

Present distribution of *Protaetia fieberi* (Kraatz, 1880) (Insecta, Coleoptera, Scarabaeidae) in the European part of Russia

Alexander B. RUCHIN¹, Leonid V. EGOROV^{1,2}, Alexey S. SAZHNEV³,
Oleg A. POLUMORDVINOV⁴, Roman N. ISHIN⁵

1. Joint Directorate of the Mordovia State Nature Reserve and National Park "Smolny", Saransk, Russia; E-mail: sasha_ruchin@rambler.ru
 2. State Nature Reserve "Prisursky", Cheboksary, Russia; e-mail: platyscelis@mail.ru
 3. Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences, Borok, Russia; e-mail: sazh@list.ru
 4. Penza State University, Penza, Russia; e-mail: entomol-penza@yandex.ru
 5. Russian Entomological Society, Tambov, Russia; e-mail: r-mail@inbox.ru
- * Corresponding author, A.B. Ruchin, E-mail: ruchin.alexander@gmail.com

Received: 25. June 2018 / Accepted: 23. November 2018 / Available online: 01. December 2018 / Printed: June 2019

Abstract. Based on our own research and literature sources, the known distribution of *Protaetia fieberi* (Kraatz, 1880) (*P. f. boldyrevi* (Jacobson, 1909)) (Insecta, Coleoptera, Scarabaeidae) in the European part of Russia is discussed. Reliably this species is known from 23 administrative units (excluding doubtful indication from the Volgograd region). The species is not yet recorded northwards of Ivanovo, Nizhny Novgorod, Kirov regions and the Republic of Udmurtia. Presumably it should also occur in Bryansk, Kursk, Lipetsk, Orel, Smolensk regions, the republics of Bashkortostan and Mari El. The Volga River it is found only in Volgograd and Saratov regions. In the south of European Russia *P. fieberi* is noted only in Novorossiysk. In the south of the Don River and in the Caucasus the species was not recorded. The main habitats are old deciduous forests with oak, linden, old willow, and black poplars. Imagines are found in the daytime on oak sap, as well as on various flowering plants like Umbelliferae, Asteraceae and Rosaceae.

Key words: *Protaetia fieberi*, Scarabaeidae, saproxylic beetles, distribution area, Russia.

Introduction

Species dependent on old-growth deciduous forests have declined due to habitat loss and intensive forest management (Speight 1989, Siitonen 2001, Stenbacka et al. 2010, Ruchin & Egorov 2018a). A conspicuous group of arthropod species naturally associated with tree cavities in old-growth deciduous forests are the saproxylic beetles of the subfamily Cetoniinae. Such saproxylic species include beetles from the genus *Protaetia* Burmeister, 1842. High species diversity and, as a result, a huge variety of ecological preferences and participation in a variety of biotic connections makes the saproxylic Coleoptera one of the most important groups of living organisms in forest ecosystems. They play an important role in the biogenic circulation of substances, accelerating the involvement of dead wood pulp in detritus nutritional chains (Fayt et al. 2006, Müller et al. 2015, Jaworski et al. 2016, Plewa et al. 2017, Ruchin et al. 2018). The composition of the saproxylic Coleoptera communities formed in the temperate forests has significant differences from similar complexes of other natural zones, so the study of individual species and whole complexes of saproxylic Coleoptera is one of the urgent tasks in solving the problem of biodiversity conservation (Dollin et al. 2008, Volodchenko 2009, Quinto et al. 2012, Ruchin & Egorov 2018a).

According to a number of studies (Kuemmerle et al. 2006, Ruchin & Kurmaeva 2010, Prishchepov et al. 2012, Potapov et al. 2015), recent decades have been characterized by an increase of forest area in most European countries. However it is noted that such increase occurs against the background of a reduction in the area of old deciduous forests and their replacement by younger small-leaved and pine forests (Baumann et al. 2011, 2012, Tomaszewska et al. 2018). This, in turn, leads to a reduction in the number of saproxylic species, which in the majority prefer precisely broad-leaved forests. Herein the distribution in the European part of Russia and some features of the biology of the

saproxylic species *Protaetia fieberi* (Kraatz, 1880) are described, which is considered for inclusion in the Red Data Book of Russia.

Material and methods

Region of research

The European territory of Russia includes the East European Plain and the Caucasus. Its bordered by the Ural Mountains and Kazakhstan. The main part of European Russia is located in the subarctic and mostly in the temperate climatic zones. The territory is characterized by a change in climatic conditions from north to south in the direction of increasing aridity: from the climate of the forest zone characterized by excessive moisture, a large amount of precipitation with relatively high air humidity, low evaporation losses, to the climate of the forest-steppe zone, which is a transition region, and further south - to the climate of the steppes and semi-deserts, where is little precipitation, the air is dry and the relative losses due to evaporation are very great. The great extent of the plain from north to south determined a well-pronounced zonality in the distribution of its landscapes. In the north the coast of the Barents Sea is occupied by cold, heavily waterlogged plains. This part of the plain is located in the tundra and forest-tundra zone. Typical forest landscapes prevailed in the middle belt-dark coniferous taiga, mixed, broad-leaved oak and lime forests. At present time many forests are cut down and forest landscapes have turned into forest-steppe. To the east of the Lower Volga is a region of the High Transvolga, directly adjacent to the Middle and Southern Urals and merging with its foothills. The region is also characterized by the presence of vast lowlands. The extreme southeast (the Caspian Lowland) is a semi-desert, that is, a region transitional from steppes to deserts. In the south there are steppe landscapes, passing to the foothills and mountains of the Caucasus (Isachenko 1985, Geography of Russia 1998).

