

SHORT COMMUNICATIONS

КРАТКИЕ СООБЩЕНИЯ

DIPTERA SPECIES, NEW FOR THE REPUBLIC OF MORDOVIA, RUSSIA

Mikhail N. Esin^{1,*} , Alexander B. Ruchin¹ , Dmitriy I. Gavryushin²,
Yu-Qiang Xi³, Libor Dvořák⁴, Kateřina Dvořáková⁴

¹Joint Directorate of the Mordovia State Nature Reserve and National Park «Smolny», Russia

*e-mail: esinmishka@gmail.com

²Lomonosov Moscow State University, Russia

³Henan Agricultural University, China

⁴Tri Sekery, Czech Republic

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The nature conservation depends on the completeness of the knowledge about the biodiversity in the study area. Today, data on distribution and diversity of Diptera taxa remain fragmentary. This paper supplements data on the diversity of Diptera species in Europe, Russia, and the Republic of Mordovia. We have studied 1321 specimens of 241 species collected in 2013–2022. Among them, there are species, which are new for Russia (*Neoempheria brevilineata*, *Desmometopa discipalpis*) and for both Russia and Europe (*Neophyllomyza flavescens*, *Phyllomyza auriculatula*, *P. luteipalpis*, *P. orbita*, *P. piceus*, *P. striolatum*). We have found for the first time 231 Diptera species for the fauna of the Republic of Mordovia; the families of Bolitophilidae, Keroplatidae, Scatopsidae, Platypezidae, Micropezidae, Opomyzidae, Asteiidae, and Milichiidae have been found for the first time in this region. *Anthrax incomptus* (Bombyliidae), being previously reported for the Republic of Mordovia, has been excluded now from the fauna of this region. Nine Diptera species have been previously indicated for the Republic of Mordovia without reliable confirmation by collected specimens. In this study, we have confirmed their presence in the Republic of Mordovia. Taking into account the results of the present paper, the Diptera fauna of the Republic of Mordovia includes currently 1187 species belonging to 71 families. Data on collecting methods have been presented for the found species. We provide a comparison of collecting methods and suggestions for an effective inventory of the regional Diptera fauna. We are of the view that the number of the used collecting methods affects positively the results of the fauna inventory.

Key words: collecting method, Europe, flies, Milichiidae, trap

Introduction

A basis for inventories of living organisms, enabling the creation of taxonomic checklists, are new records of species in countries, smaller regions or Protected Areas (e.g. Wagner, 2020; Baranovski et al., 2021; Méndez & Thomaes, 2021; Dvořák et al., 2022). Since the anthropogenic impact is increasing in many regions in the world, such studies are important for a more accurate assessment of the biodiversity status (e.g. Govorushko & Nowicki, 2019; Blowes et al., 2022; Hoffmann, 2022; Zouaimia et al., 2022; Chowdhury et al., 2023).

There is a small number of publications containing comprehensive checklists of various Diptera families. In the Republic of Mordovia, detailed species lists have been published only for Asilidae (Astakhov et al., 2019), Simuliidae (Budaeva & Ruchin, 2014), Bombyliidae (Chursina & Ruchin, 2018a), Syrphidae (Chursina & Ruchin, 2018b), Limoniidae, Pediciidae, Tipulidae (Dvořák et al., 2020; Pilipenko et al., 2020), Sciomyzidae (Dvořák et al., 2020; Vikhrev et al., 2020), Fanniidae and

Mucsidae (Vikhrev et al., 2020), Ephydriidae and Lonchaeidae (MacGowan et al., 2021). In addition to the Diptera faunistics, general ecological aspects of this insect order have been studied (e.g. Ruchin & Esin, 2021; Ruchin et al., 2021a; Gornostaev et al., 2022). Recently, Esin (2021) has summarised all available data on the Diptera fauna in the Republic of Mordovia. A few more papers on Diptera have also been published, including new faunistic records (Grichanov, 2021; Ruchin et al., 2021b; Gornostaev et al., 2022; Lutovinovas et al., 2022) and Lonchaeidae species new for Russia (MacGowan & Ruchin, 2022). Other Diptera families remain poorly studied in the Republic of Mordovia. The present paper is devoted to present records of Diptera species, new for the Republic of Mordovia, Russia and Europe.

