

NATIVE BUGSEED SPECIES *CORISPERMUM INTERMEDIUM* SCHWEIGG AND ALIEN *CORISPERMUM PALLASII* STEVEN IN COASTAL HABITATS OF LATVIA - NEW KNOWLEDGES OF DISTRIBUTION AND INVASIONS

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Corispermum is known as one of taxonomically most problematic genus in Chenopodiaceae and species identification is primarily based on fruit characters and presence or absence of perigonium. Six species were reported for the territory of Baltic countries and Latvia. The endemic species for Eastern Baltic region – *C. intermedium* Schweigg. is considered as typical for annual vegetation on embryonic shifting dunes and other coastal habitats, another species in similar habitats is the neophytic and invasive *C. pallasii* Steven. At the same time, the endemic *C. intermedium* is not officially protected in Latvia in spite of fact, that the population of our only native bugseed species is decreasing and the areal has been narrowing for several years due to natural reasons and as the result of human activities. It is completely clear, that remaining populations of *C. intermedium* in Latvia should be protected before the species becomes extinct as it happened in Poland and Russia.

Key words: *Corispermum*, Latvia, endemic species, invasive species, coastal habitats, chorology.

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INTRODUCTION

The genus *Corispermum* L. contains at least 65 annual psammophytic species spreading mainly in non-tropic climatic zone of Eurasia and North America. *Corispermum* is most abundant in arid regions of Central Asia – here is a diversity centre of this genus (Sukhorukov et al. 2014), some

species occurring in temperate and subarctic zones. Six species were reported for the territory of Baltic countries and Latvia (Страздиньш 1985, Strazdiņš 1993). Nearly all *Corispermum* species known as introduced and naturalized in Latvia and in Baltic region at all, far beyond their native ranges. The only endemic species for East-Baltic region is *C. intermedium* that is related to

the Eurasian steppe flora (Rasiņš 1960, Мозякин 1996, Sukhorukov 2007).

Corispermum is known as one of taxonomically most problematic genus in Chenopodiaceae and species identification is primarily based on fruit characters (Sukhorukov 2007, Mosyakin 1997, 2003) as well as presence or absence of perigonium, morphology of inflorescence, leaf width, stem color a.o, immature specimens are difficult to identify with certainty. Genus *Corispermum* is most believable relatively phylogenetically young (Страздиньш 1985), it indicates such features as morphological plasticity, large variation of morphological features under varying environmental conditions, similar chromosome numbers - all taxa reported are diploid with $2n=18$ (Löve & Löve 1961, Sukhorukov 2007).

The endemic species for Eastern Baltic region – *C. intermedium* is considered as typical for annual vegetation on embryonic shifting dunes and other coastal habitats (Страздиньш 1985, Mosyakin 1997, Мозякин 2006). Another species in similar habitats is the neophytic and invasive *Corispermum pallasii* (syn. *C. leptopterum* Iljin). In Europe it was most probably escape from culture in the early 19th century in Southwestern Germany (Aellen 1961), being first reported in Belgium in 1917 (Verloove 2006) it started to get naturalized in 1924. Then it spread widely as ruderal weed along railways, in urban areas, especially in sandy soils and in wasty places around all Eastern and Central Europe (Jalas & Suominen 1980; Aellen 1993). As a result of habitat loss and other anthropogenic influence, *C. intermedium* decreased their native areal, and in some sites got replaced by invasive *C. pallasii* in dunes of Baltic coast of Poland, Russia and Lithuania (Dolnik et al. 2011). The species replacement of the Baltic endemic species *C. intermedium* by the neophytic *C. pallasii* in Poland, Russia Kaliningrad region and Lithuania is one of the main problems, why it was necessary to analyze the situation in Latvia and why such study was carried out.

The aim of this study is to improve the knowledge on distribution, especially, distribution of two most widespread *Corispermum* species in Latvia – native *C. intermedium* and alien *C. pallasii* in coastal dunes. The description and analysis of morphological features essential in identification and original distribution maps based on personal observations and analysed herbaria materials for the analysed species in Latvia, are presented.

MATERIAL AND METHODS

Comprehensive revision of the most known coastal localities of *Corispermum* species as well as revision of all major herbaria in Latvia - the Laboratory of Botany, Institute of Biology, University of Latvia (LATV), the Herbarium of the Museum of Botany, University of Latvia (RIG), the Laboratory of Botany, Daugavpils University (DAU) - are carried out during this study.

