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VISCUM ALBUM L. IN PROTECTED AREAS OF THE UKRAINIAN POLISSYA

Anzhela Dzyba

Department of Landscape Architecture and Phytodesign, Education and Research Institute of Forestry and Landscape-Park Management, National University of Life and Environmental Sciences of Ukraine, 19 General Rodimtsev Str., 03041 Kyiv, Ukraine.
E-mail: orhideya_oncydium@ukr.net

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Abstract

In our work we determined the representation of trees that serve as hosts to common mistletoe (*Viscum album* L.) in protected areas of the Ukrainian Polissya. Our research goal was to conduct a quantitative and qualitative inventory of tree taxa damaged by the mistletoe. The study was conducted in 57 protected areas of the Ukrainian Polissya with a combined area of 715.22 ha. We identified 455 trees hosting 8586 mistletoe plants in 36.8 % of the entities covering 51.5 % of studied areas. The total number of host-tree taxa was 64, belonging to 9 families and 16 genera, with 45 tree species being on IUCN Red List. By bio-morphological characteristics, these 64 taxa were distributed among moesophanerophytes (44), megaphanerophytes (11) and microphanerophytes (9). By ecological characteristics, the dominant taxa were heliophytes (60.9 %), followed by moesotrophs (57.8 %) and mesophytes (46.9 %). Based on damage to host trees, 46.2 % taxa had low, 31.9 % - moderate, 10.5 % – high and 11.4 % – very high levels of mistletoe damage. The highest damage was observed on five species, including *Tilia cordata* Mill., *Acer platanoides* L., *Populus simonii* Carrière, *Populus nigra* L. and *Juglans nigra* L. By origin, 72.3 % of damaged host trees were introduced species, whereas by number of damaged trees, 51.4 % of trees were native. On study sites, in southern section of Volyn and Zhytomyr Polissya, the rate of mistletoe infestation per plant was high and constituted 43 and 41 bushes per host tree, respectively.

Key words: dendrological park, infected trees, European mistletoe, monument of nature.

Introduction

Protected areas of the Ukrainian Polissya have not only historical, cultural and aesthetic values, but also healing, recreational, functional and ecological values (Markov 2014, Markov and Terelya 2019, Markov et al. 2020). However, due to the increase in air temperatures and the decrease in precipitation, tree growth may decrease (Petkova 2018). In order to effectively plan the protected area, all threats and factors that may adversely affect its functioning should be investigated (Prots et al. 2010). *Viscum album* L. can lead to decline of tree plantations, reduced tree growth, premature tree mortality and deterioration of the aesthetic appearance

of woody plants, including rare trees; as a result, it poses a threat to plantations in protected areas, protective strips along roads and fruit orchards (Taran et al. 2008, Yurel and Liakh 2019). This semi-parasitic plant can reduce the intensity of the assimilation apparatus of host trees by more than 20 % (Rybalka and Verheles 2017). Mistletoe is now an invasive plant species that is actively spreading (Yurel and Liakh 2019). European mistletoe has become an important agent of destruction of forest trees in Central Europe. During 2008–2018, an increase in infected trees was noted in the forests of Poland (Lech et al. 2020). In Hungary, since the beginning of the 20th century, area where mistletoe was widespread has tripled (Varga et al. 2014). Monitoring and control of mistletoe is becoming increasingly difficult as more and more new plant species become mistletoe hosts (Krasylenko et al. 2020). From the temperate to the tropical world, 464 species of mistletoe host trees are known (Ahmed and Dutt 2015). In Europe, mistletoe can infect over 380 taxa of trees (Varga et al. 2014). Spread of white mistletoe occurs as a result of stand thinning (Rybalka 2017). Growing on the edges, trees in groups with an open crown are most affected by mistletoe (Baltazár et al. 2013). Infecting of trees by *Viscum album* L. resumes after sanitary pruning (Bilonozhko et al. 2019). The density of white mistletoe is positively correlated with the density of the road network and the share of buildings (Rybalka 2017). *Viscum album* primarily inhabits large trees of the genus *Populus* L. and *Acer saccharinum* L. (Ivchenko et al. 2014). Trees that are most often infected are weakened old trees with soft wood and a thin cork layer, growing in river valleys, moist beams and ancient manor parks. Trees growing in urban plantations are infected less often (Dobrynia 2013, Yakymenko et al. 2019). Mistletoe mainly affects old trees (Tsopelas et al. 2004, Evstihneev and Fedotov 2005), prefers sparse plantations in which trees have sufficient light, as well as suppressed trees (Velichkin 2012). Among the environmental factors and landscape characteristics, the main ones influencing the spread of mistletoe in urban areas are tree age and relative humidity. Factors that reflect environmental pollution (content of heavy metals in the soil and the concentration of nitrogen dioxide in the air) do not statistically affect the spread of mistletoe (Skrypnik et al. 2020). To keep green area in proper condition, it is important to control the distribution of *Viscum album* (Barannik et al. 2010). Inventory and examination of positive and negative processes resulting from a decrease in the distribution of white mistletoe will allow avoiding unwanted biological effects (Yurel and Liakh 2019). The vast majority of research on the spread of white mistletoe was conducted in forest plantations (Tsopelas et al. 2004, Varga et al. 2014, Lech et al. 2020) and urban areas of different European countries (Kołodziejek et al. 2013, Rybalka 2017, Bilonozhko et al. 2019, Yakymenko et al. 2019, Krasylenko et al. 2020, Skrypnik et al. 2020), for example in the roadside forests of the Forest-Steppe zone (Vinnytsia and Cherkasy Regions) and Polissya (Zhytomyr Region) (Hnatyuk and Kavun 2017), in parks and recreation areas of the Forest-Steppe and Polissya (Hnatyuk and Kavun 2016). Therefore, there is a need to conduct research in the protected areas of the Ukrainian Polissya to study the spread of mistletoe.