Research methods

The authors in total have inspected more than 1,000 localities in the following administrative units: Belgorod, Volgograd, Penza, Nizhny Novgorod, Tambov, Saratov, Republic of Mordovia, Chuvash Republic. In addition, the collections from other regions were studied. In the course of research habitats visited by imago plants were re-

corded.

Studied by the authors and their colleagues in nature, the material is presented in the section "Material examined". Catch in most cases was not produced. During the study the authors studied the most diverse forest biotopes: mixed forests, small-leaved forests, broad-leaved forests. To study imago window traps, manual collection from flowering plants, trunks, from tree crowns, mowing of vegetation were used. To study used visual observations, catch with odorous baits.

In order to assess the contemporary distribution area of *Protaetia fieberi* in the European part of Russia fully, additionally all available literature has been studied.

The collections are kept in the depositories of Penza State University (Penza), the Mordovia State Nature Reserve (Republic of Mordovia), Saratov State University (Saratov), as well as in several private collections. Abbreviations: specimen – ex.

Distribution

Material examined:

Belgorod Region (depository of the collector): Belgorie State Nature Reserve, 17 VII 2011, 1 ex., A. Ivanov.

Ivanovo Region (depository of the collector): Yuzha district, Glushitsy, 20 VI 2017, 1 ex., D. Rumyantsev.

Moscow Region (depository of the collector): Serpukhov district, Nikiforovo, 6 VI 2000, 2 ex., G.D. Samodurov; 1,2 km W Respublika, 18 VI 2016, 1 ex., A. Marchenko.

Nizhniy Novgorod Region (depository of the Mordovia State Nature Reserve): Voznesenskoe district, Svobodnyi, 16 VII 2017, A.B. Ruchin.

Penza Region (depository of the Penza State University): Shemysheika district, biostation of Penza State University, 4 VII 1999, 13 VII 2006, 4 ex., T.G. Stoiko, 10–16 VII 2003, 5 ex., I.V. Glebov, N.F. Zolina. Bessonovka district, Pobeda, 31 V 2002, 2 ex., T.G. Stoiko. Lunino district, Sytinka, VII 2017, 1 ex., E.M. Monakhov. Kuznetsk district, Chibirlei, 6 VII 2005, 1 ex., A. Pimenova; 7 km E Sosnovka, 8 VII 2012, 1 ex., O.A. Polumordvinov.

Republic of Mordovia (depository of the Mordovia State Nature Reserve): Ichalki district, National Park «Smolny», Obrezki, 14 VII 2007, 1 ex., A.B. Ruchin. Ardatov district, Probuzhdenie, 2 VII 2008, 1 ex., A.B. Ruchin. Bolshie Berezniki district, 10 km S Simkino, 29 VI 2008, 1 ex., A. Bilenkowski (det. A. Gusakov). Bolshie Berezniki district, 6 km SE Permissi, 12 VI 2015, 1 ex., A.B. Ruchin. Bolshoe Ignatovo district, National Park «Smolny», 30 km SW Bolshoe Ignatovo, 18 VI 2018, 1 ex., A.B. Ruchin. Ichalki district, National Park «Smolny», 7 km N Ichalki, 20 VII 2018, 4 ex., A.B. Ruchin. Tengushevo district, Barashevo, 2 VII 2018, 1 ex., A.B. Ruchin. Zubova Polyana district, Yavas, 2 VII 2018, 1 ex., A.B. Ruchin. Insar district, Aleksandrovka, 10 VI 2018, 1 ex., A.B. Ruchin. Kochkurovo district, Krasnaya Zorka, 20 VII 2018, 3 ex., A.B. Ruchin. Ruzaevka district, Khovanschina, 10 VI 2018, 1 ex., A.B. Ruchin. Ruzaevka district, Boldovo, 10 VI 2018, 1 ex., A.B. Ruchin. Temnikov district, 10 km N Temnikov, 6 VIII 2018, 2 ex., A.B. Ruchin.

Republic of Tatarstan (depository of the collector): Kazan city, Arakchino, 23 VII 2010, 1 ex., D.A. Klemin.

Roston-on-Don Region (depository of the collector): Ust-Donetsky district, Razdorskaya, 25 VI–10 VII 2008, 1 ex., E. Khachikov. Belaya Kalitva district, Pochtovyi, 28 VI 2013, 1 ex., V.Yu. Zubov.

