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A new species of *Veronica* (Plantaginaceae) in the extreme north of Europe: a northward migration due to recent climatic changes?

Ilona V. Blinova

Polar-Alpine Botanical Garden-Institute, Kola Research Centre of Russian Academy of Sciences, Kirovsk, Murmansk Region, Russia.
Corresponding author: ilbli@yahoo.com

Abstract

Twelve species of *Veronica* (Plantaginaceae) are recorded from Murmansk Region (Russia). We report the first localities (N 67°35′42″ E 33°24′50″, 67°16′58″ 32°27′56″) of *Veronica beccabunga* for the region. The species distribution range in Europe extends to nearly 65 °N. The first find of *V. beccabunga* in *Lapponia Imandrae* in Russia is briefly described, and ecological data about its habitat are given. A dispersal route of this species from its northern range in Europe to the new isolated locality is suggested. The spread success could be explained by regional climatic changes along with the high degree of seed and vegetative survival of *V. beccabunga*. It is proposed to include this species in the next regional Red Data Book in the group "In need of monitoring".

Keywords: *Veronica*, Plantaginaceae, Murmansk Region, flora, new record

Introduction

Murmansk Region is one of the best studied in Russia botanically. The most important treatments were published in five volumes in 1953–1966 with descriptions of 1162 vascular plant species (Gorodkov 1953–1954, Pojarkova 1956–1966). Since then any additions, especially of native plants, have been made one at a time. The species total has increased mainly through alien species and various taxonomic resolutions, and it has reached 1336 species (Kostina and Filimonova 2009). The most recent, but uncompleted, work on the flora of Murmansk Region was been conducted in 2010: the list of vascular plants of Murmansk Region included 1372 species (Kostina et al. 2010, unpubl.).

Eight species of *Veronica* were included in the Flora of Murmansk Region (Russia): *V. alpina* L., *V. chamaedrys* L., *V. fruticans* Jacq., *V. longifolia* L., *V. officinalis* L, , *V. scutellata* L., *V. serpyllifolia* L., *V. tenella* All. (Kuzeneva 1966). Recently *V. tenella* has been united with *V. serpyllifolia.* Three records of alien *Veronica*s were made relatively recently: *V. gentianoides* Vahl was collected in 2010 by Gryaznova (Kozhin 2013) and in 2011 by Kostina (Borovichev et al. 2013), *V. arvensis* L. was found in 2010 by Kravchenko (Kravchenko 2011), and *V. persica* Poir. is recorded by Kostina (Kostina et al. 2010, unpubl.). One native species *V. anagallis-aquatica* L. was included in the "The list of vascular plants of Murmansk Region" (Kostina et al. 2010, unpubl.). In 2019 during preparation of this work no herbarium sheet - neither *V. gentianoides*, *V. arvensis* and *V. persica* nor *V. anagallis-aquatica* - was found in the public collection of KPABG. However, these herbarium specimens might be found in an unsorted collection made by Kostina. It means that in 2019 the total number of *Veronicas* in Murmansk Region might be 12 including the newly discovered *Veronica beccabunga* L.

V. beccabunga is a herbaceous plant with succulent leaves belonging to the family Plantaginaceae. The shoot formation is monopodial long-shoot with plagiotropic shoots (Savinykh 2003). The species has a Eurasian range (Hultén and Fries 1986) (Figure 1), and it occurs widely in Russia (Borissova 1955, Elenevsky 1978). In the north it is found mainly in the middle taiga at the latitudes of Petrozavodsk and Medvezhyegorsk (Kravchenko 2007). The group of aquatic *Veronicas* is extremely polymorphic in the section *Beccabunga* (Hill) Dumort, and within *V. beccabunga* three subspecies have been distinguished: *V. beccabunga* ssp. *abscondita*, *V. beccabunga* ssp. *beccabunga*, *V. beccabunga* ssp. *muscosa* (Fischer 1985, Ellmouni et al. 2018).

