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The Composition of Zoophilic Fly Species in Eastern Ukraine

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ABSTRACT

Zoophilic Diptera plays a leading role in the epizootic foci formation of many infectious and parasitic diseases and directly affects the quality of livestock products. The current study aimed to analyze the number and species composition of parasitic Diptera in industrial, farm, and homestead agrobiocenoses of large and small cattle, pig, and poultry farms in Eastern Ukraine. The research involved entomological collection during the peak activity daylight hours in early May, July, and early September 2021-2022 per farm. A total of 360 entomological collections were made, and 4310 zoophilous flies were examined. In livestock farms of five districts of the Kharkiv region of Ukraine, 28 species of zoophilic flies were registered, among which *Musca domestica*, *Muscina stabulans*, *Stomoxys calcitrans*, *Lucilia sericata*, *Protophormia terraenovae*, and *Drosophila* species were dominant species. The analysis revealed that cattle biocenoses hosted 27 fly species, pigs had 8 species, and poultry and small cattle each had 7 species. The study indicated an increase in the population of *Musca autumnalis*, the main species in the pastures, near livestock premises during the summer. *Stomoxys calcitrans* was also recorded in livestock agrobiocenoses. The species *Musca domestica, Musca autumnalis,* and *Stomoxys calcitrans* account for 78.8% to 88.3% of the entire complex of zoophilous flies. The two species of *Ortellia caesarion* (shiny dung beetle) and *Ortellia cornicina* (green dung beetle), known for their role as manure mineralizers and deemed non-threatening to animals, were completely absent during the research period. The findings indicated the species of *Eristalis tenax* in agrobiocenoses in 2021. Therefore, it can be concluded that zoophilic flies are physical irritants to animals and potential carriers of many infectious diseases, especially diseases caused by unicellular organisms.

Keywords: Biotopes, *Musca autumnalis*, *Musca domestica*, *Stomoxys calcitrans*, Zoophilic flies

INTRODUCTION

Animal health and production are critical factors in the agricultural industry, and the health of livestock directly affects its productivity and, in turn, farmers' income (Nanka et al., 2018; Hernandez-Patlan et al., 2023). Ensuring stable epizootic well-being is also an integral part of the livestock industry. Despite the successes achieved in the fight against animal diseases of various etiologies, the issue of controlling ectoparasites, studying their biodiversity, and developing new means of eradication remain relevant today (Belluco et al., 2023). Stable flies, *Stomoxys calcitrans* (Linnaeus, 1758), are significant threats to humans and animals worldwide (Rochon et al., 2021). Studies have indicated that in individual animal herds infested with flies, the average annual loss of productivity per animal was 139 kg of milk for dairy cows, 6.26 of body weight for preweaning calves, and 9 kg of body weight for fattening cattle (Taylor et al., 2012; Narladkar, 2018).

Research on the biodiversity of flies (Diptera) was conducted in different ruminant farming systems in Poland (Nosal et al., 2019). Moreover, studies in farms in Romania have investigated the role of the intermediate host *Musca autumnalis* (*M. autumnalis*) in the spread of equine thelasiosis (Cotuțiu et al., 2022).

Flies are permanent residents of livestock premises, farm territories, and pastures. Large accumulations of cattle manure in feedlots, wet grain feed, and unprotected silage lead to an increase in stable fly population within the livestock industry (Cook et al., 2018). Hematophages, which are direct animal pests, are particularly important for veterinary medicine (El Ashmawy et al., 2021). When parasitizing directly on animals, flies cause discomfort, anxiety, and irritability, negatively affecting their productivity (Machtinger et al., 2021). In addition, these insects can serve as carriers of many pathogens (Khamesipour et al., 2018). Houseflies can acquire and transmit various enteric bacterial pathogens, such as *Salmonella* and *Campylobacter* (Thomson et al., 2021). *Musca domestica* (*M. domestica*) plays a significant role in the dissemination of bacteria resistant to antimicrobial drugs (Bertelloni et al., 2023). Houseflies carry

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clonal lines of multidrug-resistant bacteria identical to those found in animal feces. (Zurek and Ghosh, 2014). Moreover, 26 types of pathogens causative agents of bovine mastitis were isolated from flies (Gioia et al., 2022).

