# Analysis of the invasive activity of *Cotoneaster lucidus* Schlecht. in the Kalinovsky forest park in Yekaterinburg

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**Abstract.** The article is devoted to a comprehensive analysis of *Cotoneaster lucidus* Schlecht. in the forest park area of Yekaterinburg (Russia) based on population (age and vitality structure) and organismal parameters (morphometric indicators). The purpose of the study is to analyze the invasive activity of *Cotoneaster lucidus* Schlecht. in the Kalinovsky Forest Park in Yekaterinburg. Plants in the habitat are presented in the form of geoxyl bush. In the Age structure, two periods have been identified - pregenerative and generative, and six ontogenetic states. All habitats are at the stage of colonization, exclusively in forb pine forests with a canopy density of 0.6-0.7. The main route of penetration of the brilliant cotoneaster into the Kalinovsky Forest Park is artificial plantings along the paths, near equipped recreation areas. Its spread was facilitated by the presence of edible, long-lasting fruits on the shoots, which provided food for many species of birds. The established features indicate the high potential of the species and successful naturalization.

## 1 Introduction

In the flora of Russian cities, alien species account for an average of 27% [1-2]. It is no coincidence that the shining cotoneaster (*Cotoneaster lucidus* Schlecht.) was chosen as the object of study, since it is one of the most widespread in culture; it can be found in landscaping almost everywhere both in our country and abroad [3]. This type is used as a plastic material for creating artistic compositions in gardens and parks, in suburban forests. These ornamental shrubs are distinguished by their variety of habit, size, shape, branching pattern, arrangement of leaves, abundance of flowering and fruiting, and pronounced autumn color of the leaves. In the forest park area of Yekaterinburg, *Cotoneaster lucidus* is found as a naturalized introduced species in various forms of plantings [4].

The purpose of the study is to analyze the invasive activity of *Cotoneaster lucidus* Schlecht. in the Kalinovsky Forest Park of the city of Yekaterinburg based on population and organismal parameters of plants.

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## 2 Materials and methods

The study was carried out from July to August 2023 on the territory of the Kalinovsky Forest Park (Figure 1), where 4 fragments of the coenopopulation (hereinafter referred to as CPF) were studied. When examining *Cotoneaster lucidus*, standard methods were used [5-7].

## 3 Results

Kalinovsky Forest Park is located in the north-eastern part of Yekaterinburg, near the Elmash microdistrict (56°54′50.98″ N 60°40′14.23″ E). Belongs to Shartash forestry. Area - 1099.7 hectares. This forest park is characterized by a heterogeneous relief: in the northern part, swampy depressions alternate with small hills, and in the southern part there is a highly dissected relief, there are high hills. Scots pine and silver birch grow on the territory of the forest park; Siberian larch is less common. The average age of the tree stand is 110-130 years. The undergrowth is not dense, but diverse in species composition.

The brilliant cotoneaster is distributed in twelve of the fifteen forest parks of Yekaterinburg on an area of 396.8 hectares [8]. In this forest park, it is found in conditions of some shading with a canopy density of 0.6 to 0.7 exclusively in mixed-grass pine forests (Table 1).

**Table 1.** Characteristics of the habitats of the brilliant cotoneaster in the Kalinovsky Forest Park of Yekaterinburg.

| Fragments of coenopopulation | Habitat characteristics | | | Fragments of coenopopulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | total density, ind./ha | morphometric indicators | | |
| | Forest type | Tree stand | | | height, m | crown projection area, m² | crown volume, m³ |
| | | compound | tree canopy density | | | | |
| 1 | Pine forest of various herbs | 6C4B | 0.7 | 750 | 1.48±0.15 | 3.58±0.95 | 3.03±0.91 |
| 2 | Pine forest of various herbs | 5C5B | 0.7 | 480 | 1.83±0.16 | 6.5±1.08 | 5.38±0.97 |
| 3 | Pine forest of various herbs | 10C | 0.6 | 12000 | 1.09±0.04 | 0.74±0.11 | 0.29±0.05 |
| 4 | Pine forest of various herbs | 7C3Lp | 0.6 | 4100 | 1.38±0.06 | 1.55±0.21 | 0.83±0.14 |
| $X \pm mx$ | | | 0.65 | 4332 | 1.45±0.10 | 3.09±0.59 | 2.38±0.52 |

In the Kalinovsky Forest Park, the height of the brilliant cotoneaster varies from 0.31 to 3.15 meters; the largest amplitude in terms of plant height is observed in the second fragment of the coenopopulation. The crown projection area in this forest park ranges from 0.74 to 6.5 $m^2$, and the crown volume ranges from 0.29 to 5.38 $m^3$. The highest density of individuals on the trial plot is observed in fragment 3 of the cenopopulation. With an increase in the density of the tree canopy, the density of individuals decreases ($r$ = 0.79, $p$ <0.05) and the vitality of plants decreases ($r$ = - 0.64, $p$ <0.05). The abundance of cotoneaster depends on the age of individuals; the older the individual, the lower its vital state ($r$ = - 0.60, $p$ <0.05).

