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Studies on Vectors of Onchocerciasis, *Simulium* Species, in Achi, Oji River Local Government Area, Enugu State, Nigeria.

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ABSTRACT

The vectors of Onchocerciasis, *Simulium*, flies were studied in Achi, Oji River Local Government Area, Enugu State, Nigeria, to determine the breeding sites, distribution, the vectorial capacity, parous and nulliparous rates, as well as the infection rate, the transmission potentials and the species spectrum of the flies, with a view to recommending some feasible and applicable control measures for the vectors. This would complement or form a component of the chemotherapeutic control of this disease by the use of the drug, Ivermectin. The breeding sites of *S. damnosum* s.l complex - the vectors - were located around the waterfalls and rapids along the courses of some rivers in Achi, like Oji river, Iyi Nwankpu and Ubeneji. Larval forms were collected by ice collecting method from the substrates in bijou bottles containing carnoy fixative with entomological forceps, for cytotaxonomic studies. The adult flies were collected in collecting tubes on human baits, for morphological identification , parous and nulliparous as well as infection rate studies. They were counted and recorded as daily, monthly and annual biting rates and also vectorial density or capacity. Total flies caught were 3,135 in one year period, in which 1,527 (70%) were parous and 632 (30%) nulliparous. The Annual biting rate were 4,635, the infected flies were 40 (1.7%). The Annual transmission potential was 25.78. Some *Simulium* species identified were *S. damnosum* s. s., *S. squamosum*, *S. yahense* and *S. sirbanum*. Integrated vector control (IVC) is recommended by the use of good chemical larvicide like Temophos, and a mopping up with the biological use of *Bacillus* thuringiensis, to complement the present control programme using the efficient drug, Ivermectin.

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INTRODUCTION

In Nigeria, Onchocerciasis is reported in both the forest and savanna areas thus involving all the states, including the Federal Capital city, Abuja. Population at risk is about 40 million, with over 7 million active infection and over 120, 000 cases of Oncho-blindness (Abiose, 1993; NOCP, 1996; Ogunba, *et al.,* 1990). Nigeria, therefore, harbours over a third of the affected world population, as the most endemic country in the world. From studies highlighted in national conferences, the morbidity is great and the prevalence of the disease, the infection rate and the transmission potentials of the flies are high. This has therefore necessitated the current control measures by the National Onchocerciasis Control Programme (NOCP) and WHO/UNDP/WORLD BANK/FAO in most endemic areas (Edungbola *et al.,* 1983; Abiose, 1990; Okolo *et al.,* 1995; NOCP, 1997). In these endemic areas the prevalence of the vectors, *Simulium*, alone constitutes both a threat and a plague to man. These flies are of *Simulium damnosum* s.l. complex of West Africa, of which six out of 26 cytological species recognised are so far found in Nigeria (Dunbar and Vajime, 1972; Dumbar, 1976). All of the known species are involved in the transmission of the disease. The control of Onchocerciasis in Oji River Area could be traced back to the 1950s when DDT was used to prevent the construction workers from contracting Onchocerciasis from *S. squamosum*, during the construction of Oji River power station. Since then, no other control strategy has been employed. The need to establish the current entomological status in the endemic area is therefore exigent.

The entomological studies in Achi was carried out to draw a correlation between the study of the disease, which was found to be hyperendemic in prevalence and the entomological studies of the vector. It is believed that the vectors play great role in the transmission and distribution of the disease in the endemic areas (Okolo *et al.*, 1995). This study was carried out in a collaborative work with WHO researchers in the area whose main objective was to control the disease through both the chemotherapeutic method of administering the new, good, safe, Nobel and effective drug, Ivermectin, donated free by Merk, Sharp and Domchelbret USA and entomologically, by employing the most foreseeable, feasible and applicable entomological methods, for the control of the vectors. The vectors always constitute a nuisance or a biting menace in these endemic areas.

The main objectives of the entomological study were to determine the breeding sites and the distribution of flies in Achi , as well as the vectorial capacity, parous and

nulliparous rates, the biting rates or density, the infection rate and use them to determine the Transmission Potentials. To be studied also was the determination of the species spectrum in the area enabling us to suggest their control, should they be found to be vectors of the disease: i.e. belonging to the *S. damnosum* s.l complex of West Africa as aforementioned. The overall studies were with a view to recommending some of the most feasible and applicable control measures against the voracious biting vector of transmission to complement or form a component of the chemotherapeutic control measure using Ivermectin, which is already in place.