Species distribution maps have been made in order to enable the analysis of the age of the localities, the dynamics of species distribution across the country. Therefore the species occurrence is shown in three stages:

1. The researches at the turn of the 19th - 20th centuries till 1940.
2. The period from 1941 till 1990 (World War II and the years of Soviet occupation when Latvia experienced significant changes in land processing methods and transport flow, mainly the flow of railway transport from the East).
3. 1991 - till nowadays, when land processing methods and directions of transport flow have again significantly changed.

We consider that in the researches on species distribution, especially the ones devoted to one-year plants, we can regard the localities as topical if they have been surveyed and the plant in it has been identified within the last 20-25 years, therefore the actual distribution of the species can be discussed only according to the locality maps made after 1990.

The flora of annual vegetation on seashore, embryonal dunes with active migrating sand and disturbed grey dunes and wooded dunes was studied during seasons of 2015 and 2016 along the seashore in Latvia from Nida (Near Lithuanian border) to Ainaži and Ikla (in Estonia). We have chosen 60 locations with 1 km long transects, along which the counting and identification of *Corispermum* species have been carried out according to free routing (Fig. 1 and Table 1).

RESULTS AND DISCUSSION

C. intermedium Schweigg., 1812. In Königsb. Arch. Naturw. 1: 211 Fleischer et Lindem 1839. Fl. Esth-, Liv- u. Kurl. 95.

An annual plant is 10-50 cm long, all parts are more or less pubescent. The leaves are relatively wide, linear, 3-6 mm long, the margins of leafblades are not entire. The spikes are usually

short and dense. At the time of fruiting the top turns yellow. Perianth segments are absent in nearly all flowers. Fruits (winged nuts) are usually speckled, suborbicular, 3,5-4,5 x 4-5 mm, bigger than seeds of other Baltic *Corispermums*. The wing is membranous, 1/3 – 1/4 as wide as the seed (Fig. 2).

An endemic species for the Eastern Baltic region are distributed from Poland till the Northern borderline of Latvia seashore (Strazdiņš 1993). Specimens, sampled and revised in the last decades in dune areas of the Vistula and Curonian Spit in Russia, belong to *C. pallasii*, and the newest specimen dates back to 1967 (Dolnik et al. 2011). A similar situation is in the Lithuanian part of Curonian spit and other parts of the seashore, where *C. pallasii* is much more frequent than *C. intermedium* (Gudžinskas 2000). It is fully believable, that species can be considered as extinct for this part of areal – the species has not been encountered for the last 30-40 years. The oldest herbarium material from those found

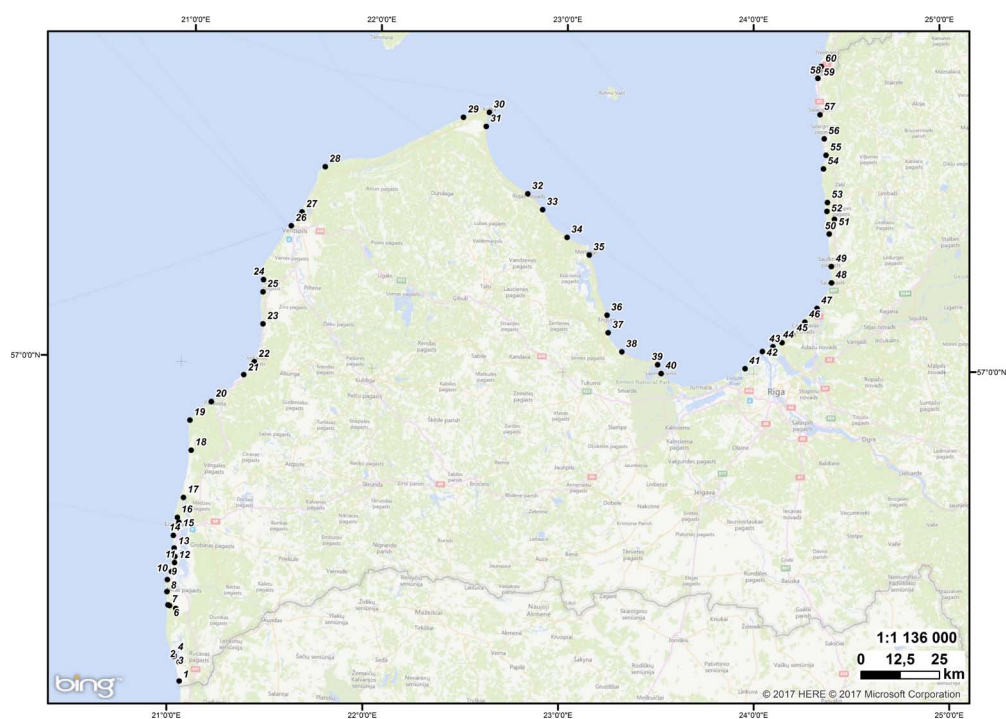


Fig. 1. Locations of transects in coastal habitats in the whole seashore of Latvia (Explanation of transects numbers see Table 1).

