



## Features of the daily dynamics of trophic activity of various types of blood-sucking mosquitoes (Diptera, Culicidae) in the south of Tyumen region

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### Article info

Received 03.03.2018

Received in revised form

19.04.2018

Accepted 21.04.2018

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**Khlyzova, T. A. (2018). Features of the daily dynamics of trophic activity of various types of blood-sucking mosquitoes (Diptera, Culicidae) in the south of Tyumen region. Biosystems Diversity, 26(2), 123–127. doi:10.15421/011819**

We conducted research on the determination of the daily activity of blood-sucking mosquitoes of the family Culicidae in 2005–2015 in the south of Tyumen region in three climatic zones (subzones): the subzone of the southern taiga (Nizhnetavdinsky district), the subzone of aspen-birch forests (Tyumen and Yalutorovsky districts) and in the forest-steppe zone (Isetsy district). In each of the three subzones, counts were conducted twice for the summer season – in June and July. A high number of blood-sucking mosquitoes in the south of the Tyumen region have 24-hour activity. The maximum number in all natural and climatic zones of the region is observed at 23 hours. The daily rhythm of activity of certain species of mosquitoes depends on their abundance in the summer season and on their ecological characteristics. The optimal meteorological conditions under which an active flight of mosquitoes are observed: air temperature 12.6–26.0 °C, relative humidity of air – 54–100% and illuminance – 0–8600 lux. In studying the circadian rhythm, 29 mosquito species of the family Culicidae, belonging to 6 genera: *Anopheles*, *Culiseta*, *Coquillettidia*, *Aedes*, *Ochlerotatus* and *Culex*, were recorded. In the subzone of the southern taiga, we recorded a flight of 25 species, in the subzone of small-leaved aspen-birch forests – 20, and in the forest-steppe zone – 24. The peak of species diversity in all three subzones coincided with the maximum number. All registered species in terms of temperature preferences (thermophilicity) can be conditionally divided into two groups. The first group (10 species) are species that actively attack at a temperature 10–20 °C. The second group (19 species) are species that actively attack at an air temperature 10–30 °C.

**Keywords:** mosquitoes; species diversity; daily rhythm of activity; air temperature

### Introduction

Over the day, the activity of Culicidae changes due to the constant impact of periodically changing environmental factors. According to the literature data, daily rhythm of Culicidae activity significantly depends on the number of these insects over the year of study and meteorological conditions during the period of the study. The greatest impact on the activity of mosquitoes, according to a number of researchers, is caused by the temperature and relative humidity, illuminance and wind (Monchadskiy, 1950, 1958; Polyakova & Patrusheva, 1974; Chernyshev, 1981). Depending on the fluctuations of these meteorological characteristics over the day, the activity of mosquitoes significantly varies. The activity of mosquitoes increases in the evening – before sundown and in the morning – before sunrise. Quick transition of daylight to twilight and night darkness to sunrise is a stimulus for female mosquitoes. Over the day, the activity of mosquitoes is inhibited by high temperature and bright light, and in the night – by decrease in the temperature and the dark. The activity of mosquitoes is to a large extent affected by heavy rains and dew. Insignificant rains have no impact on the most species of mosquitoes. The optimum humidity for mosquitoes ranges within 50–99% (Anufriyeva, 1971; Red'kina, 2008). Because in various geological areas and natural-climatic zones, different meteorological conditions are formed, the daily local rhythm of mosquito activity has a number of peculiarities.

### Materials and methods

We conducted our study on the determination of daily activity of Culicidae in 2005–2015 in the south of Tyumen oblast and three natural-climatic zones (subzones): the subzone of northern taiga (Nizhne-

tavdinsky District), the subzone of aspen-birch forests (Tyumen & Yalutorovsky Districts) and the forest-steppe zone (Isetsy District). In each of the three subzones, counts were made twice over the summer season – in June and July.

