

Distribution of *Cichorium intybus* L. in the Russian Far East

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Abstract

In this study the current distribution of *Cichorium intybus* L. beyond the boundaries of its area is discussed, and the dynamics of the species' migration is traced from the beginning of the 20th century when it was first discovered in the Far East of Russia. A search in literary sources, handling of herbarium materials, and our personal field explorations helped to find out that *C. intybus*, which emerged in the Russian Far East in the early 20th century, had limited distribution. Presently, its most numerous localities are in the southern areas of Primorskii Krai, while in Khabarovskii Krai, Jewish Autonomous Oblast', Amurskaya Oblast', Sakhalinskaya Oblast' and Kamchatka this species occurs sporadically. Its representatives are regarded as crop wild relatives.

Key words: *Cichorium intybus*, distribution, adventive plant, 'runaway' from cultivation, Russian Far East, crop wild relatives.

Introduction

Historically, it was as long ago as in the early Cretaceous that angiosperms (and possibly their ancestors as well) were able to colonize open habitats in early stages of ecological succession and new areas unoccupied by vegetation due to their shortened reproductive cycle, dispersion of small seeds with water and wind, and pollination by insects and wind (Herman, 1999). All this gave them big advantages over other plants, together with rapid adaptability to changing climate conditions.

At present, numerous plant species have become permanent companions to man. As a result of anthropogenic transformations in the natural environment and emergence of new ecogeographic niches, adventive species occupy territories unusual for them. However, today it is difficult, and sometimes even impossible, to find out which factor has had greater effect on the distribution of adventive species – anthropogenic activities or climate – because both components are equipotent and interlinked.

A special group deserving attention includes 'runaways' from cultivation. Many introduced plant species that temporarily settle in the disturbed territories have 'escaped' from their cultivated habitats, as their diaspores were carried away with the wind, litter, animals or humans. Such species mainly occur on

garbage dumps and lawns, along roadsides and river banks (on beaches) as solitary plants or, less often, in clusters.

In horticulture, one can frequently encounter medicinal and spicy plants that do not belong to the indigenous vegetation and also may be found on disturbed grounds or garbage dumps, sometimes soundly incorporated into ruderal communities within urbanized territories of various types. Common chicory or succory (*Cichorium intybus* L.) is among such plants.

For a long time chicory was known to folk medicine as an appetite-enhancing drug and a digestive. Chicory roots are used in the food industry as a substitute for natural coffee or an admixture to it (Telyatev, 1985). Chicory is also a food (vegetable) plant. Chicory roots and leaves are both used to prepare salads. The leafy variety of this species – radicchio, radichetta, French endive or red endive (*Cichorium intybus* var. *foliosus* Hegi) – is a popular garden crop, especially in Western Europe. Leaves are usually red, with white veins. Not only salads but also hot meals are cooked with radicchio. The bitter and spicy taste of its leaves is mitigated by heat treatment. Syrup from its fructose-rich roots is used in confectionary and canning industries. *C. intybus* has been cultivated as a crop for quite a long time; there are leafy and root cultivars (Ulyanova, 2005).

Chicory is also exploited as an ornamental plant. Widespread utilization of chicory for medicinal and ornamental purposes, its expanding assortment of seeds, and poorly cleaned seed material of other cultivated plants led to rapid dispersion of this species not only over Eurasia but also in other parts of the globe.

The species of gen. *Cichorium* L. are widespread in the Ancient Mediterranean region; they may be found in the range from the Iberian Peninsula and North Africa to the western provinces of China (Tzvelev, 1964). The area of natural distribution for *C. intybus* encompasses the Mediterranean Basin, Western Europe, Asia Minor, Iran, Northern India, and Northern China. As an adventive plant, it occurs in South Africa, North and South Americas, Australia, New Zealand, and western provinces of China (Tzvelev, 1964; Hulten & Fries, 1986; Marenchuk & Dudar, 2007).

