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RESEARCH ARTICLE

Northernmost records of mosquito species (Diptera: Culicidae) in northwestern Russia

Наиболее северные находки видов кровососущих комаров (Diptera: Culicidae) на Северо-Западе России

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Abstract. The northernmost records of all 47 mosquito species (Diptera: Culicidae) recorded from northwestern Russia, are reviewed and mapped for the first time, based on the recently collected original material, the collection of the Zoological Institute of the Russian Academy of Sciences, and the available published data. All records of *Aedes rossicus* Dolbeskin, Gorickaja et Mitrofanova, 1930, *Ae. caspius* (Pallas, 1771) and *Ae. detritus* Haliday, 1833 in northwestern Russia are considered as doubtful.

Резюме. Впервые дан обзор наиболее северных находок для всех 47 видов кровососущих комаров (Diptera: Culicidae), отмеченных с территории Северо-Западного региона России. Эти находки нанесены на карту. Работа основана на определении собственных сборов авторов, ревизии фондовых коллекций Зоологического института РАН, а также на анализе литературных данных. Все находки видов *Aedes rossicus* Dolbeskin, Gorickaja et Mitrofanova, 1930, *Ae. caspius* (Pallas, 1771) and *Ae. detritus* Haliday, 1833 на территории Северо-Запада России рассматриваются нами как сомнительные.

Keywords: mosquitoes, distribution, northwestern Russia, Culicidae, northern records

Ключевые слова: кровососущие комары, распространение, Северо-Запад России, Culicidae, северные находки

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Introduction

The mosquitoes (Diptera: Culicidae) is an important family of bloodsucking insects responsible for the transmission of many medically important pathogens and parasites such as viruses, bacteria, protozoans and nematodes, which cause serious diseases, e.g. malaria, West Nile fever and filariasis (Platonov et al., 2014). In northwestern Russia, some species of *Aedes* Meigen, 1818 (using the classification by Wilkerson et al., 2015, as opposed to Reinert et al., 2009) have been recorded as vectors of Ockelbo virus (Lvov et al., 1989). Studying the associations of mosquitoes with their specific pathogens requires both correct identification of vector species and the reliable data on the mosquito fauna in the study region.

Mosquitoes are distributed over most of northwestern Russia (NWR). NWR corresponds to the Northwestern Federal District of Russia and includes the following administrative territories: Arkhangelsk Province (including Nenets Autonomous Region), Kaliningrad Province, Komi Republic, Leningrad Province, Murmansk Province, Novgorod Province, Pskov Province, Republic of Karelia, St Petersburg (federal city) and Vologda Province (Fig. 1). NWR includes both the regions with relatively well-studied mosquito fauna (e.g. Murmansk Province, Republic of Karelia, St Petersburg and Komi Republic) and poorly studied regions (Arkhangelsk[1] and Kaliningrad provinces, Nenets Autonomous Region) (Khalin & Aibulatov, 2019).

The following researchers contributed much to the knowledge of Culicidae in NWR and its parts. A.A. Stackelberg and A.V. Gutsevich investigated mosquitoes in St Petersburg (Stackelberg, 1937; Gutsevich, 1948). T.S. Ostroushko contributed to the mosquito fauna of the Komi Republic (Ostroushko, 1967; Ostroushko et al., 2007; Panyukova & Ostroushko, 2017). M.P. Lobkova and A.A. Sharkov studied the mosquito fauna of the Republic of Karelia and the Murmansk Province (Lobkova, 1964; Sharkov, 1976, 1980, 1982).

Robert et al. (2019) reported 46 species from NWR but did not include the Kaliningrad Province in this region. Hence, *Anopheles atroparvus* van Thiel, 1927, which was previously known from the Kaliningrad Province but unknown from the other territories of NWR, was not included in the species list. Considering that NWR is partly situated within northern Europe, our research aimed to clarify the northernmost ranges of Culicidae species for a considerable part of Europe.

In the article, we analysed the material that was recently published by Khalin & Aibulatov (2019). It includes the material collected by Aibulatov and Khalin (MAK) and deposited in the collection of Zoological Institute of the Russian Academy of Sciences (ZIN), the material by other collectors kept in the same collection (MOC; in most cases, collector names not indicated on labels), and the published data for the regions of NWR. In some cases, the collection material duplicated the published data on the northernmost records of certain mosquito species. The collection material for each species is listed below if the respective data were not found in the publications. In this case, we checked the identifications of mosquito specimens. In contrast to this, we cannot assess the reliability of identification in the publications.

We reviewed the records of 47 mosquito species in the NWR: *Anopheles* (*Anopheles*) *atroparvus* van Thiel, 1927; *An.* (*Ano.*) *beklemishevi* Stegnii et Kabanova, 1976; *An.* (*Ano.*) *claviger* (Meigen, 1804); *An.* (*Ano.*) *maculipennis* Meigen, 1818; *An.* (*Ano.*) *messeae* Falleroni, 1926; *Aedes* (*Aedes*) *cinereus* Meigen, 1818; *Ae.* (*Aed.*) *geminus* Peus, 1970; *Ae.* (*Aed.*) *rossicus* Dolbeskin, Gorickaja et Mitrofanova, 1930; *Ae.* (*Aedimorphus*) *vexans* (Meigen, 1830); *Ae.* (*Finlaya*) *geniculatus* (Olivier, 1791); *Ae.* (*Ochlerotatus*) *annulipes* (Meigen, 1830); *Ae.* (*Och.*) *behningi* Martini, 1926; *Ae.* (*Och.*) *cantans* (Meigen, 1818); *Ae.* (*Och.*) *caspius* (Pallas, 1771); *Ae.* (*Och.*) *cataphylla* Dyar, 1916; *Ae.* (*Och.*) *communis* (De Geer, 1776); *Ae.* (*Och.*) *cyprius* Ludlow, 1919; *Ae.* (*Och.*) *detritus* Haliday, 1833; *Ae.* (*Och.*) *diantaeus* Howard, Dyar et Knab, 1913; *Ae.* (*Och.*) *dorsalis* (Meigen, 1830); *Ae.* (*Och.*) *euedes* Howard, Dyar et Knab, 1913; *Ae.* (*Och.*) *excrucians* (Walker, 1856); *Ae.* (*Och.*) *flavescens* (Müller, 1764); *Ae.* (*Och.*) *hexodontus* Dyar, 1916; *Ae.* (*Och.*) *impiger* (Walker, 1848); *Ae.* (*Och.*) *intrudens* Dyar, 1919; *Ae.* (*Och.*) *leucomelas* (Meigen, 1804); *Ae.* (*Och.*) *mercurator* Dyar, 1920; *Ae.* (*Och.*) *nigrinus* (Eckstein, 1918); *Ae.* (*Och.*) *nigripes* (Zetterstedt, 1838); *Ae.* (*Och.*) *pionips* Dyar, 1919; *Ae.* (*Och.*) *pullatus* (Coquillett, 1904); *Ae.* (*Och.*) *punctor* (Kirby, 1837); *Ae.* (*Och.*) *riparius* Dyar et Knab, 1907; *Ae.* (*Och.*) *sticticus* (Meigen, 1838); *Ae.* (*Rusticoidus*) *rusticus* (Rossi, 1790); *Culex* (*Barraudius*) *modestus* Ficalbi, 1890; *Cx.* (*Culex*) *pipiens* Linnaeus, 1758; *Cx.* (*Cux.*) *torrentium* Martini, 1925; *Cx.* (*Neoculex*) *territans* Walker, 1856; *Culiseta* (*Culiseta*) *alaskaensis* (Ludlow, 1906); *Cs.* (*Cus.*) *annulata* (Schrank, 1776); *Cs.* (*Cus.*) *bergrothi* (Edwards, 1921); *Cs.* (*Culisella*) *fumipennis* (Stephens, 1825); *Cs.* (*Cuc.*) *morsitans* (Theobald, 1901); *Cs.* (*Cuc.*) *ochroptera* (Peus, 1935); *Coquillettidia* (*Coquillettidia*) *richiardii* (Ficalbi, 1889).