Saratov Region (depository of the Saratov State University): Balashov district, Repnoe, 10–30 VI 2013, 3 ex., A.N. Volodchenko. Khvalynsk district, Staraya Yablonka, 15 V 2014, 2 ex., A.S. Sazhnev; National Park «Khvalynsky», 19 V 2013, 1 ex., A.S. Sazhnev. Novye Burasy district, Mokhovoe boloto, 24 IV 1985, 1 ex., O.A. Garanin. Rtishchevo district, Kluchi, 13 VI 1992, 1 ex., I.V. Kryukov; same label, 26–28 VI 2008, 1 ex., A.S. Sazhnev. Saratov district, Burkin Buerak, 11 VII 2009, 2 ex., A.S. Sazhnev; same label, 20 VI 2010, 2 ex., A.S. Sazhnev; Saratov city, Kumyssnaya Polyana, 26 VI 2010, 1 ex., A.S. Sazhnev. Engels district, Engels, Lesnoi, 29 VI 2012, 1 ex., A.S. Sazhnev. Atkarsk district, Krasavka, 10 VI 2012, 1 ex., A.S. Sazhnev. Lysye Gory district, Simonovka, 27 VI 2012, 1 ex., A.S. Sazhnev.

Tambov Region (depository of the collectors): Inzhavino district, Olkhovka, 11 VII 1997, 2 ex., R.N. Ishin. Tambov district, Tulinovka, 23 VI 2015, 1 ex., R.N. Ishin; Tambovsky Leskhoz, 21 VI 2017, 2 ex., R.N. Ishin; 5,6 km E Tambov, natural boundary "Kurgan Vshivaya Gorka", 24 V 2014, 2 ex., R.N. Ishin. Tambov city, 15–21 VII 2017, 4 ex., R.N. Ishin. Rasskazovo district, 5 km S Novaya Lyada, 29 VI 2003, 1 ex., Ya. A. Urbanus.

Volgograd Region (depository of the collector): Staraya Poltavka district, Saltovo, 9 V 2010, 1 ex., A.S. Sazhnev.

Distribution in the European part of Russia (Published data):

Vladimir Region: Gorokhovets district (Mukhanov, 2012: 124).

Volgograd Region: Kamyshin town (Medvedev, 1964: 239). Ilovlya district (Shokhin, 2007: 176). Without further locality information (Arzanov et al. 1992: 31; Shokhin, 2002: 136).

?Vologda Region: Kirillovsky district (Belova et al., 2008: 87).

Voronezh Region: Bobrovsky district, Podgorensky district, Novokhopersk district (Red Data Book of Voronezh Region, 2011: 167). «Shipov les» (Medvedev, 1964: 239).

Ivanovo Region: Pestyaki district (Red Data Book of Ivanovo region, 2007: 52).

Kaluga Region: Ulianovo district (Red Data Book of Kaluga region, 2006: 85).

Kirov Region: Kotelnichi district, Vyatskie Polyany district, Malmyzh district, Kilmez district (Red Data Book of Kirov Region, 2014: 104). Vyatskie Polyany town (Dedyukhin, 2006: 133).

Krasnodar Region: Novorossiysk city (Shokhin, 2016: 79).

Moscow Region: Voskresensk district, Serpukhov district, Likhovitsy district (Red Data Book of Moscow Region, 2008: 203).

Nizhniy Novgorod Region: Bor district (Anufriev, Bayanov, 2002: 261).

Orenburg Region: Buzuluk district, Tashla district, Sakmary district, Orenburg district, Saraktash district, Tyulgan district, Kuvandyk district (Shapovalov et al., 2011: 68). Kuvandyk district (Nemkov, 2012: 60). Without further locality information (Nemkov, 2011: 217).

Penza Region: Penza city (Medvedev, 1964: 238). Without further locality information (Red Data Book of Penza Region, 2005: 193).

Republic of Mordovia: Mordovia State Nature reserve (Egorov, Ruchin, 2013: 120; Ruchin, Egorov, 2017: 5).

