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Control of ixodid ticks by means of pheromones and acaricidal preparation

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ABSTRACT

The article describes a method for catching arthropods, i.e., for collecting and counting ticks, and can be used for collecting ixodid ticks in natural biotopes and counting their number. In another aspect, the present study additionally relates to a method for killing ticks, using an agent with a mixture of pheromone and acaricidal agents for protection against ticks in natural and urban biotopes. The paper presents the action of the pheromone-deltamethrin complex on ixodid ticks, which are known to be usually parasitic on animals. During the study, a preparation with the active ingredient deltamethrin was chosen as an acaricide because deltamethrin is the main drug currently used for tick control. Moreover, deltamethrin is not a repellent and therefore will not affect the response of ticks to pheromones.

Keywords: Tick, Ixodid, Deltametrin, Arthropod, Acaricide.
Article type: Short Communication.

INTRODUCTION

Ixodes ticks (family Ixodidae of the order Parasitiformes) are a relatively small, taxonomically isolated group of ticks - obligate bloodsuckers, highly specialized parasites of terrestrial vertebrates, mainly mammals and birds. The world fauna of these arthropods includes about 700 species belonging to two subfamilies and 14 genera.

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Representatives of the family Ixodidae inhabit all climatic zones. Ixodidae inhabit all climatic zones, but only a few species are found in polar regions. The constant interest in the study of ixodid ticks and the large number of publications devoted to various aspects of their morphology, physiology, biology, etc. is explained by their very great practical importance (Balashov 1998). Mass infestation by ixodid ticks causes enormous damage to animals, loss of fatness, decreased immunity, allergic reactions of the organism, and a large number of ixodid ticks feeding at the same time can even cause death of the host. But the most important thing is that ixodid ticks are carriers and often keepers of a large number of pathogens of natural focal diseases and participate in the circulation of spirochetes, bacteria, rickettsiae, viruses and protozoa among wild animals. Ixodes ticks are specific vectors for many natural focal diseases (Pavlovsky 1957). The range of pathogens transmitted by Ixodes ticks is constantly expanding - just cite as an example of tick-borne borreliosis (Lyme disease), first identified in the late 1980s in the United States and spread over vast areas of North America, and subsequently found in Europe and Asia (Colonies 1981). Ixodes ticks are temporary ectoparasites with a long-term diet, spending much of their life cycle in the external environment. A key event in the life of any temporary ectoparasite is contact with a potential feeding host. Thus, behavior plays a major role in the formation of parasitism and its evolution in terrestrial arthropods. Inhabiting in different ecological conditions, each species of ticks has acquired in the course of evolution its own adaptation complex, which allows it, on the one hand, to successfully adapt to specific habitats; on the other hand, to successfully find a host. The acquisition of appropriate behavior by the species at certain stages of its life cycle is of utmost importance (Romanenko 2007). In recent decades in our country there have been significant changes in the conditions of agricultural production. This has led to an increase in habitats favorable for ixodial ticks and an increase in the number of ixodids, which has affected the deterioration of the epidemic and epizootic situation for a number of diseases transmitted by ticks. In particular, in the south of Kazakhstan, the epidemiological situation on Crimean hemorrhagic fever (CHF), the epizootic situation on animal piroplasmidosis and a number of other infections has become more complicated (Sabanshiev *et al.* 2006). The study and clarification of the species composition of ixodid ticks at the present stage, the influence of environmental factors on the number and distribution, confinement to certain natural habitats, the relationship between ticks and feeders, allowing to predict and timely carry out a set of measures aimed at preventing epidemic and epizootic complications of a number of infectious and invasive diseases is currently one of the urgent tasks.

