

Loranthus europaeus (*Loranthaceae*) in Ukraine: an overview of distribution patterns and hosts

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Krasylenko Yu.A., Gleb R.Yu., Volutsa O.D. 2019. *Loranthus europaeus* (*Loranthaceae*) in Ukraine: an overview of distribution patterns and hosts. *Ukrainian Botanical Journal*, 76(5): 406–417.

Abstract: Updated information on geographic distribution patterns and hosts of *Loranthus europaeus* in Ukraine is presented as a list of known localities and a schematic map based on data of field observations, herbarium collections, and literature sources. The field study areas with eight localities directly surveyed by the authors included: Chernivtsi Region (Hertsayiv'sky and Kelmenets'ky districts), Zakarpattia (Transcarpathian) Region (Rakhiv'sky District) and Khmelnyts'kyi Region (Kamianets-Podil'sky District) of Ukraine. In Ukraine *L. europaeus* has been recorded since the 19th century. In total, it was reported from ca. 30 localities in Ukraine, mostly in the southwestern regions of the country at the northeastern limits of the Eastern European part of its range. The records from Kyiv Region and Crimea remain questionable. Within its range in Ukraine, *L. europaeus* parasitizes *Quercus* species as its primary hosts. In our opinion, this mistletoe species is not expected to become a noxious pest causing considerable damage for the Ukrainian forests, unlike the European mistletoe, *Viscum album*. Moreover, *L. europaeus* is recommended for special protection in Khmelnyts'kyi Region and is included in the list of regionally rare plants of administrative units of Ukraine.

Keywords: distribution, hosts, *Loranthus*, mistletoe, *Quercus*, range, stem hemiparasite, Ukraine

Submitted 11 March 2019. Published 31 October 2019

Красиленко Ю.А.^{1,2}, Глеб Р.Ю.^{3,4}, Волюца О.Д.^{5,6} 2019. *Loranthus europaeus* (*Loranthaceae*) в Україні: огляд особливостей поширення та рослин-господарів. *Ukrainian Botanical Journal*, 76(5): 406–417.

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Реферат. У статті наведено оновлені відомості щодо поширення та рослин-господарів рідкісного стеблового напівпаразита дубової омели європейської (*Loranthus europaeus*) в Україні у вигляді переліку локалітетів та схематичної мапи, складеної на основі польових спостережень, опрацювання гербарних зборів та літературних джерел. Авторами було безпосередньо досліджено близько восьми локалітетів у Чернігівській (Герцаївський та Кельменецький райони), Закарпатській (Рахівський район) та Хмельницькій (Кам'янець-Подільський район) областях. Перші знахідки *L. europaeus* в Україні відомі з 19 ст. Загалом, цей вид знайдено у близько 30 локалітетах переважно у південно-західній частині України, де він перебуває на північно-східній межі східноєвропейського ареалу. Знахідки у Київській області та Криму потребують підтвердження. Головними господарями *L. europaeus* в Україні є різні види дубів (*Quercus* spp.). Цей вид омели, на відміну від омели білої (*Viscum album*), не завдає суттєвої шкоди лісам України і наразі вона не вважається фітокарантинним видом. Більш того, *L. europaeus* рекомендовано охороняти на регіональному рівні у Хмельницькій області.

Ключові слова: ареал, омела, поширення, рослини-господарі, стеблові напівпаразити, Україна, *Loranthus*, *Quercus*

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Introduction

Mistletoes, which is an English vernacular name for many species of obligate hemiparasitic plants belonging to several currently recognized genera (e.g., *Viscum* L., *Arceuthobium* M. Bieb., *Tupeia* Cham. & Schldl., *Phoradendron* Nutt., *Strutanthus* Mart., *Loranthus* Jacq., etc.) and even families of *Santalales* (e.g., *Viscaceae*, *Santalaceae*, *Loranthaceae*, etc.), are aerial hemiparasites of woody plants distributed widely from tropical to boreal physiographic zones (Beylin, 1986; Aukema, 2003; Mathiasen et al., 2008; Nickrent, 2010; Kuijt, 2015). Their role in forests and other habitats/ecosystems is considered to be ambivalent, or even contradictory. First, mistletoe fruits, due to their persistence in cold seasons in temperate regions, are usually consumed by birds and other animals. At the same time, mistletoes compromise trees' water balance and photosynthetic activity as pests by pirating water due to the haustorial connection of their endophytes to the host vascular system (Watson, 2001). Ornithochory favors an aggregated spatial distribution of infected trees (Glatzel, Geils, 2008). The infestation patterns are mostly discrete and distance-dependent (Matula et al., 2015).

The taxonomic circumscription of *Loranthus* Jacq. (*Loranthaceae*) considerably changed over time, and it remains problematic even now. Various authors recognized in the genus from ca. 500 or even 600 species (Krüssmann, 1977, and earlier authors) to ten (Nickrent et al., 2010) or just two (Kuijt, 2015) species. In earlier literature the genus encompassed most species of mistletoes parasitizing representatives of phylogenetically distant taxa (Krüssmann, 1977). Recently, according to the fundamentally revised phylogenetic classification of *Santalales* by Nickrent et al. (2010) based on nucleotide sequence data, it is widely accepted that subtribe *Loranthinae* Engl. includes just two genera: monotypic *Cecarria* Barlow with the only species *C. obtusifolia* (Merr.) Barlow inhabiting the Philippines, New Guinea, New Britain, and the Solomon Islands, and *Loranthus* Jacq. with ca. ten species occurring from Europe to southern China, and Sumatra. This classification is supported by palynomorphological data, since the genus *Loranthus* from subtribe *Loranthinae*, clade G, have pollen of Type B (Grímsson et al., 2018). However, Kuijt (2015) recognized only two species of *Loranthus*. Moreover, phylogenetic analysis of *L. europaeus* mitochondrial

genome performed for the studies of the mitochondrial genome evolution places this species in the *Santalales* as sister to *Gaiadendron* G. Don (*Loranthaceae*) (Zervas et al., 2019), though the taxonomic classification of Nickrent et al. (2010) separates *Loranthus* and *Gaiadendron* into different clades, and places these two genera in two different tribes, *Loranthae* and *Gaiadendreae*, respectively.

