ISSN 0013-8738, Entomological Review, 2015, Vol. 95, No. 5, pp. 583–593. © Pleiades Publishing, Inc., 2015.
Original Russian Text © E.V. Panyukova, S.V. Pestov, 2015, published in Parazitologiya, 2015, Vol. 49, No. 3, pp. 208–224.

Mosquitoes (Diptera, Culicidae) of Kirov Province

E. V. Panyukova and S. V. Pestov

Institute of Biology, Komi Science Center, Ural Branch, Russian Academy of Sciences, Syktyvkar, 167982 Russia
e-mail: panjukova@ib.komisc.ru

Received October 11, 2014

Abstract—Data on mosquitoes collected in Kirov Province were analyzed. An annotated list of 25 species of the family Culicidae was compiled. Analysis of their biotopic distribution and species diversity was performed. The Berger-Parker dominance index, Shannon diversity index, and index of occurrence of adult mosquitoes in typical biotopes of the region were calculated.

DOI: 10.1134/S0013873815050036

Mosquitoes of the family Culicidae Meigen, 1818 are a component of natural parasitocenoses. This group of dipterans is of considerable medical and veterinary significance and is well studied in the greatest part of the territory of Russia. Recently, new taxonomic, morphological, and faunistic research of this group has been carried out (Khalin and Gornostaeva, 2008; Nekrasova et al., 2008; Aibulatov, 2009; Medvedev, 2009, Khalin and Aibulatov, 2013, 2014). However, faunistic data on the family Culicidae in some regions of Russia are still fragmentary and scanty. One of such territories is Kirov Province.

Kirov Province is part of the Volga Federal District. In the north it borders on Arkhangelsk Province and the Komi Republic, in the west, on Vologda, Kostroma, and Nizhny Novgorod Provinces, in the east, on Perm Territory and the Udmurt Republic, in the south, on the Mari-El and Tatarstan Republics. Kirov Province lies in the northeast of the Russian Plain, in the central part of the Volga basin, whereas its northwestern districts belong to the Severnaya Dvina basin. The greatest part of the province is occupied by the southern taiga while small plots of the northern taiga occur in the northwest and northeast. In the south of Kirov Province there is a narrow strip of the mixed coniferous-broad-leaved forest (subtaiga) zone. The climate is temperate continental, the long-term mean temperature of January being −13–15°C, that of July, 17–19°C. Kirov Province belongs to the zone of sufficient humidity; the mean annual precipitation is 500–650 mm, of which 60–70% falls on the warm season (Frenkel, 1997).

The first data on the fauna of mosquitoes in the territory of Kirov Province were published by Shernin (1960), who reported three species: *Anopheles maculipennis*[1], *A. claviger*, and *Culex pipiens*. During further research, 15 species of the family Culicidae were recorded in Kirov Province, of which 14 were new to its fauna (Panyukova and Tselishcheva, 2006, 2011; Lyapunov and Panyukova, 2010); the resulting list thus included 17 species of mosquitoes.

The goal of the present work is to characterize the fauna and ecological traits of the mosquitoes of Kirov Province.

MATERIALS AND METHODS

The species composition of mosquitoes of the family Culicidae in Kirov Province was studied during the expeditions of 2005–2014. In total, we examined 1340 specimens of 23 species of Culicidae, including 1312 adults and 28 larvae. The authors' collections comprised 534 adults belonging to 15 species from 5 genera of mosquitoes. Collections of our colleagues (E.P. Lachokha, L.G. Tselishcheva, and A.N. Lyapunov) included 806 adults and larvae belonging to 23 species of the family Culicidae.

Altogether, 251 collections of adult mosquitoes were made in 18 different biotopes. The main method of the field studies was collection of female mosquitoes landing on the researcher's forearm during 20 minutes (Gutsevich et al., 1970). Collections of larvae were fragmentary; they were made by A.N. Lyapunov by the standard tray technique in tem-

[1] The authors and years of the original descriptions are given in the annotated list of species of mosquitoes.

