SEASONAL VARIATIONS IN THE BITING DENSITIES OF *Simulium damnosum* COMPLEX (DIPTERA: SIMULIIDAE) IN ENUGU STATE, NIGERIA: IMPLICATIONS FOR FARMERS

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ABSTRACT

Seasonal variations in the biting densities of *Simulium damnosum* complex were studied in Uzo-Uwani Local Government Area of Enugu State, Nigeria, with the objectives of discovering the season with the highest biting densities and relating the seasonal biting densities with the farming seasons of the people. The study was carried out in different seasons of the year between April, 1999 and March, 2000. Two human baits were used to catch biting flies between 6.00a.m. and 7.00p.m. on each fly-catching day. The average numbers of flies caught per man per hour and per man per day were recorded. The results showed variations between the different seasons studied. The highest average biting densities of 30 flies/man/day were recorded during the dry season with harmattan but biting activities of the flies were concentrated in the evenings. The second highest average biting densities of about 25 flies/man/day were recorded during the early rainy season and biting activities were spread throughout the day with morning and evening peaks. Low average biting densities of about 4 flies/man/day and about 11 flies/man/day were recorded during the dry season without harmattan and late rainy season respectively. The probability of finding biting flies at any given hour was highest (0.91) during the early rainy season. This very high probability of man-fly contact coupled with the most intense farming activities (clearing and cultivation) within this season makes it very dangerous to farmers. It is recommended that the farmers take such precautions as covering themselves better and using repellents to prevent man-fly contact during farm work.

Keywords: Seasonal variations, biting densities, *Simulium damnosum*, onchocerciasis

INTRODUCTION

Dipterous insects of the family, Simuliidae transmit the parasite, *Onchocerca volvulus*, which is the cause of human onchocerciasis commonly called ‘river blindness’. In West Africa, transmission is by members of the *Simulium damnosum* (Theobald) species complex (Boakye, 1999). *Simulium damnosum* is made up of a complex of sibling species described on the basis of cytotaxonomic identification which depends on variations of the larval polytene chromosomes (Vajime and Dunbar, 1975). The members of the *S. damnosum* complex can be classified into savanna and forest species according to their relative abundance in the respective climatic zones of West Africa and this largely depends on their preferred habitats (Boakye, 1999). Changes in the distribution patterns of blackflies occur annually in association with the pronounced seasonal climatic variations manifested in West Africa by the dry and wet seasons. The seasonal change is accompanied by shifts in wind direction and by the drying out or flooding of rivers which provide the *S. damnosum* breeding sites (Boakye et al., 1998). During the main rainy season, prevailing monsoon winds blow from the Southwest to the Northeast and there is heavy precipitation. Enhanced flow in the river results in many more potential breeding sites. The opposite happens during the dry season. Other factors influencing species distribution include the hydro-chemical and physical characteristics of rivers (Grunewald, 1981) and human activity leading to change in the fly’s habitat e.g. deforestation (Boakye, 1999).

Biting activity can be highly seasonal in tropical regions with prolonged dry season, which eliminates or at least severely reduces the available breeding habitats. In West Africa, biting activity of *S. damnosum* complex ceases for several months in the long dry season of the northern savannas when rivers stop flowing, or are reduced to trickles and resumes only when rivers run again in the rains. On the other hand, where the climate is almost uniform throughout the year and rivers run perennially, biting activity occurs year-round in association with continuous breeding (though not necessarily at the same intensity) (Crosskey, 1990). In a study by Renz (1987) in north Cameroon, the variation of the biting rates over the year depended on the water-flow of the main rivers and on the differential dispersal of the flies from the breeding sites during the dry and rainy seasons.

Severe human onchocerciasis, which ends in blindness results from continuous exposure of individuals to the bites of *S. damnosum* vector flies (Renz, 1987). To interrupt the transmission of this seriously disabling disease in an area, there is need to break or at least reduce man-fly contact. To be able to do this, one needs to know the seasonal biting activity pattern of these flies and relate this to the seasonal farming activity pattern of the people of the area. The present study was designed to compare the biting densities of *Simulium* flies in different seasons of the year in the study area, relate the seasonal biting densities with farming seasons of the year, and make recommendations on how best to reduce man-fly contact.

MATERIALS AND METHODS

The Study Area: The study area was Nkpologu in Uzo-Uwani Local Government Area (L.G.A.) of Enugu State, which belongs to the savanna-mosaic-vegetation zone of Nigeria (Crosskey, 1981). This community is traversed by River Adada, a perennially flowing river belonging to the
Anambra River system identified by Crosskey (1981) as one of the breeding sites for *S. damnosum* complex vector of onchocerciasis. Nkpologu was also found to be endemic for onchocerciasis (Ubachukwu, 2001). The 16 communities in Uzo-Uwani Local Government Area have farming as their major economic activity and the area is a major source of food supply in Enugu State.

