

## Elm forests in North Bulgaria and conservation strategies

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### Abstract

From the genus *Ulmus*, the naturally spread species in Bulgaria are *Ulmus minor*, *U. laevis*, and *U. glabra*. The main reason for the decreasing of the number and density of the elm populations in Bulgaria are the epyphytonic expressions of the Dutch elm disease (DED) in the 1920s and 1970s, after which the representatives of genus *Ulmus* today occur predominantly as solitaire trees, biogroups and rarely form stands. In connection with the preservation of the genepool of the elms after the *in situ* method, an inventory of their genetic resources in North Bulgaria has started in 2002. To study the variability according to morphological signs and health status 17 permanent sample plots have been established and 60 plus trees have been determined. For the needs of the afforestation six seed stands were established. The *ex situ* conservation method was carried out through clone collections, progeny trials and experimental plantations.

**Key words:** inventory, variability, *in situ* and *ex situ* conservation, breeding.

### Resumen

#### Los bosques de olmos en el norte de Bulgaria y estrategias para su conservación

Las especies naturalmente presentes en Bulgaria del género *Ulmus* son *Ulmus minor*, *U. laevis* y *U. glabra*. La principal razón para el descenso en el número y densidad de las poblaciones de olmo en Bulgaria son las pandemias de grafiosis de las décadas de 1920 y 1970, tras las cuales los representantes del género *Ulmus* aparecen hoy en día predominantemente como pies solitarios y biogrupos, y sólo raramente formando rodales. En relación con la conservación *in situ* de la variabilidad genética de los olmos, en 2002 se inició un inventario de sus recursos genéticos en Bulgaria septentrional. Para estudiar la variabilidad en función de las características morfológicas y de su estado sanitario, se ha establecido 17 parcelas permanentes y se ha determinado 60 árboles plus. Para cubrir las necesidades de reforestación se ha establecido seis parcelas semilleras. La conservación *ex situ* se ha desarrollado con recolección de clones, ensayos de progenie y plantaciones experimentales.

**Palabras clave:** inventario, variabilidad, conservación *in situ* y *ex situ*, mejora genética.

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### Introduction

The afforested area in Bulgaria presents 3.4 million ha and the average age of the forests is 49 years. The total growing stock is 526 million m<sup>3</sup>, 44% of them coniferous species and 56% deciduous ones, the average productivity being 156 m<sup>3</sup>/ha (National Forestry Board of Bulgaria, 2002). The geographic position of Bulgaria includes three phyto-geographic zones and various climatic and soil conditions, which determines, in spite of the comparatively small area of the country, its third place in Europe with regard to the biodiversity.

The conservation of the forest gene pool and the biodiversity with the *in situ* and *ex situ* methods are among

the main priorities in the forest policy of the Republic of Bulgaria, to be executed by state administration and scientific organizations through legislation adapted towards the requirements of the European Union (Fig. 1).

