Using phytosociological databases for analyses of level of invasion or temporal changes in floodplain forests

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Introduction

- Invasions of non-native plant species, especially neophytes, are considered as one of the major threats to the diversity of natural ecosystems including floodplain forests
- Among natural and seminatural vegetation types, riparian forests belong to the most invaded habitats
- Floodplain forests are characterized by natural disturbances: periodic flooding repeatedly creates new ecotopes for successful establishment of non-native species, such as bare soils, open gravel and sand banks.
- Most large rivers in Europe are strongly altered by human disturbances (e.g. eutrophisation, damming, and water regime management), river valleys therefore are important corridors for spreading of neophytes

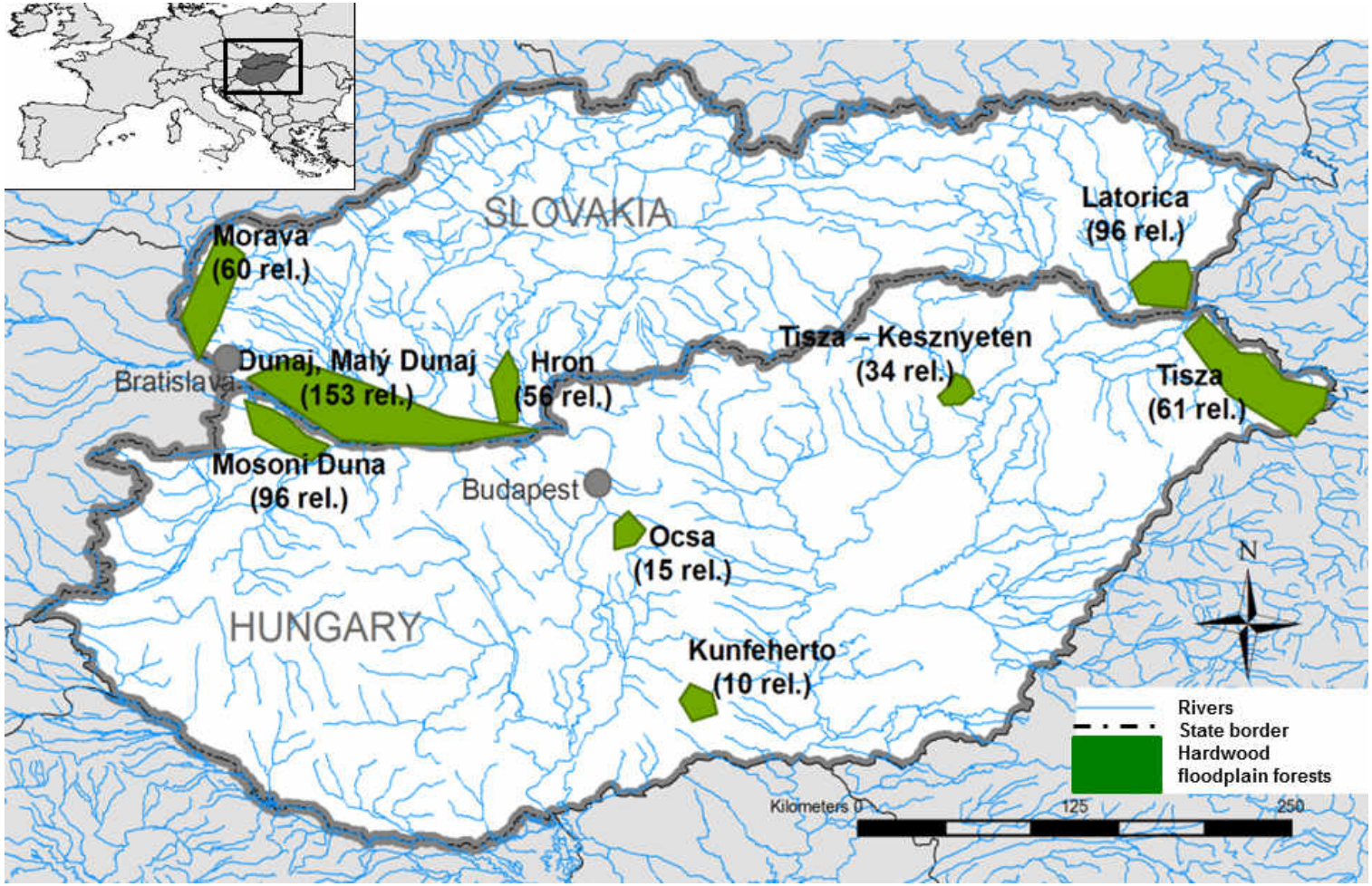
Aims

- to find out if there is a significant increase in the number of neophyte species and their cover in the hardwood floodplain forests over time
- to compare the occurrence of neophytes in Slovak and Hungarian datasets in different periods
- to explain the relationship between ecological factors and species richness of native vegetation, and the level of invasion of hardwood floodplain forests
- to predict short future trends in the level of invasion in Pannonian hardwood floodplain forests

Methods

- Study is based on the dataset of 359 relevés ordered within the suballiance *Ulmenion* in the CDF and 218 relevés in the Hungarian database
- Neophytes were identified according to the Slovak list of non-native species (Medvecká et al., 2012) and Hungarian list of non-native species (Balogh et al., 2004).