As a result, the northernmost records of these species are presented for the first time. Two

[1] Below, the Arkhangelsk Province is considered without the Nenets Autonomous Region.

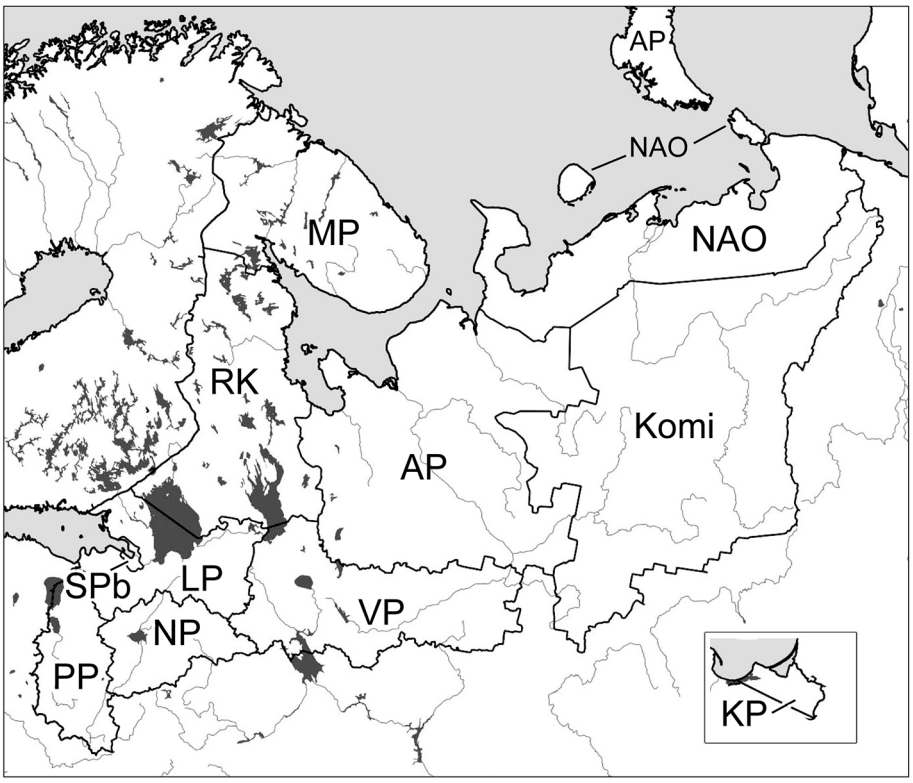


Fig. 1. Northwestern Russia.
AP – Arkhangelsk Province, Komi – Komi Republic, KP – Kaliningrad Province, LP – Leningrad Province, MP – Murmansk Province, NAR – Nenets Autonomous Region, NP – Novgorod Province, PP – Pskov Province, RK – Republic of Karelia, SPb – St Petersburg, VP – Vologda Province.

northernmost records for two mosquito species were determined using MAK, 14 northernmost records for 14 species, using MOC. An analysis of the published data allowed us to determine 105 northernmost records for 45 species.

Our original material was collected in the Republic of Karelia, St Petersburg, the Leningrad, Novgorod and Vologda provinces since 2005 to 2017, from April to October (the sampling methods were as reviewed by Khalin et al., 2021). The material from ZIN reexamined in the scope of this study was collected in NWR and adjacent territories since 1896 to 2005, from March to November. The identifications of the specimens from ZIN, representing new regional records were checked using the available keys, mostly Gutsevich et al. (1970) and Becker et al. (2010).

We consider as doubtful all records from NWR of *Aedes caspius*, *Ae. detritus* and *Ae. rossicus*, as well as some records of *Anopheles messeae*, *Ae. rusticus*, *Ae. sticticus* and *Culex pipiens*. Doubtful records as well as species with all records doubtful are marked with an asterisk (*); see Notes for further details. In our opinion, all of these doubtful records result from misidentifications (possible exception is *An. messeae*).

Below, we provide the northernmost records in NWR (coordinates and localities) for each of 47 mosquito species known from NWR and list the regions of NWR where the species were recorded. When a single record is given, it is the northernmost point known in NWR. When two records are specified, one is the northernmost in the western part of NWR and another one in the eastern part. For example, two northernmost points are given for *Anopheles beklemishevi*, i.e. in the Republic of Karelia (western part) and in the Komi Republic (eastern part). In the cases when the distribution of species is known in more detail, three or four records are given, which characterise better the northern border of the species range. For example, three northernmost points are provided for *An. claviger*, i.e. in St Petersburg (western part), the Vologda Province (central part) and the Komi Republic (eastern part).

The distribution of mosquito species outside NWR is briefly characterised according to the published data (for the references, see Khalin & Aibulatov, 2019). In the "Distribution" section for each species, we consider under "Europe" the continental and insular parts of Europe outside Russia, except for Norway, Sweden, Finland and

the countries of the former Soviet Union. The mosquito records in the Republic of Belarus are based on Suslo (2019), in Norway on Mehl (1996), in Sweden on Lundström et al. (2013) and Möhlmann et al. (2017), in Finland on Culverwell et al. (2021), in Estonia on Remm (1957), in Latvia on Spungis (2000), in Lithuania on Pakalniškis et al. (2006), in other European countries on Robert et al. (2019), in Russia outside NWR and in non-European countries on Gutsevich et al. (1970) and Khalin & Gornostaeva (2008). The distribution of *Culiseta* species in Russia outside NWR is based on Maslov (1967). We used SimpleMappr (Shorthouse, 2010) to generate a template for the mosquito distribution map.

The following abbreviations are used for the administrative territories: AP – Arkhangelsk Province, Komi – Komi Republic, KP – Kaliningrad Province, LP – Leningrad Province, MP – Murmansk Province, NAR – Nenets Autonomous Region, NP – Novgorod Province, PP – Pskov Province, RK – Republic of Karelia, SPb – St Petersburg, VP – Vologda Province.

Northern records of mosquitoes in northwestern Russia

Anopheles* (*Anopheles*) *atroparvus
van Thiel, 1927

Northernmost record (Fig. 2a). 54°48′40.644″N, 21°11′11.580″E, KP, Slavsk Distr. (Levenson et al., 1959).

Distribution. NWR: KP. Adjacent countries: Sweden, Latvia, Lithuania and Belarus. Southern European Russia, Ukraine, Moldova, Europe (ranging northward to the UK, Belgium and Denmark).

Anopheles* (*Anopheles*) *beklemishevi
Stegnii et Kabanova, 1976

Northernmost records (Fig. 2a). 64°57′19.92″N, 34°35′54.14″E, RK, Kem' Distr., Kem' (Perevozkin et al., 2012); 63°33′45.45″N, 53°41′2.48″E, Komi, Ukhta Distr., Ukhta (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, LP, NP, RK, VP. Adjacent countries: Sweden, Finland. European Russia, Siberia.

Anopheles* (*Anopheles*) *claviger
(Meigen, 1804)

Northernmost records (Fig. 2a). 59°56′20.74″N, 30°18′57.12″E, SPb, 15.IX.1928 (MOC); 59°58′24.55″N, 42°45′31.94″E, VP, Tot'ma Distr., Tot'ma, 28.VI.2004 (MAK); 61°40′7.65″N, 50°50′11.04″E, Komi, Syktyvkar (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, KP, LP, NP, PP, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium and Denmark), European Russia, West Siberia, Transcaucasia, North Africa, West and Central Asia.

Anopheles* (*Anopheles*) *maculipennis
Meigen, 1818 (sensu stricto)

Northernmost records (Fig. 2b). 64°57′19.92″N, 34°35′54.14″E, RK, Kem' Distr., Kem' (Perevozkin et al., 2012); 63°33′45.45″N, 53°41′2.48″E, Komi, Ukhta Distr., Ukhta (Gordeev & Moskaev, 2014).

Distribution. NWR: KP, LP, NP, RK. Adjacent countries: Sweden, Finland, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium and Denmark), European Russia, West Siberia, Transcaucasia, West and Central Asia.

Note. We consider *Anopheles maculipennis* as a separate species rather than *An. maculipennis* species complex. Therefore, here we cited only the publications containing identifications to species.