MATERIALS AND METHODS

THE STUDY AREA - ACHI

Achi is located about 50 km south of Enugu in Oji River Local Government Area of Enugu State, South-East of Nigeria. Achi is made up of 12 villages and 23 and is bound in the East by Awgu; the North by Ezeagu, Udi and Awka, the West by Aguata and on the South by Imo State (Fig.1). Many rivers traversing the Udi-Hill escarpment empty into the main Oji River, creating breeding sites for *Simulium* flies as rapids and falls are formed. Achi is located at the interface of forest and Savannah zones. The population under study is over 15,000 and is mainly farmers in this fertile area.

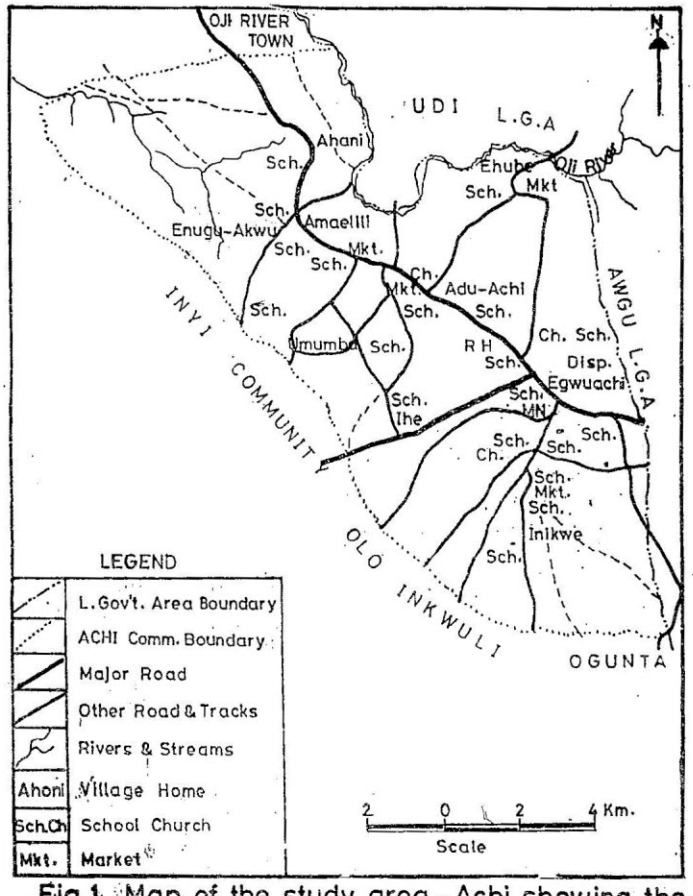

Fig.1 : Map of the study area - Achi showing the different villages.

METHODS

In Achi, breeding sites of *Simulium damnosum*_s.l. complex was prospected along the courses of some of the rivers and streams with rapids and falls. Both adult and larval forms were collected by ice collecting method of (Dunbar and Vajime, 1972, 1981; Service, 1977). Prospecting was carried out from 7 hours to 16 hours of the day of study. During collection of the larval forms, all trailing vegetations, rocks and other substrates were carefully surveyed, emphasis placed on part of the rivers and streams with waterfalls and rapids. The larvae and pupae collected were carefully separated from the substrates with fine entomological forceps and put in bijou bottles with carnoy fixatives for cytotaxonomic studies (for the flies identification) and stored in insulated cool box with ice (Dunbar and Vajime, 1972, 1981; Vajime and Dunbar, 1975; Vajime and Gregory, 1990). Some of the larvae for morphological studies (for identification of species) were stored in 80% ethanol. Adult female flies were collected in the farm sites with collecting tubes, on human baits, which exposed their legs while sitting under the tree shades. One fly was caught per tube and the flies for morphological identification stored in 80% ethanol, but the rest in the tubes were stored in a large insulated cool box with ice for some time. The flies were later counted, recorded and dissected on hourly basis. The head, the thorax and the abdomen were dissected separately, for the presence of the microfilarial larvae L1, L2 and L3 of *O. volvulus*, in order to determine the infection rate. Parous and nulliparous studies were done on the dissected flies using their fat content for the determination (Crosskey, 1958; Duke, 1968). The parous had less fat while the nulliparous had more fat. This investigation was carried out over a period of one year in order to confirm *S. damnosum* s.l. complex prevalence all the year round, breeding and biting along the breeding sites of the rivers. The morphological identification of the flies was by use of wing tufts and other features such as colours of antennae (Garms 1978; Offor, 1997).

