IV. FOREST ECOLOGY AND BIOLOGY

CHARACTERISTICS OF *METASEQUOIA GLYPTOSTROBOIDES* ARTIFICIAL COMMUNITY KOKALYANE VILLAGE, SOFIA REGION

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Abstract: The aim of the present study is phytocoenological characteristics and preliminary assessment of the health status of the first Dawn redwood (*Metasequoia glyptostroboides*) artificial plantation in Bulgaria established in 1969. The plantation of metasequoia is located in the land of the Kokalyane village (Sofia region) on an area of about 2500 m^2. The study was conducted in the period April-July, 2021. The results show that the artificial stand was created on the locality of indigenous communities of *Alnus glutinosa*, which occupy the main part of the Iskar river banks between Plana and Lozenska mountains. The health status of the Dawn redwood plantation was assessed as "good". From the distance of the 50-year period, the artificial afforestation with this exotic relic in the area of the village of Kokalyane can be considered successful.

Keywords: phytocoenoses, insect pests, pathogens, forest stands, Dawn redwood

INTRODUCTION

Dawn redwood (*Metasequoia glyptostroboides* Hu & Cheng) (Taxodiaceae), a living fossil endemic to China, may be the most successfully recovered threatened species, with many more individuals and a much wider distribution than fossil records indicate [10]. The species was re-introduced to its ancestral domains in the American Northwest, in Russia, and in Japan, but it has established itself in new homes all over the globe [12]. Its rapid growth rate has led to consideration for using the tree in forestry plantations [13].

The introduction of *M. glyptostroboides* in Bulgaria began in 1953 [4]. Due to the limited amount of planting material, the seedlings were carried out in groups or individually, mainly in Krichim Park, Plovdiv and Sofia.

One of the rare examples of Dawn redwood artificial planting on the territory of Bulgaria was the first such plantation near Sofia established in 1969 [4]. For the last 30 years it has not been the subject of research, although in addition to the experimental value it carries, its phytocoenosis falls within the protected area "Iskar River" from NATURA 2000 [2].

The aim of the present study is phytocoenological characteristics and preliminary assessment of the health status of the specific *Metasequoia* plantation.

MATERIALS AND METHODS

The Dawn redwood artificial stand is located in the Iskar River gorge between Plana and Lozenska Mountain on an area of about 2500 m^2. The studied community is situated at a distance of 5 to 25 m from the river in the local place named Yuzinata (close to Kokalyane village), coordinates 42°34'8.821"N, 23° 25'56.07"E. (Fig. 1).

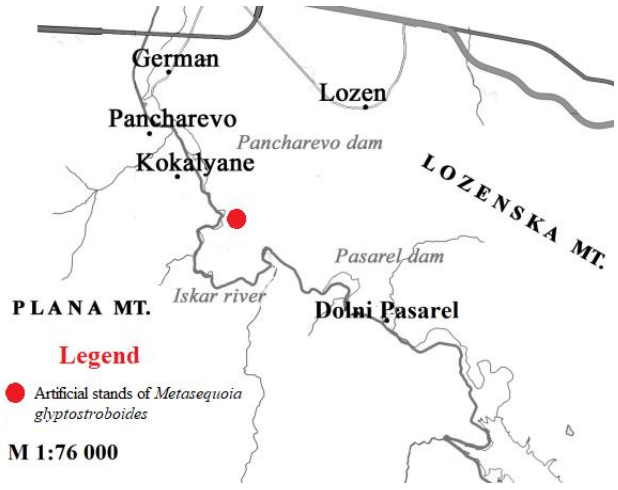

Fig. 1. Map of the area with the location of the artificial community of *Metasequoia glyptostroboides*

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The altitude is 630 m a.s.l. the slope declination is 0°. Soils are Alluvial Fluvisols [7]. The planting sheme of the fast-growing Dawn redwood plantation was probably 2,0 - 4,0 m x 1,5 - 2,0 m (according to Annex № 10 to Art. 45, paragraph 1, 2 и 4 of the Ordinance № 2 from 2.02.2009 for forestation and inventory of forest plantations.

