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10.2478/botlit-2018-0012

BOTANICA
ISSN 2538-8657

2018, 24(2): 124–131

DISTRIBUTION TRENDS OF SOME SPECIES OF THE BRASSICACEAE FAMILY IN LATVIA

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Abstract

Rūrāne I., Evarts-Bunders P., Nitcis M., 2018: Distribution trends of some species of the Brassicaceae family in Latvia. – Botanica, 24(2): 124–131.

The aim of this paper was to clarify and analyse the distribution trends of some Brassicaceae species (*Bunias orientalis*, *Sisymbrium volgense*, *Barbarea arcuata*, *Draba nemorosa* and *Camelina alyssum*) in Latvia. Field studies and the herbarium material analyses were carried out. The distribution trends were analysed by comparing all selected species in three time periods: by 1940, from 1941 to 1990, and from 1991 to the present. The study shows that the distribution of Brassicaceae species such as *Bunias orientalis*, *Sisymbrium volgense*, *Barbarea arcuata* and *Draba nemorosa* has increased significantly in Latvia during the time period from 1991 to the present, and these species are mostly found on railway, ruderal areas and roadsides, which are important habitats for species distribution. The occurrence of *Camelina alyssum* has considerably declined or perhaps the species has even disappeared from the flora of Latvia, which has been affected greatly by changes in the cultivation of agricultural crops as well as in agricultural land management.

Keywords: alien species, *Brassicaceae*, distribution, Latvia.

INTRODUCTION

The composition of flora isexposed to various natural and anthropogenic processes that include habitat transformation, human impact, and climate change, all of which have consequences on species occurrence (Rejmánek et al., 2005; Ööpik et al., 2008). Brassicaceae Burnett is one of the largest families in the flora of Latvia and comprise 48 genera and 103 species. More than half of the species are aliens (Gavrilova & Šulcs, 1999). In Lithuania, Brassicaceae is represented by 46 genera and 103 species (Gudžinskas, 1999), and in Estonia by 51 genera and 113 species (Kukk, 1999). A great proportion of Brassicaceae taxa consist of plants adapted to disturbed habitats (Al-Shehbaz, 1984; Booth et al., 2003) and a large number are considered to be weeds (Pratap & Gupta, 2009; Warwick, 2011).

Among all naturalized alien plant species present in Europe, 64.1% occur in industrial habitats and 58.5% on arable land and in parks and gardens (Lambdon et al., 2008); many species invade disturbed and seminatural communities (Richardson et al., 2000). Contaminants in seed, mineral materials and other commodities are also responsible for the introduction of alien species to Europe (Pyšek et al., 2009).

Botanical research in the territory of Latvia began at the end of the 18th century (Fischer, 1778, 1784, 1791). In the middle of the 19th century, the Society of Riga Naturalists was founded, an entity that made a significant contribution to the knowledge on the flora in Latvia. In that period, the herbaria collections

began to form, thereby providing invaluable material for the study of flora and its dynamics over approximately two centuries. Local flora research and study continued throughout the 20th century, in the first half of which several plant identification books were published (Ašmanis, 1923; Bickis, 1920, 1923, 1926, 1935). Along with the change in the political system in Latvia after 1940, the flow and variety of goods among the republics of the Soviet Union increased (Šulcs, 1972). In the second half of the 20th century, the territory of Latvia experienced significant changes in agricultural cultivation methods (Āboliņš et al., 1969). A new political system formed in 1991, thereby putting an end to the previous structure of the agricultural sector and decreasing the cross-border flow of railway cargo: from almost 90 million tonnes in 1985 to 30–40 million tonnes in the early 1990s (Paiders, 2018).

The aim of this paper was to clarify and analyse the distribution trends of the selected species of Brassicaceae: *Bunias orientalis* L., *Sisymbrium volgense* M. Bieb. ex E. Fourn., *Barbarea arcuata* (Opiz ex J. et C. Presl) Rchb., *Draba nemorosa* L. and *Camelina alyssum* L. occurring in Latvia.

