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Investigations on the transmission potentials of *Simulium damnosum* and the risk of human onchocerciasis in Kaduna Metropolis, Kaduna State, Nigeria

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Onchocerciasis is transmitted to humans by the black fly, *Simulium damnosum*. Preliminary investigations were carried out between the months of June, 2008 and February, 2009 to verify the transmission potentials of *S. damnosum* for *Onchocerca volvulus* in a Public Amusement Park and its environs in Kaduna Metropolis of Kaduna State, Nigeria. Out of the 224 female black flies caught and dissected during the period of study, 48.21% (108/224) were found to harbor different larval stages of *O. volvulus*. Of the total infected flies recorded, 36.75% (68/185), 41.08% (76/185) and 22.16% (41/185) had larval stages of *O. volvulus* in their head, thorax and abdominal segments, respectively. The high percentage of black flies found to harbor different larval stages of *O. volvulus* is indicative of active transmission in and around the park. There is therefore the need for relevant Governmental agency to take a proactive step aimed at controlling the insect vector before the disease attains an epidemic proportion.

Keywords: Black flies, onchocerciasis, prevalence, Public Amusement Park.

INTRODUCTION

Onchocerciasis commonly referred to as river blindness is a terminally blinding human disease caused by a filarial parasite *Onchocerca volvulus*. It is non- fatal but mainly incapacitating chronic disease that can last about 14 years in the human host (Plaisier et al., 1991). It is transmitted to the human victim by a blood sucking black fly *S. damnosum* as a filariform larva (L3). The fly vectors of this disease breed along fast flowing streams and rivers regularly visited by users of the water bodies for drinking, recreation, washing and irrigation

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(Eezzuduemhoi and Wilson, 2006). Human onchocerciasis is characterized by initially painless skin manifestations such as itching of the body and pruritis or papular onchodermatitis, followed by fibrosis, atrophy, depigmentation and nodular swellings containing adult filarial worms (males and females). Tekie et al. (2014) and Njepuome et al., (2014) estimate that 37 to 86 million people in 35 Onchocerciasis endemic countries of tropical Africa, Latin America and Yemen are infected with *O. volvulus*, while 2 million and 50,000 out of these exposed individuals are blind and visually impaired respectively. In Nigeria, onchocerciasis has been reported as the commonest single cause of bilateral blindness among endemic communities and is responsible for between 27.3 and 50.0% of blindness cases (Umeh et al., 2010). This, among other socioeconomic burden imposed by onchocerciasis led to the launching of Onchocerciasis Control Program (OCP) by the World Health Organization (WHO) in 1974 with the mandate to effectively control onchocerciasis through the eradication of the black fly vector in seven endemic areas of West Africa including Nigeria (WHO, 1999; Hall and Pearlson, 1999). In spite of the significant successes achieved by spraying DDT along fast flowing rivers where the insect vector breeds, the use of this insecticide was abandoned because of the high toxicity to humans and the environment. Similarly, the relative therapeutic successes achieved in the attempts to control the scourge of onchocerciasis using Diethyl Carbomazine (Forgione, 2006) and Suramin (Cupp et al., 2011) had to be abandoned due to their high toxicity to the human patients being treated (Thylefors and Rolland, 1979; Frames et al., 1985). In 1987, a pharmaceutical firm (Merck) developed and introduced oral formulation of ivermectin (Mectizan) as the most effective, free and safest larvicide for the treatment of onchocerciasis (WHO, 1995). In Kaduna State, mectizan distribution started in 1988 in 2 Local Government Areas (LGAs) and later was expanded to cover 15 other LGAs under the African Program on Onchocerciasis Control (APOC) (WHO, 2003). It was believed that mectizan clearance of *O. volvolus* microfilaria in human host will disrupt the transmission chain of onchocerciasis and subsequently lead to gradual clearance of infective larval load in the black fly vector since microfilaria will increasingly be unavailable in human host for the fly vectors to pick during blood meals.

