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Original article

SOME BIOLOGICAL AND ECOLOGICAL FEATURES OF *HYPODERMA* LATREILLE, 1818 IN TAVUSH REGION OF ARMENIA

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Background. *Cattle hypodermosis is a chronic parasitic disease (entomosis) that occurs as a result of parasitizing the larvae of warble flies in the body of animals. Disease is common in more than 55 countries of the world, causing great economic damage. It is considered as a parasitic disease with a certain zoonotic potential.*

Purpose. *To conduct research on biological and ecological features of the warble flies that determines certain epidemiological traits of the caused pathology in Tavush Region of Armenia.*

Materials and methods. *The observations were carried out in Tavush Region, and the experiments were carried out at the Research Center for Veterinary Medicine and Veterinary Sanitary Expertise at the Armenian National Agrarian University. The warble flies marked with stain, were released at a distance of 0.5 to 1.5 km from livestock farms with subsequent search and trapping of insects, located on pastures and on the skin of animals. Generally, 275 warble flies were released. Warble fly activity was evaluated visually counting the comparative number of flying insects at the fixed point per minute at different times of the day, as well as animal anxiety state caused by warble flies was identified. Statistical processing of experimental data was performed by means of "Vassart.net" online calculator.*

Results. *Female warble flies Hypoderma bovis flew up to 12.1 km, while female warble flies H. lineatum did it up to 8.6 km. Females of H. bovis and H. lineatum demonstrated various spatial and circadian flying activity that depends on season, and altitude above the sea level. Spring generation of warble flies is more resistant to low air temperatures compared to the summer generation. Mild and humid summers, as well as an increase in the number of animals, contribute to an increase in the population of warble flies, while high temperature and high soil moisture contribute to the mass death of warble fly pupae developing in the ground.*

Conclusion. *The research data cited in the article, detect the presence of a wide range of biocenotic factors that determine the epidemiology of cattle hypodermosis in the Tavush region of the Republic of Armenia. Cattle hypodermosis control plan was designed based on the results of the research, as well as natural and climatic conditions of Tavush region. Pasture prevention activities and periodic treatment of the cattle with insecticides were emphasized.*

Keywords: *climate; invasion; larva; pasture; Hypoderma*

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Научная статья

НЕКОТОРЫЕ БИОЛОГИЧЕСКИЕ И ЭКОЛОГИЧЕСКИЕ ОСОБЕННОСТИ *HYPODERMA* LATREILLE, 1818 В ТАВУШСКОЙ ОБЛАСТИ АРМЕНИИ

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Обоснование. *Гиподерматоз крупного рогатого скота – хронический энтомоз, вызываемый паразитируемыми в организме животных личинками подкожных оводов. Болезнь распространена более чем в 55 странах мира и причиняет большой экономический ущерб. Болезнь относится к паразитозам с определенным зоонозным потенциалом.*

Цель. *Изучить биологические и экологические особенности подкожных оводов, являющихся эпизоотологическими детерминантами гиподерматоза крупного рогатого скота в Тавушской области Армении.*

Материалы и методы. *Наблюдения проводили в Тавушской области, а эксперименты – в Исследовательском центре ветеринарии и ветеринарно-санитарной экспертизы Национального аграрного университета Армении. Половозрелых оводов помечали краской и выпускали на расстоянии 0,5-1,5 км от животноводческих ферм с последующим отловом насекомых на пастбище и на кожных покровах животных. В общей сложности было выпущено 275 насекомых. Активность оводов оценивали визуально, подсчитывая количество летающих в течение минуты насекомых в определенной*

точке в разное время суток, а также по степени беспокойства животных, вызванного оводами. Статистическая обработка экспериментальных данных проведена с помощью онлайн-калькуятора "Vassart.net".