The housefly *M. domestica* (Linnaeus, 1758) is known for its ability to carry exogenous forms of ascarids, esophagostoma, and hookworm on its body (Förster et al., 2009; Otu-Bassey et al., 2022), and *M. autumnalis* is an intermediate host of *Parafilaria bovicola* (Hund et al., 2021). The *M. domestica* may act as as a potential mechanical vector or reservoir in the epidemiology of bovine leukemia virus (Panei et al., 2019) and contagious ovine ecthyma (Raele et al., 2021).

To combat zoophilic parasites in animal husbandry, many insecticides and repellents have been developed and proposed, which differ in their method of application and the active substances they contain. However, their widespread and uncontrolled use leads to the emergence of resistance generations of insects, creating uncontrolled environmental risks in limited areas (Espinoza et al., 2021). Today, litigation against livestock producers associated with pest filth flies has become more frequent and has a high profile (Machtinger and Burgess, 2020). Thus, the timely and scientifically based control of parasitic dipterans in livestock biocenoses is of great sanitary, epizootological, epidemiological, and social importance. Successful implementation of antiparasitic measures is possible only with a preliminary study of the species composition and number of zoophilous dipterans. This study aimed to study the species composition of zoophilic flies in various livestock biocenoses of Eastern Ukraine.

MATERIALS AND METHODS

Ethical approval

The current study followed the current legislation of Ukraine (Article 26 of the Law of Ukraine 5456-VI of 16.10.2012 "On the Protection of Animals from Cruel Treatment)" and international biotic norms (materials of the IV European Convention on the Protection of Vertebrate Animals, which are for experimental and other purposes, Strasbourg, 1985) (Simmonds, 2018). The research program was reviewed and approved by the bioethics commission of the Institute of Animal Husbandry of the National Academy of Sciences (Kharkiv, Ukraine) in the current order.

Sampling time and study design

The collection of insects was carried out on the premises of industrial, farm, and homestead farms on walking platforms in summer camps, places of mass grazing of animals in five districts of the Kharkiv region (Bogoduhivskyi, Krasnogradskyi, Lozivskyi, Kharkivskyi, and Izyumskyi) in Ukraine (Figure 1).

Entomological collection was carried out in each household in three time periods of early May, July, and early September 2021-2022 during daylight hours during mass fly activity. In each district, one industrial, farm, and home farm was surveyed, where different types of animals were kept. A total of 360 entomological collections were held.

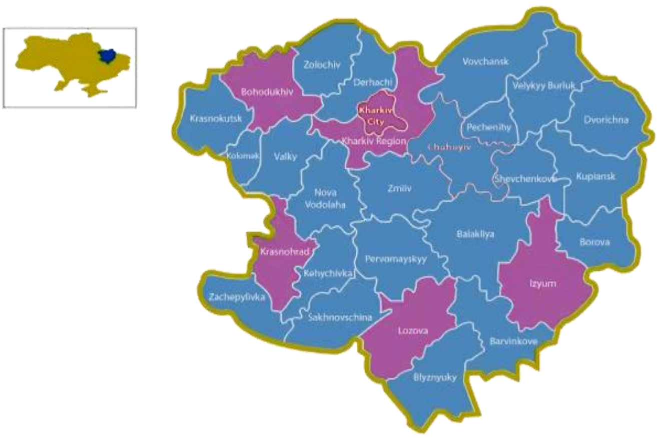

Figure 1. The studied regions in the Kharkiv, Ukraine

Entomological analysis

According to the generally accepted methods used in ecological and entomological studies, a survey of livestock agrobiocenoses was carried out for the presence of dipterans (McCravy, 2018; Marchioro et al., 2020). Diptera field collections were conducted according to generally accepted methods used in entomology (Lamarre et al., 2018). Insects were collected from various sources, including the skin surface of animals both indoors and on pastures, as well as from windows and other structures of livestock premises. During the active flight of insects, the collection was carried out with the help of an entomological trap by the method of mowing (the selection of standard samples of 50 sweeps is foreseen, which made it possible to calculate the average indicators of the qualitative and quantitative composition of insects with different biotopes). The activity and dynamics of insect attacks on animals were recorded with a digital camera (GoPro HERO12 Black Creator Edition, CHDFB-121-EU, China), and subsequently, the number of insect adults was counted on a computer monitor. The 4310 collected insects were fixed in 70% ethanol and delivered to the laboratory for further identification and quantification. Collected and caught insects were identified using the identifier atlas (Sorokina and Pont, 2010; Gregor et al., 2016; Lendzele et al., 2019).

