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Biological control of house fly

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We determined that *Musca domestica* L. is the most abundant zoophilous fly in the pig stock complex. *Musca domestica* has been found to play a leading role in the transfer of exogenous forms of helminths. We also identified the Ascaris and Oesophagostomum eggs in our study. We proved that the *Musca stabulans* could be the source of environmental pollution of eggs by Trichostrongylidae. Our data concerning the laboratory breeding *Hydrotea aenescens* testified the possibility of its use as a biological agent that could control the harmful activity of houses fly at livestock farms and complexes. We revealed that one generation of *Hydrotea aenescens* could grow in 24 days at optimum temperatures of 26-27 °C. Lowering the temperature to 20 °C had prolonged the generation time to 40 days and reduced the age of the imago from 20 to 14 days. Low positive temperatures delayed the development of larvae, but not affected the basic biological characteristics of the species. We also established that the density of 0.5-1.0 larvae/cm^3 per substrate was optimal; when we increased the density, this lead to a decreasing the viability of the species. The consumption of house fly larvae by predator larvae grows with an increase in the prey density. Thus, we registered that the larva can destroy 11 larvae of house fly per day.
Key words: zoophylous flies; exogenous forms of helminths; Hydrotea aenescens; larvae; imago; temperature

Introduction

Flies are the most highly organized representatives of the short-circular knitted insects of the double-winged unit (*Diptera*). According to the richness of the species, a large population and breadth of distribution, they occupy one of the first places among the two-winged insects. Zoophilous flies are insects that have biocenotic relationships with pets in pastures and indoors (Hanan, 2010).

Today *Musca domestica* L. (*Diptera: Muscidae*) is one of the major pests for animals around the world. In this case, manure plays a major role in the development and distribution of *M. domestica* (Khan et al., 2012). The case of detecting *M. domestica* larvae in the wounds of the snake is described (Dehghani et al., 2012). It has been established that the fauna of flies of premises is significantly different from the pastures. Thus, in animal housing, dominated by *M. domestica, Fannia canicularis, Stomoxys calcitrans, Drosophila funebris*, and in pasture – *Musca amita, M. tempestiva, M. autumnalis, M. larvipara* (Marchiori, 2014). The number and species composition of the flies varies depending on the species of the animal, its age and type of retention. This is due to the presence of various larval substrates (Heath, 2014). Of all types of livestock farms, livestock and pig farms are the most diverse. The damage caused by zoophilous flies is quite significant. In the period of mass flying of these insects the productivity of animals decreases and the veterinary and sanitary quality of agricultural products deteriorates.

Thus, in livestock farms, regardless of the form of ownership, we need to apply some veterinary and sanitary measures to protect animals from infectious and invasive diseases (Wieman et al., 1992; Paliy et al., 2015). Among the measures taken, an important role is played against parasitic insects, namely, zoophilous flies (Campbell et al., 1971; Foil et al., 2006). The market for insectocaricide agents, in its clear majority, consists of drugs belonging to the groups: synthetic pyrethroids, macrocyclic lactones, organophosphorus compounds, carbamates, and complex compounds containing synergistically active components. These drugs should have not only qualitative indicators of biological efficiency, but also the absence of adverse effects on the environment. Drugs, as a rule, have different commercial names, but similar to active substances (Paliy et al., 2017).

Along with the improvement of chemical means of protection, reducing their toxicity for warm-blooded animals, in recent years, the biological method is being developed and increasingly widely implemented. In poultry farms and pig farms, promising joint use of chemical agents and biological methods (Axtell, 1998).

The *Hydrotea* (*Ophyra*) *aenescens* (Wiedemann, 1830) is used as an agent for biological protection from synanthropic flies in many countries. Earlier, brilliantly metallic species were isolated into a separate genus of *Ophyra*, distributed in warm climate countries and represented by 20 species. The genus *Hydrotea* is represented by 130 species of bivalves, species of this genus are biologically related to decaying remains, they are often found on corpses. The species of *Hydrotea* are identified as predators on other species of bivalves (Patitucci et al., 2010). In the countries of South America, they are typical inhabitants of garbage pits and landfills, for what have also been called garbage flies.