- The number and cover of recorded neophyte species were calculated for each relevé (JUICE software)
- The most frequent neophytes were identified

Study area


SLOVAKIA
HUNGARY
Bratislava
Budapest
Morava
(60 rel.)
Dunaj, Malý Dunaj
(153 rel.)
Hron
(56 rel.)
Mosoni Duna
(96 rel.)
Ocsa
(15 rel.)
Kunfeherto
(10 rel.)
Latorica
(96 rel.)
Tisza – Kesznyeten
(34 rel.)
Tisza
(61 rel.)
N
Rivers
State border
Hardwood
floodplain forests
Kilometers 0
125
250

Methods – temporal changes

- the dataset was divided into decades
- The number and cover of neophytes in each period was compared by Kruskal-Wallis nonparametric ANOVA, with multiple comparison of mean ranks for all groups (Statistica 7.0)
  - Hungarian and Slovak databases
  - Merged database – Pannonian region
- Corresponding periods in Hungary and Slovakia were compared by t-test (Statistica 7.0)

Methods – ecological factors

- To analyse the influence of ecological factors on the level of invasion generalised linear model was used (GLM, R-software)
- Number of native species in the plot, Shannon-Wiener diversity index and the information about vegetation structure together with Ellenberg's indicator values for ecological factors – light, temperature, moisture, soil reaction and nutrients
- GLM:
  - Poisson distribution family with a log-link function
  - The chi-squared test was used to test for overdispersion
  - Several models were made by excluding the non-significant variables and subsequently compared by one-way ANOVA
  - As there were no significant differences between the models, the simplest one was chosen