The purpose of this study is to conduct an inventory of *Viscum album* in protected areas of the Ukrainian Polissya and to solve the following tasks: to analyze dis-

tribution of *Viscum album*, to assess the degree of impact on trees and to establish taxonomic, ecological and biomorphological characteristics of the host-trees.

Materials and Methods

A systematic approach and comparative analysis of the obtained empiric data were applied; inventory of species of woody plants affected by white mistletoe was carried out by route method (State Committee … 2014). The plant species were verified (Kokhno et al. 2001, Spohn and Spohn 2011), as well as species name, according to the international classification (WFO 2021). Tallied woody plant species were checked according to the Red List of the International Union for Conservation of Nature (IUCN Red List) (IUCN 2021). Also, the degree of damage to trees from the mistletoe was assessed. Classification of woody plants into four groups was done based on the level of infection, reflected as the number of mistletoe plants on one tree. Classes included low (less than 10 mistletoe plants per tree), medium (10–30 plants per tree), high (30–50 plants per tree) and very high (more than 50 plants per tree) (Skrypnik et al. 2020). The allocation of woody plants to the ecological groups was conducted based on main environmental factors. Classification of life forms was conducted based on Raunkiær (1934). Distribution of woody plant species by height classes was based on Kalinichenko (2003), where trees have height exceeding 25 m, between 20 and 25 m, between 15 and 20 and between 5(7) and 15 m, for trees of 1st, 2nd, 3rd and 4th height classes, respectively. Shrubs were also separated into height classes including 2.5 to 5 m, 1 to 2.5 m and 0.5 and 1 m for high, medium and low shrub height classes, respectively.

Study Area

We examined 57 protected areas of the Ukrainian Polissya, among them 3 dendrological parks (DP), 42 park-monuments of landscape art (PMLA), three botanical monuments of nature (BNM), six complex monuments of nature (CNM), zoo, and arboreta within the Natural National Parks and Landscape preserve). Plants of *Viscum album* were identified in 21 protected areas (Fig. 1).

Results and Discussion

Viscum album is distributed in Central Europe, Southwest-and-East Asia to Japan (Becker 2000), over most of the territory of Ukraine, western and southern Europe, the Caucasian Mountains, the Southwest, Central and Southern Russia and Belarus (Yurel and Liakh 2019). The area of distribution of white mistletoe over the past decade has expanded significantly to the northeast and east (Velichkin 2012, Yakymenko et al. 2019). In Ukraine, the area occupied by *Viscum album* ssp. *album* is characterized by uneven distribution of the population with gaps in the south and east of the country, whereas the distribution of the highly specialized *V. album* ssp. *abietis* (Wiesb.) Abr. and *V. album* ssp. *austriacum* (Wiesb.) Vollm. is mainly limited to the western and central regions and the mountainous part of the Crimean Peninsula.

