

# The distribution of *Bombus (Megabombus) consobrinus* Dahlbom, 1832 (Hymenoptera: Apidae) in Northern European Russia

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The focus of this study is to summarise the data on the distribution of *Bombus (Megabombus) consobrinus* Dahlbom, 1832 in Northern European Russia. The range of *B. consobrinus* in this region mostly repeats the disjunctions of the range of wolf's-bane (*Aconitum septentrionale* Koelle) that is also known in Scandinavia. In other regions of Northern Eurasia, the close relationship of *B. consobrinus* with *Aconitum* is not obvious. This bumblebee species may be regarded as oligolectic in Northern Europe and Northern European Russia. In the studied region, *B. consobrinus* prefers the taiga habitats, where its main food plant, *A. septentrionale*, is concentrated.

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## INTRODUCTION

*Bombus (Megabombus) consobrinus* Dahlbom, 1832 is one of the most interesting species of bumblebees in Northern Europe. It is well known that in Fennoscandia this species is oligolectic and closely related with its main food plant wolf's-bane (*Aconitum septentrionale* Koelle). A large number of papers have shown that the range of *B. consobrinus* almost completely repeats the disjunctions of the *A. septentrionale* range in Fennoscandia (Løken 1961, 1973; Pekkarinen *et al.* 1981; Pekkarinen 1988; Pekkarinen & Teräs 1993; Söderman & Leinonen 2003; Parkkinen *et al.* 2018). Due to this reason, *B. consobrinus* is vulnerable to anthropogenic changes of habitats. It is included in the Red List of Species of Finland (Paukkunen *et al.* 2019) and Arkhangelsk Oblast (Potapov & Kolosova 2020).

The flight season of *B. consobrinus* in Scandinavia is from the end of May to the end of August (Løken 1973). This species of bumblebee rarely visits other species of plant during the flowering of *A. septentrionale* (approximately from mid-June to mid-August), but before and after this period its range of visited plants is quite broad (Mjelde 1981, 1983; Pekkarinen 1998). It is especially true for males of *B. consobrinus* which visit other plants after the blooming period of *A. septentrionale* (Løken 1961). Owing to its specialisation, *B. consobrinus* is a more efficient pollen collector of *A. septentrionale* than generalist bumblebee species (Laverty & Plowright 1988; Thøstesen & Olesen 1996; Pekkarinen 1998).

However, in other regions of Eurasia, the close relationship of *B. consobrinus* with *Aconitum* is not obvious (Bolotov & Kolosova 2006; Konusova 2010). In Siberia and the Far East, this species was observed

on the other food plants or recorded in habitats where were no species of *Aconitum* (Sam-Eun *et al.* 2002; Konusova 2010; Lelej *et al.* 2012; Potapov *et al.* 2014a; Kolosova *et al.* 2019).

In this paper, we analyse the distribution of *B. consobrinus* in Northern European Russia. This region directly borders with Scandinavia, which allows us to trace how the patterns of distribution of *B. consobrinus* in the Scandinavian countries and Finland correspond to the studied region.

## MATERIALS AND METHODS

Specimens of bumblebees were studied in the collections of the Russian Museum of the Biodiversity Hotspots (RMBH), N. Laverov Federal Center for Integrated Arctic Research of the Ural Branch of the Russian Academy of Sciences, Arkhangelsk, Russia. This material covers the territory of Arkhangelsk Oblast and Nenets Autonomous Okrug (Appendix 1). Overall, 270 specimens of *B. consobrinus* were studied, bumblebees were identified according to Løken (1973) and Panfilov (1978) and the plant species are given according to Skvortsov (2000) and the Plant List (2013).

We also use in our research the published records of *B. consobrinus* from Murmansk Oblast, Nenets Autonomous Okrug, Karelia and the Komi Republic (all are located in Northern European Russia). These materials have been studied and summarised by Pekkarinen *et al.* (1981), Söderman & Leinonen (2003), Filippov (2014) and Paukkunen & Kozlov (2015, 2020). Coordinates of localities are given in Table 1. With

Table 1. Coordinates of localities of Northern European Russia and surrounding areas, near to which specimens of *Bombus consobrinus* were collected (studied by the authors and published data).

