



Large Chicory aphid (*Uroleucon cichorii* (Koch, 1855): Sternorrhyncha: Aphididae) – Invasive Alien Aphid Species in the Fauna of Belarus

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Abstract. *Uroleucon cichorii* (Insecta: Hemipteroidea: Rhynchotha: Sternorrhyncha: Aphididae) is an invasive alien species in the fauna of Belarus. In 1854 the species has been described by C. L. Koch from Germany. For the first time *U. cichorii* has been noted in Great Britain in 1876, in Estonia – 1894, in Romania – 1896, in Italy – 1900, in Belgium – 1901, in Crimea – 1903, in Latvia – 1924, in Poland – 1930, in Netherlands – 1939, in Finland – 1941, in Ukraine – 1945, in France – 1948, in Sweden – 1949, in Norway – 1953, in Denmark – 1954, in Moldavia – 1955, in Austria – 1956, in Czech – 1958, in Hungary – 1959, in Bulgaria – 1960, in European Russia – 1962–1964, in Bosnia and Herzegovina – 1963, in Serbia – 1963, in Lithuania – 1963–1980, in Macedonia – 1964, in Switzerland – 1967, in Spain – 1971, in Sicily – 1973, in Corsica – 1973, in Balearic Islands (Mallorca) – 1982, in Belarus – 1986 and Greece – after 1992.

It is obvious that this chronological list describes a history of aphidological research rather than spreading of the invader across the European regions. As considered, the species has Mediterranean origin. Outside of Europe the species is known from Near East as well as Central Asia, Korea and North America. As host plants *U. cichorii* s.str. uses common chicory (*Cichorium intibus* L.) and related species of Cichorieae (Asteraceae). The species is known as a pest of common chicory (including leaf chicory) and endive.

For the first time *U. cichorii* has been registered in 1986. At present the species is common for *C. intibus* growing on roadsides and in other ruderal biotopes. During 1986–2018 *U. cichorii* has been registered in the all regions of the Republic of Belarus. The map of geographic points of registrations is given. It is obvious that the invader's expansion in the regions of Belarus is finished.

The species is holocyclic and monoecious. Feeding on forage plants contributes to the loss of a significant amount of plastic substances, which leads to their dehydration and slow growth, and, as a result, a slight deformation of the stem. *U. cichorii* does not initiate the deformation of leaf blades and the premature dying off of the inflorescences, and also does not lead to the formation of galls.

Perennial data show the appearance of fundatrices from overwintering eggs in the third decade of April – the first decade of May. Further a series of successive parthenogenetic generations and the growth of colonies occur. The winged females are recorded in July–August. The appearance of winged males and normal females occurs in September – the first decade of October. The eggs are deposited in the end of October. The largest peak in the number of *U. cichorii* registrations occurs in July–August.

Key words: Aphidoidea, geographic distribution, biological cycle, alien species, biological invasions.

Велика цикорієва попелиця (*Uroleucon cichorii* (Koch, 1855): Sternorrhyncha: Aphididae) – інвазивний чужорідний вид фауни Білорусі

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Резюме. Проаналізовано результати афідологічних публікацій про перші реєстрації великої цикорієвої попелиці (*Uroleucon cichorii* (Koch)) в країнах Європи. Вид за межами континенту відзначений у Передній і Центральній Азії, Кореї. У Білорусі *U. cichorii* є чужорідним видом, який здійснив експансію із Середземномор'я після успішної натуралізації й становлення кормової рослини – цикорію звичайного (*Cichorium intybus* L.) – як фонового елементу рудеральної та сеgetальної рослинності.

У результаті обробки багаторічних (1986–2018 рр.) зборів на території всіх адміністративних областей Білорусі складено карту реєстрацій *U. cichorii*. Найбільшу кількість реєстрацій відзначено в липні–серпні, що опосередковано відображає сезонну динаміку популяційної чисельності. Велика цикорієва попелиця є відкритоживучою меристемофільною нетератогенною формою, належить до гербобіонтної фітобіонтної екологічної групи попелиць, в умовах Білорусі – спеціалізований монофаг цикорію звичайного. Біологічний цикл – повний, нормальний однодомний. Шкодить цикорію як декоративній, лікарській і сільськогосподарській культурі.

