Collection of Experiences from 25 Years Work on Seed Propagation of Allochthonous Dendroflora at the Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering in Skopje and the Surroundings

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INTRODUCTION & METHODOLOGY

Various efforts in the past decades have contributed for a large variety of allochthonous tree species to become a part of the urban and suburban landscape in Skopje. Of more than 200 registered allochthonous species in the urban and suburban green areas of the city of Skopje, we have propagated from seed 65 species, of which 19 coniferous and 46 broadleaved, and subsequently analysed the attributes of their generative propagation potential. This paper summarizes 25 years' experience in generative propagation of allochthonous species at the Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering (HEF) in Skopje, R. of North Macedonia.

The seed material was gathered from several locations of different nature across Skopje, e.g., park-forests, public parks, Botanical Garden, arboretum etc. (Fig.1). After gathering, the plant material was examined in regards to the germination rate or viability after species-appropriate pre-sowing treatments were applied (Table 1). Subsequently, the seeds were used for production of one year old seedlings (1+0).

Figure 1. Main sampling locations.

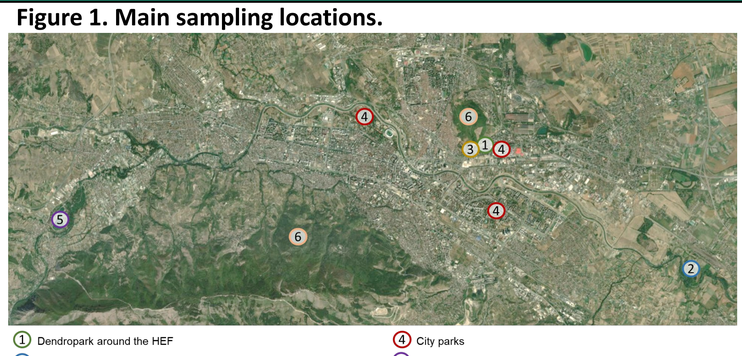

Table 1. Characteristics of Sampled Allochthonous Species (1997-2022).

