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ATTRACTIVITY OF MAMMAL HAIR FOR FEMALE TAIGA TICKS *IXODES PERSULCATUS* SCHULZE

ПРИВЛЕКАТЕЛЬНОСТЬ ШЕРСТИ МЛЕКОПИТАЮЩИХ ДЛЯ САМОК ТАЕЖНОГО КЛЕЩА *IXODES PERSULCATUS* SCHULZE

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ABSTRACT

Hair samples of 20 mammal species from 6 orders as well as 5 volunteers' odours were investigated in the vertical olfactometer. All tested mammal species and 4 volunteers were attractive for taiga female ticks caught in natural environment. The highest degree of attractivity was revealed by one of the volunteers and the hair samples of the wolf, the dog, the boar and some other species. Laboratory reared females displayed a weaker reaction to the same hair samples than females caught in natural environment.

РЕЗЮМЕ

В вертикальном ольфактометре исследовались поведенческие реакции самок таежного клеща в ответ на предъявление запахов шерсти 20 видов млекопитающих и различных частей тела человека. Отловленные в природе самки *Ixodes persulcatus* проявляли положительные реакции на запахи. Самки из лабораторной культуры показали более слабые реакции на те же самые раздражители. Наиболее привлекательны для самок *Ixodes persulcatus* оказались запахи шерсти волка, собаки, кабана и некоторых других видов.

It is a known fact that when treating territories with the aim of controlling taiga ticks, the positive effect can be reached only if this territory is thoroughly covered by acaricide particles. This is explained by a low degree of horizontal mobility of ticks. During acaricide treatments about 0.00001th of the used preparation is spent on ticks destruction. The rest pollutes the environment, killing non-target organisms. The acaricide expenditure can be significantly (by 2 to 3 orders) lowered if attractive substances are applied [Uspensky, 1973]. For some time the idea was ignored, as taiga ticks were believed not to possess horizontal mobility [Babenko & Arumova, 1985]. Review of the literature has shown that the latter is true of the cases when stimuli to movement are absent, but ticks have the ability to detect the odour of the host at a significant distance and proceed actively and purposefully to the odour source. It is this ability that can be used for the creation of a new generation of tick control strategies, i.e. attractive-acaricide granules (AAG) [Naumov, 1990; Naumov & Gutova, 1991].

In the former USSR [Naumov, 1985; Labzin, 1985] about 280 species of mammals and birds have been reported as taiga tick hosts. Hedgehogs, squirrels, hares and even ungulates carry large numbers of both adult and immature ticks at the same time. This lack of tick-host specificity suggest odours given off by hosts' hair contain a component that attracts, apart from adults, immature ticks *I. persulcatus*, too, and probably ecologically similar species such as *I. ricinus* and *I. scapularis* as well. The purpose of this study is evaluation of mammal hairs and different human smells as possible attractants for selective tick control.

MATERIALS AND METHODS

In order to determine the most attractive materials, hair samples (for the most part, it was hair shed from zoo animals) of 20 mammal species from 6 orders were collected. In addition, hair taken from 4 parts of each of 5 human volunteers' body (2 male and 3 female) were also used. The tested volunteers did not use deodorants or any other smelly substances during 2 days before the experiment. Tests were taken by wiping the hairline of volunteers' head (forehead, temples, behind the earlobes) and armpits with water-dampened cotton wool balls. A cotton wool ball was also won under the waist belt and under the toes for 24 hours. The responses of wild-caught taiga tick females to samples of mammal hair and cotton balls contaminated with the odours of human volunteers were investigated in a vertical Y-shaped olfactometer. These females were held in test-tubes with high humidity and stored in a household refrigerator prior to the experiment.

The olfactometer consistes of three airtight plastic chambers connected by plastic tubes: the lower or starting chamber (Fig.1, a) and two upper ones (Fig.1, b,c) divided inside by grids (Fig.1, d). The material to be investigated was placed into one of the upper chambers that are connected with the starting chamber by means of an Y-shaped tube (Fig.1, e). The vacuum pump (Fig.1, f) supplied a slow current of air from the upper chamber to the starting chamber. On the way to the upper chamber, the air passed through a charcoal filter (Fig.1, g) and humidifying chamber (Fig.1, h).

First, the tested sample was placed in one of the upper chamber, and vacuum pump was switched on. A few minutes later up to 50 female ticks were allowed into the starting chamber. Three tick categories were distinguished for evaluation of results: inactive female ticks that did not leave the starting chamber during the period of the experiment (30–45 minutes) (Category 1); active females that crawled into the upper chambers (Categories 2 and 3). Among the active female ticks we distinguished normally active, individuals that displayed negative geotaxis (Category 2) and aggressive ones, displaying both negative geotaxis and searching activity, i.e. the ability to react by moving in the direction of the host's odour (Category 3).

