

Presence of North American taxa in the synanthropic flora of Stara Zagora town, South Bulgaria

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Abstract

Synanthropization of flora and vegetation is a global phenomenon, revealed quite distinctively in big cities floras. Significant parts of ligneous and frutescent species which form urban floras originate from remote floristic regions and are characterized with long-term acclimatization and naturalization, while these periods are by far shorter when grass species are concerned. The study analyzes the condition of 27 seed plants of North American origin with different residential status. Comparative analysis comprises abiotic specification of their natural areas, dendrologic features, artificial breeding, metric data achieved for Bulgaria, and condition of representative exhibits of the same taxa in the city. Conclusions are drawn with respect to the degree of adaptation to the regional climate and the chances of maintaining self-reproductive populations.

Key words: synanthropic flora, introduction, alien species, invasion

Introduction

Plant-growing science uses the term “introduction” to describe the growing of plants from remote floristic regions to regions with similar climate, aiming enrichment of the aboriginal flora. The closer the climatic conditions in the country-host, more successful the introduction. Taxa of Northern origin are easier to introduce. It is subsequently found that except for the abiotic factors it is a number of species features that are of a crucial importance to the adaptation of alien species, such as: genetic material, adaptability, aggressiveness. Introduction includes acclimatization processes - change of the genetics of the plant itself to the new conditions of naturalization - alien species acquire the ability to support self-reproductive populations without the direct intervention of humans or despite it. These days in connection with the influence of alien species on the aboriginal flora, and especially on the crops, there is emphasis on the invasion - the last phase of naturalization, including capture of new territories and forming their own self-reproductive populations.

The status of introduced species is an important indicator with respect to the abiotic components of the environment, while in the same time defines a number of specific species features – adaptability, competitiveness, degree of invasiveness.

Materials and methods

The object of this investigation are 27 ligneous, frutescent and grass species of American origin, used for landscaping of Stara Zagora.

Explorations are made in 2010-2012 time span.

Biometric measurements are fulfilled with the altimeter type Silva Clinomaster CM 1015 2025 LA/Re, and diameter of the trunk is measured with a steel measuring tape at breast height. Representative specimens are selected during the course of examination.

For determination of species belonging, the works of Vakarelov, Anisimova (2012), Dotchev (2011) are used, and the works of Dyankov (1998, 2000) for the used ornamental

species in Stara Zagora lay outing. For determination of species resident status the works of Pyšek & al. (2002) are taken into account.

The analyzed area has transitional continental climate with Mediterranean influence. The winter is milder and warmer in comparison with other cities in the Thracian lowland due to the protective effects of the Sredna Gora Mountain. The average annual temperature is 13° C (average temperature in January is +1° C, and that in July is +24,0° C), the annual amount of rainfall is 650mm. Continentalization tendency of the climate is observed over the past 3-4 years. Soils are maroon forest, on limestone (Forestry Zoning - Regional Forest Management, 2006). The average altitude is 196 m.

Results and discussion

There are 27 taxa belonging to 15 families of North American origin on the territory of Stara Zagora town. They are higher plants belonging to the group of spermatophytes, and their distribution is as follows: 10 species of 3 families are gymnosperms, 17 species of 12 families are angiosperms. Metric data for 20 species is given in Table 1.

The group of gymnosperms includes the following families and species:

Cupressaceae Family

Juniperus virginiana L. (Eastern redcedar, Pencil cedar) - it is a tree reaching 450 years of age, 12 to 21 m height and 30-71 cm thickness. Its dimensions strongly vary depending on the conditions of the site. The species is aboriginal for the eastern North America. It has a shallow, highly branched root system, reaching 7.6 m in depth. The species climbs up to 1500 m in altitude, develops mostly on northern and eastern slopes with shallow soils on limestone or sandstone. The tree is dry and cold resistant; it is a pioneering species in artificial seeding and invasive in self - seeding. In breeding gives small, juicy dark blue berries, dispersed by birds and small mammals. Its seeds colonize eroded spots and abandoned and degraded areas; acclimatized for Bulgaria species.

Habitats in Stara Zagora: in the “Ayazmoto” forest park - 1 withered specimen, on the way to “Zagorka” Brewery - 7 specimens in groups with cypresses or monoculture, fructiferous, no self-dispersal. Metric data is given in Table 1.