**Fly Collection:** A farmland about 500 metres from River Adada at Nkpologu was selected as fly catching site. Fly collection was carried out for 28 days within different seasons of the year between April, 1999 and March 2000. The seasons covered included early rainy season (April-May, 1999), late rainy season (September-October, 1999) and dry season (November, 1999-March, 2000). Within the dry season, the harmattan season was studied as a separate sub-season. Human baits (people purposely stationed to attract blackflies) were used for fly collections. On each fly catching day, two human baits sat at the fly catching locations exposing their lower legs (WHO, 1966). Blackflies that landed on the baits for bloodmeal were killed, collected and stored in specimen bottles containing 10% formol saline for preservation. Fly catching took place from 6.00 a.m. to 7.00 p.m. on each fly-catching day, and for 30 minutes every hour. The number of flies caught per man per hour was recorded. At the end of the day, the average number of flies per man per day (i.e. the total number of flies collected by the two human baits divided by two) and the average number of flies per man per hour (i.e. the average number of flies per man per day divided by 13 hours) were calculated.

**RESULTS**

The seasonal variations in the biting densities of *S. damnosum* species complex in Uzo-Uwani L. G. A. of Enugu State, Nigeria together with the temperature variations during the different seasons are shown in Figure 1 and Table 1 respectively.

**Table 1: Average Temperature Readings for Different Seasons of the Study Year (°C)**

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Early Rainy Season</th>
<th>Late Rainy Season</th>
<th>Dry season without Harmattan</th>
<th>Dry season with Harmattan</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00 – 7.00 a.m.</td>
<td>23.2</td>
<td>21.7</td>
<td>21.5</td>
<td>19.0</td>
</tr>
<tr>
<td>7.00 – 8.00 a.m.</td>
<td>24.4</td>
<td>22.7</td>
<td>22.4</td>
<td>20.5</td>
</tr>
<tr>
<td>8.00 – 9.00 a.m.</td>
<td>25.3</td>
<td>23.3</td>
<td>24.2</td>
<td>23.6</td>
</tr>
<tr>
<td>9.00 – 10.00 a.m.</td>
<td>27.2</td>
<td>24.7</td>
<td>28.4</td>
<td>26.6</td>
</tr>
<tr>
<td>10.00 – 1.00 a.m.</td>
<td>29.5</td>
<td>27.6</td>
<td>32.3</td>
<td>28.9</td>
</tr>
<tr>
<td>11.00 – 12.00 noon</td>
<td>30.2</td>
<td>28.8</td>
<td>34.4</td>
<td>30.3</td>
</tr>
<tr>
<td>12.00 – 1.00 p.m.</td>
<td>31.3</td>
<td>29.6</td>
<td>35.3</td>
<td>31.6</td>
</tr>
<tr>
<td>1.00 – 2.00 p.m.</td>
<td>32.2</td>
<td>30.6</td>
<td>35.8</td>
<td>31.7</td>
</tr>
<tr>
<td>2.00 – 3.00 p.m.</td>
<td>32.2</td>
<td>29.6</td>
<td>36.0</td>
<td>31.9</td>
</tr>
<tr>
<td>3.00 – 4.00 p.m.</td>
<td>31.3</td>
<td>28.4</td>
<td>35.7</td>
<td>31.6</td>
</tr>
<tr>
<td>4.00 – 5.00 p.m.</td>
<td>30.4</td>
<td>26.5</td>
<td>34.9</td>
<td>30.4</td>
</tr>
<tr>
<td>5.00 – 6.00 p.m.</td>
<td>29.4</td>
<td>25.3</td>
<td>33.0</td>
<td>28.0</td>
</tr>
<tr>
<td>6.00 – 7.00 p.m.</td>
<td>27.1</td>
<td>23.5</td>
<td>31.3</td>
<td>26.4</td>
</tr>
</tbody>
</table>

**Early Rainy Season:** During the early rainy season, the blackflies were observed to bite from dawn to dusk. The biting pattern was clearly bimodal with a low morning peak of about 2 flies/man/hour between 10.00 and 11.00a.m. and a higher evening peak of about 4 flies/man/hour between 5.00 and 6.00p.m. The evening peak was found to exceed the morning peak by a factor of about 2 (Figure 1). The average number of flies/man/day was about 26 (range 12 - 64), while the average number of flies/man/hour was about 2 (range 0-12). The probability of catching biting blackflies at any given hour (number of hours flies were caught divided by the number of hours sampled) was found to be 0.91 (76/84).

**Late Rainy Season:** During the late rainy season, the biting densities were generally lower than during the early rainy season (Figure 1). The season was marked by sudden fluctuations in climatic factors, rainstorms often threatening with sudden decrease in temperature. The average number of flies/man/day was about 11 (range 5-17), while the average number of flies/man/hour was about 1 (range 0-6). The probability of catching biting flies at any given hour was found to be 0.60 (42/70).

**Dry Season (without harmattan):** During the dry season, the weather was generally sunny, hot and dry. The highest temperature of 38°C was recorded within this period (Table 1) and the lowest fly densities were also recorded within this season (Figure 1). The average number of flies/man/day was about 4 (range 0-8), while the average number of flies/man/hour was less than 1 (range 0-4). The probability of catching biting flies at any given hour was 0.21 (19/84).

