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The yew (*Taxus baccata* L.) population in Knyazhdvir Nature Reserve in the Carpathians (Ukraine)

Abstract: The natural population of yew in the Knyazhdvir Nature Reserve was described and its status has been analyzed. It was stated that more than 22,000 specimens of yew grow there and it is the most numerous population of the species in Ukraine. The most important factor for *Taxus baccata* occurrence there are the presence of calcium carbonate and humidity of the soils. The height and diameter structures of the population indicate that the population is in progress. The largest specimens in 1976 were of 12 m high and of 30 cm d.b.h. The natural regeneration is satisfactory. The increment of height of the yew was greater in the conditions of less density of the canopy of beech-fir stand under which the species grows.

Additional key words: plant protection, stand structure, occurrence conditions

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Introduction

The common yew is rare and endangered plant species in Ukraine. It grows only in the southern and south-western part of the country, in the Carpathians and in the Crimean Mts (Stoyko, Tasenkevich 1996). Only a few specimens grow normally on particular localities of the species, mostly as a relic of previous more frequent occurrence, reduced by wood exploitation and forest environment changes. The number of yew specimens decreased drastically on their Carpathian localities in the 17th and 18th centuries (Kontny 1937). Only a few of the surviving natural populations of *Taxus baccata* are composed of large numbers of yew trees. In Knyazhdvir one encounter the largest population of the species, the most numerous in the whole country and one of the largest in Europe. The other large population of the

species in Ukraine is known from Mala and Velika Ugolka in Transcarpathia (Stoyko, Tasenkevich 1996).

The aim of the present study is to characterize the situation, protection, site conditions and structure of the yew population in Knyazhdvir reserve. The changes in the population during the last 60–70 years are also briefly described based on literature and unpublished data of M. Lucak and J. Malecki.

Location

The Knyazhdvir nature reserve is located at the North-East Carpathians Foothills, on the north-facing, steep (25–35°) slopes above Prut river, at elevations of 320–460 m. The nearest village Knyazhdvir is at distance of about 10 km to the west of Kolomya (Fig. 1).

