Environmental Conditions favouring Growth of "Blackfly" in Ikov Ward of Ushongo Local Government Area of Benue State of Nigeria.

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Abstract-*The purpose of the study is to examine the environmental conditions favouring the growth of "black fly" resulting to the disease Onchocerciasis in Ikov ward of Ushongo Local Government Area of Benue State, Nigeria. Data was collected on the disease, Environmental Conditions Favouring the Growth of Blackfly*, Blackfly species, *Physicochemical Parameters and Density of Simuliids in rivers in the study area.* The results of the study showed that both physicochemical and ecological parameters constitute the major environmental conditions in the area and they influenced the density of simuliids. *For methodology, Aquatic stages of simulium were sampled covering 5 kindred areas of study area. Water samples were collected from the 5 rivers and analysed. Questionnaires were distributed in the 5 kindred areas to acquire relevant information about the breading sites. The study concluded that the dominance of Simulium damnosum complex, in the study area presents potential risk for the area.*

Keywords **– Amire - Ukiriki river basin, Blackfly, Disease, Environmental Conditions, Onchocerciasis.**

1. INTRODUCTION

Onchocerciasis ranks as one of the most formidable infectious disease of the world, occurring mostly in savannah and rain forest area of Africa. It is also known as "river blindness" the parasitic disease is caused by filarial worm oncherca volvulus and transmitted by blood sucking blackflies of genus simulium which breed in rapidly flowing rivers. It has only devastating effects. Some of the effects are blindness in able-bodies men, abandonment of fertile valleys, as of Africa (Bradley, 1976 and Hocking 1962). The family simuliidae is worldwide in distribution and is found in most rivers extending from the tropics to the Arctic Circle, only in flowing streams and rivers, even in desert ecosystems and in high polar latitudes, and coral islands (Doreen, 2006). Simuliids are found attached to various substrates in the fresh water streams and exhibit peculiar breeding habitat selection (Malmqvist, Zhang and Adler2002). These simuliids are widely distributed in Ikov ward, the study area where they bite and cause discomfort to man. Adult female blackflies require a blood meal (Gibson and Torr, 1999).Because of their blood-feeding activity blackflies are considered ideal disease transmitters (Crosskey, 1990) and are best known for transmitting the filarial nematode worm *Onchocerca volvulus* to humans (Nelson, 1991; Davies, 1994; Hougard et al, 1997). The resulting disease known as ***onchocerciasis*** or "river blindness" has left more than 20 million people infected and millions more blind in West Africa and South America (Samba, 1995; Hougard et al, 1997; Mdyneux and Davies, 1997). The bites of some blackfly species can also cause allergic reactions in certain people, a condition known as ublackfly fever" (Crosskey, 1990;

Palmer, 1997). This is characterized by swelling, itching, haemorrhage and Oedema and requires medical attention in severe cases (Mason and Schemanshuck, 1990). In animals, it has also been shown that allergic reactions to blackfly bites, similar to that described in humans, can lead to the death of cattle (Mason and Schemanshuck, 1990 In South Africa, simuliids have been implicated in the spread of pathogens to animals. In livestock, blackflies readily attack the exposed parts of the body, e.g. the eyes, ears and teats (Anderson and Voskuil, 1963) and the resulting wounds are prone to secondary infections, which sometimes lead to the death of animals (Palmer, 1997). In addition, blackflies cause considerable irritation (annoyance) to livestock (Crosskey, 1990; Kok et al, 1994). In southern New Zealand and Canada the irritation value alone of the pest is high enough to have it Zaeeclassified as the most significant insect pest in these areas (Gibson and Torr, 1999).Blackfty annoyance furthermore leads to economic losses through reduced efficiency of agricultural and industrial workers, interference in recreation, and reduced real estate values (Mason and Shemanshuck, 1990).

The Black fly (Simulium damnosum) produces well in the temperate, subarctic zones and also in tropics where there is vegetation and rocks in a great variety of river systems, including the largest rivers such as the Nile, and the Volta as well as small streams, provided they are oxygenated (Muller, 1975). The Black fly (Simulium damnosum) produces maximally during the raining season, which is therefore the main period of transmitting diseases (Nnochiri, 1975). Provided the river and stream habitats are flowing, the immature stages and emerging adult flies occurs in them at any time of the year. In the dry savannah region of West Africa, Where rivers stop flowing for several months, the Black fly complex vectors circumvent the drought problem not by dormancy but by annually repopulating these regions form reservoir breeding sites in distant perennially flowing rivers. Long range migration of flies helped by the monsoon winds that bring rain to the patched savannah as the wet season begins, enable them to establish new colonials when the river flow again (Crossky, 1956). The geographical distribution of this disease has been observed to follow closely that of its vector in Africa. Onchocerciasis is prevalent in Kenya, Uganda, Rwanda and Brundi. The disease is hyperendermic in parts of nearly all West African countries, notably the northern territories of Ghana, Liberia, Sierra-Leon and uperVolta,Togo and Dahomey, Spanish and Fernando (Gemade,1980). In Nigeria, Onchocerciasis has been noticed in part of Benue State especially in Ikov Ward of Ushongo Local Government Area, causing river blindness.Gemade (1980), discovered during his research on epidemiology of human onchocerciasis that Ikov ward is mostly affected by this parasitic disease. Many environmental factors (biotic and abiotic) have been associated with the richness and variation in simuliids species composition. The principal environmental factors affecting simuliids distribution are water temperature, current velocity, pH, stream width and depth, vegetation, characters of stream bed, turbidity, and availability of food materials and dissolved oxygen concentration (Hamada, McCreadie, and Adler, 2002). Many of these factors have been used to predict species distribution. The complete picture of distribution of the disease Oncherciasis caused by the blackfly in the study area has not been obtained. There is therefore need for more work to be done on this dreadful scourge and its devastating effects in order to provide the necessary information on both the vector and the disease in all parts of the Ikov ward. This study therefore seeks to determine the true position of environment conditions favouring the growth of black flies in the study area.

