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STUDIES ON GROWTH AND DEVELOPMENT OF *HEDERA HELIX* L. ON DIFFERENT WOODY SPECIES

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Abstract

The most known spontaneous species of woody climber, common ivy, it was found to prefer some species more then others as host for its growth and development. Different trees and shrubs from the biggest urban park in Bucharest were investigated to find the presence of spontaneous growth of Hedera helix on their trunks and branches. Seven species of trees and three shrubs were labeled as preferred hosts (100% presence) for Hedera helix, no matter their age or health condition, while four species of trees and nine shrubs were found as totally inconvenient (0% presence) for ivy growth. It was concluded that some species of woody plants create better conditions for Hedera helix to grow as an invasive plant, with considerable repercussions on the plantations management programs.

Key words*: Hedera helix, host species, invasive growth, plantations management.*

INTRODUCTION

Ivy (*Hedera helix* L.) is a natural presence in the European temperate forests, especially broadleaves ones (Rizzetto et al., 2016; Moser et al., 2017). Unlike other lianas species of these habitats, such as *Clematis vitalba* or *Lonicera caprifolium*, ivy can grow at the ground level, covering the soil, or at the canopy layer, climbing the trees. Thus, *Hedera* species were considered having a positive impact on the forest, in general, but mainly on the host tree, because of nutrients inputs in spring with the foliage fall, tree stability and attracting and hosting desirable organisms (Trémoliéres et al., 1988; Bell et al., 2012; Smets et al., 2016; Ruggeri et al., 2016).

In urban environment, green areas are made by a mixture of native and exotic species, for ornamental reasons but also as a consequence of preventing the cities problems such as pollution or poor soils (Barrico et al., 2018; Müller et al., 2018; Vieira et al., 2018). Furthermore, the remaining urban forests were sometimes completed with exotic species of trees and shrubs. However, some of the native species, such as *Hedera helix* shows local invasions in these plantations, especially when the human interference is absent. Originally, ivy appears here from the seeds brought by various birds, which consume the fruits (Mitchell, 1975; Reichard, 2000). Then, the ivy grows covering the ground and climbing the trees, in some cases became invasive (Beekman, 1984; Trémoliéres et al., 1998; Badre et al., 1998; Schnitzler and Heuzé, 2006). On some species of trees *Hedera* may add weight and increase the storm damage (Reichard, 2000; Schnitzler and Heuzé, 2006). Invasive growth necessitates costly eradication programs in some countries.

The objectives of this work were to examine ivy population dynamics in forest-like plantations of one of the biggest urban park in Europe and provide information about host species that ivy prefers to attach and develop.

MATERIALS AND METHODS

The study was conducted in Herăstrău Park, situated in the northern side of Bucharest, Romania. Opened in 1936, the park covers an area of 187 ha and is bordering by high traffic streets. For this reason, the peripheral limits of the park were designed as a protective zone, made from massive trees and shrubs plantations.

In these plantations, various species, mainly broadleaves, both native and exotic, grow together without any human intervention, as a

natural forest. The structure of these plantations is characterized by medium-low dense woody vegetation, developed in three levels: shrubs, small trees and medium-big trees.

We analysed in this study the ivy plants, from natural spreading, which appear frequently covering the ground or the plants (both trees and shrubs) in these massive plantations.

Area of study was limited at the south of the park (approximate 20 ha), where ivy is much more present, growing frequently on trunks and branches of trees and shrubs.

For evaluation of ivy preference for certain hosts, the proportion of invaded hosts and condition of the hosts (Table 1), this area was divided in plots. In each plots, all shrubs and trees of >5 cm diameter at breast height (dbh) were inventoried, identified and analysed for age, health condition and ivy presence.

Table 1. Category of woody plants condition

Class	Condition	Description
A	Excellent	Healthy, vigorous plants
B	Medium	Healthy, vigorous plants in general, but with maximum 25% wounds or dead branches. No disease or parasitic attack.
C	Poor	Plants vigour affected. Unhealed wounds or chronic parasitic attack to maximum 50%.
D	Irreversible decline	Plants with large dead branches, cavities or signs of internal decay to maximum 75%. Irremediable damaged.
E	Dead	-

Observations and measurements were carried out during the autumn-winter in 2016 and 2017. The relationship between quantitative data was examined using statistical analysis (Pearson's *R*).

