IV. FOREST ECOLOGY AND BIOLOGY

VEGETATIVE PROPAGATION AND REINTRODUCTION OF COMMON YEW (*TAXUS BACCATA* L.) IN ITS NATURAL HABITATS IN STRANDZHA AND VITOSHA MOUNTAINS

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Abstract. *Ex situ* propagation and reintroduction in the wild could be a promising approach in the conservation of rare species, including the Common yew. Its conventional vegetative propagation by rooting of cuttings do not provide satisfying results since a major factor remains the stage of development of the donor plant. Cuttings from stage-young individuals taken from Maglizh site formed more root primordia, with successful rooting of 44%. Individuals in the reproductive stage of their development form root primordia, but root development follows in 8 to 20 % of cuttings, while the other cuttings necrotize. The attempt to reintroduce *Taxus baccata* revealed that young plants hardly develop in the lower part of the steep slopes of thinned forest communities, forming the natural habitat of the mixed scree forests, on steep slopes and ravines, a xerophytic variant of the Tilio-Acerion alliance. Young Yew plants are sensitive to summer droughts and to the allelopathic effect of their neighboring *Rhododendron ponticum* shrubs, which reduces the success of their reintroduction. A limiting factor is also the thick layer of leaf litter and shading by beech trees in the lower part of the slopes, as well as damage by wild herbivores, mainly roe deer and rabbits. Young saplings require good soil aeration, combined with sufficient moisture during the summer drought period and intensive cultivation, including lightening under beech shading during the initial three-year period after planting.

Keywords: common yew, habitats, nature parks

INTRODUCTION

The common yew (*Taxus baccata* L.) is a relict tertiary species and is one of the most ancient European trees (Thomas and Polwart, 2003). Although it rarely forms pure forest stands, only a few centuries ago it was an integral part of forests in much of Europe, from Scandinavia to the Mediterranean and from North Africa to Turkey and the Caucasus Mountains (Dovciak, 2002; Dhar et al., 2006). As a result of climatic changes associated with drying climate (Stefanov, 1943), the range of yew in Europe contracted. Combined with anthropogenic pressure since the Middle Ages, initially because of its specific and valuable wood, later because of the poisonous leaves, young twigs and arils affecting grazing, it has led to a further reduction of its population in the natural environment evaluated as one of the fastest range reductions of any European tree species (Paule et al., 1993; Dovciak, 2002). It is believed that yew populations consist mainly of old trees that show weak regenerative abilities and its range will continue to decrease in the future. The reasons for the weak regenerative abilities of yew have not been fully studied. Therefore, studies related to the natural processes of population recovery, as well as the possibilities to support these processes, require efforts to adapt appropriate management and conservation techniques (Dovciak, 2002). In Bulgaria, the yew is a protected species, included in Annex No. 3 of the Biological Diversity Act of Bulgaria. In the Red List of Bulgarian higher plants, the species is categorized as "threatened" (Petrova & Vladimirov, 2009). It is included in the Red Book of Bulgaria because of its limited distribution, small population size, high degree of fragmentation, logging in the past, as well as the specific ecological requirements that limit regeneration and threaten the species with destruction (Evstatieva, 2015). The species is listed as conservation significant for the natural habitats of mixed scree forests, on steep slopes and gorges (Tashev, 2015). In Bulgaria, the habitat is represented by two subgroups – Linario-Acerion and Tilio-Acerion with different ecological variants. Syntaxonomically, the natural habitat in Strandzha belongs to the xerophytic variant of the union Tilio-Acerion (Tashev, 2015).

Due to the extreme conditions and the long period of adaptation without human intervention, the forests of this natural habitat possess a special structural diversity. They are relatively heterogeneous, with a rich and diverse species composition in the tree floor, including due to the small area of occurrence of these habitats and the high influence of the ecotone zones with the neighboring habitats. The economic activity in this natural habitat in Vitosha and Strandzha is minimal and its fragmentation is determined by the specific orographic conditions for development with small, long, rugged slopes. In structural terms, the forests

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in this natural habitat possess most of the characteristics of old forests, except for a low number of trees with marginal diameters for the species (Savev et al, 2015).

Most yew genotypes are propagated by cuttings, which root without much difficulty. Cuttings of the genus *Taxus* can be rooted outdoors in cold greenhouses or in vegetative houses with misting, which gives much faster results. The cuttings are 20 to 25 cm long. They are cut in early autumn. Annual shoots with a two-year base are used. The leaves at the base are removed. Treated with 4000-20000 ppm IBA powder based on talc (Dirr, Heuser, 1987; Krüssmann, 1997; Hartmann et al., 2010) or IBA or treated once with 5000 to 10000 ppm IBA solution (Hartmann et al., 2010). Rooting proceeds slowly during the following spring and summer (Krüssmann, 1997; Hartmann et al., 2010).