No.	Localities (type)	Latitude (N)	Longitude (E)	Origin of records
1	Ponoy (village)	67.008	41.262	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003), Paukkunen & Kozlov (2015)
2	Kuzomen (village)	66.286	36.857	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003), Paukkunen & Kozlov (2015)
3	Tohmajärvi (Finland) (village)	62.226	30.350	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003)
4	Sortavala (town)	61.722	30.693	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003)
5	Impilahti (village)	61.672	31.161	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003)
6	Yalguba (village)	61.885	34.556	Pekkarinen <i>et al.</i> (1981), Söderman & Leinonen (2003)
7	Nes (village)	66.600	44.678	This study, Filippov (2014), Paukkunen & Kozlov (2020)
8	Pinega Nature Reserve, Sotka River	64.665	43.140	This study
	Pinega Nature Reserve, Sychyovo Lake	64.562	43.166	This study
	Pinega Nature Reserve, Golubino (tourist camp)	64.560	43.270	This study
9	Svetlaya River	65.084	41.102	This study
10	Northern Dvina delta, Lyavlya (river)	64.386	41.049	This study
	Northern Dvina delta, Izhma (river)	64.735	40.785	This study
	Northern Dvina delta, Talagi (village)	64.622	40.648	This study
	Northern Dvina delta, Babonegovo (village)	64.422	41.001	This study
	Northern Dvina delta, Rikasikha (village)	64.545	40.177	This study
11	Kholmogory (village)	64.247	41.594	This study
	Lukovetskiy (village)	64.314	42.005	This study
12	Bolshoy Bor (village)	63.608	39.103	This study
13	Kenozero Lake, Zekhnova (village)	61.982	38.250	This study
14	Lekshmozero Lake, Morshchikhinskaya (village)	61.776	38.037	This study
	Levuzero Lake	61.829	37.955	This study
	Perikheria Lake	61.833	38.001	This study
15	Svyatoye Lake, Klimovskaya (village)	60.865	39.502	This study
	Svyatoye Lake, Duplikha (village)	60.878	39.523	This study
	Gora (village)	61.025	39.335	This study
	15 km from Konosha	60.934	39.981	This study
16	Ilyinsko-Podonskoe (village)	61.143	47.969	This study
17	Fominskiy (village)	61.263	48.688	This study
18	Naryan-Mar (town)	67.615	53.057	This study, Filippov (2014), Paukkunen & Kozlov (2015)
19	Nizhne-Maerskoe Lake	66.377	53.402	Filippov (2014)
20	Tobysk River	65.755	51.141	Filippov (2014)
21	Volochanskoe Lake	65.913	53.838	Filippov (2014)
22	Shchelyayur (village)	65.313	53.390	Filippov (2014)
23	Usinsk (town)	65.992	57.441	Filippov (2014)
24	Inta (town)	66.052	60.124	Filippov (2014)
25	Lemvinskiy Natural Landmark	65.683	61.148	Filippov (2014)
26	Pizhemskiy Protected Area	64.887	51.340	Filippov (2014)
27	Latyuga (village)	64.290	48.805	Filippov (2014)
28	Usogorsk (village)	63.402	48.819	Filippov (2014)
29	Belaya Kedva Protected Area	64.281	52.648	Filippov (2014)
30	Vezhavozhskiy Protected Area	63.113	53.859	Filippov (2014)
31	Soyvinskiy Protected Area	62.734	55.771	Filippov (2014)
32	Sykytvykar (town)	61.665	50.707	Filippov (2014)
33	Beloyarskiy Protected Area	61.777	51.830	Filippov (2014)
34	Vizinga (village)	61.046	50.131	Filippov (2014)

Note: No. corresponds to a number of the locality on the map (Figure 1).