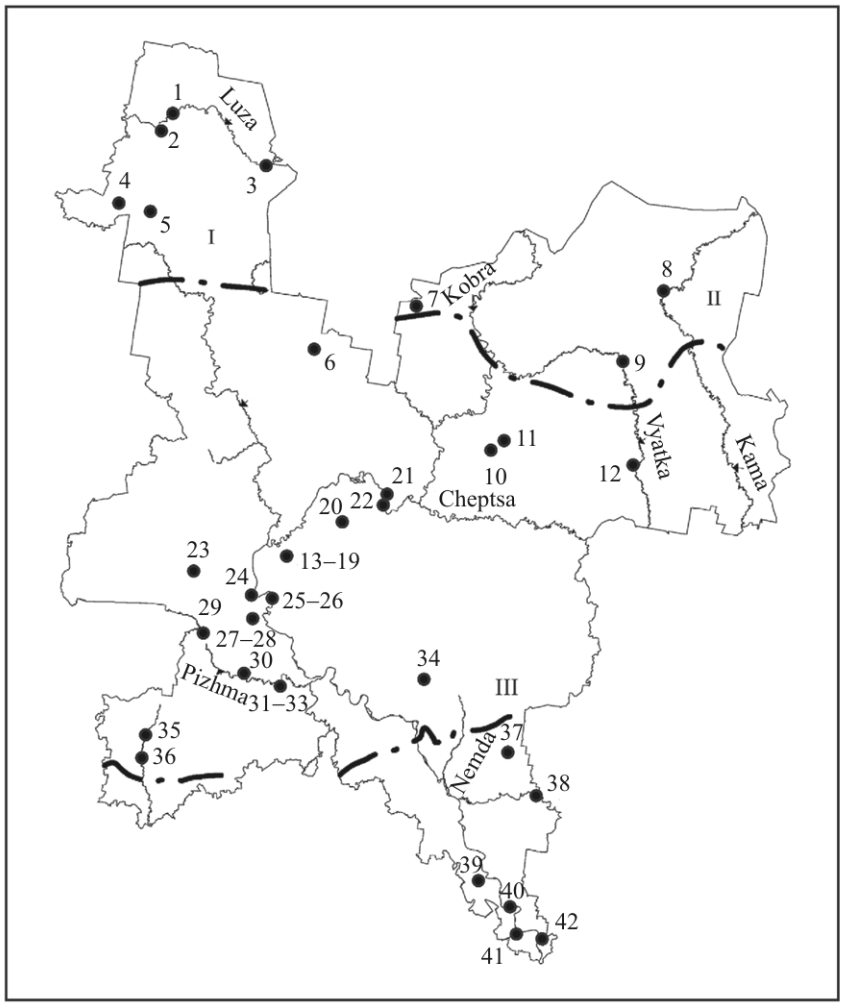

Fig. 1. The study region. The dashed lines mark the borders of natural zones and subzones: (I) middle taiga subzone; (II) southern taiga subzone; (III) subtaiga (mixed coniferous-broad-leaved forest) zone. Black numbered circles mark the material collection sites in the territory of Kirov Province. Luza District: (1) Vachelovo; (2) Berezino; Podosinovets District: (3) Godovo; (4) Golovino, Bylina state wildlife refuge; (5) Lodeino; Murashi District: (6) Murashi; Nagorsk District: (7) Tulashor locality of Nurgush Reserve; Verkhnekamsky District: (8) Loino; (9) Kirs; Belokholunitsky District: (10) Belaya Kholunitsa; (11) Kopiya River outfall; Omutninsk District: (12) Belorechensk; Orichi District: (13) Novozhily; (14) Maradykovo; (15) Ershi; (16) Serichi; (17) Mirnyi; (18) Tereshichi; (19) Omolichi; (20) Strizhi; Kirov Municipal Area: (21) Kirov, Dymkovo; (22) Kirov, Korchemkino; Svecha District: (23) Lebedi; Kotelnich District: (24) Vishkil; (25) cordon of Nurgush Reserve; (26) Nurgush Reserve, Pishchalsky Island; (27) Borovka; (28) Razliv; Tuzha District: (29) Bokovaya River outfall; Arbazh District: (30) Koktysh; (31) Lake Elevets; Pizhanka District: (32) Obukhovo; (33) Borok; Nolinsk District: (34) Klyuchi, Voya River; Kiknur District: (35) Kiknur; (36) Tsekeevo, Luya River; Kilmez District: (37) Rybnaya Vataga; (38) Taugovo, Loban River meander; Malmyzh District: (39) Malmyzh; Vyatkopolyansky District: (40) Karakulskaya Pristan; (41) Vyatskie Polyany; (42) Ust-Lyuga.

porary reservoirs in two localities: Karakulskaya Pristan and Lebedi villages. The material was identified using the published keys (Gutsevich and Dubitsky, 1981; Danilov, 1986). To test the correctness of identification, some specimens were compared with those from the stock collections of the Zoological Institute, the Russian Academy of Sciences (ZIN RAS, reg. no. 2–2.20), and their identification was checked by A.V. Khalin. The material collected is kept in the museum of the Institute of Biology, Komi Science Center of RAS, Syktyvkar.

Collections were made within all the natural zones of Kirov Province at 42 sites, of which 28 were situated in the southern taiga subzone, 8 in the middle taiga subzone, and 6 in the subtaiga zone (Fig. 1). The southern taiga subzone was quite extensively studied while the scantily populated northwestern and south-

eastern regions in the Moloma and Cheptsy basins remained little studied. There are long-term collections from the territory of the Nurgush State Nature Reserve.

The abundance of adult mosquitoes in Kirov Province was estimated by the percentage ratio of the number of the individuals recorded. According to the scale used in our study (Panyukova and Medvedev, 2006), the species comprising over 10% were described as mass species, 1–10%, as common, 0.1–1%, as rare, less than 0.1%, as sporadic. Statistical analysis of the material was performed in PAST 2.15 software (Hammer et al., 2001).

The index of occurrence (IO) of a given species was calculated as the fraction (%) of samples containing this species in the total number of samples. The association of mosquito species with different types of habitats was estimated using the habitat preference index (PI) by abundance (Beklemishev, 1970). The species with the PI values over 50% were regarded as indicators of the given habitat. The index of dominance (ID) was calculated as the fraction (%) of individuals of the given species in the total number of individuals in the sample (Balashov, 2008).

To analyze the species diversity of the mosquitoes of Kirov Province, we selected six typical biotopes of the southern taiga subzone: floodland meadow, oak, lime, small-leaved, spruce, and pine forests. The sample from each biotope included more than 100 ind. (the table). Comparison of the species composition and structure of biotopic complexes was made by cluster analysis, using the Euclidean distance (Ward's method) and the Jaccard index as measures of similarity. The Berger-Parker dominance index and Shannon diversity index were also calculated (Pesenko, 1982; Tatarinov, 2010).

RESULTS AND DISCUSSION

So far, 25 species from 5 genera of mosquitoes have been recorded in Kirov Province (the table). The genus *Ochlerotatus* Lynch Arribalzaga, 1891[2] is the most diverse, being represented by 17 species. The remaining genera are represented by fewer species: the genera *Aedes* Meigen, 1818 and *Anopheles* Meigen, 1818, by three species each, the genera *Coquillettidia* Diar, 1905 and *Culex* Linnaeus, 1758, one species each. In comparing the typical biotopes of Kirov Province the highest species diversity was recorded in pineries (Shannon index 2.54), the lowest, in spruce forests (Shannon index 1.72; see the table). The fraction of rare species was the greatest in the pine forest: of the 19 species recorded in pineries, *A. vexans*, *C. richiardii*, and *O. annulipes* were rare. The sporadic *Ochlerotatus cyprius* was collected only in the pineries.

The prevalent species were determined in each biotope (the table). The most aggressive attacker in the floodplain meadow was *A. cinereus* (ID 0.27), whereas *O. communis* prevailed in oak and small-leaved forests (ID 0.27), and A. *rossicus* dominated in the lime forest (ID 0.25). In the spruce forest, *O. cantans* was most common in collections (ID 0.37); in the pinery, it was *O. behningi* (ID 0.19).

Calculation of the biotope PI of adult mosquitoes indicated that *O. pullatus* preferred the ecological conditions of the spruce forest (PI 75.38%) while *O. excrucians* preferred those of the floodland meadow (PI 44.39%). Sporadic *O. nigrinus* and *O. sticticus* were recorded only in the floodplain meadow. The prevalent species in riparian oak forests were *O. diantaeus* (PI 42.74%) and *O. communis* (PI 30.56%). The species of the group *cantans*, namely *O. riparius* and *O. euedes*, were confined to pineries (PI 56.53 and 56.73, respectively) but rarely occurred in samples from other biotopes. Two species had high preference for the lime forest: *A. rossicus* (PI 87.77) and *O. diantaeus* (PI 42.74). The conditions of common secondary small-leaved forests were preferred by *O. cataphylla* (PI 42.64), *O. communis* (PI 30.25), and *O. punctor* (PI 40.16). High preference for the typical spruce forests was recorded for *O. pullatus* (PI 75.38) and *O. flavescens* (PI 42.66). These groups of species were quite stable under the environmental conditions studied.