Thuja occidentalis L. (West tuya) - it is described for the first time by K. Linnaeus in 1753 and is defined as 'Arbor vitae' - “The tree of life”. It is widespread in northern North America - in the ecotone between sphagnum marshes and upland ligneous communities. At maturity the species reaches heights up to 12-15 m and trunk diameter of 30-60 cm, lives more than 800 years. West tuya grows well in mountain and lowland areas on limestone, climbs up to 1300 m above sea level. It begins to produce cones as young as 6 years of age; the best production occurs after age 75, the species can also reproduce itself vegetatively. The tree is a shade tolerant pioneer species, acclimatized, archaeophyte.

Habitats in Stara Zagora: overall distribution in the “Ayazmoto” forest park, in the green areas around Tracian University, on the way to “Zagorka” Brewery, fructiferous specimens, no self-dispersion. Metric data is given in Table 1.

Thuja gigantea Nutt. - it is a ligneous species, occurring along the Pacific coast of North America. The species reaches 50 m in height and 2-5 m in circumference at breast height, climbs up to 1500 m in altitude, dry resistant and shade tolerant species, prefers moist, swampy areas near mountain streams.

Habitats in Stara Zagora: the “Ayazmoto” forest park - withered species.

Chamaecyparis lawsoniana Parl - it is a tree, common in the Pacific regions of North America. The species is long-lived, shade-tolerant, reaching heights of 60 m and trunk diameter of 120-180 cm. Some old specimens can be 73 m tall and 600 years old. The species climbs up to 1500 m above sea level. Reproduces by means of slowly germinating seeds, doesn't form renovating buds, and therefore grows more slowly than the

other pines and firs, it is fire resistant species. It prefers habitats with warm and dry summer, and cold and humid winter, acclimatized.

Habitats in Stara Zagora: the “Ayazmoto” forest park - single specimens, fructiferous, no self-dispersal; metric data is given in Table 1.

***Taxodiaceae* Family**

Sequoiadendron giganteum Lindl. (Giant sequoia) - at maturity the species reaches heights of 90 m and 17 m in trunk diameter, more than 3000 years of age - one of the most long-lived plants on the planet, placed in the category of “vulnerable” of IUCN, cold resistant. Naturally spread only on the western slopes of the Sierra Nevada, California, in 68 groves with total area $\approx 145 \text{ km}^2$ fully inventoried. The species prefers humid summer and snowy winter, climbs up to 2000 m in altitude. It is difficult to reproduce in culture species, acclimatized.

Habitats in Stara Zagora: in the District Hospital park - 3 specimens, no fruiting; next to the “3 Chuchura” bus stop - 3 specimens, 2 of them with signs of drying, no fruiting; “Bedečka” park - 3 young no fruiting specimens in excellent condition. Metric data is given in Table 1.

***Pinaceae* Family**

Abies concolor Lindl. et Gord. (Silver fir) – the species develops within 900 to 3400 m above sea level, reaching sizes of 50-70 m in height and 2 m in diameter at breast height. The species originates from the continental parts of western North America - California, Oregon, Arizona, Utah and Colorado. It is light loving species, tolerant to continental climate, low winter temperatures, dry air and soils, acclimatized. Metric data is given in Table 1.

Habitats in Stara Zagora: in Tracian University garden - young, no fruiting specimen; in the “Ayazmoto” forest park- young overall spread single specimen, fructiferous, no self-dispersal. Metric data is given in Table 1.

Picea pungens Engelm. (Blue spruce) - it is a tree reaching 21-50 m in height and 0.9 m in trunk diameter. The species reproduces from seeds; occurs up to 3000 m in altitude. It is a pioneer species in riverside communities, originates from the central parts of North America - Rocky Mountains, Colorado, where grows near rivers and damp swampland ranging from 2000 to 3000 m in altitude. The tree tolerates atmospheric aridity, high summer and low winter temperatures, typical of continental climates; it is not demanding to soils, extremely light loving and resistant to atmospheric pollutions species, acclimatized.

Habitats in Stara Zagora: the “Ayazmoto” forest park - single specimens, fructiferous, no self-dispersal. Metric data is given in Table 1.

Pinus coulteri Don. - it is a ligneous species, common endemically in coastal mountain areas of California, where it grows in dry and warm sandy-loam soils from 800 to 1500 above sea level. It requires mild and humid climate, acclimatized

Habitats in Stara Zagora: single specimens in the “Ayazmoto” forest park, “Bedečka” park, no self-dispersal. Metric data is given in Table 1.