The count of attacking mosquitoes was conducted using a butterfly net with removable mesh (Rasnitsyn & Kosovskikh, 1979) in 5 replications. The trajectory of every sweep of the butterfly net resembled the figure “eight” and consisted of two moves: at the level of the head and level of the knees. One replication included 10 such sweeps. Each replication of the count was made at a new spot, moving 20–30 steps along a fixed route in a selected plot after a change of net by, i.e. along a so called transect. Because during the day, mosquitoes prefer forest areas of pastures, an area of collecting usually was a forest edge and forest 30 m away from the edge. At the same time, we used the schemes suggested by Lubishev (1958) and Pesenko (1982). Unlike the method of quantitative count along a transect, described by Petrozhytska et al. (2002), we made our counts only in particular areas, without repeated visits, and not constantly along a route in a there and back manner. The interval between the counts was two hours. At the same time, we recorded the temperature and relative humidity, wind speed, the amount of precipitation.

For identification of the species composition of mosquito imagoes, we used special identification tables of Kukharchuk (1980) and Gornostayeva & Danilov (1999), classifying *Ochlerotatus* subgenus as a genus (Gornostayeva, 2009).

### Results

The studies conducted earlier determined that in the conditions of the subzone of the southern taiga, under the canopy of the forest, during the mass flight in the June–July – mosquitoes struck humans

throughout the day (Khlyzova & Pavlova, 2006; Khlyzova & Latkin, 2015). In June, the highest number of mosquitoes was observed at 23 h (i.e. 11 pm) and from 3h to 7h (i.e. 3 am – 7 am). In late July, two maxima were observed over the 24 h activity: 21–23 h and 5–7 h. On open ground, the number of mosquitoes was much lower compared to the forest, and the daily dynamic of the flight in June was characterized by prolonged activity in the night (from 23 to 5 h) and the absence of strikes over the day.

During the study on the daily rhythm of mosquitoes activity in the conditions of the subzone of the southern taiga, we recorded flight of 25 species (Table 1). The maximum species diversity was recorded at 23 h. At that time, there were observed strikes by 20 species of mosquitoes: the complex *Anopheles maculipennis* Mg., *Culiseta alaskaensis* Ludl., *Coquillettia richiardii* Fic., *Aedes cinereus* Mg., *Ae. rossicus* D. G. M., *Ae. vexans* Mg., *Ochlerotatus caspius* Pall., *O. cantans* Mg., *O. riparius* D. K., *O. mercurator* Dyar., *O. behningi* Mart., *O. excrucians* Walk., *O. euedes* H. D. K., *O. cyprius* Ludl., *O. flavescens* Mull., *O. communis* Deg., *O. punctor* Kirby, *O. diantaeus* H. D. K., *O. intrudens* Dyar., *Culex modestus* Fic. For the rest of the time, the number of attacking species ranged from 12 to 19. We observed the minimum species diversity of mosquitoes at 15 h, when active strikes were made by females of 12 species of mosquitoes. 24 h activity was manifested by 10 species: *Ae. cinereus*, *Ae. vexans*, *O. cantans*, *O. riparius*, *O. excrucians*, *O. euedes*, *O. cyprius*, *O. communis*, *O. punctor*, *O. diantaeus*. The shortest period of activi-

ty was observed among *C. richiardii* and *C. modestus*, these species were found caught only at 23 h.

In the subzone of small-leaved aspen-birch forests of Tyumen oblast in June, the peak activity of strikes of mosquitoes in the forests was recorded in the period 23–5 h, and at 23 h and 7–11 h on open ground. The peaks of the number of mosquitoes were observed in June under the forest canopy at 23 and 5 h. On open ground, the maximum activities of mosquito strikes were recorded at hour 23 h and 7 h as under the forest canopy (Khlyzova & Latkin, 2015).

In July, the period of the highest mosquito activity under the forest canopy and on open ground lasted from 21 h to 5 h. The peaks of activity were recorded at 21 h and 5 h, and at 1 h on open ground.