Rostov-on-Don Region: Ust-Donetsky district, Tarasovo dis-

trict, Sholokhov district (Shokhin, 2007: 176).
 Ryazan Region: Oka State Nature reserve (Nikolaeva, Nikolaeva, 2017: 64).
 Samara Region: Kamyshla district (Red Data Book of Samara Region, 2009: 110). Samara city (Medvedev, 1964: 238). Without further locality information (Isaev et al., 2004: 33).
 Saratov Region: Balashov district, Khvalynsk district (Volodchenko, Sazhnev, 2016: 12). Novye Burasy district, Rtishchevo district (Sazhnev, Rodnev, 2010: 506). Without further locality information (Anikin, Sazhnev, 2016: 43)
 Tambov Region: Vorona State Nature reserve (Beskokotov, Samokhin, 2009: 128).
 Tula Region: Odoevsk district, Dubna district, Shchekino district, Belev city (Bolshakov et al., 2015: 13).
 Ulyanovsk Region: Melekessky district (Artemyeva et al., 2010: 109). Cherdakly district, Novospassk district (Isaev, 1995: 44). Without further locality information (Isaev et al., 2004: 33). Melekessky district, Staraya Maina district (Artemyeva et al., 2013: 11).
 Udmurt Republic: Votkinsk district, Sarapul district, Kizner district, Malaya Purga district, Karakulino district, Izhevsk city, Syumsa district (Dedyukhin, 2006: 133).
 Chuvash Republic: it is known almost from all districts of the republic, including Zavolzhye (left-bank part) (Kozlov, Oliger, 1960; Isajev et al., 2004: 33; Red Data Book of Chuvashia Republic, 2010: 42; Egorov, Egorova, 2012: 26; Egorov, Grigorjev, 2012: 24; Egorov, 2017: 111; Egorov, Ivanov, 2018: 194).

Contemporary distribution in the European part of Russia:

Belgorod, Vladimir, Volgograd, Vologda (?), Voronezh, Ivanovo, Kaluga, Kirov, Moscow, Nizhny Novgorod, Orenburg, Penza, Rostov, Ryazan, Samara, Saratov, Tambov, Tula, Ulyanovsk Regions, Republic of Mordovia, Udmurt Republic, Republic of Tatarstan, Chuvash Republic, Krasnodar Region (Fig. 1). Presumably it should also live in Bryansk, Kursk, Lipetsk, Orel, Smolensk Regions, Perm Region, Republic of Bashkortostan and Republic Mari El.

Discussion

According to the information from the mid XX century (Medvedev, 1964), the northern distribution border of *P. fieberi* in the European part of Russia was in the south of Tula Region, through Penza, Samara. The eastern border passed through the Volga valley to Kamyshin (Volgograd Region), from which the southern border further stretches along the south of Voronezh Region and leaves to the middle course of the Severskiy Donets River (Ukraine) (Fig. 1). However, it should be noted that the first record for *P. fieberi* (as *Potosia incerta* Costa, p. 69) from the Middle Volga belongs to Kozlov and Oliger (1960), who reported it from the collections of the mid-1950s from three localities in Chuvash Republic.

To the north of Ivanovo, Nizhny Novgorod, Kirov regions and the Republic of Udmurtia (Votkinsky, Sarapulsky, Kiznersk, Malopurginsky, Karakulinsky, Syumsinsky districts, Izhevsk (Dedyukhin 2006: 133)) the species was hitherto not reported. However, there is an indication from the Vologda Region exists, but the authors (Belova et al. 2008)

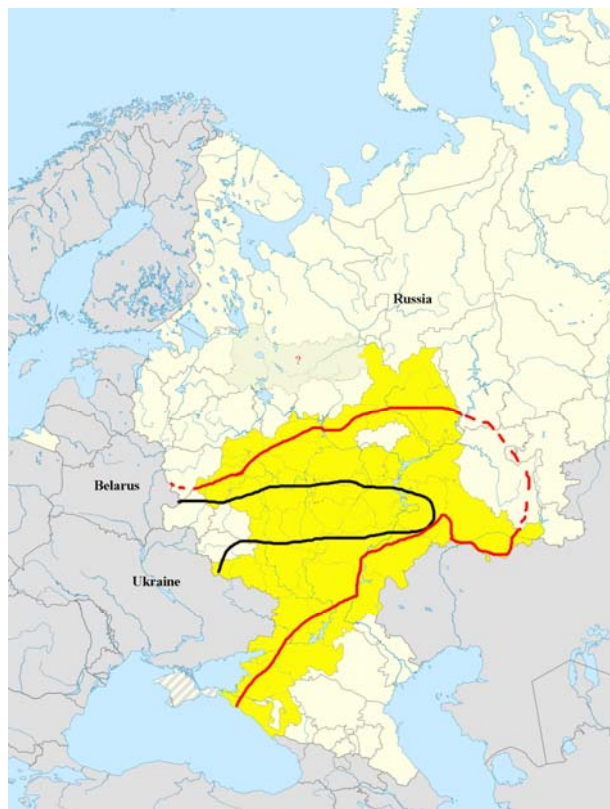


Figure 1. The updated distribution area of *Protoetia fieberi* (Kraatz, 1880) in the European part of Russia. Yellow colour shows administrative regions from where *P. fieberi* is reliably known; the solid red line indicates the distribution boundary of the species, the dotted red line limits the potential extend of the range of the species, the black line indicates the range border according to Medvedev (1964).