MATERIALS AND METHODS

Field studies were carried out from 2009 to 2018 in order to primarily clarify the distribution changes in neophyte species of Brassicaceae in Latvia. Over the study period, 239 biological inventory grid squares were randomly surveyed (Fig. 1) over the whole territory of Latvia. In the surveyed grid squares, a 100–500 m length transect was set up in a freely chosen spot and direction, and Brassicaceae species were recorded. During the study, taxonomically unclear and rare species were collected (216 herbarium sheets) and deposited at the Herbarium of the Laboratory of Botany, Institute of Biology, University of Latvia (LATV). Analysis was done of the Brassicaceae herbarium material sourced from about 5000 herbarium sheets from the following collections: the Herbarium of the Laboratory of Botany, Institute of Biology, the University of Latvia (LATV); the Herbarium of the Museum of Botany, University of Latvia (RIG); the Herbarium of Slītere National Park (SVR); the Herbarium of the Natural History Museum of Latvia (LDM); the Herbarium of Daugavpils University (DAU); and the Herbarium of the Latvia University of Agriculture (LLU), as well as from the private collections of botanists Alfrēds Rasiņš (RAS) and Austra Āboliņa (AB).

Distribution maps were prepared using the Latvian biological inventory grid, which is based upon geographical coordinates and in which one grid square is approximately 7.6 × 9.3 km (70.68 km^2) in size. The total number of squares in Latvia is 1017, of which 822 fall entirely within the territory of Latvia, and 195 partly overlie national borders (Tabaka et al., 1980). On the maps, both the recording of a species and a surveyed square is indicated with (●). The programme ESRI ArcGIS 10.3.1 was used to make the maps.

The distribution of the species was analysed using the evaluation scale that has been created by the Laboratory of Botany, Institute of Biology, University of Latvia, based on the number of squares in which a species is recorded as: very rare (1–10 squares), rare (11–30), rather rare (31–100), not rare (101–250), rather frequent (251–500), frequent (501–750), very frequent (more than 751) (Fatare, 1992).

Based upon economic and political system changes in Latvia in the 20th century, three time periods for distribution analyses were used: by 1940, from 1941 to 1990, and from 1991 to the present. Distribution trends were determined by noting the changes in distribution numbers per square over the three time periods. Regarding nomenclature, generic classification was used according to Brummitt (1992) and the species nomenclature after Gavrilova & Šulcs (1999).

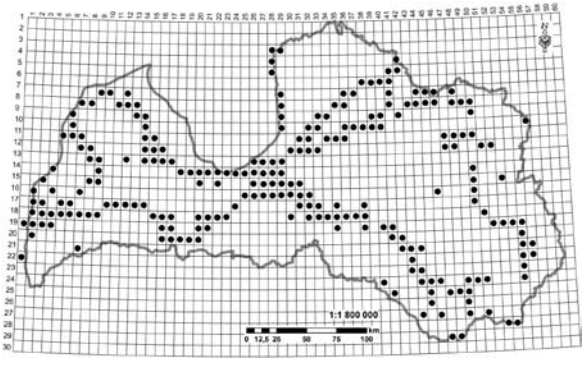

Fig. 1. Biological inventory grid with surveyed squares (2009–2018), Latvia

RESULTS

***Bunias orientalis* L.**

By 1940, *Bunias orientalis* was rare and found in 22 squares mostly occurring in urban areas and their surroundings (Fig. 2). In the period from 1941 to 1990, the number of localities increased to 81 squares, but still the species was rather rare. From 1991 to 2008, *B. orientalis* was considered to be rather frequent, and was found in 163 squares. In the period from 2009 to 2018, *B. orientalis* was found in 23 squares in which the species had not been detected in the previous period, indicating that the species was spreading. Now it is found throughout Latvia and is more frequent in the central and eastern parts of the country. Typical habitats for *B. orientalis* are railway embankments, roadsides, fallows, field edges, river banks as well as cultivated and fallow grasslands.

