

Bombus (Pyrobombus) jonellus (Kirby, 1802) in the north-western Russian Plain: its distribution and ecology

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Abstract

The fauna and ecology of bumblebees in the European North are quite well-studied. However, there is a scarcity of information about the distribution and ecology of certain species of bumblebees, especially for the territory of Northern Russia. In this study, we summarised materials concerning *Bombus (Pyrobombus) jonellus* (Kirby, 1802), which is typical bumblebee species for the north-western portion of the Russian Plain and surrounding areas. The studied territory includes the Arkhangelsk Region and the western part of the Nenets Autonomous District, i.e. a wide strip from taiga to tundra ecosystems. Due to the studies of materials that were collected over a period 17 years, we established that *B. jonellus* is widely distributed and the northern border of its range within the studied region reaches the northern part of the Kanin Peninsula. In the north-western Russian Plain, *B. jonellus* has been found in various types of habitats, the most common being coniferous and birch forests, secondary meadows and ruderal patches. In the Solovetsky Islands, White Sea, Russia, *B. jonellus* is typical on coastal heathlands. In the northern part of the studied region, *B. jonellus* has a tendency to forage in open habitats and visits a wide range of entomophilous plants, mostly of the family Ericaceae. Our findings highlight that the territory of the north-western Russian Plain and surrounding areas is where *B. jonellus* is widely distributed and abundant, being recorded in different types of habitats.

Keywords

Bumblebees, European North of Russia, species range, habitat preference

Introduction

Bombus (Pyrobombus) jonellus (Kirby, 1802) is widely distributed in the northern latitudes from Iceland through Northern Europe, European part of Russia and Asian part of Russia, to Alaska and Western Canada (Løken 1973, Proshchalykin and Kupianskaya 2005, Williams et al. 2014, Levchenko and Tomkovich 2014, Kratochwil 2016, Rasmont and Iserbyt 2019). In Europe, *B. jonellus* is well studied (Rasmont et al. 2015) and is more common in the northern part of Europe, especially Iceland, the British Isles and Fennoscandia. Southern populations are known from mountain ranges, such as the Pyrenees and the Cantabrian Mountains (Rasmont et al. 2015).

The species is also abundant in the European North of Russia, and there are plenty of data from the western part of this region, i.e., the Murmansk Region and Karelia Republic (Pekkarinen et al. 1981, Söderman and Leinonen 2003). The central and eastern parts of the European North of Russia are less well studied, but there are some published literature from the Nenets Autonomous District and the Komi Republic (Kolosova and Potapov 2011, Filippov 2014, Potapov et al. 2017, Rasmont and Iserbyt 2019). The names of the collecting localities from the Arkhangelsk Region are given in the checklist of bumblebees of this region (Potapov and Kolosova 2016).

B. jonellus is known in Europe as the heath bumblebee (Dylewska 1996, Söderman and Leinonen 2003, Falk and Lewington 2017, Parkkinen et al. 2018) and in also the British Isles, this species is associated with open habitats, i.e., mainly heathlands and moorlands (Alford 1975, Falk and Lewington 2017). *B. jonellus* visits a wide range of entomophilous plants, especially Ericaceae (Løken 1973, Alford 1975, Dylewska 1996, Falk and Lewington 2017).

In Western and Southern Europe, *B. jonellus* occurs in mountain ranges, such as the Pyrenees (Iserbyt 2009, Rasmont et al. 2015). *B. jonellus* is a forest species in Eastern Europe (Poland) (Dylewska 1996), as well as in the central part of European Russia (Panfilov 1957). In Fennoscandia, the species is distributed almost everywhere, but like in the British Isles *B. jonellus* prefers open habitats here, i.e. heathland and mountain meadows (Løken 1973, Pekkarinen et

al. 1981, Söderman and Leinonen 2003). However, *B. jonellus* is associated with forests in the southern part of Finland (Bäckman and Tiainen 2002).

The study of the distribution and ecology of *B. jonellus* is important due to global warming (Rasmont et al. 2015). According to the models of Rasmont et al. (2015), a significant reduction in area in Europe that would be suitable for many bumblebee species, including *B. jonellus*, is expected by 2050 and especially by 2100. This critical circumstance requires further monitoring of bumblebee populations in the European North of Russia.