In Kazakhstan, the main means of tick control is the use of chemical acaricides. However, despite their well-known disadvantages, researchers are actively developing alternative tick control strategies. One of the alternative control measures, which is not usually applied in our country, is the use of semiochemicals. Semiochemicals are chemical signaling agents emanating from the host/tick that are released into the external environment to control tick behavior. These information-containing compounds include pheromones (used for conspecific communication), allomones (defense secretions) and kairomones (used for host identification and location; Regnier 1970). Pheromones are the best known, intensively studied pheromones and include retention pheromones (assembly), attraction pheromones, aggregation-attachment pheromones (AAA) and sex pheromones (sexual attachment pheromone, as cited in this paper by Ranju *et al.* (2018), which uses assembly pheromone to control ixodial ticks (Ranju *et al.* 2018). Among the semiotic substances, the collection/retention (AP) has been used with great success (Sonenshine 2004). A patented device incorporating purines from the faeces of the prostatic tick, *I. scapularis* into oily droplets released from a pump sprayer was developed for delivery to vegetation. The oily droplets adhered to vegetation where *I. scapularis* sought hosts (Allan *et al.* 2002). The components in the pheromone, including guanine and xanthine, as well as an acaricide (permethrin), caused ticks that were caught in the droplets to cling to contaminated surfaces where they received a lethal dose of acaricide (Sonenshine 2004). In laboratory studies using *I. scapularis* ticks, an increase in mortality rate from 70% with an acaricide product alone to 95% with a product with mixture of pheromone and acaricide tick control agents has been reported (Sonenshine 2004). The aim of this study is to use pheromones of ixodid tick aggregation and the acaricide drug deltamethrin to control tick abundance in natural biotopes.

MATERIALS AND METHODS

The study was conducted in spring, between the end of April and the end of May 2024, as tick populations are higher at this time of year in the West Kazakhstan region. At each collection site, n = 20 samples were taken (a total of 60 samples were taken at three sites). Each sampling consisted of simultaneous use of both flags (with and without mixture) in adjacent 2 m wide plots by two people who changed the flags every fifty meters to obtain

uniform results. Every 5 m the flagging was checked for the presence of ticks. The effectiveness of the method was determined by comparative counts of total tick counts and counts of individual developmental stages. The task to be solved by the study is to collect and destroy a large number of sexually mature individuals of ixodid ticks, which is provided by applying to the flag cloth a methylene chloride extract of 5000 females feeding on blood for 7-8 days and the acaricidal preparation Delcid, which contains synthetic pyrethroid deltamethrin - 4.0% as an active ingredient and tween 80, neonol and nephras as auxiliary components (LLC "АВЗ С-П", Russian Federation; Fig. 1).

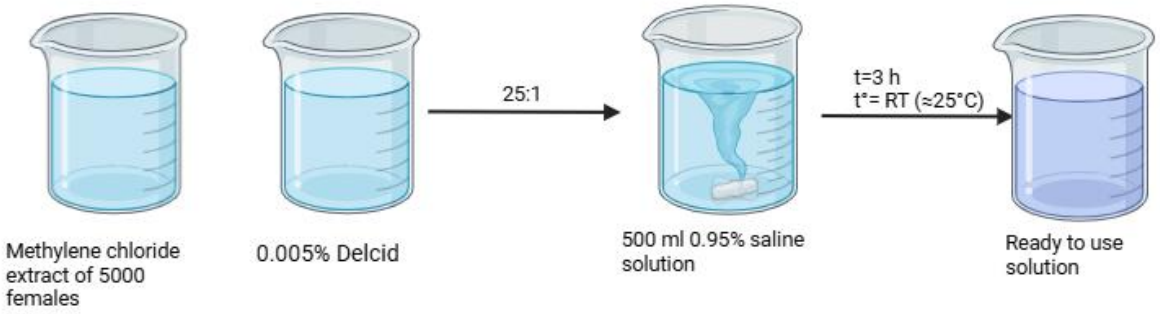

Fig. 1. Preparation of the mixture.