	Level of presence[1]	Species	Germination or viability	Pre-sowing treatment	Seedlings features SH [cm]/RCD [mm] brr	Seedlings features SH [cm]/RCD [mm] cnt
ALLOCHTHONOUS CONIFERIOUS SPECIES	RARE	*Cryptomeria japonica*	VL	PS 2-3 d	12/2.5	x
		Calocedrus deccurens	L	PS 2-3 d	11/2.3	x
		Pinus wallichiana	M	PS 5-8 d	x	11-16/1.0-2.1
		Taxodium distichum	M	AS/SF 1-2 m	12/2.1	x
		Thuja plicata	M	PS 1-2 d	10/1.2	x
	COMMON	*Abies concolor*	L	AS/SF 2-3 m	5-7/0.6-1.4	x
		Cedrus deodara	M	AS/PS 5-7 d	11-18/1.1-1.9	12-20/1.7-2.5
		Cedrus atlantica	M	AS/PS 5-7 d	12-20/1.4-2.2	13-22/2.2-3.1
		Chamaecyparis lawsoniana	L	PS 2-3 d	13-18/1.2-2.2	16-21/1.8-2.5
		Ginkgo biloba	H	AS/SF 3-4 m	14-25/2-3.5	x
		Larix decidua	L	PS 3-5 d	13-18/1.5-2.1	x
		Picea pungens	H	PS 1-2 d	6-11/0.6-1.5	9-11/0.8-1.3
		Picea omorika	H	PS 1-2 d	x	8-10/0.7-1.2
		Pinus strobus	H	AS/SF 2-3 m	10-13/1.5-2.2	x
		Pseudotsuga menziesii var. *menziessi*	L	AS/PS 5-7 d	7-35/0.6-3.8	8-21/0.7-2.6
	ABUN-DANT	*Cupressus arizonica*	L	PS 3-5 d	10-32/0.6-3.3	9-37/0.8-3.5
		Cupressus sempervirens	L	PS 3-5 d	11-30/0.5-2.9	12-26/1.3-2.6
		Thuja occidentalis	L	PS 1-2 d	10/1.3	x
		Platycladus orientalis	M	PS 3-5 d	12-22/1.8-3.1	13-20/1.8-2.6
ALLOCHTHONOUS BROADLEAF SPECIES	RARE	*Acer buergerianum*	VL	SF 2-3 m	22-28/1.9-2.6	x
		Acer davidii	L	SF 2-3 m	22-40/1.5-2.7	x
		Aesculus glabra	H	AS/SF 3-5 m	12-27/4.5-8.5	x
		Alnus cordata	M	PS 3-5 d	21/2.3	62/7.5
		Aronia melanocarpa	M	SF 1-2 m	18/2.5	x
		Carya ovata	H	AS/SF 3-4 m	15-30/2.5-5.1	x
		Chimonanthus praecox	M	SF 1-2 m	31-38/3.1-4.3	x
		Citrus trifoliata	M	SH 1 m	30-58/2.5-5.6	x
		Exochorda racemosa	L	SF 1-2 m	23/2.8	x
		Idesia polycarpa	L	PS 3-4 d	22/2.5	51/4.5
		Juglans mandshurica	H	AS/SF 2-3 m	41/6.3	x
		Maclura tricuspidata	M	SF 1-2 m	26-48/2.3-6.2	x
		Melia azedarach	L	AS/SF 3-5m	32/5.2	x
		Parrotia persica	M	SF 1-2 m	27/3.4	x
		Pterocarya fraxinifolia	L	SF 5-6 m	21/3.8	x
		Quercus aegylops	H	AS/SF 1-2 m	26/4.2	x
		Sterculia platanifolia	VL	SF 2-3 m	24/3.3	x
	COMMON	*Acer saccharinum*	H	PS 1-2 d	30-65/2.5-5.4	x
		Acer palmatum	L	SF 2-3 m	10-15/1-1.5	12-17/1.8-2.1
		Albizzia julibrissin	M	HT 15-20 s	15-180/2.1-15.2	x
		Amorpha fruticosa	M	PS 3-5 d /WW	23-42/1.9-3.6	x
		Campsis radicans	M	SF 1-2 m	34-52/2.8-4.3	x
		Catalpa bignonioides	H	PS 2-3 d	21-25/1.8-2.3	58/7.1
		Cercis siliquastrum	H	HT 20-30 s	12-60/0.8-5.3	x
		Diospyros kaki	L	AS/SF 1-2 m	20-40/2.5-6	x
		Juglans nigra	H	AS/SF 2-3 m	18-55/4.5-8.3	x
		Koelreuteria paniculata	M	AS/MC	22-78/3.3-10.1	x
		Laburnum anagyroides	M	HT 10-20 s	28-77/2.5-9.2	x
		Lagerstroemia indica	L	SF 1 m	20/1.8	x
		Liquidambar styraciflua	L	SF 1 m	15/1.7	x
		Liriodendron tulipifera	L	SH 2-3 m	30-42/3.5-5.2	x
		Maclura pomifera	M	PS 3-5 d	34-55/2.7-6.7	x
		Magnolia grandiflora	M	SF 2-3 m	14-26/2.5-4.5	x
		Magnolia x soulangeana	M	SF 2-3 m	10-21/1.2-2.5	x
		Paulownia tomentosa	H	PS 1-2 d	x	62/7.3
		Pistacia vera	H	SF 1-2 m	27-48/3.5-5.3	x
		Quercus rubra	H	AS/SF 1-2 m	18-84/2.2-12.2	25/3.4
		Ulmus pumila	H	PS 1-2 d	23-56/3.2-7.3	x
		Wisteria sinensis	M	HT 10 s/WW 2-3 d	25-52/3.5-6.3	x
	ABUNDANT	*Acer negundo*	H	PS 3-4 d	32-82/3.5-6.7	x
		Fraxinus americana	H	PS 2-4 d	14-75/1.5-9.6	19-22/2.1-2.6
		Gleditschia triacanthos	H	HT 30-60 s	22-75/2.5-8.3	x
		Hibiscus syriacus	H	PS 1-2 d	20-47/2.5-6.3	x
		Prunus pissardii	M	AS/SF 2-3 m	43/5.5	x
		Robinia pseudoacacia	H	HT 10-40 s	23-240/1.8-15.6	25-54/2.3-4.2
		Sophora japonica	M	HT 10-40 s	35-57/3.6-8.4	x

[1]Rare, solitaries or only several individuals; Common, present in many green areas; Abundant, very often present in green areas; Abbreviations: VL, very low (<10%); L, low (10-40%); M, medium (40-60%); H, high (> 60%); PS, pre-soaking in cold water; HT, hydro-thermal procedure, AS, autumn sowing; WW, pre-soaking in warm water, MC, maceration in HCl, SF, cold stratification; AS/SF, autumn sowing or cold stratification; s, seconds; d, days; m, months; SH, shoot height, RCD, root collar diameter, brr, bare root seedlings, cnt, container seedlings.

Figure 2. Part of the sampled allochthonous coniferous species in various developmental stages. a. *Ginkgo biloba* seeds in natural conditions. **b.** *Calocedrus deccurens* cones in natural conditions. **c.** *Taxodium distichum* cones and seeds in laboratory, before treatment and analysis. **d.** *Cupressus arizonica* seeds in laboratory, before treatment and analysis. **e.** *Cedrus deodara* container seedlings (Nursery forest subsidiary Sveti Nikole, photo courtesy of Kristina Pančevska). **f.** *Cupressus arizonica* container seedlings (Nursery forest subsidiary Sveti Nikole, photo courtesy of Kristina Pančevska). **g.** 1+0 *Cupressus arizonica* bareroot seedlings (Nursery forest subsidiary Karadzica, photo courtesy of Sonja Nikolovska). **h.** 1+0 *Ginkgo biloba* bareroot seedlings (Nursery forest subsidiary Karadzica, photo courtesy of Sonja Nikolovska). **i**. 1+0 *Pseudotsuga menziesii* bareroot seedlings (Nursery forest subsidiary Plachkovica – Vinica).

