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ORIGINAL ARTICLE

Some data on zoophilic flies of Siberia and the Russian Far East

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In the vast territories of Siberia and the Russian Far East that include various landscapes and climatic zones of the country, flies play an important role as they are constantly present in the life of humans and animals. Flies belong to the Order Diptera, comprising of two-winged flies, the suborder *Cyclorrapha (circular-seamed flies).* Flies are vectors of many infectious and invasive diseases (they spread pathogens of microorganisms, protozoa, and fungi) and can also cause independent diseases in the larval phase. In this genus case, the flesh-fly family (Sarcophagidae), Wohlfahrtia magnifica genus, Schin.,1862, is a classic example of flies with a free-living pattern to a parasitic lifestyle. Species specificity of flies is weakly expressed, though they give the most significant preference to cattle. Traditional fly control methods include preventive and exterminating measures. Preventive steps are targeted at the elimination of potential fly breeding places by practicing routine sanitation. The advantage of preventive measures is their environmental friendliness. However, they do not significantly reduce the number of flies. Other methods such as chemical, physical, biological, or combination can be more effective when fighting against flies. Zoophilic flies of the Asian part of Russia are represented by four families: flesh flies (*Sarcophagidae*); true flies or house flies (*Muscidae)*; bluebottles or greenbottles (*Calliphoridae*); and louse flies (*Hippoboscidae*). Research conducted in Western Siberia is prevalent in the region (68.9%). Research subjects are primarily devoted to studies of fauna and ecology (48.1%) and the development of means and methods for animal protection (30.5%). Researchers paid less attention to investigating such subjects as epidemiological and epizootological importance(11.8%), research methods (6.7%), and economic assessment (2.9%).

Keywords: Zoophilic flies, researchers, Siberia, Far East, control methods.

Introduction

Four families represent zoophilic flies on the territory of Siberia

The flesh-fly family (Sarcophagidae); true fly or house flies family (Muscidae); bluebottles or greenbottles family (Calliphoridae); and louse fly family (Hippoboscidae) (Shtakelberg, 1933, 1940, 1956). Flies belong to the group of widespread temporary ectoparasites of animals. They are widespread in both artificial and natural ecosystems. To date, more than 120 species of these insects are linked with animals; 92 species are present in the pastures, 57 species are found in cowsheds, 48 species live in pigsties, and 27 species hurt horses in the stables. (Yatusevich & Miklashevskaya, 2018). Suffering from fly attacks, animals significantly lose productivity: live weight gain decreases by 200-300 g., milk yield goes down by 10-30%, milk fat content drops by 0.1%, all this resulting in a reduced sanitary condition of animal by-products (Zimin, 1951; Pavlov, 1970; Jonson & Matschoss, 1998; Jonson & Mayer, 1999; Sivkova, 2010). Flies are of particular importance as vectors of infectious and invasive diseases such as foot-and-mouth disease, anthrax, tularemia, tuberculosis, swine fever, anaplasmosis, surra or trypanosomosis, helminthiasis (thelaziosis, habronematosis, drascheiosis, and parafilariosis). More than 20 fly species are responsible for the cause and development of helminth (worm) biological cycles (Sivkov & Glazunova, 2010; Yatusevich, 2016; Miklashevskaya, 2020; Ismoilov & Ruzimorodov, 2021). A critical review of the available materials has revealed that 39 scientists and specialists from 29 scientific institutions specializing in the veterinary, medical, and general biology fields participated in the research work devoted to studying flies on such a vast territory. The presented material is divided into sections according to fly families, having veterinary and medical importance. The goal of the present research was to analyze the scientific works devoted to zoophilic flies of the mentioned four families on the territory of the Asian part of Russia.

Methodology

The flesh-fly family (Sarcophagidae) includes a large number of synanthropic and zoophilic flies. The most significant representative of the family is *Wohlfahrtia* genus numbering 23 species that are widespread throughout the world (Derbeneva-Ukhova, 1952, 1974).

Flies of the Sarcophagidae family can serve as an indicator of the synantropization degree of the areas and be used for environmental health monitoring. In the ecosystem, their role is rather important because they help with the decomposition of dead animals. Some species can cause intestinal myiasis in animals and humans. Many species of flies, especially necrophage species belonging to the *Sarcophaga Mg.* genus, are of forensic value (Narchuk, 2003).