According to the vitality index, CPF1, CPF3 and CPF4 are classified as healthy (index >80%), and CPF2 are classified as slightly damaged, because the index value falls in the range of 50-79% (Figure 1).

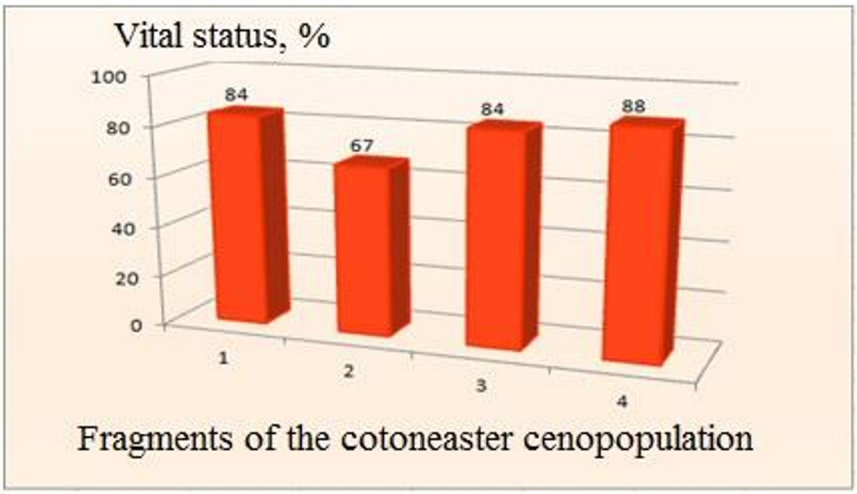


**Fig. 1.** Life status of cotoneaster in the Kalinovsky forest park.

A positive correlation can be traced between morphological indicators and the vitality of cotoneaster, that is, the larger the individual, the worse its condition. At the same time, a close relationship was established between the age of the plant and its height ($r = 0.68$, $p < 0.05$), as well as height with the projection area ($r = 0.96$, $p < 0.05$) and crown volume ($r = 0.94$, $p < 0.05$).

In the ontogenesis of Cotoneaster splendor, two periods were identified: pregenerative and generative (Figure 2), six ontogenetic states were identified (Figure 3).

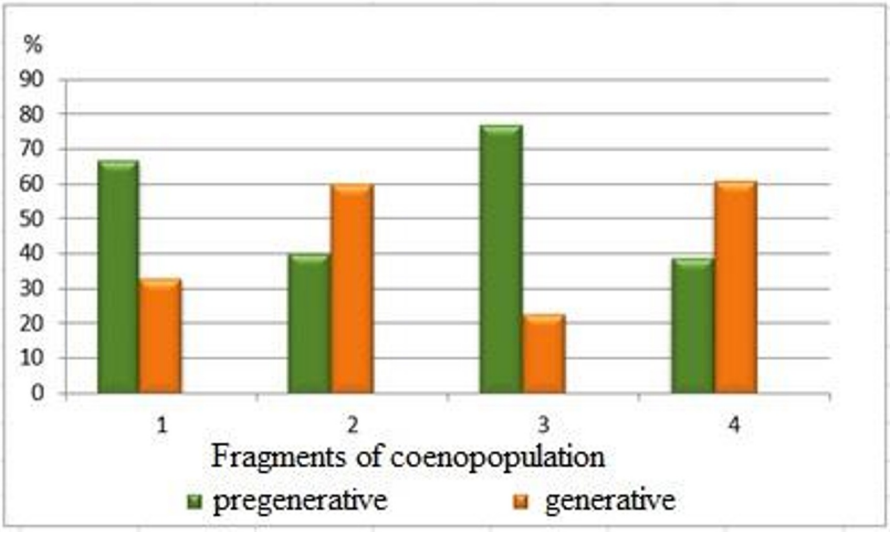


**Fig. 2.** Age structure of cotoneaster in the Kalinovsky Forest Park.

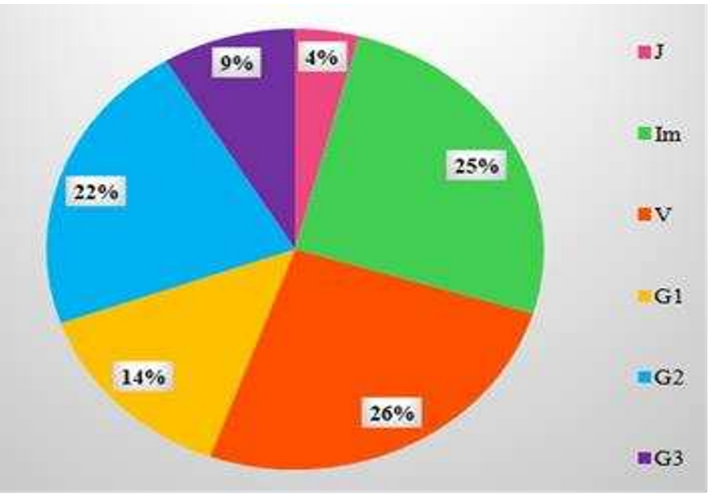


**Fig. 3.** Ontogenetic structure of cotoneaster brilliants.

The share of the pregenerative fraction is: juvenile individuals - 4.2%, immature - 25.5%, virginal - 25.9%. The generative fraction is represented by young generative ones - 14%, mature generative ones - 21.7%, old generative ones - 8.7% (Figure 3). In CPF1 and CPF3, individuals of the pregenerative period in the immature age state predominate. In CPF2 and FTP4, the proportion of generative individuals prevails over pregenerative ones. In cenopopulation fragment 3 there are no juvenile and old generative individuals, in fragment 4 there are juveniles. There is no post-generative period in all fragments of the cenopopulation.

