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Research Article

Local fauna of bumblebees (Hymenoptera, Apidae) in the lower reaches of the Northern Dvina River

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Abstract

This article is devoted to an investigation of the local fauna of bumblebees in the lower reaches of the Northern Dvina River in northern Russia where 27 species of bumblebees were found during the present study. The basis of the local fauna of bumblebees in the lower reaches of the Northern Dvina River is related to species with a wide range. The majority of the species are Transpalaearctic. Holarctic, Sub-Transpalaearctic, whereas West-Central Palaearctic are less represented. According to the latitudinal aspect the majority of the species are temperate, and the rest are boreal and arcto-temperate. One of species found in the local fauna is subboreal. The number of species in the studied local fauna is the largest among the local faunae of the northern part of the Arkhangelsk Region. It is comparable to the local faunae of the southern part of this region. Here is recorded species such as *Bombus soroeensis*, *B. distinguedus*, *B. ruderarius*, *B. veteranus*, *B. humilis*, and others, which are not typical of native taiga habitats but are the meadow species in the European North of Russia. Due to the wide development of meadows and ruderal communities in the lower reaches of the Northern Dvina River, these species are widely represented here. The rare species in the studied local fauna are *B. patagiatus*, *B. humilis*, *B. consobrinus*, and *B. schrencki*.

Keywords

Bumblebees, local fauna, biodiversity, European North, Arkhangelsk Region

Introduction

The study of the bumblebee fauna in the Arkhangelsk Region (north of European Russia) has a long history. A small amount of data is known from the end of the 19th century to the end of the 20th century (Potapov and Kolosova 2016a). An intensive study of the local faunae of this region began from the beginning of the 21st century. The localities include the Solovetsky Island, the taiga landscapes of the Russian Plain, the Mezen River, and a number of localities situated in the southern and central part of the Arkhangelsk Region (main publications: Bolotov and Kolosova 2006, Kolosova 2010, Kolosova and Podbolotskaya 2010, Kolosova and Potapov 2011, Bolotov et al. 2013, Potapov and Kolosova 2016b, 2017). Available materials are presented in the general summary of a previous study regarding the bumblebee fauna of the Arkhangelsk Region (Potapov and Kolosova 2016a).

Concerning the lower reaches of the Northern Dvina River, there are currently a few publications that are mainly related to bumblebee ecology (Potapov 2010, Kolosova et al. 2011, 2012). However, for a long period of time since the 1990s the large bulk of material on this territory was collected but not analysed.

These local data are important in connection with the forecasts of changes in the range of bumblebee species under conditions of global warming (Rasmont et al. 2015, Potapov et al. 2018). The territories of the European North of Russia are especially interesting, because they are not well studied compared with Europe, and here we can observe the northwards expansion of a number of species which can affect the future scenario (Potapov et al. 2018).

The purpose of this paper is to analyse the local fauna of bumblebees in the lower reaches of the Northern Dvina River.

Materials and methods

Bumblebees were collected in the lower reaches of the Northern Dvina River (Fig. 1) during the period 1994–