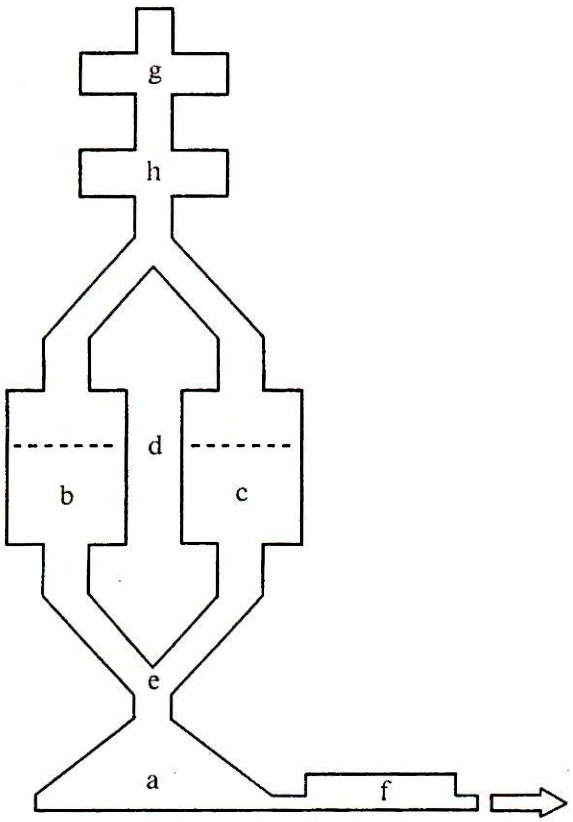

Fig 1. The scheme of vertical olfactometer:
a — starting chamber; b,c — experimental chambers, one of which contained hair samples; d — grid; e — Y-shaped tube, connecting the starting and the experimental chambers; f — vacuum pump; g — charcoal filter; h — humidifying chamber.
Рис 1. Схема вертикального ольфактометра:
a — стартовая камера; b,c — экспериментальные камеры, в одну из которых помещался образец шерсти; d — сетка; e — Y-образная трубка, соединяющая стартовую и экспериментальные камеры; f — вакуумный насос; g — угольный фильтр; h — влажная камера.

In preliminary experiments carried out with the same hair sample it has been noticed that the attractivity of the hair (the percentage of females having crawled into the experimental chamber from the total number of ticks that covered the distance between the starting chamber and upper chambers) depends on the ticks' physiological state. The higher the number of inactive females (Cat.1) in the group, the lower the share of aggressive ones (Cat.3) and, consequently, the attractivity of the hair sample. Therefore, only those results were recorded, if they were obtained in the experiments in which inactive ticks did not exceed 20%.

To exclude the influence of occasional factors all experiments were duplicated, that is the hair sample was placed into one upper chamber, then into the other, and each group of ticks was tested twice.

The uniform distribution of ticks in the two upper chambers (50% positive) meant there has been recorded no reaction to the odour. The prevalence of ticks in the control chamber (less than 50% positive) signified that the sample acted as a repellent, while the prevalence of ticks in the experimental chamber (over 50% positive) proved the hair sample's attractivity.

RESULTS AND DISCUSSION

Hair from all investigated mammal species was obviously attractive to female taiga ticks (Table 1). The only exception was the *Felis manul* hair that displayed a remarkable repellent effect, and as far as *Ovibos moschatus* hair, ticks did not react to it at all. In the two latter cases hair sample activity could be camouflaged by alien repellent substances with which the animals' hair may be soiled in captivity (disinfectant, paint, etc.). A year later new samples of hair from the same animals have caused an authentic positive reaction on the part of taiga ticks. Alien admixtures are likely to be blamed for the fact that the hair from a domestic dog №2 and domestic cat showed a low degree of attractivity. Low attractivity for taiga ticks was demonstrated by *Mus musculus*, *Meriones* sp. and a cow kept on forest pasture. Previously most researchers thought that cows were the chief hosts for adults ticks in foci of tick-born encephalitis, though cows, as a rule, are scarcely infected with ticks. Such a phenomenon is probably due to low attractivity of cows for ticks, and not to the abundance of ticks on pastures. According to our data hares in the Krasnoyarsk region were infected with ticks 10–15 times more, than cows. In all other cases all investigated mammal species revealed good (over 75%) attractivity for taiga female ticks.