Material and Methods

Study area

The Republic of Mordovia is located on the edge of the forest and forest-steppe natural zones in

the middle zone of European Russia (Fig. 1). Its area is about 26 200 km². The Republic of Mordovia is characterised by a high habitat diversity. Coniferous and mixed (coniferous-deciduous) forests are situated predominantly at the west and north-west of the region. Broadleaved forests are located in the centre and east of the Republic of Mordovia. Forest-steppe landscapes are distributed in the eastern and south-eastern areas of the region (Yamashkin, 2012).

The material was collected in the Republic of Mordovia (Russia) in 2013–2022 (Fig. 1). The main amount of data were obtained in two federal Protected Areas, namely Mordovia State Nature Reserve (MSNR) and the National Park «Smolny». To collect insects, we used beer traps (Ruchin et al., 2020), Malaise traps (Skvarla et al., 2021), yellow pan traps (Csanády et al., 2021), light traps (Singh et al., 2022), and hand held sweep-net.

Scientific names of Diptera families are ordered according to Nartshuk (2003). Species names within families are listed alphabetically. For each location, we present the following information: municipal district of the Republic of Mordovia, geographical co-ordinates, collecting method(s), habitat, date of the record, name(s) of the collector(s). The complete list of species, which are new for the fauna of the Republic of Mordovia, is available in the Electronic Supplement. New species for the

fauna of Europe and Russia are listed in the main text of this paper. The general distribution of species is indicated according to recent publications taking into account our data.

Specimens were identified by Dmitriy I. Gavryushin (Mycetophilidae, Limoniidae, Keroplatidae, Bibionidae, Ptychopteridae, Bolitophilidae, Pediciidae, Platypezidae), Nikita E. Vikhrev (Lonchopteridae, Chamaemyiidae, Sciomyzidae, Opomyzidae, Chloropidae, Hippoboscidae, Anthomyiidae, Fanniidae, Muscidae), Marina G. Krivosheina (Ephydriidae), Andrey L. Ozerov (Micropezidae, Pallopteridae, Piophilidae, Scathophagidae), Anatoliy I. Shatalkin (Psilidae, Lauxaniidae, Clusiidae), Valery A. Korneyev (Ulidiidae, Platystomatidae), Miroslav Barták (Sepsidae), Theo Zeegers (Tabanidae), Yu-Qiang Xi (Milichiidae), Libor Dvořák (Rhagionidae), Kateřina Dvořáková (Sciomyzidae, Heleomyzidae), Mikhail N. Esin (Xylophagidae, Xylomyidae, Stratiomyidae, Rhagionidae, Bombyliidae, Therevidae, Scenopinidae, Tephritidae, Chamaemyiidae, Asteiidae). Collected specimens are deposited in collections of the Zoological Museum of the Lomonosov Moscow State University (Russia), the Mordovia State Nature Reserve (Russia), the Henan Agricultural University (China), and in the Miroslav Barták's private collection (Czech Republic).