Cluster analysis of the mosquito species composition revealed a distinct assemblage of the lime forests (Fig. 2). By their population structure, lime forests were found to be more similar to the floodplain meadows (Fig. 3), possibly due to the similar humidity regimes. Under the conditions of Kirov Province lime forests grow in the floodlands of rivers and lakes.

Analysis of the species composition of the family Culicidae revealed two clusters of biotopes: one of small-leaved and spruce forests, the other of pine forests and floodplain meadows. In our opinion, the

[2] The taxon *Ochlerotatus* Lynch Arribalzaga, 1891 is considered here as a distinct genus according to Reinert (2000).

Species diversity of mosquitoes in the typical habitats of Kirov Province (by collections of adult females)

Species	Floodplain meadow		Oak forest		Lime forest		Small-leaved forest		Spruce forest		Pine forest	
	adults	%	adults	%	adults	%	adults	%	adults	%	adults	%
Aedes cinereus	94	26.70	13	8.13	25	15.43	15	13.76	8	6.56	18	10.34
A. rossicus	2	0.57	–	–	40	24.69	–	–	–	–	5	2.87
A. vexans	1	0.28	–	–	–	–	–	–	–	–	7	4.02
Anopheles messeae	2	0.57	13	8.13	–	–	–	–	–	–	–	–
Coquillettidia richiardii	2	0.57	–	–	–	–	–	–	–	–	2	1.15
Culex pipiens	–	–	13	8.13	–	–	–	–	–	–	–	–
Ochlerotatus annulipes	1	0.28	–	–	–	–	–	–	1	0.82	2	1.15
O. behningi	–	–	2	1.25	10	6.17	5	4.59	5	4.10	33	18.97
O. cantans	6	1.70	17	10.63	13	8.02	11	10.09	45	36.89	30	17.24
O. cataphylla	11	3.13	–	–	10	6.17	8	7.34	–	–	1	0.57
O. communis	44	12.50	43	26.88	30	18.52	29	26.61	–	–	6	3.45
O. cyprius	–	–	–	–	–	–	–	–	–	–	1	0.57
O. diantaeus	50	14.20	37	23.13	–	–	3	2.75	8	6.56	13	7.47
O. euedes	1	0.28	1	0.63	–	–	2	1.83	2	1.64	10	5.75
O. excrucians	10	2.84	–	–	–	–	2	1.83	–	–	3	1.72
O. flavescens	2	0.57	–	–	–	–	1	0.92	5	4.10	7	4.02
O. intrudens	58	16.48	6	3.75	13	8.02	3	2.75	1	0.82	8	4.60
O. leucomelas	7	1.99	2	1.25	–	–	–	–	1	0.82	1	0.57
O. nigrinus	3	0.85	–	–	–	–	–	–	–	–	–	–
O. pullatus	23	6.53	3	1.88	–	–	–	–	40	32.79	4	2.30
O. punctor	32	9.09	10	6.25	22	13.58	28	25.69	3	2.46	12	6.90
O. riparius	2	0.57	–	–	–	–	2	1.83	3	2.46	11	6.32
O. sticticus	1	0.28	–	–	–	–	–	–	–	–	–	–
Total number of ind.	352	–	160	–	162	–	109	–	122	–	174	–
Shannon index	2.19	–	2.05	–	1.96	–	2.00	–	1.72	–	2.54	–
Berger-Parker index	0.27	–	0.27	–	0.25	–	0.27	–	0.37	–	0.19	–

leading factor in such similarity is illumination of biotopes. Shaded spruce and small-leaved forests are inhabited by the psychrophilic mosquito species, whereas well-illuminated pineries and floodplain meadows are favorable for thermophilic ones.

By the structure of mosquito population, three clusters of communities could be distinguished: floodplain meadows and lime forests, small-leaved forests and oakeries, and spruce and pine forests (Fig. 3). The oakery community was similar to that of small-leaved forests. The leading ecological factor of their similarity may be biotope humidity. The indicator species distinguished by the high biotope preference indices (over 50%) were *A. cinereus* for the floodplain meadow, *A. rossicus* for the lime forest, *O. communis* for the oak forest, *O. cantans* for the spruce forest, and *A. vexans* for the pine forest. No indicator species could be established for the small-leaved forest.

The annotated list of the species of the family Culicidae of Kirov Province is given below. The material is presented by the following scheme: the taxon name, the amount of the material collected, the collection sites, conclusion on the abundance based on the collections of adults, the index of occurrence (IO), the landscape-zonal distribution of the species, the biotopic distribution of adults, specific traits of the species' phenology, and assessment of its abundance in adjoining territories.

An Annotated List of Species of the Family Culicidae of Kirov Province

Aedes cinereus Meigen, 1818. Material: 201 ♀. Sites 2, 8, 12–19, 21, 25–28, 30–32. A mass species comprising 15.3% of collections of adults (IO 42.9%) and widely distributed across the whole Kirov Province. Adults were collected in floodplain meadows, alder thickets, small-leaved, lime, oak, pine, spruce, and birch forests. The species is confined to floodplain meadows (42% of all the collections of adults), where it dominates; it was recorded as a dominant in lime forests, and was abundant in pine forests (25% of all the collections). The species can be recorded from the third decade of May to the first decade of August. In adjoining territories it was recorded as a common species in Arkhangelsk Province and the Komi Republic, as a subdominant in Perm Territory; according to observations, it is rare in Vologda Province and scarce in Udmurtia[3].

Aedes rossicus Dolbeshkin, Gorickaja et Mitrofanova, 1930. Material: 122 ♀. Sites 13, 25, 27, 42. A common species comprising 9.3% in collections of adults (IO 9%). It is characteristic of the floodland forests of the Nurgush Reserve but rare in the rest of Kirov Province. Adults were collected in the southern taiga subzone and the subtaiga zone. The species was recorded in the first decade of June, in a floodland meadow of the river Vyatka, and also at the end of July, in a forb pine forest with admixture of birch, 100 m from the Vyatka. The species co-occurred in collections with *A. cinereus*, *A. vexans*, *Ochlerotatus cantans*, *O. riparius*, and *O. punctor*. The species is associated with lime forests (PI 87.77). Its mass attacks were observed in the first decade of September in the Nurgush Reserve, in the floodland of the river Prost. *Aedes rossicus* actively attacks from June to September. It was not recorded in the adjoining territories.

