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## THE HEALTH CONDITION OF TREE AND SHRUB SPECIES OF TOPČIDER PARK

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**Abstract:** *The research deals with the health condition of tree and shrub species of the natural resource known as Topčider Park assessed on the basis of the conducted visual assessment and determination of the degree of defoliation and discolouration. During the growing season 2018-2019, the health condition of plant species belonging to 50 different genera was determined. The following species were found to be healthy, without any visible damage: Cedrus atlantica, Corylus avelana, C. colurna, Juglans nigra, Maclura aurantiaca, Mahonia aquifolium, Prunus cerasifera, P. spinosa, Quercus rubra and Sambucus nigra. Trees with visible injuries included: Acer negundo, A. pseudoplatanus, Aesculus hippocastanum, Cryptomeria japonica, Fagus moesiaca, Gleditsia triacanthos, Morus alba, Platanus acerifolia, Populus alba, P. nigra, and P. tremula. Dying trees and dead trees were not recorded in Topčider Park. The plant species most threatened by the attack of pathogenic fungi and fungus-like organisms were the species of maple, horse chestnut, lime, poplar, and plane. The species of insects and mites here present did not significantly affect the health status of the investigated plant species.*

**Keywords:** visual assessment, defoliation, discolouration, Belgrade, Serbia

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# ZDRAVSTVENO STANJE DRVENASTIH I ŽBUNASTIH VRSTA TOPČIDERSKOG PARKA

**Izvod:** Tokom istraživanja izvršena je procena zdravstvenog stanja drvenastih i žbunastih vrsta prirodnog dobra Topčiderski park na osnovu utvrđene vizuelne ocene, stepena defolijacije i dekolorizacije. Tokom vegetacijskog perioda 2018-2019 utvrđeno je zdravstveno stanje biljnih vrsta iz 50 rodova. Vrste koje su okarakterisane kao zdrave, bez vidljivih oštećenja su: *Cedrus atlantica*, *Corylus avelana*, *C. colurna*, *Juglans nigra*, *Maclura aurantiaca*, *Mahonia aquifolium*, *Prunus cerasifera*, *P. spinosa*, *Quercus rubra* i *Sambucus nigra*. Stabla sa izraženim povredama su: *Acer negundo*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Cryptomeria japonica*, *Fagus moesiaca*, *Gleditsia triacanthos*, *Morus alba*, *Platanus acerifolia*, *Populus alba*. *P. nigra*, *P. tremula*. Stabla u odumiranju i potpuno mrtva stabla nisu zabeležena u parku Topčider. Najugroženije biljne vrste od napada patogenih gljiva i gljivama sličnih organizama su vrste javora, divlji kesten, vrste lipa, topola i platan. Prisutne vrste insekata i grinja nisu u značajnijoj meri uticale na zdravstveno stanje istraživanih biljnih vrsta.

**Ključne reči:** vizuelna ocena, defolijacija, dekolorizacija, Beograd, Srbija

## 1. INTRODUCTION

By the Law on Nature Protection, Topčider Park was declared a natural monument of the third category of protection in 2015 (Official Gazette of RS, No. 36/09, 88/10, 91/10). The area occupied by the park is excluded from the Special Forest Management Plan and represents a special cultural and historical entity of the City of Belgrade (Official Gazette of the SRS No. 47/87). Topčider Park has great biological value due to its diversity and age of its plant material. The plant diversity is represented by about fifty broadleaved, about twenty coniferous, and about forty shrub species, with some trees dating back to the 19th century.

Due to the changing environmental conditions in park ecosystems, tree and shrub species are at a permanently high health risk. It is necessary to assess the vitality of park species and determine biotic and abiotic factors that directly or indirectly threaten their condition so that optimal preventive action can be taken and adequate and timely care and protection measures applied.

Besides the harmful effects of phytopathogenic fungi, insects, and mites, park dendro-material is also exposed to the adverse effects of anthropogenic factors that result in numerous mechanical injuries and thus deteriorate the general health condition and decrease the ornamental value of plants. The joint action of biotic and abiotic factors leads to premature defoliation, discolouration, and finally desiccation. Therefore, the crown condition can be used to assess the tree condition as it represents a valid measure for the evaluation of the overall tree health state. Early detection, diagnosis, and assessment of the situation in the field are necessary preconditions for the successful control of diseases and pests and rehabilitation of hazardous trees in order to provide public safety in parks.

Having considered the importance of Topčider Park, the factors affecting the trees in the park, as well as the extremely negative effect of biotic factors on the health of trees, the study was aimed to assess the general health of trees in this park,

assess the vitality of some tree and shrub species in the park, and determine the sensitive and resistant species that need to be paid attention to when managing this park.