***Sisymbrium volgense* M. Bieb. ex E. Fourn.**

By 1940, *Sisymbrium volgense* was found in only four squares – in Riga and Liepāja (Fig. 3). The

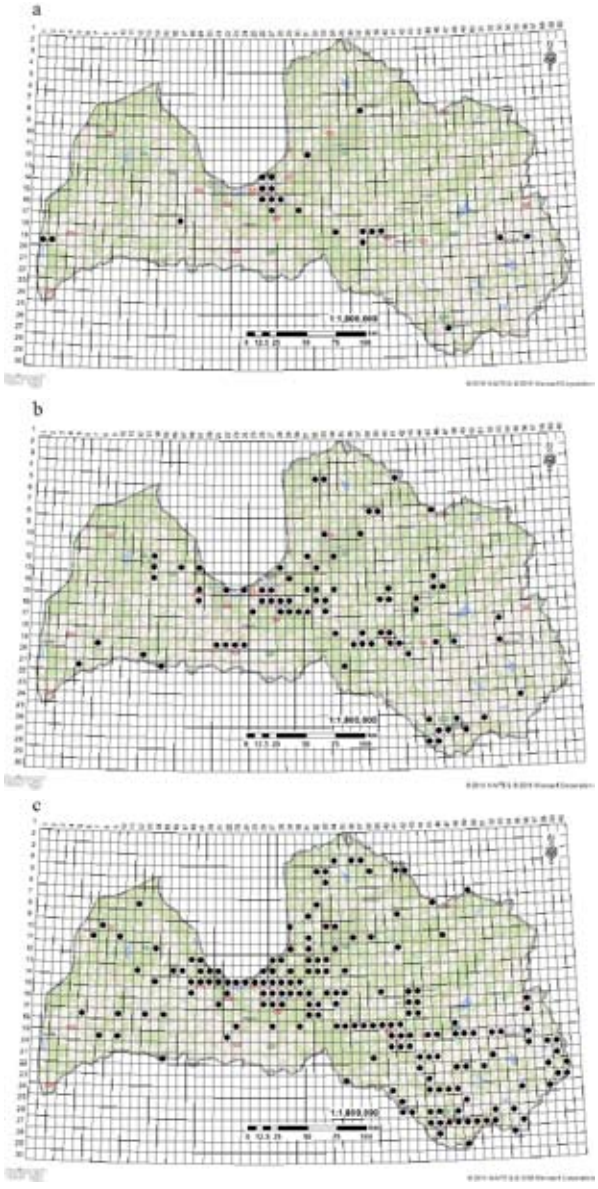

Fig. 2. Distribution of *Bunias orientalis* L. in Latvia (a – localities by 1940; b – localities from 1941 to 1990; c – localities from 1991 to the present)

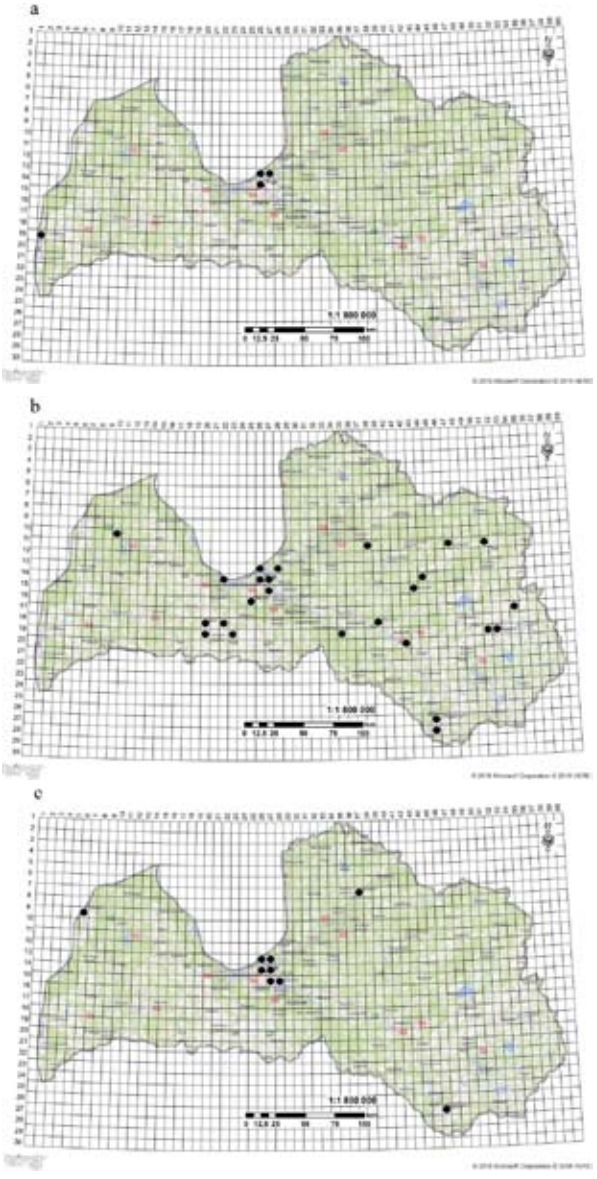

Fig. 3. Distribution of *Sisymbrium volgense* M. Bieb. ex E. Fourn. in Latvia (a – localities by 1940; b – localities from 1941 to 1990; c – localities from 1991 to the present)