According to the data of 1935, *C. intybus* occurs in Russia as an indigenous species – in the European part, Northern Caucasus, Western and Eastern (south) Siberia. The northern boundary of its area of distribution runs from Lake Sandal in Karelia through Velsk, Kostroma and the northern Kazan to Malmyzh, Yelabuga, Sarapul and Ufa; from the latter it ascends to Perm and descends from it southwards to Zlatoust, then goes to Tymen and Kokchetav; running southward of Omsk and the Baraba steppe, it reaches Barnaul and the Uriankhai steppes. In the Russian Far East, it is recorded as an adventive plant in the vicinity of Lake Khanka (Areas of distribution..., 1935).

The data of 2008 report that the natural area of the species' distribution includes all areas in the European Russia, except the northernmost Karelia-Lapland and Dvina-Pechora floristic districts (according to the zoning presented in *Flora of the USSR*). The entire Russian Caucasus and the south of Western Siberia should also be regarded as part of its natural distribution area. Chicory sporadically occurs in the said northernmost floristic districts of the European Russia and in the south of Eastern Siberia as a rare adventive plant (Smekalova, 2008).

Despite the fact that the natural area of the species' distribution comprises the entire Mediterranean Basin, and the species is absent in many continents, chicory is now dynamically spreading out to numerous natural zones both in Russia and abroad.

In East Asia, for example, this species is registered for China in Beijing and the provinces of Heilongjiang, Liaoning, Shanxi, Xinjiang, Gansu, Hebei, Henan, Jilin, Shaanxi and Shandong, where it grows near rivers, on wastelands, along shores, slopes and ditches (Zhengyi & Raven, 2011). According to N. I. Vavilov (Vavilov, 1967), *C. intybus* was often found as a wild plant, especially on the northern slopes of the Tian Shan, but not as a cultivated crop. The species was brought to the Island of Taiwan together with the seeds of *Trifolium alexandrinum* L. and managed to naturalize there in pastures (Peng, 2004). It was observed in the northern part of the Korean Peninsula (Lee Yong No, 1996). In Japan, plants of this species are found on Hokkaido (Obihiro, Hokkaido prefecture) (Wild flowers ..., 2004; Discover life). In Vietnam, chicory has been recorded as growing in Sa Pa (old part), Son La, Hà Giang and Lâm Đồng provinces (Ngành Mộc Lan, 2005).

In the Russian Far East (hereinafter: RFE) chicory occurs as an adventive plant (Hulten, Fries, 1986; Gubanov *et al.*, 2004) along roadsides, on lawns, and in ruderal sites.

C. intybus has been officially listed among crop wild relatives (CWR) of Russia in the food economic group list (Smekalova & Chukhina, 2005). According to the criterion of economic importance, this species belongs to the first rank, where the species most valuable for Russia's national economy, represented

as crops and having cultivars, are listed. In the context of the CWR conservation methodology in Russia (Smekalova & Chukhina, 2005), chicory is a species prioritized for conservation. Between the two ways of biodiversity conservation – *ex situ* (in seed genebanks) and *in situ* (within natural plant populations) – the latter was emphasized as preferable in the Convention on Biological Diversity (CBD), signed in 1992 in Rio de Janeiro.

Studying the distribution and biology of ‘runaways’ from agricultural practice helps to examine naturalization and adaptation mechanisms in the plant species that quitted cultivation, while making regional maps of their areas of distribution (dot mapping) makes it possible to forecast and control further dispersion of adventive species.

The objective of this work was to study the distribution of *C. intybus* beyond the borders of its primary area and learn the dynamics of its penetration into the Russian Far East – a new land for this species.

Materials and methods

The localities (collection sites) where *C. intybus* had been found in the RFE were mapped on the basis of the data from literary sources, field explorations by the authors, and the herbaria of the Komarov Botanical Institute (LE); Vavilov Institute of Plant Genetic Resources (WIR); Biology and Soil Science Institute. Far-Eastern Branch, RAS (VLA); Amur branch of Botanical Garden-Institute FEB RAS (ABGI); and Moscow State University (MW).