in Latvia and Lithuania is the one collected by Kupfer in Palanga in 1989.

In literature the species was first reported for Latvia in Fleischer and Lindemann's flora of Estonia, Vidzeme and Kurzeme (1839), where it was identified in Liepāja, in the seashore, whereas the oldest herbarium collected in Latvia has been kept since 1873 (without the collector's name) from Asari (Jūrmala); at the end of the 19th century it was collected in various places in Rīga and nearby as well as to the south of Liepāja (Fig.1).

The situation with *C. intermedium* in Latvia looks more hopeful than in south Baltic – the species has remained in Kurzeme in the form of some localities in the area from Jūrmalciems to Liepāja and the localities have been known since the end of the 19th century, though the population from Vecāķi to Ainaži can be considered to be rich and stable and still not endangered (especially the population of Ainaži and Salacgrīva). However, as can be seen in table 1, the species is disappearing or has already disappeared in the places with intense anthropogenic load and it has been replaced in such places by the ecologically

aggressive, obviously invasive *C. pallasii*. This is the case in Rīga (Bolderāja, Daugavgrīva, Mangaļi) and Jūrmala, Pape, Saulkrasti, etc., although in other places, in damaged biotopes in dunes (roadsides, footpaths, etc.) both species have been identified (e.g. Liepāja, Saulkrasti, Salacgrīva).

It is interesting to note that there are localities of *C. intermedium* in Estonia in dune biotopes in Ikla and Metsapoole. The species has been identified in the area for the first time (Kukk & Kull 2005); moreover, the localities of the species though being less rich than that found near Ainaži can be probably spread further into the area of Estonia - Kabli, Häädemeeste, etc., where there are suitable biotopes of embryonal dunes.

It is completely clear, that remaining populations of *C. intermedium* in Latvia should be protected before the species becomes extinct as it happened in Poland and Russia. The further evaluation and elaboration of the protection plan for the Baltic (nearly only in Latvia) endemic species *Corispermum intermedium* is to be done within the nearest years. In the same way, new-discovered populations should be evaluated and



Fig. 2. Achenes of *Corispermum intermedium* (left) and *C. pallasii* (right). Image: I. Svilāne.

other potential localities of this species in Estonia and, possible, in Lithuania should be mapped.

C. pallasii Steven 1817. Mém. Soc. Imp. Nat. Moscou 5:336

C. leptopterum (Aschers.) Iljin 1929. In Bull. Jard. Bot. URSS 28(5/6): 653; Rasiņš, 1960. In: Latv. veģ. 3:121.

C. sibiricum auct., non Iljin: Rasiņš 1954. Latv. nez. augļi 138.

An annual plant, 10-30 (50) cm long, usually richly branched, branches are of variable length, ascending. All parts are shortly pubescent or naked. The leaves are linear, 1,5-3,5 mm long, the margins of leafblade are entire. The spikes are usually short and dense. At the time of fruiting the stem and the biggest leaves turn red. Perianth segments are present for most flowers. Fruits (winged nuts) are usually speckled, suborbicular, 2,4-2,8 x 3,2-3,8 mm long, smaller than the seeds of endemic *C. intermedium*. The wing is membranous, 1/4 – 1/6 as wide as the seed (Fig. 2).

The species is not homogeneous, it is subdivided into two sub-species taxa –varieties:

var. *membranaceum* (Iljin) Tzvel. The seeds with tight, non-transparent wing. The wing is approx. 1/4 as wide as the seed. The leaves are approx. 2 mm wide. At the time of fruiting the leaves and the stem turn red. Often in the whole Latvia. There are specimens related to this variety found in the dunes.

var. *pallasii*. The seeds with thin, transparent wing. The wing is approx. 1/6 as wide as the seed. The leaves are wider than in the first variety – 2,5-3(4) mm wide. The plants are dark green, at the time of fruiting do not turn red. It is a far more rare variety, mostly found along the railways.