Imago *H. aenescens* has a brilliantly black body without plaque, a length of 5-7 mm, different from other species of the genus, yellow or reddish tunic. On the ventral surface of the hind swab there is a dense bundle of soft, long hair, the hind legs are ventral with two or three bristles. Middle and back thighs with several short, strong spines in the base. The pointed triangle is elongated, extending to the anterior edge of the forehead, reaching to the top of the hole, truncated or broadly rounded (Sabrosky, 1949; Patitucci et al., 2010). Primary habitat of the species *Hydrotea aenescens* – Neotropic and Nearctic regions. It is believed that he was introduced into Europe as an agent of biological control of synanthropic flies in the 1960s. However, Sabrosky K.V. (1949) in a publication devoted to the genus *Ophyra* of *Pacifica*, pointed out that *Ophyra aenescens* lives in America and southern Europe. In any case, the importation of this type from America provided additional opportunities for its distribution in Europe. After some time, the species became invasive for Europe, Africa and the Middle East. As of 2007, it was marked in the following European countries: England, Ireland, Norway, Sweden, Denmark, Netherlands, Germany, Austria, France, Switzerland, Spain, Slovenia, Czech Republic; in the Middle East – in Israel and Turkey; in Africa – in Tunisia and Morocco (Vikhrev, 2008).

In a detailed study of the biology and morphology of all stages of development of this species, it was found that the flies are geographically attached to the breeding grounds and are always in the immediate proximity of the substrate on which they feed and lay eggs. Stimulated the study of *H. aenescens* that preimaginal developmental stages were detected in garbage that decomposed below air freezing temperatures, which made it possible to use them in temperate climates (Johnson et al., 1957). It was established that for a substrate temperature of 27±2.0 °C, one generation developed for 14 days. In this case, the first-year larvae were saprophages, the second and third – fed larvae of indoor flies. Subsequent study showed that because of livestock's life, the temperature of the substrate significantly increases – at a depth of 5 cm the substrate temperature in the individual sections was 35-41 °C at an air temperature minus 2.2 °C and 38-43 °C – at a temperature of 0 °C. The larvae were concentrated in those places of the substrate, where the temperature was maintained at 26-32 °C. The study of the peculiarities of the biology and the conditions of the laboratory breeding of this species continued, and from the 80s of the last century many European and American scientists have investigated the species as a potential object of biological control of the room flies (Muller et al., 1981; Nolan, 1985). The advantages of this type include the fact that flies spread from the place of departure to no more than 300 m in places most suitable for their residence (Hogsette, 1999) In addition, the study of their behavior in the poultry farms showed that they, in contrast to indoor flies, always concentrate on the bottom of the premises near the places of development of larvae and do not disturb the domestic animals. In 90s, the features of development biology (Lefebvre, 2004) and the methods of mass breeding of this species in many countries were clarified (Turner, 1990). Thus, the history of mass breeding of the species *N. aenescens* has shown that their use as a biological agent, limiting the number of indoor flies, is economically viable. Currently, there are several private firms in Europe that deal with mass breeding of this species to protect poultry farms and pig farms from indoor fly.

In Ukraine, *H. aenescens* is not used in the biological control of house flies and thus our research could fulfill this gap.

Materials and methods

The collection of insects was carried out on the surface of the leather cover of animals in the premises, as well as on windows, under the machine tools and other places of livestock buildings using the entomologic butterfly net and exhauster. The collected insects were fixed in 70 % ethyl alcohol and delivered to the laboratory for further determination of their species belonging, quantitative accounting, and autopsy. In experiments from the entire complex of insects attacking animals, the seasonal dynamics of *Muscidae* numbers was considered. The flies were identified as determinant (Gucevich, 1969). Part of the collected donkeys of flies was kept in gardens for 20 days and an autopsy was conducted using the Kotelnikov method (Kotelnikov, 1984). The research was conducted with the laboratory culture of *H. aenescens*, which was grown on an artificial nutrient medium. Hydrothermal conditions for the maintenance of this species and composition of the diet for larvae and imago are the subject of research by many scientists and described in the literature (Muller et al., 1981; Nolan, 1985). In our experiments, flies were kept in special kindergartens. The basis of the nutrient medium for the larvae was fish meal.

Results and discussion

The research was carried out in the spring-summer-autumn period at the pig complex of Balakliy HPP. Of the three rooms, we were caught with 300 insects. At the previous stage, we studied the species composition (Table 1).