Ключові слова: Aphidoidea, географічне поширення, біологічний цикл, чужорідні види, біологічні інвазії.

Introduction

The study of 'biological invasions' phenomenon is currently on the keen focus as one of the major global ecological problems [1, 2]. The geographic expansion processes of transcontinental and transregional transport communications that have been observed in recent decades, the active implementation of introduction work with the aim of improving the urban environment create prerequisites for an increase in the intensity of invasive processes [3].

The herbivorous insects, in particular Hemipteroidea, alien to the recent fauna of Belarus, form a large group of economically significant pests of economically valuable plants [4]. For that reason they should be considered invasive. Among them are the specialized phytophagous which feed on the plants with the status of adventitious species in the flora of Belarus. These plant species include such representatives as common coffee-free.

The genus *Cichorium* L., 1753 includes 10 herbaceous plants species, among them 2 cultivated species: *Cichorium endivia* L. and *C. intybus*, and 8 wild species – *Cichorium alatum* Hochst. & Steud., *Cichorium bottae* Deflers, *Cichorium callosum* Pomel, *Cichorium calvum* Sch. Bip. & Asch., *Cichorium dubium* E.H.L. Krause, *Cichorium hybridum* Halácsy, *Cichorium pumilum* Jacq. and *Cichorium spinosum* L. [5]. Representatives of the genus are widely distributed in moderately warm and subtropical regions of Eurasia and Africa, as well as in many other extratropical countries of the world, both as introducents and cultivated plants [6].

Common chicory (*C. intybus*) is a perennial herbaceous plant, very polymorphous, with erect, striated, branching stem, 30–180 cm tall. Chicory has a fusiform, fleshy, reaching a length of 1,5 m taproot. The basal leaves are stalkless, lance-like to linear, with margins that either have dentations or more pinnate with sharply defined indentations, usually forming a rosette. The stem leaves are alternate, smaller, and partly clasping the stem. They can be entire or toothed. The flowerheads are numerous,

placed at the top of the stems, or in the axils of the stem-leaves, generally in clusters of two or five. Inflorescence is a capitulum, flowers with light blue ligulas (quite rarely white or pink). Chicory flowers from June until September. Fertile flowers produce a dry smooth brownish cypsela (achene like seed). Reproduction is by seeds and by parts of the roots (vegetative) [6, 7].

In the conditions of Belarus, *C. intybus* flowers on the 2nd year after the planting. The flowering period is observed from June to July, and seed producing occurs in July–September [8]. When not cultivated, chicory is found as a ruderal plant in dry meadows, roadsides and railway tracks, where they form large thickets.

Chicory originated in the Mediterranean [9, 10]. Currently, the species is widely distributed throughout Europe, East Asia, India, Southern and Northern Africa, North, Central and South America, Australia and New Zealand [11].

C. intybus is one of the cultivated plant species and is widely used as a medicinal, food (vegetable), fodder and melliferous culture [12]. Milky juice of chicory contains bitter substances, such as lactucin, lactucopicrin, etc., which have a positive effect on the increase in appetite. The roots of *C. intybus* are used to produce coffee-free chicory coffee, as well as for making beverages that have an astringent and antimicrobial effect. The use of this kind of infusions increases and improves the appetite and functioning of the digestive system. Chicory is used in the treatment of diabetes. Syrup, derived from chicory root, is used in canning and confectionery production. Chicory is a good melliferous culture. Under favourable weather conditions, its median productivity can reach up to 100 kg/ha [13].

