

Distribution, abundance, and habitats of rare species *Parnopes grandior* (Pallas 1771) (Hymenoptera, Chrysididae) in Mordovia and adjacent regions, Russia

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Abstract. Ruchin AB, Antropov AV, Khapugin AA. 2019. Distribution, abundance, and habitats of rare species *Parnopes grandior* (Pallas 1771) (Hymenoptera, Chrysididae) in Mordovia and adjacent regions, Russia. *Biodiversitas* 20: 303–310. The study of biological and ecological characteristics is essential in conservation efforts of threatened and locally rare species. Obtaining the comparable data in different regions of a species range allows developing a conservation strategy. We aimed to study the distribution, acquired characteristics of the abundance and habitats of the biology of a rare species *Parnopes grandior* (Pallas, 1771) in the Republic of Mordovia (European Russia). As a result of our study, the biology of *Parnopes grandior* found in the Republic of Mordovia and in five adjacent regions (Volga River Basin, Russia) is described. In the Republic of Mordovia in 2008–2018, 18 habitats of this species were identified. In all cases, it was found next to the host wasp colonies of *Bembix rostrata* (Linnaeus, 1758). The species population was low (no more than five individuals per study site). In all the sites surveyed, it inhabited xerophytic plant communities on sandy disturbed substrate. In these habitats, the coverage of plants is low and does not exceed 20%. The list of plants visited by the adults of *Parnopes grandior* is given. In the adjacent regions, the species abundance is also not high, but the number of records and abundance increases significantly to the south of the Ulyanovsk region.

Keywords: Abundance, Chrysididae, habitats, *Parnopes grandior*, Republic of Mordovia

INTRODUCTION

The Chrysididae, commonly known as cuckoo wasps, jewel wasps or ruby tail wasps is a cosmopolitan family which includes about 2500 species in the world (Aguiar et al. 2013) and divided into 92 genera. They are the kleptoparasites of many representatives of the superfamily Aculeata (Sphecoidea, Vespoidea, Apoidea) and can affect their abundance in biocenoses significantly. There are currently known 330 species of Chrysididae in Russia (Lelej and Belokobylskij 2017).

Three species of *Parnopes* genus are known in Russia, i.e., *P. glasunowi* (Semenov 1901), *P. grandior* (Pallas 1771), and *P. popovii* (Eversmann 1857). However, took into account size of the range, *P. grandior* is the most frequently occurred native species (Rosa et al. 2017). One of the largest representatives of Chrysididae is *Parnopes grandior* (Pallas, 1771). It is a parasitoid of the genus *Bembix* F. (Crabronidae) (Linsenmaier 1968; Standfuss 2009). The range of this species covers Central and Southern Europe, North Africa, South-West Asia, the Caucasus, Iran, the south of Western Siberia, Kazakhstan, Turkmenistan, Uzbekistan (Linsenmaier 1968; Kimsey and Bohart 1991; Jaroszewicz 2007; Guéorguiev and Ljubomirov 2009). From northern Europe, it is indicated only from Lithuania (Orlovskytė et al. 2010; Paukkunen et al. 2014). This species is listed in the Red Data Book of the Russian Federation (2001) as the species with a steady

tendency to reduce its abundance. *Parnopes grandior* is not included in the Global IUCN Red List.

The study of the rare insect species in the Republic of Mordovia has been increasingly intensive in recent years (Ruchin and Kurmaeva 2010; Khapugin et al. 2016, 2017a, b; Ruchin and Egorov 2017). Moreover, the biology and ecology of such species are studied at a high scientific level (Ruchin and Kurmaeva 2010; Ruchin 2018; Ruchin and Grishutkin 2018). In addition, the quality and intensity of entomological research made it possible to discover new habitats of the rare insect species, expand the range and retrace the dynamics of the abundance of other species (Ruchin and Artaev 2016; Ruchin and Egorov 2017, 2018a, b,c,d; Chursina and Ruchin 2018; Ruchin and Mikhailenko 2018; Ruchin et al. 2018; Tomaszewska et al. 2018).