The only European species of this genus, *Loranthus europaeus* Jacq. (synonyms: *L. dioicus* Stokes, *Hyphear europaeum* (Jacq.) Danser; vernacular name: yellow or yellow-berried mistletoe) is a widespread deciduous hemiparasitic plant (Uotila, 2011–onward). Primary hosts of *L. europaeus* are species of *Quercus* L. (*Fagaceae*), such as *Q. pubescens* Willd., *Q. cerris* L., *Q. robur* L., *Q. petraea* (Matt.) Liebl., though it may also occur on *Castanea sativa* Mill. (*Fagaceae*) and rarely on *Olea europaea* L. (*Oleaceae*) (Krüssmann, 1977; Eliás, 1985; Zebec, Idžojt, 2006; Kumbasli et al., 2011; Saraj et al., 2015). It was reported that in Croatia it parasitizes several native and introduced oak species (*Q. robur*, *Q. petraea*, *Q. cerris*, *Q. pubescens*, *Q. frainetto* Ten., *Q. rubra* L., *Q. palustris* Münchh.) and *Castanea sativa* (*Fagaceae*), and also *Carpinus betulus* L. (*Betulaceae*) (Zebec, Idžojt, 2006). In Slovakia *L. europaeus* was also found on *Q. pubescens*, *Q. cerris*, *Q. petraea*, *Q. robur*, *Q. dalechampii* Ten., *Q. virgiliana* (Ten.) Ten., *Q. rubra* (*Fagaceae*), and on *Betula pendula* Roth (*Betulaceae*). Some additional hosts were reported, but these records remain unconfirmed: *Acer campestre* L., *Castanea sativa*, *Carpinus betulus*, and *Crataegus monogyna* Jacq. (Eliás 2002). In Slovenia (Kogelnik, 2002) *L. europaeus* parasitizes three native species of oak (*Q. petraea*, *Q. pubescens* and *Q. robur*) and *Castanea sativa*. The infestation rate (also known in literature as "infection rate") was greatest on *Q. petraea* and lower in *Q. frainetto*; no infestation was detected on *Q. cerris* in Turkey (Kumbasli et al., 2011). In the early publication by von Tübeuf (1923), several resistant non-host species for *L. europaeus* were mentioned, since the attempts to infect artificially were unsuccessful: *Populus balsamifera* L., *Malus domestica* (Suckow) Borkh. (reported as *Pyrus malus* L.), *Prunus padus* L., and *Laburnum anagyroides* Medik. (reported as *Cytisus laburnum* L.). Furthermore, hyperparasitism (epiparasitism) of *Viscum album* L. subsp. *album* on *L. europaeus* was described as well (Grazi, Urech, 1986).

Loranthus europaeus is widely distributed in Central and Southeastern Europe, the Eastern Mediterranean region, and also has several isolated populations in Asia Minor (Glatzel et al., 2016). In Ukraine, records of *L. europaeus* are quite scarce. These issues are addressed in the present article based on our revision of available specimens in the Ukrainian herbaria, relevant literature, and field observations made during 2005–2019.

Materials and Methods

Herbaria

The specimens from the main Ukrainian herbaria: KW (National Herbarium of Ukraine, M.G. Kholodny Institute of Botany, National Academy of Sciences (NAS) of Ukraine, Kyiv), KWHA (M.M. Gryshko National Botanical Garden, NAS of Ukraine, Kyiv), KWHU (O.V. Fomin Botanical Garden of Taras Shevchenko National University of Kyiv, Kyiv), LW (Institute of Ecology of the Carpathians, NAS of Ukraine, Lviv), UU (Uzhhorod National University, Uzhhorod), MSUD (I.I. Mechnykov National University of Odessa, Odessa) and CHER (Yuriy Fedkovych Chernivtsi National University, Chernivtsi) were studied. It has to be noticed that specimens of *L. europaeus* have not been found in or reported from KWU, LWKS, YALT, ASCN, LBE, SIBS, CSAU, SIMF, PHEO, DSU, ZAU, KRW, KRWI, MELIT, LUM, and LUU.

The following herbaria were visited by the authors of the present article, and all specimens of *Loranthus* from Ukraine available in these herbaria were physically examined: KW, KWHA, and CHER.

We also received digital images of and/or information on available specimens from some other herbaria; that information was provided by their staff or other colleagues (see Acknowledgments), in particular: KWHU, LW, MSUD, and UU.

In the list of localities below we cite (1) herbarium specimens (the specimens physically studied in herbaria are marked with "!" following the herbarium acronym); (2) digital images of herbarium specimens provided from some herbaria (accompanied by the word "image"); (3) reliable publications (with relevant references given); (4) original observations of the authors of the present article, and (5) personal communications ("pers. comm.") of colleagues.

Herbarium acronyms are given following *Index Herbariorum* (Thiers, 2008–onward) and, if necessary,

Index Herbariorum Ucrainicum (Shiyan, 2011). Specimens from the herbaria of the neighboring countries (e.g., Poland, Czech Republic, Slovakia) have not been studied. We hope that they will be analyzed in our further studies.

The survey areas

The field study areas directly surveyed by the authors included: Chernivtsi Region (Hertsayivs'ky and Kelmenets'ky districts), Zakarpattia (Transcarpathian) Region (Rakhivs'kyi district) and Khmelnyts'kyi Region (Kamianets-Podils'ky district) of Ukraine. Ca. 8 localities were attended during route and area surveys.

Mapping

The distribution range of *L. europaeus* is presented on a map according to the subdivision of Ukraine into administrative regions (in Ukrainian, singular: *oblast*, *область*) and districts (*rayon*, *район*). Chorological data (herbarium specimens, literature data and original observations) are presented here as a list of localities (alphabetically arranged within administrative units).

Results and Discussion

Morphological characteristics and biological peculiarities of *Loranthus europaeus* related to its hemiparasitism, distribution and dispersal

The occurrence of this deciduous mistletoe on host stems and/or branches can be diagnosed from the distance as it forms spherical tufts (clutches) ca. 60–80 cm in diameter, scattered on the host branches and/or stems (Fig. 1; Fig. 2, A, B, C).