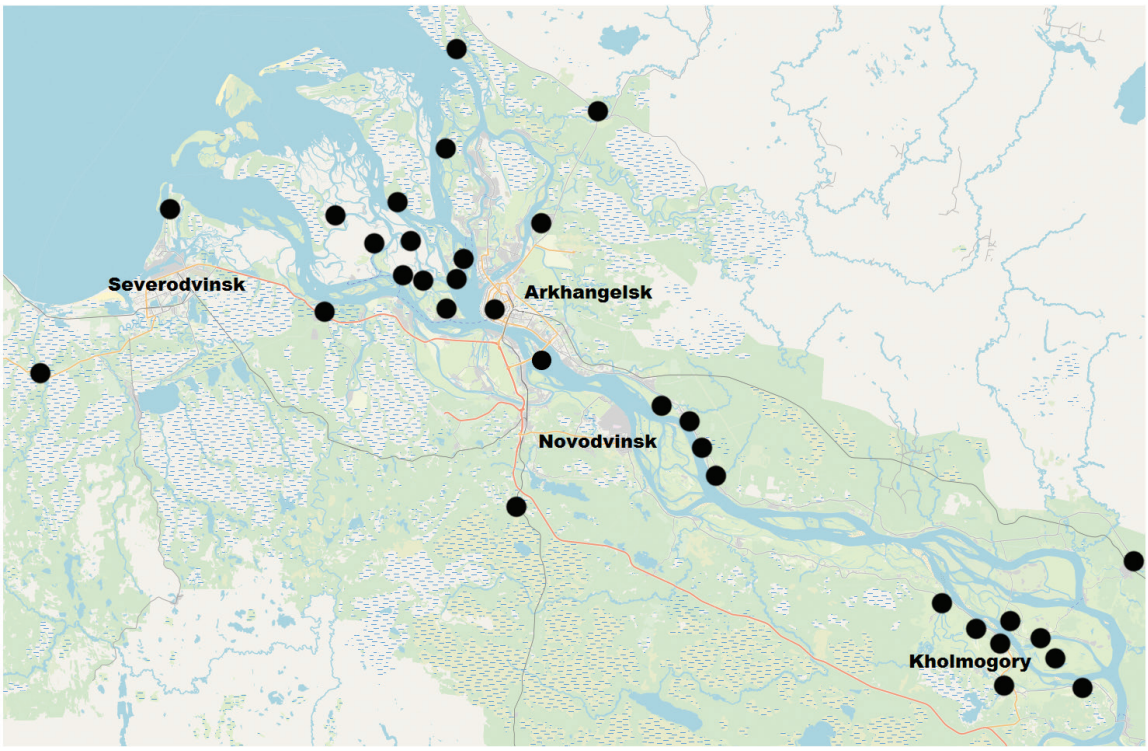

Fig. 1. Map of the lower reaches of the Northern Dvina River. Black circles indicate the main studied localities