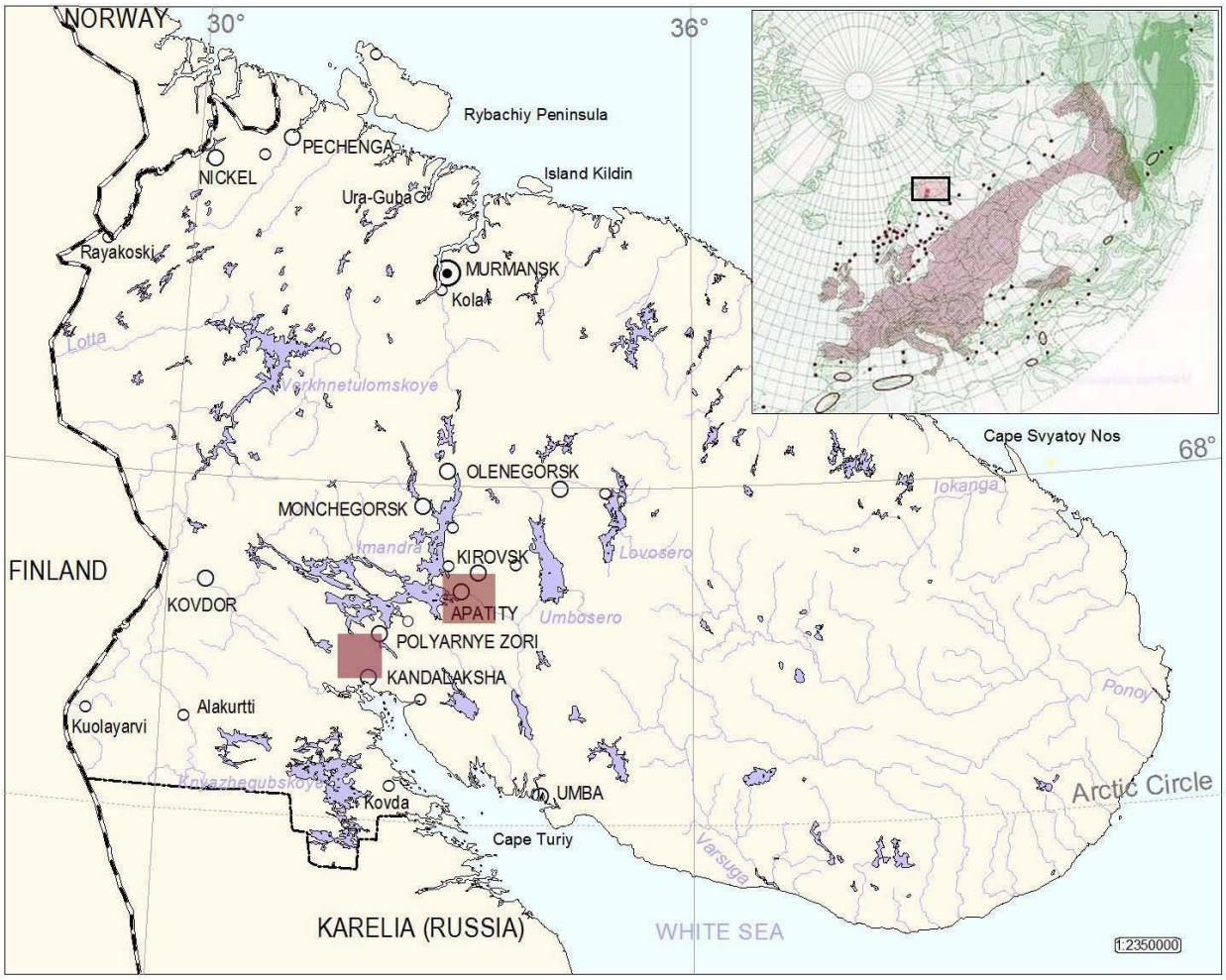

Figure 1. The localities of *V. beccabunga* near the town of Apatity and in the Kandalaksha District (Murmansk Region, Russia). The new sites are indicated by shaded squares. Top right: part of the map in Hultén and Fries (1986) showing the Eurasian range of *V. beccabunga*. Murmansk Region is outlined with a black rectangle in this map.

