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RELATIONSHIP OF GEOGRAPHIC DISTRIBUTION OF THE MOST CHARACTERISTICAL INVASIVE PLANT SPECIES IN HABITATS ADJACENT TO THE RIVER DAUGAVA WITHIN THE TERRITORY OF DAUGAVPILS CITY

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Movement of species is affected not only by anthropogenic but also natural factors. The main routes for natural entry of alien species in Latvia are valleys of rivers, especially of the River Daugava.

On the banks of River Daugava within the city area very few natural meadows have been preserved. Banks are used for grazing. As a result, the meadows have strongly changed, plant diversity has reduced, and grasslands have become less frequent. With increasing economic and recreational use of areas, also the threat for entry and strengthening of alien species is growing. As a result of research in habitats adjacent to the River Daugava valley, 27 most common site-specific invasive plant species were studied. Habitats adjacent to the valley as major infested habitats (% of the total number of quadrants infested by the plant in the city) are typical for three taxa - *Xanthium strumarium* L., *Echinocystis lobata* Torr. Et Gray and *Rumex confertus* Wild. However, for most of the species found in the River Daugava valley, distribution of the frequency ratio of habitats adjacent to the Daugava valley to the frequency in the rest of the area within the city limits is comparatively insignificant (15% or less), so in case of these taxa the river as a natural distribution form of plants is playing a minor role.

There are plants (*Xanthium strumarium*, *Echinocystis lobata*, *Medicago falcata* L. s.l., etc.), which are most widely distributed in the immediate vicinity of the river or are forming large stands in coastal shrubs. Since their fruits are moving also by floating, the seeds can be carried over longer distances. Certain plants (*Armoracia rusticana* Scherb., *Helianthus tuberosus* L., *Solidago canadensis* L. S.l., etc.) in the research area have likely migrated from the nearby household gardens and allotment areas.

Key words: Invasive alien species, habitats adjacent to the River Daugavas valley in Daugavpils city, natural ways of migration.

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INTRODUCTION

With the development and expansion of human economic activity, a rapid spread of plant species outside their natural regions of origin is also taking place. With respect to the main dispersal agent, they may be divided into (a) terrestrial "transport habitats", including road verges and ditches as well as railway embankments and stations; and (b) water "transport habitats", including river and stream bank (Pyšek & Prach 1994). In Latvian case, valleys of rivers, especially of the River Daugava are among the most important water "transport habitats".

Rivers play a significant role as corridors for spreading of both native and non-native species (Pyšek & Prach 1993, Pyšek & Prach 1994, Pyšek & Prach 1996, Pyšek et al. 1998, Brabec & Pyšek 2000, Priede 2009, Säumel & Kowarik 2010, Wärnera et al. 2011, thus allowing them to enter new areas and extend their geographical ranges (Brabec & Pyšek 2000). A dynamic, diverse environment, continuous human impacts along the rivers create suitable niches for the establishment of non-native species (Pyšek et al. 1998, Richardson et al. 2007, Foxcroft et al. 2008), simultaneously altering the composition and structure of native riparian vegetation. In such a way riparian habitats are important both as corridors in the spread of species into new areas and as suitable habitats and usually establishment and expansion of non-native invaders in (semi-) natural habitats including riparian zones indicates the beginning of rapid spreading phase, especially in riparian habitats that provide both suitable soil and moisture conditions and migration pathways (Priede 2008a).

Researches carried out in the central part of Europe are indicative of the habitats in central European landscapes differ in encouraging the movement of diaspores (Pyšek & Prach 1994). Aliens occur most frequently in cities and villages, and riparian habitats (the second most important group of habitats) (Pyšek et al. 1998). Via rivers in the region many invasive alien plants are spreading such as *Impatiens parviflora, Bidens frondosa, Reynoutria sachalinensis* (Pyšek & Prach 1993, Pyšek & Prach 1998), and some of them are troublesome weeds in riparian habitats - *Impatiens glandulifera, Heracleum mantegazzianum* and *Reynoutria japonica* (Pyšek & Prach 1994).

Existing research on the riverbank invasive flora (Priede 2008a,b, 2009) suggests that in Latvia, several large- to medium-size rivers serve as important migration routes for the non-natives, namely longer stretches of riversides are invaded by scattered stands of alien plants. As the most important are the River Daugava (*Aster salignus, Echinocystis lobata*), the river Lielupe (*Aster salignus, Echinocystis lobata*), the river Venta (*Echinocystis lobata*), the river Salaca (*Aster salignus*), the river Pededze (*Aster salignus*). Among all riparian aliens in Latvia, Aster salignus and Echinocystis lobata seem to be the most successful in riparian habitats.