Flies spreading myiasis in the region were first mentioned in 1904 in the reports of the Tobolsk scientist N.L. Skalozubov recorded adult Wohlfahrtia genus flies in the suburban areas of Tobolsk city (Skalozubov, 1898). M. D. Ruzsky (1928) described the Wohlfahrtia fly as well as some other short-tailed Diptera species of the Karachi resort (the Barabinsky district) of the city of Tomsk (Ruzsky, 1928). In the Asian part of the country, 42 scientists and specialists from the Urals to the Pacific Ocean devoted their research to studying flies belonging to the Sarcophagidae family, exceptional attention to the Wohlfahrtia fly.

Scientists from 8 scientific institutions researched the main characteristic features of Wohlfahrtia fly appearance and development of this parasite's biological cycle in the conditions of Western Siberia, its adaptive and reproductive abilities in lab conditions, as well as different methods aimed to affect *W.magnifica* with a purpose to limit their abundance number. Early works include research done by B.B. Rodendorf (1937), N.G. Kolomiets (1966) in the Tomsk region; and B. Kuznetsova (1965) in the Omsk region. However, systematic studies of wohlfahrtiosis were started by the team of scientists of the All-Russian Research Institute of Veterinary Entomology and Arachnology (VNIIVEA, Tyumen) Prof. G. A. Vesyolkin and continued by Prof. V. N. Domatsky. The results of these research works conducted in the sheep-breeding farms of the Trans-Urals region were summed up in the monograph work "Sheep wohlfahrtiosis" (Yamov, 1998).

Results and Discussion

The relative number of scientists engaged in research in Eastern Siberia was ten people from 2 scientific research institutions. Distribution of Wohlfahrtia flies and damage caused by them to the sheep breeding industry in the Irkutsk region (Transbaikal area) were studied by I.M. Migunov and N.V. Timofeev (1983-2001), whose works later became widely known. Scientists from 2 scientific research institutions were engaged in such research works in the Russian Far East. The best-known works are studies conducted by B.K. Petrova in Southern Primorye and Khabarovsky krai (1974, 1987); she is the author of the reference guide for the diagnosis of synanthropic flies in Primorsky Krai, which became the first work of such kind and included a description of more than 170 species belonging to 23 families. The reference guide included 15 species that had not been previously mentioned in the guides of dipterans found in the USSR, and more than 70 species had not been included in the guides of synanthropic dipterans; S.D conducted another essential work. Artamonov in the Ussuriisky taiga and southern part of Primorye (1988-2003) studied fauna, ecology, and economic importance of the two-winged species belonging to Sarcophagidae and Calliphoridae families.

He was the one who described for the scientific world five new species of the Sarcophagidae family (Artamonov, 1988, 1996, 2000, 2003); and another well-known researcher was A.L. Ozerov (1989-2018), who researched fauna of necrobiotic two-winged insects (Diptera) of forests of the southern Far East of USSR.

The results of studies devoted to the biological features of the Wohlfahrtia fly served as a scientific foundation for organizing and conducting further research works aimed at developing means and methods to limit the abundance of this pathogen carrier in nature as well as finding ways to treat animals suffering from myiasis (Vesyolkin, 1967, 1977, 1989; Vesyolkin & Domatsky, 1989; Lychagin et al., 1997; Migunov, 1998). As a result, not only recommendations and new methods were put into practical use, but also new drugs were introduced such as Miatrin, Miatsid, and group treatment methods involving application of sprayers, aerosols, insecticidal smoke cartridges based on the mixtures of DDVP and pyrethroids (Domatsky et al., 1989). Spraying unit UOO-2 came into wide use when treating sheep against causative agents of associative invasions and necrobacillosis. During this period, VNIIVEA scientists started to develop a new direction in veterinary medicine aimed at the creation of integrated technologies for the prevention of myiasis, acariasis, helminthiasis, and some other infectious diseases of animals (necrobacillosis of sheep and reindeer in their associative course) headed by Professor G. S. Sivkov. Associations of diseases were taken in different variations (for example, myiasis, acariasis, nematodiasis, and a helminthiasis of all animal species). First, the new technologies were introduced in the sheep-breeding farms of the Tyumen and Kurgan regions, and then they came into practical use in all regions of western Siberia.

