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HOST DETECTION, HOURLY ACTIVITY, AND THE PREFERRED BITING SITES OF CULICOIDES IMICOLA (DIPTERA, CERATOPOGONIDAE) ON A CALF IN ISRAEL

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I. SUMMARY

Collections from a bait calf yielded 522 Culicoides spp.; 520 of them were C. imicola. The backside, in particular the black hair patches, were preferred for landing and biting, and 95% of the C. imicola were collected from this site, versus 5% aspirated from the lateral sides of the body. Out of six location sites, at only one site were C. imicola collected in large numbers. That is because C. imicola detect their hosts by odor and visually.

The landing and biting activity of C. imicola is limited to the twilight time, i.e. half an hour before and half an hour after sunset and sunrise. The largest peak of activity is at sunrise.

A constant ratio between parous and nulliparous C. imicola females was found in the three time lots at sunset, but a different constant ratio was found between the time lots at sunrise. C. imicola constituted 98.5% of the Culicoides spp. collected in suction light traps during 38 nights. Most C. imicola were nulliparous and parous females at a constant ratio of 2:1 throughout the night hours. The numbers of C. imicola peaked during the autumn. The flight activity of C. imicola in July/August peaked between 3:00 am to 5:00 am. The peak hours varied from month to month according to the changes in night length, temperature, and relative humidity. During daytime operations of the suction light trap, only single numbers of Culicoides spp. were trapped. Of all the meteorological parameters tested, the only correlation was found with temperature. Numbers of C. imicola increased between temperatures of 17 to 25C.

II. INTRODUCTION

The hourly activity of light-attracted populations of C. imicola was found in South Africa to be between 1:00 am to 3:00 am.[1] This determination was not made throughout the year and no distinction was made in this study between the

nulliparous and parous members of the population. Studies were carried out in various places in the world to identify the Culicoides spp. biting various parts of the body of cattle. C. brevitarsis, which is considered a close relative of C. imicola, prefers to bite the back side of cattle.[2] It was, therefore, reasonable to assume that C. imicola would have the same preference. The preferred time of biting activity of medically important Culicoides spp. is reportedly at twilight time.

It was found in AL, USA[3] that Culicoides spp. prefer the environmental conditions of open fields for biting. Preferred meteorological conditions for biting are: calm air or slight wind, high relative humidity, and temperatures around 20C.[2] This study was undertaken to identify the Culicoides spp. biting cattle, the parts of the body preferred by them, and their diel landing and biting activity as compared to the diel activity of the species population attracted to suction light traps. A principal goal was to find the influence of the site location of the bait animal on the number of Culicoides collected. Other objectives were to find the influence of temperature, relative humidity, wind velocity, wind direction, and cloud cover on the numbers of Culicoides spp. collected from a calf and/or attracted to suction light traps.

III. RESULTS AND DISCUSSION

A. THE ASSOCIATION BETWEEN HOST SITE AND NUMBERS OF CULICOIDES SPP. COLLECTED

Table 1 shows the numbers of Culicoides spp. collected at the various sites. Fifty-two collections at 6 sites located in a 360° circle were made. Of these sites, only site number V was positive and yielded 98% of the Culicoides spp. This site was situated in an open area that could be seen from all angles. Site preference findings are supported by past suction light trappings at three sites of the animal compound, where significant differences in numbers of Culicoides were detected.

In the present study, suction light trap caught Culicoides spp. at site #V at the same time that no or single Culicoides spp. were collected from the five negative sites. This fact indicates the existence of factors that prevent Culicoides spp. from detecting the host. The known host attractive parameters are: temperature, humidity, odor, and sight of the host. It is assumed that the host's temperature was similar at all collections as they were done in the same hour and most collections were done from the same calf. At site #IV where the calf was put inside a citrus grove, few Culicoides spp. were caught, probably because the host was hidden from the Culicoides spp. This finding is in accord with the study in AL, USA.[3]

TABLE 2
Physiologic Age Composition of C. imicola Collected from the Back and Lateral Sides of a Calf

Collection zone	# of nulliparous	# of engorged nulliparous	# of parous	# of engorged parous	Total	%
Back	296	29	145	27	497	95
Side	16	1	7	1	25	5
Total	312	30	152	28	522	100

C. THE DIEL BITING CYCLE OF C. IMICOLA

The fact that the biting of many Culicoides spp. occurs mainly at crepuscular times is well-known.[5] Little information has been published on the biting habits of C. imicola. According to a recent publication, a peak biting time is sunset, but sunrise was not checked.[4] The present study shows a greater peak in sunrise than in sunset biting (Table 3).