Common chicory was introduced on the territory of Belarus in the 60s of the 20th century [14] as a medicinal plant, occasionally it is planted as a food crop for the production of coffee-like drinks. At present, *C. intybus* is ubiquitous, common in dry lands and lands with ruderal vegetation.

In the conditions of Belarus, chicory is damaged by a number of phytophagous insects. Leaf-miner

flies of Agromyzidae family, *Napamysa lateralis* (Fall.) and *Ophiomyia pinguis* (Fall.), damage the leaves and underground parts of the plant. On *C. endivia* roots were recorded the rhizobiont forms of Aphidoidea – dioecious gall-forming aphid species from family Eriosomatidae – *Pemphigus bursarius* L. Also chicory is damaged by another specialized invasive species feeding on herbs – large chicory aphid (*Uroleucon cichorii* (Koch)).

The purpose of this paper was to examine the current distribution of the large chicory aphid (*Uroleucon cichorii* (Koch)) throughout Europe and Belarus, in particular, as well as its bioecological characteristics in the context of the study region.

Material and Methods

The paper is based on the analysis of a vast number of bibliographic works containing information about the presumably first record of the large chicory aphid in different countries and regions in Europe. The data obtained are used to get an overview about the species distribution throughout the European continent. To assess the current dynamics of the species distribution in Belarus, perennial registrations and collections of entomological material were carried out by the authors in all 6 administrative regions, 5 landscape-geographical provinces [15], 7 forest vegetation [16] and 4 agroclimatic [17] zones, as well as 5 tree introduction districts [18] of Belarus. The collection of material was carried out according to generally accepted methods of aphidological studies [19].

Results and Discussion

The large chicory aphid was first described in Germany by K. L. Koch in 1854 as *Siphonophora cichorii* Koch. The analytical review of printed

works of different years on *U. cichorii* makes it possible to state that the species has many synonymous names, which are shown in table 1.

The introduction and widespread cultivation of *C. intybus* created the prerequisites for the expansion of *U. cichorii* beyond its natural, historically formed area, which is considered the territory of the Mediterranean. By the first decade of the current century, the species was recorded in Eastern, Northern, Central, Southern and Western Europe. Figure 1 shows years, table 1 shows as well as the publications with presumably first records of the chicory aphid for the Old World countries. The exceptions are Portugal, Slovenia, Croatia and Iceland (fig. 1), since the data about *U. cichorii* are not available in these countries. Outside Europe the species is recorded in the Near East and Central Asia, Eastern Siberia, and Korea [19].



* – according to Fauna Europaea [20]

Fig. 1. Distribution of the Large Chicory Aphid (*Uroleucon Cichorii* (Koch, 1855)) Throughout Europe, by Years of Registration

Table 1

Chronology of Publications Which Content Information on Registrations of the Large Chicory Aphid (*Uroleucon Cichorii* (Koch, 1855)) in the European Regions

Years of the First Registration	Regions	Synonyms / Host Plants	Literary Source
1	2	3	4
1854	Germany	<i>Siphonophora cichorii</i> Koch / <i>Cichorium intybus</i> L.	[21]
1876	Great Britain	<i>Macrosiphum cichorii</i> (Koch) / <i>Agrostemma githago</i> L., <i>Cichorium intybus</i> L.	[22]
1894	Estonia	<i>Siphonophora serratulae</i> Koch / <i>Cirsium</i> sp.	[23]
1896	Romania	<i>Siphonophora picridis</i> F. / <i>Cichorium intybus</i> L.	[24]
1900	Italy	<i>Siphonophora pricridis</i> / <i>Picridium vulgare</i> Desf.	[25]
1901	Belgium	<i>Macrosiphum cichorii</i> Koch / <i>Cichorium</i> sp.	[26]