Our paper is aimed to study the distribution, obtained characteristics of the abundance and examine some aspects of the biology of *P. grandior*, which inhabits the northeastern border of the range.

MATERIALS AND METHODS

The Republic of Mordovia is located in the center of the East European Plain between 42°11' and 46°45' E and 53°38' and 55°11' N in the southwestern periphery of the Volga River basin in the interfluvium of rivers Moksha and Sura. The area includes forest and forest-stepped zones of Central Russia. The Republic of Mordovia borders on the

Chuvashia, Ryazan region, Nizhniy Novgorod region, Ulyanovsk region and Penza region (Fig. 1). The Eastern Mordovia is located in the northwest of the Volga Upland and the western part in the Oka-Don lowland. In this regard, a variety of habitats is observed in the area of study. In the west, north-west, and north of the country there are common boreal coniferous and mixed forests under protection of the Mordovia State Nature Reserve. Broad-leaved forests cover the central and eastern parts. In the east and south-east forest-steppe landscapes predominate. Elements of steppe vegetation occur on a small number of "islands" of land unsuitable for agricultural use (on slopes of ravines, on hills and indigenous banks in the river valleys) (Yamashkin 1998).

The material was collected in periods 2008-2018. During this time, we examined more than 200 study sites in the Republic of Mordovia, Ulyanovsk region, Nizhniy Novgorod region, Ryazan region. For the distribution

analysis, literature data on adjacent regions are involved. The botanical description of the habitats of *P. grandior* in the Republic of Mordovia was made on 5×5 m study areas according to Khapugin et al. (2014). The Latin names of the plant species are given according to the Plant List (2018) database.

In the section "new material" we describe the collection of material that has not been previously published. The colleagues indicated in the acknowledgements provided the separate data about the collection materials. The label data from the collection material are specified (district, settlement, date, number of specimens, collectors). The storage place of the material is the entomological collection of the Mordovia State Nature Reserve (Pushta, Temnikov district, Republic of Mordovia). The following abbreviations were used: the collection of the Zoological Institute of RAS (Saint-Petersburg, Russia) - [ZIN], the collection of Gian Luca Agnoli - [GLA coll.].