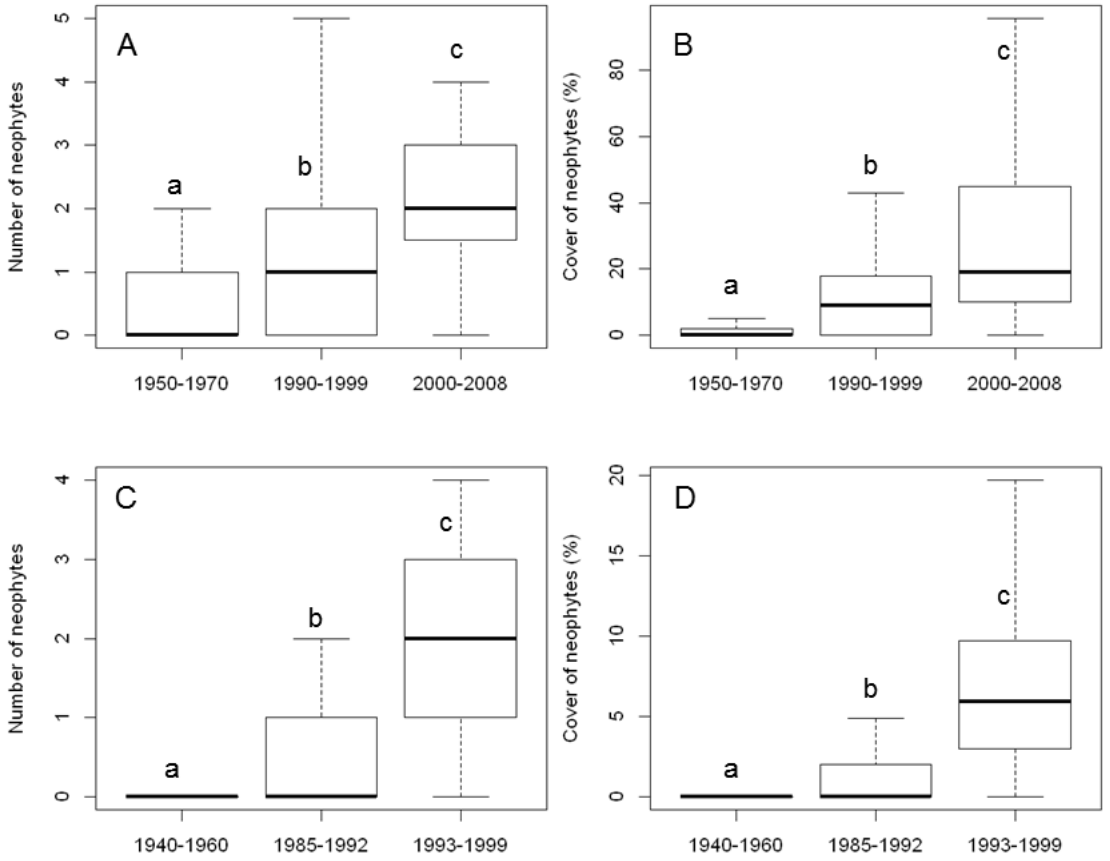
Results

- 23 neophyte species were found.
- 16 species in the Slovak and 18 species in the Hungarian dataset
- The most frequently recorded neophytes were *Robinia pseudoacacia, Impatiens parviflora, Solidago gigantea*

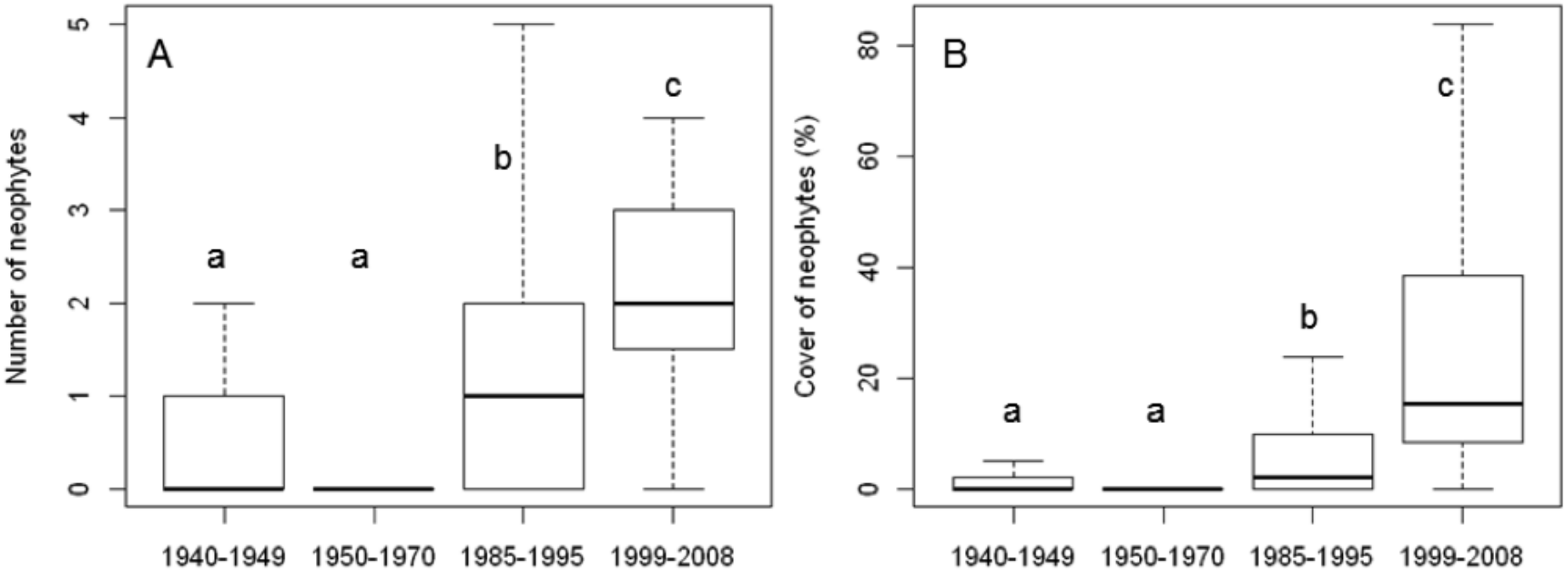
Percentage occurence of neophytes (%) in the whole dataset		
	SK	HU
Robinia pseudoacacia	22	18
Impatiens parviflora	19	9
Solidago gigantea	11	13
Negundo aceroides	8	8
Fraxinus pennsylvanica	0	7
Stenactis annua	2	5
Solidago canadensis	4	0
Aster lanceolatus	5	0
Celtis occidentalis	0	4
Ailanthus altissima	3	1
Padus serotina	0	3
Populus x canadensis	2	1
Xanthoxalis stricta	2	0
Ribes rubrum	0	2
Impatiens glandulifera	1	1
Parthenocissus quinquefolia	1	1
Conyza canadensis	1	1
Juglans nigra	1	0
Echinocystis lobata	1	0
Iris germanica	1	0
Bidens frondosa	1	0
Vitis vulpina	0	1
Amorpha fruticosa	0	1
Ambrosia artemisifolia	0	1