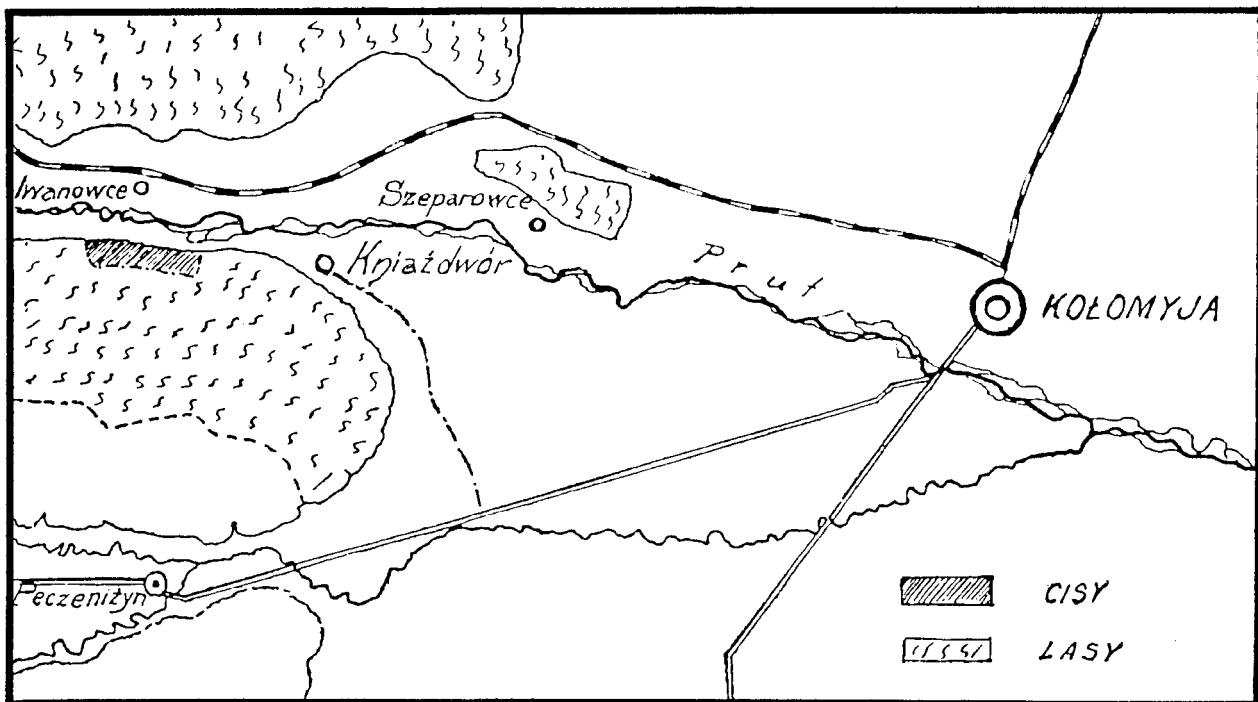


Fig. 1. The original Szafer's (1913) map of Knyazhdvir Nature Reserve location (cisy = the yew trees, lasy = forests)

Site conditions

The Carpathian foothills in the vicinity of Kolomyja are composed mostly of Neogene sandstones, which are covered with loamy or sandy-clay Pleistocene deposits. The slopes where the *Taxus baccata* occurs are ultimately formed by the river, which has cut through the Pleistocene deposits in the past and undermines them presently. The water-bearing horizons are exposed here and a few springs and many water seepages are causing the permanently high soil moisture in many places. The steepness and hydration of the unstable slopes are the main reason for landslides, which have occurred several times in the past. The last are called "spouza" in Ukrainian, and the name is sometimes used for the forest range where the yew grows. The erosion of the steep slopes was intensified after tree felling in the years from 1880 to 1890 (Szafer 1913) and then after the World War I.

The brown or slightly acid brown highly leached soils predominate in the forest where the yew grows. Mechanically the soils are developed from Pleistocene deposits, mostly loams or sandy clays. The upper and lower soil horizons in the places continuously saturated frequently have gley layers. The soils are fertile and contain a significant amount of calcium carbonates, rather rare in the Eastern Carpathians. The $\text{pH}_{(\text{H}_2\text{O})}$ of the soil varies between 7.2 in the upper and 7.8 in the lower layers. The earth-sliding processes and water trickling are enriching soils with the active elements from the deep horizons. The soils are rich in such elements as calcium, magnesium and potassium, but phosphorus deficiency is frequently observed.

The plant cover

The beech (*Fagus sylvatica* L.) forest with European silver fir (*Abies alba* Mill.) is formed in site conditions briefly characterized above. Szafer (1913) considered the stand containing yew as remnants of the primeval, typical for the lower forest layer of the East Carpathians.

The more recent forest inventory from 1976 (Lucak's unpublished materials) describes the stand as 2-storied with the canopy usually 20–23 and maximally to 30 m high, formed by beech and European silver fir in proportion 8:2, with single participation of *Acer pseudoplatanus*, *A. platanoides*, *Picea abies*, *Carpinus betulus*, locally also *Cerasus avium* and *Alnus incana*. The age of the *Fagus sylvatica* canopy trees was determined as 80, and the *Abies alba* as 60 years in 1976. It suggests the described stand was established shortly before Szafer's visit there, and in 1913, when he published his work, it was composed of small beech and fir trees 15–20 years old.

The sub-canopy is developed locally under a canopy of beech and is composed mostly of *Taxus baccata* trees (Figs. 2 and 3), which are 7–8 m high approximately. The underbrush is formed fragmentally or only in some places, mostly by *Corylus avellana*, *Euonymus europaea*, *Sorbus aucuparia*, *Sambucus racemosa* and *Daphne mezereum*.

Herbaceous vegetation covers 5–20% of the analysed area, and is characteristic for broadleaved forests of the mountain zones of central Europe. The communities of *Fagus sylvatica* in Knyazhdvir can be included in the suballiance *Eu-Fagion* of *Fagion sylvatica*.



