

# INVESTIGATION OF WINTER HARDINESS AND STEM DIAMETER OF PHYLLOSTACHYS TAXA IN HUNGARIAN COLLECTIONS

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## Abstract

*The aim of our work is to investigate the genus Phyllostachys which one of the best cold-tolerant genera of bamboos in these collections. Taxa of the genus Phyllostachys can be grown well in Hungarian conditions and can be classified as larger bamboos with their size. We examined in the largest Hungarian collections whether the most common taxa could reach the same stem diameter in the Carpathian Basin as in their home country. The collections we examined are the Diószegi Sámuel School Botanical Garden in Debrecen, László Nagy's bamboo garden in Gyula, Jenő Kiss's bamboo garden in Erdőtelek, the Dmkert Kft. in Pécs, and the MATE Gödöllő University Botanical Garden. In addition, we tested the winter tolerance of the given taxa under domestic conditions for two years.*

*Based on the obtained results, we determined which taxa can be recommended in the gardens due to their outstanding properties in Hungary, also as groves or hedges, and with their unusual appearance they can increase the complexity of the Hungarian garden culture.*

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## 1 Introduction

People of the ever-changing, mechanized world of the twentieth century, they are increasingly forgetting that their lives are closely intertwined with nature and that their existence would be unthinkable without plants. Among the plants, the family of grasses (*Poaceae* or *Gramineae*) also stands out. One of the most interesting, diverse members of this family is bamboo. These plants are an essential part of everyday life and culture in Asia, as their use is almost limitless, they are used to make furniture, musical instruments, important paper raw materials, are used in architecture, and their buds are considered an important food raw material. Because of their high adaptive and renewable capacity, they are gaining more and more ground not only in Asia but on all continents. Their horticultural usability is also outstanding good hedge plants, beautiful groves can be formed from them, due to their evergreen nature, they are able to flaunt green even in winter. In addition, their environmental needs are not very high, they are not selective in terms of soil. Nor does their care require special expertise. More and more gardeners are dealing with their distribution, so it can be said that it is easy to procure them with a little follow-up.

There are more than 1250 species in about 75 woody bamboo genera worldwide [2]. Bamboos (subfamily *Bambusoideae*) form one of the 12 subfamilies of grasses (*Poaceae*) and represent the only major grass line that diversifies in forests (flowering periods of bamboo plants can take up to several decades) [12]. Bamboos are classified into the phylum Magnoliophyta within the family

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Lacopsidae (*Poaceae* / *Gramineae*), within which they are members of the Bambusoideae subfamily [13]. During its taxonomic history, few changes have been made to other genera [12].

The name of the genus is derived from the Greek words 'phyllon' = letter and 'stachys' = panicle [12]. Bamboos came mainly from the lowland regions of China, although they may have occurred on a smaller scale also in Nepal and India [4]. Their distribution area is the center of East and Central China. Their vertical distribution ranges from 2500 to 2600 m above sea level, although some of their species have significant populations in the Eastern Himalayas at an altitude of 3400 m [12].

They have long been cultivated in Japan, where many species have become a natural part of the landscape. In these wild populations or during cultivation, many spontaneous variations have appeared, often with different colored stems, different leaves, or individual distortions, thus creating a diverse color palette that can be an exciting choice for any garden [4]. Furthermore many species have been introduced by human intervention into North and Northeast China, Korea, South China and neighboring regions [9]. In the XIX-XX. century many species, varieties and forms were introduced to Europe, mainly from Japan, for naturalization. Records show that as early as 1823 and 1825, black-stemmed bamboo (*Phyllostachys nigra*) and some forms of it appeared in French and English horticulture [12].

The planting of the Bamboo Botanical Garden in Anduze (France) was started in 1856 by Eugène Mazel, the original exotic plants from Japan, America and the Himalayas [3]. It has long been found in Hungary as well [10]. *Phyllostachys* is economically one of the most important bamboo genera. Its uses went beyond traditional uses, extending to intensive industrial use and high added production such as weaving articles (baskets, fans), furniture (chairs, beds), agricultural tools (tools, sweeper), house building, food (chopsticks, sieves, bamboo shoots [9, 5, 11].