Spring cutting of the cuttings and planting in a vegetative house is also practiced (Hartmann et al., 2010; Bertels, 2012). A basal warm-up is recommended. Cuttings are initially dipped once in a solution containing 2000 to 2500 ppm IBA and 1000 to 1250 ppm NAA. Misting is provided. The substrate is a mixture of 90% sand and 10% peat. Its temperature is maintained around 21°C, and the air – from 10 to 13°C. Rooting only about 2 months, but the cuttings should not be taken out too early. It is necessary to wait for the roots of the first order to branch (Hartmann et al., 2010).

Autovegetative propagation was carried out by using donors in different stages of development and production of planting material for recovery and support of natural regeneration by importing female individuals of the common yew (*Taxus baccata*) population on the territory of the Nat "Strandja". For the population in NP "Vitosha", an attempt at autovegetative propagation by local individuals at a stage-old age and an attempt to support regeneration by importing the produced saplings are presented.

The aim of the present study was to test the vegetative propagation of the Common yew and the possibilities for introduction of the propagated saplings into the natural conditions of the two yew habitats in the Nature Park "Strandja" and in the NP "Vitosha".

OBJECTS AND METHODS

OBJECTS

The natural conditions in both sites are determined by the boundary conditions of the ecotone between beech forests and mixed forests on scree, steep slopes and gorges.

In the NP "Strandja", the beech forests are represented by the West Pontian beech forests. The micro-growth in which the yew trees are located in the NP "Strandja" has an irregular microrelief with yellow-earth (Alisols) soils of the yellow-earth-podzolic subtype (Stagnic Alisols Alj.), moderate power and a thin humus horizon (FAO). The exposure is shady (northern) with high air and soil humidity. Average annual precipitation and temperature are 950 mm and 11.3°C, respectively (Vekilska, Topliiski, 1990).

The site of common yew (*Taxus baccata*) in Strandzha in the area of Marina Reka is located on the steep northeastern slopes of the Elenitsa River (Marina Reka), 150 m above sea level. and represents a single yew with a branching stem and a bushy habit. The site is in the area of Pisan Kamak, near the "Tisovitsa" reserve, at 130 m. above sea level is with north exhibit, and also presents a single yew with a branching stem and bushy habit.

In the NP "Vitosha" beech forests are represented by the habitat of acidophilic beech forests, with a very steep slope, in some places passing into scree. In the range 1200 – 1300 m. above sea level mean annual precipitation and temperature are 818 mm and 6.9 °C, respectively (Georgiev et al., 1970).

The species composition of the grass floor is characteristic of beech and hornbeam forests (Gusev and Tsonev, 2015). The main gradients that influence variations in the floristic composition of this habitat type are moisture, nutrients, temperature and light (Sekulić et al., 2023).

Within the boundaries of the Nature park "Vitosha", the yew deposit is a remnant of a more extensive formation. Over the years, the area of this deposit has gradually decreased due to human impact on it. The locality of the species is located in the place where the Petrovichka river crosses the tourist trail from the district of Boyana to the mountain hotel of "Esperanto". The stand in which the yew is involved is of scion origin and there are 109 yew individuals, 90 of which are severely damaged and in unsatisfactory condition. The yew individuals are mosaic scattered over an area of about 30 dka. The population occupied a non-forested area with a slope of about 25°, in the border ecotone of the habitats "Acidophilic beech forests" and "Mixed forests on scree, steep slopes and ravines" with a north exposure and is located at an altitude of 1200 m. The estimated age of the plantation is about 70 years. The average height of the yew is about 5 m.,

and its fullness is relatively low. The condition of individuals can be defined as unsatisfactory.

Natural regeneration was not found in both sites. Due to the exceptional conservation importance of the species, artificial support for its recovery is necessary.

METHODS

The reproductive materials for NP "Strandja" were harvested in two consecutive years – 2011 and 2012, and for NP "Vitosha " – 2020 and 2021. For the two sites in NP "Strandja", one-year shoots were collected from adult male individuals and female stage-young individuals from the locality in Sredna Stara Planina.

Stage-ripe male and female individuals from the same locality were used for the site in NP "Vitosha".

One-year shoots 30-50 cm long were harvested, in the phenophase before the beginning of vegetation – the month of April. Wet towels were used to preserve humidity during transport.

Propagation of the vegetative materials was carried out in the greenhouse of the educational arboretum of University of Forestry. The recommendation for autovegetative propagation by mature stem cuttings in an unheated vegetative house was used (Iliev et al., 2015).

The cuttings are cut with a length of 7 – 10 cm, and the one-year shoots are separated with a two-year base. The diameter of the base of the cutting is 4-6 mm, with the leaves removed at the base 3-4 cm from the basal cut

They are planted in pots with a depth of 20 cm at a depth of 50% of the length of the cutting in a substrate mixture of sand and perlite in a ratio of 4/1. The water regime was maintained by double misting with an automatic fogging system, and the relative air humidity was maintained above 80%.