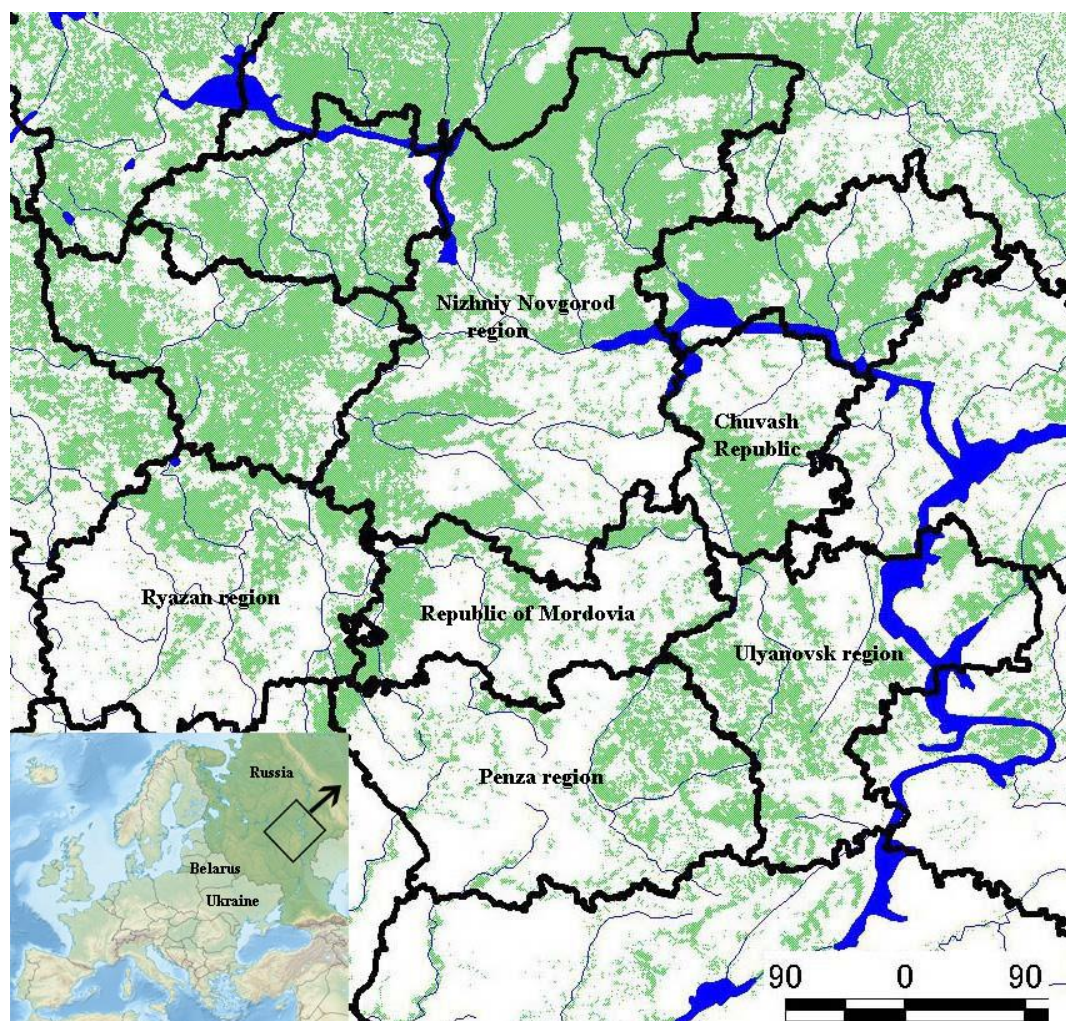


Figure 1. Map of the study area in the Republic of Mordovia, Russia

RESULTS AND DISCUSSION

In the Republic of Mordovia and adjacent regions, the sites of *P. grandior* records are scattered almost everywhere, except for the Ulyanovsk region (Fig. 2). Most of the records in the Republic of Mordovia are located in the eastern and western parts of the region. *P. grandior* was not observed in its central part. Apparently, this is due to the significant anthropogenic development of this region by cutting of mixed and pine forests on sandy soils. As a result, a significant part of the biotopes was destroyed. In the Nizhniy Novgorod region and the Chuvashia, almost all records are located in their southern parts, in the Penza region - in its eastern part. Among the five regions mentioned, the most significant number of *P. grandior* records was made in the Ulyanovsk region. At the same time, the number of habitats reaches the greatest concentration in the south of the region.

Nizhniy Novgorod region

Literatures data: Ardatov Distr., Arzamas Distr., Perevoz Distr., Sosnovskoe Distr., Dzerzhinsk Town (Red Data Book of Nizhniy Novgorod Region 2014: 259). Ardatov Distr., Arzamas Distr., Dzerzhinsk Distr., Perevoz Distr., Sosnovskoe Distr. (Mokrousov and Zryanin 2010: 94).

New data: Voznesenskoe Distr., Svobodnyi, 16.VII.2017, 1 ex.

Penza region

Literatures data: Gorodische Distr., Bessonovka Distr. (Shibaev 2006: 111). Lunino Distr., Lopatino Distr., Nikolsk Distr., Kameshkir Distr. (Stojko and Polumordvinov 2004: 56).

Republic of Mordovia

Literatures data: Temnikov Distr. (Plavilshchikov 1964: 121; Ruchin and Kurmaeva 2010: 715; Ruchin and Egorov 2017: 5-6). Bolshie Berezники Distr. (Ruchin et al. 2016: 417).