MATERIALS AND METHODS

Study area

Daugavpils is situated in the south-eastern part of Latvia. The city is the second largest in Latvia with 106,000 inhabitants (Central … 2011), situated on the banks of the river Daugava and covers an area of 72.48 km^2.

The River Daugava is rising in the Valdai Hills (Russia), flowing also through Belarus. The total length of the river is 1,005 km, in the Latvian territory - 352 km (Сапунов 1893). The River Daugava valley is a unique complex having resulted from mutual interaction of specific environmental conditions in the valley and vegetation during its development (Fatare 1987).

The first publication that provides more or less important details of the River Daugava valley flora is the paper by L.Bray issued in 1822 on the Livonian flora and vegetation. Further periods of the River Daugava valley plant research are examined in papers by A.Bunge, E.Lindemann, Y.Weber. In the middle 19th century botanists of the Riga Nature Researchers Society - K.Heigel,

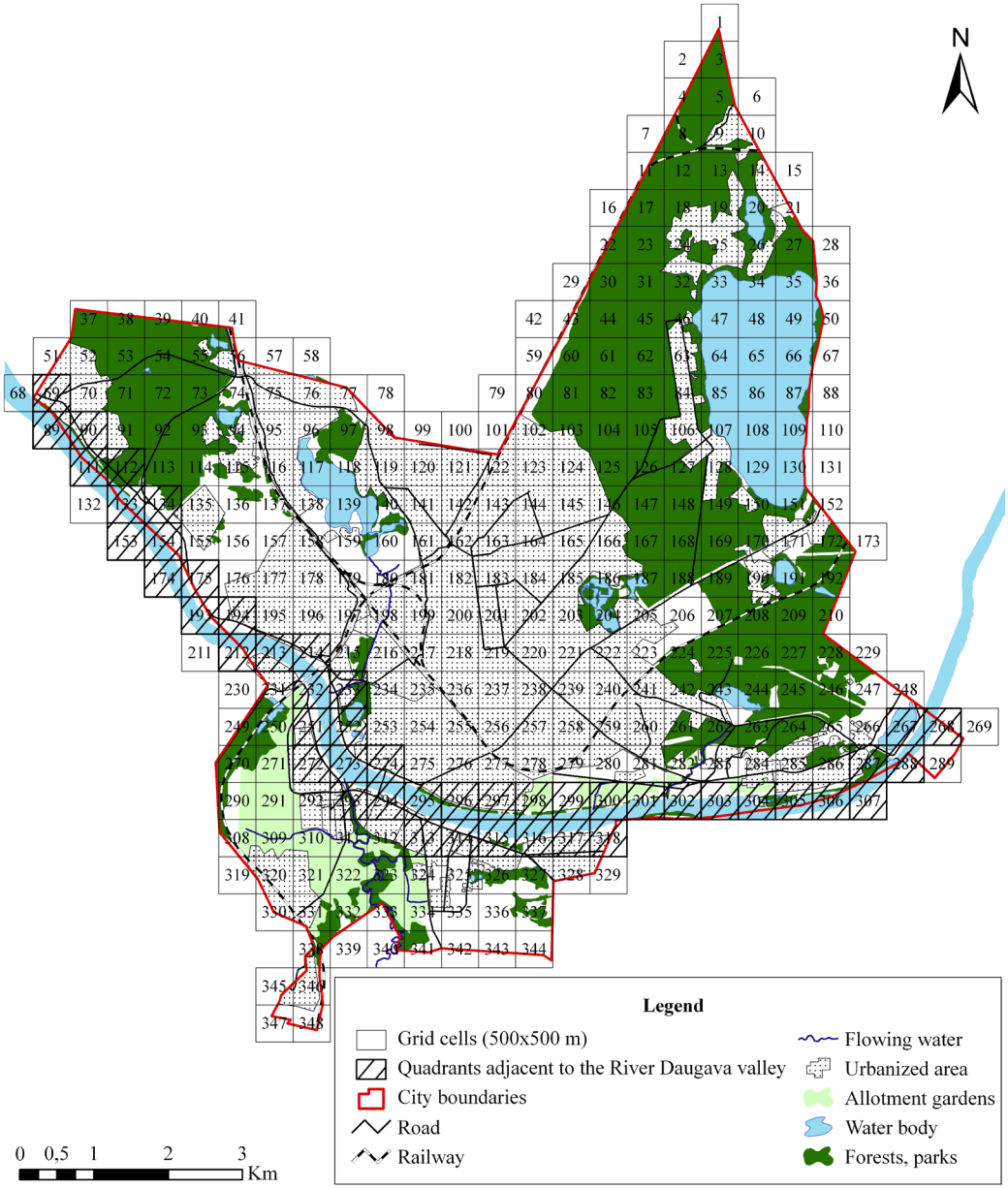

Fig. 1. The territory of field research – Daugavpils city with remarked quadrants, which includes habitats adjacent to the Daugava river.