Figure 3. Part of the sampled allochthonous broadleaf species in various developmental stages. a. Rejected pre-mature seeds of *Acer davidii,* common occurrence observed in natural conditions. **b.** Cold stratification of *Melia azedarach* fruits in sand. **c.** *Chimonanthus praecox* seeds in laboratory, before treatment and analysis. **d.** *Koelreuteria paniculata* seeds in laboratory, before treatment and analysis. **e.** Gathered seeds from *Robinia pseudoacacia*. **f.** 1+0 *Catalpa bignonioides* bareroot seedlings (Nursery forest subsidiary Prespa drvo - Resen). **g.** 1+0 *Robinia pseudoacacia* bareroot seedlings (Nursery forest subsidiary Plachkovica-Radovish, photo courtesy Bosilka Jovanova). **h.** 1+0 *Acer negundo* bareroot seedlings (Nursery forest subsidiary Bor-Kavadarci). **i.** 1+0 *Albizzia julibrissin* bareroot seedlings (Nursery forest subsidiary Plachkovica-Radovish, photo courtesy Bosilka Jovanova).

MAIN CONCLUSIONS & FUTURE PERSPECTIVES

The presented data (Table 1) and figures (Fig. 1 and 2) provide a summary of 25 years of experience with allochthonous tree and shrub species that have been identified as potential seed sources. Although the ecological characteristics of the nurseries where the seedlings were produced have certainly had an impact on their characteristics, we use this extensive information to pinpoint several conclusions:

- Allochthonous species are abundant in the city of Skopje and its surroundings and can serve as potential seed sources for plant propagation of various species in the nurseries across the country with different climatic conditions.
- 1+0 coniferous seedlings obtain better characteristic as container seedlings, while 1+0 broadleaved species as bare-root seedlings.
- Within the coniferous groups, variation of seedling characteristics are minor, while in the broadleaved group large variations can be observed.
- For those species characterized as 'rare', urgent experiments are needed in order to prevent the loss of the potential seed sources.
- Future efforts for increase of the urban green areas need to be more inclusive, both in terms of the type of green areas and species selection. Table 1 indicates of an uneven species distribution, which can be due to the seeds vitality, but also due to the lack of knowledge in the nurseries regarding the production (e.g., the pre-sowing treatment) and biased species selection.
- The more extensive properties of the species need to be taken into consideration in combination with their viability and 1+0 seedling characteristics. A suggested approach of grouping the sampled species depending on their risk or opportunities is presented in Fig. 4.

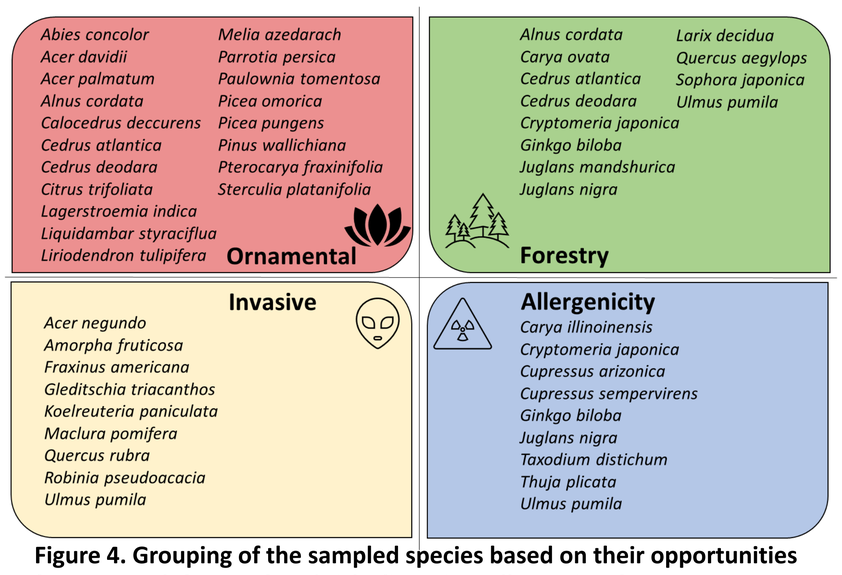

Figure 4. Grouping of the sampled species based on their opportunities (ornamental, forestry) and risks (invasive, allergenicity).