Methylene chloride extract of 5000 blood-fed females of 7-8 days and 0.005% delcid were used in a 25:1 ratio. The mixture was diluted in 500 mL of 0.95% physiological saline solution and stored at room temperature for 3 hours before use. A preliminary study using 50% ticks showed that 200 µL of the mixture was suitable for attracting ticks. The technical result is to enhance the traditional collection method by spraying pheromones and an acaricidal agent onto white flannel. The flag consists of a shaft and a web. The shaft is made of hollow aluminum tubing and the web is made of white technical flannel. A 500 g bottle of JBL mix and electromagnetic regulator (for use in aquariums, KRASS®, Russia) were attached with plastic seals to the shaft. A silicone rubber hose was connected to the electromagnetic regulator; the hose was passed through an aluminum rod and connected to a flag. The rubber hose was punctured (to release the mixture) and attached to the flagging with seams forming a mesh structure (Fig. 1). The hose was made of bend-resistant silicone rubber with an inner diameter of 1 mm and an outer diameter of 2 mm with wall thickness of 0.5 mm. The flagging had a surface area of 0.48 m^2 (80 × 60 cm), allowing unobstructed passage through all types of vegetation. Two identical flags were made, one with the mixture and one without (control; Romanenko 2018; Danchinova 2013; Koshkina & Kolesnikov 2019). Species identification was performed using morphological characters under a binocular microscope. (Garcia 1962; Evenden *et al.* 1999)

RESULTS AND DISCUSSION

To determine the optimal ratio of the two active ingredients of a mixture of pheromones with an acaricidal preparation, we have laid down an experiment under laboratory conditions in 2024. The acaricidal activity of the above preparations in laboratory conditions was studied on laboratory strains of ticks *Dermacentor reticulatus*. Ixodid adults were used in the experiments. For this purpose, ticks (10 pieces each) were placed in mill gas and immersed for one minute in different concentrations of the tested preparations, afterward they were transferred to dry filter paper placed in Petri dishes, Control ticks were immersed in distilled water. Experiments were carried out in three repetitions, and the results of experiments were calculated according to the method after 24-48-72 hours. In order to study the acaricidal properties of the selected preparations, first of all, experiments were conducted to select the most effective working concentrations of these compounds. Delcid in 0.005% concentration, has an absolute percentage (100%) of ticks death in laboratory conditions already in 24 hours. Sufficiently high acaricidal activity of 0.003% aqueous emulsion of Delcid already after 48 hours causes death of 90.9,100, and 100% of ticks, respectively. The other concentrations of preparations were the least effective and showed some acaricidal effect only after 72 hours. For example, 0.001% concentration of Delcid showed acaricidal activity in 87.5% of cases. As follows from the data in Table 1, all tested working concentrations of the drug have clearly expressed acaricidal properties and differ only in the duration of their action.

Table 1. Acaricidal activity of Delcid under laboratory conditions.

Operating concentration (%)	Acaricidal activity (%) after different times (hour)			
	12	**24**	**48**	**72**
0.001	6.7	14.3	33.3	87.5
0.003	23.3	52.2	90.9	100
0.005	73.3	100	-	-
Water	No tick mortality has been noted			

In the process of studying acaricidal properties of new preparations it was found that the most toxic for ixodid ticks is Delcid, as its SC_{50} was 0.00047 ± 0.091. The second part of the study was conducted in April-May 2024 at three sites in the West Kazakhstan region. The habitats consisted of herbaceous vegetation alternating with small shrubs located at the edges of forests, which are special habitats for ticks. The climate is sharply continental. After treating the cloth with the above-mentioned mixture for the whole observation period (three days), the results of the experiments were recorded at 24, 48 and 72 hours after treatment and are shown in Table 2.

Table 2. Efficacy of the product for controlling ixodid tick populations.

Item	Number of ticks collected in the experiment	Tick mortality after collection with a flag treated with the mixture after one hour					
		24		**48**		**72**	
		Individuals	**%**	**Individuals**	**%**	**Individuals**	**%**
1	83	15	18.1	11	13.5	45	62.5
2	81	20	24.7	29	47.5	25	78.1
3	85	46	54.1	36	92.3	14	16.5

The flagging treatment was carried out by low-volume fine and medium-volume spraying from "Automax", once, in a volume of 0.5 L. The obtained data allow us to summarize 100% mortality of ixodid ticks 48 hours after collection. The control flag showed 15-20% less number of ticks, also no death of ticks was observed.

CONCLUSION

The obtained results allow us to conclude that the highest acaricidal activity against Ixodes ticks, in particular *Dermacentor reticulatus*, has 0.005-0.003% aqueous emulsions of Delcid, 0.05% aqueous emulsion of Veterin, which indicates their promising and the need to conduct similar studies in production conditions. The results of these works were the basis for continuing the work with the developed mixture in order to effectively control the number of ixodid ticks.

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