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BIRDS AS HOSTS OF PARASITIC LOUSE FLIES (DIPTERA) IN THE SOUTH OF THE RUSSIAN FAR EAST

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In 2017–2020, 3833 birds representing 103 species were captured at two localities in the Lazovsky State Nature Reserve, Primorye Territory, Russian Far East. All birds were ringed and released on site. The research team recorded the presence of louse flies in 646 birds representing 62 species (51 nestlings, 11 migrants), while 41 species from two orders, Charadriiformes and Apodiformes, were found to be uninfested. A total of 1184 specimens of louse flies from two subfamilies, Ornithomyinae (3 genera, 6 species) and Lipopteninae (1 genus, 2 species), were revealed. Forty-seven species of birds were recorded to be infested by *Ornithoica momiyamai* Kishida 1932, most of these serving as hosts new to this louse fly. Forty-two bird species were infested by *Ornithomya avicularia* (L. 1758) s. l., 11 bird species were found hosts to *O. fringillina* (Curtis 1856). *Ornithoica unicolor* Speiser 1900 was revealed on 11 bird species, being the most abundant on the Ural owl (*Strix uralensis*). *Ornithomya comosa* (Austen 1930) and *Crataerina hirundinis* (Curtis 1856) were found on Hirundinidae birds and *Parus palustris*. *Lipoptena cervi* (Linnaeus 1758) and *L. fortisetosa* Maa 1965 were recorded as uncommon bird parasites, as both species were only found on six bird species.

Keywords: Hippoboscidae, Lazovsky State Nature Reserve, Primorye Territory, Russia

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Four groups of Arthropoda are known bloodsucking ectoparasites of adult birds: ticks (Ixodidae, Argasidae and Gamasoidea), fleas (Siphonaptera), some true bugs (Hemiptera), and louse flies (Diptera, Hippoboscidae). The plumage and skin of birds are occupied by mites from the families Analgesidae and Psoroptidae. Louse flies are the main group of obligate blood-sucking ectoparasites of birds, with adult louse flies of both sexes being hematophagous. Females are macrolarviparous, with larvae developing in their uterus and feeding on secretions from internal accessory glands. These larvae are later laid on the ground or in bird nests, where they pupate immediately. Adult flies are small or medium-sized (2.5–10 mm); their body is usually dorsoventrally flattened as an adaptation to their ectoparasitic mode of life. Louse flies are important parasites of many birds, except for aquatic bird orders such as Anseriformes, Podicipediformes, Laridae, Alcidae, and others. The Hippoboscidae family comprises over 213 species (Dick, 2006), distributed all over the world, most inhabiting the tropics of both Hemispheres. There are 55 species from 12 genera known in the Palearctic Region (Soós, Hůrka, 1986), with 26 of those species being recorded in the Asian Palearctic (Iwasa, Choi, 2013). Most ornithophilous louse flies are polyxenous, parasitising several tens of bird species. Louse flies are vectors of several blood-borne pathogens of wild birds, which are considered some of the most significant pathogens for the conservation of wild populations of birds. Parasites known to occur in the blood of birds are haemosporidian, piroplasmid, kinetoplastid, protozoans, bacteria and viruses. Some stages of the life history of these pathogens occur in the bodies of louse flies (Bequaert, 1953; Baker, 1967; Matyukhin, Boiko, 2007, 2008; Zabashta et al., 2017, 2017a; Khametova et al., 2018). Ornithophilous louse flies can be carried long distances by migrant birds and transfer pathogenic agents between localities, as seen by the circulation of West Nile virus by the dispersal of louse flies of the genus *Icosta*