During recording the 24 h rhythm of mosquitoes' activity, we observed active strikes at humans by females of 20 species of mosquitoes (Table 2). The period of activity of most species recorded during the counts (17–19 species) lasted from 21 h to 3 h, i.e. in the period of the optimum meteorological conditions (temperature and relative humidity and illuminance). The peak of species diversity was recorded at 23 h, when the highest number of striking mosquitoes during the 24 h period was observed. At that time, we recorded strikes of females of 19 species: *Culiseta morsitans* Theob., *Ae. cinereus*, *Ae. rossicus*, *Ae. vexans*, *O. caspius*, *O. cantans*, *O. riparius*, *O. mercurator*, *O. behningi*, *O. excrucians*, *O. euedes*, *O. cyprius*, *O. flavescens*, *O. communis*, *O. punctor*, *O. diantaeus*, *O. intrudens*, *O. cataphylla* Dyar. and *C. modestus*.

**Table 1**

Twenty-four-hour activity of different species of mosquitoes in the conditions of the southern taiga

Species	The number of individuals caught												Total
	07 h	09 h	11 h	13 h	15 h	17 h	19 h	21 h	23 h	01 h	03 h	05 h	
<i>Aedes cinereus</i> Mg.	115	111	36	15	59	72	52	215	321	47	26	64	1 133
<i>Ae. vexans</i> Mg.	36	22	36	4	6	18	20	54	170	35	36	31	468
<i>Ochlerotatus cantans</i> Mg.	423	302	215	126	66	127	111	379	590	133	93	354	2 919
<i>O. riparius</i> D. K.	59	134	70	16	16	5	26	34	60	40	62	85	607
<i>O. excrucians</i> Walk.	249	203	123	72	66	72	78	190	390	135	98	337	2 013
<i>O. euedes</i> H. D. K.	40	91	40	10	4	7	7	25	68	27	26	55	400
<i>O. cyprius</i> Ludl.	27	20	4	3	5	9	10	16	9	18	7	42	170
<i>O. communis</i> Deg.	61	26	7	6	7	14	4	55	82	15	3	57	337
<i>O. punctor</i> Kirby	199	181	76	27	16	24	19	98	353	177	144	279	1 593
<i>O. diantaeus</i> H. D. K.	139	45	16	6	17	27	31	44	124	24	19	52	544
<i>Ae. rossicus</i> D. G. M.	8	–	1	–	–	–	–	9	7	4	–	9	38
<i>O. caspius</i> Pall.	3	7	–	–	–	14	–	13	50	1	11	2	101
<i>O. mercurator</i> Dyar.	3	15	–	–	4	8	5	7	5	6	2	–	55
<i>O. intrudens</i> Dyar.	80	5	20	8	–	–	–	–	10	–	3	–	126
<i>Culiseta longiareolata</i> Macq.	8	–	–	–	–	–	–	–	–	–	–	–	8
<i>O. dorsalis</i> Mg.	–	1	1	1	–	7	6	9	–	1	1	–	27
<i>O. leucomelas</i> Mg.	–	3	–	–	–	–	–	–	–	–	–	–	3
<i>O. cataphylla</i> Dyar.	–	–	10	1	–	–	–	–	–	–	–	–	11
<i>O. flavescens</i> Mull.	–	–	–	–	2	–	3	6	24	5	–	3	43
<i>O. behningi</i> Mart.	–	–	–	–	–	–	–	3	4	2	3	–	12
Комплекс <i>Anopheles maculipennis</i> Mg.	–	–	–	–	–	–	–	–	22	7	5	–	34
<i>Cs. ochroptera</i> Peus	–	–	–	–	–	–	–	–	–	3	3	–	6
<i>Cs. alaskaensis</i> Ludl.	–	–	–	–	–	–	–	–	7	5	2	–	14
<i>Coquillettia richiardii</i> Fic.	–	–	–	–	–	–	–	–	16	–	–	–	16
<i>Culex modestus</i> Fic.	–	–	–	–	–	–	–	–	11	–	–	–	11
Total: individuals	1 450	1 166	655	295	268	404	372	1 157	2 323	685	544	1 370	10 689
of species	15	15	14	13	12	13	13	16	20	19	18	13	25

In the daytime, the number of flying species decreased to 8–16. Twenty-four-hour activity was observed among 5 species of mosquitoes: *Ae. cinereus*, *Ae. rossicus*, *Ae. vexans*, *O. cantans* and *O. excrucians*. The shortest period of flight was recorded for two species: *C. morsitans*, strikes of females of this species on humans were recorded only at 23 h, and *Ochlerotatus sticticus* Mg., single females of this species were caught at 3 h.