V. beccabunga is included in the European Red List of species (Bilz and al. 2011) and in the Red Data Book of Eastern Fennoscandia and Finland (Kotiranta and al. 1998, Rassi and al. 2010). However, it was excluded from the Red Data Book of Karelia (Ivanter and Kuznetsov 2007), and is not listed in the Norwegian Red List (Kålås and al. 2010).

V. beccabunga grows in wet habitats. By spreading vegetatively, it can form carpet-like stands. In Karelia, the species occurs on swampy banks, in swamps around springs, and in ditches (Ramenskaja 1983, Kravchenko 2007).

The census of biodiversity is especially important in the regions where many plant species grow at the limits of their ranges because theses natural borders are very influenced by climatic changes. One such area is Murmansk Region (Russia) in the extreme north of Europe. The aim of the current study was to present the first discovery of *V. beccabunga* in the region and to give an overview of its isolated position in the north of its range.

Material and Methods

Study region. Murmansk Region (66–70° N) is situated in the Atlantic-Arctic climatic zone of the temperate belt, and climatically the region is very heterogeneous. Two latitudinal vegetation zones can be distinguished: tundra and taiga. The average annual temperature in Murmansk Region has been –0.32 °C in the reference period 1981–2010 (with extreme years of –3.3 °C and 1.4 °C). Since 2000 there has been a tendency to earlier onset and mainly to later end of the growing season. The actual length of the growing season reached 120 days on average, from 30 May to 27 September (Blinova and Chmielewski 2016).

Field work and lab studies. Vegetative and generative individuals of *V. beccabunga* were photographed in the field. Additional photos were made in order to show the habitat of the population. Some individuals were collected to prepare herbarium specimens. The following characteristics were studied in the lab: leaf shape, presence/absence of petiole, length of peduncle, length of pedicels, and number of flowers per inflorescence. Herbarium collections of *Veronicas* in KPABG and literature data were analysed.

Nomenclature. Species names are given in accordance with The Plant List (2010).

Results and Discussion

In July 2016 the species was found in the center of Murmansk Region (Russia) about 3.3 km north-north-east of Apatity (N 67°35′42″ E 33°24′50″). It was observed by the right bank of the River Belaya in the South Khibiny Mts which flows into Belaya Bay of Lake Imandra (Figure 1). The banks here had a rather heterogeneous vegetation. *Phalaris arundinaceae* stand prevailed on relatively high and dry sites, whereas hydrophytes were frequent in depressions (Figure 2). *V. beccabunga* was found in one such a water-logged area adjacent to the river. It was locally abundant. *Epilobium ciliatum, Myosotis scorpioides* and some grasses occurred sparsely in this habitat. Two voucher specimens were collected by Blinova on 27.07.2016 helped by Kirillova and deposited in the Herbarium of the Polar-Alpine Botanical Garden-Institute (KPABG) (Figure 3).

At the end of July of 2016 individuals of *V. beccabunga* were in late-flowering stage (Figure 4). The greater part of the inflorescences already had unripe fruits. The study material had the typical characters of *V. beccabunga* ssp. *beccabunga* (Ellmouni et al. 2018): leaves obovate or broad elliptic with clear petiole, and not longer than the subtending leaf; pedicels subpatent, up to 10 mm; number of flowers 16–20 (Figure 3 and 4). The identification was confirmed by Ellmouni and Albach (27.05.2019). Regarding the peduncle our study shows that on the apical half of shoot it is indeed less than 30 mm long, whereas on the basal half of the shoot, especially submerged in water, the peduncles are more elongated.

The two northernmost records of *V. beccabunga* in Karelia are located in the biogeographic province *Karelia pomorica occidentalis*: Sosnovets N 64°25′24″ E 34°28′24″ and Zolotets N 64°29′24″ E 34°39′01″ (Kravchenko 2007). Three herbarium records at similar latitudes are known from Finland: two from municipality Hyrynsalmi (N 64°45′23″ E 28°37′14″, N 64°45′23″ E 28°21′43″) and one near the city of Oulu – N 65°1′23″ E 25°24′19″ (Lampinen and Lahti 2018). One herbarium specimen was collected in Norway in the county Røyrvik of the province Nord-Trøndelag – N 64°54′46″ E 13°34′24″ (NTNU

University Museum 2019). All these records are situated near latitudes 64–65°, and none is located north of the Arctic Circle N 66°33′44″. Thus, the Apatity' record of *V. beccabunga* in *Lapponia Imandrae* (N 67°35′42″ E 33°24′50″) in Russia is the northernmost for Europe.