Fig. 2. *Taxus baccata* in the beech wood in Knyazhdvir Nature Reserve (photo A. Boratyński, 1998)



Fig. 3. A stem of *Taxus baccata* under canopy of beech wood in Knyazhdvir Nature Reserve (photo A. Boratyński, 1998)

ticae alliance, from the ordo *Fagetalia sylvaticae* of *Quercu-Fagetea* class. The phytosociological characters of the broadleaved woods are known insufficiently in the East Carpathians and whole Ukraine and classification of the beech-forest from Knyazhdvir into particular plant association is impossible at the moment. The forest association under discussion resembles *Dentario glandulosae-Fagetum* known from Poland, but such characteristic species as *Dentaria glandulosa*, *Symphytum cordatum*, *Polystichum braunii* and *Elymus europaeus* do not occur here. In their place the species characteristic of *Fagion* alliance, as *Dentaria bulbifera*, *Salvia glutinosa*, *Euphorbia amygdaloides*, *Festuca gigantea* and *Senecio fuchsii* are more or less frequent. The species characteristic for the lowland beech forest (*Melico-Fagetum*) are also growing here. The last association is considered to be the poorest one among the fertile associations of *Fagion* alliance (Medweczka-Kornaś 1972, Matuszkiewicz 1981), but includes many species of *Carpinion betuli* alliance, as for example present also in Knyazhdvir *Asarum europaeum*,

Pulmonaria officinalis, *Hepatica nobilis*, *Lathyrus vernus*, *Hedera helix* and *Carex digitata*, but *Melica uniflora*, characteristic for the *Melico-Fagetum* association has not been found here.

The floristic composition described above indicates a somewhat atypical, transitive between *Fagion* and *Carpinion* alliances character of the beech wood in Knyazhdvir. It depends on low altitude of locality (300–400 m), the steepness of the slopes and anthropogenic influence in the past, the most important tree-felling.

In addition to the *Taxus baccata* the floristic peculiarities of the Knyazhdvir forest include some other rare plant species, as *Cypripedium calceolus*, *Neottia nida-avis*, *Leucojum vernalis*, *Crocus banaticus*, *Allium ursinum* and *Lilium martagon*, mentioned by Szafer (1913) and recently confirmed.

The dynamic processes in the ground, its instability and high calcium carbonate contents have had a positive influence on the *Taxus baccata* and the structure of its population.

Characteristic of *Taxus baccata* population

Occurrence of *Taxus baccata* in Knyazhdvir, at Pechenizhyn vicinities was known from the end of the 19th century (Spausta 1893). This locality was also mentioned by Łomnicki in 1900 (after Szafer 1913). The first detailed information concerning of the strength of the yew population in the beech forest on the slopes above Prut river valley in Knyazhdvir was given by Szafer (1913). He estimated the number of *Taxus baccata* specimens as 20,000–30,000 growing on the area of about 30 hectares, but only about 1500 specimens had a diameter of 20 cm or more. He also inferred that such age structure of population has resulted from the felling of the older yew trees, because the wood of *T. baccata* were traditionally utilised for decorative parts of construction or household implements by the local population (Szafer 1913, Kontny 1937). A number of yew stumps was found there, as well as mechanical injuries made with axe were observed on the older specimens (Szafer 1913).

Through the efforts of the Copernicus Polish Naturalist Association and the Polish Forester Association, the forest area where *Taxus baccata* occurred was excluded from exploitation in 1914 (Sokołowski 1921).

The second inventory of *Taxus baccata* specimens in the Knyazhdvir nature reserve was made in 1920 by a delegation of the State Commission for Nature Protection (Państwowa Rada Ochrony Przyrody), personally conducted by Prof. Dr. E. Romer, Prof. Dr. A. Kozikowski, Prof. Dr. S. Wierdak, Dr. T. Wilczyński and Dr. A. Wróblewski. The commission stated, that the number of yew specimens decreased at least of

30–40% in comparison with the status in 1914. The greatest damage was caused by the war, especially a double line of trenches, which crossed the lower part of the slope above the Prut river in the spring of 1915. Subsequently the local population devastated a number of yews when harvesting other trees for fuel and construction. Some older yew trees were also damaged by the peeling of bark, because the local medical practitioner utilised it as a medicine. Nevertheless, the commission stated, that conservation and protection of this population of *Taxus baccata* is very desirable (after unpublished materials of Wróblewski).