Based on the conducted route analysis, mistletoe was found in 21 protected areas, covering 368.14 ha (Table 1).

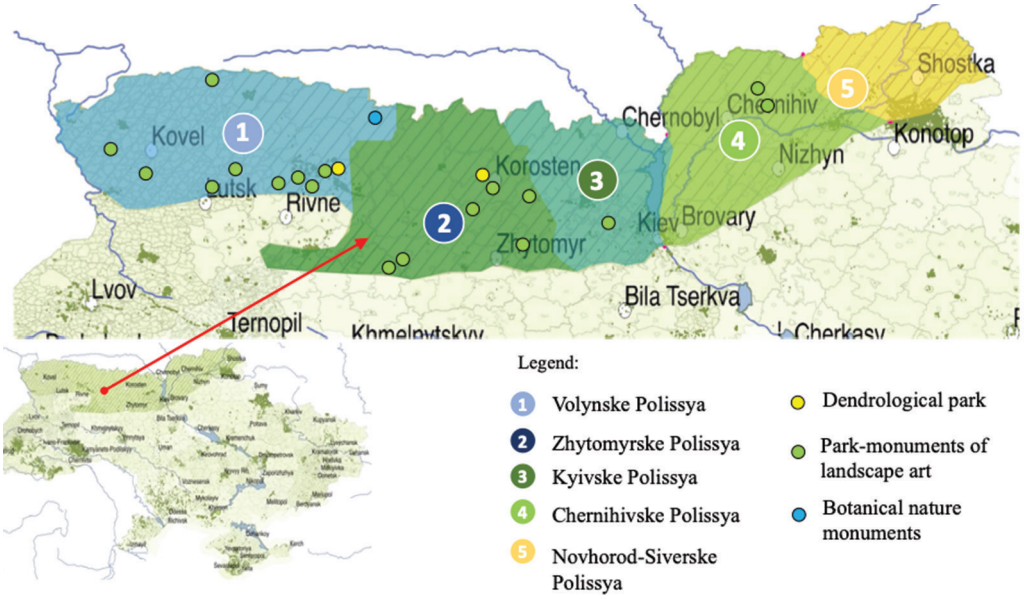

Fig. 1. Distribution of *Viscum album* in the protected areas of the Ukrainian Polissya.

Table 1. *Viscum album* in protected areas of the Ukrainian Polissya.

Protected areas	Absolute altitude, m	Area, ha	Number of host species/ hybrid/ ssp./ cultivar	Number of infected trees	Number of mistletoe specimens	Rate of mistletoe infes-tation*
Volynske Polissya (VP)						
PMLA 'Zdorovia'	195	13.6	2	2	6	3
PMLA 'Litynskyi'	196	8.4	1	2	10	5
PMLA 'Liubeshivskyi'	151	12.0	2	3	16	5.3
PMLA 'Makarevychivskyi'	191	0.9	3	25	969	38.8
PMLA 'Bairak'	192	13.6	1	1	5	5
PMLA 'Horodotskyi'	178	8.0	7	22	425	19.3
PMLA 'Zirnenskyi'	170	17.2	6	12	76	6.3
PMLA 'Oleksandriiskyi'	189	5.0	7	54	2280	43.0
PMLA 'Tuchynskyi'	178	10.0	3	11	176	16
DP 'Beresnivskyi'	165	29.5	46/4/3/3	162	2052	12.7
BNM 'Yuzefinska dacha'	152	100.0	1	2	9	4.5
Zhytomyrske Polissya (ZP)						
PMLA 'Vilkhivskyi'	247	11.2	1	2	40	20
PMLA 'Dvoryshchanskyi'	188	1.5	4	29	811	28
PMLA 'Korostyshivskyi'	180	12.9	2	12	491	40.9

Protected areas	Absolute altitude, m	Area, ha	Number of host species/ hybrid/ ssp./ cultivar	Number of infected trees	Number of mistletoe specimens	Rate of mistletoe infestation*
PMLA 'Ushomyrskyi'	187	12.91	8	24	554	23.1
PMLA 'Park imeni Miklukho-Maklaia'	172	29.63	5	23	489	21.2
DP 'Elita'	170	4.8	2	2	4	2
PMLA 'Polonskyi'	264	37.0	4	17	123	7.6
Kyivske Polissya (KP)						
PMLA 'Kopylivskyi'	185	8.0	11	41	325	7.9
Chernihivske Polissya (CP)						
PMLA 'Lyzohubivskyi'	158	22.0	1	3	16	5.3
PMLA 'Tupychevskyi'	138	10.0	3	5	93	18.6

Note: * the rate of mistletoe infestation presents the number of mistletoe bushes per tree.