## **2. MATERIAL AND METHOD**

The inspection and assessment of the health condition of tree and shrub species of Topčider Park were performed four times in two growing seasons (2018 and 2019). During the field visits, the health of the most important plant species was visually assessed and this visual assessment was used as an indicator of their condition and influence of biotic and abiotic factors expressed through the following scale: 5 – a healthy tree (without visible symptoms of damage to foliage, trunk, and branches); 4 – a slightly injured tree (occasional damage to foliage, trunk, and branches, a small percentage of dead branches); 3 – a severely injured tree (damage to foliage, trunk, and branches, dieback, decaying trunk and/or branches; rehabilitation possible); 2 – a dying tree (significantly reduced leaf surface area, advanced trunk and branch decay; safety hazard); 1 – a dead tree (Mladenović et al. 2016). The crown condition was observed through different classes of crown volume loss and discolouration of assimilation organs. The assessment of defoliation was performed in July. It was assessed by the following five classes: 0 – no defoliation (0 – 10%); 1 – slight defoliation (>10 – 25%); 2 – moderate defoliation (> 25 – 60%); 3 – severe defoliation (> 60 – <100%); 4 – dead trees (100%) (Anonymus 2006, 2010). Discolouration was assessed in August and presented in four categories: 0 - no discolouration (0 – 10%); 1 – slight discolouration (> 10 – 25%); 2 – moderate discolouration (> 25 – 60%); 3 – severe discolouration (> 60 – <100%) (Anonymus 2006, 2010). Young trees were excluded from the assessment.

In order to determine potential risks, plant material was collected and processed in the laboratory applying standard methods (Jung 2009, Jung et al. 1996, 2000; Milenković 2015; Krantz & Walter 2009, Evans & Browning 1955). Biotic agents of damage were determined using adequate keys for different groups of agents of plant diseases and pests (Agrios 2005; Alexopoulos et al. 1996; Barnett and Hunter 1998; Breitenbach and Kränzlin 1986; Černý 1989; Davidson et al. 1938; Gilbertson 1979; Hagara 2012; Jung 2009; Jung et al. 1996, 2000; Karadžić 2010; Karadžić et al., 2014; Karadžić and Milenković 2014, 2015; Milenković 2015; Murrill 1903, 1908; Overholts 1953; Pegler and Waterston 1968; Ryvarden and Johansen 1980; Stalpers 1978; Wagner and Fischer 2002; Amrine et al. 2003; Baker et al. 1996; Nalepa 1910; Petanović 1988; Baker & Tuttle 1994; Mitrofanov et al., 1987; Migeon and Dorkeld 2020; Alford 1995; Johnson and Lyon 1991; Maceljski 1986, 2002; Mihajlović 2008; Petrović-Obradović 2003; Tanasijević and Simova-Tošić 1987; Strous & Winter 2000; Vacante 2015).

## **3. RESEARCH RESULTS AND DISCUSSION**

The condition of the examined tree and shrub species in Topčider Park was assessed on the basis of a visual inspection (Table 1).

**Table 1.** Visual assessment of tree and shrub species in Topčder Park

Plant species	Health condition	Defoliation score	Discolouration score
<i>Abies alba</i>	4.9	0	0
<i>Acer campestre</i>	4.3	0	0.5
<i>Acer ginnala</i>	4.0	0.0	1.5
<i>Acer negundo</i>	3.4	1.5	3.1
<i>Acer platanoides</i>	5.0	0.0	0.0
<i>Acer pseudoplatanus</i>	3.9	0.5	1.2
<i>Acer tataricum</i>	4.0	0.0	1.3
<i>Aesculus hippocastanum</i>	3.4	2.3	2.2
<i>Alnus glutinosa</i>	4.1	1.5	1.0
<i>Betula verrucosa</i>	4.2	1.0	1.0
<i>Buxus sempervirens</i>	4.1	1.8	1.6
<i>Carpinus betulus</i>	4.1	1.5	1.0
<i>Catalpa bignonioides</i>	4.4	1.0	1.0
<i>Cedrus atlantica</i>	5.0	0.0	0.0
<i>Celtis australis</i>	4.5	1.5	1.5
<i>Cercis siliquastrum</i>	4.0	0.0	0.0
<i>Chamaecyparis lawsoniana</i>	4.2	0.0	0.0
<i>Cornus alba</i>	4.5	0.0	0.0
<i>Corylus avelana</i>	5.0	0.0	0.0
<i>Corylus colurna</i>	5.0	0.0	0.0
<i>Cryptomeria japonica</i>	3.8	1.5	1.5
<i>Euonymus europaeus</i>	4.1	1.5	1.0
<i>Fagus moesiaca</i>	3.9	1.2	1.5
<i>Forsythia</i> spp.	4.6	0.0	0.0
<i>Fraxinus angustifolia</i>	4.4	1.0	0.5
<i>Fraxinus excelsior</i>	4.1	1.0	0.5
<i>Fraxinus ornus</i>	4.0	1.0	0.5
<i>Gleditsia triacanthos</i>	3.4	2.0	1.0
<i>Hybiscus syriacus</i>	4.8	0.0	0.0
<i>Ilex aquifolium</i>	4.5	0.0	0.0
<i>Juglans nigra</i>	5.0	0.0	0.0
<i>Juglans regia</i>	4.0	1.0	1.0
<i>Juniperus virginiana</i>	4.4	0.0	0.0
<i>Kerria japonica</i>	4.1	0.0	0.0
<i>Ligustrum</i> spp.	4.6	0.0	0.0
<i>Lonicera x purpusii</i>	4.9	0.0	0.0
<i>Maclura aurantiaca</i>	5.0	0.0	0.0
<i>Mahonia aquifolium</i>	5.0	0.0	0.0