In literature the species was first mentioned for Latvia by Rasiņš (1960), whereas the oldest herbarium collected in Latvia has been kept since 1932, it was collected along the railways in Riga by Mühlenbach. All previously collected specimens belong to other alien *Corispermums* – *C. declinatum* Stephan ex Iljin, *C. hyssopifolium*

L. or native *C. intermedium*. For instance, specimen from the railway near Riga, collected by Kupfer and determined as *C. hyssopifolium* (Kupfer 1927) after our revision still belongs to *C. hyssopifolium* contrary to the opinion of C. Dolnik (Dolnik & al. 2011), that the specimens correspond to *C. pallasii*. Nevertheless, the species virtually appeared among Latvian herbarium specimens only after World War II (Fig. 3); besides, the species distribution before 1990 was mainly connected with railways, to the less degree with non-landscaped, newly built areas. After 1990 the number of localities along the railways has significantly decreased, which is mainly due to the specificity of modern railway management methods – intensive processing of railway lines by herbicides. A more disturbing tendency for the distribution of *C. pallasii* in Latvia is that lately the species has more often been encountered in the dune biotopes, especially in places with intense anthropogenic load in cities or their suburbs. Nowadays *C. pallasii* is considered to be the simplest species in Latvia. It is acknowledged to be aggressive invasive species corresponding to the definition of an invasive species, i.e. - it degrades natural biotopes, threatens allied wild species and in the result of genetic erosion pushes out all other species of bugseeds, including *C. intermedium* considered to be endemic species in the Eastern Baltic region, from their usual biotopes. Approximately 95% of DAU herbarium for the last 10 years is comprised of specimens of this species.

Both species in European scientific literature are often groundlessly viewed together according to Flora Europaea (Aellen 1993). Based on this historical taxonomical confusion, in publications from the second half of 20th century that cover southern Baltic coastal dune vegetation and that do not differentiate between *C. intermedium* and *C. pallasii*, it is difficult to correctly assess the species (Dolnik et al. 2011).

In Latvian scientific literature, though, both similar species have been clearly distinguished already since the 1960s (Rasiņš 1960, Страздиньш 1985). While analysing herbarium specimens it can be clearly seen that both species have been

acknowledged and distinguished, therefore we can speak about distribution peculiarities in Latvia with some degree of certainty not only after the revision of the herbaria but also after having analysed literature sources. Both species are sufficiently distinct (perianth, seed anatomy and morphology etc.) (Sukhorukov 2007) and divided now into two different subsections – subsect. *crassifolia* Mosyakin (*C. intermedium*) and subsect. *pallasiana* Mosyakin (*C. pallasii*) (Mosyakin 1997).

Worldwide, the distribution of coastal dune habitats is decreased significantly because of the influence of both – natural and mostly anthropogenic factors. Latvia is one of the rare European countries where coastal dune habitats can still be found and evaluated as relatively non-disturbed (Auniņš (red.) 2013). According to the latest information, the total registered coastal and inland dune habitat area is 65478 ha or 1,01% of the total area of the land territory of Latvia (Conservation status of... 2013). Dune habitats have formed in very