The use of bamboos in the garden is increasing [5]. In China, there are also traditional foundations for this, so they are also preferred to be placed in front of houses [1]. Therefore, recommend 89 types of bamboo for horticultural use [5]. In China, there has been a serious problem with wood supply. Compared to trees, bamboo grows faster and gives higher yields. Usually 3-5 years old bamboo is suitable for use in the wood industry. The cutting cycle of bamboo is only 1/3 of that of fast-growing wood species, but the yield is twice that of these [8]. It is very difficult to distinguish different species. Inflorescence cannot be used for taxonomic classification because for many species flowering occurs only after 120 years. Instead, morphological hallmarks such as rhizome, stem, bud are considered, but these traits are strongly influenced by environmental influence [6].

## 2 Method

The collections we examined are the Diószegi Sámuel School Botanical Garden in Debrecen, László Nagy's bamboo garden in Gyula, Jenő Kiss's bamboo garden in Erdőtelek, the Dmkert Kft. In Pécs and the MATE botanical garden in Gödöllő. Data were recorded by personal examination of the collections during all 2 study years.

### 2.1 Winter tolerance testing

The investigation of winter tolerance took place in the year 2018-2019. Our work was done in person at each collection. The studies were performed in the spring (May) of all 2 years, depending on the weather. In the first year of the studies, the affected part was measured on 5 branches per plant on 5 leaves. During the measurements, we encountered quite extreme weather in both measured years. For this reason, our results are extreme, they show the possibilities of bamboos in the examined collections in different parts of Hungary.

#### 2.1.1 Winter 2018

Unlike previous years, the winter of 2017/2018 had unusually cold weather, especially January 2018. In terms of precipitation conditions, it was significantly drier than before, with almost two-thirds of the rainfall usual in the season falling.

The average temperature of the season was  $-1.46^{\circ}\text{C}$  in the winter of 2018/2019, which was  $1.3^{\circ}\text{C}$  lower than the many-year average. The north-eastern parts of the country proved to be the coldest (three-month average temperature below  $-3^{\circ}\text{C}$ ), from which the northern part of the Great Plain was barely behind (between  $-2$  and  $-3^{\circ}\text{C}$ ). The average winter temperature increased (between  $-1$  and  $0^{\circ}\text{C}$ ). During the winter, the highest measured temperature was  $21.6^{\circ}\text{C}$ , while the lowest was  $-28.1^{\circ}\text{C}$ .

### **2.1.2 Winter 2019**

The winter of 2018/2019 was again warmer than usual, especially February 2019. In terms of precipitation conditions, it was drier overall, with 27% less precipitation than in the period 1981–2010.

The average temperature of the season was  $+1.2^{\circ}\text{C}$  in the winter of 2018/2019, which is 1.4 degrees higher than the multi-year average. Our landscapes in northern Hungary proved to be the coldest during the winter (three-month average temperature below freezing). In the Great Plain and Transdanubia, seasonal averages were already above freezing. Within that, it was a little cooler in the Northern Great Plain. The average winter temperature was already above  $+2^{\circ}\text{C}$  in the western part of Transdanubia through the Little Plain to Inner Somogy.

During the winter, the highest measured temperature was  $28.5^{\circ}\text{C}$ , while the lowest was  $-15.6^{\circ}\text{C}$ .

## **2.2 Stem frost damage**

Stem frost damage was recorded by simple counting work when examining the collections. During the counting task, the number of dried or already removed bamboo stalks that died in color was compared with the number of green and intact stalks. The measurements were only performed in 2018 because in 2019, the mild winter did not cause any serious problems anywhere.

In 2019, we only encountered stem freezing in Debrecen, but the sudden precipitation (tin rain) was the main cause of the problems. Due to the youth of the Gödöllő and Erdőtelek collection, it is not included in the data that can be indicated.

## **2.3 Stem diameter test**

A caliper was used to examine stem diameters. The results obtained in this way show in the proposals which taxa can potentially be used in horticulture under Hungarian conditions. When recording the largest diameters, we also visited the Eötvös Loránd Garden in Budapest.

