term of evaluation | | | |
|---|---|---|---|---|
| | Utilized | | Unused | |
| | July | August | July | August |
| *Acer sp.* | 0.09 | 0.14 | | |
| *Acinos arvensis* | | | | 0.13 |
| *Aegopodium podagraria* | 2.21 | 0.36 | | |
| *Achillea millefolium* | 0.14 | 0.09 | | |
| *Ajuga reptans* | 0.01 | | | |
| *Allium sativum* | 0.07 | | | |
| *Anagallis arvensis* | | | 0.05 | 0.05 |
| *Anthriscus sylvestris* | 0.03 | 0.07 | | 0.13 |
| *Arrhenatherum elatius* | 0.79 | 0.09 | 0.75 | 0.13 |
| *Artemisia vulgaris* | | 0.01 | | |
| *Atriplex oblongifolia* | | | 0.13 | |
| *Calamagrostis epigejos* | 2.86 | 0.73 | | |
| *Capsella bursa-pastoris* | | 0.01 | | |
| *Carduus acanthoides* | 0.01 | 0.01 | 0.03 | 0.03 |
| *Centaurea jacea* | 0.07 | | | |
| *Cerastium lucorum* | 0.07 | | | |
| *Cirsium arvense* | | | | 0.63 |
| *Clematis vitalba* | | | 3.78 | 3.78 |
| *Convolvulus arvensis* | 2.23 | 2.29 | 0.13 | 0.13 |
| *Conyza canadensis* | | 0.07 | 0.13 | 0.65 |
| *Cornus sanguinea* | 0.01 | 0.01 | | |
| *Crataegus monogyna* | 0.01 | 0.01 | | |
| *Dactylis glomerata* | 0.43 | 0.09 | | |
| *Digitaria ischaemum* | | 0.14 | | 0.65 |
| *Echinochloa crus-galli* | | 0.50 | | |
| *Echium vulgare* | | | 0.03 | 0.63 |
| *Epilobium ciliatum* | | 0.07 | 0.28 | 0.28 |
| *Equisetum arvense* | 5.66 | 5.36 | | |
| *Euonymus europaea* | 0.09 | 0.37 | | |
| *Euphorbia cyparissias* | 0.07 | 0.36 | | |
| *Euphorbia helioscopia* | | | 0.03 | |
| *Falcaria vulgaris* | | | 0.13 | 0.13 |
| *Festuca pratensis* | 0.07 | | | |
| *Fragaria vesca* | | | 0.13 | 0.13 |
| *Fraxinus sp.* | | | 0.13 | 0.13 |
| *Galium album* | 0.01 | 0.01 | | |
| *Galium mollugo* | 0.50 | 2.57 | | |
| *Galium verum* | 0.01 | 0.01 | | |
| *Geranium pratense* | 0.01 | 0.09 | | |
| *Geranium pusillum* | 0.01 | 0.07 | 0.03 | 0.03 |
| *Geum urbanum* | 0.09 | 0.01 | 0.63 | 0.63 |
| *Glechoma hederacea* | 0.01 | | | |
| *Humulus lupulus* | | 0.07 | | |
| *Hypericum perforatum* | | | 0.13 | 0.13 |
| *Chenopodium album* | | | | 0.03 |
| *Chenopodium murale* | 0.01 | 0.01 | | |
| *Knautia arvensis* | 0.07 | | | |

| | | | | |
|---|---|---|---|---|
| *Lactuca serriola* | 0.07 | 0.07 | 0.63 | 0.13 |
| *Lamium purpureum* | 0.01 | | | |
| *Linaria vulgaris* | | | 0.63 | 0.75 |
| *Lotus corniculatus* | 0.36 | | 0.63 | 0.63 |
| *Lysimachia nummularia* | 0.09 | | | |
| *Malva neglecta* | 0.07 | | | |
| *Medicago falcata* | 0.01 | 0.07 | | |
| *Medicago lupulina* | 0.50 | 0.16 | 0.15 | 0.05 |
| *Microrrhinum minus* | | | 0.03 | |
| *Myosotis arvensis* | 0.07 | | | |
| *Oenothera biennis* | 0.36 | 0.36 | | |
| *Onobrychis viciifolia* | 0.07 | 0.07 | | |
| *Oxalis fontana* | | 0.07 | | |
| *Pastinaca sativa* | | | 0.03 | 0.15 |
| *Persicaria lapathifolia* | 0.01 | 0.07 | | |
| *Plantago lanceolata* | 0.01 | 0.03 | | 0.03 |
| *Poa annua* | 0.01 | 0.03 | 0.13 | |
| *Polygonum aviculare* | | | 0.03 | 0.63 |
| *Potentilla reptans* | 2.50 | 2.50 | 3.75 | 8.75 |
| *Rosa canina* | 0.01 | 0.01 | 0.03 | 0.13 |
| *Rubus caesius* | 0.17 | 0.16 | 0.25 | 0.18 |
| *Salix caprea* | 0.07 | | | |
| *Securigera varia* | 0.07 | 0.07 | | |
| *Senecio vulgaris* | 0.03 | | 0.75 | 0.63 |
| *Setaria pumila* | | | 0.15 | 0.25 |
| *Setaria viridis* | 0.01 | 0.07 | | 0.13 |
| *Solidago canadensis* | 0.39 | 0.16 | 0.78 | 0.28 |
| *Sonchus asper* | 0.07 | 0.14 | | 0.03 |
| *Taraxacum sect. Ruderalia* | 0.10 | 0.16 | 0.70 | 0.20 |
| *Torilis japonica* | 0.07 | 0.07 | | |
| *Tragopogon dubius* | | | 0.13 | 0.03 |
| *Trifolium repens* | 2.14 | 0.36 | | |
| *Tripleurospermum inodorum* | | | 0.03 | 0.03 |
| *Urtica dioica* | 5.71 | 2.86 | 0.63 | 3.75 |
| *Verbascum thapsus* | 0.07 | | 0.38 | 0.40 |
| *Veronica persica* | | | 0.03 | 0.03 |
| *Vicia sepium* | 0.03 | 0.17 | | 0.13 |
| *Viola arvensis* | | | 0.13 | 0.03 |
| *Viola odorata* | 0.07 | 0.07 | | |