In the conditions of forest-steppe zone of Tyumen oblast, we determined that in June under the forest canopy, mosquitoes struck humans throughout the 24 h period. On open ground, mosquitoes were not active in the daytime, their strikes were not recorded from 9 h to 17 h and at 21 h. In the twenty-four-hour rhythm of activity in both habitats, we observed two peaks at 23 h and 05 h (Khlyzova & Latkin, 2015). In July, under the forest canopy, mosquito strikes were

not observed only at 15 h and 19 h, and on open ground, they actively struck only at 23 h and 5 h.

During the study of the twenty-four-hour rhythm of mosquito activity in the forest-steppe zone of Tyumen oblast, we recorded strikes of 24 species of mosquitoes (Table 3). Active flight of the highest number of species (14–16 species) was observed in the period from 23 h to 1 h, i.e. during the maximum 24 h activity. Maximum species diversity was observed at 23 h – at that time, we recorded strikes on humans by *C. richiardii*, *Ae. cinereus*, *Ae. rossicus*, *Ae. vexans*, *O. caspius*, *O. dorsalis* Mg., *O. behningi*, *O. cantans*, *O. riparius*, *O. excrucians*, *O. euedes*, *O. cyprius*, *O. punctor*, *O. diantaeus*, *O. intrudens* and *C. pipiens*. In the daytime, only individuals of the most common species were observed. The minimum species diversity was recorded at 11 h (i.e. 11 am), when humans were struck by

single individuals of *O. riparius*, *O. punctor* and *O. diantaeus*, and at 13 h, when the counts included *O. cantans*, *O. diantaeus* and *Ae. rossicus*. The species which in the southern taiga and small-leaved aspen-birch forests were characterized by twenty-four-hour activity, due to their low number, struck mostly in the evening and morning hours in the forest-steppe zone.

During conducting all the recording of the 24-h rhythm of mosquito activity, the air temperature fluctuated within 10–30 °C. We recorded no temperature below 10 and above 30 °C. The analysis of meteorological conditions over the 24-h recording in 2005–2015 indicated active strikes of mosquito females at the temperature of 12.6–30.0 °C, relative humidity of 33–100% and 0–37,000 lux illuminance. During the highest activity of mosquitoes, the air temperature equaled 12.6–26.0 °C, relative humidity – 54–100%, illuminance – 0–8,600 lux. All 29 species recorded over the study could be conventionally divided into two groups in relation to their preferences (ther-

mophilicity): the species which actively struck at the temperature 10–20 °C, and species which actively struck at the air temperature 10–30 °C (Table 4). The first group included 10 species, one of them (*C. ochroptera*) had a clearly manifested peak of activity at the temperature range of 10–15 °C, 6 species (*A. maculipennis* complex, *C. alaskaensis*, *C. morsitans*, *C. richiardi*, *C. modestus* and *C. pipiens*) struck most actively at 15–20 °C, three species (*O. sticticus*, *O. pionips* and *O. behningi*) had no clearly manifested peak of activity and practically equally struck both at 10–15 and at 15–20 °C.

The second group is represented by 19 species. Among them, 14 species had their peak strike activity at the temperature of 15–20 °C, and two species (*O. leucomelas* and *C. pipiens*) were observed to strike only at this temperature, one species (*O. dorsalis*) at the air temperature of 20–25 °C. *O. punctor* was the most active at 10–20 °C, and *O. cantans* – at 15–25 °C. Therefore, the highest number of mosquitoes was caught at the air temperature of 15–20 °C.