K.Müller, F.Buze, K.Dirke, etc. began an intensive study of Latvian flora, paying serious attention to plants of the River Daugava valley (Fatare 1987).

During 80-ties of the 19th century E. Lehman carries out rather detail research of the River Daugava valley flora, including the previously little-studied span from the Belarus border to mouth of the River Aiviekste at the River Daugava (Lehman 1895). At the turn of 19th and 20th centuries, significant research work is carried out by K.Kupfer and in his publications he is actually the first to emphasise the River

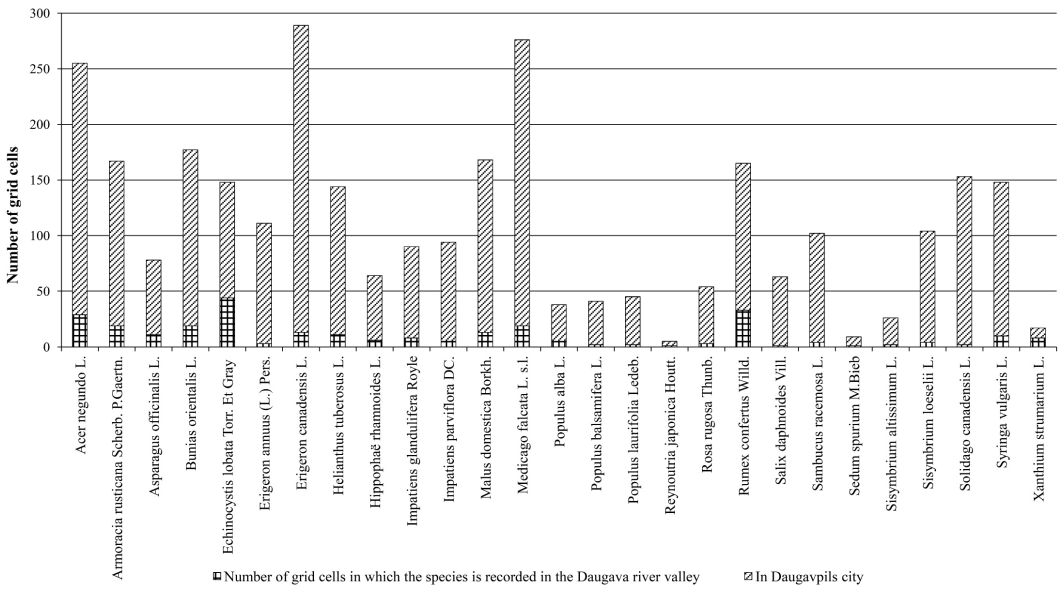

Fig. 2. Frequency ratio of invasive taxa found in habitats adjacent to the Daugava valley compared to frequency in the rest of the area within the city limits (invaded quadrants in %).

Daugava as a natural migration path for some plant species. During 30-ties of the 20th century valley of the River Daugava in Daugavpils vicinity is occasionally explored by A.Villerts and E.Valters (Fatare 1987).

Carried out by Fatare (1987) during the period from 1976 to 1983 detailed research work of the River Daugava valley flora is carried out by I. Fatare. In general, during this time 1016 vascular plant species are listed constituting 61.9% of the entire Latvian flora. Including 76 - adventive species and 68 species, which revert to the wild. Overall, this structure describes all the Latvian plant flora, but it has also specific features.

Today flora of Daugavpils city is considered as one of most unique in Latvia. It is determined by large diversity of natural and semi-natural habitats, as well as by most continental climate in Latvia. Town was a longstanding existing industrial and transport centre of Eastern Latvia, one of the first railway junction in Latvia, therefore, here is a large diversity of different antropogenically transformed habitats. After last investigations, 1041 vascular plant species are known in the flora of Daugavpils city, 262 or 25 % of them are considered as alien plant species (Evarts-Bunders 2011) Summarizing the DAU herbarium (herbarium of Laboratory of Systematic Botany in Institute of Systematic Biology) and studies in recent years (from 2007 to 2010) in the city was found 255 non-native species from 48 families. Most species are from the Asteraceae (37 species), Cruciferae (28), Rosaceae (26), Poaceae (25) families. (Romanceviča et al. 2011).