For some species the experiment was repeated 1, 1.5 and 2 years later using the same hair samples that were kept in plastic bags under room conditions, and those samples did preserve their attractive properties, though the attractiveness of samples generally decreases with time. An increase in the attractivity for several species, observed a year later, is likely due to either the absence of alien odours on the hair sample under investigation, or the highest degree of aggressiveness on the part of the ticks used in the experiment.

The human odour attractivity test showed that people vary in the range of their attractivity for taiga ticks (Table 2) — from high to complete absence, some even acting as repellents (volunteer №2' waist, volunteer №5's armpit). The most attractive odour for taiga ticks is that given off by the feet, the next in line is head hairline, whereas armpit and waist odours hold the third and fourth position. However, in one3 out of 5 cases (volunteer №3) attractive bodypart odours came in the reverse order. Men and women did not differ as far as attractivity is concerned, perhaps, owing to scarcity of the material tested.

The undertaken research showed that:

1) females *I.persulcatus* are positive in their reaction to odours of hair samples from all of the 20 species of mammals from 6 orders;

2) a human being is also tick attractive, though different individuals vary greatly as far as this feature is concerned;

3) hair samples taken from a wolf, a dog, a boar and next another species revealed their attractive properties to the utmost.

Probably, odours of mammalian hair might be combined with an acaricide to attract and kill ticks.

Table 1.

I.persulcatus females behavior in responce to various mammals' hair presentation

Таблица 1.

Реакции самок *I.persulcatus* в ответ на предъявление образцов шерсти различных млекопитающих

Mammal species	Time of assay								
	1 month			13 month			18-25 month		
	Total number of ticks	Number of active females	% positive reacted females	Total number of ticks	Number of active females	% positive reacted females	Total number of ticks	Number of active females	% positive reacted females
Erinaceus europaeus	108	90	82.2	-	-	-	-	-	-
Canis lupus	92	74	91.7	137	111	83.8	62	52	73.5
C.familiaris №1	99	82	87.8	-	-	-	171	144	72.5
C.familiaris №2	147	119	68.9	-	-	-	-	-	-
C.familiaris №3	199	161	82.8	-	-	-	197	167	86.2
C.familiaris №4	202	163	79.8	-	-	-	-	-	-
C.familiaris №5	78	63	79.4	-	-	-	-	-	-
Chrysocyon brachiurus	88	72	90.3	81	65	92.3	-	-	-
Felis libyca	103	86	73.3	-	-	-	-	-	-
F.manul	66	53	37.7	87	72	66.7	-	-	-
Panthera pardus	75	62	87.1	111	92	77.2	84	70	71.4
Equus caballus	80	65	83.1	70	57	73.7	-	-	-
E.przewalskii	100	82	75.6	-	-	-	-	-	-
Sus scrofa	127	102	88.2	109	92	71.7	318	277	72.6
Bos taurus	100	83	59.0	-	-	-	-	-	-
Ovibos moschatus	96	78	57.7	73	59	79.7	-	-	-
Bison bonasus	75	63	81.0	171	140	73.5	-	-	-
Gasella subgutturosa	109	88	80.7	65	53	67.9	-	-	-
Nemorhaedus goral	84	69	82.6	86	72	87.5	-	-	-
Oryctolagus cuniculus	188	152	76.3	84	69	78.2	-	-	-
Mus musculus	288	233	67.4	-	-	-	-	-	-
Meriones meridianus	101	82	64.6	80	66	78.8	-	-	-
M.unguiculatus	212	184	63.0	140	119	62.2	-	-	-
Microtus gregalis	107	89	87.6	111	99	73.3	-	-	-

Table 2.

I.persulcatus females behavior in responce to human' body parts odour presentation

Таблица 2.

Реакции самок *I.persulcatus* в ответ на запахи различных частей тела человека

№ of volun-teer	sex	body part												mean % positive reacted females
		head			armpit			waist			foot			
		Total number of ticks	Number of active females	% positive reacted females	Total number of ticks	Number of active females	% positive reacted females	Total number of ticks	Number of active females	% positive reacted females	Total number of ticks	Number of active females	% positive reacted females	
1	man	98	82	81.7	102	87	77.0	100	82	48.8	97	80	92.5	75.0
2	man	90	74	71.6	80	65	64.6	61	49	36.7	84	71	78.9	63.0
3	woman	317	283	76.1	76	64	93.8	171	151	86.1	77	63	74.6	82.7
4	woman	198	161	70.2	93	77	66.2	179	151	65.6	91	79	89.9	73.0
5	woman	139	119	53.8	66	55	36.4	201	179	48.6	69	59	71.2	52.5

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