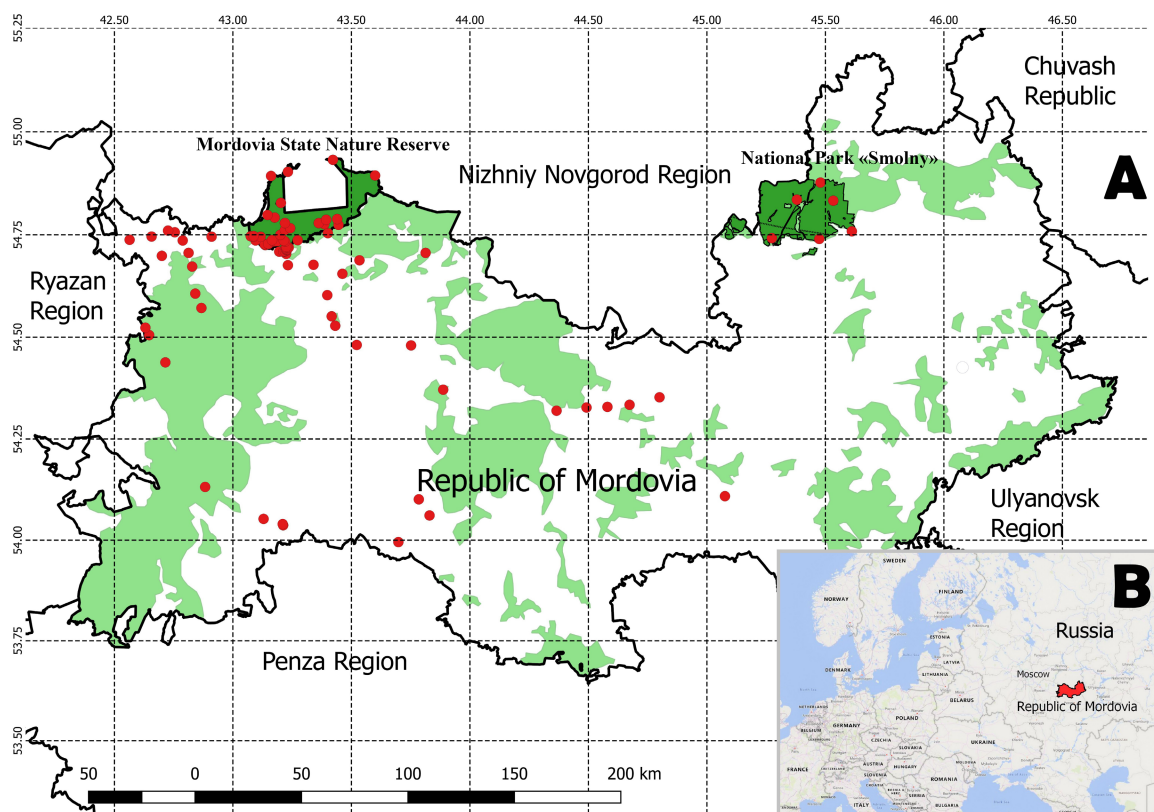


Fig. 1. Locations of the sampling sites (red dots) in the Republic of Mordovia (Russia) (A) and the location of the region in Europe (B).

The first publications on Diptera in the Republic of Mordovia (Plavilshchikov, 1964; Feoktistov, 2011) do not specify who exactly identified specimens and where exactly they were collected. Therefore, these data are at least to be considered doubtful. In the Electronic Supplement, we listed such species, i.e. reported previously by Plavilshchikov (1964) and Feoktistov (2011) and found by us, with an asterisk (*). The exception are Diptera species, new for the fauna of Russia (**) or for both Russia and Europe (***), which are listed only in the main text of this paper. The used term «cordon» means a lodge in the area of the Mordovia State Nature Reserve where forest rangers or other staff members may live and work.

Results

Records of Diptera species new in the Republic of Mordovia

Our studies have resulted in new data on the distribution of 241 Diptera species, including 231 ones, which had never been noted in the fauna of the Republic of Mordovia (see Electronic Supplement). In addition, the presence of nine species in this region has been confirmed by collected specimens.

The found 241 Diptera species belong to the families of Mycetophilidae (57 species), Limoniidae (30), Ephydriidae (14), Stratiomyidae (14), Milichiidae (10), Keroplatidae (9), Anthomyiidae, Lauxaniidae (8 both), Heleomyzidae, Rhagionidae (7 both), Sciomyzidae, Ulidiidae (6 both), Muscidae, Scathophagidae, Sepsidae (5 each), Bombyliidae, Clusiidae, Fanniidae (4 each), Psilidae, Scenopinidae (3 both), Asteiidae, Bibionidae, Chloropidae, Hippoboscidae, Lonchopteridae, Micropezidae, Piophilidae, Ptychopteridae, Tephritidae, Therevidae, Xylophagidae (2 each), Bolitophilidae, Chamaemyiidae, Opomyzidae, Pallopteridae, Pediciidae, Platypezidae, Platystomatidae, Scatopsidae, Tabanidae, Xylomyiidae (1 each). The families of Bolitophilidae, Keroplatidae, Scatopsidae, Platypezidae, Micropezidae, Opomyzidae, Asteiidae and Milichiidae have been recorded for the first time in the Republic of Mordovia.