Fusiform malformations are present at sites of the old aerial exophyte (outer part) entry on host terminal branches (Fig. 2, B (arrow), F). *Loranthus europaeus* is green from early spring to late autumn (Fig. 2, A, B, E, G), then it loses leaves (Fig. 2, C, F) and bears yellow berries in winter (Fig. 2, D, O).

Fragile dark brown aerial shoots of *L. europaeus* have sympodial pseudodichotomous branching, are 1.0–5.0 cm in diameter near the base, narrowing at younger branches (Fig. 2, E, G) (Morozyuk, 1987; Kubát, 1997).

Flowering in Ukraine occurs in May–August, fruits ripen in November and persist during winter (Morozyuk, 1987). The seeds covered with sticky viscin ("bird glue") (Fig. 2, L, M, N) are dispersed by birds, such as the common blackbird (*Turdus merula* L.), mistletoe thrush (*T. viscivorus* L.), and jay [*Garrulus glandarius* (L.)]

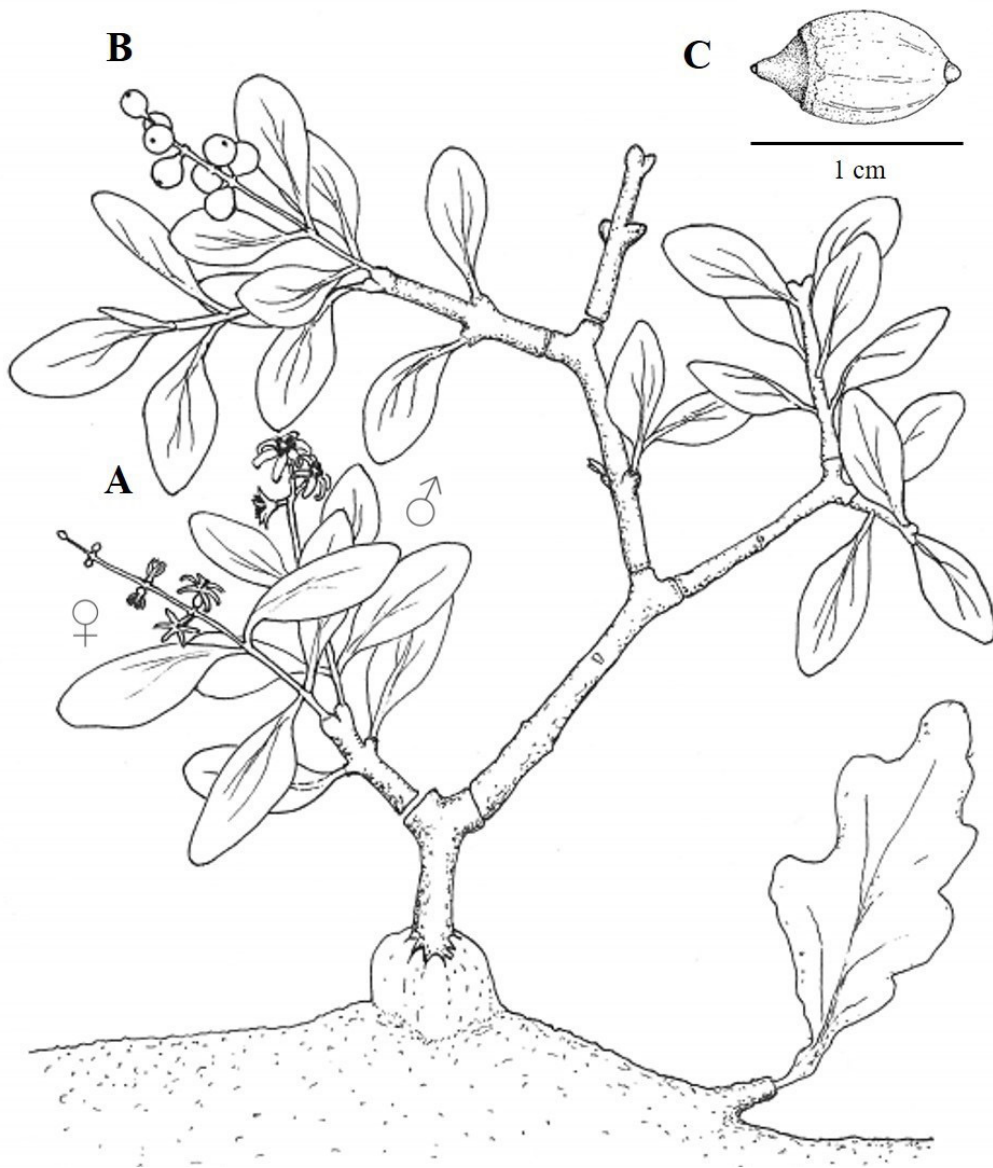


Fig. 1. An exophyte of hemiparasitic *Loranthus europaeus* on its primary host (*Quercus* sp.). A: staminate (♂) and pistillate (♀) flowers; B: fruits; C: seed. Graphical drawings by Kateřina Janošikova.