In protected areas, *Viscum album* is distributed unevenly, mostly in Volynske Polissya (VP) and Zhytomyrske Polissya (ZP) on 11 and 7 sites, respectively. However, in terms of the number of host-tree species, two locations had the most, DP 'Beresnivskyi' (46 species, 4 hybrids, 2 ssp., 2 cultivars) (VP) and PMLA 'Kopylivskyi' (11 species) on Kyivske Polissya (KP). PMLAs 'Makarevychivskyi', 'Oleksandriiskyi' and DP 'Beresnivskyi' (VP) and PMLA 'Dvoryshchanskyi' (ZP) have the highest rate of damage from mistletoe (Fig. 1). In protected areas of Chernihivske Polissya (CP) white mistletoe plant count was between 16 and 96 plants per host-tree. Infected trees are distributed evenly throughout the parks area. Significant damage by mistletoe was observed on trees that are 100-year-old in historical parks, which were created in the second half of the 19th century (PMLAs 'Makarevychivskyi', 'Horodotskyi', 'Polonskyi', 'Tuchynskyi', 'Oleksandriiskyi' (VP), PMLAs 'Dvoryshchanskyi', 'Korostyshivskyi', 'Ushomyrskyi', 'Park imeni Miklukho-Maklaia' (ZP), PMLA 'Kopylivskyi' (KP).

Similar trend was observed by Evstihneev and Fedotov (2005), Velichkin (2012), Dobrynia (2013), Yakymenko et al. (2019), who also observed most frequent damage to ancient trees. In these studies damaged trees were thought to be associated with river valleys, wet beams and plantations with adequate lighting in ancient parks. The study sites located in the western part of Volynske Polissya showed much sparser distribution of the mistletoe, usually with 2–3 plants per one or two host trees (PMLAs **'**Zdorovia**'**, **'**Litynskyi**'**, **'**Liubeshivskyi**'**, **'**Bairak**')**.

Within the boundaries of studied sites, 455 host trees with 8586 specimens of mistletoe were discovered. The average host-tree was found to have more than 18 mistletoe plants per tree. Depending on the number of mistletoe plants per host-tree, four classes were identified, including low, medium, high and very high. The first class contained 46.2 % of host-plants (Fig. 2a, b), the second one contained 31.9 % (Fig. 3a, b), the third one contained 10.5 % (Fig. 4a, b), the fourth one contained 11.4 % (Fig. 5a, b). Five species

a) *Populus trichocarpa* Torr. & A.Gray ex. Hook PMLA 'Zdorovia'

b) *Malus domestica* Borkh. PMLA 'Zirnenskyi'

Fig. 2. Low degree of the mistletoe infection.

a) *Acer platanoides* PMLA 'Tuchynskyi'

b) *Betula litwinowii* Doluch. DP 'Beresnivskyi'

Fig. 3. Medium degree of the mistletoe infection.

a) *Tilia cordata* PMLA 'Horodotskyi'

b) *Robinia pseudoacacia* PMLA 'Polonskyi'

Fig. 4. High degree of the mistletoe infection.

a) *Acer platanoides* PMLA 'Dvoryshchanskyi'

b) *Tilia cordata* PMLA 'Makarevychivskyi'

Fig. 5. Very High degree of the mistletoe infection.

were most affected (with all four classes): *Tilia cordata* Mill., *Acer platanoides* L., *Populus simonii* Carrière, *Populus nigra* L., *Juglans nigra* L. (Table 2).

Table 2. Host of *Viscum album* in protected areas of the Ukrainian Polissya.