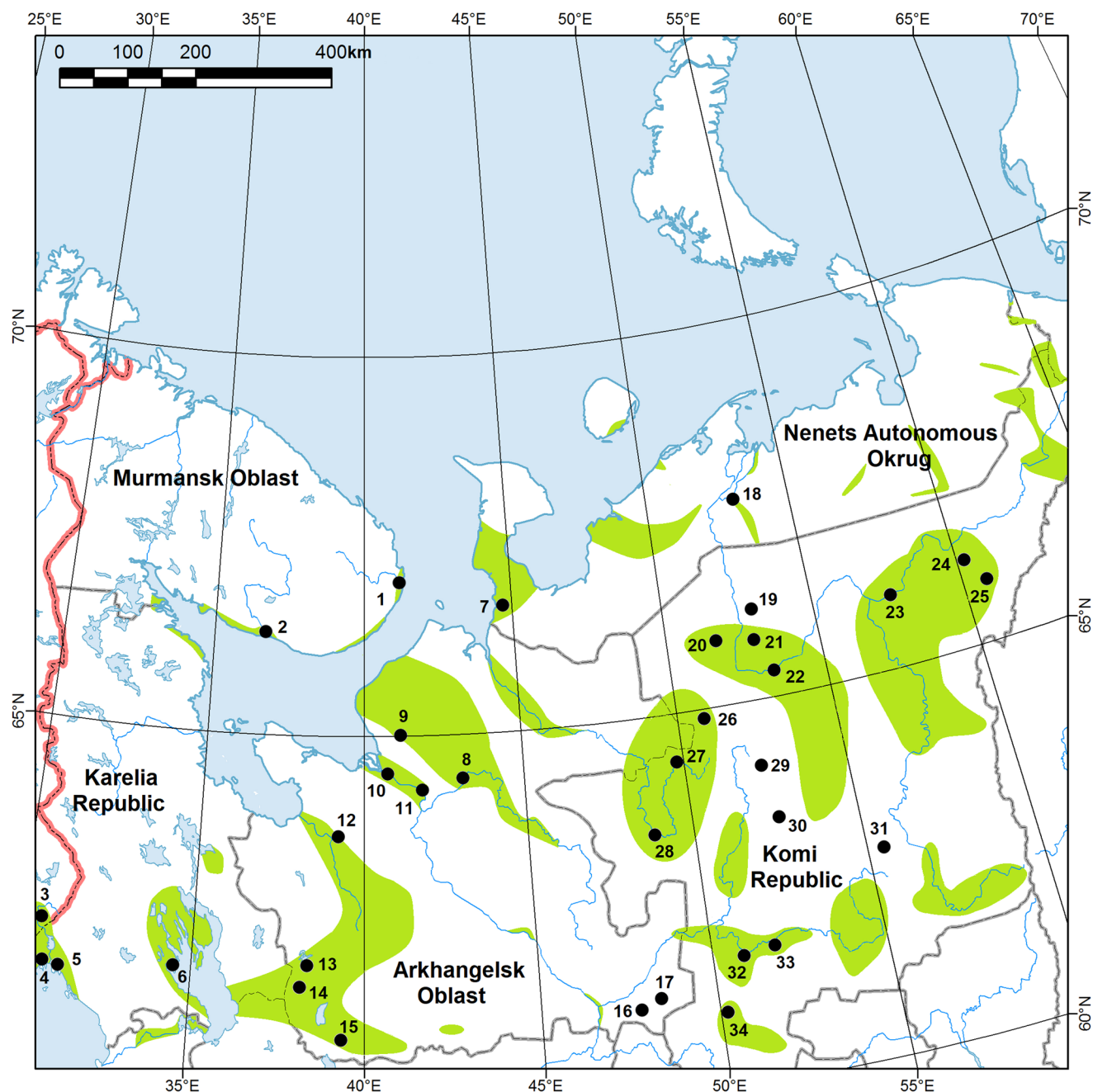


Figure 1. Map of Northern European Russia. Records of *Bombus consobrinus* are shown as black dots (●), including the studied materials and published data. Numbers for the localities are given in Table 1. The red line is the state border; the grey lines are the administrative borders between regions of the Russian Federation. The range of *Aconitum septentrionale* is presented as green areas on the map.

regards to several localities from the Komi Republic in the northeast of European Russia (Filippov 2014), it is impossible to determine the coordinates in a sufficiently accurate manner (for example, Knyazhepogostskiy District with a radius error of ca. 100–150 km). These records are not included in Table 1.