True flies (*Muscidae*) dominate over other families by their species composition. The territory of Siberia has not been thoroughly studied concerning flies of the Muscidae. Scientists paid special attention to studying fly species diversity found in cattle breeding and pig breeding farms (18 researchers were engaged in such studies). During the livestock breeding, big cattle-breeding complexes were being constructed, large numbers of animals were placed together in relatively small areas, thus provoking a real threat of infectious diseases to outbreak among the livestock, which is why proper sanitary conditions on the farms were of great importance. Flies on the farms were indicators of low sanitary culture, and issues concerning the limitation of their abundance numbers were considered high priority. Such understanding served as a good foundation for starting fundamental studies of epizootic and epidemiological significance. Such studies have shown that flies only of this particular family alone are responsible for transmitting and spreading more than 50 ICD diseases of various etiologies (Vesyolkin, 1990; Domatsky, 1990; Sergeyeva, 1990; Nazhmitdinova, 1996).

The earliest information on this fly family in Western Siberia was given by P. A. Kvasnikova (1931) in her work on the species composition of flies in residential premises in the city of Tomsk; in the work of I.F. Zhovty (1950, 1955) describing a year-long life cycle of a housefly in the conditions of Baraba area and work devoted to the research of the seasonal dynamics of the number of stable flies in the city of Novosibirsk (Sorokina, 2006).

It should be noted that the geography of the conducted research is mostly (64.6%) represented by the territory of Western Siberia (Tyumen, Kurgan, Novosibirsk, Tomsk, and Omsk regions). With this, most of the researchers (33.3%) devoted their works to studying biology, epidemiology, epizootiology. Among them, the most prominent works are attributed to G.A. Vesyolkin (1964-1992), V.I. Kotlyar (1975-1985), A I. Zagrebin (1985-1992), S. N. Gagarin, A. N. Domatsky (1985-1994), G. K. Sergeeva (1987-1994), E. N. Nazhmitdinova (1990-1996), T M. Kutuzova (1989-1993) and others. A third of the engaged specialists devoted their works to the development of means and methods to limit the number of flies in large cattle breeding complexes and farms and protect animals from them. Moreover, these issues could not be solved without a thorough knowledge of the biological features of flies, so most of the mentioned above researchers conducted their works as a combination of studies devoted both to biology and the development of fly control methods. V.A. Polyakov (1986-1990), V.D. Kuznetsov, L.A. Bodreyeva (1975-1984), V.N. Lekanov, E.S. Elin, A. M. Sergienko (1970-1985), A. N. Domatsky (1986-1990), A. I. Zagrebin (1985-1990), E. N. Nazhmitdinova (1990-1994), and M. A. Levchenko (2009 -2021) devoted their research works to the development of chemical agents and methods of protection against flies.

The result of such work contributed to the appearance of a large number of insecticides and means for mechanization of insect disinfection procedures (including sprayers, aerosol equipment, traps, thermal insecticides in the form of smoke cartridges, thermal insecticidal mixtures, tablets, plates, spirals); besides that, integrated systems and technological means of animals protection from this group of insects were developed. In addition, new highly effective agents based on pathogenic fungi were suggested for practical use by some scientists engaged in developing biological methods of protection (E.G. Karpov, A.I. Popov, V.I. Ignatiev, L.P. Turovinina).

Bluebottles or greenbottles (*Calliphoridae)* are widespread everywhere in Siberia, breeding and feeding in the corpses of mammals and meat waste, in cattle burial grounds, and stand-alone field toilets. They are vectors of intestinal infections, poliomyelitis, causative agents of facultative tissue myiasis (*Lucilia sericata, Lucilia illustrus, Phormia regina*); they also cause myiasis antlers of the young Siberian stag, the disease is called booponus (*Booponus borealis Rohd, 1959*). Parasitizing in the tissues of antlers, they cause deep foul ulcers and release toxic substances, significantly decreasing the grade level and quality of antlers. It is not rare that an inflammatory process begins in the places occupied by parasitizing larvae, and it often leads to the abscess of the antler's osteochondral layer (Sadovnikova, 1968).