Tree scientific name	Number of infected trees	Number of mistletoe specimens	Rate of mistletoe infestation*	Number of host trees (% to total number of trees)			
				Low	Medium	High	Very high
Tilia cordata Mill.	85	1725	20.3	27 (31.8)	23 (27.1)	19 (22.4)	16 (18.7)
Robinia pseudoacacia L.	55	560	10.1	36 (65.5)	18 (32.7)	1 (1.8)	-
Acer platanoides L.	53	1640	30.9	15 (28.3)	17 (32.1)	9 (17.0)	12 (22.6)
Populus simonii Carrière	31	1008	32.5	8 (25.8)	11 (35.6)	4 (12.9)	8 (25.8)
Populus nigra L.	25	820	32.8	4 (16.0)	8 (32.0)	6 (24.0)	7 (28.0)
Fraxinus excelsior L.	15	167	11.1	8 (53.3)	7 (45.7)	-	-
Salix alba L.	15	145	9.7	8 (53.3)	7 (46.7)	-	-
Acer saccharinum L.	13	158	12.2	7 (53.8)	6 (46.2)	-	-
Juglans nigra L.	11	317	28.8	2 (18.2)	6 (54.5)	1 (9.1)	2 (18.2)
Betula pendula Roth.	11	156	14.2	4 (36.4)	6 (54.5)	1 (9.1)	-
Fraxinus angustifolia Vahl.	10	174	17.4	5 (50.0)	3 (30.0)	2 (20.0)	-
Betula occidentalis Hook.	9	176	19.6	3 (33.3)	4 (44.4)	2 (22.2)	-
Betula platyphylla ssp. *Mandshurica* (Regel) Kitag.	8	50	6.3	3 (37.5)	5 (62.5)	-	-
Betula albosinensis Burkill	7	57	8.1	5 (71.4)	2 (28.6)	-	-
Prunus pensylvanica L.f.	7	145	20.7	1 (14.2)	5 (71.4)	1 (14.4)	-
Betula litwinowii Doluch.	5	50	10	3 (60.0)	2 (40.0)	-	-
Tilia platyphyllos Scop	4	387	96.8	1 (25.0)	-	-	3 (75.0)
Juglans × intermedia Jacgues.	4	245	61.3	-	-	-	4
Fraxinus chinensis Rox.	4	56	14	3 (75.0)	-	1 (25.0)	-
Acer rubrum L.	4	37	9.3	3 (75.0)	1 (25.0)	-	-

Tree scientific name	Number of infected trees	Number of mistletoe specimens	Rate of mistletoe infestation*	Number of host trees (% to total number of trees)			
				Low	Medium	High	Very high
Betula turkestanica Litv.	4	32	8	3 (75.0)	1 (25.0)	-	-
Fraxinus pennsylvanica Marsh.	4	18	4.5	4	-	-	-
Betula×caerulea Blanch.	3	60	20	1 (33.3)	1 (33.3)	1 (33.3)	-
Carpinus betulus L.	3	28	9.3	2 (66.7)	1 (33.3)	-	-
Betula grossa Siebold & Zucc.	3	24	8	3	-	-	-
Acer tataricum ssp. Semenovii (Regel & Herder) A.E.Murray	3	18	6	3	-	-	-
Quercus rubra L.	3	14	4.7	3	-	-	-
Salix caprea L.	3	14	4.7	2 (66.7)	1 (33.3)	-	-
Sorbus aria (L.) Crantz	3	10	3	3	-	-	-
Malus zumi (Matsum.) Rehder.	3	8	2.7	3	-	-	-
Crataegus sanguinea Pall	3	7	2.3	3	-	-	-
Quercus palustris Muenchh.	2	37	18.5	1 (50.0)	1 (50.0)	-	-
Salix babylonica L.	2	29	14.5	-	2	-	-
Betula kenaica W.H.Evans	2	24	12	1 (50.0)	1(50.0)	-	-
Acer pseudoplatanus L.	2	12	6	2	-	-	-
Populus alba L.	2	9	4.5	2	-	-	-
Betula pubescens Ehrh	2	6	3	2	-	-	-
Betula schmidtii Regel	2	6	3	2	-	-	-
Tilia platyphyllos 'Laciniata'	2	6	3	2	-	-	-
Sorbus×thuringiaca (Ilse) Fritsch	2	4	2	2	-	-	-
Prunus cerasifera Ehrh	2	3	1.5	2	-	-	-
Malus pallasiana Juz.	2	2	1	2	-	-	-
Sorbus aucuparia L.	1	26	26	-	1	-	-
Aesculus hippocastanum L.	1	21	21	-	1	-	-
Juglans cinerea L.	1	18	18	-	1	-	-
Sorbus aucuparia 'Pendula'	1	17	17	-	1	-	-