Table 1. The species composition of zoophilous flies on a pig complex.

№	Types	Quantity	
		Number	%
1	*Musca domestica*	414	46
2	*Musca stabulans*	95	10,56
3	*Stomoxys calcitrans L.*	68	7,56
4	*Drosophila spp.*	323	35,88
5	All	900	100

When analyzing the results presented in Table 1, we founded that the largest number of zoophilous flies in the insect community of the pig complex belongs to *Musca domestica.* Along with this, the significant distribution of *Drosophila spp*. At the next stage, we conducted a study to determine the presence of exogenous forms of helminths on the surface and the gastrointestinal tract of flies (Table 2).

Table 2. Presence of exogenous forms of helminths of farm animals in flies

№	Species flies	Exogenous forms of helminths		%
		Eggs of types helminths	Number	
1	*Musca domestica*	*Ascaris suum* *Oesophagostomus dentatum*	2 6	0,77
2	*Musca stabulans*	*Trichuris suis* *Oesophagostomus dentatum*	1 1	0,23
3	*Stomoxys calcitrans*	–	–	–
4	*Drosophila spp.*	–	–	–
5	All		9	1,00

We concluded that *Musca domestica* plays a major role in the transfer of exogenous forms of helminths (Table 2). In her study, eggs of Ascaris and Oesophagostomus were detected. It has also been established that *Musca stabulans* may be the source of environmental contamination of eggs by *Trichuris suis* and *Oesophagostomus dentatum*. Other scientists have established the presence of encapsulated larval nematodes in *Musca domestica* (Amado et al., 2014). The results of the study of pathological material from flies in the RIF allowed us to conclude that the Muscovy (*Musca domestica*) flywheel is a mechanical carrier of IRT and AR, in the conditions of its large accumulation in animal farms and in contact with animals infected with viral infections (Stegniy et al., 2017). The role of flies in the transmission of the lumpy skin disease (LSD) agent (Chihota et al., 2003) and infectious anemia (Foil et al., 1983) has been established. The obtained data confirm the necessity of combating zoophilous flies on livestock farms to prevent infectious animal diseases.

The use of chemical agents to control insects is not always justified, and it also has an impact on environmental ecology. Therefore, the search for effective, environmentally friendly pest control is an urgent task of modern veterinary science.

As noted above, the biological agent that restricts the number of flies is *H. aenescens*.

To determine the duration of the stages of ontogeny, the laboratory dilution of *H. aenescens* was carried out at a temperature of 26-27 °C and a photoperiod of 12 hours. The number of larvae per unit volume of the feed substrate was calculated so that the density of the larvae did not affect the temperature of the substrate and did not lead to its heating, 1 cm^3 had 0,5 larvae (Table 3).

Table 3. Duration of development of preimaginal stages and age of imago *H. aenescens* at different temperatures

Temperature, °C	Duration of development, day			
	Eggs	Larvae	Pupariy	Imago
26-27	1	11	12	20
20	1,5	20	18	14

Lowering the temperature to 20 °C slowed down the pace of preimaginal stages and reduced the age of the imago (Table 3). The influence of low temperatures (5 °C) on the development of larvae was carried out in a household refrigerator. The development of the larvae lasted for 40 days, after which they began to decollate. Then the puppets were placed in optimum conditions where they completed their development. Receiving the imago had biological indicators close to the norm. Other researchers have also found that the rate of development of *Ophyra aenescens* (Wiedemann, 1830) and *Ophyra capensis* (Wiedemann, 1818) flies increases as the growing temperature increases, and larval and full development of these species can be estimated if the temperature of the environment is within 17 °C and 30 °C (Lefebvre et al., 2004).

Some scientists have found that this type of flies best survives in heifer manure and in the cow. At the same time, the percentage of survival varied by about 50 % (Hogsette et al., 2002). investigation of the effect of larval densities in the feed substrate on biological indices was carried out at two values: 1 larvae/cm^3 and 2 larvae/cm^3 (Table 4).