The study site was therefore selected because of its characteristic suitable breeding site for *Simulium* species and its social role as an amusement park where people from different works of life and communities go to relax. In addition, there is paucity of published report on the prevalence of *O. volvulus* infection in *S. damnosum* in the study area despite report of the presence of larvae and pupae of *S. damnosum* on floating vegetations of river Kaduna within the recreational park area by Nuhu et al. (1986). The study was aimed at determining *O. volvulus* infection rates in *S. damnosum* within the park area and environs.

MATERIALS AND METHODS

The study was conducted on river bank of a section of river Kaduna that is located within Hassan Katsina recreational park and its environs (Figure 1) between June 2008 and February 2009. The park is equipped with facilities to accommodate large number of recreational visitors which are located on recreational lawns with well-trimmed grass and ornamental shrubs. Many shops and office complex daily visited by people are also located within the park. The fast flowing water, bathing the rocks and leaves of elephant grass suitable for *S. damnosum* (Black flies) infestation and breeding are readily visible along the river within the park. Several high density residential buildings can be seen within close vicinity of the amusement and recreational park.

Harvest of *S. damnosum*

This was done by scooping with nets fitted with handles through the tall grasses and the recreational lawns for two hours during each monthly sampling day (Johnson and Bailey, 1999). Flies caught were demobilized by dipping the scooping nets in water and removing same after approximately 10 seconds. These flies were harvested from the net by hand picking and dropped in labeled specimen bottles containing formalin before conveying to the laboratory in the Department of Biological Sciences, Nigeria Defence Academy.

Laboratory analysis

The standard external and sex keys previously used by Maikaje et al., (2008) were used for the identification of the harvested flies, after which all the females used during this study were counted. The head, thorax and abdomen of black flies caught in each month during the survey were dissected under the dissection microscope and larval stages (L2 to L3) of *O. volvulus* seen were isolated (Maikaje et al., 2008). The number of larvae isolated from each morphological segment of flies dissected were stained with haematoxylin, identified and counted.

Statistical analysis

Data generated were subjected to analysis of variance, chi square test of association using online statistical package (www.physics.csbsju.edu/stats) while prevalence was calculated as simple percentages. Probability level < 0.05 was considered significant.