Some researchers point to the possibility of using fly larvae to sanitize foul wounds. Such an approach to using blowflies turned out to be of great use in medicine and led to the development of a new direction in bio-surgery based on fly larvae for treating infected wounds and ulcers (Sherman, 2000).

60 researchers from 8 scientific institutions, or 14.3% of all works conducted on flies, devoted their works to studying specimens of this fly family in Siberia and the Far East. Most works are devoted to studying biology, spread, and antler flies control measures in the Altai and Sayan Mountains. A.N. Tikhomirova first found the antler fly in 1957 in the Usinsk stag breeding farm of the Krasnoyarsk Krai. The first description was done by B.B. Rodendorf (1959). Research works devoted to the study of biology and development of the antler fly control measures in the territories of Gorny Altai and Sayan Mountains were performed by T. P. Sadovnikova (1968, 1975), V.E. Razmakhnin (1964, 1975), N.K. Melua (1979, 1983), V. M. Latkin (1986, 1988), A. I. Bakhtushkin (2001, 2010), V. B. Karamaev (2001), I. Yu. Raabe (2001), V. A. Marchenko (2001) and others.

Fauna and species diversity of bluebottles and greenbottles fly families on the territory of the Trans-Urals are described in the works of G.A. Vesyolkin (1968-1992) and A.N. Domatsky (1992-1997); the works of G.K. Sergeyeva (1989- 1992) have results of the research conducted on the animal farms of the Yamal territory. While conducting biological, faunistic, and ecological studies, the authors successfully developed means and methods to limit the abundance of blowflies in nature.

Louse flies (*Hippoboscidae family*) are blood-sucking insects that generally parasitize on horses, sheep, dogs, elks, and stags and sometimes hurt humans. Fifteen researchers devoted their works to studying specimens of this family on the territory of Siberia.

The most fundamental research of the sheep louse fly in the Tyumen, Kurgan, and Omsk regions was conducted by M.D. Domatskaya (1971-1984); the works of I.M. Migunov and P.V. Timofeyev (1998-2001) were devoted to the Chita region while A. V. Matyukhin and S.I researched the Tomsk region in relation to this topic. Gashkov (2020). Siberian researchers paid much attention to the study of distribution biology and harmful effect of the deer louse fly (*Lipoptenia cervi*); most authors devoted their works to this topic, among them are B.V. Tikhomirov (1965), K.H. Zolotarev (1968, 1972), P.V. Semyonov (1987), I.Yu.Raabe (1991, 2008), V.G. Lunitsin (2008), and A.I.Bakhtushkina (2001). Interesting findings are given in the works of N.M. Stolbov (1976) and N.G. Lisina (2003) found *L. cervi* on forest birds. In her work, G.V. Farafonova (1982) reported the species composition of louse flies. Along with already mentioned works, G.A. Vesyolkin, M.D. Domatskaya, V.I. Potemkin, B.A. Korolyov and V.I. Ignatiev were engaged in developing means and methods for louse fly control, providing a toxicological assessment of new drugs.

Conclusion

Thus, the presented information on the fauna, species diversity, ecological patterns of habitation in various natural and climatic zones shows that large-scale research works have been conducted to study these specimens of Siberian fauna. Altogether, 139 specialists from 29 scientific institutions were engaged in the research works. Such work is the appearance and development of a

scientifically grounded direction in veterinary dipterology aimed at protecting animals from zoophilic flies. A list of zoophilic flies (as of 1986) has been compiled; it includes 256 species from 28 families, 78 species have direct links with animals. They are 39 species of facultative and 13 obligate hematophages, 6 obligate and 20 facultative myiasis flies. The rest of the species have trophic links with animals through feces, manure, feed, corpses. Thus, the authors have developed an ecological classification and have given trophic characteristics of all species of zoophilic flies.

On the farms and pastures of various types of livestock in the southern part of Siberia, researchers have found and described 122 species of flies belonging to 62 genera and 19 families, and 73 species were discovered for the first time. Considering all new technological approaches to organizing livestock farms, and the branch is taken to an industrial level (poultry farms, large complex pig-breeding, and livestock farms), reindeer and Siberian stag breeding farms, integrated systems have been developed to protect all types of animals from being hurt by insects of this group.

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