herbaria data suggest that *S. volgense* became more frequent in the 1970s and 1980s – in that period it was found in 27 squares, mostly in central and eastern parts of Latvia. Since 1991, *S. volgense* has been found in nine squares, which include large cities. *S. volgense* has been found mostly in the proximity of large cities and towns – Riga, Liepāja, Dobele, Valmiera, Gulbene, Madona, Pļaviņas, Daugavpils, Rēzekne, and Balvi. *S. volgense* most commonly grows on railway embankments, roadsides and weedy places.

***Barbarea arcuata* (Opiz ex J. et C. Presl) Rchb.**

In the period from 1941 to 1990, *Barbarea arcuata* was detected in 594 squares, and, therefore, was a frequent species. In that period, the species was most often identified as a single individual, as a cluster of a few plants, or as a co-dominant species. As field studies show, in recent years large populations of the species have been observed on agricultural lands, where it is considered a weed in cultivated fields of *Brassica napus* and other crops. *B. arcuata* has a tendency to establish in fallows and disturbed habitats; it also occurs on roadsides, the edges of fields, on waste grounds, on railways, and in cultivated and fallow grasslands.

***Draba nemorosa* L.**

By 1940, *D. nemorosa* was found in 10 squares and was determined to be a very rare species in Riga and its surroundings as well as in some localities in eastern Latvia (Fig. 4). From 1941 to 1990, the species was found in 21 squares. Most of these localities were in the areas close to the Daugava River valley. From 1991 to the present, the number of squares remained the same, but there is a change in the position of the squares. Analysis of the data concerning *Draba nemorosa* reflects that its occurrence has increased significantly during the last few decades. It is found not only in natural habitats (dry grasslands), but also in ruderal habitats – on roadsides, railway embankment slopes, quarries and weedy places. *D. nemorosa* has become a much more common species in eastern Latvia, especially in Daugavpils and the surrounding area, where *D. nemorosa* forms large populations on railway embankments.

***Camelina alyssum* L.**

By 1940, there were 14 squares, where *Camelina alyssum* was recorded, and from 1941 to 1990 it was found in 12 squares (Fig. 5). Occurrence of *C. alyssum* was reported by the middle of the 20th century, but since then, there are no more data available. The last herbarium specimen was collected in 1979, in Daugavpils district. In both of the earlier time periods, the species was dispersed throughout the territory of Latvia, however, its distribution can be evaluated as very rare.