Data analysis

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The dominance of Diptera (D) was estimated according to the following formula.

Dominance = (number of one species/total number of species) × 100%

RESULTS AND DISCUSSION

Regarding the diversity of the species of parasitic insects in the agricultural biotopes of animals in five districts of the Kharkiv region in Ukraine, the obtained results indicated the presence of 28 species of zoophilic flies. A different composition of zoophilic parasites could depend on the species of animals and the season (Table 1). According to the research results, 28 species of flies were identified in 2021, of which 21 belong to the Muscidae family. Among these, the highest diversity of flies was observed in cattle biocenoses, particularly the Ukrainian black and spotted breeds (27 species), followed by large white pig breeds (8 species). In contrast, poultry (Rhode Island white breed) and small cattle (Ascanian blackhead breed) exhibited the lowest diversity, with 7 species each.

In the subsequent insect collections in 2022, 10 species of zoophilous flies were found in the biocenoses of small cattle, while 11 species were found in the biocenoses of poultry. During 2021-2022 insect collections, *Lucilla sericata* (*L. sericata*) was found in all the investigated livestock farms despite its small number. Species, such as *M. domestica, Stomoxys salcitrans, Protophormia terraenovae, Muscina stabulans, L. sericata, Drosophila* spp., were found in all livestock premises regardless of the type of animals kept there. Notably, *Ortellia caesarion* was absent in the 2021-2022 insect collections. Therefore, the main species from the Muscidae family under modern climatic conditions were *M. domestica, M. autumnalis, Stomoxys calcitrans,* and *Muscina stabulans*. According to the results of entomological collections, an analysis of the frequency of distribution of zoophilous dipterans among cattle was carried out, depending on their species and the place of parasitism (Table 2).

Table 1. Species composition and abundance of the main species of zoophilous flies in agrobiocenoses of the Kharkiv region during 2021-2022

Kind of insects	2021				2022			
	Cattle	Pigs	Small cattle	Poultry	Cattle	Pigs	Small cattle	Poultry
Calliphora vicina (Robineau-Desvoidy, 1830)	+	–	+	–	+	–	+	+
Drosophila spp.	+	+	–	+	+	+	+	+
Eristalis tenax (Linnaeus, 1758)	–	+	–	–	–	+	–	–
Fannia canicularis (Linnaeus, 1761)	+	+	–	+	+	+	–	+
Fannia scalaris (Fabricius, 1794)	+	+	–	+	+	+	–	+
Haematobia atripalpis (Bezzi,1895)	+	–	–	–	+	–	–	–
Haematobia stimulans (Meigen, 1824)	+	–	–	–	+	–	–	–
Hydrotaea dentipes (Fabricius, 1805)	+	–	–	–	+	–	–	–
Lucilia caesar (Linnaeus, 1758)	+	–	–	–	+	–	–	+
Lucilia sericata (Meigen, 1826)	+	+	–	+	+	+	+	+
Lyperosia irritans (Linnaeus, 1758)	+	–	+	–	+	–	+	–
Lyperosia titilans (Bezzi)	+	–	–	–	+	–	–	–
Mesembrina meridiana (Linnaeus, 1758)	+	–	–	–	+	–	–	–
Morellia hortorum (Fallén, 1817)	+	–	–	–	+	–	–	–
Morellia simplex (Loew, 1857)	+	–	–	–	+	–	–	–
Musca amita (Linnaeus, 1771)	+	–	–	–	+	–	–	–
Musca autumnalis (De Geer, 1776)	+	–	+	–	+	+	+	+
Musca domestica (Linnaeus, 1758)	+	+	+	+	+	+	+	+
Musca larvipara (Linnaeus, 1758)	+	–	–	–	+	–	–	–
Musca osiris (Wiedemann, 1830)	+	–	–	–	+	–	–	–
Musca tempestiva (Fallén, 1817)	+	–	–	–	+	–	–	–
Musca vitripennis (Meigen, 1826)	+	–	–	–	+	–	–	–
Muscina assimilis (Fallen, 1823)	+	–	–	–	+	–	–	–
Muscina stabulans (Fallén, 1817)	+	+	–	+	+	+	+	+
Ortellia cornicina (Fabricius, 1805)	+	–	–	–	+	–	–	–
Protophormia terraenovae (Robineau-Desvoidy, 1830)	+	+	+	–	+	+	+	+
Stomoxys calcitrans (Linnaeus, 1758)	+	+	+	+	+	+	+	+
Wohlfahrtia magnifica (Schiner, 1862)	+	–	+	–	+	–	+	–