Aedes vexans Meigen, 1830. Material: 12 ♀. Sites 13, 14, 18, 19, 30. A rare species comprising 0.9% of collections of adults (IO 12%). It was collected in the southern taiga subzone and is likely to be found in the subtaiga zone as well. Adult females were recorded in the second and third decades of July in pineries, floodplain meadows, and alder thickets. The species

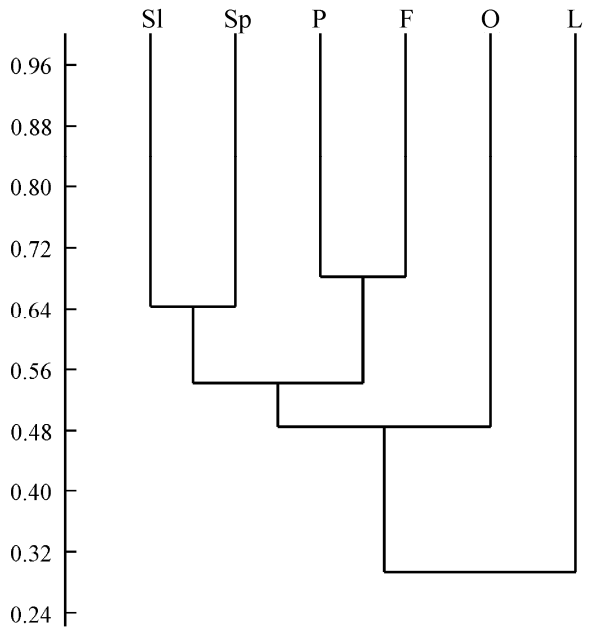

Fig. 2. Similarity of biotopes in the southern taiga subzone of Kirov Province by the species composition of mosquitoes. Ordinate: Jaccard index. F, floodplain meadow; L, lime forest; O, oak forest; P, pine forest; Sl, small-leaved forest; Sp, spruce forest.

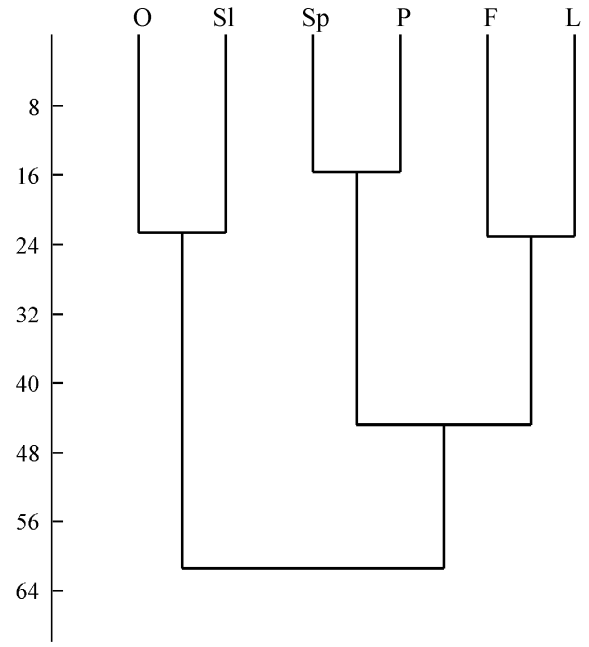

Fig. 3. Similarity of biotopes in the southern taiga subzone of Kirov Province by the structure of the mosquito communities. Ordinate: Euclidean distance. Other designations as in Fig. 2.

[3] The species composition and occurrence of mosquitoes of the family Culicidae in Arkhangelsk Province are given according to Gracheva and Shevkunova (1959), Shevkunova and Gracheva (1961); Chetverikova and Egorova (2010); in the Komi Republic, according to Ostroushko and co-authors (2007), Pestov and Panyukova (2013); in Vologda Province, according to Sharkov (1982), Filonenko (2008); in Perm Territory, according to Kutuzova (1997), Kutuzova and Samarina (2008); in Udmurtia, according to Mukanov and Shumikhin (1989).

most often co-occurred in collections with *A. cinereus* and *Ochlerotatus cantans*, less frequently with *O. communis* and O. *riparius*. According to our data, it is confined to pineries (67% of the adults collected, PI 93.40). In the adjoining territories *A. vexans* is scarce.

Anopheles claviger (Meigen, 1804). The species is absent in our collections; it was recorded in Makarie village, Kiknur District (Shernin, 1960). In adjoining territories it occurs sporadically in the Komi Republic.

Anopheles maculipennis Meigen, 1818. The species is absent in our collections. The species was listed for the entire territory of Kirov Province (Shernin, 1960), possibly as the result of misidentification. It was not recorded in the adjoining territories.

Anopheles messeae Falleroni, 1926. Material: 17 ♀. Sites 1, 25, 26. A common species comprising 1.3% of collections of adults (IO 7%). It was identified by eggs obtained from fed females. The species was collected in the middle and southern taiga subzones, and is likely to be found in the subtaiga zone. Single attacks of overwintered females were recorded in the first decade of May. Aggressive attacks of this species were observed in the first decade of September when the adults were preparing for wintering. The greatest number of females (7 ind.) was collected in the first decade of July in the oakery at the cordon of the Nurgush Reserve. Together with it, such species as *C. pipiens*, *O. communis*, *O. pullatus*, *O. cataphylla*, *O. intrudens*, and *O. cantans* were recorded in collections. The species is confined to oakeries (60% of all the adults collected, PI 93.46). Adults of *A. messeae* were recorded in floodplain meadows and in willow thickets around settlements. Preimaginal development takes place in temporary stagnant floodplain reservoirs, at the water edge of slow streams, and in artificial reservoirs (ditches, holes, and ponds). Adults were collected from May to July and in September. In the adjoining territories the species is scarce.

Coquillettidia richiardii (Ficalbi, 1889). Material: 8 ♀. Sites 9, 21, 25. A rare species comprising 0.6% in collections of adults (IO 7%). It was collected in the middle and southern taiga subzones but not in the subtaiga zone, in the second and third decades of July. Females attacked in the floodplain pine forests and meadows. The species is confined to pine forests (PI 66.92). Larvae and pupae develop in rivers and lakes; adults were collected close to the larvae hatching places. The floodplain species *A. cinereus* was recorded together with *C. richiardii* in most samples. In nearby territories, the species was listed as sporadic for the southern taiga subzone of the Komi Republic and as subdominant in the subtaiga zone of the Perm Kama region.

Culex pipiens Linnaeus, 1758. Material: 14 ♀, 9 larvae. Sites 21, 22, 25, 26, 27, 40. A rare species comprising 0.7% in collections of adults (IO 14%). It was collected in the southern taiga subzone and in the subtaiga zone. Larvae were found at the beginning of June, in pools of the village Karakulskaya Pristan. In the first decade of May overwintered adults attacked the recorder in the oakeries at the cordon of the Nurgush Reserve, and also in willow thickets on Pishchalsky Island. The main hosts of *C. pipiens* are probably birds nesting in the reserve. Only single attacks on humans in the nature have been recorded. Adults were collected in September, from indoor walls in the environs of Kirov and Borovka. Adults attack from May till October. The species was recorded in all the adjoining territories.