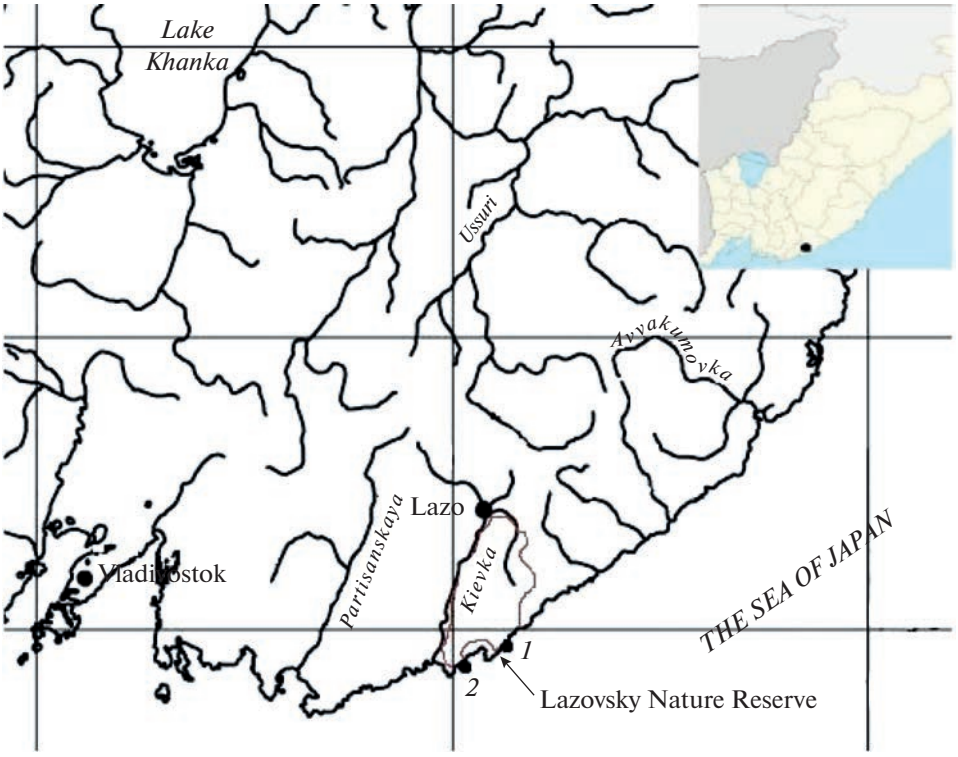

Fig. 1. South of Primorye Territory: *1*, *2* – localities of collecting birds.

Speiser 1905 (Ganez et al., 2002; Farajollahi et al., 2005; Matyukhin et al., 2013). Such potential for pathogenic dispersal gives great epidemiological importance to research on bird ectoparasites (Pavlovsky, Tokarevich, 1966; L'vov, Il'ichev, 1979).

STUDY AREA, MATERIALS AND COLLECTION METHODS

All material was collected in the Lazovsky State Nature Reserve in 2017–2020, which is situated in the eastsouthern part of the Primorye Territory, between the Kievka and Chernaya Rivers, on the southern spurs of Sikhote-Alin, occupying the meridional ridge of Zapovedny at a height of 600–900 m with peaks Chernaya, Nogievskaya, and others more than 1000 m. Rivers and springs are numerous and belong to several basins. Musson climate is softer on the sea coast and colder in mountain parts of the territory. Forests occupy more than 95% of the territory with the dominance of oak forests (*Quercus mongolica*, 64%). Forests dominated by *Pinus koreana* are situated only in the continental parts of the Reserve. Upper parts of ridges and hills are covered with spruce-fir forests. Valley forests with high plant biodiversity occur along big rivers. Vegetation changes from sea meadows to mountain beach wood and mountain meadows. The research team captured birds using mist nets in two localities, which were 50 km apart from each other (Fig. 1).

Locality *1*. Valley of the Proselochnaya River (43°01′ N, 134°07′ E).

Locality *2*. Petrov Bay (133°48′ N, 133°48′ E).