1	2	3	4
1903	Crimea	<i>Siphonophora cichorii</i> Kalt. / <i>Centaurea</i> sp.	[27]
1924	Latvia	<i>Macrosiphum pirdicis</i> Fabr., 1794 / <i>Leontodon autumnalis</i> L.	[28]
1930	Poland	<i>Macrosiphum picridis</i> Fabr. / <i>Cichorium intybus</i> L.	[29]
1939	Netherlands	<i>Dactynotus cichorii</i> Koch / <i>Cichorium intybus</i> L.	[30]
1941	Finland	<i>Dactynotus cichorii</i> (Koch) / <i>Lapsana communis</i> L.	[31]
1945	Ukraine	<i>Dactynotus cichorii</i> Koch / <i>Cichorium intybus</i> L.	[32]
		<i>Megalosiphum picridis</i> Fabr. / <i>Cichorium intybus</i> L.	[33]
1948	France	<i>Dactynotus cichorii</i> Koch / <i>Cichorium</i> sp.	[34]
1949	Sweden	<i>Dactynotus cichorii</i> (Koch) / <i>Lapsana communis</i> L.	[35]
1953	Norway	<i>Dactynotus cichorii</i> (Koch) / <i>Leontodon autumnalis</i> L.	[36]
1954	Denmark	<i>Dactynotus cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[37]
1955	Moldavia	<i>Dactynotus cichorii</i> Koch / <i>Cichorium intybus</i> L.	[38]
1956	Austria	<i>Dactynotus cichorii</i> (Koch) / <i>Cichorium intybus</i> L.	[39]
1958	Czech	<i>Uroleucon cichorii</i> (Koch, 1955) / <i>Cichorium endivia</i> L.	[40]
1959	Hungary	<i>Dactynotus cichorii</i> Koch / <i>Cichorium intybus</i> L.	[41]
1960	Bulgaria	<i>Dactynotus (Dactynotus) cichorii</i> (Koch) / <i>Cichorium intybus</i> L.	[42]
1962–1964	European Russia	<i>Dactynotus cichorii</i> (Koch) / <i>Cichorium intybus</i> L.	[43, 44]
1963	Bosnia and Herzegovina	<i>Uroleucon cichorii</i> (Koch, 1955) / <i>Cichorium intybus</i> L.	[45]
1963	Serbia	<i>Uroleucon cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[45]
1963–1980	Lithuania	<i>Uroleucon cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[46]
1964	Macedonia	<i>Uroleucon cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[45]
1967	Switzerland	<i>Uroleucon cichorii</i> (Koch, 1855) / <i>Senecio paludosus</i> L.	[47]
1971	Spain	<i>Uroleucon (Uroleucon) cichorii</i> (Koch, 1955) / <i>Crepis taraxacifolia</i> (Thull.)	[48]
1973	Sicily	<i>Uroleucon cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[49]
1973	Corsica	<i>Uroleucon cichorii</i> (Koch) / <i>Cichorium intybus</i> L.	[50]
1982	Balearic Islands (Mallorca)	<i>Uroleucon (Uroleucon) cichorii</i> (Koch, 1955) / <i>Cichorium intybus</i> L., <i>Crepis tectorum</i> subsp. <i>tectorum</i> , <i>Reichardia picroides</i> (L.) Roth	[51]
1986	Belarus	<i>Uroleucon cichorii cichorii</i> (Koch, 1855) / <i>Cichorium intybus</i> L.	[52]
after 1992	Greece	<i>Uroleucon (Uroleucon) cichorii</i> (Koch) / <i>Cichorium</i> sp.	[53]

As indicated in table 1, for Belarus *U. cichorii* was first collected by prof. S. V. Buga (1986) namely in Priluki Village, Minsk District, Minsk Region, on *Cichorium intybus* L. [52]. Registration points of the large chicory aphid during the field seasons 1986–2018 in accordance with the information of the database «Aphids of Belarus» [54] are displayed on the map (fig. 2).