The maps were drawn using MapInfo 8.5 software. Field explorations were made in 2009–2017 over Amurskaya Oblast' (Blagoveshchensk and its outskirts; Arkharinsky, Bureysky, Blagoveshchensky and Ivanovsky Districts), Primorskii Krai (Nakhodka and Ussuriysk; Ussuriysky, Spassky, Chernigovsky, Mikhailovsky, Anuchinsky, Yakovlevsky, Chuguevsky and Khasansky Districts), and Khabarovskii Krai (Bolshekhekhtsirsky Nature Reserve, Khabarovsky District).

Results and discussion

According to the information we retrieved from herbaria, *C. intybus* was registered as present in the RFE as early as in 1928, when it was seen in the village of Gaivoron, Spassky District, Primorskii Krai, occurring in pastures and along the roads (LE). There are herbarium materials collected by Maksimovich near the Amur, but without any date or definite collecting site mentioned (LE). In 1936, chicory was reported to be found in the RFE as a rare plant in the villages of Eldovak (later renamed Marevka; now nonexistent), Dalnerechensky District, and Sosnovka, Spassky District, where it was recognized as a ‘runaway’ from the cultivated environment or as a non-native brought there by the Russian population (Shishkin, 1936). There is a report concerning plants of this species growing as weeds among oat crops near Bolsheretsky State Farm (Ust-Bolsheretsky District, Kamchatka) in 1935, collected by N. V. Pavlov (MW), and on a fallow land in the Sydagou River valley, Southern Sikhote-Alin (presently: Izvilinka River, Chuguevsky District, Primorskii Krai) in 1944, collected by P. Zhudova (MW). In *Flora of the USSR*, however, there is no mention of *C. intybus* in the RFE.

The localities of chicory were identified basically according to the data retrieved from the multivolume summary book *Vascular Plants of the Soviet Far East* (Barkalov, 1992), and supplemented with contemporary literary data and the findings of our own plant explorations.

In 2010, we found a solitary plant of *C. intybus* in the VEPR hunting farm, Ussuriysky District, Primorskii Krai. In 2013, the species was collected at the entrance to the village of Kaymanovka, Ussuriysky District. Its occurrence was registered along the sides of the highway leading from Ussuriysk, in the vicinities of the villages Abrazheyevka, Chernigovks, Sibirtsevo, Vysokoye, Dmitrievka, Gorny Khutor (all in Chernigovsky District), Krasnyi Kut, Vishnevka (Spassky District); the road from Ussuriysk via Arsenyev to the village of Nizhniye Luzhki, in the vicinities of the villages Ivanovka, Osinovka and Gorbatka (Mikhailovsky District), in the village of Novovarvarovka (Anuchinsky District), in the vicinities of the town of Arsenyev and the villages Novosysoevka, Varfolomeyevka and Andreyevka (Yakovlevsky District), vicinities of the villages Verkhnyaya Breyevka, Kamenki, Uborka, Shumny and Nizhniye Luzhki (Chuguevsky District); and in the cities of Nakhodka and Ussuriysk. In 2014, the species was found in the village of Andreyevka, Khasansky District, near a roadside.