All localities are also presented on the map of Northern European Russia (Figure 1). This map was produced by using ArcGIS 10.0 software. The range of *A. septentrionale* on this map is given in accordance with the data of Perfilyev (1936), Fries (1949), Tolmachev *et al.* (1976), Ramenskaya (1983), Shmidt (2005), Kravchenko (2007) and Sergienko (2013).

## RESULTS

Foraging individuals of *B. consobrinus* were recorded in different types of habitats in Northern European Russia. The most common of these are meadows and roadsides near coniferous and birch forests (Figure 2). In a number of cases, *B. consobrinus* was observed in garden areas that are located close to forests. This species is not typical for open secondary meadows in the studied region. The flight season of *B. consobrinus* in Northern European Russia is from the beginning of June to the end of August.

Unfortunately, accurate information concerning food plants is not available for all of the studied localities. The reason for this is that there have not been, in all cases, direct observations of bumblebees on the food plants. However, there have been recorded cases, when individuals of *B. consobrinus* were caught not only on



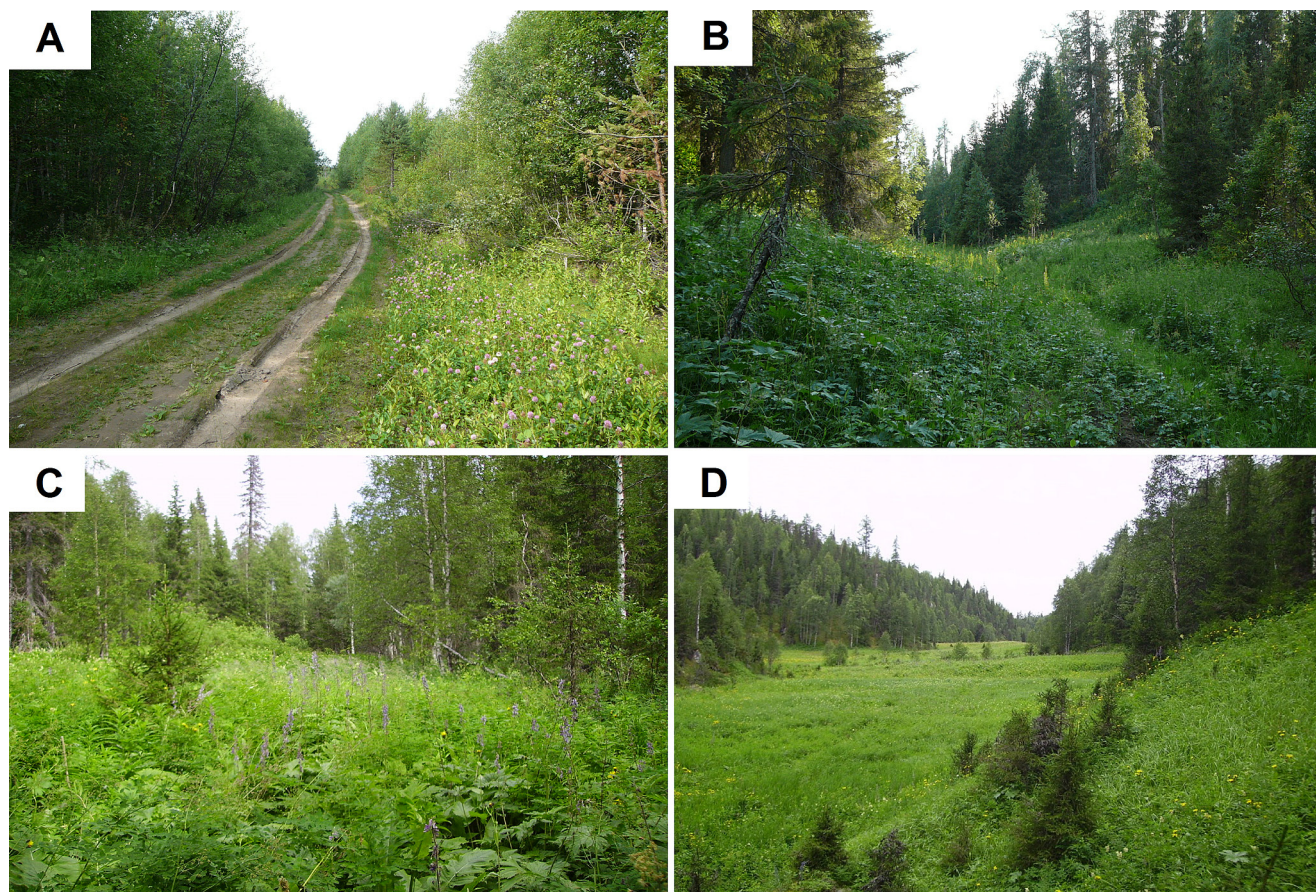


Figure 2. The typical foraging habitats of *Bombus consobrinus* in Northern European Russia: (A) Ruderal patches near roadside in coniferous-birch forest, Lukovetskiy; (B) Meadow near coniferous forest, Svetlaya River; (C) Coniferous forest, the Pinega Nature Reserve; (D) Meadow near coniferous forest, the Pinega Nature Reserve. Photos: Yulia Kolosova and Grigory Potapov.



Figure 3. *Aconitum septentrionale* in the Pinega Nature Reserve. Photos: Yulia Kolosova.

*A. septentrionale*, but on the other plant species, especially at the end of the flight season of this bumblebee species (Appendix 1). The typical plants of *A. septentrionale* during their flowering in Northern European Russia are shown in Figure 3.

Nevertheless, the records of *B. consobrinus* correspond to the range of *A. septentrionale* in Northern European Russia, except for several localities (Figure 1). This fact indicates that, it can be assumed, this bumblebee species definitely prefers the areas with *A. septentrionale*.

