

Morphogenesis of growth processes of *Ligustrum* L. in the Botanical Garden of the Ural Branch of the Russian Academy of Sciences in Yekaterinburg

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Abstract. The article is devoted to the study of the duration of phenophases of two species - *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc. in the collection of the Botanical Garden of the Ural Russian Academy of Sciences. The patterns of growth of annual vegetative shoots have been established. The average duration of growth and development of branching shoots ranges from 112 days in *Ligustrum ibota* to 126 days in *Ligustrum vulgare*. Features of the mechanisms of apical growth of vegetative shoots are manifested in the form of differences and similarities in growth rhythms. Apical growth has similar curves of seasonal dynamics in shape and is characterized by synchrony in *Ligustrum vulgare*, which may indicate the similarity of their mechanisms in different shoots. There are also specific characteristics in the growth rate of privets; of the two species, *Ligustrum vulgare* is characterized by a high rate of apical and radial growth.

1 Introduction

The privet genus *Ligustrum* L. includes shrubs, less often small trees, deciduous or evergreen, with opposite simple leaves, usually elliptical, often leathery, entire, on short petioles [1]. The genus *Ligustrum* L. of the Oleaceae family is distributed in tropical, subtropical and temperate regions of the Eastern Hemisphere. There are about 30 species in the genus [2]. For the most part, they grow quickly, tolerate shade and are not very demanding on the soil. Many form bright decorative inflorescences and fruits - inedible for humans, but readily eaten by birds [3]. In suitable climate conditions, they are bred as beautiful flowering shrubs [4-5]. The most famous species is the common privet *Ligustrum vulgare* L.. This is the only European species, in cultivation since ancient times, it is widely used in hedges and in various types of landscape displays. *Ligustrum ibota* is rarely found in culture, usually in the collections of Botanical Gardens. Among the current tasks of

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studying the collection in the Botanical Garden are the clarification of differences in growth and development in different species of privet [6-8] and the corresponding assessment of their prospects for introduction.

The purpose of the study is to study the bioecological characteristics of introduced privet species with subsequent identification of the most promising of them in local conditions for implementation in landscaping practice.

2 Materials and methods

The research was carried out during the growing season of 2023 in two areas - in the syringaria and the closed part of the arboretum of the Botanical Garden of the Ural Branch of the Russian Academy of Sciences in Yekaterinburg. Objects – various species of *Ligustrum* at the age of 8 years. The parameters of heights, projection area and volume of the crown, length and diameter of the vegetative shoot of second-order branching were studied. The total length of vegetative shoots was measured once every 6-7 days from 05/08/2023 to 09/10/2023. After growth ceased, the diameter of the shoot base was measured. Length measurements were carried out with an accuracy of 0.5 mm, and diameter measurements were carried out with an accuracy of 0.01 mm.

3 Results

Features of acclimatization in the Middle Urals have been studied since 1936 [9]. Currently, two species from the genus *Ligustrum* grow in the collection of the Botanical Garden of the Ural Branch of the Russian Academy of Sciences - *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc. Natural and climatic conditions in 2023 varied in temperature from 6.7 to 21.7°C, and the rainiest months were June (60 mm), July (72 mm) and August (110 mm) (Table 1). It should be noted that throughout the entire shoot growth season, the air temperature was relatively stable, while the amount of precipitation varied unevenly.

Table 1. Climatic conditions for the growing season 2023.

Month	Average temperature, °C	Total precipitation, mm	Number of days with precipitation
April	6.7	18	11
May	16.5	0.5	8
June	16.1	60	22
July	21.7	72	19
August	17.8	110	20
September	13.5	28	10

Observations of the growth processes of annual vegetative shoots of *Ligustrum* made it possible to establish a number of features in growth and development during one growing season, which varied for 127 days in *Ligustrum vulgare*, and 112 days in *Ligustrum ibota*. Vegetative shoots of *Ligustrum* are formed from a common array of meristem (shoot growth cone) which has a single conducting system. In apical growth, species specificity was revealed, for example, in *Ligustrum vulgare* (it has two maxima in growth), but there are also differences in shoot growth, while in *Ligustrum ibota* one maximum was recorded.

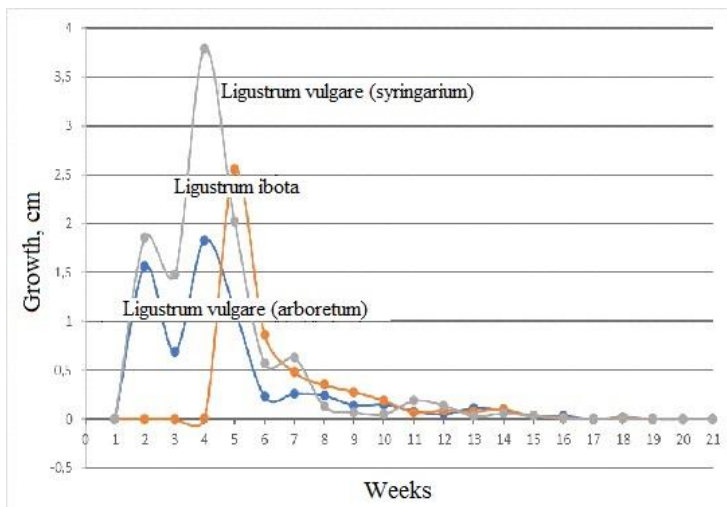


Fig. 1. Seasonal dynamics of apical growth of vegetative shoots - *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc..