Plant species	Health condition	Defoliation score	Discolouration score
<i>Morus alba</i>	3.9	1.5	1.0
<i>Picea abies</i>	4.0	1.2	1.5
<i>Picea omorika</i>	4.0	1.0	1.5
<i>Picea pungens</i>	4.0	1.1	1.5
<i>Pinus nigra</i>	4.4	1.3	1.0
<i>Pinus pinaster</i>	4.6	1.0	0.0
<i>Pinus silvestris</i>	4.7	1.0	0.0
<i>Pinus strobus</i>	4.0	1.4	1.2
<i>Pinus wallichiana</i>	4.3	1.1	1.0
<i>Platanus acerifolia</i>	3.9	1.9	3.2
<i>Platanus orientalis</i>	4.0	1.4	2.0
<i>Populus alba</i>	3.7	2.2	2.3
<i>Populus nigra</i>	3.9	2.6	2.1
<i>Populus tremula</i>	3.9	2.5	2.3
<i>Prunus cerasifera</i>	5.0	0.0	0.0
<i>Prunus spinosa</i>	5.0	0.0	0.0
<i>Pseudotsuga taxifolia</i>	4.9	1.0	0.0
<i>Pyrus piraster</i>	4.0	1.1	1.3
<i>Quercus rubra</i>	5.0	0.0	0.0
<i>Quercus cerris</i>	4.0	1.3	1.0
<i>Quercus robur</i>	4.2	2.1	1.2
<i>Robinia pseudoacacia</i>	4.5	1.1	1.3
<i>Rosa canina</i>	4.8	1.3	0.0
<i>Salix</i> spp.	4.1	1.2	1.0
<i>Sambucus nigra</i>	5.0	0.0	0.0
<i>Sorbus acuparia</i>	4.6	1.1	1.2
<i>Syringa vulgaris</i>	4.1	2.0	1.0
<i>Tamarix</i> spp.	4.5	0.0	0.0
<i>Taxus baccata</i>	4.9	0.0	0.0
<i>Thuja occidentalis</i>	4.0	1.1	2.1
<i>Thuja orientalis</i>	4.3	1.2	1.0
<b>Tilia argentea</b>	4.0	1.3	0.0
<i>Tilia cordata</i>	4.0	1.2	1.0
<i>Tilia grandifolia</i>	4.0	1.0	1.1
<i>Ulmus</i> spp.	4.1	1.2	1.5
<i>Viburnum opulus</i>	4.0	0.0	0.0
<b>average</b>	<b>4.3</b>	<b>0.9</b>	<b>0.8</b>