## DISCUSSION

*B. consobrinus* is recorded in a number of localities of Arkhangelsk Oblast, up to the southern part of the Kanin Peninsula. No specimens of *B. consobrinus* were found in the central part of Arkhangelsk Oblast. This is also the disjunction of the range of *A. septentrionale*. In the Komi Republic, *B. consobrinus* is more common (Filippov 2014), as with *A. septentrionale* (Figure 1). There are several records of *B. consobrinus* in these two regions, outside the range of *A. septentrionale*. The most likely reason for this is that a number of populations of *A. septentrionale* are still being discovered in Northern European Russia. Compared to Scandinavia, the knowledge regarding



the distribution of *B. consobrinus* and *A. septentrionale* in Northern European Russia, is obviously much worse (Potapov & Kolosova 2016).

In Karelia, *B. consobrinus* occurs only in two areas (Pekkarinen *et al.* 1981; Söderman & Leinonen 2003). This is the south-western part of Karelia, which is close to the border with Finland and the north of Lake Onega. However, in the present time, there are scant data, concerning the bumblebee fauna of Karelia, especially in the eastern part of this region (Potapov *et al.* 2013).

Only two old records of *B. consobrinus* are known from Murmansk Oblast, i.e. more exactly, the southern and eastern parts of the Kola Peninsula (Paukkunen & Kozlov 2015). No specimens of *B. consobrinus* have been found in the other parts of Murmansk Oblast. Recent studies of bumblebees have confirmed this (Potapov *et al.* 2015). For this reason, the closest population of *B. consobrinus* that is known is in Abisko, Northern Sweden (Paukkunen & Kozlov 2015).

Compared to Fennoscandia (except for the Russian part), where bumblebee fauna is studied in detail (Løken 1973; Pekkarinen *et al.* 1981; Söderman & Leinonen 2003), we can see the presence of insufficient data from Northern European Russia. Further studies will likely be capable of clarifying the distribution of *B. consobrinus* in this region.