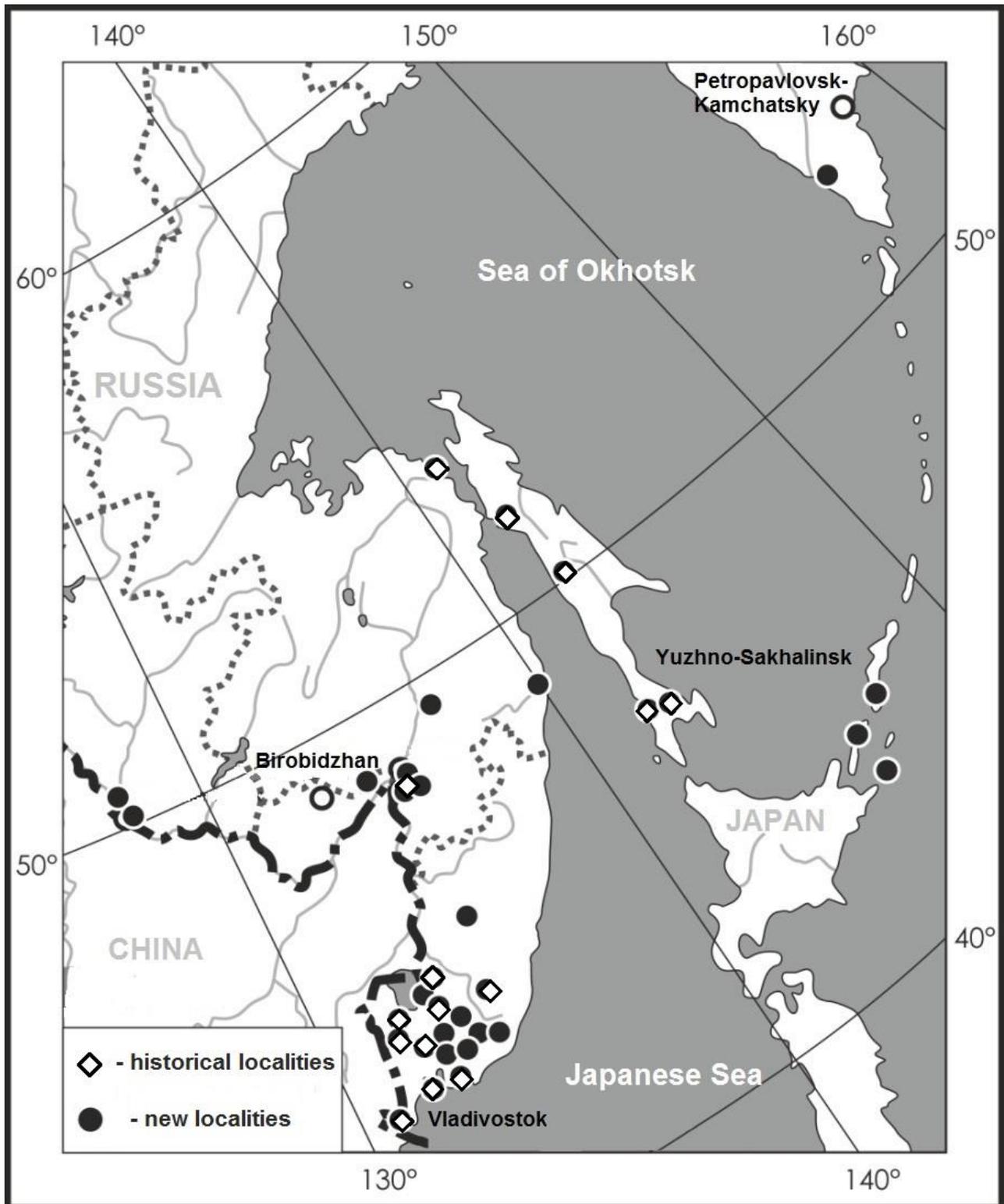


Figure 1. Distribution of *Cichorium intybus* L. in the Russian Far East.

Some authors (Bykov, 1965) opine that *C. intybus* L. can form weedy clusters in meadows. Such phenomenon was observed in Primorskii Krai on disturbed meadows, where chicory had clustered into small monodominant communities.

For Khabarovskii Krai, *C. intybus* was recorded beginning from the mid-1960s in the village of Pereyaslavka, Lazo District, where it occurred in shrub thickets (Shaga, 1967). Later, its solitary plants were found along the roadsides in the vicinities of the village of Gyрман, Nikolaevsky District (Shaga, 1974). At

present, the species occurs in the city of Khabarovsk, Korfovsky and Oktyabrsky settlements, the village of Nergen (Antonova, 2009), and, less frequently, along the coast of Strait of Tartary (Antonova, 2014). In 2014, we found plants of this species in the Korfovsky settlement as well.