In this paper, we analyse the data, concerning the distribution of *B. jonellus* in the north-western Russian Plain and surrounding areas and also we consider a number of aspects of the species ecology in this region.

Materials and methods

Bumblebees were collected in different localities of the north-western Russian Plain and surrounding areas during the period 2000–2017 (Table 1). According to the administrative division of Russia, the studied areas included Arkhangelsk Region and the western part of the Nenets Autonomous District. This territory stretches a wide strip from taiga to tundra ecosystems (Isachenko 1995).

Various types of habitats were also studied. The collecting localities are shown on the map of this region (Figure 1). Bumblebees were caught with an entomological net. A total of 1192 specimens of *B. jonellus* were studied.

The specimens of bumblebees are deposited in the Russian Museum of the Biodiversity Hotspots (RMBH), N. Laverov Federal Center for Integrated Arctic Research of the Russian Academy of Sciences, Arkhangelsk, Russia.

The nomenclature follows Williams (2019). Bumblebees were identified according to Løken (1973) and Panfilov (1978). The plant species are given according to Skvortsov (2000), Sorokina et al. (2010) and the Plant List (2013).

The map of the studied region was produced by using ArcGIS 10.0 software.

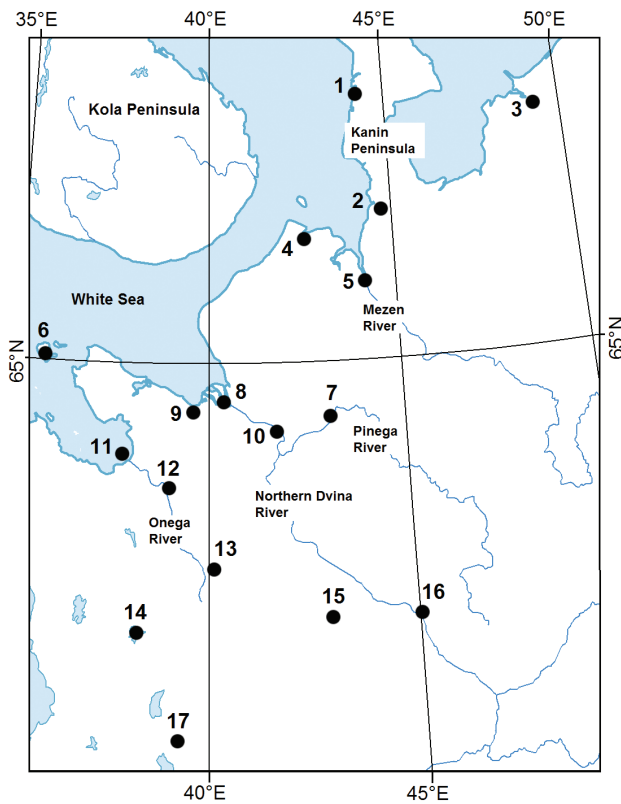


Fig. 1. Map of the north-western Russian Plain and surrounding areas. Numbers indicate collecting localities that are given in Table 1. Records of *Bombus jonellus* from the Kola Peninsula (Pekkarinen et al. 1981, Söderman and Leinonen 2003) and also records from the early 20th century (Potapov and Kolosova 2016) are not shown on this map

Results

In the list of the studied material we give locality; data; number of specimens; habitat, where bumblebees were caught; plant species, from which the bumblebees were collected. This list of materials is mostly documented in the paper of Potapov and Kolosova (2016). Here we do not include the old data from the end of 19th and early 20th centuries. They contain only 11 specimens from the north of the Arkhangelsk Region (Potapov and Kolosova 2016).

In the present research, we include material from a number of additional localities (indicated by asterisks) and ecological information. The localities have been ordered in this list from the northernmost point (Shoyna) to the southernmost one (Svyatoye Lake) and follow, in general, as the zonal gradient from the southern tundra to the middle taiga (Isachenko 1995).