**Dry Season (with harmattan):** The harmattan season was marked by cold mornings with temperatures that were as low as 15°C on some days; sunny, dry, windy and hot afternoons and warm evenings. The biting pattern was clearly bimodal with a low morning peak of about 1.5 flies/man/hour between 9.00 and 10.00a.m. and a much higher evening peak of about 11 flies/man/hour between 5.00 and 6.00p.m. The evening peak was found to be higher than the morning peak by a factor of about 7 (Figure 1). The average daily fly densities were found to be highest within the harmattan season but concentrated mostly in the evenings. The average number of flies/man/day was 30 (range 11-53), while the average number of flies/man/hour was < 3 (range 0-25). The probability of catching biting flies at any given hour was 0.61 (63/103).

**DISCUSSION**

As mentioned earlier, Crosskey (1990) reported that biting activity can be highly seasonal in tropical regions with prolonged dry season which eliminates, or at least severely reduces, the available breeding habitats. According to him, in West Africa, biting activity of *S. damnosum* complex ceases for several months in the long dry season of the northern savannas when rivers stop flowing or are reduced to trickles, resuming only when the rivers run again in the rains. On the contrary, where the climate is almost uniform throughout the year and the rivers run perennially, biting activity occurs year-round in association with continuous breeding (though not necessarily always at the same intensity). In Uzo-Uwani L. G. A., the rivers run perennially and continuous breeding can be assumed. Biting activity was observed throughout the year but the biting densities varied with seasons, with the dry season (without harmattan) having the lowest densities and the rainy season having higher densities. It was, however, observed that the highest fly densities were recorded during the harmattan season.
The recording of higher fly densities during the rainy season than during the dry season (without harmattan) can be attributed to the provision of better breeding sites for the blackflies as a result of increase in water levels and attachment objects that usually occur during the rains (Crosskey 1990). However, the reason for the observation of the highest fly densities during the harmattan season may lie in the addition to local flies of migrating savanna flies carried down into the area with the help of the north-south harmattan winds blowing from the Sahara to the coasts (Boakye, 1999). Uzo-Uwani L. G. A. is in the forest-savanna-mosaic zone and so should have species of blackflies that are short-range migrants (Crosskey, 1990). Forest-savanna-mosaic vegetation can be likened to severely deforested sites, which are usually invaded during the dry season by migrating savanna flies (Boakye, 1999). Possible addition of these migrating flies to the local flies during the harmattan season would most likely be responsible for swelling the biting populations of the blackflies within this season.

Crosskey (1990) reported that in Simulium damnosum complex, the peak biting rates occur in the wet season and are rarely sustained at more than about 3-60 flies/man/hour (FMH) in savanna regions and 200 FMH in forested regions. In some Central American species e.g. Simulium ochraceum, the biting rates lie between 100-1000 FMH and with the heaviest biting in the drier part of the year. In Uzo-Uwani L. G. A., the peak and average biting rates were highest (25 FMH and < 3 FMH respectively) during the harmattan season and lowest (4 FMH and <1 FMH respectively) during the dry season without harmattan. During the early rainy season the peak biting rate was 12 FMH while the average biting rate was about 2 FMH. On the other hand, during the late rains, they were 6 FMH and about 1 FMH respectively. It is, however, noteworthy that the probability of man-fly contact at any given hour of the day was highest during the early rainy season (0.9) and lowest during the dry season without harmattan (0.2), while for the late rainy season and harmattan, the probability was approximately 0.6 in each case. This implies that although the harmattan season has the highest FMH, the early rainy season appears more dangerous in terms of possible onchocerciasis transmission. This is because biting activities occur almost all the hours of the day leading to the higher probability of man-fly contact. During the harmattan season, on the other hand, biting activities are concentrated within the evening period. The observation that the highest probability of man-fly contact at any given hour of day was recorded during the early rainy season has serious implications. This is because this season happens to be the season when the most intense farming activities (clearing and cultivation) occur and when greater numbers of people work in the farms. The implication of this observation is that there is continuous man-fly contact and the highest probability of transmission of onchocerciasis within the early rainy season.

Conclusion: In this study, an attempt was made to measure the seasonal variations in the biting densities of Simulium flies, which serve as vector of onchocerciasis (river blindness). It was found that the highest fly densities were recorded during the harmattan season but the flies were concentrated in the evenings. However, the highest probability of man-fly contact (0.9) was recorded during the early rainy season and this season happens to be the season with the most intense farming activities (clearing and cultivation). To break man-fly contact and hence possible transmission of onchocerciasis in this agriculturally important area, there is need for health extension and enlightenment campaigns on the disease (onchocerciasis), its effects, its vector, the biting activity patterns of the vector and how the farmers can protect themselves against the bites of the Simulium vector. They can protect themselves by either wearing their clothes while farming or by the use of repellents (e.g. off). They should also be encouraged to take the choice drug Mectizan, which is freely distributed in the area under the African Programme for Onchocerciasis (APOC) of the World Health Organization (WHO) against the disease.

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REFERENCES