1.1 Aim and Objectives of the Study

The aim of the study is to examine the environmental conditions favouring growth of “blackfly” resulting to onchocerciasis in Ikov Ward of Ushongo Local Government Area of Benue State, Nigeria. The major objectives of the study are:

1. To identify the environmental factors responsible for the growth of black flies in Ikov Ward of Ushongo Local Government Area, Benue State.
2. Assess the specific breeding sites of the black flies in the river or streams systems and their tributaries in the study area.
3. To investigate the problems the people face as the result of the disease(Onchocerciasis) which is transmitted by blood sucking black flies in the study area.
4. To make suggestions based on the findings, black flies elimination measures and treatment of the people affected in the study area and entire Nigeria.

1.2. Study Area

Location: Ushongo local government is one of the 23 local governments in Benue State. It is located between latitude 6° 31' and 7° 10' N and 6° 08' and 6° 59'E.It has a total area of 1,056km2. The local government is situated on the eastern part of Benue State. It is bounded in the north by Buruku and Gboko local Government Areas, in the east by Katsina-Ala Local Government Area, South-east by Kwande local Government Area, in the South by Vandeikya Local Government Area and in the South- west by Konshisha Local Government Area. Ikov Ward which is the main focus of the study is the biggest in Ushongo Local Government area covering an area of about 50sq kilometers. To the west it is bounded by Mbayegh council ward, to the south it is bounded by Kwande Local Government Area, to the North- East it is blessed with a river and streams. The streams are: Amire-kiriki which runs from south to north and other tributaries namely Umanor, Uavande, Akenge and Uchor streams. These streams are fast flowing during the wet season and dry up completely during the dry season except river Amire-Ukiriki which runs about 25km inside Ikov ward. Ikov ward is made up of five kindred areas which include: 1. Gbesaar 2. Ingyorov 3. Bilaja 4. Seev and 5. Tarshaa. The research covers detailed study of the above mentioned areas.

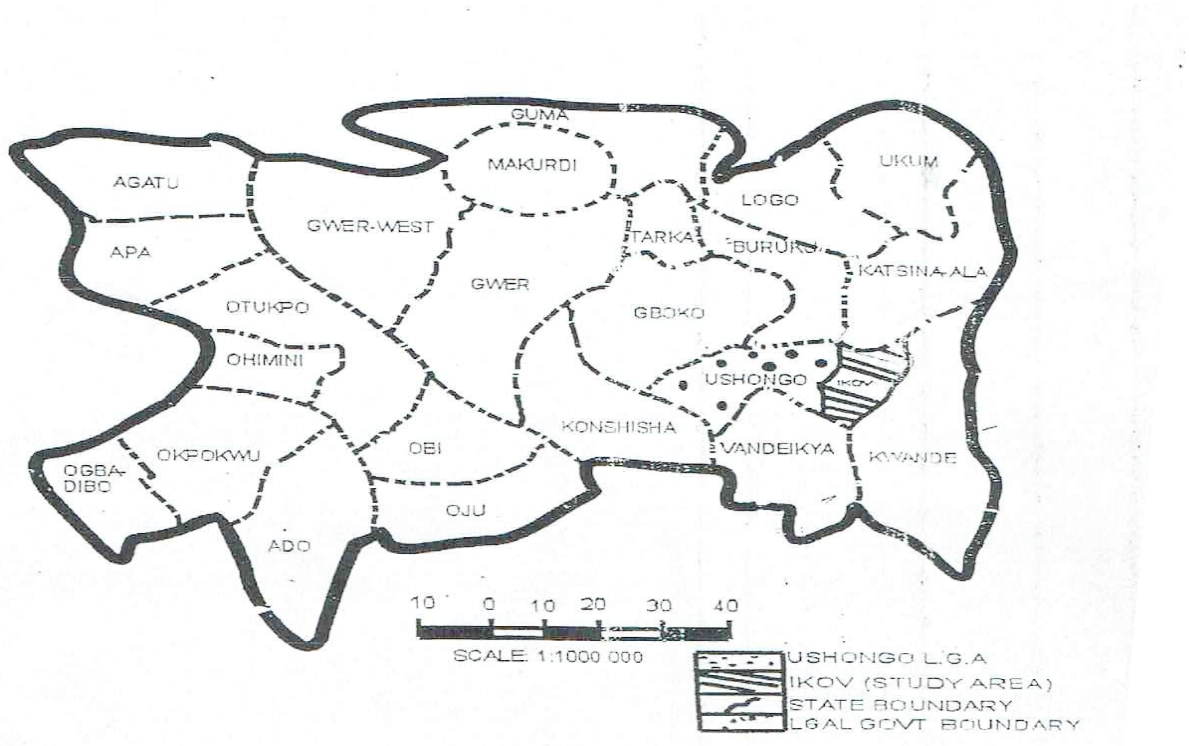

FIG. 1: Benue State Showing Ushongo L.GA and Ikov Ward (Study)
(Source: Bureau of land and survey, Makurdi, 2018)