Material examined: **Shoyna***, 12.VII–1.VIII.2003, 62 ♀, shrub-tundra, meadow-like habitat; **Nes***, 27–30.VII.2002, 2–27.VII.2002, 6.VIII.2002, 14 ♀, 1 ♂, shrub-tundra, meadow-like habitat, wet meadow in floodplain; **Indiga***, 3.VII.2015, 11 ♀, wet meadow in floodplain; **Koyda**, 28.VII.2000, 32 ♀, 11 ♂, shrub-tundra, *Calluna vulgaris* (L.) Hull; **Mezen**, 10–19.VII.2015, 6 ♀, meadow-like habitat, coniferous forest, *Rhinanthus minor* L.; **Solovetsky Islands**, 2007–2012, 245 ♀, 86 ♀, 367 ♂, coniferous and birch forests, roadside, ruderal patch, coastal

Table 1. Collecting localities of *Bombus jonellus* in the north-western Russian Plain and surrounding areas

No.	Localities	Latitude (N) /Longitude (E)
1	Shoyna	67°51'N, 44°09'E
2	Nes	66°36'N, 44°40'E
3	Indiga	67°30'N, 49°19'E
4	Koyda	66°22'N, 42°33'E
5	Mezen	65°49'N, 44°13'E
6	Solovetsky Islands	65°01'N, 35°42'E
7	Golubino	64°33'N, 43°15'E
8	Delta of the Northern Dvina River	64°32'N, 40°26'E
9	Solza River	64°29'N, 39°32'E
10	Kholmogory	64°14'N, 41°37'E
11	Kiy Island	63°59'N, 37°53'E
12	Bolshoy Bor	63°36'N, 39°06'E
13	Mirniy	62°46'N, 40°18'E
14	Kenozero Lake	62°04'N, 38°11'E
15	Shenkursk	62°06'N, 42°53'E
16	Verkhnyaya Toyma	62°13'N, 45°02'E
17	Svyatoye Lake	60°51'N, 39°31'E