expressed doubt about the habitat of the species in the region. Therefore Vologda Region record of *P. fieberi* needs further confirmation. In the south of the Yaroslavl Region, where coleopterological studies are conducted quite intensively (Yakovlev 1902, Gemmelman 1927), the species has not been found yet. In the Republic of Mari El the species is likely to live but it has not been reliably found so far. The eastern boundary of known findings covers Tatarstan, Udmurtia and Orenburg Region. At the same time in the Republic of Bashkiria there are also quite suitable habitats available where *P. fieberi* could occur. South of the Samara Region beyond the Volga River it has been found only in Volgograd (Staraya Poltava district) and Saratov (Engels district) regions. In the very south of Russia the species is known only from Novorossiysk. In this case to the south of the Don River in the Rostov-on-Don Region *P. fieberi* does not occur. In the Caucasus this species was not observed as well. In the west of Russia in the Bryansk, Orel, Smolensk and Kursk regions it is also not yet reliably found. However, suitable habitats are present in this area considering occurrence of another rare saproxylic species such as *Osmoderma barnabita* Motschulsky, 1845 and *Protoetia speciosissima* (Scopoli 1786).

In Penza Region *P. fieberi* considered to be a very local and rare, confined to broadleaved and mixed forests dominated by *Quercus robur* L. It mainly inhabits floodplains and the natural banks of rivers, where veteran hardwood are

available in sufficient quantity. Beetles occur from late May to August (more often in July). Diurnal, use trees with flowing sap and forest glades with flowering herbaceous plants for feeding, mainly the inflorescences of Umbelliferae. Regular records are timed to the biostation of Penza University, which is located on the south-eastern shore of Penza Reservoir. Here, in the water protection zone, is a mixed forest with a predominance of uneven-aged trees of deciduous species: aspen, linden, birch and oak. Here are many old trees and fallen trees, high humidity and developed undergrowth (filbert and rowan).

In Voronezh Region just a few specimens were found (Red Data Book of Voronezh region 2011, Negrobov 2015). In Kaluga Region it is very rare (Red Data Book of Kaluga region, 2006). On the territory of Tambov Region *P. fieberi* is most common in the central part and is confined to the floodplain forests of the Tsna River. Most of the observations are made at forest edges with predominance of alder, black poplar, oak, adjacent to wetlands. Beetles are noted from the flowering meadowsweet *Filipendula ulmaria* (L.) Maxim., the inflorescences of *Galium verum* L. together with *Cetonia aurata* (Linnaeus, 1758), *Protaetia metallica* (Herbst, 1782), and *Strangalia attenuata* (Linnaeus, 1758). In the south-east of the region the species is observed in the floodplain oak forests of the Crow River.

In Udmurtia, most of the records of *P. fieberi* are confined to the old deciduous forests in the valleys of Kama and Vyatka. The largest population is known from the territory of the national park "Nechkinskiy", where this beetle occurs in the floodplain forests with the participation of oak. This population is protected. On the watersheds of rivers, *P. fieberi* is very rare and sporadic. It develops in rotten wood and hollows of old oaks, white willows and black poplars (Dedyukhin 2006).

In Orenburg Region it occurs in broad-leaved forests, preferring items with oak and lime. Beetles were observed on tapped oaks and other deciduous trees, as well as on the inflorescences of *Spiraea*, *Padus*, *Rosa*, *Echinops*, *Filipendula*, *Heracleum*, *Angelica*, and other plants. The population is moderately rich however, at some places it is quite common (Shapovalov et al. 2011).

In the Republic of Mordovia, it inhabits floodplain oak forests (with oak and lime), floodplain meadows near these forests, as well as secondary deciduous forests, mixed forests with the participation of hardwood tree species (Ruchin & Egorov 2017). According to the dates of the published observations, the period of imago activity is in June and July. However, in the southern part of the range imago is found in May and even in April.

Thus *P. fieberi* is predominantly rare in most of its range in Russia (Sazhnev & Rodnev 2010, Shapovalov et al. 2011, Volodchenko & Sazhnev 2016), but it is quite common in southern areas (Saratov, Orenburg regions). The main habitats are old deciduous forests of oak, lime, willow, and black poplars. Imago are diurnal and appear on tree sap, as well as on various flowering plants of Umbelliferae, Asteraceae and Rosaceae (Bourneuf 1997, Tauzin 2007, Shapovalov et al. 2011, Ruchin & Egorov 2017). The main limiting factors are the rarity and vulnerability of the species on the northern and eastern boundaries of its range, the reduction of areas

occupied by old-growth oak forests; dying out and felling of old oaks.

Acknowledgements. We thank A.N. Volodchenko (Russia, Balashov), I.V. Kryukov (Russia, Saratov), D.A. Klemin (Russia, Kazan), T.G. Stojko (Russia, Penza), I.V. Glebov (Russia, Penza), D. Rumyantseva (Russia, Ivanovo), Ya. A. Urbanus (Russia, Lipetsk) for the information about the findings.