+: The presence of a species of Diptera, –: The species is missing

Table 2. Species composition and abundance of the main species of zoophilic flies in industrial cattle agrobiocenoses of the Kharkiv region during 2021-2022

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Type of flies	Number	Percentage	Biotopes					
			Pastures		Summer camp		Livestock premises	
			Number	Percentage	Number	Percentage	Number	Percentage
Calliphora vicina (Robineau-Desvoidy, 1830)	1	0.02	–	–	–	–	1	0.08
Drosophila species	40	0.92	–	–	16	0.7	24	1.9
Fannia canicularis (Linnaeus, 1761)	1	0.02	1	0.15	–	–	–	–
Fannia scalaris (Fabricius, 1794)	38	0.9	–	–	5	0.2	33	2.7
Haematobia atripalpis (Bezzi, 1895)	1	0.02	1	0.15	–	–	–	–
Haematobia stimulans (Meigen, 1824)	2	0.05	1	0.15	1	0.04	–	–
Hydrotaea dentipes (Fabricius, 1805)	1	0.02	1	0.15	–	–	–	–
Lucilia caesar (Linnaeus, 1758)	1	0.02	–	–	–	–	1	0.08
Lucilia sericata (Meigen, 1826)	1	0.02	–	–	–	–	1	0.08
Lyperosia irritans (Linnaeus, 1758)	161	3.7	72	10.5	66	2.8	23	1.8
Lyperosia titilans (Bezzi)	50	1.2	27	3.9	23	0.9	–	–
Mesembrina meridiana (Linnaeus, 1758)	1	0.02	1	0.15	–	–	–	–
Morellia hortorum (Fallén, 1817)	48	1.1	29	4.2	18	0.8	1	0.08
Morellia simplex (Loew, 1857)	1	0.02	1	0.15	–	–	–	–
Musca amita (Linnaeus, 1771)	1	0.02	1	0.15	–	–	–	–
Musca autumnalis (De Geer, 1776)	813	18.9	326	47.7	482	20.2	5	0.4
Musca domestica (Linnaeus, 1758)	1624	37.7	16	2.34	792	33.2	816	65.9
Musca larvipara (Linnaeus, 1758)	115	2.6	68	9.9	46	1.9	1	0.08
Musca osiris (Wiedemann, 1830)	1	0.02	1	0.15	–	–	–	–
Musca tempestiva (Fallén, 1817)	1	0.02	1	0.15	–	–	–	–
Musca vitripennis (Meigen, 1826)	1	0.02	1	0.15	–	–	–	–
Muscina assimilis (Fallen, 1823)	1	0.02	1	0.15	–	–	–	–
Muscina stabulans (Fallén, 1817)	22	0.51	–	–	10	0.4	12	0.9
Ortellia caesarion (Meigen)	5	0.11	5	0.7	–	–	–	–
Ortellia cornicina (Fabricius, 1805)	7	0.16	7	1.0	–	–	–	–
Protophormia terraenovae (Robineau-Desvoidy, 1830)	1	0.02	1	0.15	–	–	–	–
Stomoxys calcitrans (Linnaeus, 1758)	1368	31.7	120	17.5	928	38.8	320	25.8
Wohlfahrtia magnifica (Schiner, 1862)	1	0.02	1	0.15	–	–	–	–
Total	4310	100	683	100	2389	100	1238	100

It has been proven that the species composition of zoophilic flies is represented by different families. The Muscidae family had the most numerous in the general structure of insects. The occurrence index of the house fly (*M. domestica*) was 37.7%, and this species occupied the main livestock biotopes and was dominant (65.9%) indoors. It was established that in the case of violations of sanitary conditions in animal husbandry premises, the number of house fly adults that attack one animal at the same time ranged from 200 to 300 in specimens.