Результаты. *Максимальная дальность полета самок Hypoderma bovis составила 12,1 км, а самок H. lineatum – 8,6 км. Самки H. bovis и H. lineatum демонстрировали различную пространственную и суточную активность, зависящую от времени года и высоты местности над уровнем моря. Весенняя генерация оводов более устойчива к низким температурам воздуха по сравнению с летней генерацией. Мягкое и влажное лето, а также увеличение поголовья скота обусловливает увеличение популяции подкожных оводов, тогда как высокая температура воздуха и высокая влажность почвы приводят к массовой гибели куколок оводов, развивающихся в почве.*

Заключение. *Приведенные в статье результаты исследований обнаруживают наличие широкого диапазона биоценотических факторов, определяющих эпизоотологические особенности гиподерматоза крупного рогатого скота в Тавушской области Республики Армения. На основании результатов исследования, а также с учетом природно-климатических условий Тавушской области, разработан план профилактики и борьбы с гиподерматозом крупного рогатого скота. План основан на пастбищной профилактике и периодических обработках животных инсектицидными препаратами.*

Ключевые слова: *климат; инвазия; личинка; пастбище; Hypoderma*

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Introduction

The natural, climatic and geographical conditions of the Tavush Region of the Republic of Armenia contribute to the spread of numerous parasitic diseases of farm animals, among which the cattle hypodermosis caused by warble flies is well distinguished. Adult forms of the causative agent of the cattle hypodermosis – warble flies (Insecta: Diptera: Oestridae: Hypodermatinae) - are dipterous insects that go through all three stages of their larval development in the body of cattle. Two main species are described – *Hypoderma bovis* Linnaeus, 1758 and *H. lineatum* Viller, 1789 [3, 4, 8].

Taking into account the fact that hypodermosis is a widespread disease affecting a significant number of animals, it is necessary to assess the epide-

miological state of an area that is unfavorable for the disease considering the species of pathogens, as well as their activity at different times of the year and day, depending on natural and geographical conditions.

Cattle hypodermosis is a chronic parasitic disease (entomosis) that occurs as a result of parasitizing the larvae of warble flies in the body of animals. Parasites affect the internal organs and skin of their hosts [1 – 3, 7, 8, 24]. Disease is common in more than 55 countries of the world, causing great economic damage [4, 9, 13-21, 24, 28-29]. In sick animals, anorexia, as well as low milk and meat productivity is observed. Due to the fistulae that form in the back and lumbar region, the quality of raw hides decreases, and approximately 8% of that is rejected [4, 6 – 8, 10, 14, 23, 28]. For example, in the Russian Federation, the total economic damage from hypodermosis reaches 65 billion Russian rubles per year [11].

The disease also has an immunosuppressive effect, which increases the susceptibility of the animal body, affected by the larvae of warble flies, to all kinds of infections. In addition, the products obtained from animals with hypodermosis have a negative effect on the human health due to the presence of hypodermotoxin produced by the larvae of warble flies [5].

Currently hypodermosis is considered as a parasitic disease with a certain zoonotic potential [22, 25].

Despite the above mentioned, cattle hypodermosis remains completely unexplored in Armenia. No data on biology and ecology of the agents, as well as on epidemiological features of the pathology are available in our country.

Purpose

The purpose of current work was to conduct research on biological and ecological features of the warble flies that determines certain epidemiological traits of the caused pathology in Tavush Region of Armenia.

Materials and methods

In order to implement effective control measures against the cattle hypodermosis, it is necessary to determine the distribution area of adult warble flies, as well as the flight range of warble flies, taking into account the natural and climatic conditions and terrain features of the area [12, 27]. The studies were carried out in areas rich in pastures, located on hills partially or completely covered with forests. Research area (Tavush Region) is shown on the Fig. 1.

The experiments were carried out at the Research Center for Veterinary Medicine and Veterinary Sanitary Expertise at the Armenian National Agrarian

University. Adult forms of warble flies grown under laboratory conditions from larvae, were marked with fluorescent stain that was applied to the dorsal surface of the thoracic region of insects at a temperature of $+4^0$ to $+6^0$C.