RESULTS

A total of two hundred and twenty four (224) adult female

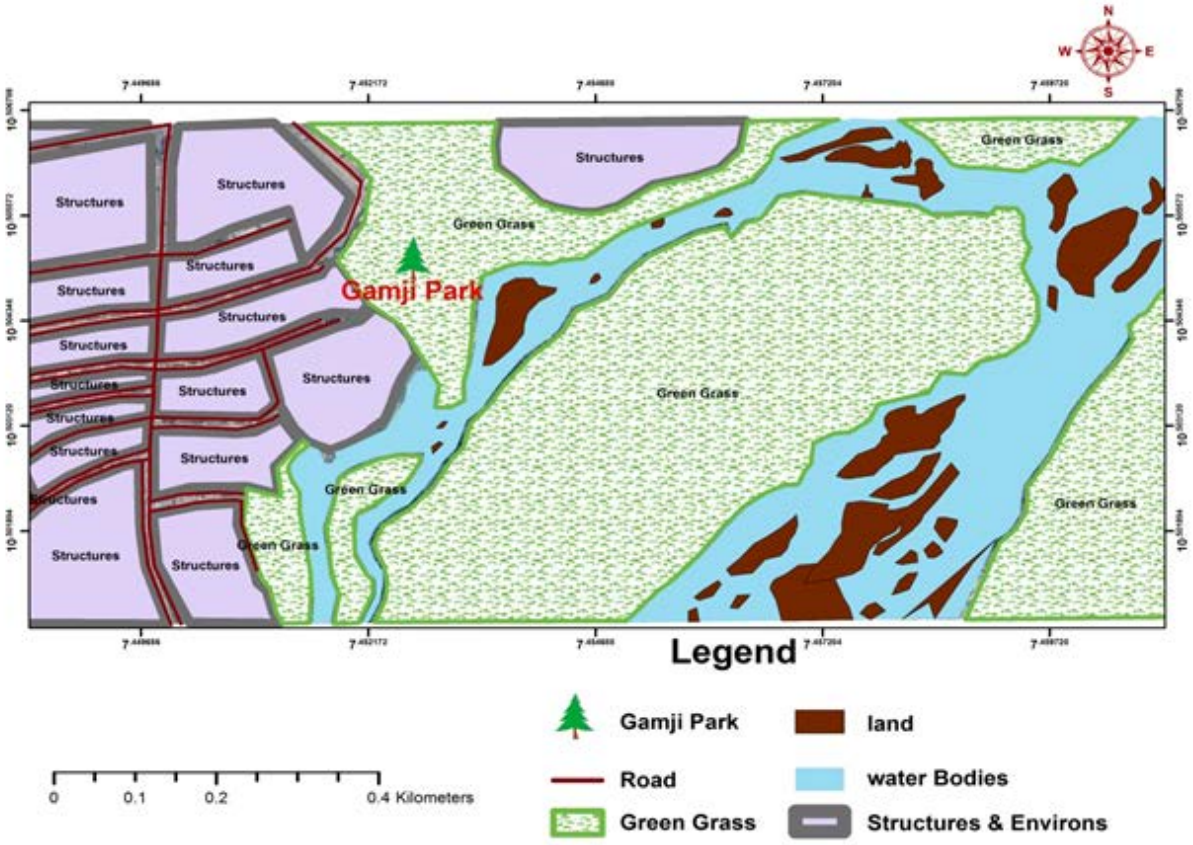

Figure 1. Sketch map of Hassan Katsina Recreational Park (Gamji Park) Kaduna.

S. damnosum were caught and examined for larval stages of *O*. *volvulus* during the nine months study. Of the total black flies examined, 48.21% (108/224) were found to be infected. The distribution of *O. volvulus* in *S. damnosum* in the Public Park and environs shows a significant difference between the months ($P < 0.05$) (Table 1). The highest prevalence (72.27%) was recorded in the month of October, followed by the months of December and January with infection rates of 68.42 and 63.33%, respectively. The least prevalence of 26.67% was recorded in February. However, prevalence of *O. volvulus* in black flies for the months of June through September ranges between 39.13 and 48.0%. Table 2 shows the seasonal prevalence of *O*. *volvulus* in *S*. *damnosum* in Kaduna Public Park and environs. Although there is no significant difference in prevalence between the seasons ($P > 0.05$), prevalence was higher (50.0%) during wet season. The prevalence of *O*. *volvulus* larvae by segments (Head, Thorax and Abdomen) of *S*. *damnosum* caught and dissected during the study period is shown in Table 3. Of the infected black flies, 22.32% had *O*. *volvulus* larvae in the thorax, 16.07% in the head and 9.82% in the abdomen. Similarly, 41.08% of the total larvae were isolated from the thorax while 36.76 and 22.16% were isolated from the head and abdomen, respectively. The approximate mean of larvae isolated from either of the morphological segment ranges from 2 ± 0.5473 to 2 ± 0.8425. Although there is a significant difference in the prevalence of *O*. *volvulus* in the three anatomical segment of infected black flies ($P < 0.05$), *O. volvulus* larvae were present in all three segments all through the survey period except July where no larvae was detected in the abdomen of infected black flies (Figure 2). However, relatively high percentage of black flies were found to harbor larval stages of *O*. *volvulus* in the months of September, October and January while relatively high percentage of black flies were found to harbor larvae in their abdomen in June.