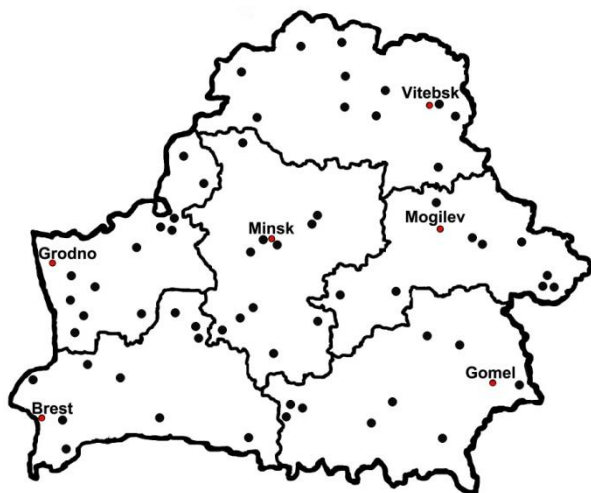


Fig. 2. The Large Chicory Aphid (*Uroleucon Cichorii* (Koch, 1855)) Registration Points in Belarus During 1986–2018

The registration data of the large chicory aphid in Belarus (fig. 2) demonstrate that by now the area of distribution of the species covers the territories of all administrative regions, physiographic provinces, forest vegetation and agroclimatic zones, as well as the introduction and dendrological regions of Belarus. The species penetrated into the adventive complex of aphids associated with herbaceous plants in Belarus.

The trophic specialization of the large chicory aphid is characterized by the nutrition and development exclusively on herbaceous plants, which determines its belonging to a herbivorous phytobiont ecological group. The imago and larvae of *U. cichorii* are localized on the upper parts of the stems and inflorescences of the chicory. They form loose aggregations, which makes it possible to rank them among the open-living species feeding on meristem. *U. cichorii* uses common chicory and related species Cichorieae as the host plants (*Crepis*, *Hieracium*, *Lactuca*, *Lapsana*, *Leontodon*, etc.). In the Palearctic region the large chicory aphid is recorded on the whole spectrum of food plants, which are represented by families Asteraceae: *Aetheorhiza*: *Aetheorhiza bulbosa* (L.) Cass.; *Andryala*: *Andryala integrifolia* L., *A. ragusina* L., *Aster maackii* (?); *Chondrilla*: *Chondrilla integrifolia*

L., *Cichorium*: *Cichorium endivia* L., *C. intybus* L.; *Cirsium*: *Cirsium vulgare* (Savi) Airy-Shaw.; *Crepis*: *Crepis alpestris* (Jacq.) Tausch, *C. biennis* L., *C. blattarioides* Vill., *C. capillaris* (L.) Wallr., *C. conyzifolia* (Gouan) A. Kerner, *C. foetida* L., *C. grandiflora* L., *C. hieracioides* Waldst. & Kit., *C. nicaeensis* Balbis, *C. paludosa* (L.) Moench, *C. praemorsa* (L.) Tausch., *C. rhoeadifolia* Bieb., *C. setosa* F. Haller, *C. sibirica* L., *C. tectorum* L., *C. vesicaria* L., *C. vesicaria haenseleri* (Boiss. ex DC.) P.D. Sell, *C. virens* = *C. capillaris*; *Hedypnois*: *Hedypnois cretica* (L.) Dum.-Cours., *Hedypnois polymorpha* = *H. cretica*; *Helichrysum* spp.; *Hieracium*: *Hieracium aurantiacum* L., *Hieracium auricula* Auct., non L. = *H. lactucella*, *H. brachiatum* Bertol. ex Lam., *H. dubium* L., *H. lactucella* Wallr., *H. murorum* L. AGG., *H. pilosella* L., *H. piloselloides* Vill., *H. umbellatum* L.; *Hyoseris*: *Hyoseris radiata* L.; *Hypochoeris*: *Hypochoeris achyrophorus* L., *H. maculata* L., *H. radicata* L., *H. ramose*; *Lactuca*: *Lactuca perennis* L., *L. sativa* L., *L. serriola* (L.) Torn, *L. viminea chondrilliflora* (Boreau) Bonnier; *Lapsana*: *Lapsana communis* L.; *Leontodon*: *Leontodon autumnalis* L., *L. crispus* Vill., *L. danubialis* Jacq., *L. hispidus* L., *L. hispidus alpinus* (Jacq.) Finch & P. D. Sell, *L. hispidus danubialis* (Jacq.) Simonkai; *Picris*: *Picris hieracioides* L.; *Reichardia*: *Reichardia picroides* (L.) Roth; *Senecio*: *Senecio erucifolius* (?), *Seriola aetnensis* = *Hypochoeris achyrophorus*; *Sonchus*: *Sonchus arvensis* L., *S. asper* (L.) Hill, *S. oleraceus* L., *Taraxacum*: *Taraxacum officinale* Weber; *Tragopogon* spp.; *Resedaceae*: *Reseda*: *Reseda luteola* L.; *Polygonaceae*: *Rumex* spp.; *Campanulaceae*: *Campanula* spp. [55]. The broad spectrum of forage plants indicates that in most countries of Europe *U. cichorii* belongs to second-degree oligophagous. In Belarus the large chicory aphid belongs to a number of specialized monophagous [4].