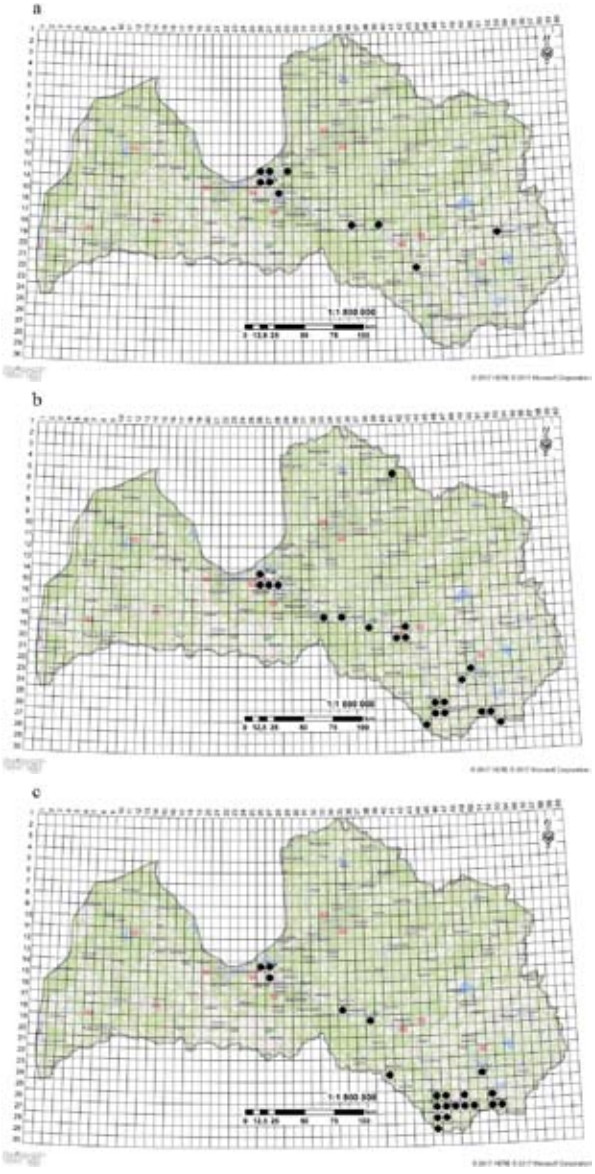

Fig. 4. Distribution of *Draba nemorosa* L. in Latvia (a – localities by 1940; b – localities from 1941 to 1990; c – localities from 1991 to the present)

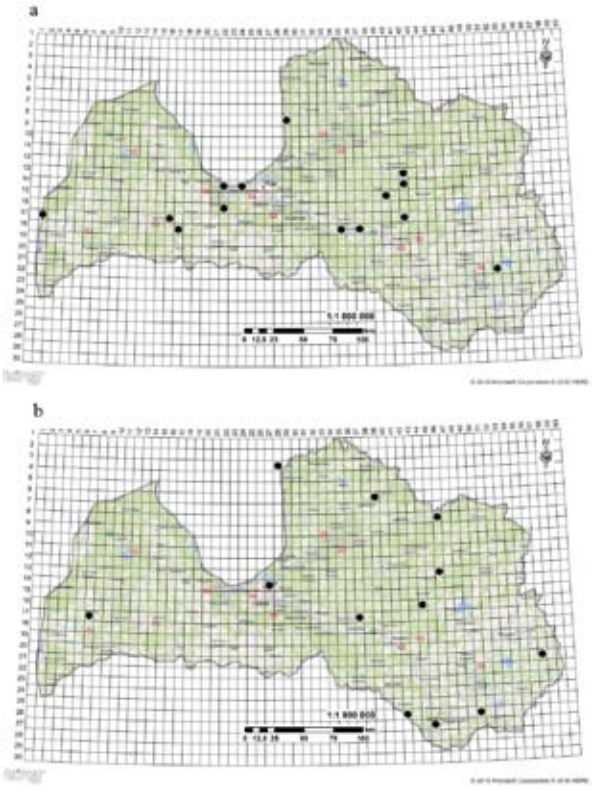

Fig. 5. Distribution of *Camelina alyssum* L. in Latvia (a – localities by 1940; b – localities from 1941 to 1990)

DISCUSSION

Distribution of the Brassicaceae species, *Bunias orientalis*, *Sisymbrium volgense*, *Draba nemorosa* and *Barbarea arcuata*, in Latvia has significantly increased. These species are mostly found on railway embankments, ruderal areas and roadsides. Railways and roadsides are important species distribution corridors (Trombulak & Frissell, 2000; Hansen & Clevenger, 2005; Rutkovska et al., 2013), which affect not only native, but also alien species distribution, especially in urban areas (Penone et al., 2012). Such a correlation can also be observed for some of the studied Brassicaceae species.