TABLE 3
Numbers of C. imicola Collected at Sunset Versus at Sunrise

Date Collected	Sunset		Sunrise	
	Collecting hours	# of midges	Collecting hours	# of midges
7/19-20	19:20-20:50	0	5:30-7:00	12
8/5-6	19:15-20:45	4	5:15-6:45	18
8/12-13	19:00-20:30	6	5:30-7:00	28
8/26-27	18:45-20:15	0	5:15-6:45	29
10/1-2	17:00-18:30	3	5:00-6:30	10
10/20-21	16:10-17:40	19	5:30-7:00	28
Total		32		125

D. THE RELATIONSHIP BETWEEN LIGHT INTENSITY AND C. IMICOLA ACTIVITY

Chi square (X^2) tests for sunrise and sunset feedings showed no significant relationship between the four parity states of female C. imicola (nulliparous, engorged nulliparous, parous, and engorged parous) and the time bands of 30 min. It means that the proportions between these parity categories is independent of the time of collection. Chi square (X^2) tests showed that the proportions of C. imicola

From the above findings, it could be concluded that the determining factor for host detection is visual. The fact that houses and trees disturb the navigation of Culicoides spp. to their hosts, can explain the seemingly random transmission of BLU viruses in which one farm is infected while a nearby farm is not. It can be concluded that the local sighting of the animal house with regard to visibility of animals to Culicoides spp., influences the extent of virus transmission by the midges.

TABLE 1
Collection of Culicoides spp. from a Calf in Various Sites of an Animal Compound at Bet Dagan

Site of calf	Date	# of Positive collections/total # of collections	# of Culicoides spp. collected
I	10/16-20/86	0/2	0
II	10/22-31/86	0/4	0
III	6/20-7/10/87	1/4	2
IV	4/23-6/11/87	1/5	3
V	7/19-11/21-87	30/34	513
VI	10/6-15/87	3/3	6
Total	10/16/86-11/21/87	35/52	524

B. THE PREFERRED BODY ZONE ON THE CALF FOR LANDING AND BITING BY C. IMICOLA

Of the total number of Culicoides spp. aspirated from a calf, 522 were C. imicola, 1 was C. newsteadi, and 1 was C. schultzei gp. It was found that C. imicola prefer to land and most probably to bite the back side (95%), especially in the dark-haired areas, and avoid the white-haired areas. Only 5% were collected at the lateral sides. The fact that C. imicola always preferred to land on the dark-haired areas of the body indicates that even at twilight and in darkness, the midges can distinguish between different light or temperature intensities. Similarly, C. imicola constituted 98.5% of the Culicoides spp. populations caught by suction light traps.

At both collection areas, most of the females captured were nulliparous. Eleven % of the females collected from both areas were engorged (Table 2). Landing preference of C. imicola on the back side was previously reported in a horse.[4] This finding strengthens the assumption that C. imicola is a sibling species of the Australian C. brevitarsis which also prefers to bite the dark areas along the back side of the cow.[2]

females collected in each of the three 30 min. time band at sunset and sunrise differs from 1:1:1 ($p<0.01$).

Checking the numbers of C. imicola caught in each 30 min time band shows that the numbers are growing towards sunrise or sunset. This confirms the fact that the biting activity is associated with changes in light intensity. That is why at sunrise in the third 30 min time band, there is a sharp drop in the numbers of midges collected, because at that time it is already full daylight. The similarity in the numbers of C. imicola collected at the first and third 30 min. time bands at sunset is probably related to too much light in the first 30 min. time band, and too little light in the third 30 min. time band. During the second 30 min. time band, when the highest changes in light intensity occur, the largest numbers of C. imicola were collected.

E. HOURLY FLIGHT ACTIVITY OF C. IMICOLA AS MEASURED BY SUCTION LIGHT TRAPS

In April to June the peak of activity was between 2:30 am to 4:30 am, in July-August, between 3:00 am to 5:00 am, in October, between 1:30 am to 3:30 am similar to the findings in South Africa,[1] and in November, between 12:30 am to 2:30 am. It can be assumed that temperature and relative humidity (%) are the major factors which determine the peak flight activity of the Culicoides spp. During the hottest months i.e. July-August, the air temperature drops to its optimum only between 3:00 am to 5:00 am and, at that time, the relative humidity is at its highest level.

F. ASSOCIATION BETWEEN METEOROLOGICAL FACTORS AND CULICOIDES SPP. ACTIVITY

Comparing the meteorological data to the numbers of collected midges showed a significant ($P<0.008$) association only with the daily maximum temperature. The peak activity occurred when temperatures were between 20 to 24C.

Despite the fact that relative humidity, wind velocity and direction, and cloud cover are known to exert an influence on Culicoides spp. activity, no such influence was detected in this study. This is probably because the meteorological data were not taken from the sites of collection nor at the exact time of collections and trappings.

IV. CONCLUSIONS

As the time of biting activity is short and limited only to sunrise and sunset, and as C. imicola bites distinctly on the back side of the animal, it can be controlled rather simply. This could minimize the risk of contracting BLU or any other Culicoides-borne pathogen. Clock-operated foggers

can be installed to spray repellent only at the times of biting activity.

An alternative method could be walk-through back-dusters or smears of repellent. Such control methods could be practical for insemination or embryo transplantation centers and farms exporting calves or lambs for breeding.

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