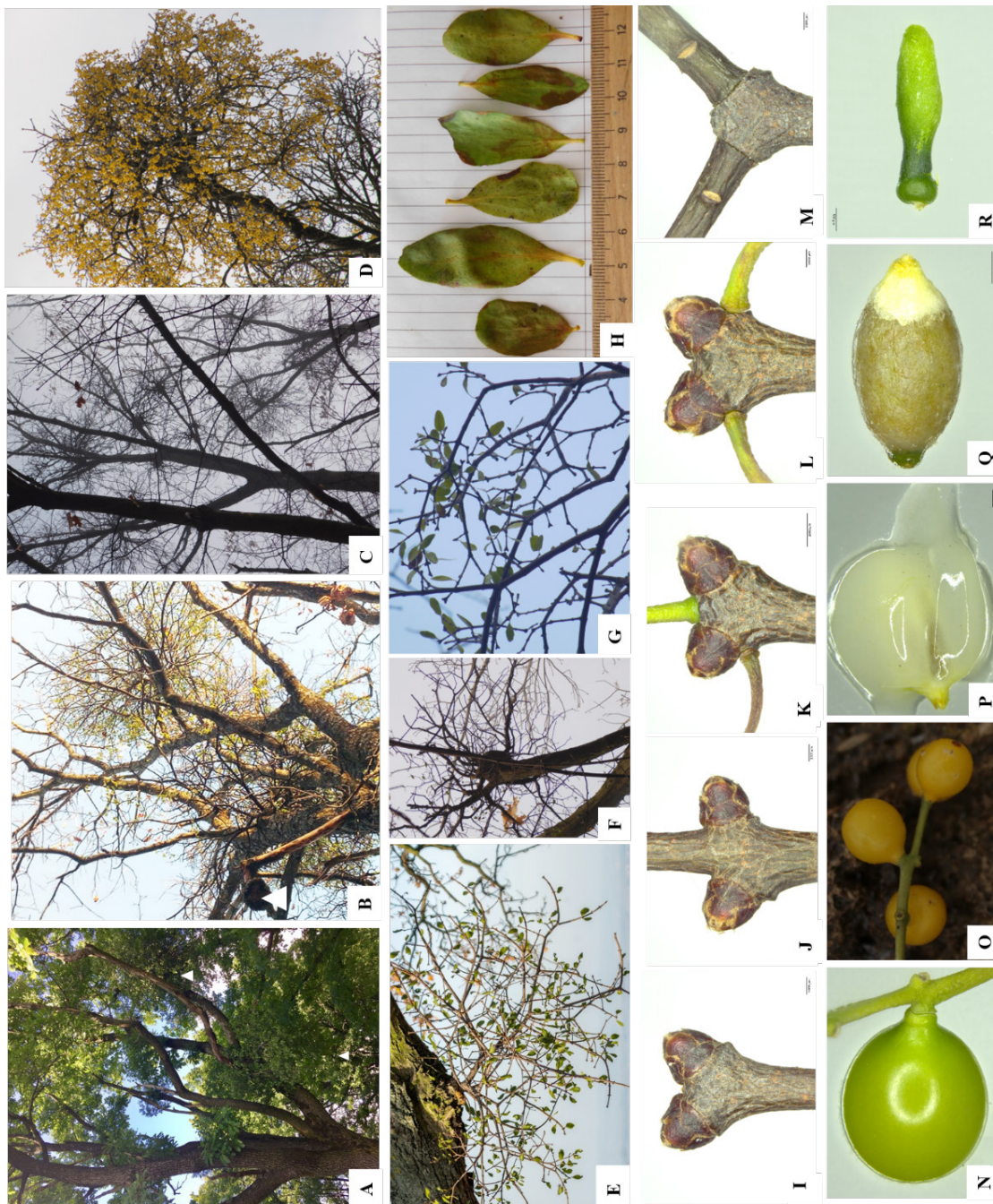


Fig. 2. Morphology of the exophyte of *L. europaeus*: mature hemiparasite on *Quercus robur* (A, B) and *Quercus rubra* (C) in different seasons (exophytes marked with white arrows); D: hemiparasite bearing mature berries; E: aerial exophyte (outer part); F: fusiform malformations on host terminal branches; G: branches with leaves; H: polymorphic leaves (November); I: apical (terminal) buds; J: intermediate (intercalary) buds; K: terminal bud with pedicle (top) and petiole (left); L: terminal bud with two petioles (left and right); M: pseudodichotomically branched terminal branch; N: immature fruit on pedicel; O: mature fruits on pedicel; P: fruit with sticky viscin released; Q: viscin-free globose seed; R: maturing embryo. Scale bars (I–R): 2 cm.

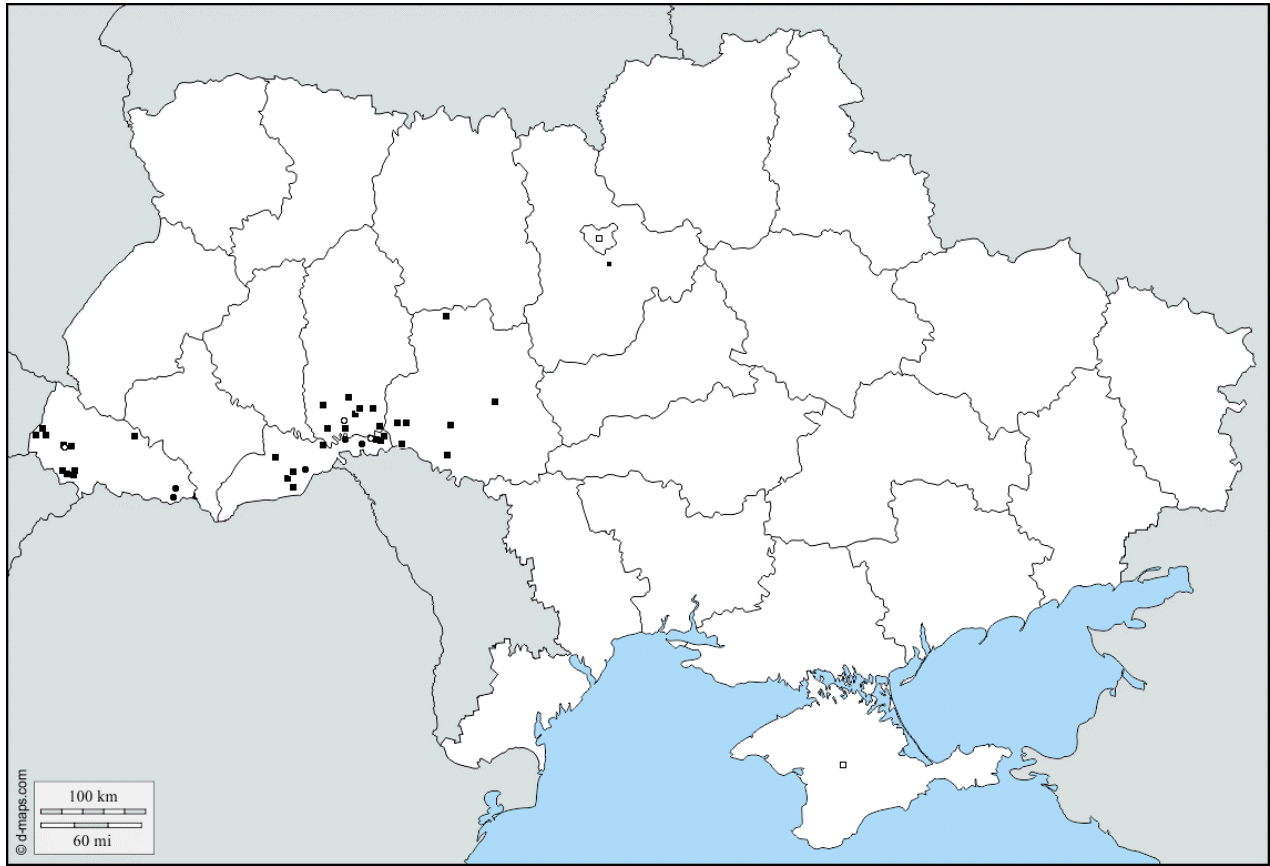


Fig.3. Distribution map of *Loranthus europaeus* in Ukraine. Designations: ● – authors' observations during 2005–2019; ○ – observations from personal communications; ■ – data from the literature and herbarium specimens; □ – unconfirmed data

within the European range of *L. europaeus* (Cramp, Perrins, 1994).