Table 4. Biological parameters of *H. aenescens*, depending on the density of larvae in the forage substrate

Density of larvae in the forage substrate per cm^3	Viability, %	The ratio of males and females	Fertility eggs/ females	Lifetime imago, days
1	68,3	1:1	350 ± 24	22
2	18,3	1:2	420 ± 51	21

The results obtained indicate that the density of 2 larvae/cm^3 leads to a decrease in viability – only 18,3 % of the imago was obtained, but in the case of high density, the ratio of articles was in favor of females – 2:1, fertility was also higher that it is possible considered as an adaptive response to increasing the density of individuals.
The study of the intensity of daily consumption of food was carried out at different ratios of predator to victim (Table 5).

Table 5. Effect of the ratio of predator-prey intensity power *H. aenescens*

№	Correlation predator-prey	Number of larvae of flies flavored with one larvae per day, ex.
1	1:2,5	1,5
2	1:5,0	2
3	1:7,5	3
4	1:10	4
5	1:15	8
6	1:20	3
7	1:25	11
8	1:30	10

Obtaining data suggests that for a day, one larva *H. aenescens* consumes from 1.5 to 11 larvae of a room flies. Moreover, with the increase in the density of the larvae of house fly, the intensity of the predator's nutrition increases significantly.

Conclusions

The largest number in insect community of zoophilous flies on the pig complex belongs to *Musca domestica*, which plays a leading role in the transfer of exogenous forms of helminths (Ascaris, Oesophagostomum). The *Musca stabulans* could cause the pollution of egg by Trichostrongylidae. We experimentally determined that the optimum temperature for growing of *Hydrotea aenescens* were 26-27 °C, which promote development of one generation within 24 days. The decrease in temperature to 20 °C prolongs the generation time up to 40 days and reduces the age of the imago from 20 up to 14 days. Therefore, low positive temperatures delay the development of larvae, but not affect the basic biological indicators of the species. The optimum density is 0.5-1.0 larvae/cm^3 of substrate, and an increase in density leads to a decrease in the viability of the species. The flying larva of *Hydrotea aenescens* can destroy 11 larvae of *Musca domestica* per day.

References

Amado, S., Silveira, A. K., Vieira, F. D., Traversa, D. (2014). Habronema muscae (Nematoda: Habronematidae) larvae: developmental stages, migration route and morphological changes in Musca domestica (Diptera: Muscidae). Exp. Parasitol., 136, 35-40. doi: 10.1016/j.exppara.2013.11.002
Axtell, R. C. (1999). Poultry integrated pest management: status and future. Integrated Pest Management Review, 4, 53-73. doi: 10.1023/A:1009637116897
Campbell, J. B., Hermanussen, J. F. (1971). Efficacy of insecticides and methods of insecticidal application for control of stable flies in Nebraska. J. of Economic Entomology, 64, 1188-1190.
Chihota, C. M., Rennie, L. F., Kitching, R. P., Mellor, P. S. (2003). Attempted mechanical transmission of lumpy skin disease virus by biting insects. Medical and Veterinary Entomology, 17, 294-300.
Dehghani, R., Sedaghat, M. M., Sabahi Bidgoli, M. (2012). Wound Myiasis due to *Musca domestica* (Diptera: Muscidae) in Persian Horned Viper, *Pseudocerastes persicus* (Squamata: Viperidae). J. Arthropod Borne Dis., 6(1), 86-89.
Foil, D. L., Younger, D. C. (2006). Development of treated targets for controlling stable flies (Diptera: Muscidae) Author links open overlay panel. Veterinary Parasitology, 137, 3-4, 311-315. doi: 10.1016/j.vetpar.2006.01.033
Foil, L. D., Meek, C. L., Adams, W. V., Issel, C. J. (1983). Mechanical transmission of equine infectious anemia virus by deer flies (*Chrysops flavidus*) and stable flies (*Stomoxys calcitrans*). Amer. J. of Veterinary Research, 44, 155-156. PMID: 6297339
Gucevich, A. V. (1969). The determinant of insects of the European part of the USSR. Moscow: Academy of Sciences of the USSR, 5, 1, 149-163. (In Russian)
Hanan, A. (2010). Prevalence of dipterous flies with veterinary importance in selected sheep's farms and slaughter houses in Jazan, Saudi Arabia. Egypt. Acad. J. Biol. Sci., 3 (2), 63-73.
Heath, A. (2002). Distribution, seasonality and relative abundance of *Stomoxys calcitrans* (stablefly) (Diptera: Muscidae) in New Zealand. New Zeal. Vet. J., 50 (3), 93-98. doi: 10.1080/00480169.2002.36289
Hogsette, J. A., Farkas, R., Coler, R. R. (2002). Development of *Hydrotaea aenescens* (Diptera: Muscidae) in Manure of Unweaned Dairy Calves and Lactating Cows. J. of Economic Entomology, 95 (2), 527-530. doi: 10.1603/0022-0493-95.2.527
Hogsette, J. A., Jacobs, R. D. (1999). Failure of Hydrotaea aenescens, a larval predator of the housefly, Musca domestica, to establish in wet poultry manure on a commercial farm in Florida, USA. Med. Vet. Entomol., 13, 4, 349-354. doi: 10.1046/j.1365-2915.1999.00173.x
Johnson, W. T., Venard, C. E. (1957). Observations on the biology and morphology of Ophyra aenescens (Diptera: Muscidae). The Ohio J. Sci., 57, 21-26.