Anopheles* (*Anopheles*) *messeae Falleroni, 1926

Northernmost records (Fig. 2b). 69°16′2.06″N, 30°8′24.28″E, MP, Pechenga Distr., Shuoniyoki River*, 6.VI.1957 (MOC); 64°31′49.15″N, 34°45′47.98″E, RK, Belomorsk Distr., Belomorsk (Perevozkin et al., 2012); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 63°33′45.45″N, 53°41′2.48″E, Komi, Ukhta Distr., Ukhta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP*, NP, PP, RK, VP. Adjacent countries: Norway, Sweden, Finland, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium and Denmark), European Russia, Siberia, Central Asia, northeastern China.

Note. The only available specimen from NWR is a head of a female from Shuoniyoki River (Murmansk Province), mounted on a slide and

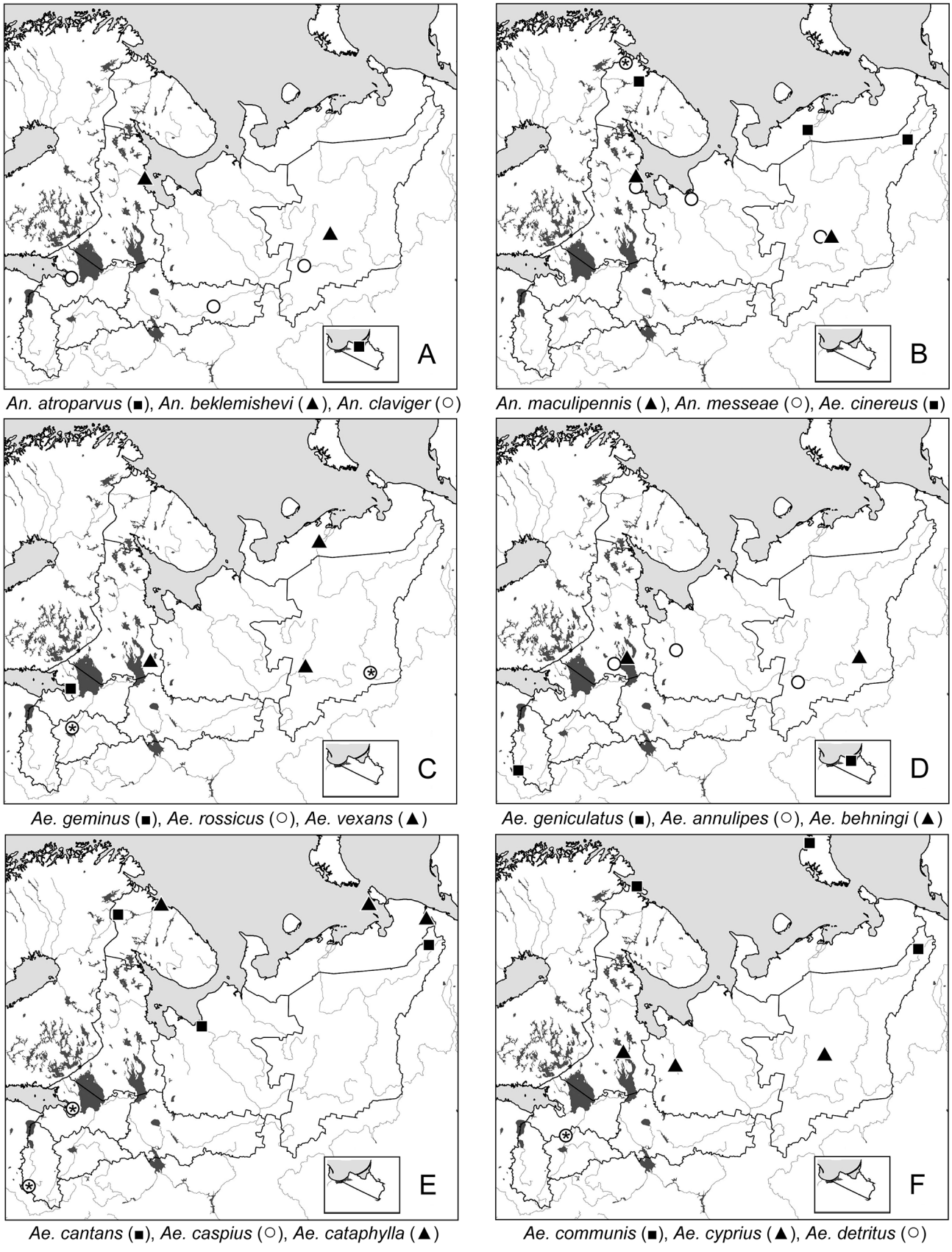


Fig. 2. Northernmost records of *Anopheles* and *Aedes* spp. Doubtful records are marked with an asterisk (*).

identified by A.V. Gutsevich as *Anopheles messeae*. We cannot confirm this identification. A reliable identification of *An. messeae* based on morphology is impossible at the adult and larval stages but it is possible at the egg stage. Possibly the female was reared from an egg identified as *An. messeae*. Three other localities mentioned above are situated not as far north as Shuoniyoki, at latitudes similar with *An. maculipennis* and *An. beklemishevi*. We have no arguments to consider these records as doubtful.

Aedes* (*Aedes*) *cinereus Meigen, 1818

Northernmost records (Fig. 2b). 68°49′N, 32°42′E, MP, Kol'skiy Distr., Tuloma (Sharkov, 1976); 67°29′16.02″N, 51°52′52.23″E, NAR, Zapolyarnyy Distr., Kamenka (Monchadsky, 1950); 66°40′29.09″N, 62°33′56.46″E, Komi, Vorkuta Distr., Sivaya Maska (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, Netherlands and Denmark), European Russia, Siberia, Russian Far East including Sakhalin Island and Kamchatka Peninsula, Transcaucasia, Central Asia, North America.

Aedes* (*Aedes*) *geminus Peus, 1970

Northernmost record (Fig. 2c). 60°6′55.8″N, 30°16′38.29″E, LP, Vsevolozhsk Distr., Yukki, 10.VI.1928 (MOC).

Distribution. NWR: LP, SPb. Adjacent countries: Sweden, Finland. Europe (ranging northward to the UK, France, Germany and Poland), European Russia (Moscow Province), South Siberia (Khakassia, Tyva, Irkutsk Province and Zabaykal'skiy Territory), Russian Far East.

Aedes* (*Aedes*) *rossicus Dolbeskin, Gorickaja et Mitrofanova, 1930*

Northernmost records (Fig. 2c). 58°31′37″N, 31°15′2.36″E, NP, Velikiy Novgorod* (Kunkova & Fedorova, 2003); 61°49′29.68″N, 56°49′15.96″E, Komi, Troitsko-Pechorsk Distr., Yaksha* (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi*, NP*. Adjacent countries: Norway, Sweden, Finland, Belarus. Europe (ranging northward to France, Germany and Poland), European Russia (Chuvash Republic, Perm Territory, Orenburg Province, North Caucasus), South Siberia.

Note. Aedes rossicus has been recorded within NWR from the Komi Republic (two localities; Panyukova & Ostroushko, 2017) and the Novgorod Province (two localities; Kunkova & Fedorova, 2003). The West-European part of the distribution range of *Ae. rossicus* is still insufficiently known (Becker et al., 2010). This species is difficult for identification and can be reliably determined only by the male genitalia. Adult females of *Ae. rossicus* are externally similar to *Ae. cinereus*, differing from the latter in the lighter coloration of scales on the scutum and abdomen. We did not collect *Ae. rossicus* in NWR; the specimens of *Ae. rossicus* from NWR are absent from the ZIN collection. Probably, the records of *Ae. rossicus* from the Komi Republic and the Novgorod Province result from misidentifications.

Aedes* (*Aedimorphus*) *vexans (Meigen, 1830)

Northernmost records (Fig. 2c). 62°3′30.4″N, 36°39′18.26″E, RK, Pudozh Distr. (Lobkova, 1964); 67°29′16.02″N, 51°52′52.23″E, NAR, Zapolyarnyy Distr., Kamenka (Monchadsky, 1950); 62°16′32.8″N, 50°40′3.54″E, Komi, Knyazhpogostskiy Distr., Lyali (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), Cosmopolitan, except for Polar regions, Australia, and South America.