The warble flies marked with stain, were released at a distance of 0.5 to 1.5 km from livestock farms with subsequent search and trapping of insects, located on pastures and on the skin of animals. Generally, 275 warble flies were released.

Warble fly activity was evaluated visually, in the pastures, counting the comparative number of flying insects at the fixed point per minute at different times of the day, as well as animal anxiety state caused by warble flies was identified.

Statistical processing of experimental data was performed by means of "Vassart.net" online calculator [26]. Fisher Exact Probability Test and Chi-square criterion were used to estimate statistical significance of the experimental data obtained.

Fig 1. Research area - Tavush Region - on the map of Armenia (Source: Tavush Province | Armenia tour (armenia-tour.am))

Results

Research has shown that female warble flies *H. bovis* (Fig. 2) flew up to 12.1 km, and female warble flies *H. lineatum* (Fig. 3) did it up to 8.6 km.

Fig. 2. Female warble fly H. bovis

Fig. 3. Female warble fly H. lineatum

The quantitative ratio of warble flies belonging to the species *H. bovis* and *H. lineatum* at various distances are demonstrated in Table 1.

Table data show that female ratio of *Hypoderma spp.* detected at the distances of 0.5; 1.5; 3.0; 5.8; 8.6; 10.2; 12.1 km equals respectively to 14:18; 10:13; 11:16; 9:12: 7:6; 4:5; and 3:2. However, the obtained results are not statistically significant (Chi-square criterion equals to 0.06, $P > 0.05$ as calculated by Fisher`s criterion).

Table 1.

Quantitative ratio of different Hypoderma spp. flight at various distances

Flight distance, km	*H. bovis* females	*H. lineatum* females
0.5	14	18
1.5	10	13
3.0	11	16
5.8	9	12
8.6	7	6
10.2	4	5
12.1	3	2

Discussion

Observations show that released adult warble flies flew in different directions. Warble flies released near livestock farms, gather in the area of barnyards and barns. About 48% of the tagged insects were found in the immediate vicinity of the animals within 10 minutes to 2 hours after release. Considering that the maximum flight range of adult warble flies is 12 km change of pasture sites for livestock should be carried out at a distance of 12 km from farms, which is not always possible in the conditions of the Tavush region due to the intensification of agricultural activities. A set of measures to control hypodermosis should cover the entire population of cattle, located in an in epidemiologically unfavorable area, otherwise the infection will be repeated with subsequent coverage of new territories.

Long-term observations revealed the absence of adult warble flies in the subalpine (at altitudes about 2000 to 2200 meters above sea level) and alpine (at altitudes about 2200 to 2900 m above sea level) areas of Tavush Region, which means that grazing animals on high-altitude summer pastures can be naturally prevented from warble fly infection.

Comparative analysis of adult warble fly activity at different times of the day is demonstrated in the Fig. 4.

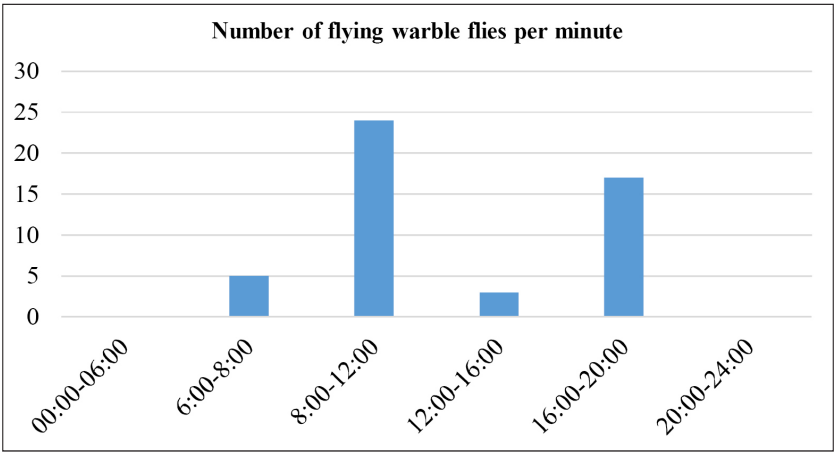

Fig. 4. Day cycles of the adult warble fly activity.