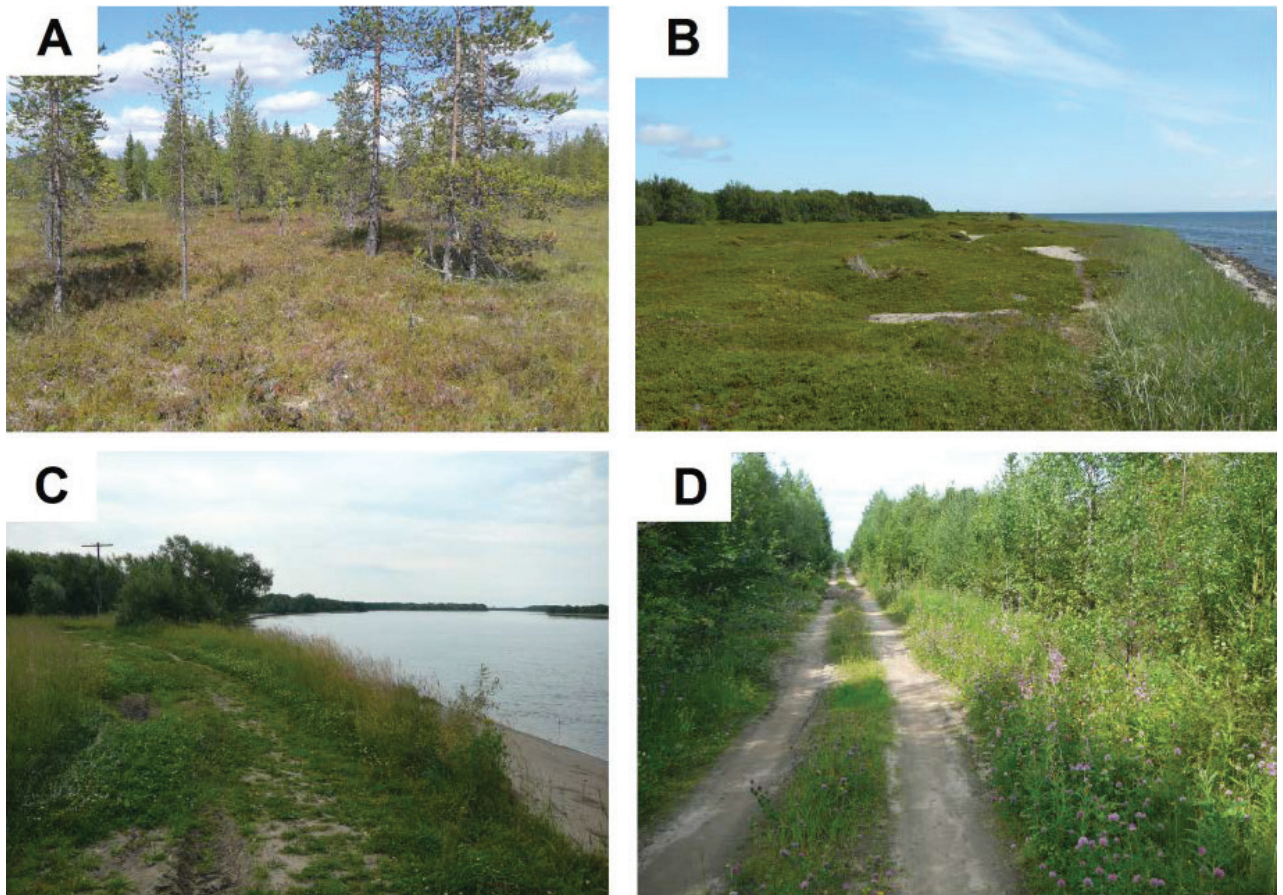


Fig. 2. Typical foraging habitats of *Bombus jonellus* in the north-western Russian Plain: (A) Coniferous forest, near Mezen Town; (B) Coastal heathland with *Empetrum nigrum*, of the Solovetsky Islands; (C) Meadow-like habitat, delta of the Northern Dvina River; (D) Roadside in the birch forest, near Kholmogory Village. Photos: Grigory Potapov

heathland, *Epilobium angustifolium* L., *Rhinanthus minor*, *Trifolium repens* L., *Vicia cracca* L., *Calluna vulgaris*, *Melampyrum pratense* L., *Lathyrus pratensis* L., *Vaccinium myrtillus* L.; **Golubino**, 29.VIII.2009, 1♀, coniferous forest; **Delta of the Northern Dvina River**, 6–29.VII.2007, 5–26.VII.2008, 2.VI.2010, 16–23.VII.2010, 10.VIII.2010, 47♀, 2♀, 44♂, birch forest, dry meadow, meadow-like habitat, roadside, ruderal patch, *Taraxacum campyloides* G.E.Haglund, *Cirsium arvense* (L.) Scop., *Epilobium angustifolium*, *Potentilla argentea* L., *Rhinanthus minor*, *Vaccinium vitis-idaea* L., *Euphrasia* sp., *Anthyllis vulneraria* L., *Rosa rugosa* Thunb., *Rubus idaeus* L., *Scorzoneroides autumnalis* (L.) Moench; **Solza River**, 3.IX.2005,

6♀, wet meadow in floodplain; **Kholmogory**, 17–18.VII.2004, 1.VIII.2004, 5–13.VII.2010, 128♀, 16♂, birch forest, dry meadow, meadow-like habitat, roadside, ruderal patch, *Rhinanthus minor*, *Trifolium repens*, *Lotus corniculatus* L.; **Kiy Island***, 12.VI.2017, 1♀, coniferous forest, *Vaccinium myrtillus*; **Bolshoy Bor**, 18.VI.2000, 13–16.VII.2000, 31♀, 4♂, meadow-like habitat, wet meadow in floodplain, raised bog, *Cirsium arvense*; **Mirniy**, 25.VII.2009, 1♂, coniferous forest; **Kenozero Lake**, 7–13.VIII.2004, 19–20.VII.2006, 10–17.VIII.2008, 51♀, 3♀, 15♂, meadow-like habitat, roadside, coniferous forest; **Shenkursk***, 28.VII.2001, 21.VI.2014, 3♀, 1♀, 1♂, meadow-like habitat, ruderal patch, *Lotus corniculatus*,