The number of *Stomoxys calcitrans* was within 31.7%, and it was also observed in all the main livestock biotopes. This species of fly-on animals were registered in 60-90 specimens. *Musca autumnalis* was also recorded in the main biotopes, and its abundance was 18.9%. At the same time, it was the dominant parasitic species on pastures, accounting for 47.7%, and its number per animal ranged from 40 to 335 individuals. These three main species of flies accounted for 88.3% of the entire complex of zoophilic parasites. It should also be noted that the species *M. larvipara* (2.6%), *L. irritans* (3.7%), *M. hortorum* (1.1%), *L. titillans* (1.2%), *Muscina stabulans* (0.5%), and *F. scalaris* (0.9%) occupied a certain place in parasitocenosis and formed the main species composition of zoophilic flies. The populations of other species of flies were small and did not have notable effects on farm animals in the general biocenosis. Along with industrial biocenoses of cattle, parasitism of zoophilous dipterans was noted in other maintenance centers, namely, farm and homestead farms (Table 3).

The species composition of zoophilous flies in specialized farms in 2021 included 9 species, and in homesteads, there were 10 species. The three main species of flies accounted for 83.7% and 64.3%, respectively, of the entire complex of zoophilic parasites. In 2022, three species (*M. domestica, Stomoxys calcitrans,* and *M. autumnalis*) accounted for 78.9% and 63.2%, respectively. Such species, including *Muscina stabulans, Fannia canicularis, Fannia scalaris,* and *Protophormia terraenovae,* were 2-4 times more abundant in homestead farms than specialized arms. This is because these types of flies are more synanthropic, and their number depends on the sanitary condition of the territories. The data does not include 11 species of flies caught in one specimen, and the species of *L. sericata* was present in one specimen in collections from both specialized farms and homestead farms. The species and numerical composition of mass species of zoophilic flies in pig farms are presented in Table 4.

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Table 3. Species composition and abundance of the main species of zoophilic flies in specialized and homestead agrobiocenoses of cattle farms in Kharkiv region during 2021-2022

Type of flies	2021				2022			
	Specialized farms		Homestead farms		Specialized farms		Homestead farms	
	Imago. number	Percentage	Imago. number	Percentage	Imago. number	Percentage	Imago. number	Percentage
Musca domestica	184	57.5	123	41.4	206	59.4	205	49.8
Stomoxys calcitrans	56	17.5	47	15.8	48	13.8	40	9.8
Musca autumnalis	28	8.7	21	7.0	20	5.7	15	3.6
Muscina stabulans	13	4.0	24	8.0	12	3.5	41	9.9
Fannia canicularis	–	–	19	6.4	4	1.2	4	0.9
Fannia scalaris	6	1.8	28	9.4	8	2.3	18	5.1
Protophornia terraenovae	4	1.2	17	5.7	5	1.4	25	6.0
Drosophila spp.	18	5.6	18	6.0	25	7.2	36	8.6
Liperosia irritans	11	3.4	–	–	14	4.0	8	1.9
Lucilia sericata	1	0.3	1	0.3	5	1.4	19	4.6
Total	321	100	298	100	347	100	411	100

Table 4. Species and numerical composition of species of zoophilous flies in pig farms of the Kharkiv region during 2021-2022

Type of flies	2021				2022			
	Industrial farms		Homestead farms		Industrial farms		Homestead farms	
	Imago. number	Percentage	Imago. number	Percentage	imago. number	Percentage	imago. number	Percentage
Musca domestica	241	57.9	217	46.5	203	51.5	192	46.9
Muscina stabulans	24	5.7	72	15.4	21	5.3	64	15.6
Stomoxys calcitrans	87	20.9	65	13.9	96	24.3	51	12.5
Fannia scalaris	–	–	34	7.4	–	–	21	5.1
Fannia canicularis	7	1.7	37	7.9	3	0.8	11	2.7
Protophormia teraenovae	–	–	18	3.8	3	0.8	23	5.6
Drosophila spp.	33	7.9	23	4.9	31	7.9	38	9.3
Eristalis tenax	24	5.7	–	–	25	6.3	–	–
Musca autumnalis	–	–	–	–	1	0.2	1	0.2
Lucilia sericata	11	3.4	1	0.2	11	2.7	8	1.9
Total	416	100	467	100	394	100	409	100