It was found out that on sunny days, adult warble flies began their flight at a temperature of +7^{0}C to +9^{0}C, and on cloudy days it was at temperature of +13 to +15^{0}C. In spring, warble flies began their flight in the time interval from 9 to 11 o'clock in the morning, and in summer it was from 6 to 8 o'clock in the morning. In summer, during the day, insects showed the greatest activity in the range between 8 and 12 o'clock. With the onset of heat (from 13 to 16 o'clock), the activity of warble flies drops sharply. In the time interval between 16 and 20 o'clock, the warble flies again become active without reaching, however, the morning degree of activity. In autumn, the flight of warble flies lasts from 10 to 16 o'clock. It should be noted that the temperature factor affects the activity of warble flies in two ways.

So, with an increase in air temperature, the intensity of metabolic processes, and hence, the overall mobility of insects, increased. Changes in air temperature were perceived by the thermoreceptors of insects, which began to look for optimal conditions for their life, leaving the uncomfortable zone. An increase in air temperature to +30^{0}C to +40^{0}C reduced the activity of adult warble flies which explains the slowdown and even termination of the flight of these insects in the summer from 13 to 17 o'clock. At the indicated time of day, warble flies, as a rule, hid from the sun's rays in the cracks of the walls, rodent burrows, or under awnings.

It should be noted that the spring generation of warble flies is more resistant to low air temperatures compared to the summer generation. A prolonged decrease

in air temperature to 0^0C, adult warble flies fell into suspended animation within two days, and some individuals even die. At the same time, the number of dead individuals is 43% in the spring generation and 85% in the summer generation of the *H. bovis*. Whereas, the percentage of individuals of the species *H. lineatum* that did not wake up from the state of anabiosis is 53% in the spring and 91% in the summer generation. Besides, a short-term decrease in air temperature to -20^0C during several hours does not kill warble flies: with an increase in air temperature, their activity is restored. Mild and humid summers, as well as an increase in the number of animals, contribute to an increase in the population of warble flies, while high temperature (+39^0C to +43^0C) and high soil moisture (65-68%) contribute to the mass death of warble fly pupae developing in the ground.

Based on the data of observations, as well as taking into account the biological characteristics of warble flies common for the targeted area, we developed a plan to control the cattle hypodermosis considering the natural, climatic and geographical conditions of Tavush region.

The invasion control plan includes the following activities:

1. Carrying out preventive treatments of the skin of cattle using insecticidals that stop the development of larval forms of the pathogens, parasitizing in the subcutaneous tissue of animals. Systematic treatment of animals should be carried out during the grazing period monthly with an interval of two weeks.

2. Animals should be grazed on periodically changing pastures; it is desirable to change pastures every 15-30 days.

3. Using areas located in the subalpine and alpine zones of the region for grazing animals in summer.

Conclusion

Based on the research results we can conclude that females of *Hypoderma bovis* and *H. lineatum* demonstrated various spatial and circadian flying activity. The activity mainly depends on season, and altitude above the sea level.

Spring generation of warble flies is more resistant to low air temperatures compared to the summer generation.

Mild and humid summers, as well as an increase in the number of animals, contribute to an increase in the population of warble flies, while high temperature (+39^0C to +43^0C) and high soil moisture (65-68%) contribute to the mass death of warble fly pupae developing in the ground.

Cattle hypodermosis control plan was designed based on the results of the research, as well as natural and climatic conditions of Tavush region. Pasture prevention activities and periodic treatment of the cattle with insecticides were emphasized.

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Conflict of Interests. None declared

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