**Table 2**

Twenty-four-hour activity of different species of mosquitoes in the conditions of the subzone of small-leaved aspen-birch forests

Species	Number of individuals caught												Total
	07 h	09 h	11 h	13 h	15 h	17 h	19 h	21 h	23 h	01 h	03 h	05 h	
<i>Aedes cinereus</i> Mg.	211	61	51	27	31	44	36	272	441	170	140	102	1 586
<i>Ae. rossicus</i> D. G. M.	4	14	14	6	7	4	7	51	95	41	43	25	311
<i>Ae. vexans</i> Mg.	16	24	19	10	2	14	13	21	52	37	25	49	282
<i>Ochlerotatus cantans</i> Mg.	98	84	67	52	45	17	21	98	378	109	138	206	1 313
<i>O. excrucians</i> Walk.	51	20	26	24	47	7	12	46	162	83	101	130	709
<i>O. caspius</i> Pall.	1	6	10	8	12	6	5	6	5	2	–	–	61
<i>O. riparius</i> D. K.	7	7	1	–	1	–	3	4	22	4	18	8	75
<i>O. mercurator</i> Dyar.	7	7	7	–	–	–	–	7	37	4	2	4	75
<i>O. euedes</i> H. D. K.	7	8	5	5	2	–	2	7	36	38	25	36	171
<i>O. cyprius</i> Ludl.	3	–	–	7	4	2	3	16	52	2	7	14	110
<i>O. punctor</i> Kirby	11	19	23	6	–	3	10	29	45	14	28	18	206
<i>O. communis</i> Deg.	2	–	–	–	–	–	–	14	8	8	4	8	44
<i>O. diantaeus</i> H. D. K.	3	1	–	8	–	–	–	5	17	8	11	18	71
<i>O. intrudens</i> Dyar.	6	–	–	–	–	–	–	–	7	13	10	13	49
<i>O. cataphylla</i> Dyar.	2	–	–	3	–	–	–	1	1	–	–	8	15
<i>O. behningi</i> Mart.	1	–	–	–	–	–	–	–	7	5	1	–	14
<i>O. flavescens</i> Mull.	–	8	–	3	2	–	5	9	77	22	27	4	157
<i>Culiseta morsitans</i> Theob.	–	–	–	–	–	–	–	–	8	–	–	–	8
<i>O. sticticus</i> Mg.	–	–	–	–	–	–	–	–	–	–	2	–	2
<i>Culex modestus</i> Fic.	–	–	–	–	–	–	–	–	6	4	2	–	12
Total: individuals of species	430	259	223	159	153	97	117	586	1 451	564	584	643	5 271
	16	12	10	12	10	8	11	15	19	17	17	15	20

**Table 3**

Twenty-four-hour activity of different species of mosquitoes in the conditions of forest-steppe zone

Species	Number of individuals caught												Total
	07 h	09 h	11 h	13 h	15 h	17 h	19 h	21 h	23 h	01 h	03 h	05 h	
<i>Coquillettidia richiardi</i> Fic.	4	–	–	–	–	–	–	–	9	1	–	10	24
<i>Ochlerotatus cantans</i> Mg.	4	6	–	2	5	4	–	7	22	4	4	11	69
<i>O. riparius</i> D. K.	2	2	1	–	–	–	–	–	6	1	–	5	17
<i>O. excrucians</i> Walk.	6	2	–	–	2	4	3	5	5	5	8	10	50
<i>O. punctor</i> Kirby	2	8	1	–	7	4	–	2	28	8	21	50	131
<i>O. diantaeus</i> H. D. K.	3	4	1	1	–	2	4	6	2	–	12	24	59
<i>Aedes cinereus</i> Mg.	4	–	–	–	–	–	–	6	13	4	–	2	29
<i>Ae. rossicus</i> D. G. M.	2	–	–	1	–	–	–	1	4	1	–	–	9
<i>O. intrudens</i> Dyar.	–	2	–	–	–	–	3	–	2	–	–	–	7
<i>O. euedes</i> H. D. K.	–	–	–	–	2	2	3	2	9	3	2	12	35
<i>O. flavescens</i> Mull.	–	–	–	–	–	–	3	–	–	1	–	–	4
<i>O. cataphylla</i> Dyar.	–	–	–	–	–	–	3	–	–	–	1	–	4
<i>O. caspius</i> Pall.	–	–	–	–	–	–	–	1	6	1	–	5	13
<i>O. communis</i> Deg.	–	–	–	–	–	–	–	1	–	–	–	2	3
<i>Ae. vexans</i> Mg.	–	–	–	–	–	–	–	2	18	4	–	9	33
<i>O. dorsalis</i> Mg.	–	–	–	–	–	–	–	–	4	–	–	–	4
<i>O. behningi</i> Mart.	–	–	–	–	–	–	–	–	4	1	1	10	16
<i>O. cyprius</i> Ludl.	–	–	–	–	–	–	–	–	2	–	–	–	2
<i>Culex pipiens</i> L.	–	–	–	–	–	–	–	–	2	–	–	–	2
<i>O. mercurator</i> Dyar.	–	–	–	–	–	–	–	–	–	1	–	–	1
<i>O. sticticus</i> Mg.	–	–	–	–	–	–	–	–	–	1	–	–	1
<i>Culiseta alaskaensis</i> Ludl.	–	–	–	–	–	–	–	–	–	–	1	–	1
<i>Cs. morsitans</i> Theob.	–	–	–	–	–	–	–	–	–	–	1	–	1
<i>O. pionips</i> Dyar.	–	–	–	–	–	–	–	–	–	–	2	2	4
Total: individuals of species	27	24	3	4	16	16	19	33	136	36	53	152	519
	8	6	3	3	4	5	6	10	16	14	10	13	24