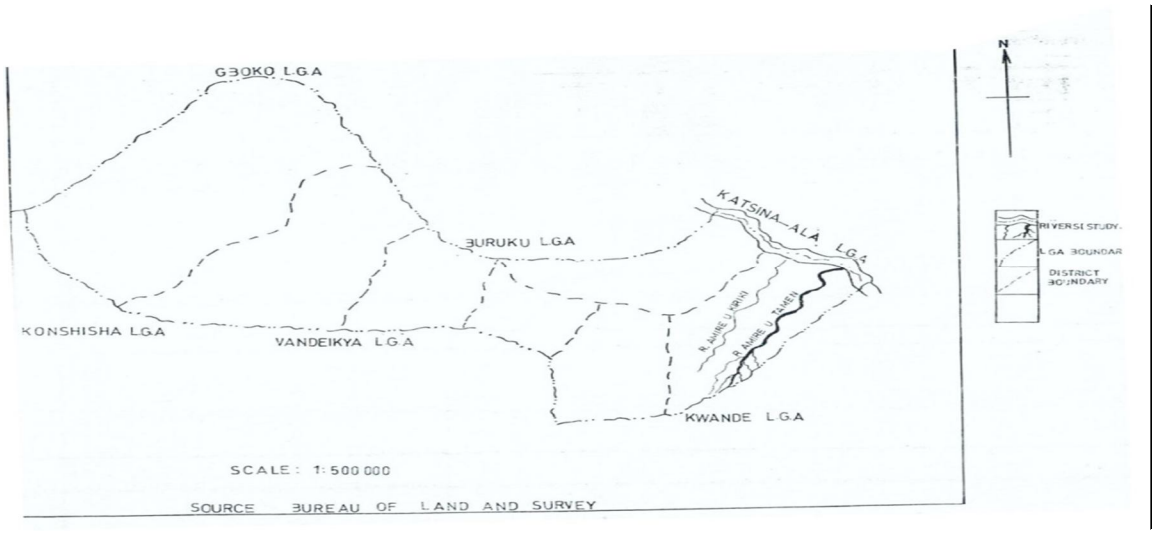

FIG. 2: Ushongo Showing the Permanent and Temporary Breeding Sites in Ikov (Source: Bureau of land and survey, Makurdi, 2018)

2. Methodology

2.1.1 Sampling of Simulium Larvae and Pupae

Aquatic stages of simulium were sampled from 5 rivers covering 5 kindred areas of Ikov ward of Ushongo LGA of Benue State. Immature stages of simulium were found in running water at rapids and rivulets attached to any fixed submerged surface substrates such as water plants, trailing roots and branches and leaves, stones, inclined rock surfaces, cans, bottles, plastics and logs of wood. The immature stages were picked using gold plated fine entomological pins into bijou bottles containing ice cold 1:3 glacial acetic acid and ethanol (carnoys solution) in ice chest. The content was renewed before leaving the river and change before driving away and finally changes again in the laboratory. This is to ensure that water is completely drained away for good preservation. The larvae and pupae were preserved in 1:3 glacial acetic acid and ethanol solution for morphological identifications in the laboratory. Standard procedures were used for morphological identification of simulium.

2.1.2 Determination of Physicochemical Parameters

Water samples were collected from the 5 rivers (in 250 ml beaker) and analyze using digital Hanna instrument model HI98129. Water parameters such as pH, water temperature, conductivity and total dissolve substances were measured.

2.1.3 Determination of Ecological Factors

Standard sampling protocol for measuring width and depth of the river, water current velocity and river bed bottom were followed (McCreadie, Adler and Hamada, 2005)

3. Data Analysis

Data analysis was carried out to determine the relationship between simullid density and each water parameter using correlation analysis to determine the fitness for the presence of different species of simulium. Principal component analysis (PCA) followed by Varimax rotations were used to collapse water parameters and physicochemical parameters into smaller number of statistically independent principal components to determine their association with the simulium distribution and density as well as the environmental conditions favouring the growth of blackflies in the study area.

4. Results

4.1 Questionnaire Administration

In the study area, 160 questionnaires were administered in the 5 kindred areas, out of this number, 158 were collected and only two were not retrieved. The number of questionnaires returned is encouraging and large enough to draw a firm conclusion regarding the study area. The table1 below presents data on the questionnaires distribution.

TABLE 1: Distribution of Questionnaires in five kindred areas of Ikov Ward

Kindred Areas	No. of Questionnaires	No. Returned
Gbesaa	32	32
Igyorov	32	32
Bilaja	32	31
Tarshaa	32	32
Seev	32	31
Total	**160**	**158**

Source: Author's Field work 2016

The table above shows that a total number of 160 questionnaires were distributed in five kindred areas and 32 questionnaires were given in each of the kindred areas. Out of the 160 questionnaires administered, only 158 questionnaires were answered and returned. The result obtained shows that river blindness is prevalent in the study area and the people mostly affected are farmers and fishermen.