Ochlerotatus annulipes (Meigen, 1830). Material: 9 ♀. Sites 14, 16, 18, 30. A rare species comprising 0.7% in collections of adults (IO 9%). All the collections were made in the southern taiga subzone, in the second and third decades of July, in different biotopes: spruce forests, floodplain meadows, and alder thickets. The species prefers spruce forests (PI 36.38). It often co-occurred in samples with *A. cinereus*, *A. vexans*, *O. communis*, and *O. riparius*. Adult females were collected in July. Of the adjoining territories, it was recorded for Arkhangelsk Province and the Komi Republic. The species is generally rare.

Ochlerotatus behningi (Martini, 1926). Material: 56 ♀. Sites 2, 14–17, 19, 32, 40. A common species comprising 4.3% in collections of adults (IO 19%) and distributed across the entire Kirov Province. Most of the specimens (93%) were collected in the southern taiga subzone. The species is confined to the pine forests (72% of the total number of adults collected, PI 54.07). It was found only in forest biotopes: riparian, small-leaved, spruce, and oak ones. Adults were collected in June and July. In nearby territories it was recorded as a rare species for the Komi Republic.

Ochlerotatus cantans (Meigen, 1818). Material: 135 ♀. Sites 2, 9, 13–19, 21, 25–27, 39. A mass species comprising 10.3% in collections of adults (IO 33%). It is widely distributed across the territory of Kirov Province and occurs in all its natural zones,

preferring spruce forests (PI 43.61). Adults were collected in floodland and upland meadows, in willow and alder thickets, and also in pine, oak, lime, and birch forests. Attacks of humans by *O. cantans* were recorded from the second decade of June till the third decade of July. In nearby territories, *O. cantans* is ubiquitous: it is rare in Arkhangelsk Province, common in the Komi Republic but dominant in the environs of Izhevsk and subdominant in the Perm Kama region.

Ochlerotatus cataphylla (Dyar, 1916). Material: 24 ♀, 8 larvae. Sites 1, 23, 25, 33, 34. A common species comprising 1.8% in collections of adults (IO 12%). It was recorded in samples from the middle and southern taiga, preferring small-leaved forests (PI 42.64). Larvae were collected on May 15, in a temporary stagnant pool in a small-leaved (birch-aspen-alder) forest near the village Lebedi (Svecha District, Kirov Province). It mostly attacks together with *O. communis*, *O. intrudens*, and *O. pullatus*. The species co-occurred in collections with *Coquillettidia richiardii* and *A. cinereus*. Attacks of *O. cataphylla* were recorded from the end of May till the end of July. In nearby territories *O. cataphylla* was indicated as the dominant species in Arkhangelsk Province; it is common in the Komi Republic and sporadic in Vologda Province.

Ochlerotatus communis (De Geer, 1776). Material: 159 ♀, 5 larvae. Sites 1, 7–9, 14, 18, 19, 23–26, 30–33, 39, 40, 42. A mass species comprising 14.3% in collections of adults (IO 43%). It occurs uniformly in the whole Kirov Province, both in protected territories and near settlements. Larvae of this species were collected in pools in a small-leaved forest in the middle of May. Adults were collected indoors, in floodplain and upland meadows, willow and alder thickets, and also in small-leaved, pine, and oak forests. The species is confined to small-leaved and oak forests (PI 30.25 and 30.56, respectively). The data on the relative abundance of adults in the northwest of European Russia showed this species to be dominant in all the landscape zones, mainly in forest biotopes (Medvedev et al., 2010). Its attacks were recorded since the third decade of May to the first decade of August. In the adjoining territories *O. communis* was indicated as a dominant but it was rare in Udmurtia.

Ochlerotatus cyprius (Ludlow, 1920). Material: 2 ♀. Sites 15, 41. A rare species making up 0.2% in collections of adults (IO 4%). It was collected in the southern taiga subzone (a pine forest near the village Ershi, at the end of July) and in the subtaiga zone (on the ferry across the Vyatka, not far from Vyatskie Polyany, in the first decade of June). Attacks on humans were recorded in June–July. In the adjoining territories *O. cyprius* is common in Arkhangelsk Province, rare in the Komi Republic, scarce in Perm Territory, and sporadic in Vologda Province; it was not recorded in Udmurtia.

Ochlerotatus diantaeus (Howard, Dyar et Knab, 1913). Material: 152 ♀. Sites 5, 9, 10, 12, 17, 20, 24–27, 30, 38, 39, 40, 42. A mass species comprising 11.6% in collections of adults (IO 36%). It was collected in all the landscape zones of Kirov Province. The species was recorded in 9 types of habitats. It was sporadically collected in a spruce-fir forest, willow thickets, agricultural lands, and also indoors where adults feed more actively than other representatives of the *communis* species group. The species was collected in small-leaved, pine, and broad-leaved riparian forests. It often attacks in oakeries and in floodplain meadows. In Kirov Province, *O. diantaeus*, as well as *O. communis*, prefers riparian oakeries (PI 42.74). Collections of *O. diantaeus* in Kirov Province confirm the previous opinion (Panyukova and Medvedev, 2007) that this species prefers valleys and floodplains of rivers and lakes. Attacks on humans were recorded since the third decade of May till the end of July. In adjoining territories, *O. diantaeus* is common in Arkhangelsk Province and the Komi Republic, and sporadic in Vologda Province; it was recorded in Perm Territory but not in Udmurtia.

Ochlerotatus euedes (Howard, Dyar et Knab, 1913). Material: 18 ♀. Sites 14–17, 29, 32, 42. A common species comprising 1.4% in collections of adults (IO 17%). The species was collected in the southern taiga subzone and in the subtaiga zone. It occurs in different biotopes: oak, spruce, pine, birch forests, floodplain meadows, and broad-leaved riparian forests. Most collections (37.5%) were made in pine forests (PI 56.73). In most samples *O. euedes* co-occurred with *A. cinereus*, *O. cantans*, *O. behningi*, and *O. flavescens*. It actively attacks from the last decade of May till the beginning of August. The species is rare in the nearby territories of Arkhangelsk Province and the Komi Republic; it occurs sporadically in Vologda Province and was not listed for Udmurtia.

