VECTOR COMPETENCE AND TRANSMISSION RATES OF ONCHOCERCIASIS IN AKWANGA AND KEFFI LOCAL GOVERNMENT AREAS OF NASARAWA STATE NIGERIA

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Abstract: A vectorial study was conducted at Akwanga and Keffi Local Government Areas of Nasarawa State to assess the vector competence and transmission rates of onchocerciasis. Monthly blackfly catching was carried out over a period of 12 months from January to December, 2011. A total number of 1,108 blackflies were caught for the period of study at the study sites. Akwanga LGA recorded 1025 blackflies while Keffi LGA recorded 83. The blackflies caught were identified as forest and savannah types based on their morphological profile. Dissections of blackflies were carried out to determine parous rate; infection and infectivity rates. The result indicated a seasonal (wet season) biting activity with a peak in the month of September at both LGAs. The blackflies identified were predominantly the savannah species. Parous flies caught at Akwanga LGA were 382(39.0%) were parous flies for Akwanga LGA while 25 (32.5%) parous flies were recorded at Keffi LGA. At Akwanga LGA 234 were infected with *Onchocerca volvulus* L_3 larvae, while Keffi LGA recorded 04(5.2%) L_3 larvae. The maximum monthly biting rate (MBR) and monthly transmission potential (MTP) for Akwanga LGA recorded 2685* in the month of September and 420.3, respectively. Annual biting rate (ABR) and annual biting potential (ATP) for Akwanga LGA were 7845 and 1210, while Keffi LGA recorded 247.5 and 34, respectively. Maximum monthly biting rate (MBR) in month of september and 16.8 for monthly transmission potential (MTP). The annual biting rate (ABR) and annual transmission potential (ATP) for Keffi LGA were 663 and 34, respectively. L_3/1000 parous flies for Akwanga LGA and Keffi LGA recorded 3390 and 522, respectively. The results were statistically analysed using one- way analysis of variance (ANOVA). Transmission rates were significantly differed in relation to study areas ($p<0.05$). The findings recorded low onchocerciasis transmission in Akwanga LGA and no transmission in Keffi LGA in the current study.

Keywords: Akwanga LGA, Keffi LGA, vector competence, predominantly savannah, Ochocerciasis

Introduction

Simulium damnosum species and Onchocerciasis have been known in Nigeria for over 100 years (Parsons, 1909; WHO, 1995). The disease is an occupational disease of rural farmers animal rearer, fishermen, hunters, wild fruits collectors as well as field scientist, peace corps volunteers whose daily work expose them to constant bite of blackflies (Crosskey, 1956; Otubanjo and Mafe, 2002; Kenneth *et al*., 2005). Several other reseachers have reported on the epidemiology of the disease in Nigeria (Nwokolo, 1950: Budden 1956; Gemade, 1998, Hopkins *et al.,* 2002). Miri (1998) reported the pioneering mectizan distribution project in Nigeria thereby leading to effective control of the disease today.

The aim of the study was to evaluate the relative abundance and transmission rates of blackflies at Akwanga and keffi LGAs of Nasarawa State.

Materials and Methods

Adult blackflies were caught using human bait at study areas, Akwanga and Keffi LGA in year 2011. Each location was sample monthly between 7am-6pm (Walsh *et al.,* 1978). The adult blackflies were identified morphologically using standardized key manual, by using features of hair crest, colours of wing turfts, scutellum, scutum, fore tarsus and antennae (Crosskey, 1973, Wilson *et al.,* 1993). Blackflies were dissected to determine parous and nulliparous as well as infection of flies. Flies were recorded as nulliparous when there was no indication of blood meal taken resulting to tightly coiled trachea system and absent of follicular relics hence no parasites present (Porter and Collins, 1988).While, Parous flies were engorged with indicated loosely stretched trachea system (Mokry, 1980). The head, thorax, and abdomen were cut with dissecting needle and the larvae where present was seen moving (Service, 1980). The number of sausage form larvae (L1), pre-infective (L2) and infective (L3) of *Onchocercavolvulus* found in the abdomen, thorax and head respectively were counted and recorded. The calculation of biting rates and transmission potential were calculated by standard methods of Walsh *et al.* (1978). The steps for standard calculations as follows:

(i) No (%) of parous flies = $\frac{No.\ of\ \ parous\ flies}{No.\ of\ \ parous\ flies\ dissected} x\,100$

(ii) No (%) of Nulliparous flies = No. of dissected flies – No. of parous flies Step I

$\frac{No.\ of\ \ nulliparous}{No.\ of\ \ flies\ dissected} x\,100$ Step II

(iii) No (%) of flies infected with,

$L_1L_2 = \frac{No.\ of\ \ flies\ \text{inf}\ ected}{No.\ of\ \ flies\ dissected} x\,100$

(iv) No (%) of flies infected with

$L_3 = \frac{No.\ of\ \ flies\ \text{inf}\ ected}{No.\ of\ \ flies\ dissected} x\,100$

(v) Annual Biting Rate (ABR) = sum of Monthly Biting Rate (MBR)

(vi) Annual Transmission Potential (ATP) = sum of Monthly Transmission Potential (MTP)

These standard calculation steps were applied for blackflies sampled throughout the period of study at the different study sites.