Note: weeks: 1 (1.05.23-07.05.23), 2 (08.05.23-14.05.23), 3 (15.05-21.05), 4 (22.05-28.05.), 5 (29.05.-04.06), 6 (05.06.-11.06.), 7 (12.06.-18.06.), 8 (19.05.-25.06.), 9 (26.06.-02.07.), 10 (03.07.-09.07.), 11 (10.07.-16.07.) , 12 (17.07.-23.07.), 13 (24.07.-30.07.), 14 (31.07.-06.08.), 15 (07.08.-13.08.), 16 (14.08.-20.08.), 17 (21.08.-27.08.), 18 (28.08.-03.09.), 19 (04.09.-10.09.), 20 (11.09.-17.09.).

The maximum parameters were singled out for the common privet, growing in the syringaria, and the minimum growth of the same species, but growing in the arboretum. This is interconnected with better agrotechnical conditions (timely weeding and watering). The duration of apical growth of *Ligustrum vulgare* is established to be about 127 days; for *Ligustrum ibota* it is 105 days (Figure 2).



Fig. 2. Apical growth of vegetative shoots - *Ligustrum vulgare* L.

Apical growth began in common privet on May 4 and reached its maximum within four weeks, and from May 29, for ten weeks, a gradual decrease in growth was characterized (Table 2).

Table 2. Characteristics of various types of privet in the collection of the Botanical Garden.

Plant parameters	Types of privet		
	<i>Ligustrum vulgare</i>		<i>Ligustrum ibota</i>
	in Sirengaria	in the arboretum	
Plant height, m	0.44	0.43	0.37
Crown projection area, m ²	0.19	0.23	0.27
Crown volume, m ³	0.08	0.1	0.1
Kidney opening	May 4th	May 4th	26 of May
Beginning of growth of vegetative shoots	May 4th	May 4th	26 of May
Peak growth of vegetative shoots	22.05 - 28.05	22.05 - 28.05	29.05 - 04.06
End of growth of vegetative shoots	8 September	8 September	8 September
Lignification of shoots	8 September	September 15th	September 18

In *Ligustrum ibota*, the apical growth of shoots began 22 days later than in *Ligustrum vulgare*, most likely due to the characteristics of frost damage and shoot formation, since this species is less cold-resistant, so the shoots freeze to the snow line. Since June 5, there has been a gradual decline in growth processes in this species. Examination of the apical growth curve of vegetative shoots indicates that the slowdown in growth coincides with the onset of certain stages. Thus, in privet, one of the reasons may be a significant outflow of organic substances aimed at preparing the shoot for the winter period, namely the beginning of the process of lignification of the shoot, covering it with cork fabric. The green color of the studied shoots is replaced by the color inherent in mature shoots of this plant species (turns brown).

From the 19th week (September 8), plant growth completely stops in all types of privet - this is a genetically predetermined condition. Growth stops completely and the process of lignification is completed.

Radial growth of shoots begins simultaneously with apical growth. It is provided by the division of cambium cells, which consists of educational tissue. In terms of the diameter of annual vegetative shoots, common privet in syringaria stands out for its maximum parameters, and *Ligustrum ibota* for its minimum parameters; a similar pattern has been established for the length of shoots (Figure 3).

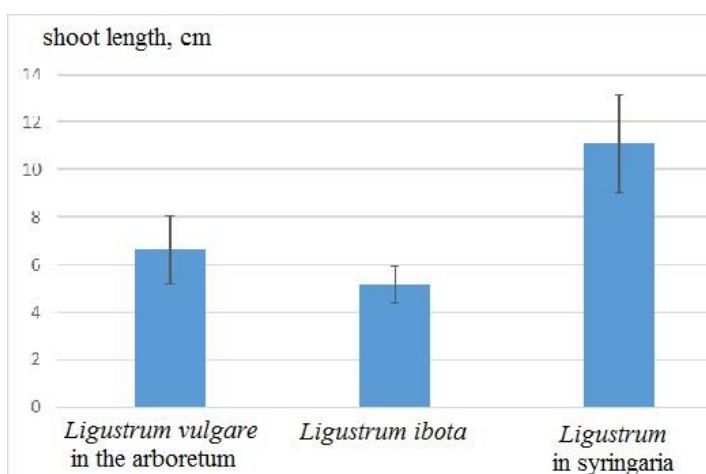


Fig. 3. Apical growth of vegetative shoots of *Ligustrum*.

Using the example of two types of privet, which differ in shoot parameters, the morphometric parameters of the bushes were established. Thus, *Ligustrum vulgare* at the age of eight reached a height of 0.43 to 0.44 m, with a crown volume of 0.08 to 0.1 m³, while the height of another species was only 0.37 m, but with a crown volume of 0.1 m³.

4 Discussion

When relatively heat-loving *Ligustrum* L. plants are introduced into culture outside their habitat, they adapt to changed environmental conditions and thereby acclimatize. This species has not yet been able to reach the full stage of acclimatization. As a result of climate warming, they grow intensively and form first- and second-order branching shoots. Using the example of two types of privet, differing in growth and development parameters, the duration of phenophases was established. The growth characteristics of privet are species-specific, but also dependent on environmental conditions. All species have an oscillatory nature of shoot growth. The growing season ranges from 112 to 126 days.

5 Conclusion

Differences in the growth and development of seedlings were established between geographical samples from the genus *Ligustrum* - *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc. *Ligustrum ibota* were found to be more sensitive to cold snaps. Thus, it is possible to identify more resistant and ornamental plants through selection. Nevertheless, the onset of the initial and final phases of the privet vegetation largely depends on the climatic conditions of a particular year. At the same time, the role of the biological characteristics of the species at the beginning of seasonal development is insignificant, while the duration of the growing season depends on the biological characteristics of the species.

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