## **3 Results**

In order to grow bamboos with adequate safety, we need to know their behavior in the Hungarian climate. As accurate measurements and data on this plant have not been made in our country so far, we have prepared a literature average on the winter hardiness of the given taxa. As can be clearly seen in the figure, each of the taxa we selected has good winter hardiness. The taxa in the first semicircle in the counterclockwise direction in the figure also withstand cold conditions particularly well within the genus (Figure 1.). A special prominent taxon is *Phyllostachys aureosulcata* and its various variations, which with their varied colors and extremely good winter hardiness can be wedges of any garden.

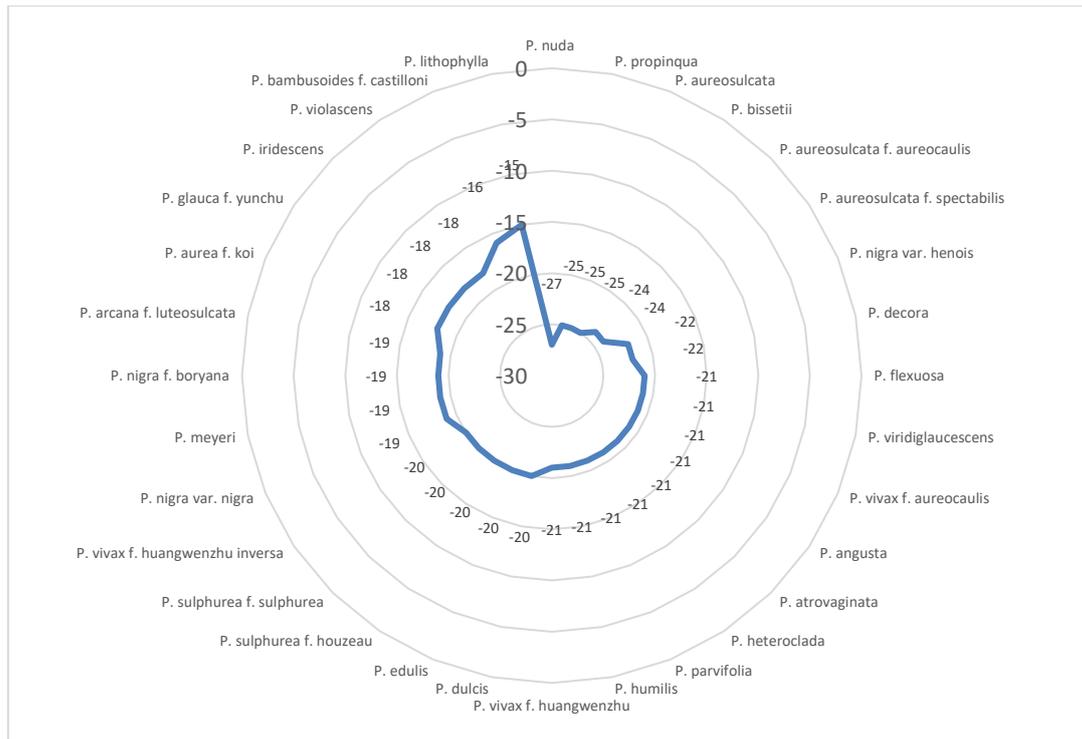


Figure 1. Frost tolerance of taxa based on literature averages

### 3.1 Frost damage 2018

Due to the cold winter of 2018, the reaction of selected bamboos in extreme cold became well visualized. While the Gödöllő (hills) and Gyula (extensive conditions outside the city, lack of irrigation) and Egerág (frosty valley) collections are located in more climate-exposed conditions, the Debrecen collection is grown in a more protected place due to the city and buildings.

#### 3.1.1 Leaf frost damage

In 2018, Gyula and Gödöllő had the largest frost damage, while Debrecen frost damage was much minimal, due to the more protected environment. The extensive conditions in Gyula are extremely well illustrated by the fact that *Phyllostachys bambusoides f. castillonii* and *Phyllostachys edulis* can suffer very severe losses in a harsh winter in Hungary. They can lose their leaves almost completely, the branches can be damaged and there can be problems with sprouting new stem buds. As one of the main decorative values of bamboo is its foliage so they are able to lose a lot of its decorative value. Importantly, the 20 taxa in the lower half of the diagram can suffer very severe leaf frost damage in extreme cold (Figure 1.). The taxa of *P. propinqua*, *P. bissetii*, *P. aureosulcata* behaved as expected with their minimum value of -24-25 ° C. The tolerance of *P. humilis* is also outstanding, as it is almost -5 ° C from its minimum in the literature, but it still suffered relatively little frost damage.