New data: Ichalki Distr., Sosnovka, 6.VIII.2008, 1 ex.; Ichalki Distr., Smolny National Park, Barakhmanovskoe forestry, quarter 99, 25.VII.2017, 1 ex.; same label, quarter 93, 2.VIII.2017, 17.VIII.2017, 2♀ (Fig. 4C); Atyurievo Distr., Klopinka, 29.VI.2013, 2 ex.; same label, Pichopolonga, 2.VII.2016, 1 eks.; Temnikov Distr., Lavrentievo, 6.VII.2013, 1 ex.; same label, Mordovia State Nature Reserve, quarter 436, 26.VI.2018, 1 ex. (Fig. 4A); Kochkurovo Distr., 5 km E Sabaev, 25.VI.2016, 2 ex. (Fig. 4D); Elniki Distr., Malye Mordovskie Poshaty, 23.VII.2016, 1 ex.; same label, Novye Shaly, 22.VII.2017, 1♀. Ardatov Distr., Piksyasi, 10.VIII.2017, 2 ex.; Bolshie Berezники Distr., Simkinskoe Lesnichestvo, 12.VIII.2017, 1♂ (Fig. 4B); Zubova Polyana Distr., Udevo, 31.VII.2018, 1 ex.; same label, Vadovo-Sosnovka, 31.VII.2018, 1 ex.

Ryazan region

Literatures data: Oka State Nature Reserve (Nikolaeva and Nikolaev 2017: 64-65). Kasimov Distr., Spassk Distr., Ryazan Distr., Shilovo Distr. (Red Data Book of Ryazan

Region 2011: 243). Kasimov Distr., Spassk Distr., Shilovo Distr. (Kochetkov 2012: 241).

New data: Gremyachka [ZIN], Spassk [ZIN].

Ulyanovsk region

Literatures data: Novospasskoe Distr., Nikolaevka Distr., Radischevo Distr., Staraya Kulatka Distr., Surskoe Distr., Staraya Maina Distr., Ulyanovsk Distr., Cherdakly Distr., nza Distr., Veshkaima Distr., Kuzovatovo Distr., Barysh Distr. (Buganin et al. 2000: 150; Red Data Book of Ulyanovsk Region 2015: 381-382).

New data: Ulyanovsk, 9.VI.2005, G.V. Kuznetsov, 1 ♂ [GLA coll.].

Chuvash Republic

Literatures data: Yalchiki Distr., Cheboksary Distr., Alatyr Distr., Komsomolskoe Distr., Shemursha Distr. (Egorov 2010: 13). Chavash Varmane National Park (Egorov 2012: 90).

Discussion

In the Mordovia State Nature Reserve, ten-year studies have shown that the abundance of *P. grandior* is very low (Ruchin and Egorov 2017). It was found in some local habitats. Perhaps the negative impact on the population is caused by the overgrowing of glades, embankments, beams by shrubby vegetation and, as a consequence, degradation of colonies of host wasps (Orlovskiy et al. 2010). A similar situation is observed concerning *Parnassius apollo* (Linnaeus 1758), whose habitats in the Mordovia State Reserve are lost precisely because of the same reasons (Ruchin and Grishutkin 2018). However, in the case of *P. grandior*, the situation is not so negative, which is due to the presence of quite suitable habitats for host wasps, which appeared after the wildfires of 2010. In one of the habitats (area of the Inorsky cordon), there is a stable population of *Bembix rostrata*. We observe this population since 2011. Wasps of *B. rostrata* inhabit small dry hillocks with thinned vegetation and on the side of a dirt road. In different years the abundance of this colony varies depending on the extent of overgrowing of nesting sites. For example, in the rainy season of 2017, its abundance declined to 6-7 nests on the side of the road. This year, the glade was overgrown with herbaceous plants, that adversely affected the *B. rostrata* abundance. However, the 1.5-month heat had a noticeable effect on vegetation in 2018. It mostly burned out on the hillocks with the southern exposure. There was a xerophytization of the habitat with more open areas on sandy soil. The vegetation thinned and the projective cover of herbaceous vegetation decreased. In this regard, the number of *B. rostrata* nests has grown to several dozen. It was this year, when several specimens of *P. grandior* were found in the overgrown colony.