Ochlerotatus excrucians (Walker, 1856). Material: 19 ♀. Sites 8, 9, 15, 17, 25, 27, 29, 42. A common

species comprising 1.5% in collections of adults (IO 19%). It was collected in all the landscape zones of Kirov Province, and recorded in floodland forests and meadows as well as pine and small-leaved forests. The species most often occurred in collections from floodland meadows (45.4% of adults collected; PI 44.39). It co-occurred in samples with *A. cinereus*, *O. cantans*, *O. diantaeus*, and *O. intrudens*. Attacks on humans were recorded from the end of June till August. The species occurs frequently and ubiquitously in Vologda Province; it prevails in samples in Udmurtia, and is common in Komi Republic, Arkhangelsk Province, and Perm Territory.

Ochlerotatus flavescens (Müller, 1764). Material: 19 ♀. Sites 2, 15–19, 21, 29, 32. A common species comprising 1.5% in collections of adults (IO 21%). It was collected in the middle and southern taiga subzones, and recorded in spruce and pine forests (20% and 40% of adults collected, respectively), preferring spruce forests (PI 42.66). The species was recorded in single samples from birch and alder forests, a floodplain meadow, and a riparian forest. The season of active attacks of this species lasts from the second decade of May till the end of July. In adjoining territories it is common in Arkhangelsk Province, Komi Republic, and Perm Territory, scarce in Udmurtia, and rare in Vologda Province.

Ochlerotatus intrudens (Dyar, 1919). Material: 97 ♀. Sites 1, 5, 8–10, 20, 24–28, 30, 32, 33, 38, 42. A common species comprising 7.4% in collections of adults (IO 38%). It was collected in all the landscape zones of Kirov Province. Biotopically, *O. intrudens* is confined to floodplain meadows (52% of adults collected, PI 45.24). It frequently occurs in riparian broad-leaved (lime and oak) forests, less frequently in bogged pine forests. The species was rarely recorded in samples from spruce-fir and small-leaved forests, and also indoors. In other territories (Novgorod Province), the species was frequently recorded in forest biotopes in low, swamped, often flooded territories (Panyukova and Medvedev, 2007). In Siberia, this species, unlike other congeners, was distinguished by persistent attacks on humans indoors (Kukharchuk, 1980). Adults were recorded from the beginning of May till the end of August. In the nearby territories, the species is dominant in the subtaiga zone of the Perm Kama region, common in the Komi Republic, and rare in Arkhangelsk and Vologda Provinces.

Ochlerotatus leucomelas (Meigen, 1804). Material: 16 ♀. Sites 5, 8, 12, 25, 28, 40. A common species comprising 1.2% in collections of adults (IO 14%). In Kirov Province, it was most frequently recorded in floodplain meadows (PI 42.92). The species was collected indoors and also in spruce-fir and oak forests, from June till October. In adjoining territories, the species was recorded as common in Arkhangelsk Province and rare in the Komi Republic; it was occasionally found in Vologda Province and Perm Territory but was not recorded in Udmurtia.

Ochlerotatus nigrinus (Eckstein, 1918). Material: 3 ♀. Site 22. A rare species making up 0.2% in collections of adults (IO 2%). Adults were collected in the second decade of May (20.05.2006), in floodplain meadow near Korchemkino, in the environs of Kirov. In adjoining territories, the species is rare in Arkhangelsk Province and occurs sporadically in Komi Republic and Vologda Province; it was not recorded in Udmurtia.

Ochlerotatus pullatus (Coquillett, 1904). Material: 72 ♀. Sites 1, 8, 10, 24–26, 32, 33, 42. A common species comprising 5.5% in collections of adults (IO 21%) and distributed in all the landscape zones of Kirov Province, where it prefers spruce forests (PI 75.38). Females of *O. pullatus* were collected in riparian pine and oak forests and also in floodplain and upland meadows. They attacked from May to August. Of the adjoining territories, the species is common in Komi Republic, rare in Arkhangelsk Province, and sporadic in Vologda Province and Perm Territory; it was not recorded in Udmurtia.

Ochlerotatus punctor (Kirby, 1837). Material: 111 ♀. Sites 4, 5, 7–9, 12–14, 20, 24–26, 31, 36, 38, 40, 42. A common species comprising 8.5% in collections of adults (IO 43%) and occurring in all the landscape zones of Kirov Province. Its attacks were recorded in raised bogs, floodplain meadows, small-leaved, oak, lime, spruce-fir, and pine forests, and also indoors, from the third decade of May to the first decade of August. The species is confined to small-leaved forests (PI 40.16). Of the adjoining territories, it is a mass species in Vologda Province, Komi Republic, and Udmurtia, and a common one in Arkhangelsk Province, being also recorded in Perm Territory.

Ochlerotatus riparius (Dyar et Knab, 1907). Material: 21 ♀. Sites 2, 5, 13, 14, 16–18, 25. A common species comprising 1.6% in collections of adults (IO 19%). It was collected in the middle and southern taiga subzones, being common in spruce, spruce-fir, pine, and small-leaved forests, and also occurred in

samples from floodplain meadows and alder forests. In Kirov Province *O. riparius* is confined to the pine forests (PI 56.53). It was recorded from the end of June to the end of July. Of the adjoining territories, the species is rare in Arkhangelsk Province and Komi Republic, sporadic in Vologda Province; it was recorded in Perm Territory but not in Udmurtia.

Ochlerotatus sticticus (Meigen, 1838). Material: 1 ♀. Site 25. This is a sporadic species making up 0.08% in collections of adults (IO 2%). It was recorded in the southern taiga subzone, where its adults were collected in a floodplain meadow surrounded with pine and spruce forests in the Nurgush Reserve, together with *O. intrudens*, *O. communis*, *O. diantaeus*, *O. pullatus*, and *O. leucomelas*. It attacked in June. In the adjoining territories, the species is rare in Komi Republic and sporadic in Vologda Province; it was recorded in the Perm Kama region but was not recorded in Udmurtia.

CONCLUSION

At present, the known fauna of Kirov Province includes 25 species of mosquitoes, of which eight were recorded there for the first time: *Aedes rossicus*, *A. vexans*, *Ochlerotatus annulipes*, *O. behningi*, *O. cyprius*, *O. nigrinus*, *O. riparius*, and *O. sticticus*. Analysis of our material revealed four mass species from two genera: *A. cinereus*, *O. diantaeus*, *O. cantans*, and *O. communis*. Such species as *Aedes rossicus*, *Anopheles messeae*, *C. pipiens*, *O. behningi*, *O. cataphylla*, *O. euedes*, *O. excrucians*, *O. flavescens*, *O. intrudens*, *O. leucomelas*, *O. pullatus*, *O. punctor*, and *O. riparius* were common in the fauna of Kirov Province. Five rare species were recorded: *Aedes vexans*, *Coquillettidia richiardii*, *Ochlerotatus annulipes*, *O. nigrinus*, and *O. cyprius*. One species, *O. sticticus*, occurred sporadically in the fauna of Kirov Province. The malarial mosquito *A. claviger*, earlier indicated according to the published data, was not recorded by us, possibly due to its low abundance. In our opinion, the previous indication of *A. maculipennis* was the result of misidentification or confusion with *A. messeae*.