The study was conducted in the period April-July, 2021. The characteristics of the community follow the basic phytocoenological principles [5]. The quantitative presence of the species is assessed on a base of the 5-degree Braun-Blanquet scale (1964) [1]. The analysis of the species composition was performed according to biological, ecological, and phytogeographical indicators [3].

The following main abbreviations are used in the material:

a) Raunkier life forms: G – geophytes; H – hemicryptophytes; He Ph – phanerophytes, Th – therophytes.

b) ecological groups according to the humidity factor: Hg – hygrophytes, Mf – mesophytes, Mx – mesoxerophytes, Xm – xeromesophytes

c) ecological groups according to the light factor: He – heliophytes, Sc – sciophytes, Sh – hemisciophytes.

d) Synanthropy anthropophytes – At, apophytes – Ap and autochthonous taxa –Av.

e) phytocoenotic layers: (a) – tree layer, (b) schrub layer, (c) grass layer.

During the field work, all *Metasequoia* individuals were examined for the presence of insect pest damage, as well as for the presence of pathological changes caused by abiotic and biotic influences. The inspection for insect damage consisted of an analysis of the leaf mass, aimed at identifying leaf-eating and piercing-sucking pests, and for damage from stem pests, an inspection of the stems and accessible branches was performed. The plant tissues of the individual trees were examined for the fruiting bodies of phytopathogenic fungi, as well as for the presence of characteristic pathological changes resulting from these or other parasitic organisms. The trees have also been checked for damage and diseases caused by abiotic factors.

RESULTS

The plant community has a three-layer vertical structure (Table 1) with partially formed second layer. The first (tree) layer has a total cover abundance of 70%, represented mainly by *M. glyptostroboides* with a single participation of *Alnus glutinosa* and *Sequoiadendron giganteum*. The total cover abundance of the schrub layer is about 20% with the participation of *Sambucus nigra*, *Cornus mas* and *Euonymus verrucosus*. The grass layer has 65% total cover abundance and two aspects with a mosaic distribution of species – spring aspect with a predominant participation of *Ficaria verna* and concomitant participation of species such as *Cardamine bulbifera, Anemone ranunculoides, Pulmonaria officinalis, Chrysosplenium alternifolium, Asarum europaeum, Viola odorata* etc. and a summer aspect in which species such as *Geranium pyrenaicum, Lamium maculatum, Festuca heterophylla, Aegopodium podagraria*, etc. have a higher presence. Impressive is the variety of understory of trees and shrubs in the grass layer, among which with higher cover abundance are *Hedera helix* and *Rubus caesius*. No signs for successful natural regeneration were found for the two introduced species – *M. glyptostroboides* and *S. giganteum.*

Table 1. Quantitative and qualitative indicators of the species composition in the studied community

Species composition by layers / horizons	Cover abundance	Life form	Floristic element	Ecological group according to the light	Ecological group according to the humidity	Synanthropy
Layer I	**Total cover abundance 70%**					
Metasequoia glyptostroboides Hu & Cheng (a)	5	Ph	Adv	He	Mx	Ap
Alnus glutinosa (L.) Gaertn.) (a)	+	Ph	Med-CAs	He	Hg	Av
Prunus padus L. (a)	+	Ph	Eur-As	Sh	Mf	Av
Sequoiadendron giganteum (Lindley) J. Buchholz (a)	+	Ph	Adv	Sh	Mf	Ap
Layer II (Horizon 2)	**Total cover abundance 20%**					
Sambucus nigra L. (b)	2	Ph	Eur-Med	Sh	Mf	Ap
Cornus sanguinea L. (b)	1	Ph	subMed	He	Xm	Av