The average health score of fir trees was 4.9. Mechanical damage was found on one of the inspected trees, while needle loss and discolouration of conifers were not determined. The following trees of the *Acer* genus were examined: field maple, box elder, sycamore maple, Norway maple, Tartar maple, and an Amur maple tree. Powdery mildew, *Uncinula aceris* Sacc., (Figure 1), was recorded on sycamore maple, as well as cicada of *Metcalfa pruinosa* (Say, 1830), mistletoe (*Viscum album* subsp. *album* L.) and carpophorec of the wood-decaying *Schizophyllum commune* Fries (1815). Top-killed trees that need to be pruned were also registered. The health condition was scored 3.9, with younger trees being in better condition. Defoliation ranged from none to slight and discolouration from slight to moderate. Field maple trees had decaying trunks, dying-back trees, and dead branches, while several trees recorded the carpophores of *Ganoderma adspersum* (Schulzer) Donk 1969. The trunks of damaged trees had carpophores of the wood-decaying *S. commune*, mechanical damage to the trunk and branches, and dieback of shoots. The average health condition score of field maple trees was 4.3, while defoliation and discolouration were none to slight. The significant presence of leaf powdery mildew was noted on box elder trees, as well as extensive mechanical damage and decay of the stem base and trunk. The average health condition score was 3.4 with severe discolouration and slight to moderate defoliation. Norway maple trees were in good health condition and scored 5.0 with only slight defoliation. Tartar maple and Amur maple trees were rated 4.0 with a slight presence of discolouration. Horse chestnut trees, one of which is a red horse chestnut tree, had frost cracks and mechanical damage to the trunks that were adequately treated. The decay of branches and higher tree parts and trunks was determined. Carpophores of wood-decaying *G. adspersum* were found on some trees and *Phytophthora* spp. were present in the stem base of some trees. *S. commune* was also observed, as well as the symptoms of chestnut leaf blotch caused by *Guignardia aesculi* (Peck) V.B. Stewart, and *Cameraria ochridella* Deschka & Dimic, 1986, the horse-chestnut leafminer. The average health score was 3.4, with slight to moderate discolouration and slight to moderate defoliation. Black alder trees had signs of decay at the site of broken branches, mechanical damage to the stem base, and damage caused by *Acalitus brevitarsus* (Fockeu, 1890,) the eriophyid alder mite, while the carpophores of *G. adspersum* could be seen on several trees in the stem base and lower parts of the trunk (Figure 1). The presence of *Phytophthora* spp. was observed on young alder trees. The mean health score was 4.1, with slight discolouration and defoliation present. Three birch trees had dead branches and mechanical damage at the stem base. The mean health score is 4.2 with slight defoliation and discolouration. The presence of the invasive pest *Cydalima perspectalis* (Walker, 1859) with low intensity of the attack was determined on boxwood shrubs. The health was assessed at 4.1. Hornbeam trees had dying branches, dieback as well as trunk cankers and leakage of exudates. The presence of *Phytophthora* spp. was noted, while several trees had *G. adspersum* carpophores. Mechanical damage to the trunk was also observed and adequately treated. The average health was rated 4.1. Defoliation ranged from slight to moderate, and discolouration was slight. Some trees of common catalpa showed signs of mechanical damage and some dying branches were noted. The average score was 4.4 with slight defoliation and discolouration. The inspected Atlas cedar trees received the highest score and had no defoliation and discolouration. The examined

nettle trees were scored 4.5 with slight defoliation and discolouration. Some cryptomeria trees were top-killed or had individual dead branches. The average score of the health condition was 3.8, while defoliation and discolouration ranged to moderate. The examined Moesian beech trees had mechanical damage of the bark, as well as necrosis with exudate leakage. The presence of *Inonotus hispidus* (Bull.) P. Karst., (1880), *Meripilus giganteus* (Pers.) Karst. (1882), *G. adspersum* and *Phytophthora* spp. was observed, while one tree was without injuries and in good health condition. The average score of the health condition was 3.9, while defoliation and discolouration ranged from not being recorded on one tree to moderate. On individual ash trees, mechanical damage to the trunk was noted and treated. There were individual dead branches with carpophores of white-rot causing *I. hispidus*. *Aceria fraxinivora* (Nalepa, 1909), a gall mite of ash flower clusters was also present. There were young trees with the symptoms of dieback and dying branches caused by *Hymenoscyphus fraxineus* (T. Kowalski) Baral, Queloz & Hosoya (Figure 1). Young ash trees were damaged at the stem base during manipulation. Their health score ranged from 4.0 to 4.4. Defoliation was slight and discolouration was none to slight. Some of the inspected honey locust trees had symptoms of decay and fruiting bodies of wood-decaying fungi. Repairs were put in hand and dead parts were removed. Carpophores of the wood-decaying fungus *Laetiporus sulphureus* (Bull.) Murrill, 1920 were recorded. The average score was 3.4 with moderate to slight defoliation and slight discolouration. All examined osage orange trees were received the highest score with no defoliation and discolouration present. The presence of *I. hispidus*, the agent of yellow-white trunk rot, was observed on white mulberry, and this group of trees was given an average health score of 3.9. The survey included trees of the *Picea* genus: Serbian spruce, blue spruce, and Norway spruce. The presence of the spruce bud-scale *Physokermes piceae* (Schrank, 1801), mechanical damage, and dying of the lower branches were noted on Serbian spruce and Norway spruce. The average health score was 4.0 with slight defoliation and slight to moderate discolouration of needles, especially in the lower parts of the crown. The examined Austrian and Scots pine trees showed symptoms of the anthracnose of shoots caused by *Sphaeropsis sapinea* Dyko et Sutton, as well as fungi that cause redness and shedding of pine needles (*Lophodermium pinastri* (Schrad) Chev. and *L. seditiosum* Minter, Staley & Millar). The average health condition of Austrian pine was assessed 4.4 and Scots pine 4.7 with a negligible to slight presence of defoliation and discolouration. The examination also included London plane and Oriental plane trees with various mechanical damage to the stem base, dying of individual branches as well as symptoms of scorch along the leaf veins caused by *Apiognomonium veneta* (Sacc. & Speg.) Höhn., (1920). A few trees had *G. adspersum* carpophores (Figure 1) at the stem base, and one tree was severely endangered by the presence of this fungus. Several trees were infected with the wood-decaying fungus *Perenniporia fraxinea* (Bull.) Ryvarden (1978) (Figure 1). The presence of the sycamore lace bug *Corythucha ciliata* (Say, 1832) and the mottled plane moth *Phyllonorycter platani* (Staudinger, 1870) was recorded on almost all examined trees. The average health score for the examined plane trees was 3.9/4.0, the defoliation ranged from slight to moderate, while the discolouration was around the moderate value and was mainly caused by the above organisms. The survey included trees of the *Populus* genus: aspen, white poplar, and black poplar, where some trees