Note. The record from Kamenka, Nenets Autonomous Region (Monchadsky, 1950), is located significantly farther north than the main part of the range. However, there is a record in Sweden located near the Arctic Circle: Övertorneå, 66°23′N, 23°40′E (Blomgren et al., 2018).

Aedes* (*Finlaya*) *geniculatus (Olivier, 1791)

Northernmost records (Fig. 2d). 56°12′0.69″N, 28°41′50.19″E, PP, Sebezh Distr., Anninskoe (Medvedev & Matov, 1999); 55°9′19.39″N, 20°51′1.05″E, KP, Zelenogradsk Distr., Rybachiy (Bernotiene, 2012).

Distribution. NWR: KP, PP. Adjacent countries: Norway, Sweden, Finland, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia, North Africa, the Caucasus, West and Central Asia.

Aedes* (*Ochlerotatus*) *annulipes (Meigen, 1830)

Northernmost records (Fig. 2d). 61°46′55.2″N, 34°24′15.17″E, RK, Petrozavodsk Distr., Petrozavodsk (Lobkova, 1964); 62°44′22.7″N, 39°37′16.56″E, AP, Plesetsk Distr. (Chetverikova & Egorova, 2010); 61°37′19.62″N, 50°45′10.38″E, Komi, Syktyvdinskiy Distr., Vylgort (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, NP, PP, RK, SPb, VP. Adjacent countries: Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia.

Aedes* (*Ochlerotatus*) *behningi Martini, 1926

Northernmost records (Fig. 2d). 61°59′19.29″N, 35°10′16.56″E, RK, Medvezh'egorsk Distr., Ernitskiy I. in Onega Lake (Jakovlev et al., 2014); 62°30′58.69″N, 56°44′34.25″E, Komi, Troitsko-Pechorsk Distr., Ust'-Ilych (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, KP, LP, RK, SPb. Adjacent countries: Sweden, Lithuania and Belarus. Europe (ranging northward and westward to Poland), European Russia, Siberia.

Aedes* (*Ochlerotatus*) *cantans (Meigen, 1818)

Northernmost records (Fig. 2e). 68°24′58.73″N, 29°30′17.92″E, MP, Kola Distr., Vuenniyaur Lake (Sharkov, 1980); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Palaearctic from West Europe to the Russian Far East.

Aedes* (*Ochlerotatus*) *caspius (Pallas, 1771)*

Northernmost records (Fig. 2e). 59°56′20.74″N, 30°18′57.12″E, SPb* (Osten-Sacken, 1858); 56°12′0.69″N, 28°41′50.19″E, PP, Sebezh Distr., Anninskoe* (Medvedev & Matov, 1999).

Distribution. NWR: PP*, SPb*. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia (central and southern), South Siberia. West and Central Asia, China, India, North and East Africa.

Note. *Aedes caspius* is known within NWR only from two localities in St Petersburg and the Pskov Province, but it has been recorded in Fennoscandia and the Baltic region (Culverwell, 2018; Robert et al., 2019; Culverwell et al., 2021). This species is close to *Ae. dorsalis*, from which it differs in the coloration of the scutum and abdomen. No reliable characters were found to distinguish *Ae. caspius* and *Ae. dorsalis* based on the male genitalia or larval morphology. Since *Ae. caspius* is distributed in Finland and Estonia, it may be also present in the Leningrad Province. However, only *Ae. dorsalis* has been found so far in the latter region, including our own collections in the Kurgal'skiy Peninsula, near the border with Estonia. The difficult diagnostics of *Ae. caspius* and *Ae. dorsalis* may lead to misidentifications. Moreover, the range of *Ae. caspius* mainly lies to the west and south of NWR. Most likely, the specimens recorded from St Petersburg and the Pskov Province as *Ae. caspius* are actually *Ae. dorsalis*.

Aedes* (*Ochlerotatus*) *cataphylla Dyar, 1916

Northernmost records (Fig. 2e). 69°20′55.67″N, 34°10′12.39″E, MP, Kola Distr., Kildin I. in the Barents Sea (Shingareva, 1926); 69°27′57.845″N, 58°31′52.694″E, NAR, Zapolyarnyy Distr., Matveev I. in the Barents Sea (Panyukova & Bogomolova, 2019); 68°49′2.6″N, 65°4′32.98″E, NAR, Zapolyarnyy Distr., Kara (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to France, Germany, Denmark and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *communis
(De Geer, 1776)

Northernmost records (Fig. 2f). 69°56′53.88″N, 31°56′45.03″E, MP, Pechenga Distr., Vayda-Guba (Natvig, 1948); 72°22′24″N, 52°43′00″E, AP, Novaya Zemlya, Malye Karmakuly, 25.VI.1900 (MOC); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic.

Aedes* (*Ochlerotatus*) *cyprius Ludlow, 1919

Northernmost records (Fig. 2f). 62°54′30.53″N, 34°26′57.53″E, RK, Medvezh'egorsk Distr., Medvezh'egorsk, 8.VI.1936 (MOC); 62°44′22.7″N, 39°37′16.56″E, AP, Plesetsk Distr. (Chetverikova & Egorova, 2010); 63°33′45.45″N, 53°41′2.48″E, Komi, Ukhta Distr., Ukhta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, NP, PP, RK, SPb, VP. Adjacent countries: Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to Germany* and Poland), forest and forest-steppe zones of the Palaearctic, from West Europe to the Far East.

Note. The record from Germany is doubtful according to Robert et al. (2019).

Aedes* (*Ochlerotatus*) *detritus Haliday, 1833*

Northernmost record (Fig. 2f). 59°16′34.7″N 32°05′19.0″E, NP, Chudovo Distr., Oskuy* (Panyukova & Medvedev, 2007).

Distribution. NWR: NP*. Adjacent countries: Norway, Sweden and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark). Kazakhstan, West and Central Asia, North Africa.

Note. *Aedes detritus* has been recorded within NWR only in the Novgorod Province (14 localities: Fedorova, 1977; Panyukova & Medvedev, 2007). In the case of partial loss of thoracic and abdominal scales, the females of *Ae. detritus* can be mistakenly identified as some other *Aedes* species, for example as *Ae. communis*. The main range of *Ae. detritus* is located far westward and southward from the Novgorod Province, and no males of this species have been found in this province. Therefore, we have no arguments indicating reliable records of *Ae. detritus* in the Novgorod Province.

Aedes* (*Ochlerotatus*) *diantaeus Howard, Dyar et Knab, 1913

Northernmost records (Fig. 3a). 69°24′36.13″N, 30°12′36.23″E, MP, Pechenga Distr., Nikel' (Sharkov, 1980); 67°37′39.54″N, 57°1′24.79″E, NAR, Zapolyarnyy Distr., Kharayakha (Panyukova & Ostroushko, 2017); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Lithuania and Belarus. Europe (ranging northward to France, Germany, Denmark and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *dorsalis (Meigen, 1830)

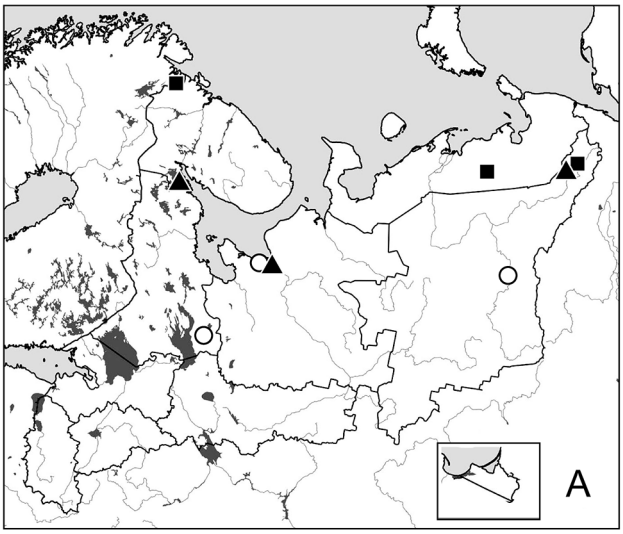
Northernmost records (Fig. 3a). 66°33′10.04″N, 33°6′10.96″E, RK, Loukhi Distr., White Sea Biological Station of Moscow State University (Tamarina & Aleksandrova, 1974); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 67°16′56.7″N, 63°39′9.26″E, Komi, Vorkuta Distr., Khanovey (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic.