Data analysis

Significance difference of *Smulium damnosum* s.l relative abundance, infection of blackflies and transmission rates based on the different study sites were evaluated by One-way analysis of Variance (ANOVA) using SPSS software version 20.

Results and Discussion

The transmission indices of black flies caught at Akwanga LGA in 2011 has revealed that persons worked were 48 (table1). The total flies caught were 1025. The Savannah blackflies caught at Akwanga LGA were 963(93.95%) while forest type was 62(6.05%). The total number of flies dissected were 979(95.5%), number of Parous flies recorded were 382(39.0%) while nulliparous flies recorded 597(60.9%). Infected flies encountered with L_1L_2 Larvae were 234(23.9%) while L_3 Larvae recorded 148(15.1%). Monthly biting rates (MBR) were recorded as shown on (Table 1) with annual biting rate (ABR) of 7845. The maximum monthly biting rate was recorded in the month of September 2685 which indicated the peak biting period of black flies observed in 2011 at Akwanga LGA while the minimum biting rate was in the month of December. Monthly transmission potential specified as seen (Table 1). Annual transmission potential (ATP) was 1210 as seen (Table 1). L_3/1000 parous flies were 3390.3.

Table 1: Transmission indices of Blackflies caught at Akwanga LGA, in 2011

Characteristics	Months												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Persons days worked	4	4	4	4	4	4	4	4	4	4	4	4	48
Total flies caught	0	0	0	0	10	15	180	287	358	148	23	04	1025
Average daily caught	0	0	0	0	2.5	3.8	45	71.8	89.5	37	5.8	01	21.4
No(%) of flies dissected	0(0)	0(0)	0(0)	0(0)	10 (100)	15 (100)	175 (97.2)	270 (94.1)	345 (96.4)	140 (94.6)	20 (86.9)	04 (100)	979 (95.5)
No(%) of parous flies	0(0)	0(0)	0(0)	0(0)	03 (30.0)	05 (33.3)	62 (35.4)	96 (35.6)	140 (40.6)	67 (47.9)	08 (40.0)	01 (25.0)	382 (39.0)
No(%)of Nulliparous flies	0(0)	0(0)	0(0)	0(0)	07 (70.0)	109 (66.7)	113 (64.6)	174 (63.5)	205 (59,4)	73 (52.1)	12 (60.0)	03 (75.0)	597 (60.9)
Flies(%) infected with L_1 L_2	0(0)	0(0)	0(0)	0(0)	02 (20.0)	03 (20.0)	41 (22.8)	57 (21.1)	87 (25.2)	39 (27.9)	05 (25.0)	0(0)	234 (23.9)
Flies(%) infected with L_3	0(0)	0(0)	0(0)	0(0)	01 (10.0)	02 (13.3)	21 (12.0)	39 (14.4)	54 (15.7)	28 (20.0)	03 (15.0)	0(0)	148 (15.1)
Monthly biting rate(MBR)	0	0	0	0	77.5	112.5	1395	2224	2685^{x}	1147	172.5	31*	7845^{A}
MTP	0	0	0	0	15.5	30	167.4	321.3	420.3	229.4	25.9	0	1210^{b}
No of infective larvae par 1000 parous flies(L_3/1000 pars)	0	0	0	0	666.7	800	338.7	406.3	385.7	417.9	375	0	3390.3

Minimum biting rate = 31*Month Dec; ATP =1210^{B}; Maximum biting rate = 2685^{x}Month Sep; ABR=7845^{A}; **MTP =** Monthly transmission potential

