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### **Bio-ecological Peculiarities of *Taxus baccata* L. in Decorative Gardening of Eastern Georgia**

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**Abstract.** The article discusses contemporary bio-ecological conditions of *Taxus baccata* L. in its natural distribution area of Georgia, particularly in Batsara National Preserve. Contemporary bio-ecological conditions of *Taxus baccata* L. spread in decorative gardening of eastern Georgia have also been studied based on the samples of the collection (47 pieces) of Tsinandali Arboretum.

We have studied the periods of bud opening, vegetation ending, starting and finishing of cambium action, sprout woodening process, time and rate of growing in height, and regularities of accumulation-transformation of storage carbohydrates.

The studies revealed that the Yew growth duration is affected by the snowless winter and frequent droughts increased in the last decades as they cause the lack of water in soils and badly affect the plant growth.

Regularities of accumulation-transformation of storage carbohydrates and the studies of sprout woodening and cambium action peculiarities prove the strong ability of frost-resistance.

In order to conserve this endangered species (*Taxus baccata* L.) it's needful to introduce it widely in decorative gardening.

**Keywords:** yew; spread; evergreen; coniferous; vegetation; cambium; life expanse; height growth period; accumulation-transformation of carbohydrates; Conservation.

#### **Introduction.**

*Taxus baccata* L. is a rare relict. Its small groups or unit trees are often preserved or dectaled as natural monuments. It's included in all regional "Red Books", including the "Red Book" of Georgia (1982) and the Red List of Georgia (2006), also in the red list of IUSN.

It is naturally spread in Western Europe, northern Persia, and the Caucasus. In the mountains it elevates up to: 1100-1400 m height in the Alps; 1600 m - in the Carpathians, 1500 m – in the Caucasus, 2300-m - in Asia Minor from the sea level. In Caucasus it occurs in Georgia, Armenia and Azerbaijan. It's spread almost in all regions of Georgia. It's more widely represented in eastern Georgia. The unaffected yew grove is remained in the south slopes of the Caucasus, in Batsara Valley at the sources of the Alazani River, where the preserve was founded in 1935 to protect the yew forest. The preserve area is more than 3000 hectares. Here the beech and yew

groves are spread at elevations of 1000-1500 (1666) meters from the sea level. The yew grove occupies the area of 800 hectares in Batsara Valley; it's the most extensive yew grove in the world [1]. Most of the yew trees existing here are more than 500-1000 years old. 220 000 yew trees grow on the preserved territory, 13 000 of them are 100 years older, and some of them with the height of 25-30 m and diameters of 150 m, reach 1200-1500 years.

Based on its biology, yew is characterized with the very slow updating, productivity and low growth rate that causes the high level of vulnerability from all kinds of negative factors. Mainly two kinds of stem damages can be seen almost at all young plants of the 11<sup>th</sup> block of the preserve and outside of it. In the first case the wood is eaten by mammals, e.g. roe, bear. In another case it's scratched with fags or claws, in some cases the scratch diameter is 9 mm. [2].

The dendroflora of yew in Batsara Valley includes 60 types of *Taxus baccata* L. Along with yew, Maple (*Acer campestral* L.), Ash (*Fraxinus excelsior* L.), Linden (*Tilia Caucasia* Rupr.), Chestnut (*Castanea sativa* Mill.), Cherry-laurel (*Laurocerasus officinalis* Rome.) and other species, included in the "Red Book of Georgia", also exist there. All of these give Batsara Preserve the worldwide significance. Yew is an evergreen, conifer plant-tree, often 20-25 meters high, with the diameter of 1,5-2,5 m. The needle leaves are flat, arranged spirally, of 2-3, 5 centimeters length, with short tips. The seeds are hard, 6-8mm length. The needle leaves contain poisonous substances, which are toxic for animals. Lives longer (1500-2000 years).

Its bark is yellowish, doesn't contain pitch and is very hard, doesn't rotten for a long time. The bark is used in turnery, furniture manufacturing and for tool handles. Yew is a valuable decorative tree. It reproduces with seeds and sprout cuttings. The cuttings root easily in the river sand; give stump shoots and maintain this ability for about 300-400 years. The lower branches root easily at the place of touching the ground. In case of the seed reproduction, it springs up difficultly. It is characterized with the better vegetative reproduction.

Yew is characterized with the strong anti-bacterial features. The substances allocated from the plant leaves destroy the micro-organisms around.

The yew is less demanding from the soil. It perfectly grows on the sour, and weak alkaline carbonate soils. It grows better on the weak alkaline limestone; grows slowly, annual height growth rarely exceeds 20cm; endures shade and dryness.

Yew begins fruit-bearing at the age of 20-25 (in open space) or 60-100 (in the forest) [3]. It easily stands the fungal disease, damages caused by insects, branch cut.

*Taxus baccata* L. is used in decorative gardening. It has lots of gardening forms. In eastern Georgia, besides Batsara Preserve, Yew trees are often found in the parks and gardens and in the city greenery. For example, in Tbilisi botanical garden Yew trees (introduced since 1950s) aged about 130 years reach 14-16 meters. Well-developed trees of the similar size are in the city greenery as well. Here they maintain normal growth-development and stand droughts quite well.