References

- Anikin, V.V., Sazhnev, A.S. (2016): The Recommended Species of Terrestrial Invertebrates for Including in the New Edition of the Red Book of Saratov Province. *Izvestiya of Saratov University. New Series. Series: Chemistry. Biology. Ecology* 16(3): 313–318. [In Russian].
- Anufriev, G.A., Bayanov, N.G. (2002): Fauna of invertebrates of the Kerzhensky Reserve according to the results of researches of 1993–2001. *Proceedings of the State Nature Reserve «Kerzhenskiy»* 2: 152–354. [In Russian].
- Artemieva, E.A., Kovalev, A.V., Krasun, B.A. (2010): Rare insects of key areas of Ulyanovsk region. *Nature of Simbirsk region of the Volga. Ulyanovsk* 2010: 107–113. [In Russian]
- Artemieva, E.A., Korolkov, M.A., Semenov, D.Yu. (2013): Materials on the Red Book species of selected groups of fauna of Ulyanovsk region. *Ulyanovsk* 2013: 88 pp. [In Russian]
- Arzanov, Yu.G., Komarov, E.V., Khachikov, E.A., Fomichev, A.I., Shokhin, I.V. (1992): Materials on the coleopterans (Coleoptera) of the Northern Caucasus and the Lower Don. III.1. Lamellicorn beetles. *Rostov-on-Don*: 31 pp. Dep. in VINITI, No. 696–B92. [In Russian]
- Baumann, M., Kuemmerle, T., Elbakidze, M., Ozdogan, M., Radeloff, V. C., Keuler, N.S., Prishchepov, A.V., Kruhlov, I., Hostert P. (2011): Patterns and drivers of post-socialist farmland abandonment in Western Ukraine. *Land Use Policy* 28(3): 552–562.
- Baumann, M., Ozdogan, M., Kuemmerle, T., Wendland, K.J., Espipova, E., Radeloff, V.C. (2012): Using the Landsat record to detect forest-cover changes during and after the collapse of the Soviet Union in the temperate zone of European Russia. *Remote Sensing of Environment* 124: 174–184.
- Belova, Yu.N., Dolganova, M.N., Kolesova, N.S., Shabunov, A.A., Filonenko, I.V. (2008): Variety of insects of Vologda region. *Vologda*: 368 pp. [In Russian]
- Beskokotov, Yu.A., Samokhin, D.M. (2009): To the knowledge of the entomofauna of the Reserve "Voroninskiy". *Proceedings of the State Nature Reserve "Voroninskiy"* 1: 118–141. [In Russian]
- Bolshakov, L.V., Dorofeev, Yu.V., Ryabov, S.A., Andreev, S.A., Lakomov, A.F., Chuvilin, A.V., Sviridov, A.V., Mikhailenko, A.P., Mamatkulov, A.L., Levchenko, T.V. (2015): Information on the cadastre of invertebrate animals of the Red Book of Tula region (2013). *Proceedings of the Mordovia State Nature Reserve* 14: 3–34. [In Russian]
- Bourneuf, F. (1997): Sur la capture de quatre espèces de Cétoines dans la Sarthe (Coleoptera, Cetoniidae). *L'Entomologiste* 53(1): 29–30.
- Dedyukhin, S.V. (2006): The data on the Red book Coleoptera and the species recommended to a new red list in the Udmurt Republic. *Bulletin of Udmurt University. Series Biology* 10: 129–140. [In Russian]
- Dollin, P.E., Majka, C.G., Duinker, P.N. (2008): Saproxyllic beetle (Coleoptera) communities and forest management practices in coniferous stands in southwestern Nova Scotia, Canada. In: Majka, C. G., Klimaszewski, J. (eds). *Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera. ZooKeys* 2: 291–336.
- Egorov, L.V. (2017): Some data concerning the Coleoptera fauna of the Nature Reserve «Prisurskiy». *Information 6. Scientific proceedings of the State Nature Reserve "Prisurskiy"* 32: 104–141. [In Russian]
- Egorov, L.V., Egorova, M.A. (2012): New data on insect findings (Arthropoda, Insecta-Ectognatha) included in the Red Data Book of the Chuvash Republic. *Ecological Herald of the Chuvash Republic* 1(75): 24–28. [In Russian]
- Egorov, L.V., Grigorjev, O.A. (2012): New data on coleopteran insects (Insecta-Ectognatha, Coleoptera) of the Red Book of the Chuvash Republic. *Ecological Herald of the Chuvash Republic* 1(75): 23–24. [In Russian]
- Egorov, L.V., Ivanov, A.V. (2018): Beetles (Insecta, Coleoptera), collected by fermental crown traps in Chuvashia. *Proceedings of the Mordovia State Nature Reserve* 21: 191–204. [In Russian]