DISCUSSION

Bich and Inuwa (2010) using baits, pooter and hand nets

Table 1. Monthly distribution of *O. volvulus* in *S. damnosum* in Kaduna public amusement park and environs.

Month	No. of black flies examined	No. of black flies infected	Percentage infected (%)	Relative percentage (%)
Jun	32	14	43.75	12.96
Jul	23	09	39.13	08.33
Aug	18	08	44.44	07.41
Sept	25	12	48.00	11.11
Oct	22	17	72.27	15.74
Nov	25	08	32.00	07.41
Dec	19	13	68.42	12.04
Jan	30	19	63.33	17.59
Feb	30	08	26.67	07.41
Total	224	108	48.21	100

Table 2. Seasonal prevalence of *O. volvulus* in *S. damnosum* sampled at Kaduna public amusement park and environs.

Season	No. of black flies examined	No. of black flies infected	Percentage (%) infected
Wet	120	60	50
Dry	104	48	46
Total	224	108	48.21

Table 3. Distribution of *O. volvulus* larvae in the head, thorax and abdomen of invected black flies in Kaduna public amusement park and environs.

Body segment	No. of black flies examined	No. (%) infected	No. (%) of larvae isolated	Approximate mean ± SD
Head	224	36 (16.07)	68 (36.76)	2±0.8425
Thorax	224	50 (22.32)	76 (41.08)	2±0.8404
Abdomen	224	22 (09.82)	41 (22.16)	2±0.5473
Total	224*	108 (48.21)	185	2±0.5473

* Not additive

caught a total of 310 black flies in a survey along river Muvur, Mubi, Adamawa State. Although the use of scoop net only might not have been a very efficient method for maximum collection of black flies, the observed prevalence of 48.21% out of the total *S. damnosum* caught and examined in the study area during the study period (9 months) suggests that *O. volvulus* is endemic in the park area and environs. The presence of larval stages of *O. volvulus* in *S. damnosum* all year round indicates the availability of human sources of blood meal some of which may be carrying the parasites. It also shows that black flies within the park and environs are moderately infected as indicated by the average number of larvae isolated from infected flies. However, the observed high presence of microfilariae in the abdomen of infected black flies in the months of June, October and January coincides with periods of high agricultural activities such as land preparation for the new cropping season, weeding and harvesting of crops which the farmers usually carry out manually and unprotected along the river bank. These activities avail the flies with enough source of blood meal, furthermore temperatures are optimal and the rivers have enough turbulence that provides the larval stages of *S. damnosum* with enough Oxygen.

Transmission of Onchocerciasis occur when infective larvae (L3) which is found in the head region of infected flies enter the human host through bite wound when female black fly takes blood meal (WHO, 2015). The relatively high presence of infective stages of *O. volvulus*