Feeding on forage plants contributes to the loss of a significant amount of plastic substances, which leads to their dehydration and slow growth, and as a result, a slight deformation of the stem. *U. cichorii* does not initiate the deformation of leaf blades and the premature dying off of the inflorescences, and also does not lead to the formation of galls. That's why it refers to non-teratogenic forms.

Under the conditions of Belarus [4], as well as in the neighboring countries of Europe [56–58], the large chicory aphid is holocyclic and monoecious. The morphs are represented by fundatrices, larvae, nymphs, virginoparae and sexuparae (males and oviparae). The whole cycle of aphid development takes place on the main host plant – chicory.

Perennial data show the appearance of fundatrices from overwintering eggs in the third decade of April – the first decade of May. Further occurs a series of successive parthenogenetic generations and the growth of colonies. The winged females are recorded in July–August. The appearance of winged males and normal females occurs in September – the first decade of October. The eggs are deposited in the end of October. The largest peak in the number of *U. cichorii* registrations occurs in July–August (fig. 3).

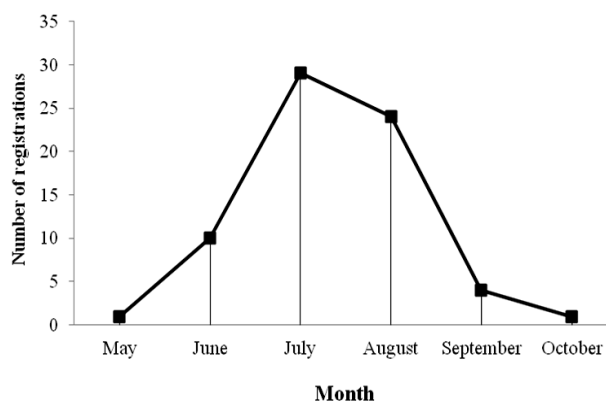


Fig. 3. Seasonal Abundance of the Large Chicory Aphid (*Uroleuon Cichorii* (Koch, 1855)) in Belarus Based on Perennial Field Data (1986–2018)

Conclusion

The results obtained show that the large chicory aphid (*U. cichorii*) is widespread throughout Europe. In Belarus, the species has completed expansion the country and penetrated into the adventive complex of aphids associated with herbaceous plants. The analysis of the bioecological characteristics of *U. cichorii* in Europe and Belarus makes it possible to classify it as an open-living, non-teratogenic species feeding on meristems. The species belongs to the herbivorous phytobiont ecological group. According to the trophic specialization, in Belarus *U. cichorii* belongs, – to specialized monophagous. The biological cycle is holocyclic and monoecious in Europe and Belarus both. In the conditions of Belarus the peak of *U. cichorii* registrations occurs in July–August.

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