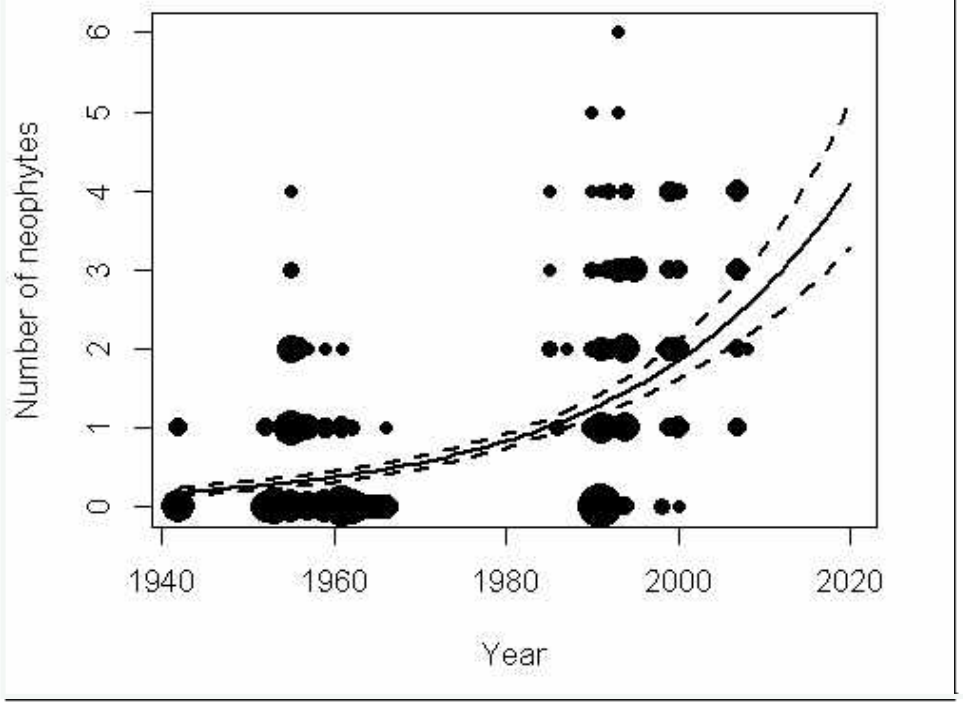
Results – temporal changes

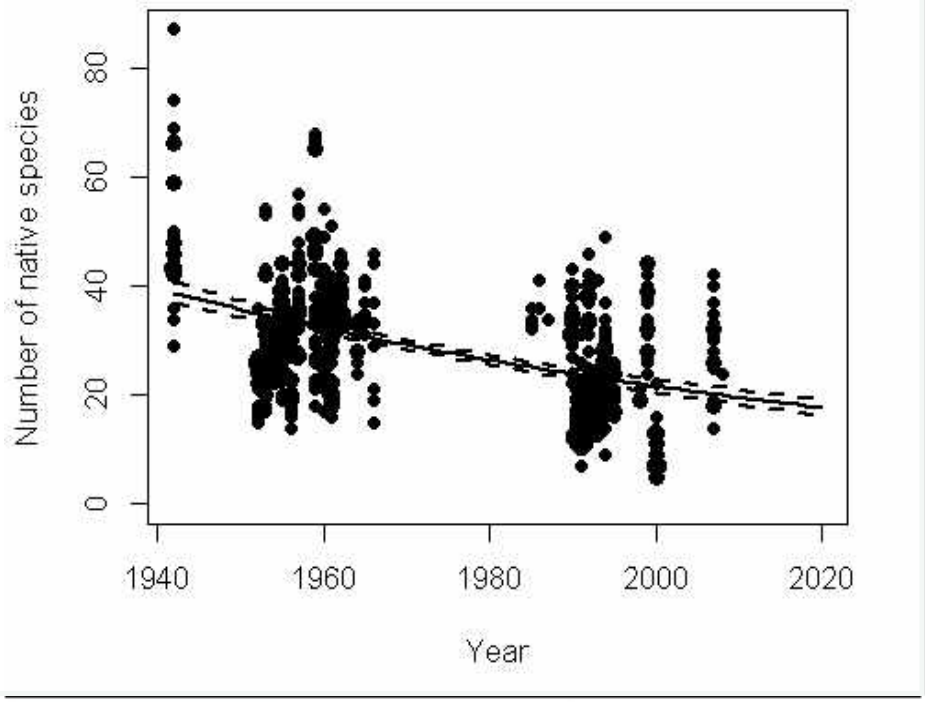
- Hungary (A,B)
- Slovakia (C,D)