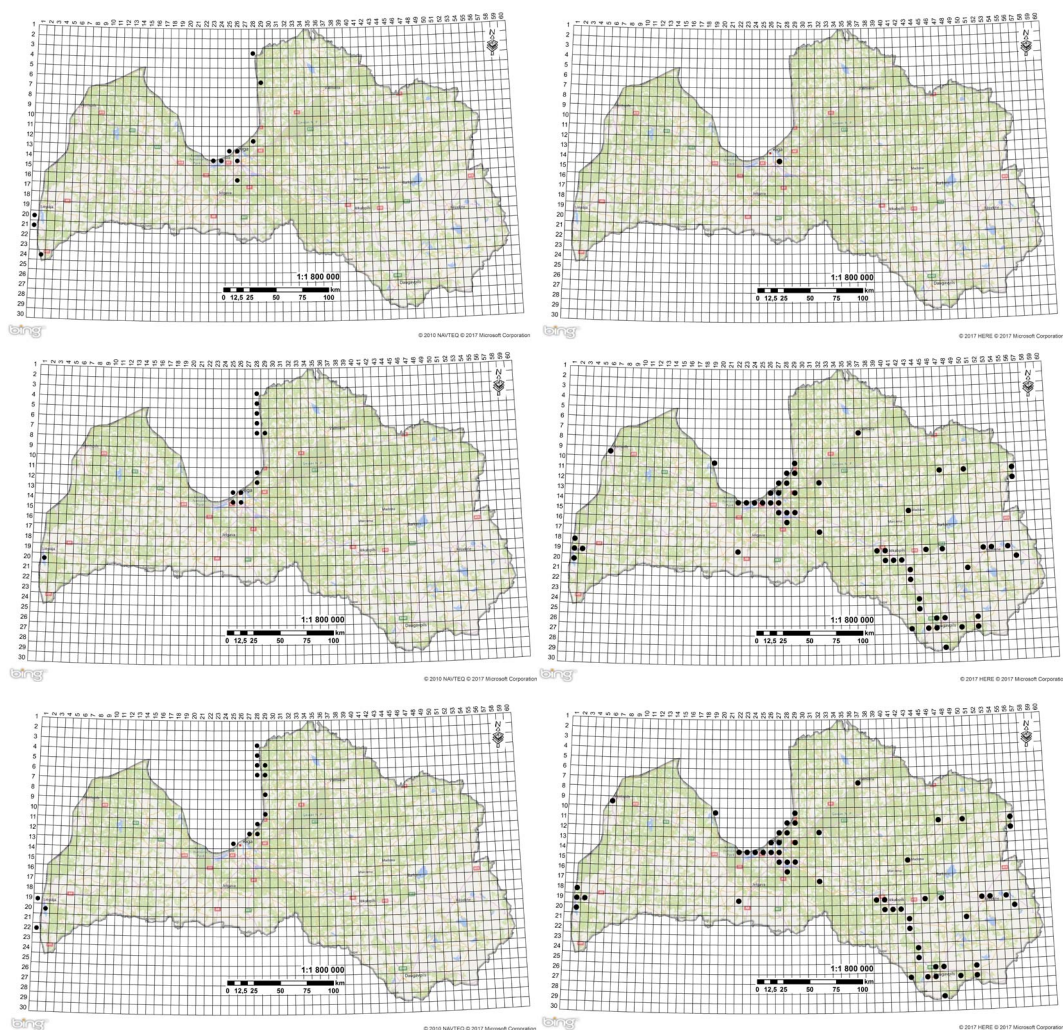


Fig. 3. Distribution of *Corispermum intermedium* Schweigg (left) and *C. pallasii* Steven (right) in Latvia (1st row – localities known till 1940; 2nd row – localities known 1940 – 1990; 3rd row - localities known or verified since 1990).

difficult and extreme conditions. Coastal dune habitats are simultaneously ecologically durable and extremely sensitive to various impacts. *Corispermum* species form sparse vegetation mostly in two coastal dune habitats – 2110 *Embryonic shifting dunes* and 2120 *Shifting dunes along the shoreline with *Ammophila arenaria** (white dunes). In both cases native *C. intermedium* can be recognized as characteristic species and can be used as an indicator of anthropogenically low-influenced dune habitats. Otherwise, *C. pallasii* shows presence of highly anthropogenically-influenced sandy biotopes (Table 1.)

Corispermum intermedium is one of the last endemic species in Latvian flora; as can be seen in Table 1, the species is disappearing or has already disappeared in places with intense anthropogenic load and in such places it has been replaced by an ecologically aggressive, considered to be invasive *C. pallasii*.

At the same time, the endemic *C. intermedium* is not included in the regulations of the Cabinet of Ministers “Lists of Specially Protected and Limitedly Exploitable Specially Protected

Species” (nr. 396), thus the species is not officially protected. The only reference to the species distribution is found in the Red Data Book of Latvia (2000).

The species is included in the 3rd category - species, the population of which is decreasing and the areal has been narrowing for several years due to natural reasons, the result of human activities, or the impact of both factors mentioned.

According to the data of the Nature data management system “Ozols” of the Nature Conservation Agency, the species in Latvia has 49 localities, with the biggest part being inspected before 1990; after 1991 - six localities around Ziemupe, the latest locality found in 2013 in the dunes near Jaunķemeri road. The biggest part of the localities has aged and have most probably been defined not precisely. Having inspected the plans of nature protection for 11 most protected areas near the Baltic Sea, it was concluded that only in some areas the species has been mapped and registered in the list of protected species (Nature Reserves “Randu pļavas” and “Vidzemes akmeņainā jūrmala”) (Soms 2004; Ruskule 2005). For example, in the Nature Park “Piejūra” during



Fig. 4. Annual pioneer vegetation with *Corispermum pallasii* on dune habitats in Mērsrags, Latvia (Photo: P. Evarts-Bunders).