Patterns of distribution of *Loranthus europaeus* in Ukraine

In the continental part of Ukraine *L. europaeus* occurs at the northeastern boarder of its range in Eastern Europe mostly in natural oak forests in Western and Central-Western Ukraine (Fig. 3). As compared to the continental climate of the most of Ukraine, in southwestern part it is milder, with snowy winters and average temperatures below freezing and higher precipitation during warm season (Peel et al., 2007).

List of localities:

Chernivtsi Region. Hertsayivs'ky District: near Kulykivka village, silviculture, on *Quercus rubra*, 14.09.2013, 09.06.2014, O. Volutsa (CHER!); near Kulykivka village, on *Q. rubra* and *Q. robur*, 08.11.18, O. Volutsa (CHER!); Hlybots'kyi District: "Im Walde bei Terescheni auf Eichen" [in forest near Tarashany on

oaks] (Herbich, 1853); "In Walde zwischen Tarescheny und Oprisheny parasitisch auf Eichen" [in forest between Tarashany and Oprisheny parasites on oaks] (Herbich, 1859); Dubivtsi (Herbich) [now Oprisheny] (Bordzilovskiy, Lonachevskiy, 1952); Oprisheni, Prevorochie [Oprysheny and Pryvoroky villages] (Topa, 1936); between Tarashany and Valya Kuzmina villages, oak-beech forest along the old route, on *Q. robur*, 09.03.19, O. Volutsa, K. Korzhan (CHER!); [Note: this locality should be considered as one site, since this population parasitized hosts in the same forest, along which are the villages mentioned above are located. Moreover, this population, observed by us in 2019, might be the one recorded by Herbich in 1853 and 1859]; Kelmenets'ky District: near Hrushivtsi village, Kelmenetske forestry, on *Q. petraea*, 21.05.2005, O. Volutsa, A. Tokaryuk, T. Nykyrsa T. (CHER!) [now Khotyns'ky National Park]; Ivanivtsi village, *Carpinus–Quercus* forest, on *Q. robur*, 18.11.2018, O. Volutsa (CHER!); Sokyrians'ky District: Lomacin-Pietrosul

[Lomachyntsi village], 29.04.1935, E. Tsopa (CHER!); "Pietrosul" Lomaceneț jud. Hotin (Topa, 1936); slopes of the Dnister Reservoir near Lomachyntsi village, 10.06.1985, [I. Kh.] Udra (KW009260!); Khotyns'ky National Park, forest near Korman' village, 15.04.2012, D. Svyrydiuk (48°34'9.22" N 27°10'33.01" E, pers. comm.); Khotyns'ky National Park, between Kulyshivka and Korman villages, Romankivets'ke forestry, oak forest on the slope of the Dnister River, parasitic on *Q. petraea*, 11.08.2014, V. Budzhak, I. Chorney, A. Tokaryuk (CHER!).

Zakarpattia Region. Berehiv'sky District: Berehy village, in oak forest on *Q. robur*, 19.05.1947, [?] Sladkevich, (KWAH!); in oak forest near Kvasove village, parasitizing *Q. robur*, 17.06.1948, F. Gryn (KW!); Kvasove (F. Gryn) (Bordzilovskiy, Lonachevskiy, 1952); near Berehove and Velyka Bakchta, [05.06.1951], I. Sydorenko, S. Fodor (UU); Berehove, in forest Atak (F. Gryn) (Bordzilovskiy, Lonachevskiy, 1952); Volcanic Carpathians, Golden Mountain in Berehove city environs, SE slope, 16.08.1965, V. I. Chopyk (KW!); near Dobrosillya (=Bene) village, above the Borzhava River, 24.07.1985, I. Kh. Udra (KW!); Mukachev'sky District: near Verchniy Koropets village, 20.05.1952, I. Sydorenko (UU, image); Mukachevo city environs, near monastery, 06.09.1972, O. M. Dubovyk (KW!); near Mukachevo city, Lovachka Mt., (48°27'34.7" N 22°42'00.7" E), 11.07.2018, V. Loya (UU, pers. comm.); Rakhiv'sky District: oak forests, suburbs of Velykyy Bychkiv, Transcarpathia, 06.02.2016, R. Gleb (pers. comm., image); oak forests of *Q. robur* and *Q. petraea*, Svydovets Ridges, 500–600 m a.s.l. (47°58'28.32" N 24°2'21.42" E), 05.11.2018, R. Gleb (pers. comm., image); Uzhhorod'sky District: near Onokyvtsi village (circa 48°40'05.2" N 22°20'03.7" N), 07.06.1946, [?] Pavlova, ID 058614 (LW, image); near Onokyvtsi village, *Q. sessiliflora* (*Q. petraea*) forest, 07.06.1946, [?] Pavlova (KW!); Onokivtsi village environs, 11.09.1950, S. Fodor (UU, image); Onokyvtsi (Pavlova) (Bordzilovskiy, Lonachevskiy, 1952); Uzhhorod city, oak forest, 15.06.1951, I. Sydorenko, S. Fodor (UU, image); near Kholmets' (Helmech) village, 28.06.1956, [?] Iliganets', S. Fodor (UU, image).