Table 5. Species and numerical composition of mass species of zoophilic flies in poultry farms of the Kharkiv region during 2021-2022

Type of flies	2021				2022			
	Industrial farms (cage maintenance)		Homestead farms		Industrial farms (cage maintenance)		Homestead farms	
	Imago. number	Percentage	Imago. number	Percentage	Imago. number	Percentage	Imago. number	Percentage
Musca domestica	312	93.1	332	81.3	239	59.5	222	50.5
Muscina stabulans	1	0.3	22	5.3	14	3.5	48	10.9
Musca autumnalis	–	–	–	–	2	0.5	18	4.1
Stomoxys calcitrans	–	–	–	–	6	1.5	21	4.8
Fannia scalaris	–	–	4	0.9	15	3.7	11	2.5
Fannia canicularis	1	0.3	7	1.7	3	0.7	9	2.0
Protophormia teraenovae	14	4.1	18	4.4	63	15.6	53	12.1
Calliphora vicina	–	–	–	–	25	6.2	18	4.1
Lucilia sericata	6	2.0	15	3.6	11	2.7	8	1.8
Lucilia caesar	–	–	–	–	4	0.9	4	0.9
Drosophila species	1	0.3	10	2.4	22	5.4	27	9.3
Total	335	100	408	100	404	100	439	100

In industrial pig farms in 2021, the composition of mass zoophilous flies was seven, and eight were in homesteads. The dominant species were *M. domestica* and *Stomoxys calcitrans*, which accounted for 78.8% of the total flies in industrial farms and 60.4% in homestead farms. The number of flies in the synanthropic complex was 21.2% and 39.6% in industrial and homestead farms, respectively. In the 2022 collection, nine species of flies were recorded on farms, and the total numbers of *M. domestica* and *Stomoxys calcitrans* were 75.8% and 59.4%, respectively. The number of flies of the synanthropic complex increased to 24.2% in industrial farms and 40.6% in homestead farms, compared to the previous year. A notable number of *Eristalis tenax* (5.7%) was observed in industrial pig farms, and their larvae were found in large numbers in liquid manure. The species and numerical composition of mass species of zoophilous flies in poultry farms are presented in Table 5.

In 2021, 7 species of flies were recorded in poultry houses during entomological collection. In the same setting in 2022, the number of recorded species increased to 11. *Musca domestica* (93.1%) was the dominant species in poultry houses with caged birds in 2021, followed by *Protophormia teraenovae* (4.1%), *L. sericata* (2.0%), and other species collectively accounted for 0.9%. In the vicinity of poultry houses, the dominant species was *M. domestica*, with a

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dominance index of 81.3%, in 2021. The subdominant species were *Muscina stabulans* (5.3%), *Protophormia teraenovae* (4.4%) and *L. sericata* (3.6%). In 2022, *M. domestica* was the dominant species (59.5%) on industrial farms and 50.5% on homesteads. The subdominant species was *Protophormia teraenovae*, accounting for 15.6% of industrial farms and 12.1% of homestead farms.

DISCUSSION

Animal productivity is directly influenced by the technology of their keeping, genetic potential, and epizootological status of the farms. Additionally, the hygiene of livestock product production plays a crucial role, with the parasitic component posing a significant challenge (Aliiev et al., 2022; Pavlenko et al., 2023). Insects, due to their widespread distribution and ability to occupy various ecological niches, as well as the strict and sometimes forced coexistence of insects and humans, are of significant concern for public health (Belluco et al., 2023). House flies (*M. domestica*) are ubiquitous insects that live in close contact with humans and farm animals (Nayduch et al., 2023). Due to their behavior and life cycle, these insects can easily become infected with bacteria, becoming mechanical carriers of potentially pathogenic microorganisms (Bertelloni et al., 2023). The present study used modern methodical approaches for catching insects, which increased the accuracy of the findings.