**Table 4**

The correspondence of the blood-sucking mosquitoes to different air temperatures

№	Species	Total of mosquitoes caught	Out of them, at the temperature of			
			10–15 °C	15–20 °C	20–25 °C	25–30 °C
1	Complex <i>Anopheles maculipennis</i> Mg.	34	9	25	–	–
2	<i>Culiseta ochroptera</i> Peus	6	5	1	–	–
3	<i>Cs. alaskaensis</i> Ludl.	15	6	9	–	–
4	<i>Cs. morsitans</i> Theob.	9	1	8	–	–
5	<i>Coquillettidia richiardii</i> Fic.	40	8	32	–	–
6	<i>Ochlerotatus sticticus</i> Mg.	3	2	1	–	–
7	<i>O. pionips</i> Dyar.	4	3	1	–	–
8	<i>Culex modestus</i> Fic.	23	6	17	–	–
9	<i>O. behningi</i> Mart.	42	19	23	–	–
10	<i>Cs. longiareolata</i> Macq.	8	6	2	–	–
11	<i>O. leucomelas</i> Mg.	3	–	3	–	–
12	<i>Cx. pipiens</i> L.	2	–	2	–	–
13	<i>Aedes cinereus</i> Mg.	2 748	313	1 557	703	175
14	<i>Ae. rossicus</i> D. G. M.	358	88	159	60	51
15	<i>Ae. vexans</i> Mg.	783	182	359	155	87
16	<i>O. caspius</i> Pall.	175	21	65	50	39
17	<i>O. dorsalis</i> Mg.	31	3	5	23	–
18	<i>O. cantans</i> Mg.	4 301	981	1 697	1 125	498
19	<i>O. riparius</i> D. K.	699	178	212	155	154
20	<i>O. mercurator</i> Dyar.	131	17	63	40	11
21	<i>O. excrucians</i> Walk.	2 772	718	929	601	524
22	<i>O. euedes</i> H. D. K.	606	175	204	126	101
23	<i>O. flavescens</i> Mull.	204	57	101	22	24
24	<i>O. cyprius</i> Ludl.	282	70	103	61	48
25	<i>O. communis</i> Deg.	384	88	172	81	43
26	<i>O. punctor</i> Kirby	1 930	576	593	393	368
27	<i>O. diantaeus</i> H. D. K.	674	92	335	181	66
28	<i>O. intrudens</i> Dyar.	182	31	116	29	6
29	<i>O. cataphylla</i> Dyar.	30	6	9	11	4
	Total: of species	29	27	29	17	16
	individuals	16 479	3 661	6 803	3 816	2 199

## Discussion

Practically all available domestic literature characterizes the quantitative aspect of the 24-h rhythm of mosquitoes, i.e. reflects the fluctuations of their number. At the same time, the materials do not reveal the changes in the species composition of striking females over the 24-h period. The foreign literature contains some fragmented data on the ecological preferences of certain species of mosquitoes (Forattini & de Castro Gomes, 1988; Charlwood, 1996; Voorham, 2002; Montarsi et al., 2015; Kim et al., 2016). The study we conducted on 24-h rhythm of activity of blood-sucking mosquitoes in the conditions of the southern Tyumen oblast allowed us to reveal both the quantitative (Khlyzova & Latkin, 2015) and qualitative aspect of the issue.