Of the adjoining territories, 23 species of mosquitoes are known in Arkhangelsk Province (Chetverikova and Egorova, 2010), 34 species in the Komi Republic (Ostroushko et al., 1997), 27 in Vologda Province (Sharkov, 1982; Filonenko, 2008), 32 in Perm Territory (Kutuzova, 1997; Kutuzova and Samarina, 2008), and 10 species in Udmurtia (Mukanov and Shumikhin, 1989). In our opinion, the absence of mosquitoes of the genus *Culiseta* in the collections from Kirov Province can be explained by their low abundance, since they were recorded as rare or sporadic in the Komi Republic, Arkhangelsk and Vologda Provinces, and Perm Territory.

The fauna of the family Culicidae of Kirov Province is the closest to that of the Komi Republic. The faunistic lists of these two regions share 24 species and differ in 13 species. The faunas of Kirov and Vologda Provinces are the most different, with 19 shared species and 14 different ones. Such species as *Anopheles claviger*, *A. maculipennis*, *Aedes rossicus*, *C. richiardii*, *O. annulipes*, and *O. behningi*, known in Kirov Province, were not recorded in Vologda Province. The faunas of Arkhangelsk and Kirov Provinces have 19 mosquito species in common. Such species as *Culiseta alaskaensis*, *Ochlerotatus impiger*, *O. hexodontus*, and *O. dorsalis*, known in Arkhangelsk Province, were not found in Kirov Province. Of them, *O. impiger* and *O. hexodontus* most frequently occur in the faunistic lists for tundra and forest-tundra localities (Nekrasova et al., 2008). The two other species, *C. alaskaensis* and *O. dorsalis*, may not have been recorded in Kirov Province due to their low occurrence. The species *Culex territans* and *O. dorsalis*, recorded by human landing counts in the environs of Izhevsk, were not found in our collections in Kirov Province. They are likely to be found as larvae in samples from their typical reservoirs.

Comparative analysis of the mosquito species composition in the typical biotopes of Kirov Province revealed the characteristic traits of this territory. In particular, the highest species diversity was observed in the pine forests. Most characteristic of these forests was the complex of species with high preference indices: *A. vexans* (PI 93.5), *C. richiardii* (66.9), *O. euedes* (56.8), *O. riparius* (56.5), and *O. behningi* (54.1). The lowest species diversity was observed by us in the lime forests of Kirov Province. No species statistically associated with small-leaved forests were revealed in our material. Nine mosquito species were recorded in different types of habitats in Kirov Province and may thus be regarded as eurytopic: *A. cinereus*, *O. cantans*, *O. communis*, *O. cataphylla*, *O. excrucians*, *O. flavescens*, *O. intrudens*, *O. leucomelas*, and *O. punctor*. High abundance of the stenotopic *A. rossicus* was recorded in the lime forests of the Nurgush Reserve (PI 87.7). This species is absent in adjoining territo-

ries; in Kirov Province it may occur at the northern boundary of its distribution.

ACKNOWLEDGMENTS

The authors are grateful to Prof. S.G. Medvedev (Laboratory of Parasitology, ZIN RAS) for support and help in preparation of this paper; to A.V. Khalin (ZIN RAS) for valuable advice on the diagnostics of mosquitoes of the family Culicidae and checking some of the identifications; to our colleagues E.P. Lachokha, L.G. Tselishcheva and A.N. Lyapunov for the material collected; to the administration of the Nurgush Reserve for organization of research in the territory of the reserve.

The work was partly supported by the Russian Foundation for Basic Research (grants 11-04-00917-a and 14-04-01139).