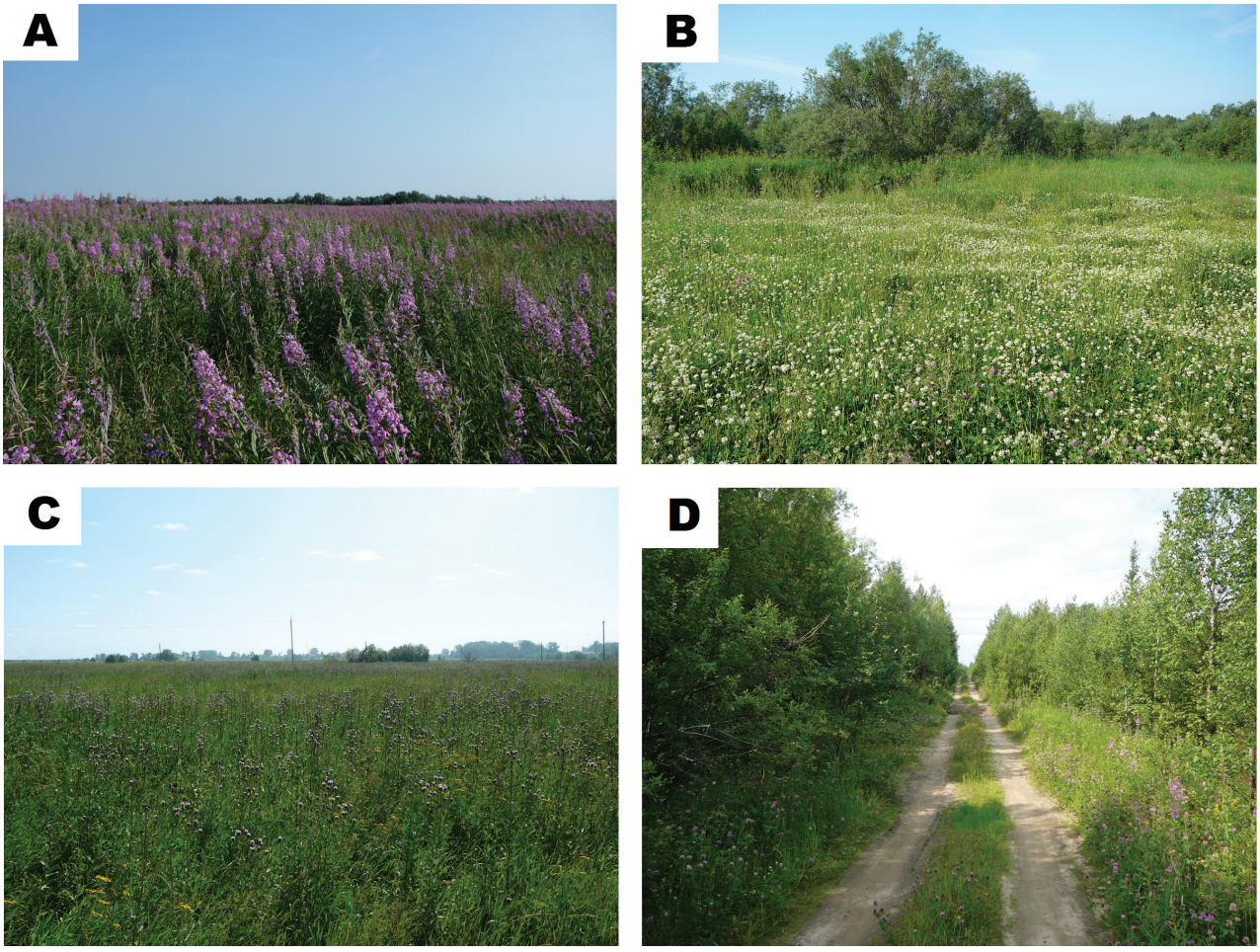

Fig. 2. Typical foraging habitats for bumblebees in the lower reaches of the Northern Dvina River. (A) Ruderal communities with *Epilobium angustifolium*. (B) Meadow with *Trifolium repens*. (C) Meadow with *Cirsium arvense*. (D) Roadsides alongside the forest. Photos: G.S. Potapov

2016 by the researchers M.V. Podbolotskaya, I.N. Bolotov, B.Yu. Filippov, Yu.S. Kolosova and G.S. Potapov.

The studied territory is located in the northern part of the Arkhangelsk Region. Various types of meadow habitats are widely represented here, both on small islands of the delta and on the mainland (Parinova et al. 2014). The meadow habitats have an anthropogenic origin and they are formed on the areas of native taiga. The age of most of these ecosystems is estimated at several centuries, since their appearance is associated with the development of economic management in the lower reaches of the Northern Dvina River (Shvartsman and Bolotov 2008). However, on this territory large areas of native taiga are preserved.

During this study, bumblebees were collected in various types of habitats. The typical sites of concentration of bumblebee individuals in the lower reaches of the Northern Dvina River are meadows and ruderal communities (Fig. 2). In native taiga forests, bumblebees are rarely encountered, but they are quite abundant on roadsides alongside the forest areas.

A total of 6793 individuals of bumblebees were studied. The specimens of bumblebees are deposited in the Russian Museum of the Biodiversity Hotspots (RMBH) of the Federal Center for Integrated Arctic Research (FCIARctic) of the Russian Academy of Sciences (RAS), and in the Northern (Arctic) Federal

University named after M.V. Lomonosov (NArFU), Arkhangelsk, Russia.

The nomenclature of species follows Williams (2018). The species of bumblebees were identified according to Løken (1973, 1984) and Panfilov (1978). Identification of species of the *Bombus lucorum*-complex is according to Rasmont (1984), Rasmont et al. (1986), and Rasmont and Terzo (2010). However, according to Bossert (2015), the identification of these cryptic species solely in accordance with morphological characters and without using the DNA-barcoding is not always reliable, especially for workers and males. We identified most of the specimens of this complex from the lower reaches of the Northern Dvina River as *B.* cf. *cryptarum* (Fabricius, 1775). A small number of specimens are *B.* cf. *lucorum* (Linnaeus, 1761). In the European North, *B. cryptarum* dominates in the bumblebee communities, but *B. lucorum* is also present (Pamilo et al. 1997).

Types of distributions of bumblebees are given according the classification of Gorodkov (1984). We used the materials of Russian and European entomologists (Pekkarinen and Teräs 1993, Byvaltsev 2009, Levchenko and Tomkovich 2014, Rasmont and Iserbyt 2018, and Williams 2018).

The plant species are given according to The Plant List (2013). The source of the map is the Open Street Map.