Khmelnits'kyi Region. *Quercus–Carpinus* forest, natural and planted *Q. petraea* oak forests, Podils'ky Tovtry National Nature Park (Novosad, Krytska, Lyubinska, 2009). Chemervets'kyi District: Cherche village, Sadova Tovtra, 23.07.1963, 18.10.1967, 10.09.1968, I.I. Moroz (KWAH!); Dunavtsi District (Lyubinska, Yuhlichek, 2017): Gorchychna (Lapchynskiy) [now

Girchychna]; Syvorogy (Makovetskyi) (Bordzilovskiy, Lonachevskiy, 1952); between Syvorohy and Kuzhelevo villages (Schmalhausen) (Schmalhausen, 1886; Bordzilovskiy, Lonachevskiy, 1952); Minkovtsy [?] Podolie [?] de Nouo-Vuschitsa dans le bois [in the forest] de Kovtonne sur un vieux chêne [on old oak tree], pl[ante] parasite, pl[ante] rare, 14.08.1881, [V.V.] Montresor (KW!) [between Mynkivtsi village and Nova Ushitsya]; (Schmalhausen, 1886; Bordzilovskiy, Lonachevskiy, 1952); on old oak trees near Minkovtsy and Otrokova villages (Montresor, 1886); near Nova Ushitsya by postal road to Yampil (Montresor, 1886); Minkovets'ke forestry, on oaks, 25.06.1985, [I. Kh.] Udra (KW! KW 009259); Kamianets-Podil'sky District (Lyubinska, Yuhlichek, 2017): between Demshyn and Kytayhorod villages near mouth of the Ternava River (Makovetskyi) (Bordzilovskiy, Lonachevskiy, 1952); near Nygyn village, on oaks, at Tovry, 22.07.1935, Ol. Sokolovsky, V. Schidlovsky (KWHU!); "Cykiv'sky" landscape protected area (Kovalchuk, 2017); Podil'sky Tovtry National Nature Park, near Vyhvatnivtsi village, 25.01.2018, D. Svyrydiuk, pers. comm. (48°40'05.2" N 26°51'47.0" E); Novovushitsky District: slopes of the Dnister Reservoir near Rudkovtsy village [0]6.06.1985, [I. Kh.] Udra (KW! KW009258).

Vynnytsya Region. Haysynskiy, Lypovetskyi, Bratslavskiy Districts (Balkovsky) (Bordzilovskiy, Lonachevskiy, 1952); Mohyliv-Podil'skyi (Vilchynskiy) (Bordzilovskiy, Lonachevskiy, 1952); Murovano-kurylivets'ky District: Vyscheolchadayiv village, Vysche-Olchadayivska sugarmill, at oaks at the edge of a forest, Mohyliv'ska Ring Road, 30.09.1926, N.O. Verner, M. Bilozor (KW!); Nemyriv'sky District, Bratslav city, "...distributed exclusively...in our forests..." (Zhuravl, 1929); Sharhorodsky District: Kropyvna (Rogowitsch) (Bordzilovskiy, Lonachevskiy, 1952); Derebchyn (Vilchynskiy) (Bordzilovskiy, Lonachevskiy, 1952); Yampil's'kyi District: Bezvodne village, 21.06.1969, D.S. Ivashin, I.I. Moroz (KWAH!).

Kyiv Region. Kagarlyts'ky District: Lipovets village. "3361. Kiev, pr. Lipowez", 10.08.1857, Rogowitsch [Rogovich]. Herb. Ed. Lindemann (MSUD, image); "Kyiv Lipovetsky uyezd near Zabory farm in Ometyn'skyi forest" [Киев. Липов. у. около хутора Заборы в Ометинском лес] (Schmalhausen, 1886).

Kyiv Region (unconfirmed). Kyiv environs, "...very rare...on *Quercus robur* L. branches..." (Stankov, Taliyev, 1949; Atlas Florae Europaeae, 1976).

Crimea (unconfirmed). "...on *Fagaceae*..." (Beylin, 1986; Moroz, 1987; Golubev, 1996).

According to Fodor (1974), this hemiparasitic species resides mainly in the Transcarpathian Lowland, Foothills and the lower forest belt. Probably localities in Ukraine are in the northeastern border of the range of *L. europaeus* in Europe, and its distribution is limited by climatic factors.

Zawadzki in his *Enumeratio plantarum Galiciae et Bucovinae* (Zawadzki, 1835) reported *L. europaeus* as parasitizing oaks near Lviv ("Auf Eichen um Lemberg"), though this record has not been confirmed later (Bordzilovskiy, Lonachevskiy, 1952), or probably the species has already disappeared in that locality. Thus, the first reliable and confirmed record of *L. europaeus* in Ukraine was published by Herbach in his *Stirpes rariores Bucovinae...* (Herbach, 1853), where the species was reported "Im Walde bei Terescheni auf Eichen" (Hlybots'kyi District, Chernivtsi Region). In his later overview of the flora of Bukovina, Herbach (1859) confirmed the locality of *L. europaeus* mentioned in his previous publication: "Im Walde zwischen Terescheny und Oprischeny parasitisch auf Eichen". Moreover, in his book on plants of Galicia (Galychyna) and Bukovina *Ueber die Verbreitung in Galizien und der Bukovina wildwachsenden Pflanzen* Herbach (1861) summarized the data on plant species composition in this region, referring to his earlier works as well as to works of other botanists, including the publication of Zavadzki, who reported *L. europaeus* from Lviv (see above).

In turn, the first known records of *L. europaeus* in Ukraine were reported by V.V. Montresor, who collected it on 14 August, 1881 in Podillya (Latinized as Podolia) near Nova Ushitsya (see the cited specimen above). Montresor (1886: 59) reported *Loranthus europaeus* only for the current Khmelnyts'kyi Region as "Growing on old oaks near Mynkovets and Otrokova villages of Nova Ushitsya county (*uyezd* – *uezd*); near Nova Ushitsya by a postal road to Yampil city. August. Flowers yellow-greenish, fruits yellowish. The plant is parasitic [the archaic word "чужееядное" was used in the original Russian text], rarely occurring" (translated from Russian: Montresor, 1886). It is noteworthy that the hemiparasite persisted in the same area for more than 100 years, since it was recorded there also in 1985. In Murovanokurylivets'ky District, at Vysche-Olchadayivska sugar mill of Vyscheolchadayiv village, *L. europaeus* parasitized oaks at the edge of a forest near Mohyliv'ska ring road, what was observed on 30 September 1926 by N.O. Verner and M. Bilozor. The easternmost confirmed locality of *L. europaeus* in Ukraine and in Eastern Europe in general is in a "pure"

(monodominant) oak forest near Bezvodne village (Vinnytsya Region, Yampils'kyi District), where the species was found on 21 June 1969.