Figure 2. River Belaya at the first site with *V. beccabunga* near Apatity (Murmansk Region, Russia) in larger image, and habitat of this species on its right bank in smaller image. The white line indicates the boundary of the local population. Individuals form a rather dense population in the water-logged area. Blinova, 27 July 2016.

Another interesting record was found during studies of herbarium specimens of *Veronica* in KPABG in 2019. A new specimen of *V. beccabunga* was deposited in KPABG recently. It was collected and identified by Kirillova in July 2018. This site comes from surroundings of the settlement of Nivskij in Kandalasksha district (67°16′58″ 32°27′56″). It was found in a spring flowing into the River Niva about 300 meters north of Lake Plesozero. As indicated on the sheet label the plants were growing on the sandy bottom of this spring at 20 cm depth. This was the second find of *V. beccabunga* in Murmansk Region, and it was situated about 52 km south of the first find.

From present climatic trends it has been proposed that enrichment of the northern taiga by southern species is possible (Blinova and Chmielewski 2016). In recent decades *V. beccabunga* has actively extended its range northwards along the White Sea-Baltic Canal in Karelia (Kravchenko and Kuznetsov 2009), and it is no longer red-listed in Karelia (Ivanter & Kuznetsov 2007). The second find of *V. beccabunga* in Murmansk Region from a spring by the River Niva proves the species distribution channel through the White Sea, and it explains the origin of the first find of this species in the town of Apatity from the River Belaya. The River Niva flows from Lake Imandra into the White Sea, and its chemical composition is determined greatly by the Lake (Cherepanova 2015). The River Belaya flows into Lake Imandra. It means that a dispersal route of *V. beccabunga* from Karelia into Murmansk Region could be –

White Sea-Baltic Canal in Karelia – the Kandalaksha shore of the White Sea in Murmansk Region – River Niva – Lake Imandra – River Belaya.