RESULTS AND DISCUSSIONS

Ivy was found frequently growing on trees located at the edge of the tree massive, near main alleys or lawns. In some zones of the massive plantations, ivy was present only at the ground level. However, we establish a mean density of ivy hosted by shrubs and trees of 36.4 ivies per hectare of green area.

The host trees dbh values indicated that ivy was more present on mature trees (Figure 1). The number of host trees with small dbh values was expected to be lower, because of climbing of ivy on particular barks. Anyway, we observed that on young host trees the climbing behaviour of ivy was stronger in exotic species (68% at broadleaves species and 100% conifers). From these non-native species, we remarked ivy climbing more often: *Acer negundo*, *Celtis occidentalis*, *Robinia pseudacacia*, *Thuja orientalis* and *Pinus nigra*.

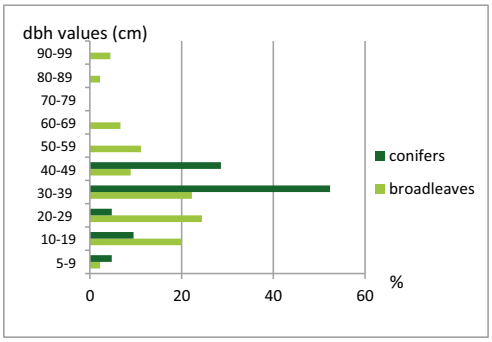

Figure 1. Frequency of ivy on different dbh of host trees

Independent of species, the diameters of large host tress were in positive correlation with the height of ivy on trunks (Pearson's $R = 0.54$, $P < 0.001$). The occurrence of ivy per layers of vegetation was considerably higher at shrub layer (Table 2).

Table 2. Distribution of ivy per layers of vegetation

	Shrub layer (1.5-5m)	Subcanopy (5-15 m)	Canopy (>15m)
Mean density of host plants (per ha) in different layers	5.9	18.9	11.6
Occurrence of ivy per layers of vegetation (%)	62	34	4

Although subcanopy is much more represented in the massive plantations of this park, ivy grows and develops better below these, particularly because of the light conditions offered at this level. Most of the trees growing in the subcanopy have small or medium leaves (57%, respectively 23%) and low density crowns.

Ivy proved to choose certain species as hosts (Figure 2). According with the ivy preference, four groups of host species were identified: the most attractive (100% of the trees support ivies), highly attractive (>60% of the trees support ivies), attractive (20-50% of the trees support ivies) and less attractive (<20% of the trees support ivies).

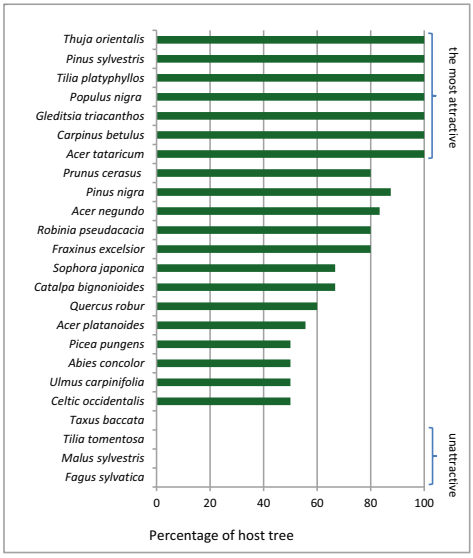

Figure 2. Preference of ivy for host tree species

Seven species of trees are the most preferred by ivy: *Acer tataricum, Carpinus betulus, Gleditsia triacanthos, Populus nigra, Tilia platyphyllos, Pinus sylvestris* and *Thuja orientalis*. Other eight tree species were found highly attractive for ivy, most of them exotic and much appreciated for their biological and ecological characteristics for this type of plantations. Four species (all native) proved to be unattractive for ivy: *Fagus sylvatica, Malus sylvestris, Tilia tomentosa* and *Taxus baccata*.