Bunias orientalis is a species the distribution of which is significantly related to transport corridors. In 1911, individuals of *B. orientalis* were detected at the Riga Central Station (Rothert, 1915), and Mühlenbach (1934) has noted that the species occurs quite often and is likely to naturalize. Over the last 200 years, *B. orientalis* has become a widespread species, which obviously shows its invasive nature (Laiviņš et al., 2006). Our results showed that *B. orientalis* is now distributed throughout the territory of Latvia, mostly in its central and eastern parts. The introduction of *Sisymbrium volgense* is also associated with transport routes. Lehmann (1896) has noted that *S. volgense* was unintentionally introduced through the transporting of crops. At the beginning of the 20th century, *S. volgense* was also found in several locations in Riga (Mühlenbach, 1934). Nowadays its distribution is related mainly to ruderal areas in cities. *S. volgense* has naturalized in many European countries (Ball, 1993). Railways are also important for *Draba nemorosa*, which is where it forms large populations, whereas in natural habitats it is found as individual plant. The analysis of distribution of *D. nemorosa* shows that it is mainly found in the eastern part of Latvia. The species is very common in Daugavpils along railway edges, and is considered to be a common species (Evarts-Bunders et al., 2015). This species can also be found on railway embankments in Austria, where it forms large populations (Stöhr, 2007). In Estonia, distribution of *D. nemorosa* has decreased and it occurs mostly in its northern part (Kukk & Kull, 2005), whereas in Lithuania it occurs in the southeastern part of the country (Gudžinskas, 1997). Agricultural land and roadsides are significant areas that contribute to the spread of *Barbarea arcuata*, which was confirmed in this study. In the flora of Latvia, it was first mentioned in 1846 (Müller, 1846), and now it is found in the fields of various crops as well as in sown perennial grasses (Ņečajeva, 2016). As observed in field studies, the distribution of *B. arcuata* in Latvia is also affected by the expansion and reconstruction of transportation roads.

Many plant species are associated with agricultural land. Changes in agricultural land use towards more intensive management have also affected many species adapted to arable habitats (Baessler & Klotz, 2006; Storkey et al., 2012). One of the species belonging to Brassicaceae, the distribution of which has decreased by such changes is *Camelina alyssum*. Bickis (1946) has mentioned that *C. alyssum* occurs frequently in Latvia, and Rasiņš (1954) has noted that *C. alyssum* is dispersed throughout Latvia. As Šulcs (1972) has noted, it is considered to be a weed in plant communities associated with flax cultivation. *C. alyssum* had been widely distributed throughout Europe, but now it is extinct or

most likely extinct in most parts of Europe (Jalas et al., 1996). In Estonia, *C. alyssum* was quite common in the 19th century and the first half of the 20th century (Kukk & Kull, 2005). In Poland, *C. alyssum* was considered to be a weed that grew in flax fields, but it has not been recorded since 1960 (Śliwiński & Dajdok, 2011). *C. alyssum* is also considered to be extinct in the eastern part of Germany (Benkert et al., 1996), but it still occurs in Bulgaria, Romania, Ukraine, and western Russia (Jalas et al., 1996). Analysis of herbaria data and literature (Kuusk et al., 1993) indicates that *C. alyssum* is becoming extinct in Latvia. *C. alyssum* has disappeared as a result of diminishing or even widespread loss of flax cultivation. For almost 40 years now there has been an absence of information on the occurrence of *C. alyssum* in Latvia. Changes in land use practices and the disappearance of suitable habitats for *C. alyssum*, such as flax fields, have severely affected the existence of this species.

ACKNOWLEDGEMENTS

This publication was supported by the science-based funding project "Ecology and Biodiversity" (LU Nr. ZD2015/AZ81) of the University of Latvia.

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KAI KURIŲ BRASSICACEAE ŠEIMOS AUGALŲ PAPLITIMO TENDENCIJOS LATVIJOJE

Ieva Rūrāne, Pēteris Evarts-Bunders, Māris Nitcis

Santrauka

Šio darbo tikslas buvo išanalizuoti kai kurių Brassicaceae rūšių (*Bunias orientalis*, *Sisymbrium volgense*, *Barbarea arcuata*, *Draba nemorosa* ir *Camelina alyssum*) paplitimo tendencijas Latvijoje. Tam tikslui buvo atlikti lauko ir genetinės medžiagos tyrimai. Rūšių paplitimo tendencijos buvo analizuojamos lyginant pasirinktų rūšių paplitimą trijuose laikotarpiuose: 1940 m., nuo 1941 m. iki 1990 m., nuo 1991 m. iki dabar. Nustatyta, kad nuo 1991 m. labai išplito *Bunias orientalis*, *Sisymbrium volgense*, *Barbarea arcuata* ir *Draba nemorosa*, kurios dažniausiai plinta geležinkelio zonose, pakelėse ir kitose ruderalinėse buveinėse. *Camelina alyssum* paplitimas labai sumažėjo arba, galbūt, ši rūšis netgi išnyko iš Latvijos augalijos. Tai susiję su dideliais pokyčiais žemės ūkio kultūrų auginime.