In general, in the Republic of Mordovia the abundance of *P. grandior* is stable, in some habitats, it was possible to observe daily 4-5 individuals of *P. grandior* next to the colonies of *B. rostrata*. In the region in 2008-2018, *B. rostrata* has been found in 45 habitats, of which 18 (40.0%)

are joint records of both species. This species mostly inhabits sandy or sandy-loam soil along river banks, in quarries, along with fringes and glades in forests, on roadsides. It is often found near or on the outskirts of rural settlements.

In the Nizhniy Novgorod region the distribution of *P. grandior* is sporadic, but in habitats, it is quite common, and in some years it is numerous (Red Data Book of Nizhniy Novgorod Region 2014). In the 1930s-1940s, it was common in the Ryazan region. Currently, it rarely occurred with a low abundance (Nikolaeva and Nikolaev 2017). In 2010-2015, *P. grandior* was noted every year in the Oka State Nature Biosphere Reserve. Until this time, the records were irregular and local. The species has been recorded steadily for five years in one location in the Spassk district, in the vicinity of Lakash (from 2010 to 2015) (Nikolaeva and Nikolaev 2017). It has also been noted in other districts of the region along dry meadows on sandy soils (Kochetkov 2012). In the Ulyanovsk region, the distribution of *P. grandior* is studied well. The most significant number of locations belongs to the southern

steppe sites, where significant areas of landscapes are represented by chalk slopes, dry steppes, sandy outcrops. The abundance of the species in such places is not very high, but it is stable and records are found annually (Buganin et al. 2000; Red Data Book of Ulyanovsk Region 2015). The species inhabits the edges of pine forests on sandy soil in the *B. rostrata* habitats, and it is quite rare in the Chuvashia. At present, it is known in the region in the State Nature Reserve "Prisursky" and the National Park "Chavash Varmane". In Chuvashia, the vulnerability of *P. grandior* is primarily determined by its location at the northern limit of its range (Egorov 2010, 2012). It inhabits virgin slopes, including beams and ravines, as well as open biotopes in forest landscapes in the Penza region (Stojko and Polumordvinov 2004). In this case, there is no information on its abundance. Thus, the *P. grandior* distribution is sporadic in the Republic of Mordovia and the adjacent regions. However, the abundance and number of locations of this species increase in the south of the region.