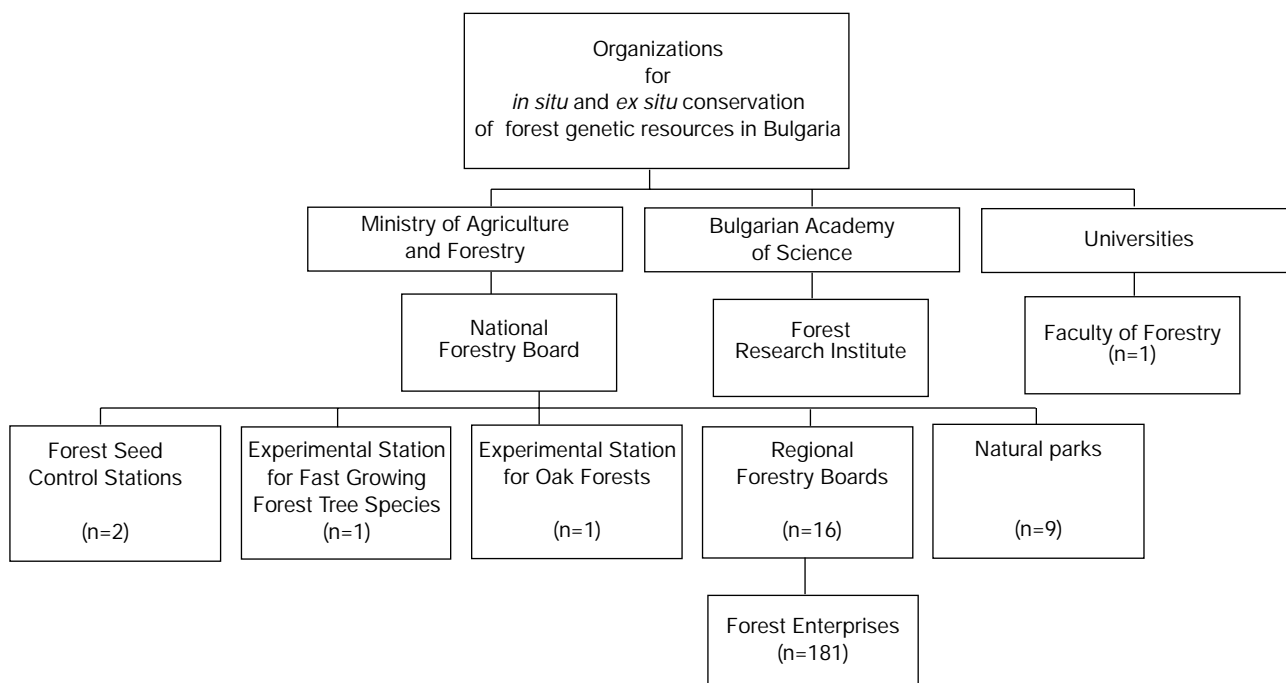
After the ephytotein expression of the Dutch elm disease (DED) in the twenties and seventies of XX century the representatives of genus *Ulmus* are with strongly narrowed distribution area in this country. This imposes the creation and application of a strategy for preservation and restoration of the forest gene pool of this genus.

The first clone collection has been established in the town of Svishtov in the 1980s by Hristo Dimitrov and comprises by 27 clones of natural hybrids between *Ulmus minor* Mill. and *U. pumilla* L., which resistance towards the Dutch elm disease was tested (Dimitrov *et al.*, 1982; Naydenov and Broshtilov, 1985).

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**Figure 1.** Organizations responsible for the preservation of the forest gene pool in Bulgaria.

With regard to the conservation of the genetic pool of elms with *in situ* and *ex situ* methods, in 2002 research team from the Forest Research Institute at the Bulgarian Academy of Sciences started the execution of a three-year programme entitled «*Distribution, variability and health condition of genus Ulmus ssp. in Northern Bulgaria*». Its object was the investigation and conservation of the genetic resources of the indigenous species of genus *Ulmus* in Bulgaria. In this chapter preliminary work on elm inventory and conservation in north Bulgaria is presented.

## Material and Methods

The study was undertaken on stands, biogroups and solitary trees of elm in good health condition and by phenotype traits on the territory of four Regional Forestry Boards: Lovech (including 12 state forest enterprises), Veliko Tarnovo (9 state forest enterprises), Russe (9 forest enterprises) and Shumen (9 forest enterprises). Additional stands and plus trees in the territories of Berkovitca and Sofia Regional Forestry Boards were included (Fig. 2).

The inventory of elms was made through: 1) *Method of inquiry*, including: sending of questionnaire lists to the regional administration of the National Forestry

Board; 2) *Terrain investigations*, including: direct observations and preparation of field checklists for characteristics and assessment of the established stands, biogroups and solitary trees of elms; 3) *Mapping*: the habitats of elms are mapped using as a background the forest maps in scale (1:10 000).

In order to study the variability of *Ulmus* in autochthonous stands 17 permanent sample plots were established. These plots included elms with good phenotype characteristics and contained more than 20 individuals. A field checklist was prepared to include characteristics and location within forest maps in scale 1:10 000.