Schmalhausen (1886) provided general data on the range of *L. europaeus* and some localities in Kyiv and Khmelnyts'kyi regions: on oaks, rarely, Lipovetsky uyezd near Zabory farm in Ometyn'skyi forest near Novoushytskyi uyezd between Syvoroha and Kuzhelivka villages, Minkovtsy – in Koltun forest (Montresor!) [На дубах; редко. Киев. Липов. у. около хутора Заборы в Ометинском лесу под. Новоуш. у. между дд. Сиворога и Кужелевка! Миньковцы — в лесу Колтун (Монтрезор!)].

The early collections of *L. europaeus* in the western part of Ukraine were done by the Romanian botanist Emilian Tsopa (Țopa) in 1935 from the environs of Lomachyntsi village (Sokyrians'ky District, Chernivtsi Region); he reported it as a supposedly new species for the regional flora [of North Basarabia] (Țopa, 1936). This locality was also recorded by Udra in 1985. *Loranthus europaeus* from Chernivtsi Region is also known from the Prut-Dnister interfluvial area (Prut-Dnistrovske Mezhyrichchya) in Kelmenets'ky and Sokyrians'ky districts and in Bukovynian Cis-Carpathia (Bukovyns'ke Prykarpattia) in Hertsayivs'ky and Hlybots'ky districts. Only 70 years after that record, a new locality of *L. europaeus* parasitizing *Q. petraea* was revealed near Hrushivtsi village (Kelmenets'ky District) in 2005 (Volutsa, Nykyrsa, Tokaryuk, CHER), then in 2012 by D. Svirydiuk near Korman' village, in 2013 in Kulykivka village (Hertsayivs'ky District) (Volutsa, CHER), and in 2014 – between Kulyshivka and Korman' villages (Sokiryans'ky District) (Budzhak, Chorney, Tokaryuk, CHER).

One of the largest surveyed populations of *L. europaeus* in Chernivtsi Oblast was revealed recently near Kulykivka village (Hertsayivs'ky District). The total area of parasitized 15–25 m-high stands of *Quercus rubra* was ca. 600 m² (150 x 50 m²) located at the northern slopes (30–40° steepness). Besides *Q. rubra*, the forest comprised other trees and shrubs, such as *Q. robur*, *Carpinus betulus*, *Acer platanoides* L., *Fagus sylvatica* L., *Populus tremula* L., and *Cerasus avium* (L.) Moench (*Prunus avium* (L.) L.). It should be noted that one of exophytes of *L. europaeus* was 1.5–2 m in diameter, and many residual parasitic stems on the swollen host branches were revealed. However, only one parasitized tree of *Q. robur* with a low rate of infestation by *L. europaeus* was found in this locality, as compared with *Q. rubra*; though, at the plain part of that hill three

more trees of *Q. robur* resided at the edge of a mixed *Quercus–Fagus* forest, having several *L. europaeus* exophytes on the upper thirds of trees. Thus, a tree 18 m tall and 30 cm in diameter had three yellow mistletoe exophytes, while the other two trees, being 15–18 m tall and 25–28 cm in diameter, had only one exophyte each.

A new site was revealed recently near Ivanivtsi village (Kelmenets'ky District, Chernivtsi Region) on 18 November 2018, where *L. europaeus* parasitized *Q. robur* trees (25–30-m tall and 50–100 cm in diameter) forming the first layer of a *Carpinus – Quercus* forest with the admixture of young *Carpinus* trees at the second one located at the comparatively flat top of the hill at the outskirts of the village towards Sokyryans'ky District. This population of *L. europaeus* occupied ca. 5 ha (100 x 500 m²) of the forest with the central part with small growing trees lacking the parasite due to recent cuttings. Some exophytes reached 50–80 cm in diameter, and, additionally, had abundant maturing berries. The relative density of the infected trees was ca. one plant per 25–50 m². Regarding the relatively rare occurrence of *L. europaeus* in Ukraine, and its residence at the northeastern borders of the Eastern European part of the species range, this hemiparasitic species is recommended to be protected at regional level in Chernivtsi Region.

It is noteworthy that *L. europaeus* has been already included to the list of rare, relict and endemic species of the Eastern Podillya Region, namely, at the Cykivs'ky landscape protected area, Khmelnyts'kyi Region (Lyubinska, Yuhlichek, 2017). In turn, the yellow dwarf mistletoe was revealed at Kamianets-Podil's'ky Region on oaks near Nygyn village, at Tovtry by Ol. Sokolovsky and V. Schidlovsky on 22.07.1935, also nearby, in a *Quercus–Carpinus* forest, natural and planted *Q. petraea* oak forests in Podil'sky Tovtry National Nature Park (Novosad et al., 2009), and recently, on 25 January 2018, by D. Svyrydiuk, in the same national park. In Chemerovets'kyi District, near Cherche village this hemiparasitic species parasitizing *Q. robur* was recorded several times (23 July 1963, 18 October 1967, 10 September 1968). In Novoushitsky District I. Udra collected *L. europaeus* at slopes of the Dnister Reservoir near Rudkovtsy village on 6 June and 25 June 1985.

In the Carpathians Mountains, two adjacent *L. europaeus* populations were recorded by R. Gleb on 11 May 2018 in the oak forests (50 x 25 m²) comprised of *Q. robur* and *Q. petraea* located at one of ridges of the Sydovets' (near Velykyi Bychkiv village, Rakhivs'kyi district) at altitudes of 500–600 m a. s. l. Circa 30%

of old *Q. robur* and *Q. petraea* trees on western slopes (steepness 10–20°) were parasitized mostly in the upper part of trees, ca. 5–10 aerial shoots per a host tree. It is noteworthy that most of old oaks survived cuttings. At the edge of a *Fagus–Quercus* deciduous forest, two infected trees of *Q. robur* located at some distance from each other were revealed on the western slope (steepness 5°). Six heavily infected *Q. robur* trees bearing 8–12 aerial shoots of *L. europaeus* at upper part of the crowns were found by the edge of a 90 m-long and 10–15 m-wide woodland belt on a northwestern slope (steepness 5°). Moreover, at the eastern slope (steepness 5–10°) at the edge of the oak forest, one *Q. robur* tree was parasitized by 5–10 *L. europaeus* individuals. In turn, on the western slope (steepness 5°) 8–10 hemiparasites were recorded on the upper part of *Q. robur* and *Q. petraea* tree crowns (8 trees in total). Furthermore, the largest *L. europaeus* samples (more than 50 cm in diameter), 8–12 individuals per a host tree, were observed on four *Q. robur* trees growing at the edge of *Fagus–Quercus* forest on western slope (steepness 5°).