Five mist nets (4 nets 12 m long and a net 9 m long, height 2.5 m) were used in May–August and 5–11– in September–November every year in both localities. Mist nets were used for 150 days (1237 mist/day for four years: 2017–299; 2018–407; 2019–261; 2020–270). A total of 3833 individual birds of 103 species were captured over four years. All captured birds were ringed and released into the wild. Nine nestlings of four species (*Cecropis daurica*, *Hirundo rustica*, *Passer montanus*, and *Apus pacificus*) were also sampled for collecting louse flies. Each bird taken from the mist net was transported into a special tent in a small fabric bag, where the plumage of each captured bird was thoroughly examined to search for louse flies. A total of 1184 specimens of louse flies were collected from 646 birds of 62 species. All the captured flies were preserved in 70% ethanol. To identify the louse flies species, the following literature resources were used: Theodor, Oldroyd, 1964; Maa, 1963, 1966, 1969; Grunin, 1970; Farafonova, 2001; Doszhanov, 2003; Iwasa, Choi, 2013. The Latin names of birds are given according to Koblik and Arkhipov (2014).

RESULTS

The results for each year are presented separately as the collecting period and the number of sampled birds and their parasitic louse flies varied every year.

2017. Birds were captured over 35 days: 7 days in July, 11 days in September, 14 days in October, and 3 days in November. A total of 1161 birds of 55 species were captured and examined. It was found that 104 birds (8.96%) of 32 species were parasitised by louse flies of 7 species. Most specimens of infected birds were captured in July and September. Twenty-three species of examined birds were free from parasites. Twenty-seven species of birds were infected by *Ornithoica momiyamai* Kishida 1932, the most common parasite. Ten species of birds were infected by *Ornithomya avicularia* (L. 1758) s. l., the second most abundant parasite. Most species of birds were infected by one or two species of louse flies. Only four species of birds, *Parus minor*, *Sitta europaea*, *Cristemberiza elegans*, and *Ocyris spodocephalus* were infected by three species of louse flies. Most specimens of louse flies were collected from *Sitta europaea* and *Cristemberiza elegans,* representing 26 and 21 specimens of louse flies respectively. The degree of infection for different species of birds varied; for example, two individuals of *Cristemberiza elegans* were investigated and both presented louse flies, while only two out of 444 individuals of *Aegithalos caudatus* had louse flies. Only one individual of *Paradoxornis webbianus* was infected from 56 investigated specimens and only 12 out of 111 individuals of *Zosterops erythropleurus* were parasitised. *Luscinia sibilans*, *Phylloscopus tenellipes*, and *Cristemberiza elegans* were infected by two species of common mammal parasites, *Lipoptena cervi* (L. 1758) and *L. fortisetosa* (Maa, 1965).

2018. Birds were captured over 56 days: 6 days in May, 10 days in July, 8 days in August, 16 days in September, 14 days in October, and 2 days in November. A total of 1443 birds from 79 species were captured and examined. Thirty-three bird species were parasite-free. Only 296 specimens of 46 species of birds were infected (20.51%) by 7 species of louse flies. Louse flies were found on 10 species of birds on which they not were found in 2017. Thirty-seven species of birds were infected by *Ornithoica momiyamai,* the most numerous louse flies as in 2017. Twenty-four species of birds were infected by *Ornithomya avicularia,* the second most abundant louse fly. Only 3 species of birds were infected by *Ornithoica unicolor* Speiser 1900. Usually, a single species of louse fly was found on a specimen of bird, seldom two or three species. *Sitta europaea* was strongly infected: 85 louse flies of two species were taken from 29 examined birds. *Parus minor*, *P. palustris*, *Phylloscopus coronatus*, *Turdus hortulorum*, *Motacilla cinerea*, and *Picus canus* were infected by three species of louse flies. *Cecropis daurica* and *Delichon urbica lagopodum* were infected by monoxenous louse fly species *Ornithomya comosa* (Austen 1930) and *Crataerina hirundinis* (Linnaeus 1758). *Parus palustris* and *Streptopelia orientalis* were infected by the common mammal parasite *Lipoptena cervi*.