Results – temporal changes in Pannonia



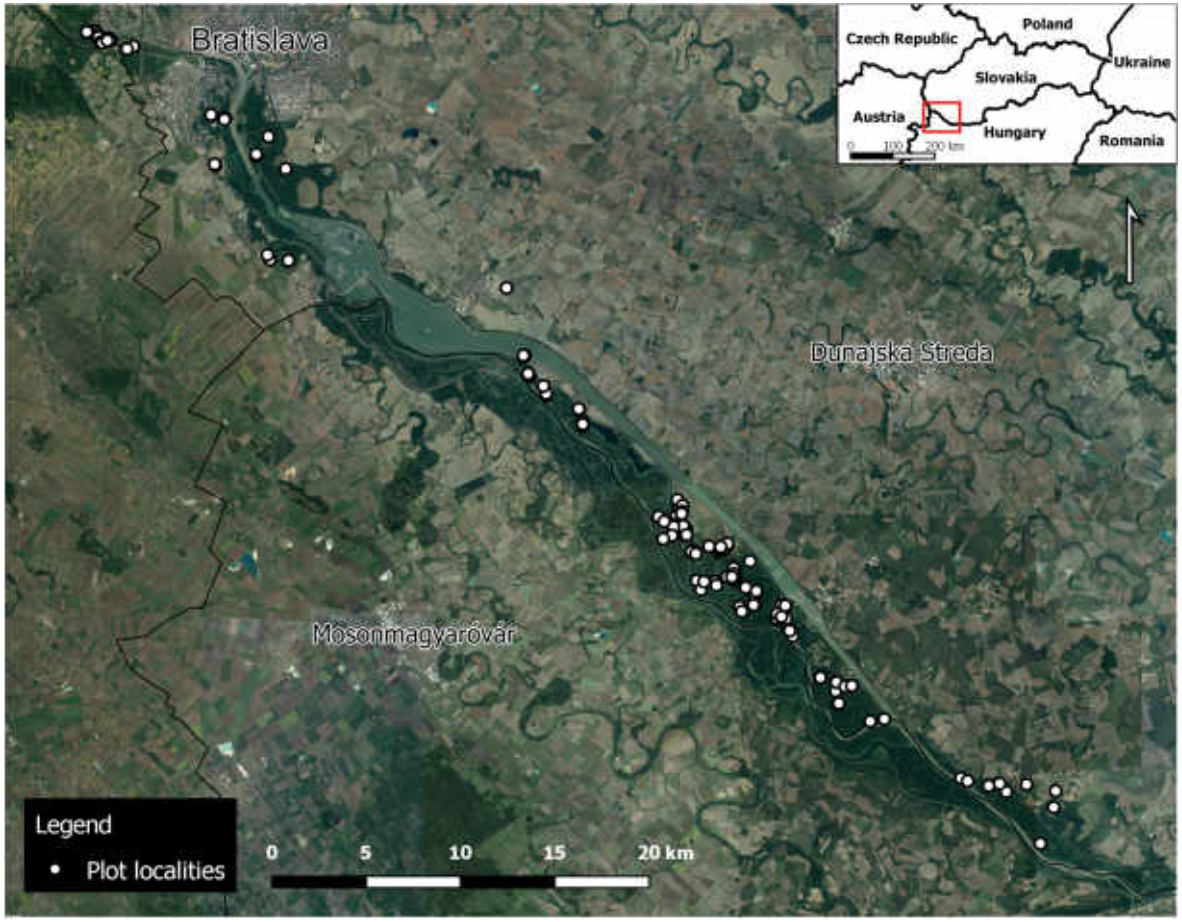

Number of neophytes
0
1
2
3
4
5
6
1940
1960
1980
2000
2020
Year


Number of native species
0
20
40
60
80
1940
1960
1980
2000
2020
Year

Results – ecological factors

	Estimate	Standard Error	P-value	Significance
(Intercept)	-77.16	5.966	< 2e-16	***
Year	0.034	0.003	< 2e-16	***
Number of native species	0.010	0.005	0.063	.
Light	0.343	0.115	0.003	**
Moisture	-0.266	0.114	0.020	*
Soil reaction	0.718	0.258	0.005	**
Nutrients	0.679	0.093	2.65E-13	***
Cover of tree layer	-0.003	0.002	0.065	.
Cover of herb layer	0.006	0.0019	0.002	**

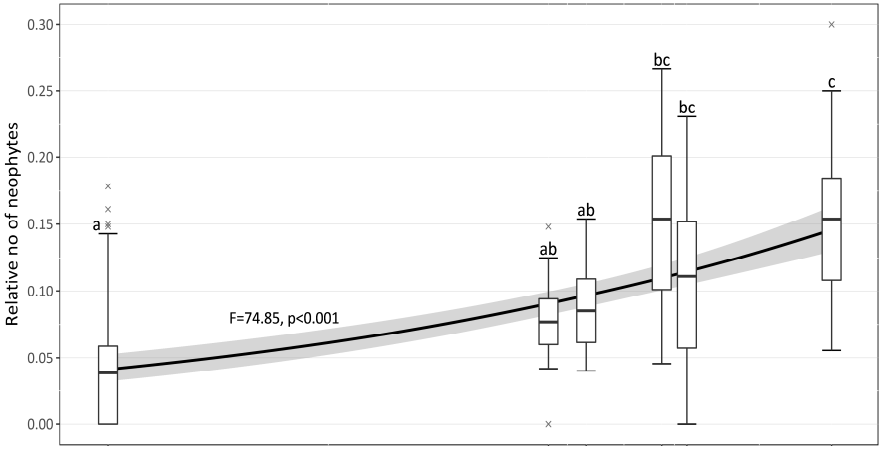
Neophytes in softwood floodplain forests of Danube inland delta