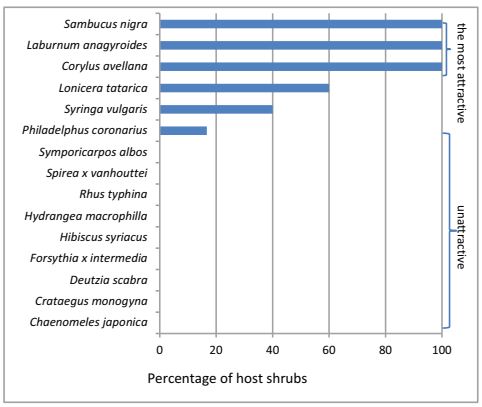

Figure 3. Preference of ivy for host shrubs species

For the shrubs placed near or in the massive tree plantations, most of them exotic species (65%), ivy proved also a different attractiveness (Figure 3). The majority of shrubs species were unattractive for ivy. In this case, even the ivy was present at the ground level or in trees nearby shrubs (in different light conditions) it was not covering at all their base or branches. However, three of them - *Corylus avellana*, *Laburnum anagyroides* and *Sambucus nigra*, all native species with vigorously growing, were highly preferred by ivy.

The evaluation of hosts' condition showed a tendency of ivy to climb trees in poor and irreversible decline more than the others (Table 3).

Table 3. State of vegetation of the host trees (%)

	Class A	Class B	Class C	Class D
Broadleaves species	14.5	20.8	20.8	43.7
Conifers species	11.1	33.3	55.5	-

Correlation between trees' state of vegetation and the incidence of ivy on their trunk showed that ivies are significantly more present in trees with poor condition (Pearson's $R = 0.63$, $P < 0.001$).

Still, in some species, such as: *Acer negundo, Acer tataricum, Carpinus betulus, Catalpa bignonioides, Fraxinus excelsior, Gleditsia triacanthos* and *Robinia pseudacacia*, even with a very good condition of trees (class A), ivy was found growing on their trunk. All of these species develop a rough bark since early stages of growth. These results confirm some other studies (Hegarty and Caballe, 1991; Schnitzler and Heuzé, 2006; Leicht-Young et al., 2010; Steinbrecher et al., 2010), which demonstrated that ivy, like other lianas, prefer the rough barks for support.

The tendency of invasive growth of ivy was observed at some species (Figure 4). A proportion of coverage over 60% of the total surface of host plant was remarked at 15 different species of trees and shrubs. Over 60% from these are exotic species and commonly present in urban green spaces.

Values of host coverage were extremely high (85%) at some species: *Catalpa bignonioides, Fraxinus excelsior, Gleditsia triacanthos, Lonicera tatarica, Quercus rubra, Robinia pseudacacia, Sambucus nigra, Syringa vulgaris* and *Thuja orientalis*.

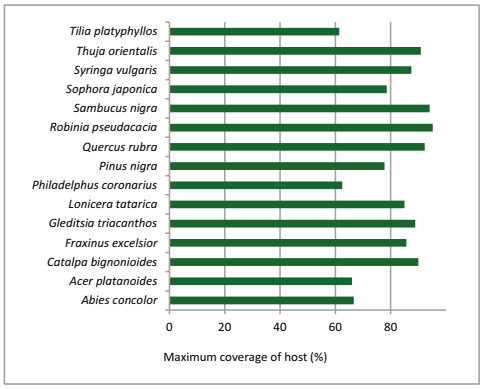

Figure 4. Percentage of ivy coverage at some species

The invasive growth of ivy is rare in urban plantations, but it was reported by some authors for ivies growing in natural forest (Schnitzler and Heuzé, 2006; Rizzetto et al., 2016).

CONCLUSIONS

Urban massive trees and shrubs plantations are made of native and exotic species. Ivy coming from natural sites can appear and populate dense plantations of green areas in certain conditions. Our results showed that some of the exotic species, especially trees, are more susceptible as host for ivy. In this case, maintenance of massive plantations can require further attention and cost more. For this reason, selection of unattractive or less attractive species for ivy or even reducing the proportion of attractive host species may be a future way to solve the problem of managing ivy propagation in urban plantations.

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