Table 1. Local fauna of bumblebees in the lower reaches of the Northern Dvina River

№	Species	Type of distribution	
1	*Bombus (Kallobombus) soroeensis* (Fabricius, 1777)	Tp	Te
2	*B. (Subterraneobombus) distinguendus* Morawitz, 1869	Hol	Te
3	*B. (Megabombus) hortorum* (Linnaeus, 1761)	Tp	Te
4	*B. (Mg.) consobrinus* Dahlbom, 1832	STp	Bo
5	*B. (Thoracobombus) muscorum* (Linnaeus, 1758)	Tp	Te
6	*B. (Th.) ruderarius* (Müller, 1776)	Tp	Te
7	*B. (Th.) veteranus* (Fabricius, 1793)	Tp	Te
8	*B. (Th.) humilis* Illeger, 1806	Tp	Sb
9	*B. (Th.) pascuorum* (Scopoli, 1763)	Tp	Te
10	*B. (Th.) schrencki* Morawitz, 1881	STp	Bo
11	*B. (Psithyrus) rupestris* (Fabricius, 1793)	Tp	Te
12	*B. (Ps.) bohemicus* Seidl, 1837	Tp	At
13	*B. (Ps.) barbutellus* (Kirby, 1802)	Tp	Te
14	*B. (Ps.) flavidus* Eversmann, 1852	Hol	Bo
15	*B. (Ps.) norvegicus* (Sparre-Schneider, 1918)	Tp	Te
16	*B. (Ps.) quadricolor* (Lepeletier, 1832)	W-Cp	Te
17	*B. (Ps.) sylvestris* (Lepeletier, 1832)	Tp	Te
18	*B. (Pyrobombus) hypnorum* (Linnaeus, 1758)	Tp	Te
19	*B. (Pr.) pratorum* (Linnaeus, 1761)	W-Cp	At
20	*B. (Pr.) jonellus* (Kirby, 1802)	Hol	At
21	*B. (Pr.) cingulatus* Wahlberg, 1854	Tp	Bo
22	*B. (Bombus) sporadicus* Nylander, 1848	Tp	Bo
23	*B. (Bo.) lucorum* (Linnaeus, 1761)	Tp	Te
24	*B. (Bo.) patagiatus* Nylander, 1848	STp	Bo
25	*B. (Bo.) cryptarum* (Fabricius, 1775)	Hol	At
26	*B. (Melanobombus) sichelii* Radoszkowski, 1860	Tp	Te
27	*B. (Cullumanobombus) semenoviellus* Skorikov, 1910	STp	Bo

Note: Hol – Holarctic, Tp – Transpalaearctic, W-Cp – West-Central-Palaearctic, STp – Sub-Transpalaearctic, At – arcto-temperate, Bo – boreal, Te – temperate, Sb – subboreal.

Results

According to the results of our study, 27 species of bumblebees were found in the lower reaches of the Northern Dvina River (Table 1). Most of the species in the studied local fauna are Transpalaearctic (17 species), 4 species are each of Holarctic and Sub-Transpalaearctic origin, and two species are West-Central Palaearctic. Concerning the zonal distribution, 15 species are temperate, 7 are boreal and 4 are arcto-temperate. One of the species found in the local fauna is subboreal.

The rarest species in the studied territory is *B. patagiatus* Nylander, 1848. Only one specimen was collected near Severodvinsk (the pine forest on Yagry Island) by Yulia Kolosova on 15th July 2013. This species is rare in the Arkhangelsk Region and is typical for the meadow habitats (Potapov 2015, Potapov and Kolosova 2016a).

B. humilis Illeger, 1806 is limited to the lower reaches of the Northern Dvina River but only in the areas near Kholmogory (the southern part of the studied territory). This species was not found in the delta of the Northern Dvina River. However, *B. humilis* is quite widely distributed on the meadow habitats in the southern and central parts of the Arkhangelsk Region (Potapov 2015, Potapov and Kolosova 2016a).

Also there are quite rare findings in the lower reaches of the Northern Dvina River of *B. consobrinus* Dahlbom, 1832 and *B. schrencki* Morawitz, 1881. These species are recorded here mainly on roadsides alongside the forest areas. *B. consobrinus* and *B. schrencki* are belonging to the forest species and they are common in the region, for example, in the northern taiga karst ecosystems (Bolotov and Kolosova 2006).