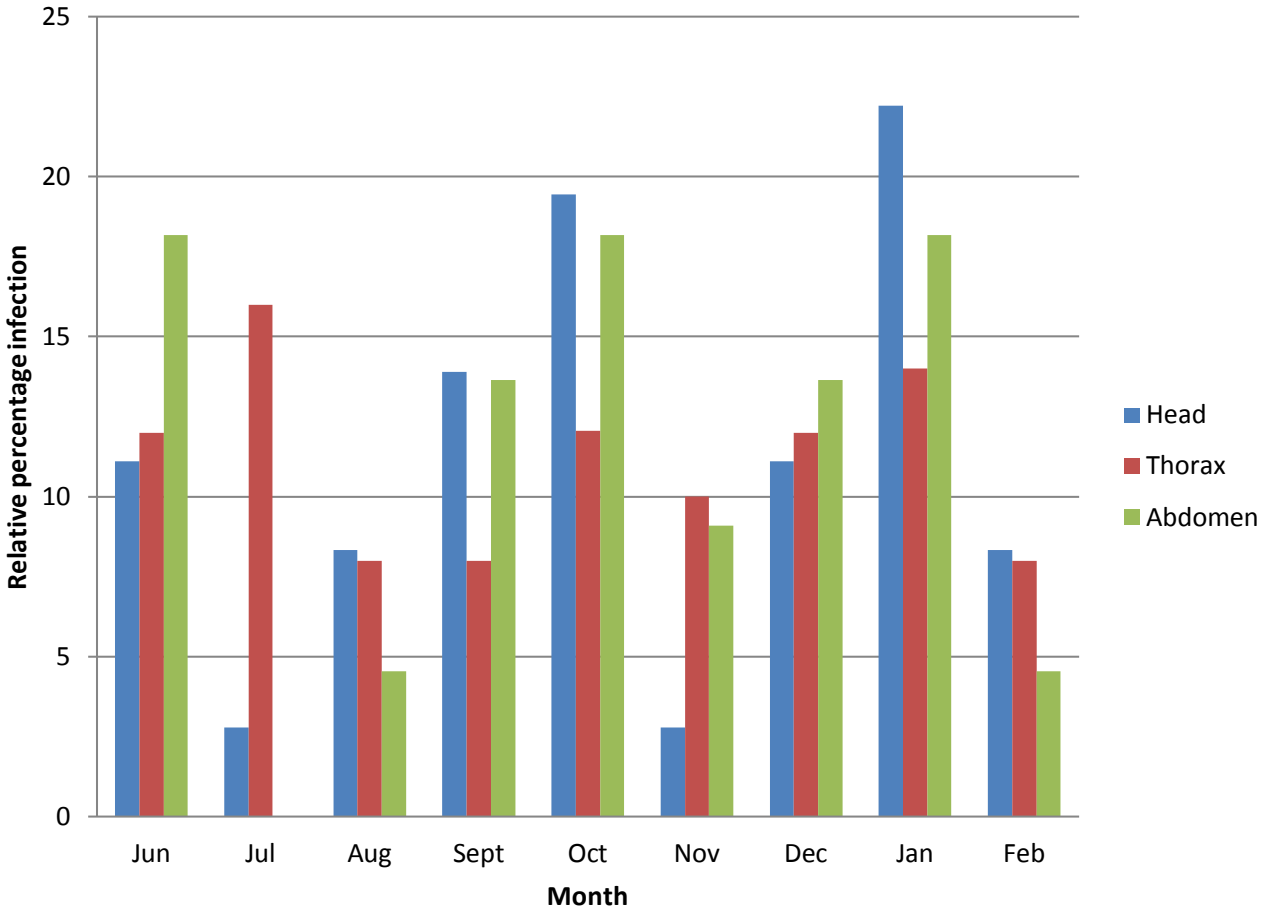

Figure 2. Distribution of *O. volvulus* in different anatomical segment of *S. damnosum* sampled in Kaduna public amusement park and environs.

in the head segment of black flies trapped within the park during the months of October and January therefore is of significant concern. This is because many people visit the park with their families during this period to mark the nation's independence or to celebrate New Year which usually comes up in October and January, respectively thus becoming exposed to risk of contracting onchocerciasis.

CONCLUSION

The isolation of *O. volvulus* larvae in the dissected head, thorax and abdomen suggest that these flies are actively engaged in the transmission of these parasites. It is also an indication of the availability of human sources of blood meals some of which probably are reservoir hosts of these filarial parasites. The apparent human Onchocerciasis risk indicator revealed by the results of this study must not be ignored.

RECOMMENDATION

A comprehensive strategic work plan should be drawn up by the Kaduna State Ministry of Health and other stake holders to assess the epidemiological factors, the infestation profile of *S. damnosum* along the whole length of Kaduna metropolis section of river Kaduna for the institution of effective control measures. The use of Rapid diagnostic test kits must be employed by management of the park to routinely assess the prevalence of human Onchocerciasis within the Park and environs for the institution of effective chemotherapeutic management.

Conflicts of interest

Authors have none to declare.

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