Research Article

THE ETHOLOGY OF BLOOD-SUCKING MIDGE (DIPTERA: CERATOPOGONIDAE) WHILE ATTACKING ANIMALS

A.A. GAVRICHKIN1*, O.A.FIODOROVA1, E.I. SIVKOVA1, A.N. SIBEN1

1All-Russian Scientific Research Institute of Veterinary Entomology and Arachnology – a branch of the Federal State Budgetary Institution of Science of the Federal Research Center of the Tyumen Scientific Center of the Siberian Branch of the Russian Academy, Tyumen, 625041, Russia

Email id : a.gavrichkin@inbox.ru
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ABSTRACT
The purpose of the research was to study the ethological peculiarities of blood-sucking midges (Diptera: Ceratopogonidae) while attacking animals. The midges behaviour while attacking animals and humans was researched using an entomological net with movable bags, sticky transparent tape (0.1x0.9 m), the Monchadsky’s net and observational method. The interval between the accounts was 1 hour. The intensity of the attack or the abundance index (AI) was recorded by the average and maximum indicators. Thus, in the period of massive flights of midgets during the hours of their diurnal activity their massive approach to the animals was recorded. During this period they were using an active searching flight or the first way of attacking their prey. The purposeful approach of midgets to the animals against the wind demonstrates that the leading stimulus to searching a prey is a scent stimulus or the animals’ smell spreading with the wind. Some previous researches demonstrated the possibility of using animal waste substances such as carbon dioxide, lactic acid, octanol etc. to attract midgets and the usage of these substances in traps for insects. We found out the high rate of zoophilic and factorial orientation of midgets while searching for an object for blood-sucking. For example, they almost do not attack humans, but the number of their attacks on animals in herds is from 8 to 10 times bigger than on a solitary animal near herds.

Keywords: midges, searching for prey, seasonal dynamics, diurnal activity, abundance.

INTRODUCTION
Bloodsucking midges (Diptera, Ceratopogonidae) are the smallest bloodsucking dipterous insects and carriers of pathogens of infectious and invasive diseases of humans and animals1-3. The orientation of insects is to regulate the spatial relation of the organism with the external environment. Relation provided by a variety of sensory information coming from the receptors into the central nervous system. According to the literature review on this issue, locomotor reactions are considered as behavioral correlates of orientation. Existing ideas about the functional mechanisms of insect orientation are based on the study of taxes and optomotor reactions, morphophysiological peculiarities of sensory systems, as well as on research of route routes in the natural habitat4. According to the literature, the focus is on the orientation of the horseflies in connection with the development of biologically based complex measures aimed at reducing the number of these bloodsucking Diptera. Despite the fact that the blood-sucking midges (Diptera: Ceratopogonidae) are mass bloodsuckers in a number of regions of Siberia and the Far East, their attack on animals in Russia and in countries far abroad has not been sufficiently studied. Y.S. Balashov5 classifies midges as free bloodsuckers. V.M. Glukhova6 points out the antagonistic nature of the relationships between these insects and their hosts that allows us to consider them parasites. It is known that midges have two ways of attacking a prey. The first one is the active searching flight. The second one is watching attack which is exercised by chasing a prey and crawling onto it. V.M. Glukhova6, 7. The majority of previous researches are based on watching bloodsuckers’ attacks under the conditions of captivity and their artificial feeding on humans10-14. The insects’ orientation consists of regulation of spatial relation of an organism with the environment which is provided by sensory information coming from receptors to the central nervous system. According to academic literature data, much attention is paid to the orientation of clegs. The purpose of the research was to study the ethological peculiarities of blood-sucking midges (Diptera: Ceratopogonidae) while attacking animals.