In the Jewish Autonomous Oblast', the species was recorded for Smidovichsky District where it grew on wastelands in the settlement of Nikolaevka (Rubtsova & Starchenko, 2006).

C. intybus has periodically infiltrated Amurskaya Oblast' together with other seed materials or as a 'runaway' from cultivation. We collected its samples in 2013 in Blagoveshchensk, in an asphalt fissure. Earlier, the species was registered as present in the Zeya-Bureya valley (Starchenko, 2001).

On the Island of Sakhalin, the species was reported to occur in the Eastern Sakhalin mountains, Tymovsky District, and the Southern Sakhalin lowland (Barkalov, Taran, 2004). At present, the area of its distribution in Sakhalin has expanded along the local oil and gas pipelines (Taran, 2012).

On the Kurils, *C. intybus* was registered as a rare adventive plant on Iturup, Kunashir and Zelyonyi; it could reach these islands either from the continent or from the nearest islands, such as Hokkaido (Barkalov, 2009). In Kamchatka, it was found in Ust-Bolsheretsky District (western part of the province) close to human habitation or along the roads (Yakubov & Chernyagina, 2004).

The map (Fig. 1) showing all presently known localities of *C. intybus* in the RFE is presented below.

It has been mentioned earlier that this species has no natural area of distribution in the RFE region, but is incorporated in a number of plant communities, having inhabited them for several years, which is the evidence of its naturalization. Populations of this species in the said region may be of interest as sources of new traits promising for breeding and serve as a model target for observations over the initials stages of a species' adaptation in new environments.