Daugavpils city is a only known locality of some alien plant species in Latvia. At this time, *Agropyron desertorum* (Fisch. Ex Link) Schult, *Cerastium dubium* (Bast.) O. Schwarz, *Reseda alba* L., *Ulmus pumila* L. and *Visnaga daucoides* P. Gaertn. (Гаврилова, Табака 1985), as well as *Gilia achilleaefolia* Benth., *Malva parviflora* L., *Macleaya* x *kewensis* Turrill and *Cerasus tomentosa* (Thunb.) Wall. are known only from Daugavpils city (Romanceviča et al. 2011).

FIELD RESERARCH

The field research was carried out from spring to autumn in 2007 till 2010. The distribution of invasive species in the Daugava river valley was

Table 1. The most typical invasive taxa identified in habitats adjacent to the River Daugava valley

Scientific name	Number of grid cells in which the species is recorded in Daugavpils city	Number of grid cells in which the species is recorded in Daugavpils city (%)	Number of grid cells in which the species is recorded in Daugava river valley	Number of grid cells in which the species is recorded in Daugava river valley (%)	Daugava/pilsēta %	Area of origin	Dispersal	Main way of regeneration
Acer negundo L.	226	65,70	29	60,42	12,83	N. America	water, wind	seeds
Armoracia rusticana Scherb. P.Gaertn.	148	43,02	19	39,58	12,84	Europe	man, water	roots
Asparagus officinalis L.	67	19,48	11	22,92	16,42	Europe	man	seeds
Bunias orientalis L.	158	45,93	19	39,58	12,03	Europe	man, wind, water	seeds
Echinocystis lobata Torr. Et Gray	104	30,23	44	91,67	42,31	N. America	explosive seeds, water	seeds
Erigeron annuus (L.) Pers.	108	31,40	3	6,25	2,78	N. America	wind, man	seeds
Erigeron canadensis L.	276	80,23	13	27,08	4,71	N. America	wind, man	seeds
Helianthus tuberosus L.	133	38,66	11	22,92	8,27	N. America	man	toberous root
Hippophaë rhamnoides L.	58	16,86	6	12,50	10,34	Asia	man, animals	seeds
Impatiens glandulifera Royle	82	23,84	8	16,67	9,76	Asia	water, man, explosive seeds capsule	seeds, roots
Impatiens parviflora DC.	89	25,87	5	10,42	5,62	Asia	animals	seeds
Malus domestica Borkh.	155	45,06	13	27,08	8,39	-	man, animals	seeds
Medicago falcata L. s.l.	257	74,71	19	39,58	7,39	Asia	animals, man	seeds
Populus alba L.	33	9,59	5	10,42	15,15	Europe	vegetative, wind	roots, seeds
Populus balsamifera L.	39	11,34	2	4,17	5,13	N. America	vegetative, wind	roots, seeds
Populus laurifolia Ledeb.	43	12,50	2	4,17	4,65	Asia	vegetative, wind	roots, seeds
Reynoutria japonica Houtt.	4	1,16	1	2,08	25	E. Asia	man, water, vegetative	rhizomes (in Europe)
Rosa rugosa Thunb.	51	14,83	3	6,25	5,88	Asia	vegetative, man	roots
Rumex confertus Willd.	132	38,37	33	68,75	37,5	Europe	wind	seeds
Salix daphnoides Vill.	62	18,02	1	2,08	1,61	Europe	vegetative, wind	roots, seeds
Sambucus racemosa L.	98	28,49	4	8,33	4,08	Europe	animals	seeds
Sedum spurium M.Bieb	8	2,33	1	2,08	12,5	Asia	vegetative	roots
Sisymbrium altissimum L.	24	6,98	2	4,17	8,33	Europe	wind	seeds
Sisymbrium loeselii L.	100	29,07	4	8,33	4	Asia	animals	seeds
Solidago canadensis L.	151	43,90	2	4,17	1,32	N. America	wind, animals	seeds
Syringa vulgaris L.	138	40,12	10	20,83	7,25	Europe	vegetative	roots
Xanthium strumarium L.	9	2,61	8	16,67	88,89	N. America	water, animals, man	seeds

mapped in grid cells of 500 × 500 m. The total number of grid cells was 344 (Nitcis et al. 2011) Habitats adjacent to the River Daugava valley take up 48 quadrants (13,95%) (See Fig. 1.). The data were processed using the GPS equipment THALES Mobilemapper CE. The sampling sites were recorded as point objects, the name of the object was entered into their attribute table. Subsequently, the obtained data were converted to *. shp format files, and from the GPS equipment they were exported to a computer, where further processing thereof was carried on with the GIS (geographic information system) software ArcView 9.1.