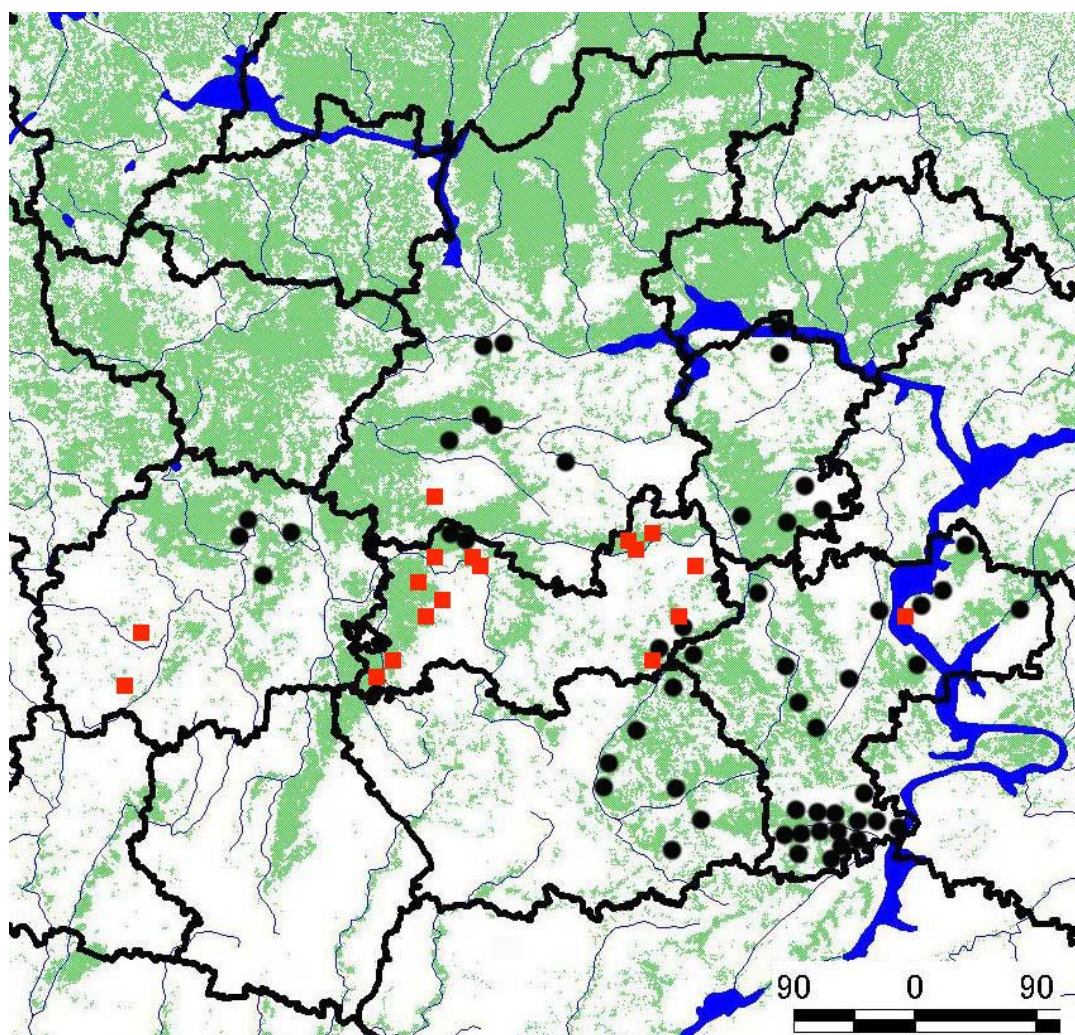


Figure 2. The distribution of *Panorpes grandior* in the Republic of Mordovia and adjacent regions. Black points - according to the literary data, red squares - new locations