Discussion

Local fauna of bumblebees in the lower reaches of the Northern Dvina River include 27 species that are close to the number of bumblebees species in the regional fauna (34 species) (Potapov and Kolosova 2016a). As well as throughout the Arkhangelsk Region, in the local fauna of the lower reaches of the Northern Dvina River there are presented species that are widely distributed in the Palaearctic. The reason for this is that the recent distribution of bumblebee species in the study region is a result of post-glacial immigration (Potapov and Kolosova 2016a).

Some of the species in the regional fauna are not represented in the lower reaches of the Northern Dvina River. The first group is *B. lapponicus* (Fabricius, 1793), which is the tundra species that is typical of many of the Arctic and Subarctic territories (Løken 1973, Chernov 1978, Proshchalykin and Kupianskaya 2005). The most southern locality with a record of *B. lapponicus* in the Arkhangelsk Region is the lower reaches of the Mezen River (Potapov and Kolosova 2016b).

The second group consists of the species that do not reach the northern part of the Arkhangelsk Region. These are *B. laesus* Morawitz, 1875, *B. deuteronymus* Schulz, 1906, *B. campestris* (Panzer, 1801), and *B. lapidarius* (Linnaeus, 1758). They are restricted mainly to the southern part of the Arkhangelsk Region, but *B. lapidarius* reaches the central part of the region (the Mirniy Town, 62°45'N, 40°20'E) (Potapov and Kolosova 2016a).

These species, as well as *B. soroeensis*, *B. distinguedus*, *B. muscorum*, *B. ruderarius*, *B. veteranus*, *B. humilis*, *B. rupestris*, *B. barbutellus*, *B. quadricolor*, *B. sichelii*, and *B. semenoviellus* are the meadow species in the European North of Russia (Bolotov and Kolosova 2006, Shvartsman and Bolotov 2008, Potapov 2015). They are the typical species for anthropogenic and meadow habitats and they are usually absent in the native taiga (Potapov and Kolosova 2016a). Due to the widespread development of these types of habitats in the lower reaches of the Northern Dvina River, these species are widely represented here. Similar patterns were analysed in detail for bumblebee communities in the European North of Russia, where meadow species quite often have a significant presence (Shvartsman and Bolotov 2008, Potapov and Kolosova 2016a, 2016b, 2017, 2018).

Concerning *B. consobrinus* in the lower reaches of the Northern Dvina River, it is noteworthy that, according to Scandinavian authors, this species is nearly monolectic and is closely related with its main food plant *Aconitum septentrionale* (Løken 1973, Pekkarinen et al. 1981, Pekkarinen 1988, Pekkarinen and Teräs 1993). For this reason, it can be stated that their ranges are quite identical in Fennoscandia. However, Bolotov and Kolosova (2006) note that the close relation of *B. consobrinus* with *A. septentrionale* is not so distinct in other regions. In the lower reaches of the Northern Dvina River, we recorded *B. consobrinus* mainly on *A. septentrionale*. Nevertheless, this species of bumblebee was found in the areas of the delta without any *Aconitum*. We assume that *B. consobrinus* could be visiting the other entomophilous plants.

According to the models of changes in the species range of bumblebees under conditions of global warming, it is expected that the northwards expansion of a number of species will be apparent between the years 2050 and 2100 (Rasmont et al. 2015). However, it is quite difficult to predict how this process will affect the bumblebee communities in the studied region. Since the 1990s, there has been a decline in agricultural production and the development of natural succession processes on agricultural territories (Shvartsman and Bolotov 2008). This process leads to a reduction in the areas of meadow communities, which in turn will affect the meadow species of bumblebees. At the present time, it is rather difficult to assess the potential contribution of landscape and climatic processes to the predicted change in the local fauna of bumblebees in the lower reaches of the Northern Dvina River.

Conclusion

The local fauna of bumblebees in the lower reaches of the Northern Dvina River has 27 species, and in general it is quite typical for areas of the Arkhangelsk Region, characterised by a wide development of secondary meadows. Similar local faunae are enriched with species that are not typical for the native habitats of taiga. Future studies of bumblebees in the lower

reaches of the Northern Dvina River should be directed towards the research of long-term trends in the bumblebee communities.

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