The first group of weed species occurred mainly on utilized sections of railway: *Acer* sp., *Aegopodium podagraria*, *Achillea millefolium*, *Ajuga reptans*, *Allium sativum*, *Artemisia vulgaris*, *Calamagrostis epigejos*, *Capsella bursa–pastoris*, *Centaurea jacea*, *Cerastium lucorum*, *Convolvulus arvensis*, *Cornus sanguinea*, *Crataegus monogyna*, *Dactylis glomerata*, *Echinochloa crus–galli*, *Eounymus europaea*, *Equisetum arvense*, *Euphorbia cyparissias*, *Festuca pratensis*, *Galium album*, *Galium mollugo*, *Galium verum*, *Geranium pratense*, *Glechoma hederacea*, *Humulus lumulus*, *Chenopodium murale*, *Knautia arvensis*, *Lamiun purpureum*, *Lysimachia nummularia*, *Malva neglecta*, *Medicago falcata*, *Medicago lupulina*, *Myosotis arvensis*, *Oenothera biennis*, *Onobrychis viciifolia*, *Oxalis fontana*, *Persicaria lapathifolia*, *Salix caprea*, *Securigera varia*, *Sonchus asper*, *Torilis japonica*, *Trifolium repens*, *Viola odorata*.

*Figure 1 Ordination diagram expressing the relation between weeds and use of railway*




*Legend: Vyuzivan – utilized railway; Nepouziv – unused railway*

*Acer* sp. – *Acer* sp., *Aci arve – Acinos arvensis*, *Aeg poda – Aegopodium podagraria*, *Ach mille – Achillea millefolium*, *Aju rept – Ajuga reptans*, *All sati – Allium sativum*, *Ana arve – Anagalis arvensis*, *Ant sylv – Anthriscus sylvestris*, *Arr elat – Arrhenatherum elatius, Art vulg – Artemisia vulgaris*, *Atr oblo – Atriplex oblongifolia*, *Cal epig – Calamagrostis epigejos*, *Cap burs – Capsella bursa-pastoris*, *Car acan – Carduus acanthoides*, *Cen jace – Centaurea jacea*, *Cer luco – Cerastium lucorum*, *Cir arve – Cirsium arvense*, *Cle vita – Clematis vitalba*, *Con arve – Convolvulus arvensis*, *Con cana – Conyza canadensis*, *Cor sang – Cornus sanguinea*, *Cra mono – Crataegus monogyna, Dac glom – Dactylis glomerata*, *Dig isch – Digitaria ischaemum*, *Ech crus – Echinochloa crus–galli*, *Echi vulg – Echium vulgare*, *Epi cili – Epilobium ciliatum*, *Equ arve – Equisetum arvense*, *Euo euro – Euonymus europaea, Eup cypa – Euphorbia cyparissias, Eup heli – Euphorbia helioscopia, Fal vulg – Falcaria vulgaris, Fes prat – Festuca pratensis, Fra sp. – Fraxinus sp., Fra vesc – Fragaria vesca, Gal albu – Galium album, Gal moll – Galium mollugo, Gal veru – Galium verum, Ger prat – Geranium pratense, Ger pusi – Geranium pussilum, Geu urba – Geum urbanum, Gle hede – Glechoma hederacea, Hum lupu – Humulus lulupus, Hyp perf – Hypericum perforatum, Che albu – Chenopodium album, Che mura – Chenopodium murale, Kna arve – Knautia arve, Lac serr – Lactuca serriola, Lam purp – Lamium purpureum, Lin vulg – Linaria vulgaris, Lot corn – Lotus corniculatus, Lys numm – Lysimachia nummularia, Mal negl – Malva neglecta, Med falc – Medicago falcata, Med lupu – Medicago lupulina, Mic minu – Microrrhinum minus, Myo arve – Myototis arvensis, Oen bien – Oenothera biennis, Ono vici – Onobrychis viciifolia, Oxa font – Oxalis fontana, Pas sati – Pastinaca sativa, Per lapa – Persicaria lapathifolia, Pla lanc – Plantago lanceolata, Poa annu – Poa annua, Pol avic – Polygonum aviculare, Pot rept – Potentilla reptans, Ros cani – Rosa canina, Rub caes – Rubus caesius, Sal capr – Salix caprea, Sec vari – Securigera varia, Sen vulg – Senecio vulgaris, Set pumi – Setaria pumila, Set viri – Setaria viridis, Sol cana – Solidago canadensis, Son aspe – Sonchus asper, Tar Rude – Taraxacum sect. Ruderalia, Tor japo – Torilis japonica, Tra dubi – Tragopogon dubius, Tri inod – Tripleurospermum inodorum, Tri repe – Trifolium repens, Urt dioi – Urtica dioica, Ver pers – Veronica persica, Ver thap – Verbascum thapsus, Vic sepi – Vicia sepium, Vio arve – Viola arvensis, Vio odor – Viola odorata*