In the rhythmicity of dusk-flying insects, including mosquitoes, relation to the illuminance is the most clearly manifested (Nayar & Sauerman, 1971; Chernyshev, 1981). According to Monchadskiy (1950, 1958), the periodic changes in the light over 24-h is determined by development and the main patterns of the 24-h rhythm, i.e. its qualitative aspect, and the changes in the temperature within the optimum and transitional zones influence only on the qualitative aspect of the 24-h rhythm. According to Monchadskiy (1950) and Pestyakova et al. (1976), the optimum illuminance equals 10–500 lux. In the forest-steppe zone of Tyumen Oblast, the study of the 24-h rhythm was conducted at a low level of mosquito abundance, the highest activity of mosquitoes occurred in the period of dusk, which indicates that the illuminance is one of the main limiting factors. Under the forest canopy in June, mosquitoes struck throughout the twenty-four-hour period, however, during the daytime, their number significantly decreased. In July, when the number of mosquitoes was significantly low, their strikes during the daylight hours either were not observed or the strikes were made by single individuals. Over the seasons of the study in the southern taiga and small-leaved aspen-birch forests, the number of mosquitoes was high, and the active

strikes of females on humans and animals was observed at illuminance from 0 to 3700 lux, which is 7 times higher than the borderline value mentioned in the literature. Some researchers mention the influence of the moon's cycle on the activity of mosquitoes, the literature describes the fact that one species were more active over the new moon phase, and the other preferred full moon (Davies, 1975; Charlwood et al., 1986; Guimarães et al., 2000).

According to the literature data, in all landscape-climatic zones of Western Siberia, mosquitoes are active at the temperature 2–37 °C, with optimum of 7–5 °C (Anufriyeva, 1971; Kukharchuk, 1981; Redkina, 2008). The analysis of meteorological conditions developed during the study indicated that at relatively high temperatures in the night (not lower than 13 °C), the main factor which inhibits the intensity and the duration of the night activity at that time is mist with increased relative air humidity of up to 100%, which coincides with the data of other researchers (Haufe, 1964). Low air humidity also negatively affects the activity of mosquitoes (Guimarães et al., 2000). We determined no negative impact of temperature 12.6–30.0 °C during the records.

One of the inhibiting factors for mosquitoes is strong wind. According to Kukharchuk (1981), their flight stopped at the wind speed of over 4 m/s. During our studies, we recorded strikes of single mosquitoes at the wind speed of 5 m/s.

Thus, apart from the main abiotic factors, the activity of mosquito females during their search of food is affected also by such biotic factors as their total number. The higher the number of mosquitoes, the harder it is for them to find food and receive the needed portion of blood. Hungry females were significantly active despite non-optimum conditions of the environment.

## Conclusions

During the study of the 24-h activity of mosquitoes in southern Tyumen oblast, we recorded flight of 29 species of mosquitoes: in the subzone of the southern taiga – 25, in the subzone of small-leaved aspen-birch forests – 20, in the forest-steppe zone – 24 species. The highest species diversity of striking mosquitoes occurred in all landscape-climatic zones of southern Tyumen oblast over the period of evening flight, i.e. at 23 h. The minimum species diversity was observed in the daytime (11–17 h), when only the females of the commonest species struck actively. The pattern of 24-h activity of each species of mosquito depends on the total number of mosquitoes in the season of study and on the ecological peculiarities of the species, which is determined by the range of the main meteorological conditions optimum for its flight. For most species recorded during the study, the optimum temperature range for active flight and strikes was 15–20 °C.

This report was prepared thanks to financial support from FANO Russia within the framework of the topic FSR No 0408-2014-0025 “Current state of biodiversity of Southwest Siberia as a reflection of anthropogenic transformation of the landscape”.

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