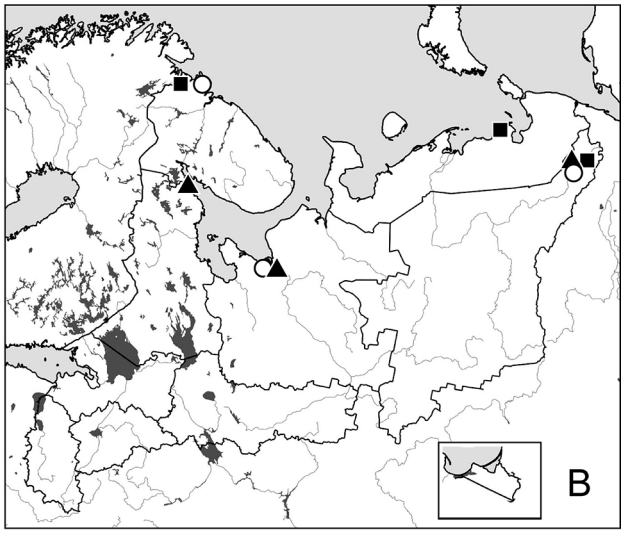
Aedes* (*Ochlerotatus*) *euedes Howard, Dyar et Knab, 1913

Northernmost records (Fig. 3a). 62°3′30.4″N, 36°39′18.26″E, RK, Pudozh Distr. (Lobkova, 1964); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 64°16′1.87″N, 57°37′6.86″E, Komi, Vuktyl Distr., Ust'-Shchugel (Panyukova & Ostroushko, 2017).

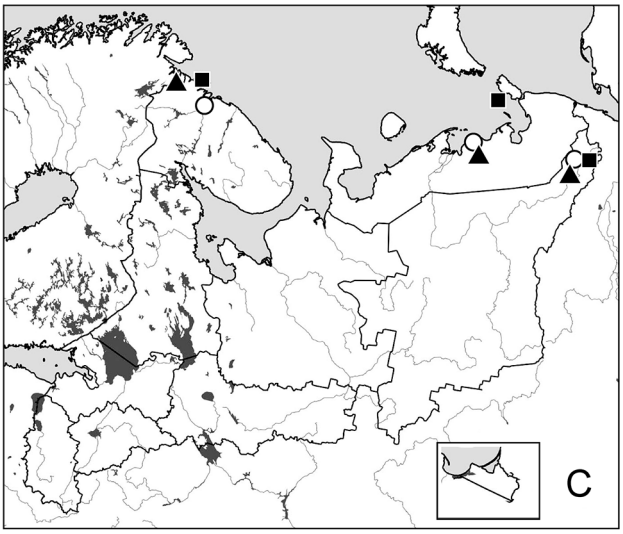
Distribution. NWR: AP, Komi, LP, NP, RK, SPb, VP. Adjacent countries: Sweden, Finland, Latvia, Lithuania and Belarus. Europe (ranging northward and westward to Poland); the Holarctic.



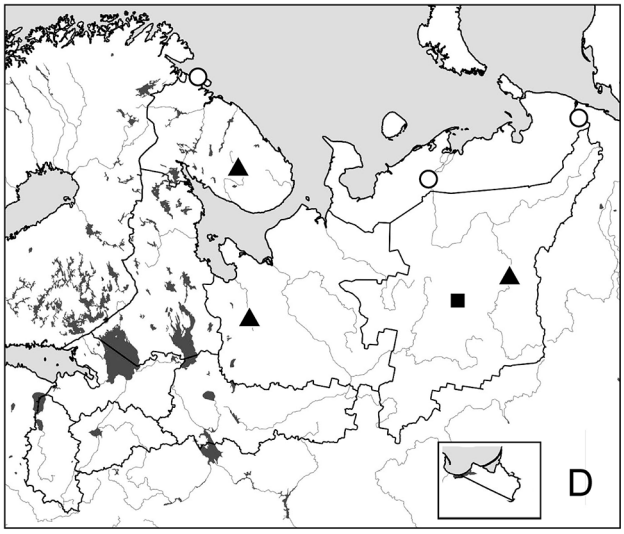
Ae. diantaeus (■), *Ae. dorsalis* (▲), *Ae. euedes* (○)



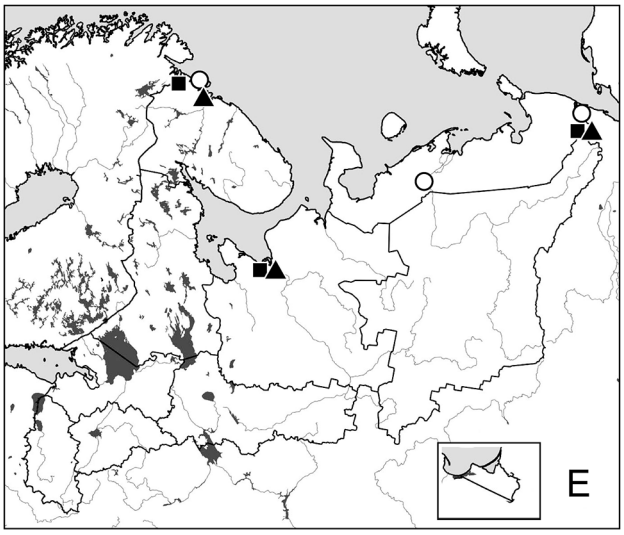
Ae. excrucians (■), *Ae. flavescens* (▲), *Ae. hexodontus* (○)



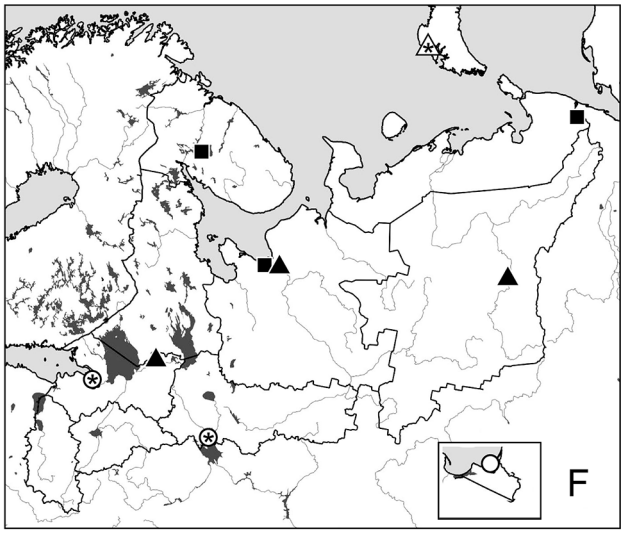
Ae. impiger (■), *Ae. intrudens* (▲), *Ae. leucomelas* (○)



Ae. mercurator (■), *Ae. nigrinus* (▲), *Ae. nigripes* (○)



Ae. pionips (■), *Ae. pullatus* (▲), *Ae. punctor* (○)



Ae. riparius (■), *Ae. sticticus* (▲, △), *Ae. rusticus* (○)

Fig. 3. Northernmost records of *Aedes* spp. Doubtful records are marked with an asterisk **(*)**.

Aedes* (*Ochlerotatus*) *excrucians (Walker, 1856)

Northernmost records (Fig. 3b). 69°24′36.13″N, 30°12′36.23″E, MP, Pechenga Distr., Nikel' (Sharkov, 1980); 68°50′4.39″N, 58°8′38.39″E, NAR, Pechora Sea near Prirazlomnaya offshore fixed platform, aboard vessel, 21–24.VII.2018 (MOC); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the Netherlands, Germany, Denmark and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *flavescens (Müller, 1764)

Northernmost records (Fig. 3b). 66°33′10.04″N, 33°6′10.96″E, RK, Loukhi Distr., White Sea Biological Station of Moscow State University (Tamarina & Aleksandrova, 1974); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 67°16′56.7″N, 63°39′9.26″E, Komi, Vorkuta Distr., Khanovey (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, NP, PP, RK, SPb, VP. Adjacent countries: Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic.