Among the obtained data, there are new records for the fauna of Russia, namely *Neoempheria brevilineata* Okada, 1939 (Limoniidae), and *Desmometopa discipalpis* Papp, 1993 (Milichiidae). Six Milichiidae species are new for both Russia and Europe, namely *Neophyllomyza flavescens* Xi & Yang, 2018, *Phyllomyza auriculatus* Xi & Yang, 2018, *Phyllomyza luteipalpis* Malloch, 1914, *Phyllomyza orbita* Xi, Yang & Yin, 2020, *Phyllomyza piceus* Xi & Yang, 2018, *Phyllomyza striolatum* Xi, Yang & Yin, 2019.

The species found for the first time in the Republic of Mordovia have various general distributions (Fig. 2). The three highest numbers of species have a Palearctic (41.1%), West-Palearctic (32%), and Holarctic (13.7%) distribution.

Diptera species found for the first time in the Republic of Mordovia

We have studied 1321 specimens belonging to 241 species. Fig. 3 shows that the use of a hand held sweep-net and yellow pan traps resulted in the highest number of Diptera species, considered new for the Republic of Mordovia. Beer traps were not so effective. However, their use allowed us to make the most interesting records. For instance, seven species new for Russia and six ones new for both Europe and Russia have been collected by using beer traps (Fig. 3). More classic sampling methods (light traps and Malaise traps) allowed us to collect a lower number of new species. Nevertheless, they also contributed to extension of the Diptera fauna of the Republic of Mordovia. We have revealed that 91% of the newly found species were caught using only one collecting method.

In some Diptera families (Mycetophilidae, Ptychopteridae, Xylophagidae, Stratiomyidae, Rhagionidae, Therevidae, Scenopinidae, Lonchopteridae, Platystomatidae, Piophilidae, Sepsidae, Clusiidae, Sciomyzidae) in the Republic of Mordovia, the number of species has increased twice or more. In addition, the families of Bolitophilidae, Keroplatidae, Scatopsidae, Platypezidae, Micropezidae, Opomyzidae, Asteiidae, Milichiidae have been found for the first time in the Republic of Mordovia.

Records of Diptera species found for the first time in Russia and Europe

Family Mycetophilidae

***Neoempheria brevilineata* Okada, 1939

Material. 1) Temnikov district, MSNR, cordon Steklyannyi (54.894° N 43.600° E), yellow pan traps, pine forest, 10–15.07.2020, 1 ♂, leg. K. Tomkovich.

General distribution. Palearctic region.

Note. *Neoempheria brevilineata* has been found in Russia for the first time. This insufficiently known species was originally described by Okada (1939) from Hokkaido (Japan), and subsequently recorded from Georgia (Adjara, Imereti) (Kurina, 2021).

Family Milichiidae

***Desmometopa discipalpis* Papp, 1993

Material. 1) Temnikov district, MSNR, quarter 442 (54.7761° N, 43.3856° E), beer trap, 27.05–06.06.2020, 1 ♂, leg. A. Ruchin.

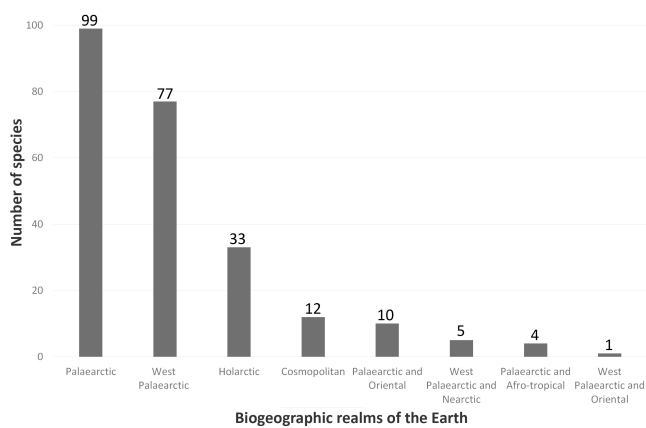


Fig. 2. The characteristics of the general distribution of Diptera species found in the Republic of Mordovia (Russia) for the first time.