RESULTS AND DISCUSSION

In Daugava River valley was found 27 invasive plant species (See Table 1) *Xanthium strumarium* L., *Echinocystis lobata* (Michx.) Torr. et A.Gray, *Rumex confertus* Willd. and *Acer negundo* L. have a trend to locate in the Daugava River valley. *Xanthium strumarium* L. is the only taxon for which more than 50 % (88,89 %) records found on the Daugava riverbanks. However river valley is not the main habitat of the others founding invasive plants in the territory of Daugavpils city.

From the localities of invasive taxa in the River Daugava valley there were 1 Cucurbitaceae, 1 Liliaceae, 4 Cruciferae, 4 Salicaceae, 2 Polygonaceae, 5 Asteraceae, 2 Rosaceae, 1 Crassulaceae, 1 Aceracea, 1 Elaeagnaceae, 1 Oleaceae, 2 Balsaminaceae, 1 Caprifoliaceae, 1 Leguminosae species.

Analysis of most typical species

***Echinocystis lobata* Michx. Torr. et A.Gray**
The most widely distributed taxon occurring in habitats adjacent to the River Daugava valley, species is frequent – known in 44 quadrants (91.67%). In many places it forms large stands in riverside bushes. In the territory of Latvia this plant is also found also on banks of rivers such as Lielupe, Mūsa and Mēmele (Priedītis 2011). Also in the rest of the city of Daugavpils area the plant is comparatively frequent - in 104 quadrants (30.23%). Spreading in the city area is related not only to habitats of water courses, it is found also in weedlands, landfills, wet areas and shrubs. Frequency of the taxon in habitats adjacent to the River Daugava valley was evaluated separately in relation to frequency in the rest of the city (See Fig. 2.). For *Echinocystis lobata*, when compared to other observed species, this ratio is one of the largest - 42.31% of the invaded quadrants are found exactly in habitats adjacent to the River Daugava valley. Turgor pressure, which is present in fruits, provides their fracture and seed dispersal (Choate 1940), but the fruits can be moved over longer distances also with water, such as during floods along the riverside (Klotz 2007). In Europe it has been introduced as a climbing ornamental plant (Pyšek et al. 2003). Interestingly that during the previous inventory of Daugavpils flora (Tabaka et al. 1985), Echinocystis lobata was found neither in the Daugava valley (Fatare 1987), nor in the rest of the urban area. Today Echinocystis lobata in Latvia is classified as species, which is aggressive and difficult to destroy (Priedītis 2011), while in Hungary it is added even to the group of transformers (Tõrõk et al. 2003). The species is defined as invasive also in the Czech Republic, Lithuania, Poland and the European part of Russia (Alien species ... 2011). In Lithuania and Ukraine the plant is classified as expansive one. In Ukraine this plant is found virtually in all types of habitats (Gołdyn 2009, Protopopova et al. 2006).

***Rumex confertus* Willd**. Large numbers of records in habitats adjacent to the Daugava valley were found – species is known in 33 quadrants (68.75%), while in area within the city limits this species takes up 132 quadrants (38.37%). Frequency ratio of *Rumex confertus* (area of habitats adjacent to the Daugava valley /rest of the area within the city limits) is the second largest one - 37.50% of the invaded quadrants is found in the River Daugava valley. It is difficult to assess to what extent and whether the taxon distribution has changed since the previous inventory, because according to Fatares (1987) data, *Rumex confertus* in the Daugava valley is a naturalized adventive species, which is relatively frequent throughout the territory in meadows,