- Egorov, L.V., Ruchin, A.B. (2013): New data on rare insect species (Arthropoda, Insecta-Ectognatha) of Mordovia. *Mordovia University Bulletin* 3-4: 116-121. [In Russian]
- Gemmelman, S.S. (1927): List of beetles (Coleoptera) of the Pereslavl district of the Vladimir province. *Proceedings of Pereslavl-Zalesky Museum of History, Art and Local Lore*. 4: 43-87.
- Geography of Russia. (1998): Encyclopaedic dictionary. Ed. A.P., Gorkina. Moscow: The Great Russian Encyclopedia: 800 pp.
- Fayt, P., Dufrene, M., Branquart, E., Hastir, P., Pontegnie, Ch., Henin, J.-M., Versteirt, V. (2006): Contrasting responses of saproxylic insects to focal habitat resources: the example of longhorn beetles and hoverflies in Belgian deciduous forests. *Journal of Insect Conservation* 10: 129-150.
- Isachenko, A.G. (1985): Landscapes of the USSR. Leningrad: Leningrad State University Press: 320 pp. [In Russian]
- Isaev, A.Yu. (1995): To the knowledge of the fauna of lamellicorn beetles (Coleoptera, Lamellicornia: Lucanidae, Trogidae, Scarabaeidae) of Ulyanovsk Region. *Insects of Ulyanovsk Region* 2: 28-45. [In Russian]
- Isaev, A.Yu., Egorov, L.V., Egorov, K.A. (2004): Coleopterans (Insecta, Coleoptera) of the forest steppe of the Middle Volga region. Catalog. Ulyanovsk: Ulyanovsk State University: 72 pp. [In Russian]
- Jaworski, T., Plewa, R., Hilszczański, J., Szczepkowski, A., Horak, J. (2016): Saproxylic moths reveal complex within-group and group-environment patterns. *Journal of Insect Conservation* 20(4): 677-690.
- Kozlov, M.A., Oliger, I.M. (1960): To the study of the fauna of the coleopterans of the Chuvash Autonomous Soviet Socialist Republic. *Scholarly notes of Chuvash pedagogical Institute* 11: 153-167. [In Russian]
- Kuemmerle, T., Radeloff, V.C., Perzanowski, K., Hostert, P. (2006): Cross-border comparison of land cover and landscape pattern in Eastern Europe using a hybrid classification technique. *Remote Sensing of Environment* 103(4): 449-464.
- Medvedev, S.I. (1964): Lamellicorn beetles (Scarabaeidae): Cetoniinae, Valginae. Moscow; Leningrad: 375 pp. (Fauna of the USSR NS No. 90. Coleoptera, 10(5)). [In Russian]
- Mukhanov, A.V. (2012): Analytical review of species of invertebrate animals in need of protection on the territory of Vladimir region. Specially protected natural territories and objects of Vladimir region and adjacent regions. *Vladimir*: 122-126. [In Russian]
- Müller, J., Wende, B., Strobl, C., Eugster, M., Gallenberger, I., Floren, A., Steffan-Dewenter, L., Linsenmair, K.E., Weisser, W.W., Gossner, M.M. (2015): Forest management and regional tree composition drive the host preference of saproxylic beetle communities. *Journal of Applied Ecology* 52: 753-762.
- Negrobov, S.O. (2015): New data of phenotypic variability of Cetoniidae (Coleoptera) the Central Chernozem region. *Euroasian Entomological Journal* 14(6): 571-573. [In Russian]
- Nemkov, V.A. (2011): Entomofauna of the steppe Priuralye (history of formation and study, composition, changes, protection). Moscow: 316 pp. [In Russian]
- Nemkov, V.A. (2012): The study of the entomofauna of the reserve "Orenburg". *Proceedings of Orenburg branch of the Russian Entomological Society* 2: 59-62. [In Russian]
- Nikolaeva, A.M., Nikolaev, N.N. (2017): Rare insects of the Oka Reserve recommended for inclusion in the Red Data Book of the Russian Federation. *Nature Conservation Research* 2(1): 61-69. [In Russian]
- Plewa, R., Jaworski, T., Hilszczański, J., Horák, J. (2017): Investigating the biodiversity of the forest strata: The importance of vertical stratification to the activity and development of saproxylic beetles in managed temperate deciduous forests. *Forest Ecology and Management* 402: 186-193.
- Potapov, P.V., Turubanova, S.A., Tyukavina, A., Krylov, A.M., McCarty, J.L., Radeloff, V.C., Hansen, M.C. (2015): Eastern Europe's forest cover dynamics from 1985 to 2012 quantified from the full Landsat archive. *Remote Sensing of Environment* 159: 28-43.
- Prishchepov, A.V., Radeloff, V.C., Baumann, M., Kuemmerle, T., Mueller, D. (2012): Effects of institutional changes on land use: agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe. *Environmental Research Letters* 7: 024021-024022.
- Quinto, J., Marcos-García, M.Á., Díaz-Castelazo, C., Rico-Gray, V., Brustel, H., Galante, E., Micó, E. (2012): Breaking down complex saproxylic communities: understanding sub-networks structure and implications to network robustness. *Public Library of Science ONE* 7(9): e45062.