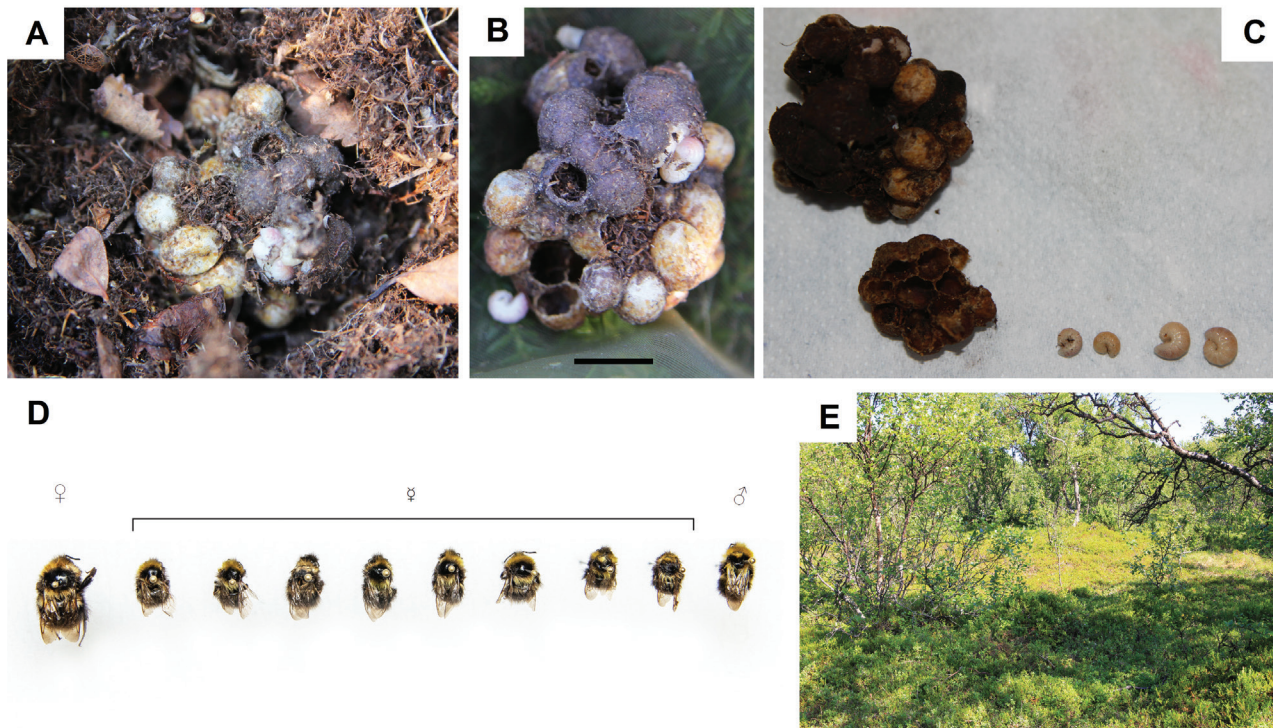


Fig. 3. The nest of *Bombus jonellus* in the Solovetsky Islands: (A) Excavated nest; (B) Excavated nest and its size. Scale bar = 10 mm; (C) Excavated nest with larvae; (D) Queen, workers and male of *B. jonellus*, which was found in the nest and caught near it; (E) Location of the nest, birch forest in the Pechak Cape. Photos: Yulia Kolosova

Vicia cracca; **Verkhnyaya Toyma***, 12.VIII.2000, 1 ♀, roadside; **Svyatoe Lake**, 16.VIII.2007, 1 ♀, meadow-like habitat.

Foraging individuals of *B. jonellus* were recorded in different types of habitats in the north-western Russian Plain. The most common of these are meadow-like habitats, roadsides, coniferous and birch forests. Meadow-like habitats consist of different types of secondary meadows, ruderal patches and roadsides, which are formed by human activities. These types of habitats are widely represented in the studied region (Shvartsman and Bolotov 2008, Parinova et al. 2014). In the Solovetsky Islands, *B. jonellus* is typical on coastal heathlands with *Empetrum nigrum*. Some foraging habitats are shown in the Figure 2.

Information, concerning food plants is not available for all studied localities. These are mainly the Solovetsky Islands and the lower reaches of the

Northern Dvina River. *B. jonellus* visits a wide range of entomophilous plants.

During our field research one nest of *B. jonellus* was found in the Solovetsky Islands (7.VII.2011, Pechak Cape, 65°57'35.3"N, 35°45'59.8"E, Kolosova and Potapov leg.) (Figure 3). This nest was located in the birch forests near the coastal heathland with *Empetrum nigrum* and was found inside the tussock (diameter about 480 mm, depth from top to the nest is about 200 mm) with a nest diameter of about 35 mm. The content of this nest was 37 cocoons, of which 13 were empty (the cocoons sizes on average were: length 12 mm, width 7 mm). Inside the nest was one queen of *B. jonellus*, four workers and one male while two workers were caught near the nest. One more worker was captured flying near this nest 10 minutes after excavation and one other after 1.5 hours. The length of the queen was about 15 mm, the lengths of workers on average was about 10 mm the length of the males about 11 mm.