Tree scientific name	Number of infected trees	Number of mistletoe specimens	Rate of mistletoe infestation*	Number of host trees (% to total number of trees)			
				Low	Medium	High	Very high
Betula lenta L.	1	15	15	-	1	-	-
Betula papyrifera Marshall.	1	10	10	-	1	-	-
Tilia amurensis Rupr.	1	8	8	1	-	-	-
Sorbus alnifolia (Siebold & Zucc.) K.Koch	1	5	5	1	-	-	-
Acer hyrcanum Fisch. & C.A.Mey.	1	3	3	1	-	-	-
Amelanchier spicata (Lam.) K.Koch	1	3	3	1	-	-	-
Tilia americana L.	1	3	3	1	-	-	-
Crataegus monogyna Jacq	1	2	2	1	-	-	-
Malus×purpurea (E.Barbier) Rehder	1	2	2	1	-	-	-
Betula microphylla Bunge	1	1	1	1	-	-	-
Betula dahurica Pall.	1	1	1	1	-	-	-
Betula pendula '*Youngii*'	1	1	1	1	-	-	-
Syringa reticulata ssp. *pekinensis* (Rupr.) P.S.Green & M.C.Chang	1	1	1	1	-	-	-
Crataegus arnoldiana Sarg.	1	1	1	1	-	-	-
Malus domestica Borkh.	1	1	1	1	-	-	-
Prunus maackii Rupr.	1	1	1	1	-	-	-
Populus trichocarpa Torr. & A.Gray ex. Hook.	1	1	1	1	-	-	-
Acer tataricum L.	1	1	1	1	-	-	-
Total	455	8586	18.9				

Note: *The rate of mistletoe infestation presents the number of mistletoe bushes per tree.

The largest numbers of affected trees were in species *Tilia cordata*, *Acer platanoides*, *Populus simonii*, *Populus nigra* and *Robinia pseudoacacia*, although the latter had a slightly lower degree of damage. *Juglans* × *intermedia* had a significant number of mistletoe plants exceeding 50 per tree (on average, more than 60 mistletoe bushes were found on one tree).

Viscum album was found on 64 taxa of woody plants belonging to 16 genera and 9 families, including 54 taxa in DP 'Beresnivskyi'. Among these, the most host-trees belonged to genus *Betula* L. (13 species and one hybrid, ssp., cultivar). Among different species of genus *Betula*, the largest number of mistletoe plants was found in *Betula pendula* (156 on 11 trees, on average 14 plants per tree) and *Betula occidentalis* (176 on 9 trees, on aver-

age about 20 mistletoe bushes per tree). Among trees that serve as host-trees for mistletoe, in total in Ukraine were identified 123 species and subspecies from 37 genera and 17 families. The majority of host-trees belong to *Rosaceae* (45 species), *Betulaceae* and *Salicaceae* (15 species each) and *Sapindaceae* (13 species) families (Krasylenko et al. 2020). In Hungary, in mistletoe-infected areas, grow 9–12 of the 18 most common host species; *Populus* spp., *Robinia pseudoacacia* L. and *Acer saccharinum* L. are frequently infected; no significant changes on mistletoe hosts have been observed over the past 90 years (Varga et al. 2014). In Poland, mistletoe is found on 12 species of forest trees, most often on silver fir and Scots pine, much less frequently on birches (Lech et al. 2020). In the castle park in Lednice (Poland), *Tilia cordata* Mill., *Juglans nigra* L. and *Acer saccharum* Marshall are intensively affected (Baltazar et al. 2013).

By presence of host-trees on IUCN Red List, it was determined that 45 species belong to the IUCN World Cup, with 68.5 % being in the category LC (Least Concern) and 7.4 % in category DD (Data Deficient). *Aesculus hippocastanum* L. belonged to category VU (Vulnerable), *Juglans cinerea* L. – to category EN (Endangered), *Fraxinus pennsylvanica* Marsh. – CR (Critically Endangered). Such a trend is alarming and requires not only the protection of these species, but also the identification of ways to preserve and restore them in protected areas.