Table 2: Transmission indices of Blackflies caught at Keffi LGA, in 2011

Characteristics	Months												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Persons days worked	4	4	4	4	4	4	4	4	4	4	4	4	48
Total flies caught	0	0	0	0	0	03	10	20	33	12	05	0	83
Average daily caught	0	0	0	0	0	0.8	2.5	05	8.3	03	1.3	0	1.7
No(%) of flies dissected	0(0)	0(0)	0(0)	0(0)	0(0)	03 (100)	10 (100)	18 (90.0)	30 (90.9)	11 (91.7)	05 (100)	0(0)	77 (92.8)
No(%) of parous flies	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	03 (30.0)	06 (33.3)	11 (36.7)	04 (36.4.0)	01 (20.0)	0(0)	25 (32.5)
No(%)of Nulliparous flies	0(0)	0(0)	0(0)	0(0)	0(0)	03 (100)	07 (70.0)	12 (66.7)	19 (63.3)	07 (63.6)	04 (80.0)	0(0)	52 (67.5)
Flies(%) infected with L_1 L_2	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	03 (30.0)	05 (27.8)	09 (30.0)	03 (27.3)	01 (20.0)	0(0)	21 (27.3)
Flies(%) infected with L_3	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	01(5.6)	02(6.7)	01(9.1)	0(0)	0(0)	04(5.2)
Monthly Biting rate(MBR)	0	0	0	0	0	22.5*	77.5	155	247.5^{x}	93	37.5	0	633^{A}
MTP	0	0	0	0	0	0	0	8.6	16.8	8.5	0	0	34^{B}
No of infective larvae par 1000 parous flies(L_3/1000 pars)	0	0	0	0	0	0	0	166.7	272.7	250	0	0	522.7

Minimum biting rate (MBR) = 22.5* Month June; Annual Transmission Potential (ATP) = 34^{B}; Maximum biting rate = 247.5^{x} Month September; Annual Biting Rate (ABR) =633^{A}; **MTP =** Monthly transmission potential

Out of 83(100%) black flies caught at Keffi LGA year 2011, 77 (92.8%) were dissected as seen (Table 2). The total days worked for the 12 months was 48 and average daily caught of 1.7 while 25 (32.5%) were parous and nulliparous recorded 52(67.5%) Infective Larvae (L_3 Larvae) of *Onchocerca volvulus* recorded 04(5.2%) also L_1 and L_2 Larvae recorded 21(27.3%). Monthly biting rate (MBR) varied as seen (Table 2) with recorded Annual biting rate (ABR) of 633. The maximum monthly biting rate was recorded in the month of september (247,5*) which was the peak biting period observed for Keffi LGA year 2011 while minimum monthly biting rate was noted in June (22.5*). Monthly transmission potential (MTP) recorded 16.8, also annual transmission potential (ATP) was 34 as seen (Table 2). L_3/1000 parous flies recorded 522.7.

A total of 1108 adult blackflies were caught during the period of study at Akwanga and Keffi LGAs. Two types of blackflies were identified, the savannah type *Simulium damnosum* s.l and the forest type *Simulium squamosum.* These findings are in consonance with the result of Hudu *et al.* (2013) who reported savannah types predominantly in their work at Kaduna state. It is obvious that the savannah types of blackflies are dominant at the savannah regions while the few forest types might have migrated from forest region since the flies are notably strong fliers. There was a remarkable seasonal variation in the relative abundance of blackflies

caught at the two study sites. An upsurge of flies caught during the raining season (May to September) than the dry season (October to April); which recorded few or no flies for the period of this study. This may be as a result of increase in volume of water in the streams, rivers, ponds, e.t.c during the rainy season hence increase in ecological habitats for blackflies abundance in study sites. This observation is in agreement with the report of Renz (1987); Crooskey (1990); Matur and Davou (2007); Tongjura *et al.* (2014) that Simulidae are insects with worldwide distribution often in most rivers.

It was further ascertain that the peak of biting activity of parous flies coincides with the hours of human activities out door. Activities notably observed were farming, cattle rearing, river banks soil collectors, fetching of water for domestic purposes, swimming, fishing, travellers on motorcycles and bicycles were seen at locations of study. Hitherto, predispose the aforementioned individuals to the bites and nuisance of blackflies. The activities above increase human –vector contact (Opara *et al*., 2008) thereby possibility of coming in contact with infected blackflies since these flies are strong fliers with capacity to fly long distances from 10 to 400 km. Infection rate of flies L_1,L_2, and L_3 were significant increase at the two study sites as well as transmission potentials. From this study there may be slight transmission in Akwanga LGA and no transmission in Keffi LGA. Low transmission rates indicate successful control of Onchocerciasis with ivermectin (Diawara *et al.*, 2009).

In conclusion, there was a remarkable low transmission rates of onchocerciasis at the study sites. Although, there was upsurge of blackflies during the wet season.

Conflict of Interest

Authors declare that there are no conflicts of interest.

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