Pinus ponderosa Dougl. (Big-cone pine) - the species reaches height up to 90 m and 4 m diameter at breast height. Widespread species along the Pacific coast of North America - California and Oregon, where occupies dry slopes with rocky sandy soils in the range of 1400-2600 m in altitude. It tolerates drought, air pollutions, low temperatures, demanding to soil moisture. The species is acclimatized.

Habitats in Stara Zagora: the “Ayazmoto” forest park, “Bedečka” park - single fructiferous specimens, no self-dispersal. Metric data is given in Table 1.

Pseudotsuga douglasii Carr. (Douglas fir) - the species occurring along the Pacific coast of North America, where climbs up to 2600 m in above sea level. It is fast growing species, reaching sizes up to 100 in height and 4 m in trunk diameter, with flat root

system. The tree prefers fresh and fertile forest soils, and high atmospheric humidity. The species is acclimatized.

Habitats in Stara Zagora: the “Ayazmoto” forest park, private yards and green patches - fructiferous. Metric data is given in Table 1.

The majority of analyzed above conifers are aboriginal to the Pacific coast of North America, characterized by mild and humid Mediterranean climate; the others form their genetic traits in mountain conditions with big humidity and low temperatures. The moderate continental climate in Stara Zagora does not provide such conditions for development, while the Mediterranean influence is rather weak. This is why American conifers are well acclimatized, but with no signs of self-dispersal.

Angiosperms are represented by the following taxa:

Aceraceae Family

Acer negundo L. (Box elder) - it is a ligneous species, originates from the Atlantic parts of North America, where it grows in moist and marshy areas near rivers. The species reaches 25 m in height and forms an uneven crown. The flowers are unisexual and appear before foliation. The tree is annually and abundantly fruitful, and gives seeds that germinate easily. The species is naturalized, invasive, neophyte (introduced after the 15th century).

Habitats in Stara Zagora: single fructiferous specimens among the spaces of the blocs of flats, in the “Ayazmoto” forest park, self-seeding plants; exemplary metric data is given in Table 1.

Acer saccharinum L. (Silver maple) - originates from the Atlantic and inland parts of North America, where it grows along rivers on sandy soils. The species reaches 40 m in height and 1.5 m in diameter at breast height, the crown is open and rounded, the root system is shallow. The tree gives germinal seeds, acclimatized.

Habitats in Stara Zagora: single fructiferous specimens in the urban area, no self-dispersal.

Berberidaceae Family

Mahonia aquifolium Nutt (Hollyleaved barberry) - It is a frutescent species originating from the Pacific coast of North America. The species is evergreen, hydrophilic, not demanding to soil conditions, shade and direct sunshine tolerant, resistant to lower temperatures. Reproduction is vegetative and by seeds; the species is naturalized and invasive.

Habitats in Stara Zagora: overall occurrence in the green patches among the spaces of the blocs of flats, in city parks, in the “Ayazmoto” forest park; self-seeding plant. Metric data is given in Table 1.

Bignoniaceae Family

Catalpa bignonioides Walt. (Indian bean tree) - it is ligneous species, originating from the Atlantic coast of North America, where it reaches up to 20 m in height. The fruit is a long, thin bean like pod, 20-40 cm long. Species is acclimatized.

Habitats in Stara Zagora: single specimens of various ages among the spaces of the blocs of flats and city parks with abundant fruiting, no self-dispersal. Metric data is given in Table 1.

Fabaceae Family

Gymnocladus dioica (L.) Koch. (Kentucky coffee tree) - it is a ligneous species originating from the Atlantic and central states of North America, where it grows in forests on moist soils. The tree reaches 30 m in height, forming highly branched and loose crown. Reproduction is vegetative and by seeds; the species is naturalized.

Habitats in Stara Zagora: the “Ayazmoto” forest park - single fructiferous specimens. Exemplary metric data is given in Table 1.

Gleditschia triacanthos L. (Honey locust) - the species occurs in deep soils near rivers on the Atlantic coast of North America, where it reaches sizes of 45 m in height and 1.3 m in trunk diameter. Highly branched spikes form on branches and stems. Reproduction is by seeds; the species is acclimatized, neophyte.

Habitats in Stara Zagora: the “Ayazmoto” forest park, “Bedeckka” park, in the green patches round the blocks of flats - numerous fructiferous specimens. Metric data is given in Table 1.