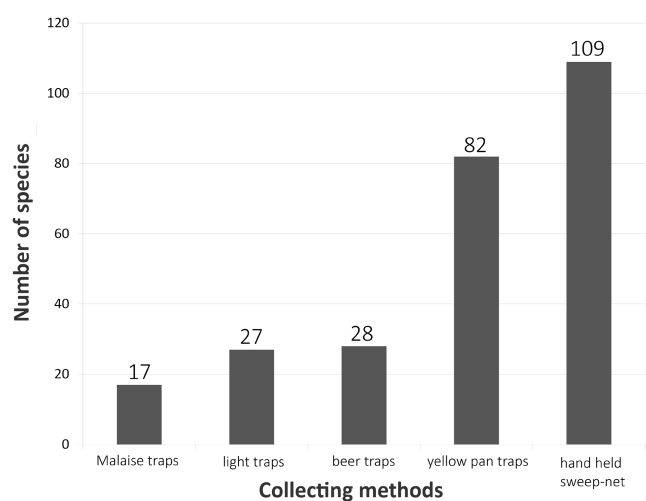


Fig. 3. Distribution of Diptera species found in the Republic of Mordovia (Russia) for the first time by using various collecting methods.

General distribution. West Palaearctic region.

Note. *Desmometopa discipalpis* has been recorded from Russia for the first time. This species is insufficiently known. It was originally described by Papp (1993) from Hungary (Tihany). Then, *D. discipalpis* has been recorded in Germany (Stuttgart), Greece (Lake Kerkini), and the Czech Republic (Northern Moravia) (Roháček, 2016).

****Neophyllomyza flavescens* Xi & Yang, 2018

Material. 1) Temnikov district, MSNR, quarter 438 (54.7300° N, 43.1912° E), beer trap at height of 12 m, 02–16.07.2020, 1 ♂, leg. A. Ruchin; 2) Temnikov district, MSNR, quarter 439 (54.7349° N, 43.2006° E), beer trap at height of 12 m, 02–16.07.2020, 2 ♀, leg. A. Ruchin; 3) Temnikov district, MSNR, quarter 440 (54.7339° N, 43.2079° E), beer trap at height of 7.5 m, 02–15.06.2020, 1 ♂, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. This is a new species for the fauna of both Russia and Europe. *Neophyllomyza flavescens* is an insufficiently known species, originally described from China: Tibet (Beibeng), Shaanxi (Zhashui), Tibet (Chayu), Tibet (Linzi) (Yang, 2018).

****Phyllomyza auriculatus* Xi & Yang, 2018

Material. 1) Temnikov district, MSNR, quarter 398 (54.7742° N, 43.4455° E), beer trap, mixed forest, 14–27.05.2020, 1 ♂, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. *Phyllomyza auriculatus* is a new species for the fauna of both Russia and Europe. This insufficiently known species was originally described from China: Shiansi (Ningshan), Yunnan (Buoshan, Dehong, Hachan, Lvchun, Lyehun, Yingjiang) (Yang, 2018).

****Phyllomyza luteipalpis* Malloch, 1914

Material. 1) Temnikov district, MSNR, quarter 438 (54.7317° N, 43.1910° E), beer trap at height of 1.5 m, 15–22.06.2020, 1 ♀, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. This species has been found for the first time in both Russia and Europe. This insufficiently known species was originally described from Taiwan (Takao, now Kaohsiung) (Malloch, 1914).

****Phyllomyza orbita* Xi, Yang & Yin, 2020

Material. 1) Tengushevo district, 6 km east of Dachnyi settlement (54.5389° N, 42.7420° E), beer trap, 28.05–08.06.2020, 1 ♂ A. Ruchin; 2) Temnikov district, MSNR, quarter 440 (54.7336° N, 43.2079° E), beer trap at height of 12 m, 02–15.06.2020, 1 ♀; 3) Temnikov district, MSNR, quarter 440 (54.7336° N, 43.2079° E), beer trap at height of 12 m, 15–22.06.2020, 1 ♀, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. *Phyllomyza orbita* is a new species for both Europe and Russia. This species was originally described from Laos (Sam Nuea) (Xi et al., 2020).