According to the classification of life forms by Raunkiær (1934) in the studied protected areas of the Ukrainian Polissya, the host trees are mainly represented by moesophanerophytes (44 taxa), megafanerophytes (11 taxa) and microphanerophytes (9 taxa) (Fig. 6). The distribution of trees by height classes showed that the host trees of class four (37.5 %) and class one (32.8 %) prevailed, with class 2 and 3 trees (14.1 % each) having lower representations.

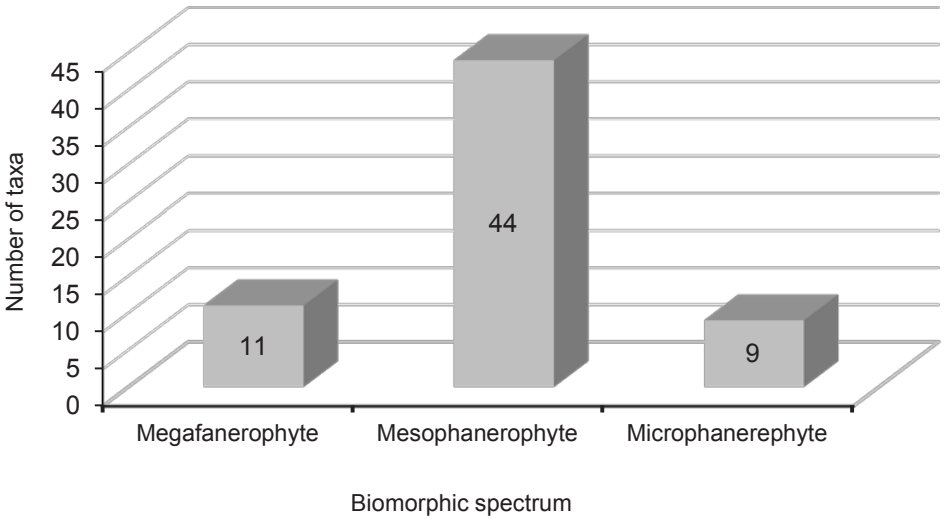

Fig. 6. Biomorphic spectrum of host trees.

After analyzing the ecology of host trees, it was determined that a significant proportion of them are heliophytes (39 taxa), moesotrophs (37 taxa) and mesophytes (30 taxa) (Fig. 7). Moesoxerophytes, oligotrophs and heliophytes such as *Robinia pseudoacacia* L. (10 mistletoe plants on average per tree) and *Betula pendula* Roth. (on average 14 mistletoe plants per tree) were significantly damaged by mistletoe (Table 2). The moesohygrophytes *Populus simonii*, *Populus nigra*, *Juglans nigra*, *Fraxinus angustifolia* and *Fraxinus excelsior* were also severely damaged with average number of mistletoe ranging between 11 and 33 plants per tree.

According to Bilonizhko (2019), mistletoe more readily damages introduced species. In contrast, our study showed that despite 72.3 % of the host trees in the Ukrainian Polissya are introduced, of which 33.3 % are of North American origin and only 27.7 % are native, the majority of trees (229 specimens with mistletoe) are native species. *Viscum album* is distributed via endozoochory, mainly by birds (Yakymenko et al. 2019). Such a phenomenon is observed in DP 'Beresnivskyi', where the spread of mistletoe occurs during the years of increasing population of *Bombycilla garrulus* L.

In most protected sites, in order to reduce the number of affected trees, they are removed mechanically. This method is quite effective when the number of host plants affected by mistletoe is small and their removal is timely. In PMLA 'Kmytivskyi' (ZP) in 1972, two 150-year-old *Populus* × *canescens* (Aiton) Sm. trees and one 80-year-old *Tilia cordata* had a high degree of mistletoe damage, so they were removed. As of 2018, the PMLA had no trees affected by mistletoe. The intensive spread of mistletoe in historical parks over the last ten years is a concern for the ancient dendroflora. Old trees are five times more likely to be affected by mistletoe than younger ones (Baltazar et al. 2013, Lech et al. 2020). In PMLA 'Kopylivskyi' (KP) during 2016–2017, the degree of damage to *Tilia cordata*, *Robinia*