Robinia pseudoacacia L. - the species originates from Appalachian Mountains (North America), where it grows singly or in groups with deciduous species on moist fertile soils. It reaches height of 25 m and 1.2 m in diameter at breast height. The species forms a broad loose crown, leaves are odd-pinnate, and stipules develop in hard woody prickles. The tree develops deep root system with high offshoot ability, and that is why it is used to reinforce slopes, embankments, etc. The species withstands low temperatures and atmospheric pollutions well; it is naturalized, invasive, neophyte.

Habitats in Stara Zagora: overall occurrence, fructiferous. Metric data is given in Table 1.

Amorpha fruticosa L - it is an upright frutex, 3-6 m tall with even pinnate leaves and easily germinating seeds. Species originates from eastern North America. It tolerates prolonged droughts, and is a light loving plant. Reproduction is vegetative and by seeds; the species is naturalized.

Habitats in Stara Zagora: rarely in the spaces among the blocks of flats, fructiferous, self-dispersing species. Metric data is given in Table 1.

***Fagaceae* Family**

Quercus rubra L. (Common red oak) - the species originates from the Atlantic parts of North America. The tree reaches sizes of 25 m in height and 1.2 m in trunk diameter. Develops well up to 1800 m above sea level; it is a light loving plant, not demanding to soil conditions, acclimatized.

Habitats in Stara Zagora: young specimens in the “Ayazmoto” forest park, the “Zelen klin” park.

***Juglandaceae* Family**

Juglans nigra L. (Eastern black walnut) - a tree reaching 38 m in height and 3 m in diameter at breast height, with broad crown and roots. The species prefers deep, moist soils, it is light loving plant, cold resistant, develops on limestone. It is aboriginal for the Atlantic North America, where climbs up to 1200 m in altitude (Appalachian Mountains), acclimatized, neophyte.

Habitats in Stara Zagora: single fructiferous specimen in the “Malak Park”, situated within the “Ayazmoto” forest park; no self-dispersal. Metric data is given in Table 1.

***Moraceae* Family**

Maclura pomifera (Raf.) Schneid. (Osage-orange) - it is a ligneous species, originating from the Atlantic North America, where it reaches 20 m in height. The tree forms juicy and fleshy infructescences. The species is sensitive to low winter temperatures, not demanding to soil conditions; tree stumps grow offshoots, reproduction also by seeds, acclimatized, neophyte.

Habitats in Stara Zagora: four mature fructiferous specimens in the “Ayazmoto” forest park, “Bedeckka” park, no self-dispersal. Metric data is given in Table 1.

***Oleaceae* Family**

Fraxinus americana L. (American ash) - it is a ligneous species, aboriginal for the eastern parts of North America, dioecious. The tree reaches sizes of 35 m in height and 1 m in trunk diameter; it is drought resistant species, self-seeding plant, naturalized, invasive.

Habitats in Stara Zagora: overall occurrence, self-dispersing.

***Solanaceae* Family**

Physalis alkekengi L. (Bladder cherry) - it is a perennial grass vine, with a stem 40-60 cm long, and a juicy fruit into papery orange fruit covering. The species originates from tropical America. It is medicinal plant, invasive, neophyte.

Habitats in Stara Zagora: rarely in private yards, self-dispersing.

***Rosaceae* Family**

Aronia prunifolia (Marsh.) Rehal. (Purple Chokeberry) - It is a deciduous frutex, reaching sizes of 2-2.5 m in height; the species is aboriginal for North America, where it develops in moist habitats and near marshes. The frutex is resistant to low temperatures and pests, demanding to soil moisture and sunshine. It is a medicinal plant, invasive species.

Habitats in Stara Zagora: rarely in the spaces among the blocks of flats, self-dispersing species. Metric data is given in Table 1.

Hydrangeaceae Family

Philadelphus latifolius Schrad. (Philadelphia) - it is strongly light loving frutex, reaching 1.5-3 m in height. The species has simple, opposite leaves, its flowers emit strong odor and are similar to those of lemon and orange. Reproduction is vegetative and by offshoots; the species is naturalized.

Habitats in Stara Zagora: fructiferous specimens are found in the Tracian University yard, and "Bedečka" park, no self-dispersal.

Magnoliaceae Family

Liriodendron tulipifera L. (Tulip tree) - the species originates from eastern North America (Illinois, Ontario, Appalachian Mountains), where it reaches 25-50 m in height and 3 m in diameter at breast height. It is a shade tolerant tree, associated with calcareous and sandy soils, acclimatized.

Habitats in Stara Zagora: the "city garden" - withered species.