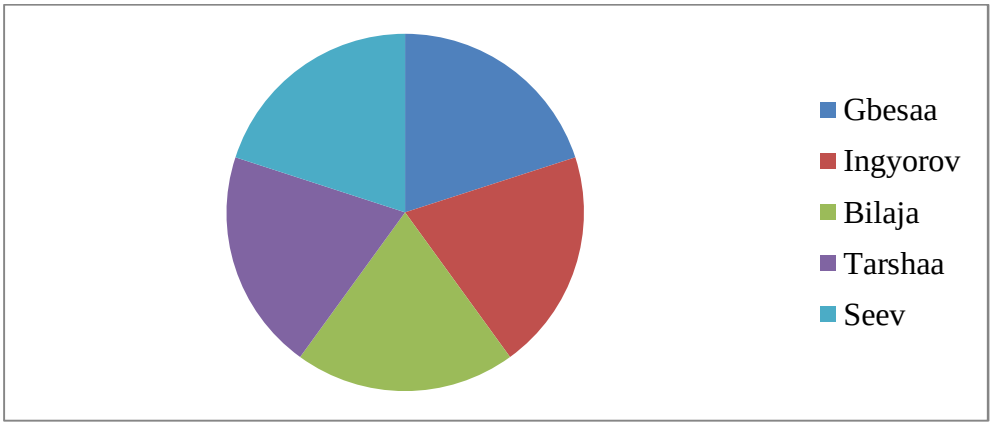

FIG.3: Distribution of questionnaires in 5 kindred Areas affected with Simulium in Ikov
Source: Author's Fieldwork, 2016

Gbesaar (Sati) $\frac{32}{160} \times \frac{100}{1}$ = 20 x 3.6 = 72

Ingyorov (Hiitom) $\frac{32}{160} \times \frac{100}{1}$ = 20 x 3.6 = 72

Bilaja (Wanze) $\frac{32}{160} \times \frac{100}{1}$ = 20 x 3.6 = 72

Tarshaa (Manor) $\frac{32}{160} \times \frac{100}{1} = 20 \times 3.6 = 72$

Seev (Ategh) $\frac{32}{160} \times \frac{100}{1} = 20 \times 3.6 = 72$

4.2 Environmental Conditions favouring the Growth of Blackfly in Ikov Area.

TABLE 2: Showing Rivers in Ikov Ward

Environmental Conditions Favouring	No of Respondents	% of Respondents
Rivers	155	98%
No Rivers	3	2%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

Table 2 above shows that, the study area has so many streams/rivers which serve as breeding sites for these blackflies. In the table above, 98% of the people responded positively that rivers which are the main environmental conditions favouring the growths of blackfly are present in the study area. At the peak of rains particularly in September, the land is observed to be pouring out water, coming off hills, sliding down over rocks and gushing down the narrow meandering footpaths into smaller streams and tributaries that supplied river Amire-Ukiriki draining into river Katsina-Ala. The smaller streams here are Uavande (rocky bedded), Ubar, Akenge, Uchor and Tyotsar-Asanyi on the east of river Amire-ukiriki and Manor on the west and so many others as given in the questionnaires, this large volume of water submerge most of the important inaccessible points due to torrential rush.

TABLE 3: Seasons of the year

Environmental Conditions	No. of respondents	% of respondents
Wet season	150	95%
Dry season	8	5%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

The table 3 above indicates that blackflies are most plentiful in wet season, 95% of the people in the area responded positively that the flies are found mostly in wet seasons when there is enough rain on the environment thereby, enhancing the growth of bushes which provides shady environment for the flies to live comfortably and spread all over the whole area. Only 8% of the respondents said that the blackflies are most plentiful in dry season. Sincerely, the blackflies are not plentiful during the dry season because the environment is not favourable for their growth during this season. Blackflies were observed to be exclusively restricted around their permanent breeding sites and at watering points along the main river in the dry season.

At the relatively cool, shady environments, the flies feed on the fishermen and women, children and adults who visited the streams. A wider distribution of blackflies was however according to the respondents seen during the wet season, greater numbers of these flies are found in bushy environment. The people also indicated that blackfly (Simulium) locally called Avumbu (plural),

Ivumbu (singular) are greatest in numbers during the rainy seasons corresponding with their planting and harvesting periods.

TABLE 4: Blindness

Problem	**No. of respondents**	**% of respondents**
Blind	87	55%
Not blind	71	45%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

As shown in table 4 above, about 55% of the people in the area (Ikov) are blind. This indicated that the problem of river blindness which is caused by continuous biting of human skin by blackflies (Avumbu) is prevalent in Ikov ward of Ushongo local government area. It was observed during field survey that most of the people within the study area had visual impairment including total blindness.