Khan, H. A., Shad, S. A., Akram, W. (2012). Effect of livestock manures on the fitness of house fly, Musca domestica L. (Diptera: Muscidae). Parasitol. Res., 111(3), 1165-71. doi: 10.1007/s00436-012-2947-1
Kotelnikov, G. A. (1984). Helminthological studies of animals and the environment. Moscow: Kolos, 208. (In Russian)
Lefebvre, F., Pasquerault, T. (2004). Temperature-dependent development of Ophyra aenescens (Wiedemann, 1830) and Ophyra capensis (Wiedemann, 1818) (Diptera, Muscidae). Forensic Sci. Int., 139, 1, 75-79.
Marchiori, C. H. (2014). Species of Diptera of medical, sanitary and veterinary importance collected from buffalo and cattle dung in South Goiás, Brazil. Int. J. Appl., 4 (2), 54-57.
Muller, P., Schumann, H., Betke, P., Schultka, H., Ribbeck, R., Hiepe, Th. (1981). Zur beteutung des Musca domestica-antagonisten Ophyra aescens (Diptera: Muscidae). I. Zum auftreten von Ophyra aescens in anlagen der tierproduktion. Angew. Parasitol., 22, 212-216.
Nolan, M. P., Kissam, J. B. (1985). Ophyra aenescens: a potential bio-control alternative for house fly control in poultry houses. J. Agric. Entomol., 2, 2, 192-195.
Paliy, A.P., Paliy, A.P., Naumenko, O.A. (2015). Innovative technologies and technical systems in dairy cattle breeding: scientific and educational manual. Kharkiv: City Press. (In Ukrainian)
Paliy, A., Paliy, A. (2017). Repellents for cattle. Farmer, 8 (92), 184-186. (In Ukrainian)
Patitucci, L. D., Mulieri, P. R., Oliva, A., Mariluis, J. C. (2000). Status of the forensically important genus Ophyra (Diptera: Muscidae) in Argentina. Rev. Soc. Entomol. Argent., 69, 1-2, 91-99.
Sabrosky, C. W. (1949). The muscid genus Ophyra in the Pacific Region (Diptera). Proc. Hawaiian Entomol. Soc., XIII, 3, 91-99.
Stegniy, B. T., Gerilovich, A. P., Paliy, A. P., Mashkey, A. M., Sumakova, N. V. (2017). Ectoparasites as mechanical and transmissible carriers of infectious diseases. Bul. of Agrarian Sci., 11, 35-38. (In Ukrainian)
Turner, E. C., Carter, L. (1990). Mass rearing and introduction of Ophyra aenescens (Wiedemann) (Diptera: Muscidae) in high-rise caged layer houses to reduce house fly populations. J. Agric. Entomol., 7, 3, 247-257.
Vikhrev, N. (2008). New data on the distribution and biology of the invasive species Hydrotaea aenescens (Wiedemann, 1830) (Diptera, Muscidae). ZooKeys, 4, 47-53. doi: 10.3897/zookeys.4.27
Wieman, G. A., Campbell, J. B, Deshazer, J. A., Berry, I. L. (1992). Effects of stable flies (Diptera: Muscidae) and heat stress on weight gain and feed efficiency of feeder cattle. J. Econ. Entomol., 85 (5), 1835-1842.

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