The variability according to the type of bark fissuring, stem, leaf and crown shapes was determined according to Flora Bulgarica for the European white elm (*Ulmus laevis* Pall. = *U. effusa* Willd. = *U. pedunculata* Foug.), field elm (*Ulmus minor* Mill. = *U. campestris* L. = *U. carpinifolia* Gled. = *U. foliaceae* Gilib.) and mountain elm (*Ulmus glabra* Huds. = *U. scabra* Mill. = *U. montana* With.). Within the field elm three varieties were considered: var. *glabra* (Mill.) Stoj. et Stef. (*Ulmus glabra* Mill. Non Huds.), var. *suberosa* (Monch) C.K. Schneid, and var. *tortuosa* (Host) Hay. (*U. tortuosa* H.) (Stoyanov *et al.*, 1967).

In order to define the ecotype variability in each sample plot the following characteristics were de-



**Figure 2.** Location of Regional Forestry Boards and number of plus trees (T), permanent plots (PP), and provenance trails (PT): Berkovica (7 T, 2 PP); Lovech (39 T, 5 PP); Veliko Tarnovo (17 T, 2 PP); Russe (7 T, 2 PP); Shumen (17 T, 2 PP); and Sofia (7 T, 1 PT).

terminated: site, altitude, exposition, soil type and mother rock.

*In situ* conservation was made through: selection of plus trees with preparation of a passport for each of it including general data (disposition, ownership, site type, quality grade); 19 breeding characteristics (inventory characteristics, stem class, stem form, stem quality, crown width, etc.) and data about the existing vegetation, altitude, precipitation and temperature regime. Permanent seed stands and solitary trees for yielding of reproductive materials of the category «identified», according to the requirements of the Regularity 5 (National Forestry Board of Bulgaria, 2001) were identified.

*Ex situ* conservation was undertaken through: plantations and short term progeny and provenance trails. The latter will be used for assessment of the inherited traits and characteristics of the established forms. The plantations included clones of selected plus trees from different populations and of different elm species.

## Results and Discussion

During the first stage of the project data from 1,083 stands occupying an area of 5,831 ha on the territories

of Lovech, Veliko Tarnovo, and Shumen Regional Forestry Boards were processed. Representatives of genus *Ulmus* in the investigated territories were distributed mainly as solitary trees and rarely their proportion in the composition of the stands exceeded 10 %. According to the statistical data of the National Forestry Board (2001) the high stem elm stands in the investigated territory (242 ha) in 2000 were 7 % of the elm area for the country, distributed mainly in the second and third age classes (Table 1). The total volume of elm wood was 17,319 m<sup>3</sup> and presented 3 % of the total volume for the country (Table 2).

In the inner parts of the country *Ulmus laevis* grows in the sub-belt of the plain-and-hilly oak forests, on fresh to moist, moderate to rich sites, on grey forest soils, on the lower parts of the slopes (along the ravines) and in the range of 200-300 m altitude. *On the Danube islands* the species grows in the sub-belt of the flooded and river-side forests on flood, fresh to moist, moderate to very rich sites, on alluvial soils, at 20-26 m altitude. It forms pure stands with single participation of *Quercus longipes*., *U. minor*, *Morus alba*, *Salix alba*, *Populus alba* and *Pirus communis*.

*U. minor* is presented in the sub-belt of the plain-and-hilly oak forests and in the sub-belt of the flooded

**Table 1.** Area (ha) of the high stem elm stands according to age classes

Forestry boards	Age classes								Total
	1-20 years	21-40 years	41-60 years	61-80 years	81-100 years	101-120 years	121-140 years	> 140 years	
Veliko Tarnovo	21	26	15	1	0	7	0	0	70
Lovech	9	23	16	1	2	3	4	17	75
Shumen	39	19	18	0	3	16	1	1	97
Total	69	68	49	2	5	26	5	18	242
Bulgaria	294	548	411	333	288	477	422	254	3,027

and river-side forests, on fresh to moist, moderate to very rich sites, on leached chernozem, dark grey and grey forest and alluvial soils at 30-150 m up to 250-450 m altitude. It rarely forms pure stands and most often participates in the composition of the mixed forests. In the sub-belt of the flooded and the river-side forests it grows with *Quercus robur*, *Fraxinus* sp., *Salix alba* and *Populus alba* and in the sub-belt of the plain-and-hilly oak forests with *Quercus petraea*, *Fagus sylvatica*, *Carpinus betulus*, *Tilia* sp., *Acer campestre*, etc.