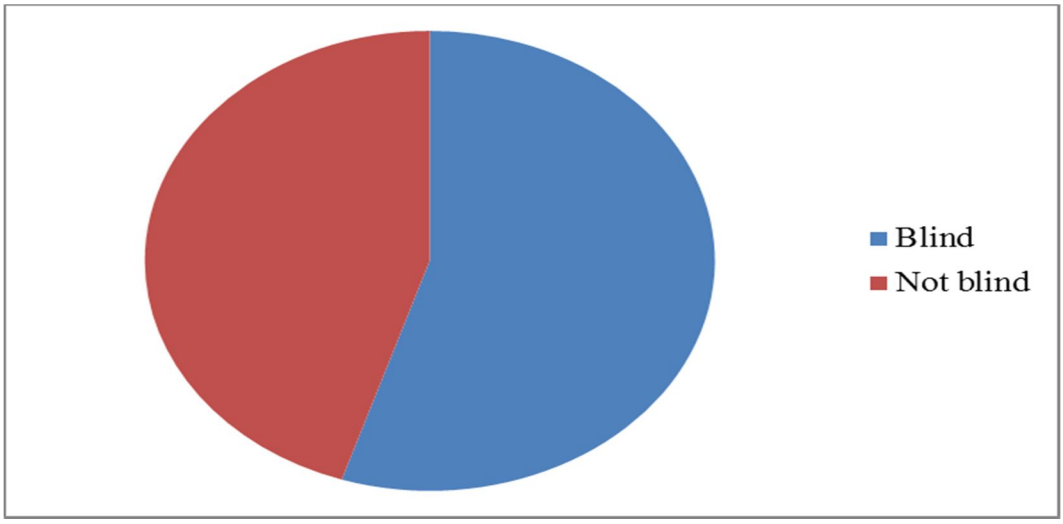

FIG 4. Blindness

Blind = $\frac{87}{158} \times \frac{100}{1}$ = 55 x 3.6 = 198

Not blind = $\frac{71}{158} \times \frac{100}{1}$ = 45 x 3.6 = 162

TABLE 5: Itching Sensation in the Eyes

Problem	**No. of Respondents**	**% of Respondents**
Itching	41	26%
No Itching	117	74%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

In the above table 5, 41 respondents out of the 158 had itching sensation in their eyes. About 117 respondents out of the 158 had no itching sensation however; they are likely to face the problem as

long as they remain in the area. The eyes of the affected persons looked closed at times in the morning, they are dim, the lower and upper eyelids swell up and the eyes looked very heavy.

TABLE: 6 Skin Problems

Problem	No. of Respondents	% of Respondents
Rashes	111	70%
No rashes	47	30%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

It could be observed from table 6 above that the percentage of the people whose skins are not affected are very few. 70% of the respondents have rashes on their skins while only 30% have no rashes on their skins. Some of the people did not grow up in the area during their youthful stage as such, they are not much affected.

TABLE 7: Preventive Measures of Blackflies Bites by the Local People

Measures	No. of Respondents	% of Respondents
Clearing of bushes	9	5.7%
No Clearing	149	94.30%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

From table 7 above, it can be observed that only 5.7% of the respondents indicated that they clear thick vegetation which provides shades for these blackflies to habour and produce thus, creating more problems to them. However, about 94% of the respondents indicated that they have no effort at all, even the bushes around don't cut down. They are infact ignorant of the whole problem caused by this thick vegetation.

TABLE 8: Use of Repellant like Oil and Smears or Grease

Measures	No. of Respondents	% of Respondents
Use of oil	30	19%
No use oil	128	81%
Total	**158**	**100**

Source: Author's Fieldwork, 2016

Table 8 above shows that 19% of the people responded positively that they use oil smears against the attack of these blackflies in Ikov. However, majority of the people in the area as seen in the table above do not apply any oil smear or grease, they don't make any effort to protect their skins rather, and they expose their skins to bites of these flies.

TABLE 9: Wearing of Protective Cloths

Measures	No. of Respondents	% of Respondents
Protective cloths	158	100%
No others	-	-
Total	**158**	**100**

Source: Author's Fieldwork, 2016

The table 9 above reveals that 100% of the respondents agreed that they wear trousers and long-sleeved shirt as protective cloths when going to the farm. Others which include wearing of hand gloves, socks, caps and canvas shoes among others were lacking as indicted in the table.

4.3 Areas of Black Fly Species Prevalence in Ikov Ward of Ushongo

TABLE 10: Five Areas of Black Fly Species Prevalence in Ikov.

Areas (Streams)	Species	No. Sampled	Percentage (%)
Amire – Ukiriki	(S.damnosum)	60	37.5
Umanor	,,	30	18.75
Uavande	,,	40	25
Akenge	,,	20	12.5
Uchor	,,	10	6.25
Total		**160**	**100**

Source: Author's Fieldwork, 2016

Simuliids sampled in Ikov ward of Ushongo Local Government Area of Benue State revealed five areas of the species (S. damnosum) prevalence as shown in Table 10 above. A total of 160 simullid larvae in the affected areas were sampled comprising *S. damnosum*. Out of the 5 streams prospected, two were found to habour simuliids larvae with high densities in Amire – Ukiriki and Uavande Streams.