Yew tree is in groups or individually met in the parks, gardens and town greenery of Lagodekhi, Kvareli, Telavi and other towns of Kakheti region (eastern Georgia). Here they are characterized with a good growth and development in open as well as in darkened places. There are 47 yew trees in Tsinandali Park. One of the 47 yew trees existing here, stands at the entrance of the park, reaches 7 meters and has a strong trunk. The lower branches lay on the ground. Some of them have roots. One plant occupies approximately 10 m<sup>2</sup> space. Here also are trees of 12 m in height and 38 cm in diameter.

### **Sources and methods**

The aim of our research was the study of the bio-ecology of yew specimens preserved in decorative gardening of eastern Georgia that is considered as an issue of a great importance, as, in fact, bio-ecology of yew collection spread in decorative gardening hasn't been fully studied. In order to study the mentioned issue Tsinandali Arboretum and yew specimens existing in the central greenery part of Telavi have been chosen.

The observation has been conducted on the selected specimens since 2001. The phenology and phenometry has been conducted on the selected plants systematically/ once or twice in the decade/ for ten years. We have observed the periods of bud opening, vegetation ending, starting and finishing of cambium action, sprout woodening process, the time and rate of the height growth.

Besides the apical growth, the cambial growth of the lateral branches has also been studied. For this purpose we took the patterns from the twigs once in every ten days from the early spring to the late autumn, then placed them in 60-70% alcohol [5], [6], [7], and observed the dividing of the

cells of secondary meristem and development of annual cycle through a microscope. Transverse veneer was taken with safranin and the process of new wood cells development was determined; the research was conducted according to the methodical instructions by Iatsenko-Khmelevski, 1954, Lobzhanidze E., 1961, and Tsitsvidze 1973.

We have also studied the peculiarities of accumulation and transformation of storage carbohydrates in the lateral branches with regard to annual development rhythm and overcoming winter frosts. For this purpose in the third decade of each month the analyzing samples were taken every morning. By the influence of chemicals on the diametrical slices we studied carbohydrate content. Starch content was determined by the Potassium iodide (starch stained in blue), sugar – by alpha naphthol, and concentrated sulfuric acid (stained in purple), and fats with the help of Sudan III (color – orange) [8].

### **Conclusions:**

The study revealed that:

The yew specimens existing in the selected area (Telavi, Tsinandali Park) start vegetation at the end of March and in the beginning on April. Apical growth of sprouts ends in August-September.

The bud opening and the beginning of sprout growth in almost don't depend on the changes of air temperature. As usually, the yew pollens at first, and then the sprout growth start. The growth of yew sprout is rapid in the beginning of vegetation, and then stunts. The height growth lasts on average 80-90 days.

The cambium activity in the sprouts begins in 4-8 days after the bud opening. For example, in 2008 the buds opened on April 25<sup>th</sup>, the needle leaves completely appeared on May 3<sup>th</sup>, cambium activity started on April 28<sup>th</sup>. The beginning of cambium action is the earliest marked at the light side of the plant.

Formation of the wood cells lasts 120-150 days in the lateral twigs, and 140-170 days – in the stem. The studies of sprout woodening conducted over the years revealed that the sprout woodening starts instantly after the xylem cells formation, or a bit later, and lasts for a quite long period.

During 2001-2005 yew trees existing in Tsinandali Park were characterized with better growth-development. Since then duration of height growth has decreased till 2013. In our opinion this isn't connected with its age, as, considering the life expectancy, the yew specimens in Tsinandali Park are not so old (not more than 400 years). Probably, the growth duration is effected by the droughts and snowless winters frequented in last decades in Kakheti region, which cause the lack of water in the soil and have a negative effect on the plant growing.

Therefore we suggest that intensive irrigation from the beginning of April would be desirable for development of yew tree specimens existing in Tsinandali Park. So it's preferable to cultivate their plantations on the wet soils.

Accumulation and transformation of carbohydrates in the branches of *Taxus baccata* L. is equivalent to the cold zone plants. Starch hydrolysis is connected with seasonal development of the plant. Its content in the branches is the maximum by the beginning of vegetation in spring; the amount is decreased in summer, increased in autumn and still decreased in winter. As a result of temperature falling the sugar and fat content is increased. Fat content reaches 3-4 points in December-February and in summer it's presented by a pretty small amount or in the form of track. In the studied plant branches regularity of accumulation and transformation of carbohydrates is correlated with annual development rhythm. The maximum starch content was revealed in September-October and at the beginning of vegetation in April-May.

Regularities of accumulation-transformation of storage carbohydrates in yew branches and the studies of cambium action peculiarities and sprout woodening confirm the strong ability of frost-resistance. Natural renewal of *Taxus baccata* L. is quite weak almost everywhere, but in the parks, gardens and open spaces it is characterized with a good growth-development.

Its reproduction is possible with seeds or vegetative. Stumps and cut stems often give lots of sprouts. The lower branches make roots easily by touching the ground. It reproduces well with the help of 1-2 years old cuttings and sleeping buds, characterized for many coniferous plants.

In future, it's desirable to pay more attention to its cultivation for different purposes – for forest cultures, parks, gardens, city greenery and etc. in open spaces as well as in darkened ones; in groups or individually. This will contribute to widening and conservation of *Taxus baccata* L. area –

area of endangered species.

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