Magnolia grandiflora L. (Southern Magnolia) - it is an evergreen tree, aboriginal for the south-eastern American states - Virginia, Florida, Texas, and Oklahoma - where it reaches 27 m in height. The species is one of the first, described by K. Linnaeus in "Systema naturae" (1759); the tree is official symbol of the state of Mississippi; acclimatized species.

Habitats in Stara Zagora: single species in private yards, no self-dispersing.

Unlike conifers, most of the American deciduous introduced species originate from the Atlantic coast of North America. This introduction centre forms a number of cold resistant and durable ligneous species, such as *Fraxinus americana* L., *Robinia pseudoacacia* L., *Gymnocladus dioica* (L.) Koch., *Acer negundo* L. и *Gleditschia triacanthos* L. There are no species with a narrow range of distribution in this group - they are all eurochoric species, with high ecological plasticity, growing equally in the most extreme conditions of habitat. In the climatic conditions of Stara Zagora they constitute a substantial proportion of deciduous communities, completely acclimatized, naturalized, and fructiferous; reproduction is vegetative and by self-seeding (invasive). Grass and frutescent species are introduced after the 15th century and possess genetic potential, allowing them self-dispersal and supporting of self-reproducing populations.

Table1. Metric data for 20 American species (2010 – 2012)

Taxon	Sizes, referred to USA		Sizes, established for Stara Zagora 2010 - 2012.	
	H (m)	D (m)	H (m)	D (m)
<i>Juniperus virginiana</i> L.	12,0 -21,0	0,3 - 0,7	9,2	0,52
<i>Thuja occidentalis</i> L.	12,0-15,0	0,3 - 0,6	7,8	0,32
<i>Chamaecyparis lawsoniana</i> Parl.	50,0 - 60,0	1,2 - 1,8	8,5	0,23
<i>Sequoiadendron giganteum</i> Lindl.				
<i>Abies concolor</i> Lindl. et Gord.	50,0 - 70,0	1,8 - 2,0	23,0	0,85
<i>Picea pungens</i> Engelm.	21,0 - 50,0	0,9	20,0	0,70
<i>Pinus coulteri</i> Don.	10,0 -24,0	1,0	20,0	0,84

<i>P. ponderosa</i> Dougl.	90,0	4,0	19,2	0,72
<i>Pseudotsuga douglasii</i> Carr.	50,0 - 75,0	4,0	13,4	0,42
<i>Acer negundo</i> L.	25,0		14,0	0,47
<i>Mahonia aquifolium</i> L.			0,5	0,2
<i>Catalpa bignonioides</i> Walts.	15,0 - 20,0		9,0	62,2
<i>Gymnocladus dioica</i> (L.) Koch.	30,0		25,0	0,89
<i>Gleditschia triacanthos</i> L.	45,0	1,3	28,7	82,5
<i>Robinia pseudoaccacia</i> L.	25,0	1,2	19,2	0,73
<i>Amorpha fruticosa</i> L.				
<i>Juglans nigra</i> L.	38,0	3,0	18,0	0,97
<i>Maclura pomifera</i> (Raf.) Schneid.	20,0	1,0	17,5	0,63
<i>Fraxinus americana</i> L.	35,0	1,0	16,0	0,65
<i>Aronia prunifolia</i> (Marsh.) Rehal.	2,0-2,5	0,5	2,1	0,3

Conclusion:

Floras of areas, subject of major ecologic fluctuations in the past, that served as refuges for many species are usually used as donors of alien species - such are those of California, Appalachian Mountains and other regions of North America. They are characterized by heterogeneous structure and offer a wide range of species with different dendrological parameters and ecologic preferences. The similarity in abiotic conditions of their natural area is not always a guarantee for successful acclimatization and naturalization. The registered on Stara Zagora territory coniferous taxa, originating from the Pacific coast of North America, although fruiting in culture, can not reproduce the populations in natural conditions, despite their introduction prior to the 15th century. It is obvious that the reasons for this are the peculiarities of the regional climate and the genetic endowments of taxa. In spite of that, they carry formed over millennia valuable genetic information, which is to be stored and used in the selection. The abiotic conditions of Stara Zagora are suitable for more plastic in ecologic terms deciduous ligneous species, originating from the eastern parts of North America. Although introduced in more recent times, they renovate their populations by seeds, which show a high degree of adaptation to the local conditions. Grass and frutescent species are also well acclimatized to the regional conditions; they are fructiferous and support self- renovating populations.

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