The second group of weed species were found mainly on unused sections of railway: *Acinos arvensis*, *Anagallis arvensis*, *Atriplex oblongifolia*, *Cirsium arvense*, *Clematis vitalba*, *Conyza canadensis*, *Echium vulgare*, *Epilobium ciliatum*, *Euphorbia helioscopia*, *Falcaria vulgaris*, *Fragaria vesca*, *Fraxinus* sp., *Geum urbanum*, *Chenopodium album*, *Lactuca serriola*, *Lotus corniculatus*, *Microrrhinum minus*, *Pastinaca sativa*, *Polygonum aviculare*, *Rosa canina*, *Senecio vulgaris*, *Setaria pumila*, *Taraxacum* sect. *Ruderalia*, *Tripleurospermum inodorum*, *Verbascum thapsus*, *Veronica persica*.

The third group was more influenced by other factors: *Anthriscus sylvestris*, *Arrhenatherum elatius*, *Carduus acanthoides*, *Digitaria ischaemum*, *Geranium pusillum*, *Plantago lanceolata*, *Poa annua*, *Potentilla reptans*, *Rubus caesius*, *Setaria viridis*, *Solidago canadensis*, *Urtica dioica*, *Vicia sepium*.

The negative effect of weeds causes railway disruption by overground and underground parts of plants. Weedy path can become dangerous especially for trains and it can lead to a skid. Railway line, which is weedy is not aesthetic for passengers even for neighboring lands.

Species with higher coverage were situated on unused sections of railway. This fact may be due to the absence of chemical control against weeds, so-called herbicides. Therefore nothing prevents weeds in further distribution. It is likely that there will be a succession on this railway sector. This means developmental sequence and succession of changes in species composition and in the internal relations of biocoenosis.

The biggest threat are those weeds that are perennial, easy to expand and have a well developed root system. From this perspective, these can be dangerous weed species as *Solidago canadensis*, *Convolvulus arvensis*, *Taraxacum* sect. *Ruderalia*, *Polygonum lapathifolium*.

## CONCLUSION

Differences in vegetation between utilized and unused railway are apparent. Species with higher coverage were situated on unused railway, such as *Clematis vitalba*, *Linaria vulgaris*, *Senecio vulgaris*, these species occurred significantly less on utilized railway. Species composition was also different on unused sections of railway than on the utilized part, such as: *Falcaria vulgaris*, *Microrrhinum minus* or *Acinos arvensis*.

## ACKNOWLEDGEMENT

This work arose as project output of Internal Grant Agency AF MENDELU, number: TP 10/2013 "Study of selected factors affecting implementation of the biological potential of crops".

## REFERENCES

Dvořák J., Smutný V. 2008. *Herbology – Integrated weed management*. 1st ed. Brno: Mendel University in Brno.

Jehlík V. 1998. *Expansive weeds of Czech Republic and Slovak Republic*. 1st ed. Prague: Academia.

Kubát K. 2002. *Key to the flora of Czech Republic*. 1st ed. Prague: Academia.

Mikulka J., Kneifelova M. 2005. *Weedy plants*. 2nd ed. Prague: Profi Press.

Moravec J. et al. 1994. *Phytocoenology*. Prague: Academia.

Schweinsberg F., Abka W., Rieth K., Rohmann U., Zullei–Seibert N. 1999. Herbicide use on railway tracks for safety reasons in Germany? *Toxicology letters,* 107(1–3): 201–205.

Ter Braak C. J. F. 1998. CANOCO – A FORTRAN program for canonical community ordination by [partial] [detrended] [canonical] correspondence analysis (version 4.0.). Report LWA-8-02 *Agricultural Mathematics Group*. Wageningen.

Torstensson L. 2001. Use of herbicides on railway tracks in Sweden. *Pesticide Outlook*, 12(1): 16–21.