#### 3.1.2 Stem frost damage

The effect of frost damage on bamboo stems depended on several factors in our studies, we observed that a more optimal satisfaction of the water demand of plants increases the number of winter survived stems and leaves (Figure 2.). The stems of *P. violascens* showed greater sensitivity than their leaves, so they lost most of their stems in most collections. There were no exceptions to this for *P. edulis* and *P. bambusoides f. castillonis*, which in 2018 had to start their above-ground development almost from the beginning of the year, creating new juvenile shoots. The taxon of *P.*

*aureosulcata* and its variations, as well as the plants of *P. parvifolia*, *P. humilis* and *P. bissetii*, have just survived the winter with stems. Overall, up to and including the taxon *P. iridescens*, we can state that, with the exception of 27% of our plants selected for the species list, the taxa performed well in a remarkably cool winter in Hungary.

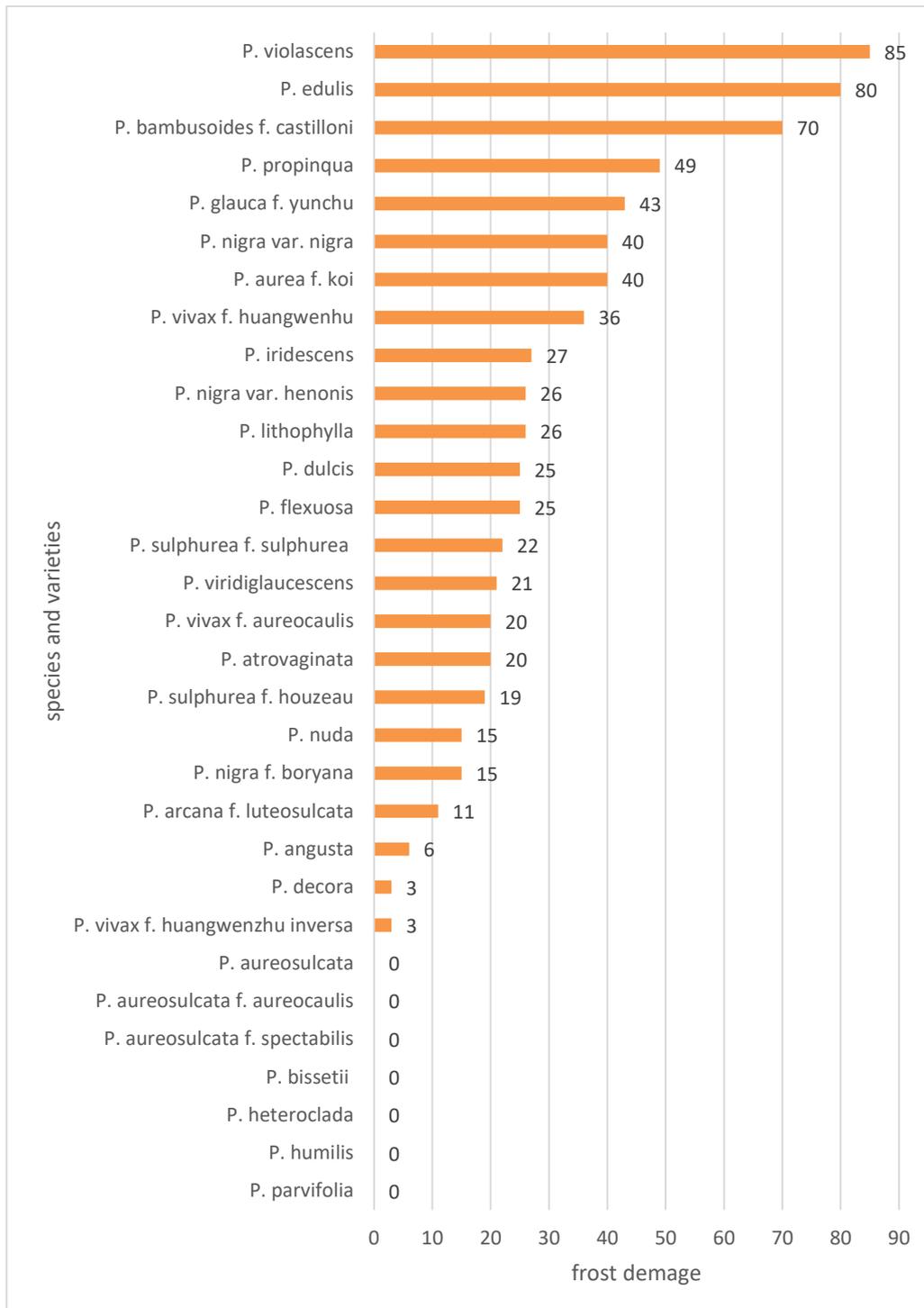


Figure 2. Extent of stem frost damage suffered by the winter of 2018 in the taxa studied

### 3.2 Frost damage 2019

We had a much milder winter this year. As a result, the symptoms of frost damage in the studied plants, in most of the collections, approached zero. So almost most of the collections reflect the smallest frost damage available in Hungary. The exception to this is the winter in Debrecen,

where we witnessed extreme spring frost damage and environmental conditions, as already mentioned in the investigations. This year, *P. nuda* is already in the first place, but this result is not outstanding, as the diagram clearly shows that, starting with *P. atrovaginata*, with the exception of the last 6 plants, almost all taxa cause only minimal damage during the winter. The winter of 2019 was not cold enough to record and depict stem frost damage, as the bamboos tested very well this winter and there was no stem freezing. This is definitely positive result as it shows that after a mild winter a maximum of one minimal leaf damage is to be expected for our plants. This is advantageous because after a less stressful winter we can expect the appearance of shoots with larger stem diameters. Overall, if all winters were as mild in Hungary as in 2019, there would be no more serious frost damage problems with the least winter-hardy *Phyllostachys* taxa.