2019. Birds were sampled over 29 days: 3 days in May, 3 days in July, 7 days in August, 12 days in September, and 4 days in October. A total of 940 birds of 67 species were captured. 173 birds of 33 species were infected (18.40%) by 5 species of louse flies. 24 species of birds were infected by the most abundant louse fly *Ornithoica momiyamai,* 9 species of birds were infected by *O. unicolor,* and 22 species of birds were infected by *Ornithomya avicularia*. Usually, a single species of louse fly was found on a single species of bird, seldom two or three species. *Sitta europaea* was infected by 4 species of louse flies; 60 louse flies were taken from 27 birds. The highest number of louse flies were found on Ural Owl (*Strix uralensis*) – 77 flies belonging to two species from 5 examined birds, 73 of these louse flies were *Ornithoica unicolor*. One specimen of the common mammal parasite *Lipoptena cervi* was found on *Phylloscopus schwarzi*.

2020. Birds were sampled over 30 days: 8 days in July, 10 days in August, 8 days in September, and 4 days in October. A total of 289 birds of 47 species were captured. Louse flies belonging to 7 species were found on 73 birds of 25 species (25.26%). 16 species of birds were infected by *Ornithoica momiyamai* and 17 species by *Ornithomya avicularia*. A female *Ornithomya comosa,* a monoxenous parasite of Hirundinidae was found on the accidental host *Parus palustris*. As in preceding years, usually, only one or two species of louse flies were found on a species of bird. Three species of louse flies were taken from *Cristemberiza elegans* and *Turdus hortulorum* and four species of louse flies from *Parus palustris*. The highest number of louse flies were found on *Turdus hortulorum* – 40 specimens on 7 examined birds. The common mammal parasite *Lipoptena fortisetosa* was found on *Cristemberiza elegans*.

DISCUSSION

Birds of the following orders were investigated: Falconiformes 2 species, Galliformes 1, Charadriiformes 9, Columbiformes 1, Strigiformes 4, Apodiformes 1, Coraciiformes Piciformes 7, and Passeriformes 77 species. Six hundred forty-six birds (16.9% from captured and investigated) of 62 species were infected by louse flies: Falconiformes 2 species, Galliformes 1, Columbiformes 1, Strigiformes 2, Coraciiformes 1, Piciformes 4, Passeriformes 51 (Table 1). Passeriformes were the most numerous group of infected birds (82.25%), and no louse flies were found on 41 species of examined birds. Most birds were nesting, and 11 species were migrants: *Anthus rubescens*, *Prunella montanella*, *Luscinia calliope*, *Muscicapa griseisticta*, *Ficedula albicilla*, *Phylloscopus borealis*, *Phylloscopus inornatus*, *Fringilla montifringilla*, *Ocyris rusticus*, *Ocyris personata*, and *Ocyris rutilus*. Only two po-

Table 1. Birds and their parasite louse flies, collected 2017–2020 in the Lazovsky Nature Reserve