were affected by the agent of white rot of the heartwood at the stem base and the *P. fraxinea* rot in the central part of the root. There was also some mechanical damage so that the average score ranged from 3.7 for white poplar to 3.9 for aspen. Defoliation and discolouration were slight to moderate. The inspected cherry plum trees and blackthorn shrubs were rated 5.0 with no defoliation and discolouration. The survey included trees of the *Quercus* genus, most of which were pedunculate oak. They had mechanical damage inflicted to stronger roots, individual dead branches, rusty brown necrosis on the trunks, while leaves had symptoms of the oak powdery mildew. The occurrence of individual dying branches was observed on Turkey oak trees, as well as the presence of powdery mildew of *Microsphaera alphitoides* Grif. & Maubl on leaves (Figure 1). Health condition scores ranged from 4.0 in Turkey oak to 5.0 in red oak. Younger trees were in better physiological condition. Defoliation was slight to moderate, while discolouration, mainly caused by leaf powdery mildew, ranged around moderate to severe values. Regarding the inspected black locust trees, dying branches and mechanical injuries were noticed. A sporadic presence of the black locust miner *Phyllonorycter robinella* (Clemens, 1859) was observed. The average health score was 4.5, and defoliation and discolouration were slight. The examined trees of *Salix* spp. had canker wounds with exudates and fruiting bodies of the wood-decaying fungus *Phellinus igniarius* (L.) Quéf. (1886). The presence of mistletoe (*Viscum album* subsp. *Album* L.) was registered. The average health condition was assessed 4.1 with slight defoliation and discolouration. Taxodium trees received the highest health score of 5.0 with no defoliation and discolouration. The examined yew trees received 4.9 as a health assessment due to the presence of mechanical damage. Northern whitecedar and Oriental arborvitae trees, *Thuja occidentalis* and *T. orientalis*, were assessed 4.0 and 4.3, respectively, with the presence of mechanical damage and individual dead branches, as well as the presence of *Pestalotiopsis funerea* (Desm.) Steyaert. Defoliation and discolouration were slight to moderate. The assessment included trees of different *Tilia* species. There were individual dead branches and one tree was top-killed. The presence of *G. adpersum* was recorded at the stem base of some trees and the presence of *S. commune* on the branches and injured lime trunks. The presence of the following mite species was observed on the examined trees: *Phytoptus tetratrichus* (Nalepa, 1890), *Eriophyes tiliae* (Pagenstecher, 1857), *Eotetranychus tiliarium* (Hermann, 1804) and *Bryobia rubrioculus* (Scheuten, 1857). The presence of mistletoe (*Viscum album* subsp. *album* L.) was noted. The average health condition score was 4.0, with slight defoliation and moderate discolouration. The presence of *Tetraneura (Tetraneura) ulmi* (Linnaeus, 1758) and mechanical damage to the stem and stem base were determined on some examined trees of *Ulmus* spp. The average score of the health condition of the trees was 4.1, defoliation was slight and discolouration slight to moderate.

It is necessary to assess the health state and determine biotic and abiotic factors that directly or indirectly threaten the condition of tree and shrub species so that optimal preventive or remedial action can be taken and adequate and timely care and protection measures applied. Observing the overall assessment of the health status of the examined tree and shrub species, it can be noticed that the greatest damage to maple was caused by the action of *G. adpersum* and *S. commune*. Horse chestnut had the greatest damage inflicted by the attack of pathogenic organisms *G.*



*aesculi*, *Phytophthora* spp. (Figure 1), *S. commune* and insects *C. ohridella*. The greatest damage to alder was caused by the wood-decaying fungus *G. adspersum*. *Phytophthora* spp. and *G. adspersum* were present on elm trees. Beech trees were most endangered by *I. hispidus*, *M. giganteus*, *G. adspersum*, and *Phytophthora* spp. Plane trees were endangered by wood-decaying fungi, such as *P. fraxinea*, *G. adspersum* and *A. veneta*, the plane lace bug *C. ciliata* and the plane tree moth *P. platani*. The health condition of poplars was most endangered by *P. fraxinea*. Tilia species were most endangered by the action of the wood-decaying fungus *G. adspersum* as well as *S. commune*.