Discussion

Our specimens of *B. jonellus* from the north-western Russian Plain resemble the Scandinavian subspecies *B. jonellus subborealis* Richards, 1933, since they have black corbicular fringes (Løken 1973) (Figure 4). There are other subspecies, which are recognized in Europe (Richards 1933, Kratochwil 2016). However, molecular data raises questions about the validity of geographic races of this species in Northern Europe and they probably should be considered as synonyms of the nominotypic subspecies of *B. jonellus* (Potapov et al. 2018b).

Overall, *B. jonellus* is widely distributed in the studied territory from its southern to northern part (Figure 1). The northernmost record for the species in the region is located at latitude 67°51'N. This is near the Shoyna Settlement. However, *B. jonellus* is recorded from more northern localities in the eastern part of the European North of Russia, i.e. the Kolguev Island (68°47'N) (Kolosova and Potapov 2011) and the Yugorsky Peninsula (69°44'N) (Potapov et al. 2017).

In Eastern Fennoscandia, the forest boundary has been shifted northwards due to the influence of the Barents Sea (Isachenko 1995). For this reason, *B. jonellus* is found far to the north, including the northern parts of the Murmansk Region, Finland and Norway (Løken 1973, Pekkarinen et al. 1981, Söderman

and Leinonen 2003). This is typical for many species of bumblebees in the European North of Russia, e.g. *B. soroensis* (Potapov and Kolosova 2018).

In the north-western Russian Plain, *B. jonellus* is found in various types of habitats and may be regarded as a ubiquitous species (Bolotov and Kolosova 2006). However, there is a tendency to foraging in open habitats for this species. This is particularly true for the northern part of the studied region, where *B. jonellus* is quite abundant.

We can conclude that in Europe *B. jonellus* prefers to inhabit forests in the south of its range, while it is associated with open habitats in the northern territories. This is the well-known rule of zonal change of habitats within the species range (Bey-Bienko 1966). In the north-western Russian Plain, as in Europe, *B. jonellus* is foraging on many plant species, mostly made up of the family Ericaceae (Løken 1973, Alford 1975, Dylewska 1996, Falk and Lewington 2017), with the small flowers of the plants of this family being accessible to *B. jonellus* due to its small size (Bolotov et al. 2013). It is possible that this is one of the reasons for the relatively high abundance of this species on heathlands in the northern regions of Europe.

One interesting feature of the biology of *B. jonellus* is that this species is able to produce two generations per season and this fact is well known in Western



Fig. 4. Worker (A) and male (B) of *Bombus jonellus*, the Solovetsky Islands. Photos: Yulia Kolosova

Europe (Meidell 1968, Douglas 1973, Alford 1975, Prÿs-Jones and Corbet 1987) and is applicable to the Solovetsky Islands in the European North of Russia (Bolotov et al. 2013, Potapov et al. 2018a) but further evidence is needed to prove this fact. In the studied region, the seasonal cycle of flight activity of *B. jonellus* is known for the lower reaches of the Northern Dvina River (Kolossova et al. 2012) where one generation per season is the typical cycle.

B. flavidus, *B. sylvestris* and *B. quadricolor* are known as social parasites of *B. jonellus* (Løken 1984, Lhomme and Hines 2019) and these species are indeed quite common in the studied region (Potapov and Kolossova 2016). However, we did not observe the cuckoo females in the nest of *B. jonellus* that was found in the Solovetsky Islands.

Conclusion

The territory of the north-western Russian Plain and surrounding areas is where *B. jonellus* is widely distributed and abundant, being recorded in different types of habitats. Due to the large territory of this research, we have established that this species tends to change habitat preference from the south to the north of the studied region. In the northern part of the north-western Russian Plain, *B. jonellus* has a tendency to forage in open habitats, such as coastal habitats

and shrub-tundra. Further south, this species is abundant and especially in the various types of forests.

We can expect a stable existence of *B. jonellus* in the north-western Russian Plain. Further monitoring of bumblebees is needed in connection with the expected changes in the species range in the next few decades (Rasmont et al. 2015).

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