****Phyllomyza piceus* Xi & Yang, 2018

Material. 1) Temnikov district, MSNR, quarter 424 (54.7335° N, 43.1714° E), beer trap, birch forest, 14–24.05.2019, 1 ♀, leg. A. Ruchin; 2) Temnikov district, MSNR, quarter 252 (54.7730° N, 43.2298° E), beer trap, 25.06–05.06.2020, 1 ♂, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. This species has been found for the first time for the fauna of both Russia and Europe. This species was originally described from China: Yunnan (Baoshan, Dali, Tengchong, Yingjiang), Shaanxi (Zhashui), Chongqing (Liangping), Guangxi (Shangsi) (Yang, 2018).

****Phyllomyza striolatum* Xi, Yang & Yin, 2019

Material. 1) Temnikov district, MSNR, quarter 249 (54.8284° N, 43.5304° E), beer trap, young birch forest, 21.06–06.07.2019, 1 ♂, leg. A. Ruchin.

General distribution. Palaearctic region, Oriental region.

Note. *Phyllomyza striolatum* has been recorded for the first time from both Russia and Europe. This insufficiently known species was originally described from China: Tibet (Motuo) (Xi et al., 2019).

Discussion

This study of the Diptera fauna in the Republic of Mordovia expands our knowledge of the efficiency of insect collecting by allowing us to plan surveys that are more effective in the future and consequently research the Diptera fauna in more details. The presented data have been collected in various years, and the number of used traps per each collecting method varied, too. Despite the lack of the widely accepted methodology, the obtained results quite clearly indicate the effectiveness of the use of various collecting methods together. The highest number of Diptera species has been caught using only one of the collecting methods. Apparently, further research are needed to make more accurate conclusions, although there is no universal collecting method for dipterans. In our opinion, the most effective way is the use of various collecting methods together to obtain better results.

In our study, the hand held sweep-net net was the most effective method. It is indeed a productive way for preliminary estimation of Diptera diversity (Ebejer & Nicolosi, 2022). However, the use of a collecting net depends on specific skills and knowledge of a specialist, and its effectiveness may highly vary. Nevertheless, the use of the hand held sweep-net net cannot be used alone. The use of various collecting methods often leads to an increase in the knowledge of the species diversity in a study area (Manko et al., 2018; Ebejer & Nicolosi, 2022).

Until recent years, beer traps have not been used in the Republic of Mordovia (Ruchin et al., 2020). Their use has provided highly valuable data on the family Milichiidae. Milichiidae species occur in all zoogeographic regions except for the Antarctic, but

are represented sporadically in insect collections being often overlooked (Swann, 2010). Biological properties of most of the Milichiidae species are understudied to date (Swann, 2016). The family Milichiidae is usually associated with decaying animal and plant organic matter (Brake, 2009; Giordani et al., 2019). These species occur together with species of Formicidae and Arachnida, often as inquilines or kleptoparasite (Wild & Brake, 2009), or being associated with plant blooming (Brake, 2009; Wild & Brake, 2009; Swann, 2016). In our opinion, to increase the collecting effectiveness, we need to apply both the intensive targeted trapping and the use of a wider diversity of collecting methods. The use of beer traps allowed us to collect a comparatively large (nine) number of Milichiidae species. Among them, seven species have been recorded for the first time in Russia, and six taxa were new for both Russia and Europe. Our records have updated actual data on general distribution of these Milichiidae species. To date, *Desmometopa discipalpis* was only known in Europe (Roháček, 2016), while our record extended the species range eastwards. To date, six species (*Neophyllomyza flavescens*, *Phyllomyza auriculatula*, *P. luteipalpis*, *P. orbita*, *P. piceus*, *P. striolatum*) were only known in China (Malloch, 1914; Yang, 2018; Xi et al., 2019, 2020). Our findings of these species in the Republic of Mordovia have extended considerably their distribution northwestward. In our opinion, the use of beer traps is a more effective method for collecting Milichiidae species.