Species of birds and number of specimens infected by louse flies	Species of louse flies and number of males/females collected
Pernis ptilorhynchus 1	*Ornithoica unicolor* 0/2, *Ornithomya avicularia* 0/1
Occipiter nasus 1	*Ornithomya avicularia* 1/2
Tetrastes bonasia 1	*Ornithomya avicularia* 1/0
Streptopelia orientalis 1	*Lipoptena cervi* 0/1
Strix uralensis 5	*Ornithoica unicolor* 23/50, *Ornithomya avicularia* 1/3
Otus bakkamoena 1	*Ornithomya avicularia* 0/2
Alcedo atthis 11	*Ornithoica momiyamai* 1/7, *Ornithomya avicularia* 3/2
Picus canus 7	*Ornithoica unicolor* 1/0, *Ornithoica momiyamai* 0/1, *Ornithomya avicularia* 6/0
Dendrocopos leucotos 6	*Ornithoica unicolor* 0/1, *Ornithoica momiyamai* 1/6, *Ornithomya avicularia* 2/2
Dendrocopos minor 3	*Ornithoica momiyamai* 0/2, *Ornithomya avicularia* 0/1
Dendrocopos kizuki 5	*Ornithoica momiyamai* 1/1, *Ornithomya avicularia* 2/6
Delichon urbica 4	*Crataerina hirundinis* 2/6
Cecropis daurica 3	*Ornithoica momiyamai* 9/20, *Ornithomya avicularia* 0/9
Anthus hodgsoni 6	*Ornithoica momiyamai* 0/3, *Ornithomya avicularia* 1/3; *Ornithomya fringillina* 0/1
Anthus rubescens 2	*Ornithomya fringillina* 0/2
Motacilla lugens 2	*Ornithomya avicularia* 1/1
Motacilla cinerea 17	*Ornithoica momiyamai* 4/9, *Ornithomya avicularia* 1/8, *Ornithomya fringillina* 0/1
Pericrocotus divaricatus 1	*Ornithoica momiyamai* 1/0
Prunella montanella 1	*Ornithomya avicularia* 0/1
Lanius cristatus 3	*Ornithoica unicolor* 0/2, *Ornithoica momiyamai* 0/4, *Ornithomya avicularia* 0/1
Turdus hortulorum 45	*Ornithoica unicolor* 7/38, *Ornithoica momiyamai* 10/45, *Ornithomya avicularia* 0/21
Turdus pallidus 1	*Ornithomya avicularia* 0/1
Zoothera varia 2	*Ornithoica unicolor* 0/2, *Ornithomya avicularia* 0/1
Phoenicurus auroreus 20	*Ornithoica momiyamai* 5/24, *Ornithomya avicularia* 0/3
Luscinia sibilans 3	*Ornithoica momiyamai* 0/2, *Ornithomya avicularia* 0/1, *Lipoptena cervi* 0/1
Luscinia cyane 3	*Ornithoica momiyamai* 0/2, *Ornithomya avicularia* 2/0
Luscinia calliope 3	*Ornithoica momiyamai* 1/2
Muscicapa dauur 26	*Ornithoica momiyamai* 9/20, *Ornithomya avicularia* 0/9
Muscicapa griseisticta 1	*Ornithoica momiyamai* 0/1
Ficedula zanthopygia 46	*Ornithoica momiyamai* 2/25, *Ornithomya avicularia* 4/16
Ficedula mugimaki 1	*Ornithoica momiyamai* 1/0
Ficedula albicilla 1	*Ornithoica momiyamai* 0/1
Cyanoptila cyanomelana 7	*Ornithoica momiyamai* 3/3, *Ornithomya avicularia* 2/2
Urosphena squameiceps 2	*Ornithoica momiyamai* 1/5, *Ornithomya avicularia* 0/1
Locustell a certhiola 1	*Ornithoica momiyamai* 1/0
Phylloscopus borealis 2	*Ornithoica momiyamai* 0/3
Phylloscopus tenellipes 5	*Ornithoica momiyamai* 2/2, *Ornithomya avicularia* 0/1
Phylloscopus coronatus 15	*Ornithoica momiyamai* 5/16, *Ornithomya avicularia* 1/6
Phylloscopus inornatus 2	*Ornithoica momiyamai* 0/2
Phylloscopus proregulus 9	*Ornithoica unicolor* 0/1, *Ornithoica momiyamai* 5/13
Phylloscopus fuscatus 1	*Ornithomya avicularia* 0/1
Phylloscopus schwarzi 5	*Ornithoica momiyamai* 0/2, *Ornithomya avicularia* 0/3 *Lipoptena cervi* 0/1
Paradoxornis webbianus 3	*Ornithoica momiyamai* 1/1, *Ornithomya fringillina* 0/1
Aegithalos caudatus 8	*Ornithoica momiyamai* 3/51, *Ornithomya fringillina* 0/1

Table 1. (Contd.)