Rooted cuttings are dipped in the fifteenth week in containers with a capacity of 2 l in substrate a mixture of equal parts peat, sand and perlite with a neutral pH. The adaptation of the spiked saplings lasted 6 weeks under the same conditions in a vegetative house. They were planted on the ground for the Strandzha Natural Park in September 2012 and May 2013, and for the Vitosha Natural Park in the months of October 2020 and May 2021. The actions of planting the produced plant material on the territory of the "Vitosha" and "Strandja" Nature Parks were carried out by teams of the two PPPs.

RESULTS AND DISCUSSION

The inventory carried out within the framework of this study in Bulgarian Strandja found only five individuals, among which no female individuals were found. The deposits in Strandzha are the lowest located in the country and in the Balkans. Certificates are available, incl. toponyms (Tisovitsa river) related to the much wider presence of yew in the Strandzha forests. In the Turkish part of Strandzha, adjacent to the NP "Strandzha", a deposit in good condition with dozens of individuals was found.

The callus formation of the cuttings started on the ninth-tenth week after planting them. Adventitious roots were laid down in the cambial zone. Rooting was completed at the thirty-fifth-sixth week after planting (Table 1).

Table 1. Rooting of cuttings

Origin	Sex/stage	Pledged cuttings, no.	Rooted		Picked up	
			no.	%	no.	%
Strandzha, Marina Reka	Male/Mature	89	14	15.7	9	10.1
Vitosha	Male/Mature	312	43	13.7	25	8.0
Vitosha	Female/Mature	257	71	27.6	53	20.6
Stara planina, Maglizh	Female/young	238	194	81.5	105	44.1

The best rooting of the grafted cuttings was obtained in stage-young, female individuals from Stara Planina in the Maglizh region. 238 cuttings were planted from this origin, callus formation with adventitious roots was 194 cuttings (81.5%). From the picked up cuttings with adventitious roots, 105 container saplings (44.1%) were produced. The cuttings from the Marina Reka site, from a stage-old

male individual, were planted using the same method one month later. Out of 89 harvested cuttings, callus formation was observed in 38 cuttings, adventitious roots were present in only 14 cuttings, and only 9 (10.1%) produced seedlings ready for planting in the following year. In cuttings collected from mature female individuals from the Vitosha site, callus formation with adventitious roots was observed in 27.6%. Callus formation with adventitious roots from stage mature males was observed in only 13.7%. From cuttings of Vitosha origin, 53 (20.6%) number of container saplings from 257 cuttings and 25 grafted saplings from 312 cuttings from stage-old male individuals (8%) were produced in 2020.

In the spring and autumn of 2013, the propagating material of 85 saplings in a 2 l container from the site in Maglizh and nine pieces of yew in Marina Reka was prepared for introduction into the natural environment in NP "Strandja".

Saplings were planted in the lower parts of steep terrains, on colluvial soils in well-developed pockets, in scree habitat, on steep slopes and ravines, the xerophytic variant of the Tilio-Acerion sub-association (Table 2).

Table 2. Planting and seedling survival

Objects of Planting	Geographical coordinates	Planted/ no.		Survived 1 year	Survived 2 years	Available
		male	female			
Vitosha	42.630395 23.260394	25	28	11	2	-
Strandja:						
a. Marina Reka	42.111248 27.764203	3	17	6	3	1
a. Daskalski dol	41.976398 27.487564	1	6	5	4	2
a. Fails	41.981946 27.492326	1	4	2	2	2
a. Chapel of St. Petka	42.055102 27.435575	1	4	1	1	1
a. Dokuzak	42.021697 27.503043	-	4	1	1	-
a. Byala Voda	42.164543 27.452250	-	3	1	-	-
a. Butamyata	42.050439 27.984377	2	18	5	5	1
a. Mrzevski dol	42.097407 27.679939	1	19	3	3	3

The saplings in NP "Strandja" were inventoried at the beginning of March next year. Two different types of damage were identified according to the type of damage. Out of all 85 saplings planted, only 10 were in good condition. Traces of game, mainly roe deer, were found at one of the destroyed saplings. The second cause identified was severely suppressed growth due to dense shading by nearby beech trees. During the inventory of saplings planted in NP "Vitosha", no live saplings were gr in the following year. (Table 2).

CONCLUSIONS

The vegetative propagation of the Common yew by using donor plants from natural localities is difficult mostly because of the lack of young plants. The best results were obtained with the donor plants from Maglizh region (Stara Planina). Planting of vegetatively propagated individuals in their natural habitats resulted in very low survival rate. Possible reasons were damages by herbivores and dense shading caused by the beech canopy.

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