Corylus avellana L. (b)	+	Ph	Med-CAs	Sh	Xm	Av
Juglans regia L. (b)	+	Ph	Eur-As/Paleo	He	Mf	At
Euonymus europaeus L. (b)	1	Ph	Eur-As	He	Mf	At
Carpinus betulus L. (b)	+	Ph	Eur-subMed	Sc	Mf	Av
Ligustrum vulgare L. (b)	+	Ph	subMed	Sh	Mx	Ap
Layer III	**Total cover abundance 65%**					
Acer platanoides L. (c)	+	Ph	SubMed	Sh	Mf	Av
Aegopodium podagraria L.	+	H	Eur-Sib	Sc	Mf	Ap
Alnus glutinosa (L.) Gaertn.) (c)	+	Ph	Med-CAs	He	Hg	Av
Anemone ranunculoides L.	+	G	Eur-Med	Sc	Mf	Av
Anemone nemorosa L.	+	G	subBoreal	Sc	Mf	Av
Asarum europaeum L.	+	G	Eur-As	Sc	Mf	Av
Carpinus betulus L. (c)	+	Ph	Eur-subMed	Sc	Mf	Av
Chaerophyllum temulentum L.	+	Th-H	Eur-Med	Sh	Mf	At
Chrysosplenium alternifolium L.	+	H	subBoreal	Sh	Mf	Av
Clematis vitalba L.	+	Ph	Eur	He	Mf	Ap
Corylus avellana L. (c)	+	Ph	Med-CAs	Sh	Xm	Av
Dactylis glomerata L.	+	H	Eur-As	Sh	Mf	Ap
Dentaria bulbifera L.	+	H	Eur-Med	Sc	Mf	Av
Euonymus europaeus L. (c)	1	Ph	Eur-As	He	Mf	At
Festuca heterophylla Lam.	1	H	Boreal	Sh	Xm	Av
Ficaria verna Hudson subsp. *calthifolius* (Reichenb.) Arcangeli	4	G	Eur-Sib	Sh	Mf	Ap
Galium mollugo gr.	+	H	Eur-As	Sc	Mf	Av
Galium odoratum (L.) Scop.	+	H	Boreal	Sc	Mf	Av
Geranium pyrenaicum Burm. f.	2	Th	subMed	Sh	Xm	Ap
Geranium robertianum L.	+	Th-H	SubBoreal	He	Mf	Ap
Geum urbanum L.	+	H	subBoreal	Sh	Mf	Ap
Hedera helix L. (c)	2	Ph	Eur-As	Sh	Mf	At
Juglans regia L. (c)	+	Ph	Eur-As/Paleo	He	Mf	At
Lamium maculatum L.	1	H	subBoreal	Sc	Mf	Ap
Lathraea squamaria L.	+	G	Eur-As	Sc	Mf	Av
Oxalis acetosella L.	2	H	subBoreal	Sc	Mf	Av
Pulmonaria officinalis L.	+	H	Eur	Sc	Mf	Av
Quercus dalechampii Ten. (c)	+	Ph	subMed	He	Mf	Av
Rubus caesius L. (c)	1	Ph	Eur-Med	Sh	Mf	Ap
Scirpus sylvaticus L.	+	H	subBoreal	Sh	Mf	At
Stellaria media (L.) Vill.	+	H-Th	Kos	Sh	Mf	At
Taraxacum officinale Weber	+	H	Eur-Sib	He	Mf	At
Urtica dioica L.	+	H	Boreal	Sh	Mf	At
Veronica hederifolia L.	+	Th-H	Eur-Med	Sh	Mf	At
Viola odorata L.	+	H	Eur-Med	Sh	Xm	Ap

In terms of floristics, the studied community consists of 42 species, 40 of which belong to the *Magnoliophyta* division and 2 species (*M. glyptostroboides* and *S. giganteum*) from the *Pinophyta* division. The percentage ratio between the two Angiosperms' classes *Magnolipsida*: *Liliopsida* is 92.5%: 7.5%. Among the life forms, phanerophytes predominate (40.5%), followed by

hemicryptophytes (35.7%) and geophytes (11.9%). The transitional forms hemicryptophytes-therophytes (9.5%) and therophytes (2.4%) have the lowest species share. There are 11 floristic elements (Table 2), of which the highest percentage are Euro-Asian, followed by Euro-Mediterranean and subboreal species. Adventive elements are represented by 2 species – *M. glyptostroboides* and *S. giganteum.*