Material And Methods
The research was done in the suburbs of Malye Velizhany village which is situated in Nizhnetavdinsky district of Tyumen region (at the picture) during 2016-2017. The suburbs are located in southern taiga subzone15. The blood-sucking midges behavior while attacking animals and humans was researched using an entomological net with movable bags16, 17. A net in the form of a cone...
was made from a mill gas with a cell size of 0.2 mm. At the top of the cone, an opening of 5 cm in diameter was left, which was reinforced with two wire rings sewn to the bottom of the cone at a distance of 1 cm from each other. At the base of the cone, a hole 30 cm in diameter was reinforced with a wire hoop equipped with a wooden handle. The depth of the bag was 60 cm, the length of the handle - 40-50 cm. A removable bag with a diameter of 6 cm, length 12 cm, sewn from a kapron fabric, before fixing was fastened between the rings on the top of the net with the help of anelastic band. Previously, a label was placed in each bag. After taking into account, the bag was removed, tied and a glass jar with ether pairs. The glass jar was a capacity of 0.75 liters and had on the bottom a layer of pieces of rubber impregnated with ether, chloroform or a mixture thereof. Above, the rubber was covered with a cardboard circle that separated it from the insect chamber and served to absorb excess moisture. The jar was tightly closed with a screw cap at the top, placed in a white coarse sack, sewn according to its volume. At the time of registration, the researcher hangs this jar on himself. In addition, we used sticky transparent polyethylene tape (0.1х0.9 m), as well as visual observation. The Monchadskybell was sewn from white coarse calico in the form of a cylinder with a diameter of 160 and a height of 150 cm, topped with a cone of 40 cm in height. Below and above, the cylinder was strengthened by hoops from thick steel wire. The bell was hung on a tree branch in such a way that the lower edge was 0.5 m above the sitting observer. After a 5-minute exposure, the bell was lowered and, on the inside, the blood-sucking midges were collected by the exhauster. The collected insects for storage were laid out on cotton mattresses or placed in 70% alcohol for storage and subsequent determination. Species of adults were determined with the help of binocular microscopes MBS-9 and MSP-1, and determinants A.V. Gutsevich, V.M. Glukhovoy, A.G. Mirzaeva. The catch of adult midges was carried out in the morning hours from 4 to 7 and evening hours from 20 to 24. Sticky tape sized 0.1х0.9 m, as well as visual observation. The interval between the accounts was 1 hour. The counting of midgets from the downwind side that were around us showed that in a distance of 25 metres the average number of midgets was about 254±28 species, in a distance of 50 metres - 115±31 species and in a distance of 100 metres - 53±29 species respectively. Whereas we could not catch any midgets from a windward side on a person with a net standing at the same distance from the calves. The culling of midgets on a person next to the corral from different sides and during the evening and morning peaks of midgets’ attacks showed that from the windward side only single midgets were caught compared to 616 species that were caught from the downwind side. Our examination of the sticky tapes that were put up in the calves corral from different sides to record how many midgets fly into and out of the corral showed that the midgets’ approach was massive. From the windward side, we found out 12±1,8 species that were caught on a tape sized 0,1х0,9 metres and from the downwind side - 514±59 species respectively. Thus, in the period of massive flights of midgets during the hours of their diurnal activity, their massive approach to the animals was recorded. During this period they were using an active searching flight or the first way of attacking their prey. The purposeful approach of midgets to the animals against the wind.
demonstrates that the leading stimulus to searching a prey is a scent stimulus or the animals’ smell spreading with the wind. Some previous researches demonstrated the possibility of using animal waste substances such as carbon dioxide, lactic acid, octanol etc. to attract midgets and the usage of these substances in traps for insects. The peculiarities of midgets’ behaviour while searching for a prey and attacking it and their high concentration among animals that were studied in our research give us to rise to confirm the relevance of using insecticides with a strong effect against midgets in the period of their diurnal activity through hinged fogging, spraying and insecticide smoking. When keeping animals in corrals the peak of midgets’ diurnal activity coincides with the period of rest of animals in corrals, so it simplifies using the insecticides. Moreover, during the evening, night and morning hours with the absence of vertical airflows smoke and sprays spread evenly and horizontally in the direction of the wind. The massive approach of midgets to a herd can be used as a way of fighting against them through arranging adhesive shields and other devices around a corral directed at midgets flying into it. Studying the spread of midgets in the corral next to a group of animals was undertaken with the use of nets and transparent sticky tapes that were attached to the bars at different heights. The bars were attached to a 3,5 metres high pole. We revealed that in the territory of the corral midgets were concentrated directly next to the animals. The catching of midgets with the net and transparent sticky tapes showed that in 5 metres distance from the animals, the concentration of midgets greatly reduced, so in 10-15 metres distance, we found only single ones. The majority of midgets were flying at the level of animals’ height. Thus, from 700 midgets that were stuck on the tapes after the four repetitions of the same experiment 479 species were at a height of 1,5 metres, 117 species were at a height from 1,5 to 2,8 metres and 44 species were at a height from 2,8 to 3,4 metres above the ground. (68,4%, 25,3% and 6,3% respectively). The comparative counting of midgets in the corral on animals with the net and on a solitary calf in 10-20 metres distance from the herd also showed the great difference in midgets’ abundance. The abundance index in the herd was ten times higher than the abundance index on the solitary animal. Thus, on the 25-26th of July 2016 from 10 pm to 5 am 237 species of midgets were caught in the herd comparing to 8 species that were caught on a solitary calf which is 30 times less. Even in the period of their high concentration, on the 7th of June 2016 at 6 am when we caught 2020 species with the net in the herd which was 15 times higher than 132 species that were caught on a solitary animal. This was probably the reason for some animals to separate from the herd in a distance and have a rest there. But it was possible only with the absence of mosquitos which attack a solitary animal in bigger numbers than animals in a herd. It was pointed out in our study and by Konstantinov in 1990. Further watching the midgets’ behaviour and their counting with the sticky tapes showed that the hungry or full of blood midgets did not fly out of the corral massively during the peak of their diurnal activity and after its decline or after the calves were taken to a pasture. After the thorough examination of the corral with single trees and no grass, it was revealed that the full of blood midgets hid in great numbers in different covers like soil litter especially from the downwind and sunlit surface roughness and also inside of loose and dry dung and soil substrate. Moreover, single midgets were noticed on the tree trunks and on the fence. It gave us to rise to assume that midgets that flew into the corral but did not suck animals’ blood did not leave the corral. They probably stayed on its territory. We observed the confirming situation in conditions of cloud after the rain in the afternoon when the massive attack of midgets on cows in the corral was recorded. Midgets were flying around the animals or crawling onto them which was clearly seen on the lying animals with a black colouring. This way of midgets’ attacks was classified by V.M. Glukhova as a stalking type. We classified an active chasing (accompanying) of moving animals by a midgets’ swarm which we repeatedly observed while cattle was coming back from the pasture as the same type of attacks. While attacking cattle midgets sat mostly on the parts of animals’ bodies with shorter fur such as heads, necks, chests, bellies and limbs. In conditions of the high midgets’ abundance they were massively crawling on cattle’s sides, backbones and the other body parts. They also were flying around the animals at the level of their height, so it seemed like the animals were in the cloud of midgets. Midgets attacking animals did not get full of blood immediately. This became clear by the fact that special devices attached to a calf and covered with plastic wraps with an adhesive layer that were designed to midgets flying out of animals’ fur contained a small number of midgets full of blood (about 15%). It followed that midgets do not always start sucking blood as soon as they sit on an animal. According to V.I. Bukhtyrynov18 the period of time midgets crawl on animals’ fur is from 10 seconds to 10 minutes. The bloodsucking usually lasts from 1 to 5 minutes. However, S.M. Jafarov28 and V.A.Isaev24 pointed out that the full portion of blood midgets get in 10 minutes. V.M. Glukhova25 believed that the process of blood-sucking lasts from 3 to 6 minutes on average. A long and repeated contact between midgets and animals while searching a place for blood-sucking and a stalking type of attack in crawling and chasing forms give us rise to assume the relevance of reduction the insects in the period of their massive flights through systematic treats of animals’ fur with long-acting insecticides with a residual effect during any time of a day while
spraying animals against blood-sucking midgets and zoophily flies before taking them to a pasture. Searching for female midgets full of blood showed that after sucking blood they do not fly out of the corral immediately. The big amount of them was found in the morning on the birch tree trunks in the corral at the height if 2.5 metres above the ground. Our counting them with a transparent sticky tape encircling trees in different height with adhesive layer directed to a trunk showed that there were 13 ± 1.7 female species full of bright red blood by square decimeter. In that regard, it is probably relevant to use long-acting insecticides with a residual effect for spraying tree trunks, poles and fences which are the places of rest for insects to reduce midgets in the territory of a corral.