In the Carpathian Biosphere Reserve, Chorna Hora Botanical Reserve (Vynohradivs'kyi district, near Vynohradiv city), *L. europaeus* was recorded in *Q. robur* and *Q. petraea* oak forests mixed with *Fagus* by R. Gleb on 25 February 2016. This population of the parasite resided at northern slopes (steepness 5–25°) at 230 m a.s.l., and circa 30% of the hosts were bearing *L. europaeus* aerial shoots. It is worth mentioning that approximately 50% of oaks were concomitantly infected by a transverse cancer accompanied by the massive wilting of oak trees in this locality.

The hemiparasite was also recorded at Mukachevo city environs, near the monastery, on 6 September 1972 by O.M. Dubovyk. Several individuals of a yellow mistletoe parasitized solitude *Q. robur* growing at the side of road H09 (Muckachevo-Rohatyn) in Zaluzhzhya village environs (Zakarpattia Region, Muckachevs'kyi district) on 13 November 2018. It was collected by I. I. Moroz also at Berehivs'ky District at Berehy village, on 9 May 1947, on *Q. robur* by F. Gryn in an oak forest near Kvasove village on 17 June 1948, and by I. Sydorenko and S. Fodor in Berehove and Velyka Bakchta environs on 5 June 1951. The species occurs also in Volcanic Carpathians, namely at southeastern slopes of the Golden Mountain near Berehove city, where it was recorded at 16 August 1965 by V. I. Chopyk, and later, on 24 July 1985 at Dobrosillya (=Bene) village environs above the Borzhava River, 24 July 1985, found by I.Kh. Udra.

Unconfirmed and/or erroneous records

Loranthus europaeus from Vinnytsya Region (Nemyrivskiy District, Bratslav city) was mentioned in the *Flora of Tul'tsinshyna* by Zhuravl (1929); however, no herbarium specimens were found. In Kyiv Region, the species was recorded on 10 August 1857 by A.S. [P.S.] Rogovych [Rogowicz] in Kagarlyts'ky District, Lipovets village, and the corresponding specimen is deposited at MSUD (personal collection of E.E. Lindemann), mentioned by Stankov and Taliev (1949) and later in the *Atlas Florae Europaeae* (1976): "...on *Quercus robur* branches – very rare, recorded for Kyiv environs. Hemi-parasite". Finally, the most challenging task still remains to confirm the observations from the Crimean Peninsula on *Fagaceae* mentioned by Morozyuk (1987) and Golubev (1996).

Generally, our data indicate that native (autochthonous) deciduous species of oaks are primary hosts for *L. europaeus* in Ukraine. Forty years ago the area of oak forests in Ukraine embraced 26% of the total forest cover in Ukraine (Shelyag-Sosonko, 1974), but now they declined due to several anthropic and natural factors. Species of *Quercus* often host both *L. europaeus* and *Viscum album* L. in the western regions of the country.

It is evident that this mistletoe species is not expected to become a noxious pest causing considerable damage to the Ukrainian forests, unlike *Viscum album*. Moreover, in Khmelnyts'kyi Region *L. europaeus* is even included in the list of regionally rare species (Kovalchuk, 2017). Following the Second Addendum to the Decision of the 5th Session of the Council of Khmelnyts'kyi Region (Oblastna Rada) of 20 December 2006, No. 18-5/2006, *L. europaeus* is present in the "List of species recommended for special protection in Khmelnyts'kyi Region" (see Andriyenko, Peregrym, 2012).

Conclusions

The geographic distribution range of the aerial hemiparasitic plant species *Loranthus europaeus* in Ukraine is confined to the southwestern regions of the country. In total, this species was reported from ca. 30 localities in Ukraine, though the records from Kyiv Region and Crimea remain unconfirmed. *Loranthus europaeus* parasitizes *Quercus* species as its primary hosts within its range in Ukraine. Due to its hemiparasitic nature and limited distribution, *L. europaeus* is not expected to become a noxious pest; on the contrary, it is recommended to be protected in Ukraine at the regional level.

Acknowledgments

The authors appreciate the kind help of curators and research staff of the Ukrainian herbaria: Natalia Shiyani (KW); Olexander Shynder (KWH); Marychka Romaniv (LW); Olena Bondarenko and Tetyana Vasylyeva (MSUD), Andriy Yena (CSAU), as well as Myroslav Shevera (M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv), who analyzed specimens from UU and UHM. The National Academy of Sciences of Ukraine is acknowledged for the research grant for young scientists (Agreement # 52/18A of 16 October 2018). We thank Kateřina Janošikova (scientific illustrator, Centre for Science Communication, Palacký University in Olomouc, Olomouc, Czech Republic) for illustrations (Fig. 1), and Vlasta Loya (M.M. Gryshko National Botanical Garden, Kyiv, Ukraine), Karol Rydlo (Zal Letov Simulátory, Olomouc, Czech Republic), Dmytro Svyrydiuk (Podilski Tovtry National Nature Park, Ukraine), and Mykyta Peregrym (Eszterházy Károly Egeyten, Eger, Hungary) for digital images of *L. europaeus*. Microscopy images (Fig. 2, I–R) were obtained using AXIO ZOOM 16 (Carl Zeiss, Germany) light microscope in the Centre of the Region Haná for Biotechnological and Agricultural Research, Faculty of Science, Palacký University (Olomouc, Czech Republic). We are grateful to Prof. Sergei L. Mosyakin (M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv) for his valuable taxonomic suggestions, various corrections, and editorial improvement of the language of the manuscript.

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Recommended for publication by G.V. Boiko