pastures, on roadsides, while in the rest of the area within the city limits distribution of *Rumex confertus* has been described as frequent - on roadsides, railway embankments, in weedlands, ruderal areas, in edges of fields and gardens (Tabaka et al. 1985). It is considered that beyond the original territory (Russia), the plant has spread with grains and grass seed material, as well as freight transport (Gudžinskas 1999). In Latvia the species has been introduced on a military transport and become naturalized (Bumburs 1955). Also in Lithuania and Estonia this species is classified as invasive one (Alien species ... 2011). *Reynoutria japonica* throughout the area within the city limits was found in a very small numbers, and only in one deposit (distribution from greenery) in the River Daugava valley. While *Reynoutria sachaliensis* in area within the city limits was found only in 2 quadrants - abandoned homesteads outside greeneries, which are not connected to watercourses at all. However, Berling et al. (1995) holds a view that the species of the genus Reynoutria possess many of the features of an "ideal invader" and are considered among the most vigorous European aliens. Plants are spread by vegetative fragments in water and thus represent a major threat to the adjacent vegetation (Brabec & Pyšek 2000), for example in Ukrainian river valleys expansive spreading of *Reynoutria japonica* is observed. (Protopopova et al. 2006). *Reynoutria japonica* is considered as invasive also in Norway, Denmark, Sweden (Alien species ... 2011), but in Germany it is included in the 12 most dangerous invasive plant list (Gregory 2003). Consequently, in case of Daugavpils from the Reynoutria family presence of the river may be mentioned as contributing factor only to spreading of *Rumex confertus*, while *Reynoutria japonica* and *Reynoutria sachaliensis* are considered "non-native garden escapers" (Pyšek et al. 2004), whose distribution is limited to the roots of offspring.

***Acer negundo* L**. The third most frequent invasive taxon in habitats adjacent to the River Daugava valley, species are found in 29 quadrants (60.42%). During the previous inventory (Fatare 1987) *Acer negundo* was found in sites throughout the territory, on roadsides and in bushes, unfortunately, there were no accurate inventory of records.

The species is regarded as invasive also in Austria, Czech Republic, and European part of Russia, Lithuania, and Poland. Southern part of Asia is considered to be the plant's natural distribution area. In other areas it is introduced as a plantation tree. The plant has extensively invaded degraded habitats, as well as river valleys in many European countries (Mędrzycki 2011). In Ukraine this plant is found in virtually all types of habitats (Protopopova et al. 2006), in Hungary - even as a transformer (Tõrõk et al. 2003).

Plant seeds are dispersed mainly by wind, but in the river valleys river flows can serve as the main advantage of dispersal, since in water the seeds keep their germination (Mędrzycki 2011). In the territory of Daugavpils city *Acer negundo* is found in 226 quadrants (65%). Since occurrences of the taxon in the River Daugava valley and the rest of the area within the city limits are very similar in terms of percentage, as 60.42% and 65%, it should be considered that wind and water flows are equally important in dispersal of *Acer negundo*. However, the frequency ratio (area of habitats adjacent to the Daugava valley / rest of the area within the city limits) is relatively small - 12.83% of the invaded quadrants are located in habitat areas adjacent to the Daugava valley, therefore, in case of Daugavpils, the wind is apparently playing more significant role as a way of dispersal of *Acer negundo*.

39.58% of the quadrants of habitats adjacent to the Daugava valley are invaded by *Medicago falcata* L. s.l., *Bunias orientalis* L. and *Armoracia rusticana.*

***Armoracia rusticana* Schreb.** Southeastern European species, which has widely dispersed throughout Europe, in the Northern Europe is regarded as invasive in Estonia and Lithuania (Alien species ... 2011). *Armoracia rusticana* is used as a food crop and has a rapid reproductive rate by roots and split-off rhizome pieces, thus the plant is of an invasive nature (Priedītis 2011). In Latvia it is widely cultivated in household

vegetable gardens, but now rapidly transfers into the wild. *Armoracia rusticana* spreading is found throughout the city of Daugavpils (invaded 43% of the quadrants), the plant spreads massively.

Armoracia rusticana frequency ratio (area of habitats adjacent to the Daugava valley /rest of the area within the city limits) is small - 12.84%. This can be explained by "allotment culture" developed in Daugavpils, where *Armoracia rusticana* is often cultivated as an herb. And since the areas of allotments and private houses are located in different parts of Daugavpils, also spreading of the plant is associated with virtually entire area within the city limits and different habitats – fallow lands, roadsides, gardens and garden edges, railway tracks, cemeteries, forest edges, weedlands, meadows, river banks.

However, the River Daugava and the floods have likely influenced distribution of *Armoracia rusticana* in adjacent areas, mainly in meadows, since part of allotments in fact are situated in habitats adjacent to the Daugava valley or in their vicinity. This is also reflected in the above relatively high number of invaded quadrants within the River Daugava valley (almost 40%).