Aedes* (*Ochlerotatus*) *hexodontus Dyar, 1916

Northernmost records (Fig. 3b). 69°44′3.2″N, 32°29′59.43″E, MP, Pechenga Distr., Rybachiy Peninsula (Sharkov, 1976); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, RK, SPb. Adjacent countries: Norway, Sweden, Finland and Belarus. Europe (ranging northward and westward to Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *impiger (Walker, 1848)

Northernmost records (Fig. 3c). 69°44′3.2″N, 32°29′59.43″E, MP, Pechenga Distr., Rybachiy Peninsula (Sharkov, 1980); 69°27′57.845″N, 58°31′52.694″E, NAR, Zapolyarnyy Distr., Matveev I. in the Barents Sea (Panyukova & Bogomolova, 2019); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, RK, SPb. Adjacent countries: Norway, Sweden and Finland. Europe (Fennoscandia only); the Holarctic (circumpolar).

Aedes* (*Ochlerotatus*) *intrudens Dyar, 1919

Northernmost records (Fig. 3c). 69°24′36.13″N, 30°12′36.23″E, MP, Pechenga Distr., Nikel' (Sharkov, 1980); 68°12′0″N, 56°30′0″E, NAR, Zapolyarnyy Distr., Chernaya (Panyukova & Ostroushko, 2017); 67°16′56.7″N, 63°39′9.26″E, Komi, Vorkuta Distr., Khanovey (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to Germany, Denmark and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *leucomelas (Meigen, 1804)

Northernmost records (Fig. 3c). 68°58′14.46″N, 33°4′29.93″E, MP, Murmansk (Sharkov, 1976); 68°31′51.95″N, 56°14′18.59″E, NAR, Zapolyarnyy Distr., Khudaya (Panyukova & Ostroushko, 2017); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, the Netherlands and Denmark), European Russia, Siberia, Central Asia.

Aedes* (*Ochlerotatus*) *mercurator Dyar, 1920

Northernmost record (Fig. 3d). 63°33′45.45″N, 53°41′2.48″E, Komi, Ukhta Distr., Ukhta, 16–17.VI.1968 (MOC).

Distribution. NWR: Komi. Adjacent countries: Sweden and Belarus. The Holarctic (Komi, Chuvash Republic, Tomsk Province, Krasnoyarsk Territory, Republic of Tyva, Primorskiy Territory, Khabarovsk Territory, Mongolia; Canada and USA including Alaska).

Aedes* (*Ochlerotatus*) *nigrinus (Eckstein, 1918)

Northernmost records (Fig. 3d). 67°20′59.45″N, 37°3′11.51″E, MP, Lovozero Distr., Krasnoshchel'e, 15.VI.1950 (MOC); 62°44′22.7″N, 39°37′16.56″E,

AP, Plesetsk Distr. (Chetverikova & Egorova, 2010); 64°16′1.87″N, 57°37′6.86″E, Komi, Vuktyl Distr., Ust'-Shchugel (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, and Lithuania. Europe (ranging northward to the UK, the Netherlands and Denmark), European Russia, West Siberia.

Aedes* (*Ochlerotatus*) *nigripes
(Zetterstedt, 1838)

Northernmost records (Fig. 3d). 69°56′53.88″N, 31°56′45.03″E, MP, Pechenga Distr., Vayda-Guba (Natvig, 1948); 67°29′16.02″N, 51°52′52.23″E, NAR, Zapolyarnyy Distr., Kamenka (Monchadsky, 1950); 68°49′2.6″N, 65°4′32.98″E, NAR, Zapolyarnyy Distr., Kara, 14.VII–13.VIII.1912 (MOC).

Distribution. NWR: AP, Komi, LP, MP, NAR, RK. Adjacent countries: Norway, Sweden, Finland. Europe (ranging northward and westward to Poland); the Holarctic (circumpolar).

Aedes* (*Ochlerotatus*) *pionips Dyar, 1919

Northernmost records (Fig. 3e). 69°24′36.13″N, 30°12′36.23″E, MP, Pechenga Distr., Nikel' (Sharkov, 1980); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk, 8.VI.1896 (MOC); 68°23′55.37″N, 64°59′16.15″E, NAR, Zapolyarnyy Distr., Khovraty (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland and Belarus. Europe (ranging northward and westward to Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *pullatus
(Coquillett, 1904)

Northernmost records (Fig. 3e). 69°17′31.18″N, 32°47′54.14″E, MP, Kola Distr., Ura-Guba (Sharkov, 1980); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 68°23′55.37″N, 64°59′16.15″E, NAR, Zapolyarnyy Distr., Khovraty (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Lithuania and Belarus. Europe (ranging northward to France, Germany and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *punctor (Kirby, 1837)

Northernmost records (Fig. 3e). 69°44′3.2″N, 32°29′59.43″E, MP, Pechenga Distr., Rybachiy Peninsula (Sharkov, 1976); 67°29′16.02″N, 51°52′52.23″E, NAR, Zapolyarnyy Distr., Kamenka (Monchadsky, 1950); 68°49′2.6″N, 65°4′32.98″E, NAR, Zapolyarnyy Distr., Kara, 08.VII.1912 (MOC).

Distribution. NWR: AP, Komi, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic.

Aedes* (*Ochlerotatus*) *riparius
Dyar et Knab, 1907

Northernmost records (Fig. 3f). 67°36′43.4″N, 33°40′5.62″E, MP, Kirovsk Distr., Kirovsk (Sharkov, 1976); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 68°49′2.6″N, 65°4′32.98″E, NAR, Zapolyarnyy Distr., Kara (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the Netherlands, Germany and Poland); the Holarctic.

Aedes* (*Ochlerotatus*) *sticticus (Meigen, 1838)

Northernmost records (Fig. 3f). 61°0′52.96″N, 33°48′7.27″E, RK, Olonets Distr., Tashkenitsy, 27.VI.2009 (MAK); 64°32′23.68″N, 40°30′56.71″E, AP, Arkhangelsk (Sharkov, 1982); 71°30′38.91″N, 52°18′3″E, AP, Novaya Zemlya, Belush'ya Bay* (Sack, 1923); 64°16′1.87″N, 57°37′6.86″E, Komi, Vuktyl Distr., Ust'-Shchugel (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic.

Note. The northernmost record of *Aedes sticticus* is 71°30′38.91″N, 52°18′3″E, Novaya Zemlya (Fig. 3f; Sack, 1923). However, in Fennoscandia the species was recorded only from the southern parts of Sweden, Norway and Finland. The northernmost records of *Ae. sticticus*

from these countries are as follows: Norway: 59°56′25.58″N, 10°56′28.91″E, Lerenskog (Natvig, 1948); 59°46′59.48″N, 11°11′40.04″E, Oieren (Mehl et al., 1983); 61°33′27.28″N, 9°56′15.52″E, Ser Fron (Mehl, 1996); Sweden: 60°38′46.83″N, 15°51′24.71″E, Karlsbyn (Natvig, 1948); 61°3′40.76″N, 14°12′53.5″E, Dalarna (Lundström et al., 2013); Finland: 60°24′N, 19°54′E, Åland (Culverwell et al., 2021). In the case of partial loss of thoracic and abdominal scales, females of *Ae. sticticus* cannot be distinguished from some other *Aedes* species, e.g. *Ae. communis*.

Aedes* (*Rusticoidus*) *rusticus (Rossi, 1790)

Northernmost records (Fig. 3f). 59°56′20.74″N, 30°18′57.12″E, SPb* (Fedorov, 1969); 59°0′23.35″N, 37°57′37.11″E, VP, Cherepovets Distr.* (Sharkov, 1982); 55°9′19.39″N, 20°51′1.05″E, KP, Zelenogradsk Distr., Rybachiy (Bernotiene, 2012).