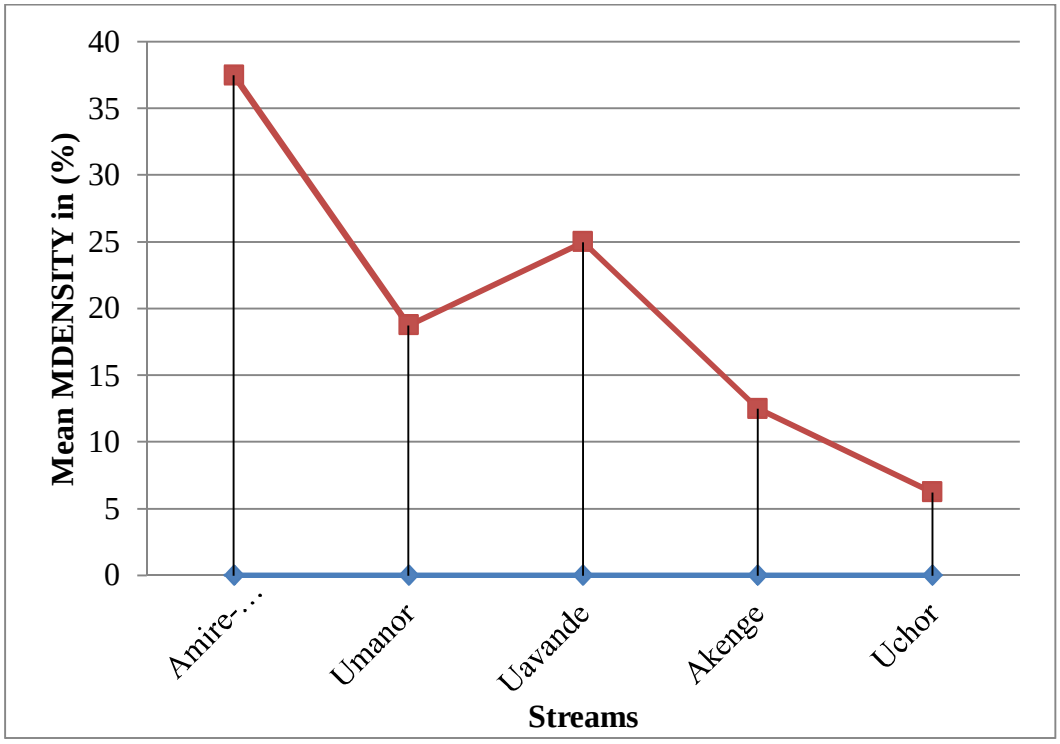

FIG 5: Frequency of Simulium larvae according to the Streams in Ikov
Source: Author's Fieldwork, 2016

The figure 6 above shows that there is high presence of Simulium larvae in the five streams. However Amire-Ukiriki which is the largest stream in the study area has the higest mean density of 37.5% follwed by Uavande which has mean density of 25%. Indicating clearly that the growth of

the 'blackfly' is actually facilitated by these environmental conditionsin the study area causing river blindness to the local inhabitants.

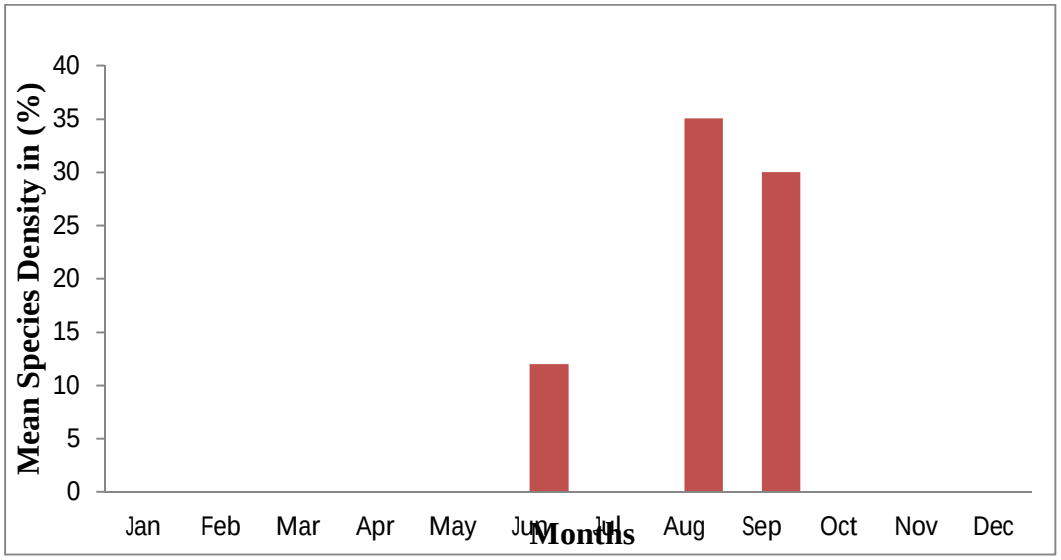

FIG. 6: Monthly frequency of simuliids from January to December 2016.
Source: Author's Fieldwork, 2016

The monthly density represented in figure 6 above shows that simuliids breed all year round in Ikov Ward of Benue State, Nigeria but with highest peaks in the months of July (12.05%), August (35.08%) and September (30.02%).