*B. consobrinus* in the studied region prefers the meadows near coniferous forests, where its main food plant, i.e. *A. septentrionale* (Bolotov & Semushin 2003), is concentrated. This type of habitat with wolf's-bane is mainly represented in the native taiga landscapes, for example, in the Pinega Nature Reserve (Appendix 1). *B. consobrinus* is also recorded in the ruderal patch and meadow habitats near coniferous-birch forests. This species is not typical from open secondary meadows in Northern European Russia.

Unfortunately, for many localities of Northern European Russia there are no accurate data on the range of visited plants of *B. consobrinus*. However, it is clear that this species visits not only *A. septentrionale*, but also other plant species, which is confirmed by our materials, which is also confirmed by data from the Komi Republic (Filippov 2014).

These facts do not contradict that *B. consobrinus* prefers or adapts to foraging for *A. septentrionale*. Even in Scandinavia it has been recorded that this species visits the other food plants (Løken 1950, 1960, 1961; Mjelde 1981, 1983). It is especially true during the periods at the beginning and the end of the flight season of *B. consobrinus* (Løken 1961; Mjelde 1981, 1983; Pekkarinen 1979, 1998). Furthermore, one place in Scandinavia (Abisko in Northern Sweden) is known to have areas with no *A. septentrionale* (Løken 1973).

However, in Siberia and the Far East, the close relationship of *B. consobrinus* with *Aconitum* has not been observed (Sam-Eun *et al.* 2002; Konusova 2010; Lelej *et al.* 2012; Potapov *et al.* 2014a; Kolosova *et al.* 2019). These facts indicate that *B. consobrinus* is polylectic in the regions to the east of the Ural Mountains.

Therefore, *B. consobrinus* may be regarded as oligolectic in Northern Europe (Pekkarinen 1998). In general, it is true also for Northern European Russia. In other regions of Eurasia, its range of visited plant species becomes broader but the exact reason for this is currently unknown.

One possible explanation for the oligolecty of *B. consobrinus* in Fennoscandia and Northern European Russia is that this species is associated in this region with riverside meadows and adjacent forest zone. These types of habitats are the main locations of *A. septentrionale* in this region (Fries 1949; Løken 1973; Bolotov & Semushin 2003). *B. consobrinus* has a complex history in Northern Europe as the postglacial immigrant from Siberia to Northern European Russia

and Fennoscandia (Pekkarinen 1979, 1988; Pekkarinen *et al.* 1981; Pekkarinen & Teräs 1993). Therefore, *B. consobrinus* might have become associated with riverside meadows as the migration ways for this species in the postglacial period in Northern Europe.

Further studies that would focus on summarising the data for the entire territory of Northern Palaearctic may clarify this topic in more detail.

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## Appendix 1. List of the examined material.

In the list of the examined material we give locality; data; number of specimens; habitat, where bumblebees were caught; and plant species (if known), from which bumblebees were collected. This list of materials is mostly documented in Bolotov & Semushin (2003), Bolotov & Kolosova 2006, Kolosova (2010), Kolosova & Potapov (2011), Potapov *et al.* 2014b and Potapov & Kolosova (2016). Here, we add the additional materials, which are indicated by asterisks. Concerning several territories with a large area, such as the Northern Dvina delta, we provide the accurate locality.