The present-day nature reserve covers an area of 208 hectares and is administrated by Pechenizhyn Forestry of Kolomya Forest District. Yew forms the subcanopy layer or grows in the form of brushwood, most frequently on the area of about 70 hectares. A total of 22,865 specimens taller than 1.5 m were count there in 1976. A more detailed inventory was made at the same time on the a plot 1-hectar in area. The height, d.b.h. and presence of fruit were determined for all *Taxus* specimens taller than 1.5 m. 748 specimens were counted, most of them less than 10 cm in d.b.h. and 3 m in height (Figs. 4 and 5).

Fruiting was observed on only about 18% of the specimens (Figs. 6 and 7), comparable with % from *Taxus baccata* populations in the Sudethians in Poland (Kosiński 1996, Boratyński et al. 1997). The % of fruiting specimens was significantly correlated with their height ($r=0.9792$) and d.b.h. class ($r=0.9478$).

The height and diameter structure of the investigated population indicate numerical superiority of young specimens. It is comparable with the age structure of populations of the shade-tolerant species in progress (Paczoski 1930). The natural regeneration

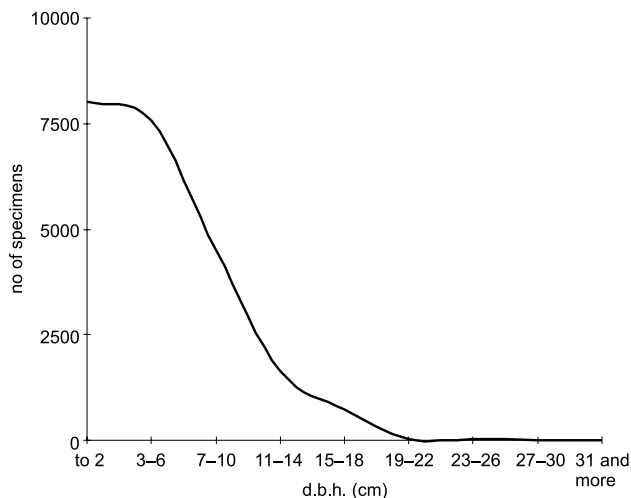


Fig. 4. The d.b.h. structure of *Taxus baccata* population in Knyazhdvir Nature Reserve (after Lucak's unpublished data from 1976)

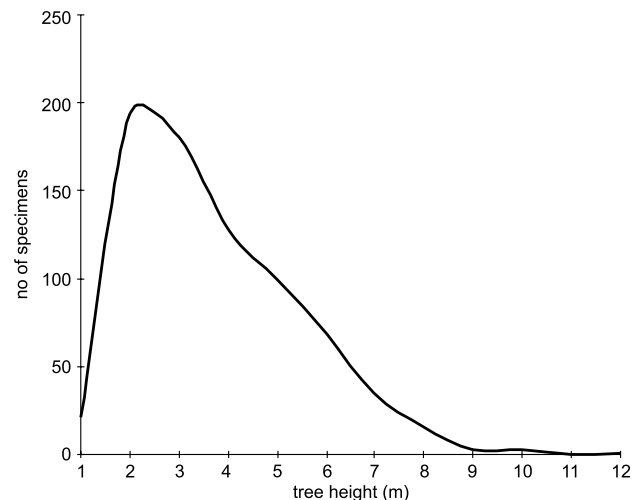


Fig. 5. The height structure of *Taxus baccata* population on 1-hectar experimental plot in Knyazhdvir Nature Reserve (after Lucak's unpublished data from 1976)