TABLE 11: Physicochemical Parameters and Density of Simuliids in Rivers in Ikov Ward

River/ Stream	pH	Cond-uctivity (µs)	Dissolved Sub-stances (ppm)	Width (m)	Temp. (C)	Velocity (m/s)	Oxygen Saturation (mg/l)	Simullid (immature stages)
Amire-Ukiriki	7.42	352.42	173.75	11.5	28.59	0.11	9.49	1303
Umanor	7.69	113.42	57.7	476	30.13	0.21	9.20	29,028
Uavande	7.6	50.5	34.8	7.3	30.31	0.12	8.38	3016
Akenge	7.59	46.4	26.3	24.6	30.29	0.13	9.00	1254
Uchor	7.46	138.08	63.58	7.6	28.13	0.14	9.56	4025

Source: Author's Fieldwork, 2016

Seven physicochemical parameters in table 11 above were analyzed and their effect on the breeding pattern of simuliids determined. The result of the correlation coefficient analysis differ significantly as follows—0.126 (temperature), 0.302 (Velocity), 0.250 (width), −0.033 (conductivity), −0.146

(total dissolve substances), 0.146 (pH), −0.086 (oxygen saturation) for all the rivers. The difference in density of simuliids among the various locations in the kindred areas was statistically significant ($F = 2.443$, $df = 7$, $p < 0.05$). Similarly the density of simuliids within the various rivers was statistically significant ($F = 4.160$, $df = 33$, $p < 0.001$). At least five principal components have Eigen value >1 and accounted for 65.73% of variation. Simuliid density was associated with kindred areas, river, conductivity; pH and total dissolve substances in the study locations. Ecological survey revealed that some species of simuliids preferred certain rivers and had preference for certain types of substrates and substratum irrespective of the river width and depth at which larvae were found.

5. Discussion/Findings

The researcher observed that the perennial river systems in the study area are potential breeding sites (Environmental Conditions) for Simulium damnosum (blackflies) vectors of Onchocerciasis, with Katsina-Ala river system constituting the greatest danger. Numerous temporary breeding sites occur during the rain in smaller streams in this area, resulting into distribution of adult female S. damnosum (blackflies) that bite and transmit river blindness. The study area has the highest simulium infection rate from the month of June to September when the population is moderate and this is the season most favourable for Onchocerciasis in the area. The Streams are made up of permanent or temporary stream(s). The present investigation has tried to give a detailed and comprehensive report on the prevalence of simuliid species in relationship to various physicochemical water parameters across 5 streams in the study area. S. damnosum constitutes the most common and the most spread species recorded in all the streams investigated. Of the 5 streams/rivers investigated for simuliid species only 2 streams (Akenge and Uchor) did not record much of the specie. Simuliids were not in much quantity probably because the streams/rivers have sandy and muddy bottoms and some areas are swampy and therefore, lack strong water flow. Opoku (2006) earlier reported that the distribution of immature stages of simuliids is influenced by rainfall which causes increase in velocity and nutrient level of the rivers, reducing algae population with increase in larval density. This could be possible reason why simuliids were absent from two of the rivers due to seasonal fluctuation and complete drying of the rivers.

The simuliid immature stages are usually found attached to trailing roots, leaves, sticks, stems, stone surfaces, twigs and grasses which are usually about 5 cm below the water surface (Bernotiene 2006; Iiiesova, Halgos, and Krno, 2008).This study recorded high S.damnosum.S.I specie per stream/river within the sampling period. It was noted that some streams/rivers support more simuliid species than others due to difference in physicochemical parameters and substrates preference. This concurs with earlier reports that the overall river health is important for the distribution and richness of simuliid species with biotic interactions acting as primary determinants of species diversity (Bergon, Harer, and Townsend 1996; Bergon, Townsend and Harper 2006). The high presence of simuliids species in all but few in two rivers in Ikov area is an indication that the streams are not yet polluted by human activities. In this study physicochemical parameters including pH, conductivity, total dissolved substances, width, velocity, Oxygen concentration and temperature influence in various ways the simuliid density and distribution in streams/rivers. Each species of the simuliids prefers different physicochemical parameters which are specific for a particular species (Rabha et .al, 2013).

5.1 Recommendations

The following recommendations have become apparent as a result of this study.

1. Need for health Education: Many people in the study area (Ikov) are still not aware of the fact that Onchocerciasis is transmitted by the bites of blackflies so an intense health education campaign should therefore be created as a matter of urgency aimed at reducing the contact between the people and the fly.
2. Need for control: It is hoped that the initiation of campaign endemic Onchocerciasis should lead to an improvement in the general level of health of the populace and hence in its productivity.
3. Government should come to the assistance of the people by eliminating the blackflies in the area through spraying of insecticides like DDT at the breeding sites to kill the flies. Aeroplanes (Helicopters) are used when spraying to capture the breeding sites easily.
4. The local people should endeavour to put on protective clothes such as trousers and long sleeve shirts at home and even when going to the farm.
5. This academic observation can be translated into practices by providing basic amenities like good water, health facilities and learning institutions in the heart of the endemic area thus encouraging victims to live in bigger settlements.

5.2 Conclusion

The breeding of simuliids larvae in both dry and wet season is an indication of serious risk to man and his animals in the study area (Ikov) which is known for subsistent agricultural (farming, poultry production, cattle rearing and fishing). The dominance of S. damnosum complex, the vector of human onchocerciasis, in most rivers in the study area presents potential risk for the area. It is justifiable at this point to conclude that environmental conditions favouring the growth of blackflies are prevalent here and Ikov area is endemic with Onchocerciasis and S. damnosum (blackfly) is the main vector in the area.