*Ulmus glabra* grows in the sub-belt of the low mountain forests of durmast, beech and fir, on fresh to moist, moderate to very rich sites on dark brown forest soil, as solitary trees or in small groups.

In 2002, six plots containing *Ulmus laevis* were defined, two in the inner parts of the country (territory of Smyadovo State Forest Enterprise) and four on the Danube islands (territory of Svishtov, Lom and Oryahovo State Forest Enterprises). In these plots the monopodial, well self-pruned, with very long, few curved stems and fine bark individuals prevailed. The presence of trees with spiral-grained wood and epicormic branches varied among the different populations. The crowns were narrow (4.0 m up to 6.0 m in diameter) to

middle wide (7.0 m up to 9.0 m in diameter) in shape, with fine to middle thick branches.

Nine permanent plots were established on the territory of the Shumen, Cherni Lom, Novi Pazar, Svishtov and Pleven State Forest Enterprises for studying the variability of *U. minor*. Monopodial, good self-pruned individuals with very long to middle long low curved stems, with fine to moderately fissured bark prevailed. The presence of spiral-grained individuals was insignificant, while elms with fork branching type varied from insignificant to significant in number for the different populations. The crowns were narrow to middle wide with fine to middle thick branches.

In order to investigate the variability of *U. glabra*, two permanent sample plots were established on the territory of Lovech, containing 20 individuals each. Monopodial, good self-pruned individuals characterizing with very long to middle long, low curved stems and fine to middle fissured bark prevailed. The greater part of the trees is with well expressed fork branching high in the crown. The crowns were narrow in shape with fine to middle thick branches.

A total of 132 plus trees were selected and their passport data were recorded: 35 belonging to *U. laevis*, 61 to *U. minor* and 36 to *U. glabra*. The permanent

**Table 2.** Volume (m<sup>3</sup>) of the high stem elm stands growing stock according to age classes

Forestry boards	Age classes								Total
	1-20 years	21-40 years	41-60 years	61-80 years	81-100 years	101-120 years	121-140 years	> 140 years	
Lovech	20	1,319	1,600	1,180	0	0	520	0	4,639
Shumen	1,960	1,380	2,120	0	0	0	0	0	5,460
Total	2,740	5,619	6,260	1,230	0	950	520	0	17,319
Bulgaria	17,270	79,433	85,935	85,825	74,610	130,940	113,615	58,505	646,133

seed stands included solitary trees and six elm woods with a total area of 20 ha: two in Veliko Tarnovo, three in Russe and one in Berkovitsa.

In the spring of 2003, three provenance trails were established on different sites including seven provenances of *U. laevis* and *U. minor* (Fig. 1). Spacing was  $3 \times 3$  m and  $4 \times 4$  m. To study the influence of other tree species on the growth and productivity of the elms, an experimental mixed oak and elm plantation was established in Veliko Tarnovo (Vardim island) (Fig. 2). The plantation consists of *Quercus longipes*, *U. laevis* and *U. minor*, in rows with  $2,5 \times 2,5$  m spacing. In the beginning 2003, 1200 root cuttings from 60 selected plus trees of *U. laevis* and *U. minor* were obtained and put for rooting following the methodology of Broshtilov (1994) for conservation of the gene pool. Fifteen percents of them were successfully rooted.

## Conclusions

The total area of high stem elm woods in Bulgaria is 3 027 ha, while in the investigated territories they occupy 242 ha (7% of them). The high stem elm woods occupy about 0.09% of the total afforested area in the country, the biggest area belonging to stands from 21 to 40 years old. The elms in the studied areas were distributed mainly as solitary trees within the stands. The wood volume is concentrated in stands from 101- up to 120-years. *U. minor* is the most widely distributed. Stands of *U. laevis* with good phenotype characteristics are preserved mainly on the Danube islands, most probably as a result of their natural isolation by the river. Of the three elm species, the most narrowed distribution has *Ulmus glabra*, of which mainly solitary trees and only two groups with more than 20 individuals were found. The forest seed base

for the elms, in the investigated territory, includes six stands with total area of 20 ha.

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