According to the method of L.A. Zhivotovsky and the developed "delta-omega" classification, CPF1 and CPF3 refer to young cenopopulations (Figure 4), which is also confirmed by high rates of recovery and replacement indices (per adult generative individual there are: for CPF1 - 2 young individuals, for CPF3 - 3 individuals).

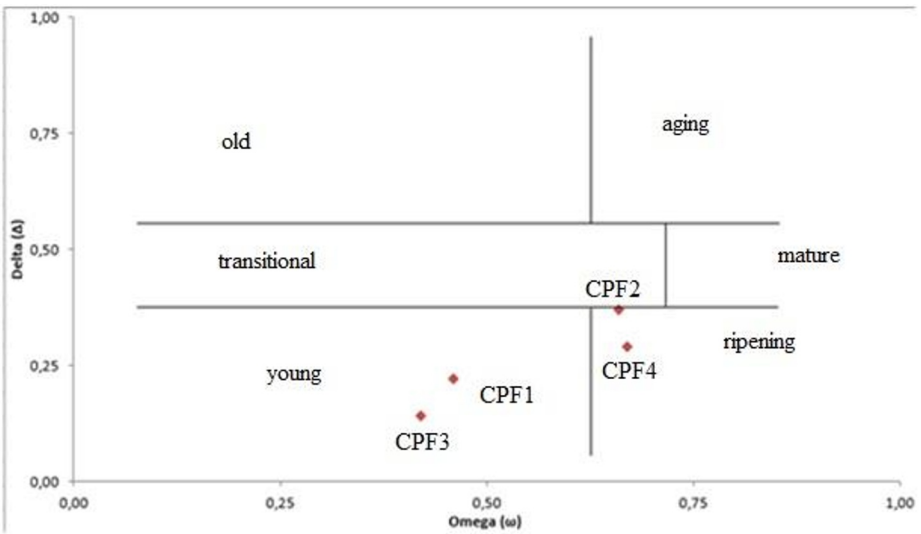


**Fig. 4.** Distribution of coenopopulation fragments of Cotoneaster brilliantus according to the “delta-omega” classification.

CPF2 and CPF4 refer to maturing cenopopulations with a high proportion of generative individuals, the recovery and replacement indices of which are less than 1, that is, the cenopopulations are weakly self-sustaining and are considered unstable, with less than 1 young individual per adult individual. In all fragments of the cotoneaster cenopopulation, there are no individuals of the post-generative period.

On average for the forest park, the restoration index and replacement index are 1.65, which means that cotoneaster specimens are actively spreading, pregenerative individuals predominate over generative ones, that is, cotoneaster is being introduced into this forest park. As a result of the study of ontogenesis in the habitat, it was revealed that all of them are normal with an intermittent spectrum and capable of self-sustainment by seed. Based on the size of the representation of ontogenetic groups, one can draw a conclusion about the time of existence of the cenopopulation and the direction of its development.

## 4 Discussion

Cotoneaster has actively invaded almost all forest parks in Yekaterinburg [4]. It is found exclusively as an understory species within a certain forest type as a forest microlandscape, but most often in forb and berry pine forests [8]. Plantings are the main route for the penetration of brilliant cotoneaster into forest parks, which are created along paths, near equipped recreation areas. Its spread was facilitated by the presence of edible, long-lasting fruits on the shoots, which provided food for many species of birds [9]. The study found that all studied habitats of *Cotoneaster ucidus* are normal, capable of self-sustaining by seed. In the age structure, two periods and six ontogenetic states are distinguished. When assessing the age and effectiveness of habitats, it was revealed that all of them are young and maturing. It has been established that all habitats are in the stage of settlement. This is confirmed by the predominance of the pregenerative fraction, which indicates continuous replenishment by new generations.

## 5 Conclusion

*Cotoneaster lucidus* Schlecht. - one of the best border plants in landscaping cities in our country and Europe. Even in trimmed hedges it is decorative and durable. Its secondary range is huge. Thanks to its edible fruits, which remain on the shoots throughout the year, it is a food source for many birds. Enzymatic treatment and scarification through the digestive tract of birds increases its germination [10]. The survival strategy of cotoneaster, despite its lability, is amazing. Our research confirms active settlement in the Kalinovsky Forest Park. Pregenerative individuals are found in all habitats, which indicates the high potential of the species and successful naturalization.

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