## 4 Summary

The results section of the dissertation revealed that the genus *Phyllostachys* is more numerous taxon, despite the extreme weather in Hungary, the ability of the plot is relatively low to survive frost damage and increase decorative stem diameters. In the light of the results obtained, horticulturally the most outstanding taxa we grouped them into 2 groups based on their uses. In the first group there were species had been added that have excellent winter hardiness and bring their stems denser. Due to their properties they are extremely beautiful and have a good cover surface, so they are ideally used as hedges. The evergreen foliage in winter can be adequate provide cover.

The taxon *P. aureosulcata* has the following maximum characteristics: its winter hardiness is one of the most outstanding, its stem diameter has almost reached it in domestic collections the maximum measured in the literature. Several variants of this taxon and *P. aureosulcata* and *P. aureosulcata* f. *spectabilis* were also studied. They showed outstandingly good results. These taxa had different stem colors which also increases the variation in use.

*P. bissetii* is also one of the most prominent bamboos we studied, which as a hedge, it is also a plant of extremely good ability. Its stem density is very high, its foliage is lush and remains largely intact during the winter.

The second group included plants that are capable of decorative to create bamboo groves. Such a bamboo grove is capable of any garden in Asia to conjure a mood. It is also important that the buds of the genus *Phyllostachys* also serve as food can be used. And the stems of bamboo also increase the useful properties of the plant. *P. vivax* 'Huangwenzhu Inversa' is one of the taxa with thicker stems member with the most outstanding winter tolerance. Brush-like green on the stems with the help of stripes it is able to create outstandingly aesthetic groves.

*P. vivax* 'Huangwenzhu Inversa' is also an excellent taxon, which has a good properties give you a choice.

Based on the results of the test, *P. dulcis* had the largest stem diameter (7 cm). The thick stems were ashy greens. Its buds had a sweet taste and bring new ones in bulk every spring shoots.

However, it is important to avoid cold or frosty areas, whereas it is also able to suffer more severe frost damage.

*P. nigra* 'Boryana' is the only major taxon with black hues winter hardy internode. The stem diameter test showed that it could reach a diameter of up to 5 cm. Even with this taxon, special attention should be paid to the winter protection as it can suffer damage during a colder winter.

*P. iridescens* is also a good choice for establishing groves. The stems were extremely flexible and were strong and flexible.

The aforementioned taxa could increase the variety of varieties in domestic horticulture and commodities, and they can contribute to the promotion of bamboo as a plant in Hungary. Namely, the bamboos are one of the most diverse plants.

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