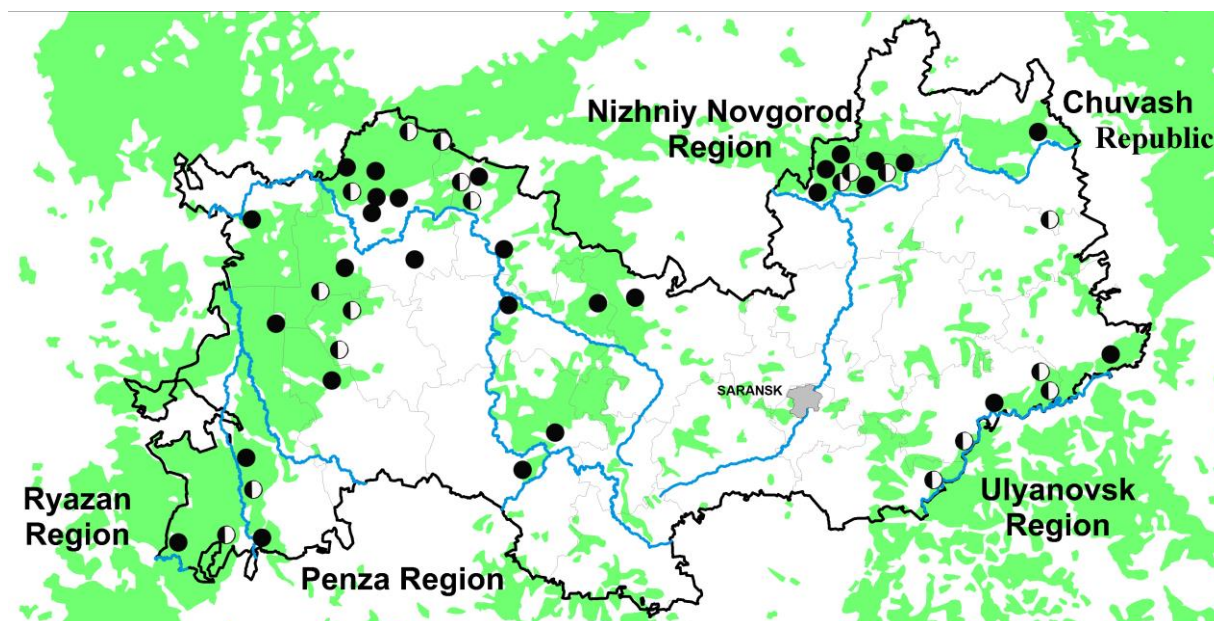


Figure 3. Distribution of *Parnopes grandior* and *Bembix rostrata* in Mordovia. Black circles are the locations of *Bembix rostrata* finds, white with black - finds of both species in one location

According to the published data from the European part of the *P. grandior* range (Blagoveschenskaya and Popova 1994; Rosa 2004; Banaszak et al. 2009; Egorov 2010; Kochetkov 2012; Kemal and Koçak 2015; Józán 2018), adult individuals visit flowering plants, such as: *Eryngium* sp., *Eryngium planum* L., *Aster* sp., *Mentha longifolia* (L.) L., *Thymus vulgaris* L., *Solidago virgaurea* L., *Pimpinella saxifraga* L., *Knautia arvensis* (L.) Coult., *Armeria* sp., *Centaurea micranthos* J.F.Gmel., *Echinops ritro* L., *Euphorbia seguieriana* Neck., *Jasione Montana* L., *Scabiosa ochroleuca* L., *Thymus* sp., *Trifolium arvense* L. We observed its individuals on the following plants: *Achillea millefolium* L., *Knautia arvensis* (L.) Coult., *Helichrysum arenarium* (L.) Moench, and *Origanum vulgare* L.

Adult individuals are found in the Republic of Mordovia and adjacent regions from late June to late August. The main habitats are dry, slightly overgrown slopes of beams, ravines, and floodplains of rivers, fresh embankments of railroads and highways, floodplain meadows (including those flooded with heavy spring flow), outskirts of dry pine forests, large dry glades in pine and mixed forests. As a rule, such habitats are weakly overgrown with herbaceous plants or small curtains of herbs alternate with bare sand deposits.

We present more detailed descriptions of some habitats of *P. grandior* (Fig. 4). In the National Park "Smolny" it was found on a glade along the electric power line in a massif of pine forests on sandy soils. Single specimens of seed renewal of *Betula pendula* Roth and *Pinus sylvestris* L. grow in this place. Shrubs are represented by individual specimens of *Gnista tinctoria* L. and *Chamaecytisus ruthenicus* (Fischer ex Woloszczak) Klásk. Among the herbs *Calamagrostis epigejos* (L.) Roth (up to 1-2%), *Pilosella officinarum* Vaill. (up to 3-5%), *Achillea*

millefolium (up to 1-2%), *Erigeron acris* L., *Helichrysum arenarium* (up to 1-2%), *Artemisia absinthium* L., and one specimen of *Solidago virgaurea* (the total projective cover is about 10%) are represented here.