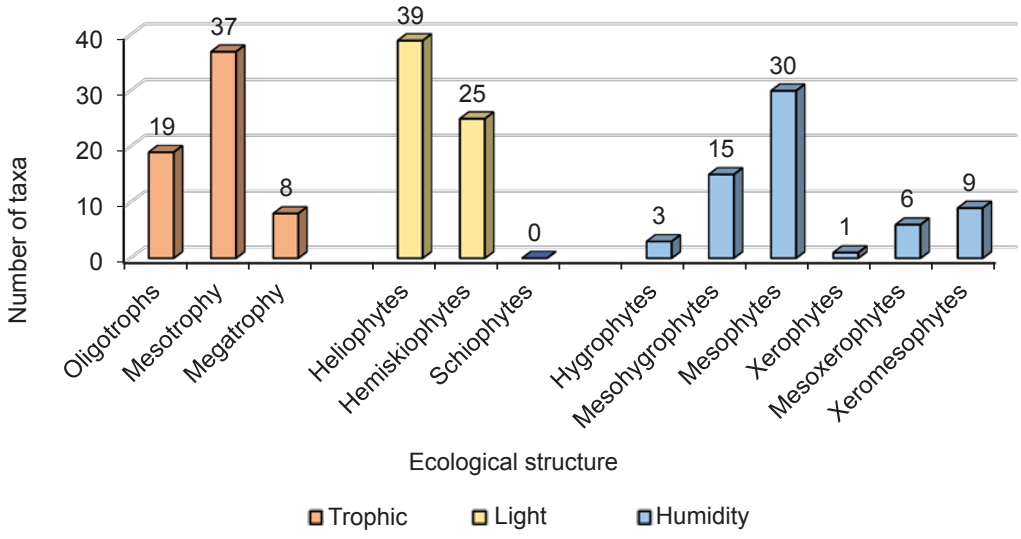

Fig. 7. Ecological structure of host trees.

pseudoacacia and *Acer platanoides* was very high. After pruning in 2018–2019 and removal of severely damaged trees, the situation temporarily improved with the number of mistletoe plants decreasing to eight per tree on average. The spread of mistletoe due to untimely removal and drought could be observed in PMLA 'Oleksandriiskyi', 'Horodotskyi', where two affected trees of species *Tilia cordata*, *Populus simonii*, *Robinia pseudoacacia* and *Tilia cordata* were present in 2015. In 2021, there were 22 to 54 woody plants affected by mistletoe, belonging to 7 species, with an average number of mistletoe plants between 29 and 43 per tree. Thus, in protected areas, especially in historic parks, one of the effective ways to stop the mistletoe spread is timely mechanical removal of mistletoe plants.

Conclusions

The first study of mistletoe distribution in the protected areas of the Ukrainian Polissya showed that the main tree species susceptible to mistletoe invasion are *Tilia cordata* (18.7 %), *Robinia pseudoacacia* (12.1 %) and *Acer platanoides* (11.6 %). It was established that the dendroflora of the Ukrainian Polissya had many host trees of white mistletoe, which include 64 taxa belonging to 16 genera and 9 families, among which the most common are *Betulaceae*, *Rosaceae*, *Salicaceae*, *Sapindaceae*. In terms of the number of affected trees, autochthonous species predominate. Moesoxerophytes, oligotrophs, heliophytes (*Robinia pseudoacacia*, *Betula pendula*) and moesohygrophytes (*Populus simonii, Populus nigra*, *Juglans nigra*, *Fraxinus angustifolia*, *Fraxinus excelsior*) suffer by significant damage. The highest level of damage from mistletoe was observed on trees of tree height class four (5(7) –15 m) (37.5 %) and trees of class one (greater than 25 m) (32.8 %).

In two PMLA ('Oleksandriiskyi', 'Makarevychivskyi') located in the southern part of Volyn and one in Zhytomyrske Polissya (PMLA 'Korostyshivskyi'), the average degree of mistletoe infestation was high with 38 to 43 mistletoe plants per host tree.

The trend towards the destruction of rare species is alarming and requires not only their protection, but also the determination of ways for their conservation and restoration in protected areas. One of the effective ways to stop the spread of mistletoe in protected areas, especially in historical parks, is the timely mechanical removal of mistletoe plants.

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