In accordance with data by Fatare (Fatare 1987), *Armoracia rusticana* often transfers to the wild in ruderal habitats throughout the area. In the rest of the area within the city limits distribution of species can be characterized as rare but reverting to the wild, found on wet riverbanks, in ruderal areas, along residential buildings (Tabaka et al. 1985). Materials obtained during research carried out at present, give evidence that *Armoracia rusticana* in Daugavpils is a naturalized species; hence its spreading has had a positive dynamics.

***Bunias orientalis* L.** Natural distribution area of this taxon is the Caucasus and southern part of the Russian Plain (Priedītis 2011). Literary sources state that in many areas where the plant is now widespread, it has been brought in by the Russian army as a horse feed additive (Birnbaum 2006). Plant is dispersed by seeds and roots, through transportation, for instance, of hay. It is capable of producing very large numbers of seeds, while the roots have good recovery capabilities (Birnbaum 2006, Steinlein et al. 1996, NeoFlora fact sheet 2011).

In Latvia recently the plant spreads rapidly and is introduced into native plant communities, especially in meadows and floodplains of river valleys, where it can form also dense stands (Birnbaum 2006, Priedītis 2011). In the central and eastern part of the country it is the most frequent (Priedītis 2011). As refers to Daugavpils, *Bunias orientalis* has become naturalized (Rutkovska & Novicka 2010), its records are large, mono-dominant or co-dominant stands and it is never growing as a separate specimen.

Species is found in most European countries and in North America. In many European countries – United Kingdom, Finland, Norway, Sweden, Denmark, Estonia, Latvian, Lithuania, Poland, Germany and the European part of Russia, *Bunias orientalis* has already become naturalized. In Estonia *Bunias orientalis* is listed in the Black Book of invasive Species in the first category, characterized by very rapid spreading (Birnbaum 2006). It should be noted that in Latvia *Bunias orientalis, Acer negundo* and *Reynoutria japonica* are included in the list of 15 most dangerous invasive plant species (The national ... 2002).

There are no significant differences among the taxon distribution (%) in habitats adjacent to the River Daugava valley (39.58%) and distribution in the rest of the area within the city limits (46%). While the frequency ratio (area of habitats adjacent to the River Daugava valley / rest of the area within the city limits) is small - 12%. Obviously, the spread of *Bunias orientalis* is facilitated by waters of the River Daugava, however in the spread of the species other ways of distribution are playing more prominent role, such as railways and road transport, and other human economic activities, and wind. The obtained results are indicative that in areas where there is no compact coverage (in the built-up areas roadsides are more regularly managed) and where heavy traffic roads are passing through habitats adjacent to the River Daugava, numbers

of *Bunias orientalis* records are significantly higher than in the areas where the River Daugava and transport links do not duplicate each other as the taxon spreading corridors.

According to Fatares (1987) data, already in the 20th century 80-ies *Bunias orientalis* was an adventive naturalized species, which is relatively frequent across the entire Daugava valley, but in the rest of the area within the city limits it had a rare occurrence – in fallow lands, crops, meadows and pastures, fields, roadsides, on railway embankments, ruderal areas, around residential buildings (Tabaka et al. 1985). The current frequency would be comparable to the qualification "very often". This represents high levels of invasiveness of the taxon.

***Xanthium strumarium* L.** Found in all the quadrants (88,89) (See Fig. 2.). Only 1 of the identified records is located within urban area at the roadside and has no direct connection with the River Daugava. This is due to characteristics of the species dispersal - one of the main ways of dispersal of *Xanthium strumarium* burrs, and thus, its seeds ways of dispersal is floodwaters, and also rivers and streams, which can carry *Xanthium strumarium* burrs for long distances and across large areas. The burrs are buoyant, floating for up to 30 days (Benyas et al. 2010).

Xanthium strumarium is found primarily in disturbed, open habitats (Uchytil 1992) such as ruderal habitats, waste places, agricultural fields, along watercourses, beaches and coastal dunes (Weaver & Lechowicz 1983). In Latvia it is relatively rare, some specimens and small groups in the river floodlands and weedlands (Priedītis 2011). In the Daugavpils area first and only once (before this research was carried out) is found in 2005 in Ruģeļi estate on the Daugava riverbanks. Over the period from 2007 to 2010, 9 invaded quadrants were identified.