Research conducted from 2000 to 2020 on the territory of Ukraine among agricultural biocenoses registered 27 species of dipterous insects, among which species of the Muscidae family dominated (74.1%). The largest number of parasitic Diptera was found in livestock premises for keeping cattle, and the least number of species were found in premises for keeping poultry (Paliy et al., 2021a). Considering pig farms, the largest number of zoophilic flies can be found in premises where sows with suckling piglets and animals are designated for fattening (Paliy et al., 2021b).

In a study performed by Domatskiy et al. (2021), more than 120 species of insects came into contact with animals, and of this number, 92 species were found in pastures, 57 in cowsheds, 48 in pig houses, and 27 in stables. Moreover, 30 most harmful species of flies (5 species of stable flies, 4 bloodsuckers, 16 licking, and 5 species of flies) caused myiasis in animals. In another study, Machtinger and Burgess (2020) found that the dominant species in pig production was the housefly *M. domestica* L. (Diptera: Muscidae), followed by the black landfill fly *Hydrotaea aenescens* (Wiedemann) (Diptera: Muscidae).

The abundance of *M. domestica* throughout the year was relatively high although some fluctuations were noted in winter. The reason is that if all sanitary standards for manure collection are observed in livestock premises, there are still hidden breeding places for flies (Paliy et al., 2020a).

The stable fly *Stomoxys calcitrans* is a major blood-sucking pest of livestock that is distributed almost worldwide. The fight against these flies was limited to strengthening sanitary measures and using insecticides to suppress larval stages (Cook et al., 2018). The species *Stomoxys calcitrans* displaces *Haematobia stimulans* and *Haematobia atripalpis* from its habitat (Olafson et al., 2021).

Musca domestica, *M. autumnalis*, *M. larvipara*, *Stomoxys calcitrans*, *Haematobia stimulans*, and *Haematobia atripalis* were identified as the main parasitic species among zoophilic flies in the northwestern region of Ukraine (Katiukha, 2020). Other researchers found that the greatest number of dipterans in livestock biocenoses was made up of insects from the family *Drosophilidae* (61.4%), and the dominant species of *Muscidae* were *M. domestica* (19.2%) and *Stomoxys calcitrans* (5.7%). At the same time, more than half (55.5%) of all flies were caught in the morning, the vast majority of them (71.8%) were near livestock premises, and 28.2% were in the middle of the premises (Nosal et al., 2019).

A total of 22 species of Diptera were found on pig farms in Estonia, of which 96.6% belonged to the order of true flies (Diptera insects) (Tummeleht et al., 2020). It has been reported that the number of zoophilic parasites directly depends on the species of animals, diet, season of the year, and the use of insecticides on the farm (El Ashmawy et al., 2021). It should be noted that parasitic dipterans could negatively affect the crop industry (Saurabh et al., 2021). Therefore, the spread of dipterans in animal husbandry is an urgent problem that requires the development of innovative means and methods for their control, taking into account modern ecological requirements (Saini et al., 2017; Lakew et al., 2021).

CONCLUSION

A total of 28 species of zoophilic flies were registered in livestock farms of five districts of the Kharkiv region of Ukraine, among which *M. domestica*, *Muscina stabulans*, *Stomoxys calcitrans*, *L. sericata*, *Protophormia terraenovae*, and *Drosophila* species dominated. In the biocenoses of cattle, the population of flies is represented by 27 species, in pigs by 8 species, and the lowest in the biocenoses of poultry (n = 7) and small cattle (n = 7).

DECLARATIONS

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Authors' contributions

Mykola Bogach and Anatoliy Paliy participated in the data collection, analysis, preparation, and revision of the manuscript. Natalia Sumakova, Ludmila Perotska, and Denis Bohach were involved in the collection of data and laboratory analysis, while Olena Pavlichenko and Olena Bohach formatted and edited the manuscript. All the authors have read and approved the final manuscripts.

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Ethical consideration

Ethical issues (including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy) have been checked by all the authors.

Availability of data and materials

The authors confirm that all the data of this study are available by request from the authors.

Competing interests

The authors have not declared any conflict of interest.

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