REFERENCES

1. Aibulatov, S.V., "Bloodsucking Dipterans (Diptera: Ceratopogonidae, Culicidae, Simuliidae, Tabanidae) of the Kurgala Peninsula, Leningrad Province," Entomol. Obozr. **88** (2), 343–359 (2009) [Entomol. Rev. **89** (6), 645–658 (2009)].
2. Balashov, Yu.S., "A Glossary of Scientific Terms Used in the Russian-Language Literature on Parasitic and Blood-Sucking Arthropods," Entomol. Obozr. **87** (2), 443–453 (2008) [Entomol. Rev. **88** (9), 1088–1096 (2008)].
3. Becker, N., Petric, D., Zgomba, M., et al., *Mosquitoes and Their Control* (Plenum Publ., New York etc., 2003).
4. Beklemishev, V.N., *Biocenotic Foundations of Comparative Parasitology* (Nauka, Moscow, 1970) [in Russian].
5. Chetverikova, T.G. and Egorova, M.A., "Mosquitoes (Diptera: Culicidae) of Plesetsk District, Arkhangelsk Province," in *The Ecology of Arctic and Subarctic Territories: Proc. of Int. Symp.*, Ed. by K.G. Bogolitsyn (Arkhangelsk, 2010), pp. 332–335.
6. Danilov, V.N., "Mosquitoes of the Group *Aedes cantans* (Diptera, Culicidae) of the Fauna of the USSR and the Palaearctic. I. A Key to the Species by Females and Their Geographic Distribution," Entomol. Obozr. **65** (2), 419–425 (1986).
7. Filonenko, I.V., "Family Culicidae Meigen, 1818: Mosquitoes," in *Insect Diversity in Vologda Province*, Ed. by A.A. Shabunov (Vologda State Ped. Univ., Vologda, 2008), pp. 212–220 [in Russian].
8. Frenkel, M.O., "Climate," in *Encyclopedia of Vyatka Land*, Vol. 7: *Nature*, Ed. by V.A. Sitnikov (Vyatka, Kirov, 1997), pp. 142–165 [in Russian].
9. Gracheva, L.P. and Shevkunova, E.A., "Materials on the Study of Mosquitoes in the South of Arkhangelsk Province," Zool. Zh. **11**, 1751–1753 (1959).
10. Gutsevich, A.V. and Dubitsky, A.M., "New Species of Mosquitoes in the Fauna of the Soviet Union," Parazitol. Sbornik **30**, 97–165 (1981).
11. Gutsevich, A.V., Monchadsky, A.S., and Stackelberg, A.A., *Fauna of the USSR. Insecta, Diptera,* Vol. 3, Issue 4: *Mosquitoes of the Family Culicidae* (Nauka, Leningrad, 1970) [in Russian].
12. Hammer, Ø., Harper, D.A.T., and Ryan, P.D., "PAST: Paleontological Statistics Software Package for Education and Data Analysis," Palaeontol. Electr. **4** (1), 1–9 (2001).
13. Khalin, A.V. and Aibulatov, S.V., "English and Russian Terminology for the Thoracic Skeletal Structures of Mosquitoes (Diptera: Culicidae): a Critical Review," Parazitologiya **47** (4), 299–319 (2013) [Entomol. Rev. **94** (7), 959–974 (2014)].
14. Khalin, A.V. and Aibulatov, S.V., *The Thoracic Morphology of Mosquitoes. A New Complex Method of Studying the Thoracic Skeletal Structures in the Family Culicidae (Diptera)* (Lambert Academic Publishing, 2014) [in Russian].
15. Khalin, A.V. and Gornostaeva, R.M., "On the Taxonomic Composition of Mosquitoes (Diptera: Culicidae) in the World and Russian Fauna (A Critical Review)," Parazitologiya **42** (5), 360–381 (2008).
16. Kukharchuk, L.P., *Mosquitoes (Diptera, Culicidae) of Siberia* (Nauka, Novosibirsk, 1980) [in Russian].
17. Kutuzova, T.M., "Eco-Faunistic Review of Mosquitoes (Diptera, Culicidae) of Perm Province," Vestnik Perm. Univ. **3**, 139–147 (1997).
18. Kutuzova, T.M. and Samarina, N.S., "Mosquitoes in the Southwest of the Subtaiga Zone of the Kama Region," Vestnik Perm. Univ. **9** (25), 27–31 (2008).
19. Lyapunov, A.N. and Panyukova, E.V., "On the Role of Adult Mosquitoes (Diptera, Culicidae) in the Feeding of Bats (Chiroptera, Vespertilionidae) of Kirov Province," Teor. Priklad. Ekol. **4**, 87–93 (2010).
20. Medvedev, S.G., "The Fauna of Bloodsucking Insects of Northwestern Russia. Characteristics of the Ranges," Entomol. Obozr. **88** (1), 83–98 (2009) [Entomol. Rev. **89** (1), 56–68 (2009)].
21. Medvedev, S.G. and Aibulatov, S.V., "Regionalization of the Territory of St. Petersburg and Leningrad Province in Connection with the Distribution of Bloodsucking Dipterans," Entomol. Obozr. **91** (3), 624–639 (2012) [Entomol. Rev. **93** (5), 608–619 (2013)].
22. Medvedev, S.G., Aibulatov, S.V., and Panyukova, E.V., "Ecological Features and Distribution of the Mosquito *Aedes communis* (De Geer, 1776) in the Northwestern European Russia," Parazitologiya **44** (5), 441–460 (2010) [Entomol. Rev. **91** (9), 1108–1121 (2011)].
23. Mukanov, S.M. and Shumilin, V.V., "Bloodsucking Dipterans of the Suburban Forest in the City of Izhevsk," in *The Fauna and Ecology of Animals of*

Udmurt SSR and Adjoining Regions: Collected Papers, Ed. by N.E. Zubtsovsky (Udmurt State Univ., Izhevsk, 1989), pp. 105–108 [in Russian].

24. Nekrasova, L.S., Vigorov, Yu.L., and Vigorov, A.Yu., *Ecological Diversity of Mosquitoes in the Urals* (Yekaterinburg, 2008) [in Russian].
25. Ostroushko, T.S., Panyukova, E.V., and Pestov, S.V., "Diptera (Insecta) of the Gnus Complex in the Northeast of European Russia," in *Invertebrates of the Northeast of European Russia*, Ed. by M.M. Dolgin (Komi Sci. Center, Russian Acad. Sci., Syktyvkar, 2007), pp. 182–223) [in Russian].
26. Panyukova, E.V. and Medvedev, S.G., "Species Composition and Ecological Peculiarities of Mosquitoes of the Genus *Ochlerotatus* (Species Groups *cantans* and *dorsalis*) (Diptera: Culicidae) of Novgorod Province," Parazitologiya **40** (6), 512–526 (2006).
27. Panyukova, E.V. and Medvedev, S.G., "Species Composition and Ecological Peculiarities of Mosquitoes of the Genus *Ochlerotatus* (Species Group *communis*) (Diptera, Culicidae) of Novgorod Province," Parazitologiya **41** (3), 223–234 (2007).
28. Panyukova, E.V. and Medvedev, S.G., "Species Composition and Ecological Peculiarities of Mosquitoes of the Genera *Culex*, *Culiseta*, and *Coquillettidia* (Diptera, Culicidae) of Novgorod Province," Parazitologiya **42** (5), 382–394 (2008).
29. Panyukova, E.V. and Tselishcheva, L.G., "Fauna and Biotopic Distribution of Mosquitoes (Diptera, Culicidae) in the Nurgush State Nature Reserve," in *Proceedings of the Nurgush State Nature Reserve, Issue 1*, Ed. by L.G. Tselishcheva (Staraya Vyatka, Kirov, 2011), pp. 115–123 [in Russian].
30. Pesenko, Yu.A., *Principles and Methods of Quantitative Analysis in Faunistic Research* (Nauka, Moscow, 1982) [in Russian].
31. Pestov, S.V. and Panyukova, E.V., "Landscape and Zonal Distribution of Mosquitoes and Horseflies (Diptera: Culicidae, Tabanidae) in the Northeastern Russian Plain," Parazitologiya **47** (4), 320–332 (2013) [Entomol. Rev. **93** (9), 1129–1137 (2013)].
32. Reinert, J.F., "New Classification for the Composite Genus *Aedes* (Diptera: Culicidae: Aedini), Elevation of the *Ochlerotatus* to Generic Rank, Reclassification of the Other Subgenera, and Notes on Certain Subgenera and Species," J. Amer. Mosquito Control Assoc. **16** (3), 175–188 (2000).
33. Sharkov, A.A., "The Distribution of Mosquitoes (Culicidae) in Arkhangelsk and Vologda Provinces," Med. Parazitol. Parasitar. Bolezni **51** (1), 51–54 (1982).
34. Shernin, A.I., "Invertebrates," in *The Nature of Kirov Province*, Ed. by A.I. Shernin (Volgo-Vyatskoe Knizhnoe Izdat., Kirov, 1960), pp. 156–158 [in Russian].
35. Shevkunova, E.A. and Gracheva, L.I., "On the Fauna and Ecology of the Mosquitoes of Arkhangelsk Province," Med. Parazitol. Parasitar. Bolezni **30** (2), 228 (1961).
36. Tatarinov, A.G., *Species Diversity and Methods of Its Assessment* (Komi Sci. Center of Russian Acad. Sci., Syktyvkar, 2010) [in Russian].