Table 1. Distribution of *Corispermum intermedium* and *C. pallasii* in coastal habitat transects

Nr.	Site (data)	<i>C. intermedium</i>	<i>C. pallasii</i>
1	Nida (03.10.2016.)	-	-
2	Pape, Koņu ciems (03.10.2016.)	-	-
3	Pape (03.10.2016.)	-	-
4	Pape, Center of ornithological researches (03.10.2016.)	-	-
5	Pape, Paipas (03.10.2016.)	-	-
6	Jūrmalciems (03.10.2016.)	-	-
7	Jūrmalciems, Balči (03.10.2016.)	X	X
8	Nature park Bernāti, Pūķi (04.10.2016.)	-	X
9	Nature park Bernāti, Bernāti (04.10.2016.)	-	X
10	Skatre (04.10.2016.)	-	X
11	Pērkone (04.10.2016.)	-	-
12	Cenkone (04.10.2016.)	X	-
13	Grīnvalti (04.10.2016.)	-	X
14	Liepāja, Southwestern district (04.10.2016.)	-	-
15	Liepāja old city, Piejūras park (04.10.2016.)	X	X
16	Liepāja, Karaosta (04.10.2015.)	-	-
17	Liepāja, Šķēde (04.10.2015.)	-	-
18	Ziemeupe (04.10.2015.)	-	-
19	Akmeņrags (04.10.2015.)	-	-
20	Pāvilosta (04.10.2015.)	-	-
21	Labrags (04.10.2015.)	-	-
22	Jūrkalne (04.10.2015.)	-	-
23	Sārnate (04.10.2015.)	-	-
25	Užava, lighthouse (04.10.2015.)	-	-
24	Užava, mouth of Užava river (04.10.2015.)	-	X
26	Ventspils, Ostgals (05.10.2015.)	-	X
27	Staldzene (05.10.2015.)	-	-
28	Ovīši (05.10.2015.)	-	-
29	Vaide (26.07.2016.)	-	X
30	Kolka (26.07.2016.)	-	X
31	Uši (26.07.2016.)	-	X
32	Roja (03.10.2015.)	-	X
33	Kaltene (03.10.2015.)	-	-
34	Upesgrīva (03.10.2015.)	-	-
35	Mērsrags (03.10.2015.)	-	X
36	Engure (03.10.2015.)	-	X
37	Ķesterciems (03.10.2015.)	-	-
38	Apšuciems (03.10.2015.)	-	-
39	Ragciems (03.10.2015.)	-	-
40	Lapmežciems (03.10.2015.)	-	-
41	Rīga, Daugavgrīva (24.09.2016.)	-	X
42	Rīga, Mangaļsala (24.09.2016.)	-	X
43	Vecāķi (09.10.2016.)	-	-
44	Nature park Piejūra, Kalngale (09.10.2016.)	X	-
45	Nature park Piejūra, Mežciems (09.10.2016.)	X	-
46	Carnikava, mouth of Gauja river (09.10.2016.)	X	-
47	Lilaste (09.10.2016.)	X	-
48	Saulkrasti, Pēterupe (09.10.2016.)	-	X
49	Zvejniekciems (24.09. and 09.10.2016.)	X	-

Nr.	Site (data)	<i>C. intermedium</i>	<i>C. pallasii</i>
50	Dunte, Korbiņas (10.10.2016.)	X	-
51	Duntes school (10.10.2016.)	-	-
52	Lebuži (10.10.2016.)	-	-
53	Tūja (10.10.2016.)	X	-
54	Veczemji (10.10.2016.)	-	-
55	Muižuļurga (10.10.2016.)	X	-
56	Lāņi manor (10.10.2016.)	X	-
57	Salacgrīva, South part (10.10.2016.)	X	X
58	Ainaži, Bērziņi (10.10.2016.)	X	-
59	Ainaži, North part (10.10.2016.)	X	-
60	Ikla, Estonia (10.10.2016.)	X	-

our research seven transects were walked through and in four of them the species was identified (Kalngale, Mežciems, Carnikava, Lilaste), in the previous plan of the park protection the species was not mentioned (Laime 2004). Since it has been stated in our research that the number of species localities has decreased (15 localities), it is especially essential to protect the species in already formed nature protection areas where it has been identified.

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