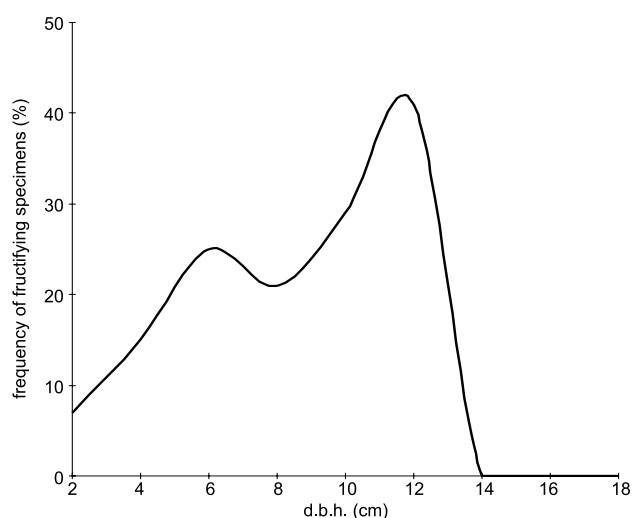


Fig. 6. Correlation between fruiting and d.b.h. of fruiting specimens

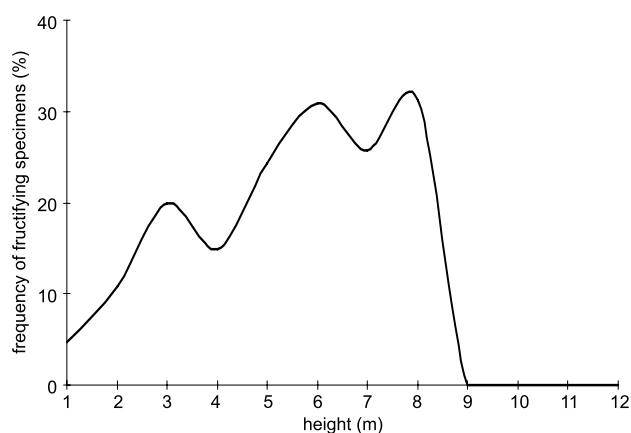


Fig. 7. Correlation between fruiting and height of fruiting specimens

Table 1. Participation of natural yew regeneration on 1-hectare plot in the Knyazhdvir Nature Reserve in 1976

Generative regeneration number per hectare					Vegetative regeneration number per hectare				
Age				Totally	Age				Totally
1-year	2-3 years	4-7 years	8 and more years		1-year	2-3 years	4-7 years	8 and more years	
11,000	1,900	1,100	500	13,500			100	400	500

of yew under beech-fir canopy is very numerous and successful (Tab. 1). The really large number about 13,000 1–8 year old seedlings of *Taxus baccata* observed on one hectare of the reserve are the best indication of the stability and durability of the species population.

The light conditions in the beech forest are generally unfavourable for most tree species, including the yew. The yew seedlings, however, can exist under the dense canopy, while those of other tree species die out in several to a dozen years (see for example Faliński and Pawlaczyk 1993, 1995, Boratyński and Filipiak 1999). Nevertheless, even the yews manifested reduction of the height increment under the dense canopy (Tab. 2). Their reaction to the light conditions in the Knyazhdvir was somewhat similar to those of *Abies alba* seedlings in the Charnokhora Mts (Shvidenko 1980).

The large number of *Taxus baccata* specimens and structure of its population in Knyazhdvir Nature Reserve indicate that the species protection established there in the second decade of the 20th century have been successful to this point and the species existence has been pro-

Table 2. Influence of the canopy density on the average yearly height increment of the second storey *Taxus baccata* specimens in the Knyazhdvir Nature Reserve

Canopy density	Average height increment [cm]
0.9	6.3
0.6	12.0

longed. Nevertheless, this very interesting locality has not been investigated sufficiently and it should be the site of more intensive ecological studies.

Conclusions

On the basis of presented material it could be stated that:

1. The *Taxus baccata* natural population in Knyazhdvir Nature Reserve contains more than 22,000 specimens and is the most numerous one in Ukraine and one of the most numerous in the whole of Europe.
2. The site conditions of the forest with yew are favourable. The most important factor for *Taxus baccata* occurrence there are the presence of calcium carbonate and humidity of the soils.
3. The height and diameter structures of the population indicate that young specimens are prevailing and that the population is in progress. The largest specimens in 1976 were 12 m high and 30 cm d.b.h.
4. The natural regeneration of *Taxus baccata* in the Knyazhdvir Nature Reserve is numerous and successful.
5. The increment of height of *Taxus baccata* specimens was greater in the conditions of less density of the canopy of beech-fir stand, under which yew grew.

6. The last inventory of *Taxus baccata* specimens in the reserve was made in 1976 and it could be very interesting to repeat it in 2001, after 25 years.
7. Stabilised plots for permanent study of ecosystem changes including the yew number fluctuation are recommended.

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