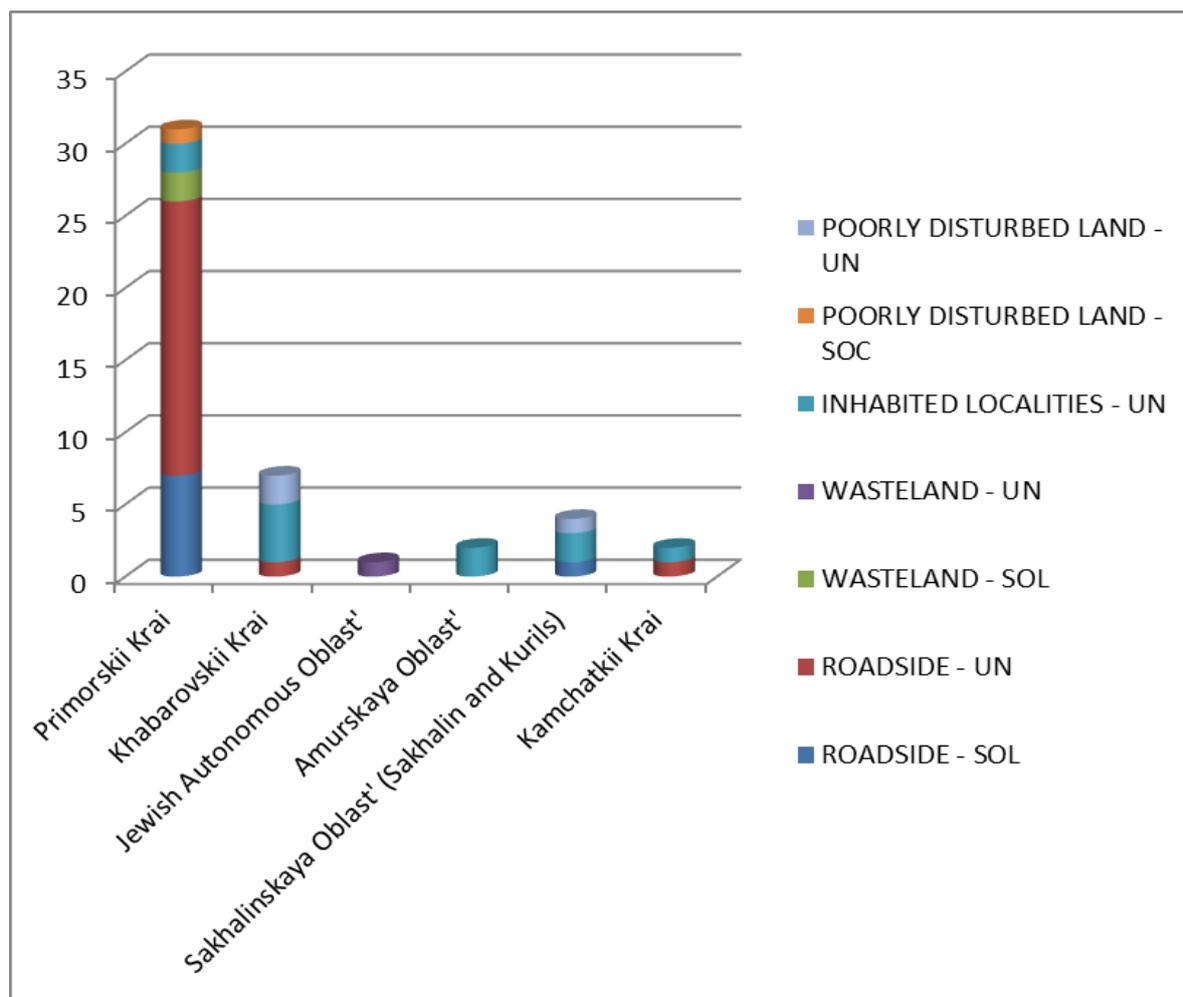


Figure 2. Frequency of the localities and habitat types of *Cichorium intybus* L. in the regions of the Russian Far East. Legend. Drude Scale: un – the species occurs once, projective cover <1%; sol – the species grows absently, projective cover 3-5%; soc – very abundant, completely, projective cover > 95%.

Thus, *C. intybus*, having appeared in the RFE in the early 20th century, had limited distribution there, occurring mostly in Primorskii Krai. In the late 20th/early 21st century, the species was already present in the entire southern part of the RFE as well as in the south of Kamchatka, on Sakhalin, and the Kuril Islands (Iturup, Kunashir and Zelyonyi).

The diagram (Fig. 2) showing all habitat types and frequency of the localities of *C. intybus* (Fig. 3) in the regions of the RFE is presented below.

During the considered period of time (from 1928 to the present), chicory has best of all adapted in Primorskii Krai, while in the other regions of the FER it sporadically appears as a rare adventive plant. The analysis of literary data and our own collecting efforts in Amurskaya Oblast', Jewish Autonomous Oblast', Khabarovskii Krai, Sakhalin, the Kurils, and Kamchatkii Krai helped to find out that in all registered cases chicory occurred either as solitary plants or up to 5–6 plants, and never was in abundance. Only within Primorskii Krai this species formed small monodominant clusters (not more than 3–4 sq. m) in some adventive sites.

Our studies have shown that chicory prefers sandy soils and open habitats with sparse vegetation and low interspecific competition. In tall stands of grass only single plants have been observed. Chicory is not found in natural cenoses.



Figure 3. Photographs of some characteristic habitat types of *Cichorium intybus* L. in the regions of the Russian Far East. Left – roadside, surroundings of the village Kaymanovka (Primorskii Krai). Right – Blagoveshchensk (Amurskaya Oblast'), in a crack in the asphalt.

Further research is needed to learn more about the distribution and biology of common chicory, which may serve as a model for studying the mechanisms of adaptation beyond agricultural environments and naturalization of plants that ‘ran away’ from cultivation, while making regional maps of its areas of distribution (dot mapping) would help to predict further dispersion of this adventive species. Populations of the species in the said region may be of interest for breeders as sources of promising traits to be incorporated in new food and feed cultivars.

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