Parnopes grandior was found on a clearing in a pine green-moss forest on sandy soils on the outskirts of Simkinskoe Lesnichestvo village (Bolshie Berezniki district). This is a site with *Oenothera biennis* L. and without woody plants. The vegetation cover is represented by *Oenothera biennis* L. (2-3%), *Berteroa incana* (L.) DC., *Bromus inermis* Leyss., *Potentilla argentea* L., *Calamagrostis epigejos* (L.) Roth (4%), *Trifolium medium* L., *Poa pratensis* L. (4%), *Tanacetum vulgare* L. (3%), *Dactylis glomerata* L., *Artemisia absinthium* L., *Chenopodium album* L., *Rumex acetosella* L., and *Festuca valesiaca* Schleich. ex Gaudin (the total projective cover is about 15%).

As we pointed out above, *P. grandior* was found on the Inorsky cordon in the Mordovia State Nature Reserve in 2018. In this habitat, there is a glade with anthropogenically disturbed vegetation. The scattered vegetation cover is represented mainly by *Plantago lanceolata* L. (10%), as well as *Erigeron canadensis* L. (3%), *Achillea millefolium* L. (4%), *Calamagrostis epigejos* (L.) Roth (2%), *Potentilla argentea* L., *Berteroa incana* (L.) DC., *Echium vulgare* L., *Apera spica-venti* (L.) P. Beauv., *Phleum pratense* L., *Dactylis glomerata* L., and *Artemisia campestris* L. (the total projective cover is about 20%).

Near the Sabaevo village (Kochkurovo district), *P. grandior* is discovered on the open sandy spit of the Sura river with the scattered vegetation cover. The scattered vegetation cover is represented by *Chenopodium polyspermum* L., *Digitaria ischaemum* (Schreb.) Muhl. (2%), *Medicago falcata* L. (3%), *Berteroa incana* (L.) DC.

(3%), *Corispermum hyssopifolium* L. (3%), *Tanacetum vulgare* L., *Oenothera biennis* L., *Erigeron annuus* (L.) Pers., *Erigeron canadensis* L., *Lactuca serriola* L., and *Xanthium albinum* (Widd.) Scholz & Sukopp (total projective cover is about 11-12%). As can be seen from the obtained data, *P. grandior* inhabits sandy soils with disturbed vegetation cover in all the sites surveyed. The total projective cover is low and does not exceed 20% in these locations. In our opinion, the scattered (including as a result of anthropogenic impact) vegetation cover and sandy substratum are favorable factors for settling of the habitats by *P. grandior* host wasps.

The similar habitats are typical for other *P. grandior* populations within the range (Kimsey and Bohart 1991; Jaroszewicz 2007; Guéorguiev and Ljubomirov 2009; Twerd 2010; Kemal and Koçak 2015; Paukkunen et al. 2015; Twerd and Banaszak 2018).

In recent years, some parts of the range *P. grandior* began to occur more often than usual. For example, in

Poland, there are data (Twerd and Banaszak 2018) indicating the expansion of its range in the north-west direction. Most of the locations of this species were identified after 2000 and, mainly, in the northern part of the country. In addition to its common habitats, *P. grandior* began to occur in sandy quarries and even on military training sites. Thus, the species began to occupy not only natural, but also anthropogenically altered habitats. To the present moment, there are 45 locations of *P. grandior* in Hungary (Jozan 2018). However, taking into account data from the Republic of Mordovia, we did not notice an increase in the number of locations yet. All the locations are found only after a thorough study of the colonies of the host wasps. This condition can only testify to the low abundance of *P. grandior*. The trends observed in Poland (Twerd and Banaszak 2018) towards the dispersal of *P. grandior* into anthropogenically disturbed habitats in Mordovia have not been seen yet. Its records are confined mainly to natural habitats.



Figure 4. Biotopes of *Panorpis grandior* in the Republic of Mordovia, Russia. A. Temnikov district (Mordovia State Nature Reserve); B. Bolshie Berezniki district (Simkinskoe Lesnichestvo); C. Ichalki district (National Park "Smolny"); D. Kochkurovo district (5 km of the Sabaev village)

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