Discussion

When studying the behavior of slimy in attacking cattle, the established by V.M. Glukhova8-10,2 types of the reaction of these insects: in the form of search flight and an oncoming attack. The observed high degree of zoophilia of Culicoidesmdigvmi insects in pastures and cattle farms established by us determines trophic connections of the dominant C.punctatus and subdominant C. grisescens and C. fascipennis species. The last two species prefer feeding on large animals according to the data of other researchers8, 12, 26-28. In relation to C.punctatus there is evidence that females of this species are equally attacking both humans and animals29, 30. Forof C.punctatuszoophilia in the south of the Tyumen region can apparently be explained by the influence of the anthropogenic factor, since the studies were carried out on farms and pastures of cattle in the conditions of developed cattle breeding. With the objects of bloodsucking, it is obvious that the leading one of the midges is the olfactory orientation, unlike the flies, mosquitoes and midges, which are more visually oriented. We noted that only the midgets purposefully fly onto the herd of animals from the leeward side. In a large number of concentrated slugs in the herd directly near the animals, with the bulk of them kept at a height of 1.5 m. When attacking animals, they longly circle around them or crawl on the surface and under the cover of the hairline. Only 15% of the female Culicoidesmdigvmi insects on the animal are sucked up by blood, indicating multiple contacts with the hair covering when searching for a bloodsucking place. The high degree of zoophilia of the Culicoidesmdigvmi, expressed by the purposeful approach to the flock for the smell of animals on the leeward side and the mass accumulation near the animals, the nature of parasitization, active flying and attack in the premises, indicate the expediency of using high-speed contact insecticides against them, through systematic treatments of the protected animals.

Conclusion

We found out the high rate of zoophilia and factorial orientation of midgets while searching for the object for blood-sucking. For example, they almost do not attack humans, but the number of their attacks on animals in herds is from 8 to 10 times bigger than on a solitary animal near herds. The midgets’ approach to animals usually occurs from the downwind side. The majority of midgets fly at the level of animals’ height. The female midgets full of blood do not fly out of a corral after the decline of their activity. They hide near animals and then stalk animals and crawl onto them or chase and attack them.

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