Distribution. KP, LP*, VP*. Adjacent countries: Sweden, Latvia and Lithuania. Europe (ranging northward to the UK, Belgium and Denmark). Ukraine, North Africa, Asia Minor.

Note. *Aedes rusticus* is known within NWR according to several publications, i.e. from St Petersburg (Fig. 3f; one locality; Fedorov, 1969), the Vologda Province (two localities; Sharkov, 1982) and the Kaliningrad Province (one locality; Bernotiene, 2012); it has been also recorded from Sweden, Latvia and Lithuania. On the other hand, we cannot confirm the occurrence of *Ae. rusticus* in European Russia by the material examined, i.e. the species is absent in our collections from the Leningrad Province and absent in the material of ZIN collection from NWR. Khalin & Gornostaeva (2008) did not list *Ae. rusticus* from European Russia. The species is rare in the most part of its range (Gutsevich et al., 1970). We consider that the correct northernmost record of *Ae. rusticus* is that in the Kaliningrad Province.

Culex* (*Barraudius*) *modestus Ficalbi, 1890

Northernmost records (Fig. 4a). 59°50′29.5″N, 30°31′32.57″E, LP, Vsevolozhsk Distr., Novosaratovka (MOC); 59°13′13.79″N, 39°53′29.48″E, VP, Vologda Distr. (Belova et al., 2008).

Distribution. NWR: LP, SPb, VP, PP, NP. Adjacent countries: Sweden and Belarus. Europe (ranging northward to the UK, the Netherlands and Denmark), European Russia, Siberia, Russian Far East, Transcaucasia, West, Central and South Asia, North Africa.

Culex* (*Culex*) *pipiens Linnaeus, 1758

Northernmost records (Fig. 4a). 67°33′46.49″N, 30°28′26.49″E, MP, Kovdor Distr., Kovdor (Sharkov, 1976); 63°18′17.5″N, 48°31′56.9″E, Komi, Udorskiy Distr., Selegvozh (Panyukova & Ostroushko, 2017); 71°30′38.91″N, 52°18′3″E, AP, Novaya Zemlya, Belush'ya Bay* (Sack, 1923); 70°2′10.73″N, 59°28′55.59″E, NAR, Zapolyarnyy Distr., Vaygach I.* (de Meijere, 1910); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

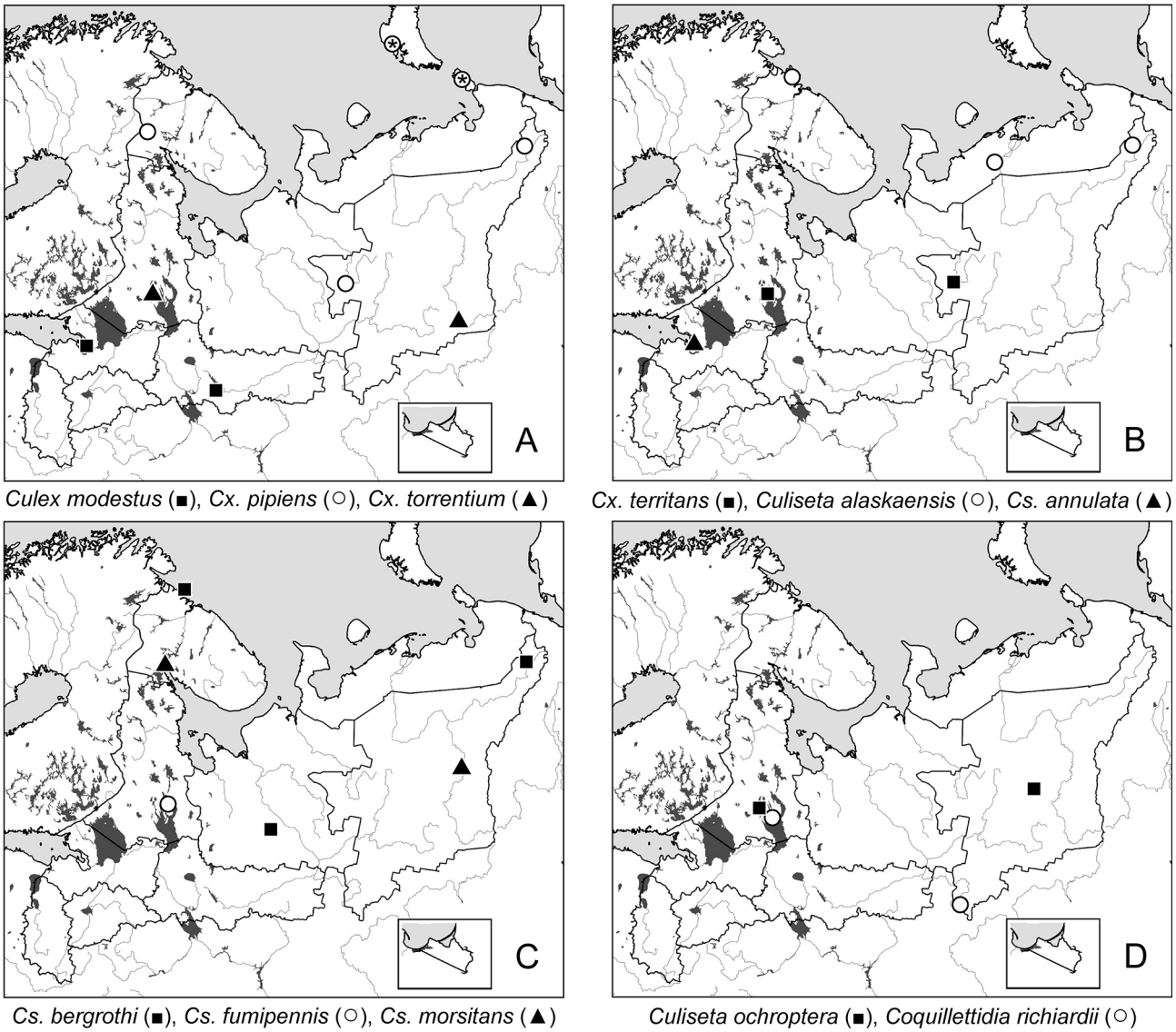
Distribution. NWR: AP*, Komi, KP, LP, MP, NAR*, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark); the Holarctic (except Polar regions); more locally in the Ethiopian, Neotropical and Australian regions.

Note. The northernmost records (Fig. 4a) of *Culex pipiens* are 70°2′10.73″N, 59°28′55.59″E, Vaygach Island (de Meijere, 1910), and 71°30′38.91″N, 52°18′3″E, Novaya Zemlya (Sack, 1923). However, in Fennoscandia this species is recorded only in the southern half of Sweden and Norway, in southern and central Finland. The northernmost records of *Cx. pipiens* from these countries are as follows: Norway: 62°33′8.85″N, 7°40′16.77″E, Grytten (Natvig, 1948); Sweden: 65°49′40.8″N, 24°04′22.8″E, Haparanda (Hesson et al, 2014); 67°3′43.73″N, 20°2′0.11″E, Norrbotten (Lundström et al., 2013); Finland: 65°44′10.0″N, 24°33′50.0″E, Kemi (Hesson et al., 2014). We consider that the correct northernmost records of *Cx. pipiens* are those from the Murmansk Province and the Komi Republic.

Culex* (*Culex*) *torrentium Martini, 1925

Northernmost records (Fig. 4a). 62°16′33.04″N, 33°58′54.59″E, RK, Kondopoga Distr., Kivach (Polevoi, 2006). 61°49′29.68″N, 56°49′15.96″E, Komi, Troitsko-Pechorsk Distr., Yakscha (Panyukova, 2018).

Distribution. NWR: Komi, LP, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Lithuania and Belarus. Europe



Culex modestus (■), *Cx. pipiens* (○), *Cx. torrentium* (▲)

Cx. territans (■), *Culiseta alaskaensis* (○), *Cs. annulata* (▲)

Cs. bergrothi (■), *Cs. fumipennis* (○), *Cs. morsitans* (▲)

Culiseta ochroptera (■), *Coquillettidia richiardii* (○)

Fig. 4. Northernmost records of *Culex*, *Culiseta* and *Coquillettidia* ssp. Doubtful records are marked with an asterisk (*).

(ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia, West Siberia, West Asia.

Culex (*Neoculex*) *territans* Walker, 1856

Northernmost records (Fig. 4b). 62°22′44.74″N, 34°30′26.12″E, RK, Kondopoga Distr., Lizhma, 9–10. VIII.1936(MOC);63°18′17.48″N,48°31′56.9″E,Komi, Udorskiy Distr., Selegvozh (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, LP, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark). European Russia, Siberia, Russian Far East, Transcaucasia, West and Central Asia, North Africa, North America.

Culiseta (*Culiseta*) *alaskaensis* (Ludlow, 1906)

Northernmost records (Fig. 4b). 69°44′3.2″N, 32°29′59.43″E, MP, Pechenga Distr., Rybachiy Peninsula (Sharkov, 1976); 67°29′16.02″N, 51°52′52.23″E, NAR, Zapolyarnyy Distr., Kamenka (Monchadsky, 1950); 67°37′40.67″N, 64°5′15.85″E, Komi, Vorkuta Distr., Tsementnozavodskiy (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, MP, NAR, NP, PP, RK, SPb, VP. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, the Netherlands and Poland); the Holarctic.

Culiseta* (*Culiseta*) *annulata (Schrank, 1776)

Northernmost record (Fig. 4b). 59°56′20.74″N, 30°18′57.12″E, SPb (Gutsevich, 1948).

Distribution. NWR: KP, LP, NP, PP, SPb. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia, Transcaucasia, Kazakhstan, Central Asia, Asia Minor, North Africa.

Culiseta* (*Culiseta*) *bergrothi (Edwards, 1921)

Northernmost records (Fig. 4c). 69°43′19.16″N, 31°53′56.52″E, MP, Pechenga Distr., Sredniy Peninsula (Sharkov, 1980); 62°7′23.57″N, 42°35′30.34″E, AP, Shenkursk Distr. (Sharkov, 1982); 67°29′50.68″N, 64°3′39.93″E, Komi, Vorkuta Distr., Vorkuta (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, LP, MP, PP, RK, SPb, VP. Adjacent countries: Estonia (according to Maslov, 1967, not to Remm, 1957), Norway, Sweden and Finland. Europe (Denmark only), European Russia, West Siberia, Russian Far East, Mongolia, Japan, Korea.

Culiseta* (*Culisella*) *fumipennis (Stephens, 1825)

Northernmost record (Fig. 4c). 62°18′26.91″N, 35°17′29.44″E, RK, Medvezh'egorsk Distr., Polya (Jakovlev et al., 2014).

Distribution. NWR: LP, RK, SPb. Adjacent countries: Norway, Sweden, Estonia and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia, West Asia, North Africa.

Culiseta* (*Culisella*) *morsitans (Theobald, 1901)

Northernmost records (Fig. 4c). 67°9′4.51″N, 32°24′46.16″E, MP, Kandalaksha Distr., Kandalaksha, 18.VII.1935 (MOC); 64°16′1.87″N, 57°37′6.86″E, Komi, Vuktyl Distr., Ust'-Shchugel (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, KP, LP, MP, NP, PP, RK, SPb. Adjacent countries: Norway, Sweden, Finland, Estonia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark). European Russia, West Siberia, West Asia, North Africa.

Culiseta* (*Culisella*) *ochroptera (Peus, 1935)

Northernmost records (Fig. 4d). 62°16′33.04″N, 33°58′54.59″E, RK, Kondopoga Distr., Kivach (Polevoi, 2006); 63°38′20.12″N, 54°50′45.02″E, Komi, Sosnogorsk Distr., Nizhniy Odes (Panyukova & Ostroushko, 2017).

Distribution. NWR: AP, Komi, KP, LP, NP, RK, SPb. Adjacent countries: Sweden, Finland, Estonia, Lithuania and Belarus. Europe (ranging northward to the Netherlands, Germany and Poland), European Russia, West Siberia, Russian Far East, northeastern China.

Note. Shevkunova & Gracheva (1961) recorded *Culiseta ochroptera* from the Arkhangelsk Province as a whole but did not indicate the locality. Hence, we do not consider this record as a northernmost one, because it cannot be localised within this large region.

Coquillettidia* (*Coquillettidia*) *richiardii (Ficalbi, 1889)

Northernmost records (Fig. 4d). 62°8′2.39″N, 34°55′52.95″E, RK, Medvezh'egorsk Distr., Uzkaya Sal'ma (Jakovlev et al., 2014); 59°37′51.19″N, 49°22′32.82″E, Komi, Priluzskiy Distr., Krutotyla (Panyukova & Ostroushko, 2017).

Distribution. NWR: Komi, KP, LP, NP, PP, RK, SPb. Adjacent countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania and Belarus. Europe (ranging northward to the UK, Belgium, the Netherlands and Denmark), European Russia, West Siberia, Kazakhstan, Central Asia, Asia Minor, North Africa.

Discussion

In this article, we reviewed for the first time the northernmost records in NWR, including the coordinates, for 47 mosquito species: 31 species of *Aedes*, five species of *Anopheles*, one species of

Coquillettidia, four species of *Culex*, and six species of *Culiseta*. Numerous publications on Culicidae are available on separate regions of NWR, but no summary analysis of the detailed data was made. An analysis of the data published in Khalin & Aibulatov (2019) allowed us to determine which records were the northernmost for the 47 mosquito species in NWR. Using the collection data (MAK, MOC), we specified the northern range borders for *Anopheles claviger*, *An. messeae*, *Aedes geminus*, *Ae. cyprius*, *Ae. excrucians*, *Ae. mercurator*, *Ae. communis*, *Ae. nigrinus*, *Ae. nigripes*, *Ae. pionips*, *Ae. punctor*, *Ae. sticticus*, *Culiseta morsitans*, *Culex territans* and *Cx. modestus*. For example, the northernmost record of *An. claviger* is Tot'ma in the Vologda Province (MAK) and the northernmost record of *Ae. geminus* is Yukki in the Leningrad Province (MOC).

The latitude of the northernmost records varies significantly between species. Some species in the subgenus *Ochlerotatus* Lynch Arribalzaga, 1891 of the genus *Aedes* (i.e. *Ae. cantans*, *Ae. cataphylla*, *Ae. communis*, *Ae. diantaeus*, *Ae. excrucians*, *Ae. hexodontus*, *Ae. impiger*, *Ae. intrudens*, *Ae. leucomelas*, *Ae. nigripes*, *Ae. pionips*, *Ae. pullatus*, and *Ae. punctor*), *Culiseta alaskaensis* and *Cs. bergrothi* are found near the coastline of the Arctic Ocean in the Murmansk Province and the Nenets Autonomous Region (Figs 2, 3 and 4). *Anopheles* spp., *Culex modestus*, *Cx. torrentium*, *Cx. territans* and *Cs. ochroptera* are found in NWR southward of the Arctic Circle (Figs 2 and 4; not taking into account a doubtful record *An. messeae* in the Murmansk Province). The northernmost records of *Ae. cinereus*, *Cx. pipiens* and *Cs. morsitans* are located in NWR northward of the Arctic Circle, but not near the coastline of the Barents and Kara seas (Figs 2 and 4; except for the doubtful records of *Cx. pipiens* in the Arkhangelsk Province [Novaya Zemlya] and the Nenets Autonomous Region). The northernmost records of *Ae. geniculatus*, *Ae. rusticus* and *An. atroparvus* are located in the south of NWR (Kaliningrad and Pskov provinces; Figs 2 and 3).

Within NWR, there are no territories with arid climate; neither there are highlands, which could prevent the distribution of mosquitoes. A number of factors, climate being one of the most important, influences the position of the northern border of range of each mosquito species. However, northern borders can be controlled not only by the number of days with a temperature sufficient for the development of larvae and activity of imagines. Extremely low winter temperatures may also serve as a limiting factor.

Taking into account climate changes, it would be interesting to trace changes in the northern borders of ranges of mosquito species in NWR. However, the information about mosquito species distribution in this area over different decades is fragmentary, so we cannot use it to analyse the dynamics of mosquito fauna.

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