Species of birds and number of specimens infected by louse flies	Species of louse flies and number of males/females collected
Parus palustris 29	*Ornithoica momiyamai* 7/22, *Ornithomya avicularia* 0/4, *Ornithomya fringillina* 0/1, *Ornithomya comosa* 0/1, *Lipoptena cervi* 0/1
Parus ater 1	*Ornithoica momiyamai* 0/1
Parus minor 51	*Ornithoica momiyamai* 18/47, *Ornithomya avicularia* 4/19, *Ornithomya fringillina* 0/2
Sitta europaea 68	*Ornithoica unicolor* 1/7, *Ornithoica momiyamai* 35/109, *Ornithomya avicularia* 3/17, *Ornithomya fringillina* 1/1
Certhia familiaris 3	*Ornithoica momiyamai* 1/3
Zosterops erythropleurus 35	*Ornithoica unicolor* 0/2, *Ornithoica momiyamai* 6/32, *Ornithomya avicularia* 1/5
Passer montanus 2	*Ornithoica momiyamai* 0/2
Fringilla montifringilla 2	*Ornithoica momiyamai* 0/2, *Ornithomya avicularia* 0/1
Uragus sibiricus 2	*Ornithoica momiyamai* 0/1, *Ornithomya avicularia* 0/1
Eophona personata 2	*Ornithomya avicularia* 1/2
Emberiza cioides 10	*Ornithoica momiyamai* 0/6, *Ornithomya avicularia* 0/6
Emberiza fucata 1	*Ornithoica momiyamai* 0/1
Cristemberiza elegans 68	*Ornithoica unicolor* 0/1, *Ornithoica momiyamai* 7/68, *Ornithomya avicularia* 2/11, *Lipoptena fortisetosa* 0/2
Ocyris tristrami 31	*Ornithoica momiyamai* 7/33, *Ornithomya avicularia* 1/8
Ocyris spodocephalus 39	*Ornithoica momiyamai* 9/41, *Ornithomya avicularia* 2/15
Ocyris personatus 1	*Ornithoica momiyamai* 9/3
Ocyris rutilus 7	*Ornithoica momiyamai* 1/4, *Ornithomya avicularia* 0/3, *Ornithomya fringillina* 0/1

lyxenous species of louse flies (*Ornithoica momiyamai* and *Ornithomya avicularia*) were found on migrant birds. Migrant birds can transport louse flies north to their nesting sites.

The research team found differences in the number of species of louse flies and the number of collected specimens of louse flies for each sampled year, where a total of 1184 louse flies of 8 species were collected and determined. The most numerous polyxenous louse fly was *Ornithoica momiyamai,* parasitising 47 bird species, closely followed by the polyxenous louse fly *Ornithomya avicularia,* which parasitised 42 bird species. *Ornithoica unicolor* was the third most abundant louse fly, parasitising 11 bird species of different orders but showing a preference for Strigiformes. The fourth most abundant louse fly species was *Ornithomya fringillina,* which parasitised 11 bird species. The closely related species *O. chloropus* Bergroth 1901was not recorded, although it is well known in the Primorye Territory and Amur Province (Belousova, 2012; Meissner et al., 2020). The research team found the monoxenous louse fly *Ornithomya comosa* usually associated with Hirundinidae, on *Parus palustris* (Paridae). Records of louse flies on accidental hosts help to understand how infection of isolated populations of Hirundinidae by the monoxenous *O. comosa* happens. The species was originally recorded in India (Austen, 1930) and later in Malaysia, Nepal, and Thailand (Maa, 1977), Japan, Kazakhstan, Kirgizstan (Doszhanov, 2003), Russian Far East (Nartshuk et al., 2019a), West Siberia, Eastern Europe in 2013, and finally in the Kaliningrad Region of Russia, on the ornithological station of Curonian Spit (Nartshuk et al., 2019). Now the species occurs in West Europe (Le Guillou, Chapelin-Visardi, 2022).

Streptopelia orientalis, *Luscinia sibilans*, *Phylloscopus schwarzi*, and *Parus palustris* were accidental avian hosts of the mammophilous louse fly species *Lipoptena cervi*, while *Phylloscopus tenellipes* and *Cristemberiza elegans* were accidental avian hosts of the mammophilous louse fly *Lipoptena fortisetosa*. The range of *L. fortisetosa*, which is assumed to have Eastern Palaearctic origin, has remarkably expanded to the West. It is presumed to be associated with the introduction of the sika deer to Europe (Kurina et al., 2019). In the authors' opinion, transportation by birds must not be ruled out.