- Red Data Book of Chuvashia Republic. (2010): Vol. 1. P. 2. Rare and endangered species of animals. Cheboksary: State Unitary Enterprise "IPC "Chuvashia": 372 pp. [In Russian]
- Red Data Book of Ivanovo region. (2007): Ivanovo: Press Room: 236 pp. [In Russian]
- Red Data Book of Kaluga region. (2006): Kaluga: Zolotaya allea: 608 pp. [In Russian]
- Red Data Book of Kirov region: animals, plants, mushrooms. (2014): Kirov: Department of Ecology and Nature Management of Kirov Region: 335 pp. [In Russian]
- Red Data Book of Moscow Region. (2008): Moscow: KMK Scientific Press Ltd: 855 pp. [In Russian]
- Red Data Book of Penza Region. (2005): Vol. 2. Animals. Penza: 210 pp. [In Russian]
- Red Data Book of Samara region. (2009): Vol. 2. Togliatti: Institute for International Relations of the Russian Academy of Sciences, "Kassandra": 332 pp. [In Russian]
- Red Data Book of Voronezh region. (2011): Animals, 2. Voronezh: MODEK: 424 pp. [In Russian].
- Ruchin, A.B., Egorov, L.V. (2017): Overview of insect species included in the Red Data Book of Russian Federation in the Mordovia State Nature Reserve. *Nature Conservation Research* 2(1): 2-9. [In Russian]
- Ruchin, A.B., Egorov, L.V. (2018a): Fauna of longicorn beetles (Coleoptera: Cerambycidae) of Mordovia. *Russian Entomological Journal* 27(2): 161-177.
- Ruchin, A.B., Egorov, L.V. (2018b): *Leptura aurulenta* (Coleoptera, Cerambycidae), a new record of a very rare species in Russia. *Nature Conservation Research* 3(1): 88-91.
- Ruchin, A.B., Kurmaeva, D.K. (2010): On rare insects of Mordovia included in the Red Book of the Russian Federation. *Entomological Review* 90(6): 712-717.
- Ruchin, A.B., Egorov, L.V., Semishin, G.B. (2018): Fauna of click beetles (Coleoptera: Elateridae) in the interfluvium of Rivers Moksha and Sura, Republic of Mordovia, Russia. *Biodiversitas* 19(4): 1352-1365.
- Sazhnev, A.S., Rodnev, N.V. (2010): Preliminary lists of species of subfamilies Trichiinae, Cetoniinae and Valginae (Coleoptera, Scarabaeidae) of Saratov region fauna. *First international Becker readings* 1: 507-509. [In Russian]
- Shapovalov, A.M., Nemkov, V.A., Rusakov, A.V. (2011): Protected coleopterans (Insecta, Coleoptera) of Orenburg region. *Proceedings of Orenburg branch of the Russian Entomological Society* 1: 49-79. [In Russian]
- Shokhin, I.V. (2002): Lamellicorn beetles (Coleoptera, Scarabaeoidea) of the Lower Volga region. Biodiversity of insects of the southeast of the European part of Russia. *Volgograd*: 93-146. [In Russian]
- Shokhin, I.V. (2007): Contribution to the fauna of lamellicorn beetles (Coleoptera, Scarabaeoidea) of Southern Russia, with some nomenclatural changes in the family Scarabaeidae. *Caucasian Entomological Bull* 3(2): 105-185. [In Russian]
- Shokhin, I.V. (2016): Contribution to the fauna of lamellicorn beetles (Coleoptera: Scarabaeoidea) of Southern Russia. Addition 1. *Caucasian Entomological Bull* 12(1): 75-79. [In Russian]
- Siitonen, J. (2001): Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forest as an example. *Ecological Bulletins* 49:11-41.
- Speight, M.C.D. (1989): Saproxylic invertebrates and their conservation. *Nature and Environment Series*, 42; Council of Europe: Strasbourg, France.
- Stenbacka, F., Hjältén, J., Hilszczański, J., Dynesius, M. (2010): Saproxylic and non-saproxylic beetle assemblages in boreal spruce forests of different age and forestry intensity. *Ecological Applications* 20: 2310-2321.
- Tauzin, P. (2007): *Chorologie et éco-éthologie de Protactia (Potosia) fieberi* Kraatz 1880 en France (Coleoptera, Cetoniinae, Cetoniini). *Cetoniomania* 3 et 4: 115-146.
- Tomaszewska, W., Egorov, L.V., Ruchin, A.B., Vlasov, D.V. (2018): First record of *Clemmus troglodytes* (Coleoptera: Coccinelloidea, Anamorphidae) for the fauna of Russia. *Nature Conservation Research* 3(3): 103-105.
- Volodchenko, A.N. (2009): Succession complexes of xylobiontic coleopterans of deciduous forests in the Middle Prihoperie. Publishing house of Saint Petersburg State Forest Technical Academy 187: 79-86. [In Russian]
- Volodchenko, A.N., Sazhnev, A.S. (2016): New and little known xylophilous beetles (Coleoptera) in Saratov Province. *Eversmannia* 47-48: 11-18. [In Russian]
- Yakovlev, A.I. (1902): List of beetles (Coleoptera) of the Yaroslavl province. *Proceedings of the Yaroslavl Natural History Society* 1: 88-186.