**Figure 1.** Representative photos of the recorded damaging biotic factors on woody hosts in Topčider Park: A- *Erysiphae* (*Microsphaera*) *alphitoides* on the pedunculate oak leaves, B- *Uncinula* sp. on the sycamore maple leaves; C- *Hymenoscyphus fraxineus* on young common ash plants; D- a diedback beech tree affected with beech bark disease; E- *Phytophthora* spp. on the bark of a horse chestnut tree; F- *Perenniporia fraxinea* and G- *Ganoderma adspersum* at the stem base of a plane tree; H- *Ganderma adspersum* at the stem base of an alder tree.

The species most endangered by the attack of pathogenic fungi and fungus-like organisms are maple, horse chestnut, lime, poplar, and plane.

The species of insects and mites here present did not significantly affect the development of the investigated plant species. Not only do the plane lace bug, wild chestnut miner, locust miner, sycamore moth miner, lime eriophyid mites, lime spider mite disturb the aesthetic appearance of plants, but they also increase discolouration and defoliation and physiologically weaken the plant over a long period. Combined with other adverse environmental factors, they can lead to plant dieback.

Extensive mechanical damage was identified on a large number of trees, both young and old. The damage needs to be repaired adequately to avoid direct penetration and further development of pathogenic fungi, especially the ones that cause wood decay.

#### **4. CONCLUSIONS**

Plant species with the best health and physiological condition in Topčider Park are silver fir, Norway maple, Atlas cedar, common hazel, Turkish hazel, common hibiscus, black walnut, privet, honeysuckle, osage orange, mahonia, maritime pine, Scots pine, cherry plum, blackthorn, Douglas fir, red oak, dog rose, black elder, rowan, and yew. The following species proved to be less resistant to biotic and abiotic damaging agents: box elder, horse chestnut, and honey locust. Most of the investigated trees are in the group of trees with small to pronounced injuries. Some trees of poplar, hornbeam, ash, willow, and chestnut are planned to be removed, while other trees need to be monitored in the future so that the safety of the park users would not be endangered.

Activities related to the detection, diagnosis, monitoring, control, and forecasting of the occurrence of the most significant harmful organisms in Topčider Park are needed to prevent the occurrence of new hotspots and prevent further spread and potential chain of damage.

Regarding the maintenance of Topčider Park, in order to preserve the long life and aesthetic value of the dendrofund and minimize the potential danger for the park users from fallen timber, broken branches, etc., it is necessary to apply integrated care and protection measures. The goals of the integrated approach, which includes the application of biological and chemical measures, are: an acceptable level of the harmful organism (control of the population size but not its extinction, with the determination of the threshold of the harmfulness of each harmful species); application of preventive measures (healthy planting material, adequate selection of plant species, removal of transitional hosts, etc.); determination and monitoring of the presence of harmful organisms; implementation of appropriate agro-technical and mechanical measures in eliminating the source of infection; use of biological control measures; responsible use of pesticides, etc.

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# THE HEALTH CONDITION OF TREE AND SHRUB SPECIES OF TOPČIDER PARK

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## Summary

The assessment of the health condition of tree and shrub species of the protected area Topčiderski Park was performed in two growing seasons (2018 and 2019) on the basis of the determined visual assessment, and the degree of defoliation and discolouration. Besides the vitality of park species, the study deals with the biotic (phytopathogenic fungi, insects, and mites) and abiotic factors that directly or indirectly threaten the health condition and ornamental value of the dendro-material.

The visual assessment of the health state of the most important plant species as an indicator of their condition and influence of biotic and abiotic factors was determined according to the scale: 5 – a healthy tree (without visible symptoms of damage to foliage, trunk, and branches); 4 – a slightly damaged tree (occasional damage to foliage, trunk, and branches, a small percentage of dead branches); 3 – a severely damaged tree (damage to foliage, trunk and branches, dieback, decaying trunk and/or branches; rehabilitation possible); 2 – a dying tree (significantly reduced leaf surface area, advanced trunk and branch decay; safety hazard); 1 – a dead tree. The crown condition was observed through different classes of crown volume loss and discolouration of assimilation organs. The assessment of defoliation was performed in July assessed by the the following five classes: 0 – no defoliation (0 – 10%); 1 – slight defoliation (>10 – 25%); 2 – moderate defoliation (> 25 – 60%); 3 – severe defoliation (> 60 – <100%); 4 – dead trees (100%) (Anonymus 2006, 2010). Discolouration was assessed in August and presented in four categories: 0 – no discolouration (0 – 10%); 1 – slight discolouration (> 10 – 25%); 2 – moderate discolouration (> 25 – 60%); 3 – severe discolouration (> 60 – <100%) (Anonymus 2006, 2010). Young trees were excluded from the assessment.