Considerably more female than male louse flies were found on birds. Infected birds were prevalent in July and September. The degree of infection significantly varied between bird species. Two individuals of *Cristemberiza elegans* were examined, and louse flies were found on each; out of the 444 *Aegithalos caudatus* individuals examined, only two birds were infected. Only one individual of *Paradoxornis webbianus* was infected out of 56 examined ones. The largest numbers

of louse fly specimens, 26 and 21 respectively, were collected from *Sitta europaea* and *Cristemberiza elegans*. Of 111 examined birds *Zosterops erythropleurus*, only 12 were infected. Four species of louse flies were found only on *Sitta europaea*. Most specimens of louse flies were found on *Strix uralensis*–77 flies of two species from 5 examined birds, 73 of them were *Ornithoica unicolor* and four *Ornithomya avicularia*. It is known that *Ornithoica unicolor* prefers to feed on Strigiformes birds. Five birds of *Strix uralensis* were infected as follows: August 17, 2019–3 males and 3 females, September 2, 2019–11 males and 24 females, September 9, 2019–8 males and 15 females, September 13, 2019–1 male and 2 females, September 29, 2019–6 females. The thick and fluffy plumage of owls is favourable for the parasitism of louse flies. Sixty louse flies of four species were taken from 27 birds of *Sitta europaea*, 37 flies belonging to three species–on 15 birds of *Turdus hortulorum*, and 26 louse flies of two species on 19 birds of *Cristemberiza elegans*. Three species of louse flies were collected on *Cristemberiza elegans* and *Turdus hortulorum*, four species of louse flies on *Parus palustris*. Most louse flies were found on *Turdus hortulorum*–40 specimens on 7 examined birds. The distribution of polyxenous louse flies *Ornithoica momiyamai* and *Ornithomya avicularia* amongst individual birds was random. Monoxenous species *O. comosa* and *Crataerina hirundinis*, parasites of Hirundinea were found on each examined bird.

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ПТИЦЫ КАК ХОЗЯЕВА-ПРОКОРМИТЕЛИ ПАРАЗИТИЧЕСКИХ МУХ-КРОВОСОСОК (DIPTERA) НА ЮГЕ ДАЛЬНЕГО ВОСТОКА РОССИИ

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В течение четырех лет (2017–2020) в двух пунктах на территории Лазовского государственного природного заповедника отловлено 3833 птицы 103 видов с использованием паутинных сетей. Все птицы окольцованы и отпущены на волю. Из них 646 птиц 62 видов были заражены мухами-кровососками и птицы 41 вида были свободны от мух. С птиц сняты 1184 особи мух-кровососок двух подсемейств: Ornithomyinae (3 рода и 6 видов) и Lipopteninae (1 род и 2 вида). 47 видов птиц служили хозяевами *Ornithoica momiyamai* Kishida 1932, большинство из них впервые указаны как хозяева этого вида кровососок. 42 вида птиц оказались хозяевами *Ornithomya avicularia* (L. 1758) s. l. 11 видов птиц отмечены как хозяева *O. fringilina* (Curtis 1856). *Ornithoica unicolor* Speiser 1900 снята с 12 видов птиц, наибольшее число экземпляров – с длиннохвостой неясыти (*Strix uralensis*). Прокормителями *Ornithomya comosa* (Austen 1930) и *Crateirina hirundinis* (Curtis 1856) служат птицы семейства Hirundinidae, но 1 экз. *O. comosa* снят со случайного хозяина *Parus palustris* (семейство Paridae). Птицы обычно не являются прокормителями *Lipoptena cervi* (L. 1758) и *L. fortisetosa* (Maa 1965), но эти мухи были сняты с шести видов птиц.

Ключевые слова: птицы, Hippoboscidae, Лозовский государственный природный заповедник, Приморский край, Россия