Since the species originated from region of North America, this continent has devoted much detail research where dangerous invasive properties of *Xanthium strumarium* are listed: *Xanthium strumarium* has the ability to maximize vegetative growth and initiate numerous flowers in short periods of time. Under suitable conditions, *Xanthiumstrumarium* has the potential to quickly colonize new sites due to its rapid germination rate and subsequent rapid growth. Also, plants stunted by lack of nutrients or saline conditions will still produce viable seeds (Weaver & Lechowicz 1983). The large foliar-like cotyledons of the emerging seedling enables early photosynthetic activity, promoting quick establishment of *Xanthium strumarium*. *Xanthium strumarium* has a phytoncide properties - allelochemicals from this plant negatively affect crops like onion (*Allium cepa* L.), sunflower (*Helianthus annus* L.) and some vegetables un graudaugus. Šīs īpašības also affected corn seedlings either by decaying of hypocotyls or by producing of dwarf plants (Benyas et al. 2010). *Xanthium strumarium* out-competes and shades out the more desirable native species on a site. It can invade large areas of wetlands (Halvorson, Guertin 2003).

***Medicago falcata* L.** From taxa found in habitats adjacent to the Daugava valley, species is the third most common in the rest of the area within the city limits (74.71% of the area within the city limits) after *Xanthium strumarium* (88,89%) and *Erigeron canadensis* L. (80.23%). Comparatively wide distribution of *Medicago falcata* in the Daugava valley, large number of records in the rest of the area within the city limits and only 7.39% high frequency ratio (area of habitats adjacent to the Daugava valley /rest of the area within the city limits) is indicative of high ecological plasticity of the taxon. It is well-adapted to a wide range of climatic and soil conditions (Dzyubenko & Dzyubenko 2008). Therefore both in Daugavpils and elsewhere in Latvia, in some places forming large stands, it occurs in a very wide variety of habitats - meadows, wood edges, gravel quarries, roadsides and weedlands (Priedītis 2011). High ecological plasticity of *Medicago falcata* is increased also with the fact that it will withstand long periods of flooding if they occur before field growth begins in the spring (Dzyubenko & Dzyubenko 2008), which also explains very frequent occurrence of *Medicago falcata* not only on banks of the River Daugava (Priedītis 2011, Vimba 2006), but also

the Lielupe and other rivers (Vimba 2006). Many authors (Rufener Al Mazyad & Ammann 1999, Levin et al. 1996) stated that *Medicago falcata* might be outcompeted in the future. It is endangered by genetic pressure. Frequency of *Medicago falcata* in natural conditions decreases and monodominant stands are becoming less and less common since hybrids of *Medicago x varia* can outcompete *Medicago falcata* (Hegi & Gams 1924), in addition, this process is rather intensive (Kaljund & Leht 2008). However, on the banks of the River Daugava within territory of Daugavpils city such a process has not been observed yet, *Medicago falcata* prevails here, and *Medicago x varia* occurs only in certain localities.

Area of origin of *Medicago falcata* is in Asia, but as an adventitious plant it has widely spread elsewhere. In Latvia it is quite frequent, but unevenly occurs across the country (Priedītis 2011). In Daugavpils *M. falcata* has to be included among fully naturalized species, in addition, its incidence already during inventory of flora of Daugavpils city made by Tabaka, et al. (1985), was described as rather frequent one, mostly on riverbank slopes, dry meadows, fallow lands and railway embankments, in continental dunes, roadsides.

Although the plant is found throughout Europe, there is few research of its level of invasiveness - under DAISIE (Delivering Alien Invasive Species Inventories for Europe) (2008) data – in Norway, Portugal, and Sweden the species has become stable, in Belarus, Ireland and Spain has not become stable, in Croatia, Denmark and Finland its status is unknown.

Frequency ratio of other (See Fig. 2.) species found on the Daugava riverbanks in habitats adjacent to the River Daugava valley to the frequency in the rest of the area within the city limits is relatively insignificant (15% or less), therefore in events of these taxa river plays a minor role as natural form of the plant dispersal. The most widely distributed plants identified in habitats adjacent to the River Daugava valley are representing three areas of origin. In equal numbers from Europe (36%), Asia (36%), slightly less - from North America (28%).

When analysis is carried out of the main way of regeneration, the River Daugava, however, is an important distributor of invasive taxa typical to the area being studied, as the main way of regeneration, since dominated by "seeds" - 61.5% (See Table 1) which the river flow, especially during the spring flood, carry away from the growth sites. With roots 38% of the taxa are dispersed.

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