Table 2. Distribution of floral elements in the studied community

Floristic element	**Abbreviation**	**%**
European-Asian	Eur-As	21,4
Euro-Mediterranean	Eur-Med	16,7
Subboreal	subBoreal	16,7
Submediterranean	subMed	11,8
Euro-Siberian	Eur-Sib	7,1
Boreal	Boreal	7,1
Mediterranean-Central Asian	Med-CAs	4,8
European	Eur	4,8
Adventive	Adv	4,8
Euro-submediterranean	Eur-subMed	2,4
Cosmopolitan	Kos	2,4

The distribution of the ecological groups of species according to the ligh factor is as follows: hemisciophytes – 47.6%, heliophytes – 23.8%, sciophytes: 28.6%. According to the soil humidity factor, the ecological group of mesophytes is predominant (81.0%), followed by xeromesophytes (11.8%), mesoxerophytes (4.8%), and hygrophytes (2.4%).

The community is dominated by autochthonous species (42.9%), apophytes (33.3%) and anthropophytes (23.8%).

Regarding the health status of the *M. glyptostroboides* plantation, in view of pests and diseases, our preliminary results showed a relatively good condition of individuals. Injuries from insect pests, as well as physiological, anatomical and morphological changes that occurred as a result of pathological processes were not identified in the investigated community.

DISCUSSION

The majority of the species in the investigated community are mesophilic hemisciophytes characteristic for the union *Alnion incanae* Pawłowski et al. 1928 (Class Class Querco-Fagetea Br.-Bl. & Vlieger in Vlieger 1937), which shows that the plantation was created on the locality of indigenous communities of *Alnus glutinosa*, which occupy the main part of the Iskar river banks between Plana and Lozenska mountains. These phytocoenoses are part of the NATURA 2000 habitat 91E0 * Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [6].

The analysis of the floristic composition shows a relatively low percentage of anthropophytes and the absence of invasive alien species. The low participation of annual species (therophytes) and the well-defined vertical structure of the community with monodominant participation of *M. glyptostroboides* in the tree layer is a sign that the species has adapted very well to habitat conditions and at this stage successfully replaces natural edificators – black alder, willow and poplars. The lack of understory of individuals from *M. glyptostroboides* confirms the findings of the study by Li et al. (2012) [11] on the difficulty of restoring the species in natural conditions.

According to Delkov (1988) [4], the culture of the Dawn redwood near Sofia shows very good results. At the age of 32, some individuals reached a height of 26 m and a diameter of 0.6 m. The high assessment of the health of the plantation in the current study, the lack of serious damage from insect

pests and pathogens show that the choice of site for afforestation with this exotic species 50 years ago was completely appropriate. The study supports Kuser's (1999) [9] view that the conditions under which Dawn redwood did best in its native range: in full sunshine on streamside sites, preferably sloping south, with water available all summer and seasonal variations in temperature-warm summers and cold winters.

In the available literature in our country, no information was found about insect pests and pathogens of *M. glyptostroboides.* It is possible that the lack of research so far is due to its limited distribution in Bulgaria. The decorative qualities of this exotic species are mostly well known and highly valued by the Guild of Landscape Architects, which necessitates its use as a single park tree in urban landscapes. For this reason, our preliminary results on the health status of *M. glyptostroboides* remain subjective.

Additional research is definitely needed in the park areas, where it is widespread, albeit in small groups. On the other hand, the lack of pests and pathogens in the surveyed artificial stand along the Iskar River is not a surprising result. Rather, this is an expected phenomenon, given the fact that the metasequoia is weakly affected by pests and diseases [8]. This resistance to natural enemies, together with its indisputable decorative qualities and environmental requirements, make the species extremely valuable, both for landscaping and why not for forestry in the face of climate change?

CONCLUSIONS

From the distance of 50 years' period, artificial afforestation with the exotic relic *Metasequoia glyptostroboides* in the Kokalyane region can be considered successful.

The investigated plantation retains a large part of the species diversity characteristic of the local riparian communities and despite its proximity to urban areas at this stage does not allow invasive alien species in its composition and the participation of ruderal elements there is low.

The health status of the Dawn redwood artificial stand was assessed as "good". The lack of natural regeneration is a problem that, with a decision for sustainable management of the plantation, can be overcome by additional afforestation with seedlings including vegetative propagules produced with the genetic material from the local population, grown in artificial conditions.

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