In Topčider Park, the following species are in the best health and physiological condition: *Abies alba*, *Acer platanoides*, *Cedrus atlantica*, *Corylus avellana*, *C. columna*, *Hybiscus syriacus*, *Juglans nigra*, *Ligustrum* spp., *Lonicera x purpusii*, *Maclura aurantiaca*, *Mahonia aquifolium*, *Pinus pinaster*, *P. silvestris*, *Prunus cerasifera*, *P. spinosa*, *Pseudotsuga taxifolia*, *Quercus borealis*, *Rosa canina*, *Sambucus nigra*, *Sorbus acuparia* and *Taxus baccata*. The following species proved to be less resistant to biotic and abiotic damaging agents: *Acer negundo*, *Aesculus hippocastanum*, and *Gleditsia triacanthos*. Most of the investigated trees are in the group of trees with small to pronounced injuries. Some trees of poplar, hornbeam, ash, willow, and chestnut are planned to be removed, while other trees need to be monitored in the future so that the safety of the park users would not be endangered.

The species most endangered by the attack of pathogenic fungi and fungus-like organisms are maple, horse chestnut, lime, poplar, and plane. Observing the overall assessment of the health status of the examined tree and shrub species, it can be noticed that the greatest damage to *Acer* spp. was caused by the action of *G. adspersum* and *S. commune*. Horse chestnut *Aesculus hippocastanum* had the greatest damage inflicted by the attack of pathogenic organisms *G. aesculi*, *Phytophthora* spp. (Figure 1), *S. commune*, and insects *C. ohridella*. The greatest damage to common alder *Alnus glutinosa* was caused by the wood-decaying fungus *G. adspersum*. *Phytophthora* spp. and *G. adspersum* were present on elm trees. Balkan beech *Fagus moesiaca* was most endangered by *I. hispidus*, *M. giganteus*, *G. adspersum* and *Phytophthora* spp. Plane trees *Platanus* spp. were endangered by wood-

decaying fungi: *P. fraxinea*, *G. adspersum* and *A. veneta*, the plane lace bug *C. ciliate*, and the plane tree moth *P. platani*. The health condition of poplars *Populus* spp. was most endangered by *P. fraxinea*. *Tilia* spp. were most endangered by the action of wood-decaying fungus *G. adspersum* as well as *S. commune*. The species of insects and mites here present did not significantly affect the development of the investigated plant species. Not only do the plane lace bug, wild chestnut miner, locust miner, sycamore moth miner, lime eriophyd mites, and lime spider mite disturb the aesthetic appearance of plants, but they also increase discolouration and defoliation and physiologically weaken the plant over a long period. Combined with other adverse environmental factors, they can lead to plant dieback.

Extensive mechanical damage was identified on a large number of trees. This damage enables direct penetration and further development of pathogenic fungi, especially the ones that cause wood decay.

Regarding the maintenance of Topčider Park, in order to preserve the long life and aesthetic value of the dendrofund and minimize the potential danger for the park users from fallen timber, broken branches, etc., it is necessary to apply integrated care and protection measures.

## ZDRAVSTVENO STANJE DRVENASTIH I ŽBUNASTIH VRSTA TOPČIDERSKOG PARKA

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### Rezime

Procena zdravstvenog stanja drvenastih i žbunastih vrsta prirodnog dobra Topčiderski park je izvršena tokom dve vegetacijske sezone (2018. i 2019.) na osnovu utvrđene vizuelne ocene, stepena defolijacije i dekolorizacije. Pored vitalnosti parkovskih vrsta utvrđeni su biotski (fitopatogene gljive, insekti i grinje) i abiotski faktori, koji neposredno ili posredno ugrožavaju kondiciju i dekorativnost dendromaterijala.