Good results have been obtained using yellow pan traps, which have not been previously used in the Republic of Mordovia. Using this collecting method, we have found 81 species, which are new to the Republic of Mordovia, including *Neoempheria brevilineata* that is new to Russia. To date, this species has only been known in Japan and Georgia (Okada, 1939; Kurina, 2021). Our record supplements poor data on the general distribution of *Neoempheria brevilineata*.

In the Republic of Mordovia, data on the Diptera fauna have been summarised recently (Esin, 2021). The taxonomic composition was represented by 820 species belonging to 62 families. Further studies have supplemented the Diptera fauna with 136 species and one family (Grichanov, 2021; Ruchin et al., 2021b; Gornostaev et al., 2022; Lutovinovas et al., 2022). *Anthrax incomptus* Walker, 1849 (Bombyliidae) has been excluded from the Diptera checklist of the Republic of Mordovia. Previously, Chursina & Ruchin (2018a) reported this species from this region, although this is an Australian species. Therefore, its listing for the Republic of Mordovia is erro-

neous. Taking into account the results of the present paper, the Diptera fauna of the Republic of Mordovia includes 1187 species belonging to 71 families. We believe that further studies of Diptera will certainly contribute to new additions to the Republic of Mordovia. The species discovered for the first time in the Republic of Mordovia have a various general distribution. We believe that such proportions of the geographical range characteristics can be explained by a general lack of knowledge about dipteran distribution in many regions of Russia and the entire world.

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Supporting Information



The list of Diptera species, which have been found for the first time in the Republic of Mordovia (Russia) (Electronic Supplement. The list of Diptera species found for the first time in the Republic of Mordovia, European Russia) may be found in the [Supporting Information](#).

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ВИДЫ DIPTERA, НОВЫЕ ДЛЯ РЕСПУБЛИКИ МОРДОВИЯ (РОССИЯ)

М. Н. Есин^{1,*} , А. Б. Ручин¹ , Д. И. Гаврюшин²,
Ю.Ц. Си³, Л. Дворжак⁴, К. Дворжакова⁴

¹Объединенная дирекция Мордовского государственного природного заповедника имени П.Г. Смидовича и национального парка «Смольный», Россия

*e-mail: esinmishka@gmail.com

²Московский государственный университет имени М.В. Ломоносова, Россия

³Хэнаньский сельскохозяйственный университет, Китай

⁴Триш Секери, Республика Чехия

Сохранение природы зависит от полноты информации о биологическом разнообразии на территории исследования. В настоящее время данные о распространении и разнообразии видов Diptera остаются фрагментарными. Данная статья дополняет известную информацию о видах Diptera в Европе, России и Республике Мордовия. В 2013–2022 гг. нами был собран 1321 экземпляр 241 вида Diptera. Среди них – виды, новые для России (*Neoempheria brevilineata*, *Desmometopa discipalpis*), а также для России и Европы (*Neophyllomyza flavescens*, *Phyllomyza auriculatus*, *P. luteipalpis*, *P. orbita*, *P. piceus*, *P. striolatum*). Впервые для фауны Республики Мордовия обнаружен 231 вид Diptera, а семейства Volitophilidae, Keroplataidae, Scatopsidae, Platypezidae, Micropezidae, Opomyzidae, Asteiidae и Milichiidae являются новыми для этого региона. *Anthrax incomptus* (Bombyliidae), ранее приводимый для Республики Мордовия, был исключен из ее фауны. Девять видов Diptera ранее были указаны для Республики Мордовия без достоверного подтверждения собранными экземплярами. В данном исследовании мы подтвердили их присутствие в фауне региона. Принимая во внимание результаты настоящей работы, фауна Diptera Республики Мордовия включает 1187 видов из 71 семейства. Для собранных видов Diptera представлены данные о методах их отлова. Приводятся сравнение методов отлова и предложения по осуществлению эффективной инвентаризации региональной фауны. Мы предположили, что количество используемых методов отлова напрямую влияет на результаты инвентаризации фауны Diptera.

Ключевые слова: Milichiidae, Европа, ловушка, метод сбора, мухи