## Material examined:

- Nes, 2 July 2002, 16 August 2002, 3♀, 1♂, meadow in floodplain, Bolotov, Filippov leg.
- Naryan-Mar, 8 August 2005, 2♀, Radyukina leg.
- Pinega Nature Reserve, Sotka River, 8 June 2000, 22 August 2000, 27 August 2004, 9 July 2005, 2♀, 15♀, 4♂, coniferous forest, meadow near coniferous forest, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 18 July 2000, 7♀, 12♂, meadow near coniferous forest, *Aconitum septentrionale*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 20-21 August 2000, 52♀, 66♂, meadow near coniferous forest, *Cirsium oleraceum*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 21-22 August 2000, 2♀, 2♂, meadow near coniferous forest, *Cirsium heterophyllum*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 22 August 2000, 1♀, 2♂, meadow near coniferous forest, *Delphinium elatum*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 23 August 2000, 4♀, 3♂, meadow near coniferous forest, *Aconitum septentrionale*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 23 August 2000, 1♀, 2♂, meadow near coniferous forest, *Delphinium elatum*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sotka River, 26 July 2001, 6♀, coniferous forest, *Aconitum septentrionale*, Bolotov, Kolosova leg.;
- Pinega Nature Reserve, Sotka River, 26 August 2004, 1♀, meadow near coniferous forest, *Cirsium oleraceum*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sychyovo Lake, 26 August 2000, 1♂, ruderal patch near roadside in coniferous forest, *Cirsium heterophyllum*, Bolotov, Kolosova leg.;
- Pinega Nature Reserve, Sychyovo Lake, 26 August 2000, 1♀, ruderal patch near roadside in coniferous forest, *Chamaenerion angustifolium*, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Sychyovo Lake, 31 August 2004, 2♀, ruderal patch near roadside in coniferous forest, Bolotov, Kolosova leg.
- Pinega Nature Reserve, Golubino, 16 June 2000, 3♀, meadow in floodplain near coniferous forest, *Lathyrus vernus*, Bolotov leg.
- Svetlaya River\*, 3 July 2013, 1♀, meadow near coniferous forest, Potapov leg.
- Northern Dvina delta, Lyavlya, 17 July 1997, 1♀, meadow in floodplain, Bolotov leg.
- Northern Dvina delta, Izhma, 29 June 1999, 2-30 August 1999, 12-16 June 2000, 15♀, 2♀, 5♂, meadow in floodplain near coniferous forest, *Aconitum septentrionale*, Bolotov and Podbolotskaya leg.
- Northern Dvina delta, Talagi, 5 August 2000, 3.IX.2000, 3♀, garden, *Aconitum napellus*, Bolotov leg.
- Northern Dvina delta, Babonegovo, 4 July 2004, 1♀, ruderal patch near roadside in birch forest, Podbolotskaya leg.
- Northern Dvina delta, Rikasikha, 13 August 2010, 2♂, ruderal patch, *Stachys palustris*, *Lythrum salicaria*, Potapov, Podbolotskaya leg.
- Kholmogory, 26 August 1997, 1♀, ruderal patch near roadside, Bolotov, Podbolotskaya leg.
- Lukovetskiy\*, 17-18 July 2004, 2♀, ruderal patch near roadside in birch forest, Bolotov, Podbolotskaya leg.
- Bolshoy Bor, 14 July 2000, 1♀, meadow in floodplain, Shvakov leg.
- Kenozero Lake, Zekhnova\*, 11 August 2009, 2♀, meadow near coniferous forest, Kolosova, Podbolotskaya leg.
- Lekshmozero Lake, Morshchikhinskaya\*, 11 August 2000, 11♀, garden, *Aconitum napellus*, Bolotov leg.
- Levuzero Lake\*, 12-13 August 2000, 6♀, meadow near coniferous-birch forest, *Carduus crispus*, Bolotov leg.
- Perikheria Lake\*, 14 August 2000, 7♀, meadow near coniferous-birch forest, Bolotov leg.
- Ilynsko-Podomskoe, 19 August 1994, 1♀, ruderal patch near roadside in coniferous forest, Filippov leg.
- Fominskiy\*, 14 August 2013, 1♀, ruderal patch near coniferous forest, Kondakov leg.
- Svyatoye Lake, Klimovskaya, 27 August 2003, 2♀, 1♂, meadow near coniferous-birch forest, Bolotov leg.
- Svyatoye Lake, Klimovskaya, 16 August 2007, 3♀, 1♂, garden, *Aconitum* sp., Kolosova, Podbolotskaya leg.
- Svyatoye Lake, Duplikha, 15 July 2007, 2♀, 1♂, meadow, Kolosova, Podbolotskaya leg.
- Gora, 26 August 2003, 1♂, ruderal patch near roadside in coniferous-birch forest, Bolotov leg.
- 15 km from Konosha, 30 August 2003, 1♀, 1♂, ruderal patch near roadside in coniferous-birch forest, Bolotov leg.