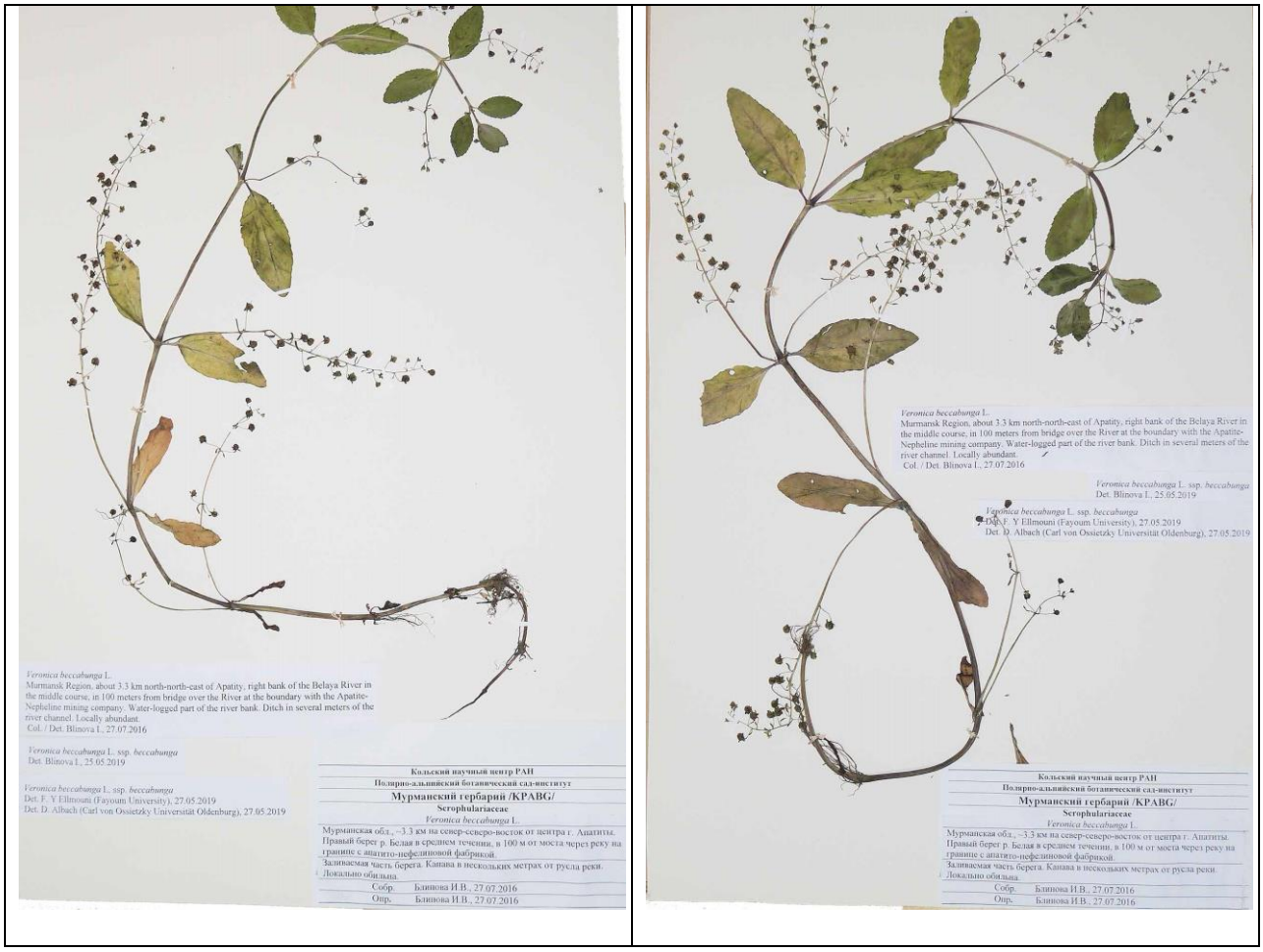

Figure 3. Two herbarium specimens of *V. beccabunga* ssp. *beccabunga* collected by Blinova on 27 July 2016 and deposited at KPABG in 2017.

The empirical studies show that climate changes may favour the establishment of new species by eliminating cold temperatures (Elliot 2006, Rahel and Olden 2008). This was proved in the analysis of macroalgal species inhabiting the Portuguese rocky coast: all shifting warm-water species expanded their range northwards (Lima et al. 2007). The success of a similar effective spread of *V. beccabunga* in the north of Europe is apparently linked with a warmer and an extended growing period in Murmansk Region along with high seed vigor and various means of dispersal of this species. *V. beccabunga* shows one of the highest rates of seed viability and seed germination among other aquatic species (van Leeuwen et al. 2014). Besides, this species is commonly dispersed by plant fragments dislodged during periods of high water flow (Les and Stuckey 1985). Another revealed way of secondary dissemination of *V. beccabunga* could be by piscivorous birds (van Leeuwen et al. 2017).

Of the IUCN-criteria *V. beccabunga* could be considered as "Critically Endangered" for Murmansk Region because of its small population size and the number of occurrences. However, based on the fact that the species is a good colonizer in various parts of its distribution area and it is a new regional find, the category "In need of monitoring" is more appropriate for the next Red Data Book of Murmansk Region. The same category is proposed for another species recently found in Murmansk Region – *Eleocharis mamillata* - with a similar strategy (Blinova and Gregor 2016).

Figure 4. Vegetative shoot and inflorescence of flowering shoot of *V. beccabunga* on the right bank of the River Belaya in the South Khibiny Mts. Blinova, 27 July 2016.

Additional field research is required to study the northernmost populations of this species. Furthermore, a detailed exploration of the hydrological system of Lake Imandra is necessary, in the course of which some new populations of this species may be discovered and the actual status of *V. beccabunga* in the extreme north of Europe re-assessed.

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