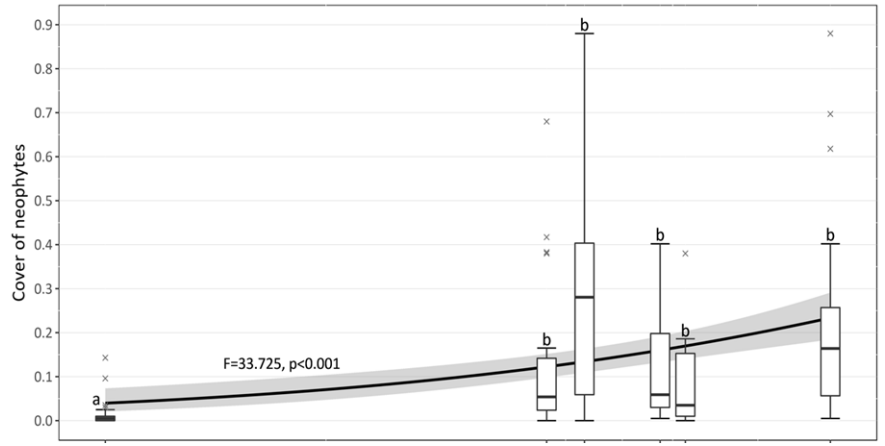


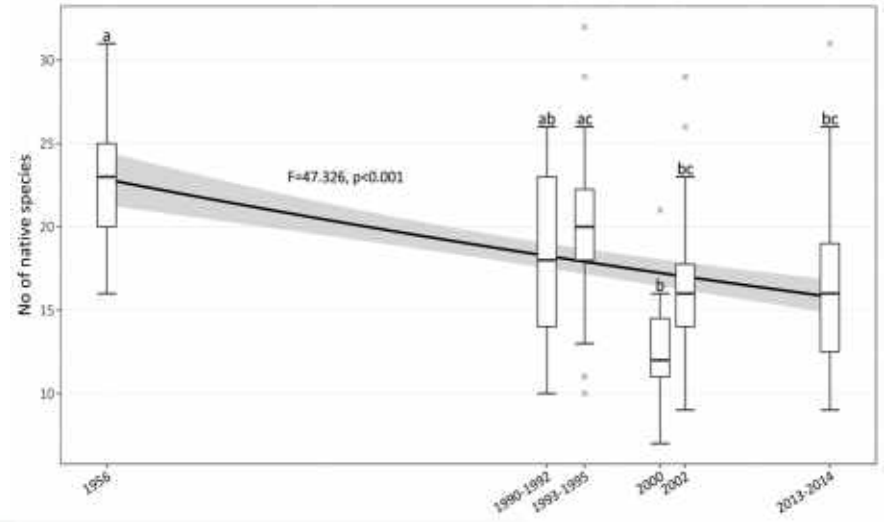
- comparison of large sets of old database data and new relevés from the same area
- Comparison of humid and mesophilous subassociations
- 177 rel.
- In 1956, extensive syntaxonomic research (Jurko 1958 – 45 rel.)
- Recent rel. sampled in 2013-2014

Results

- The species composition of the softwood floodplain forests significantly changed over time.
- Relative number and cover of neophyte species increased over time.
- The number of native species significantly declined. In 1956, the mean number of native species was almost 23 per plot. After the year 1990, the mean number of native species declined to 17 species per plot.







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Results

	Whole dataset	Mesophilous type		Humid type	
Moisture indicator value	5.67-8.85	> 7.75		<7.75	
No. of relevés	177	129		49	
	Freq.	Freq.	Fidelity	Freq.	Fidelity
Aster lanceolatus agg.	49	47	---	53	5.8
Negundo aceroides	36	44	32.9	14	---
Solidago gigantea	28	32	18.1	16	---
Impatiens glandulifera	23	29	26.5	8	---
Impatiens parviflora	21	28	36.2	2	---
Bidens frondosa	8	5	---	14	14.9
Fraxinus pennsylvanica	6	7	11.9	2	---
Populus ×canadensis	6	4	---	12	15.4
Robinia pseudoacacia	4	6	17.9	.	---
Erigeron annuus	2	3	12.5	.	---
Morus alba	2	2	10.8	.	---
Helianthus tuberosus	1	2	8.8	.	---
Oxalis fontana	1	2	8.8	.	---
Aesculus hippocastanum	1	1	6.2	.	---
Conyza canadensis	1	1	6.2	.	---
Juglans nigra	1	1	6.2	.	---
Physocarpus opulifolius	1	1	6.2	.	---

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Conclusion

- Floodplain forests are more and more invaded over time, diversity of native species is decreasing
- The most frequent neophytes in hardwood floodplain forests are *Robinia pseudoacacia*, *Impatiens parviflora* and *Solidago gigantea*
- In softwood floodplain forests *Aster lanceolatus* agg., *Negundo aceroides* and *Solidago gigantea*

…but

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Danube delta - expectations

- Rivers and river valleys – corridors for neophytes spreading
- Upper part of river should be less invaded than downstream parts
- Danube delta should be the most invaded part

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Danube delta - uninvaded

Future questions

- How invaded is Danube river from the spring to delta?
- What about other rivers in Europe?

Thank you for your attention