REFERENCES

Anderson, J.R., & Voskufl, G.H. (1963).A reduction in milk production caused by the feeding of blackflies (Diptera: Simuliidae) on dairy cattle in California, with notes on the feeding activity on other animals. Mosquito News, 23, 126 - 1 3 1

Bergon, M., Townsend, C.R. & Harper, J.L. (2006). Ecology: From individual to ecosystems. Blackwell publication, Victoria, Australia

Bergon, M., Harer, J.L., & Townsend, C.R. (1996).Ecology: individuals, populations and communities. (3rd ed.). Blackwell Science Ltd., Oxford.

Bernotiene, R. (2006). On the distribution of Blackfly larvae (Diptera, Simuliidae) in different rivers in Lithuania. Studia Dipterologica, 14, 19-25.

Bradley, A.K. (1976). “Effects of onchocerciasis on settlement in the middle Hawal valley”. Nigeria, Annals of tropical medical parasitology. (pp. 70-229)

Crossky, R.W. (1956). “The distribution of simulium damnosum. Theobaldin Nigeria” Transaction of the royal society of tropical medicine and hygiene . (pp 50-392)

Crosskey, R.W.(1990). *The national history of blackflies*. British Museum of natural history, London.

Davies, J.B. (1994). Sixty years of onchocerciasis vector control: A chronological summary with comments on eradication, reinvasion, and insecticidal resistance. Annual review of entomology, 39, 23 – 45

De Moor, F.C. (1982). Determination of the Number of Instars and Size Variation in the Larvae and Pupae of Simulium and some Bionomical Implications. Canadian Journal of Zoology, 60, 1374-1382

Doreen, W. (2006). *Taxonomy, ecology and biology of black Flies (Diptera: Simuliidae).* Proceedings of the international symposium on simuliidae, Berlin, 2004. Studia dipterological supplement, 14.

Gibson, G., & Torr, S.J. (1999). Visual and olfactory responses of haematophagous diptera to host stimuli. medical and veterinary entomology,13, 2-23.

Hamada, N., Mccreadie, J.W. & Adler, P.H. (2002). Species richness & Spatial Distributions of Blackflies (Diptera:Simuliidae) among streams of central Amazonia, Brazil. Fresh water Biology.47, 31- 40.

Hocking, Hocking J.M. (1962). "Entomological aspects of Africa onchocerciasis & observation on simulium in Sudan". Bulletin of world health organisation (pp. 27-472)

Hougard, J.M, Yameogo, L, Sek & Eli, A, Boatin & Dadzie.(1997). Twenty-two years of blackfly control in the onchocerciasis control programme in West Africa. Parasitology today, 13, 425-431

Iiiesova, D., Halgos, J. & Krno, I, (2008), Black fly assemblages (Diptera: simuliidae) of the carpathianr river*:* Habitat characteristics, longitudinal zonation and Eutrophication. [Online] Available: http://dx.doi.org/10.1007/s10750-007-9148-4 (Sept.12, 2008)

Kok, D.J., Fourie, L.J., & Oberem, P.T. (1994). A method for the assessment of blackfly (Diptera: simuliidae) attraction to and engorgement on sheep. Onderstepoort Journal of veterinary research, 61, 7-11.

Malmqvist, B., Zhang, Y & Adler, P.H. (2002). Diversity, Distribution and Larval Habitats of North Swedish Blackflies (Diptera: Simuliidae). Freshwater Biology, [Online] Available: http://dx.doi.org/10.1046/j.1365-2427.1999.444497(May 28, 2002)

Mason, P. C & Shemanschuk. J.A.(1990). *Simuliidae, insect pests,simuliidés, insectes nuisibles*. ottawa : Agriculture Canada

Mccreadie, J.W., Adler P.H.& Hamada, N. (2005). Patterns of Species Richness for black Flies (Diptera: Simuliidae) in the nearctic and neotropical regions. Ecological entomologia, 30, 201-209

Mdyneux, O.H & Davies J.B, (1997).Onchocerciasis control: Moving towards the millennium. Parasitology today, 13, 418 - 425.

Muller, P. (1975). *Worms and diseases*. A manual of medical helminthology: London, Williams Heinemann medical books limited.

Nelson, G.S (1991). Human onchocerciasis: Notes on the history, the Parasite and Life Cycle. Annals of tropical medicine and parasitology, 85, 83 - 95.

Nnochiri .E. (1975). *Medical parasitology in the tropics*. London, Oxford university press

Opoku, A.A.(2006). The ecology and biting activity of blackflies (simuliidae) and the prevalence of onchocerciasis in an agricultural community in Ghana. West African, Journal of Applied Ecology, 9, 1-7.

Palmer, R.(1997). *Principles of integrated control of blackflies (Diptera: Simuliidae) in South Africa*. WRC Report NO. 65071/97.

Rabha, B., Dhiman, S., Sunil, Y.K., Hazarika, S., Bhola, R.K & Veer, V.(2013). Influence of Water physicochemical characteristics on simuliidae (Diptera) prevalence in some streams in Meghagaga, Indian Journal of Vector Borne

Samba, E.M. (1995). *Ten years of onchocerciasis control*. Report of the World health organization No. OCP/GVA/85.1B.