Vizuelna ocena zdravstvenog stanja za najznačajnije biljne vrste kao pokazatelj kondicije i uticaja biotičkih i abiotičkih faktora utvrđena je prema skali: 5 – zdravo stablo (bez vidljivih simptoma oštećenja lisne mase, debla i grana); 4 – stablo sa manjim povredama (mestimična oštećenja lisne mase, debla i grana, prisustvo suvih grana u malom procentu); 3 – stablo sa izraženim povredama (prisutna oštećenja lisne mase, debla i grana, suhvrhost, trulež debla i/ili grana; moguća sanacija); 2 – stablo u odumiranju (znatno redukovana asimilaciona površina, uznapredovala trulež debla i grana; opasno po bezbednost); 1 – mrtvo stablo. Stanje kruna je posmatrano kroz različite klase gubitka zapremine kruna i promene boje asimilacionih organa. Ocenjivanje defolijacije obavljeno je u julu i iskazano je u pet klasa: 0 - bez defolijacije (0 – 10%); 1 - slaba defolijacija (>10 – 25%); 2 - umerena defolijacija (>25 – 60%); 3 - jaka defolijacija (>60 – <100%); 4 - suvo stablo (100%). Utvrđivanje dekolorizacije izvršeno je tokom avgusta i prikazano je u četiri kategorije: 0 – bez dekolorizacije (0 – 10%); 1 - slaba dekolorizacija (>10 – 25%); 2 - srednja dekolorizacija (>25 – 60%); 3 - jaka dekolorizacija (>60 – <100%). Mlada stabla su izuzeta iz ocenjivanja.

U Topčiderskom parku najboljeg zdravstvenog stanja i fiziološke kondicije su sledeće vrste: *Abies alba*, *Acer platanoides*, *Cedrus atlantica*, *Corylus avellana*, *C. colurna*, *Hybiscus syriacus*, *Juglans nigra*, *Ligustrum* spp., *Lonicera x purpusii*, *Maclura aurantiaca*, *Mahonia aquifolium*, *Pinus pinaster*, *P. silvestris*, *Prunus cerasifera*, *P. spinosa*, *Pseudotsuga taxifolia*, *Quercus borealis*, *Rosa canina*, *Sambucus nigra*, *Sorbus acuparia* i *Taxus baccata*. Manje otporne na biotička i abiotička oštećenja pokazala su se sledeće vrste: *Acer negundo*, *Aesculus hippocastanum* и *Gleditsia triacanthos*. Većina istraživanih stabala

su u grupi stabala sa manjim do stabala sa izraženim povredama. Pojedina stabla topole, graba, jasena, vrbe, kestena su predviđena za uklanjanje dok je ostala stabla potrebno pratiti u budućnosti kako bezbednost korisnika parka ne bi bila ugrožena.

Najugroženije biljne vrste od napada patogenih gljiva i gljivama sličnih organizama su vrste javora, divlji kesten, vrste lipa, topola i platan. Posmatrajući ukupnu ocenu zdravstvenog stanja ispitivanih drvenastih i žbunastih vrsta može se uočiti da su na javoru *Acer* spp. najveće štete zabeležene usled dejstva *G. adspersum* i *S. commune*. Na divljem kestenu *Aesculus hippocastanum*, najveće štete su uzrokovane usled napada patogenih organizama *G. aesculi*, *Phytophthora* spp. (Figure 1), *S. commune* kao i insekta *C. ohridella*. Na jovi *Alnus glutinosa* najveću štetu prčinjava gljiva truležnice *G. adspersum*. Na brestu *Ulmus* spp. prisutne su gljive *Phytophthora* spp. i *G. adspersum*. Bukvu *Fagus moesiaca* najviše ugrožavaju *I. hispidus*, *M. giganteus*, *G. adspersum* i *Phytophthora* spp. Platanu *Platanus* spp. ugrožavaju gljive truležnice: *P. fraxinea*, *G. adspersum* kao i *A. veneta*, zatim prisustvo platanove mrežaste stenice *C. ciliata* i platanovog moljca minera *P. platani*. Zdravstveno stanje topola *Populus* spp. najviše ugrožava *P. fraxinea*. Vrste lipa *Tilia* spp. su najviše ugrožene dejstvom gljiva truležnica *G. adspersum* kao i *S. commune*. Prisutne vrste insekata i grinja nisu u značajnijoj meri uticale na razvoj istraživanih biljnih vrsta. Platanova mrežasta stenica, miner divnjeg kestena, bagremovog miner, platanov moljac miner, eriofide lipe, lipin paučinar pored toga sto narušavaju estetski izgled biljke utiču i na dekolorizaciju i defolijaciju, fizioloski slabe biljku što u dužem vremenskom periodu, udruženo sa ostalim nepovoljnim uticajima urbane sredine može dovesti do desikacije.

Utvrđena su brojna mehanička oštećenja na velikom broju stabala koje obezbeđuju direktan prodor i razvoj patogenih gljiva, posebno gljiva prouzrokovaca truleži drveta.

Za održavanje parka Topčider, kako bi se očuvala dugovečnost i estetska vrednost dendrofonda a ujedno i minimizirala potencijalna opasnost za korisnike parka od izvala, lomova grana itd., neophodna je primena integralnih mera nege i zaštite.