RESULTS

Of the nine rivers and streams prospected, *Simulium damnosum* s.l. was identified at three sites namely. Oji river, Iyi Nwankpu and Ubeneji, the remaining six rivers: Iyi Owerre, Ogba, Onu Ojii, Owon, Iyi agwo and Ozom harboured *Simulium* spp other than the members of *S. damnosum* s.l. complex. Two *S. damnosum* s.l. breeding sites each were identified on rivers Iyi Nwankpu and Ubeneji, while along the Oji river, stretching for a distance of up to 15 km surveyed were, numerous breeding sites.

Table 1 shows the result of *S. damnosum* s.l. studies in Achi. In the transmission studies, 3,135 female *S. damnosum* s.l. adults were collected over one year period, 2,159 (68.9%) of them were dissected and 1,527 (70%) were found parous. The

TABLE 1 : Summary of *S. damnosum* s.l studies in Achi

Total number of days worked in a year	-	49
Total person - day worked	-	271
Total Adult flies caught	-	3,135
Total flies dissected	-	2,159
Total parous flies	-	1,527 [70.7%]
No of infected flies with L3 larvae	-	11 [0.5%]
No of infected flies with L1/L2 larvae	-	29 [1.2%]
Average density flies/ man/ hour	-	1.05
Annual biting rate [ABR]	-	4,635
Annual transmission potential [ATP]	-	25.78

nulliparous were 632 (30%). The average daily catch/person and the parous rate were highest in March being 46.5 and 570 (74.0%) respectively and lowest in November, 0.48 and 3(2,31%) respectively. The biting density (flies/man/hour and monthly biting rate (MBR) were highest in March, 4.23 and, 441.5 respectively. The monthly transmission potential was higher in April at 8.45, dropping to 3.30 in May and nearing zero from June to January 11(0.51%) flies harboured infective L3 microfilariae, while 29(1.02%) had L1/L2 larvae of *O. volvulus*. The average daily biting density /man/hour was 1.05 and the average density/man/day was 11.57, the Annual Biting Rate (ABR) was 4,635 and the Annual Transmission Potential (ATP) was 23.78 (by methods of Duke 1968, 1975). Some of the species of *Simulium* identified under *S. damnosum* s.l. complex include *S. damnosum* s s, *S. squamosum*, *S. yahense* and *S. sirbanum*.

DISCUSSION

The presence of the breeding sites of *S. damnosum* s.l. complex, the vectors of onchocerciasis, on some of the rivers gives a clue to the nature of the disease's endemic presence in Achi. There are also high fly density and high biting rates. In the parous study, parous rate is significant in indicating the frequency of blood meal, man-fly contact and hence the disease's transmission. The high prevalence of parous flies was shown by overall parous rate of 70% in the area. The infection rate and the parous

study give clues to the Transmission Potentials which were found to be high e.g. the monthly Transmission Potential (MT) in April was 8.45 (highest), while the Annual Transmission Potential (ATP) was 23.78. The weekly population dynamics over this one year period clearly indicated a single biting peak, between the months of February to April. The above observations show great correlation between the hyper-endemic nature of the disease and the results of the entomological studies. This has control implications since a break in the parasite uptake by the biting female blackflies during the period of high biting rate (e.g through mass Ivermectin therapy of the human population) could lead to a break in the transmission of the disease. Female adult biting density was generally higher in the morning and afternoon hours except in the month of March, when it was substantially higher in the evening. This is of epidemiological significance, since the period of greatest biting coincides with the period of peak farming activity and other out door activities within the focus.

RECOMMENDED CONTROL MEASURE

For control of the disease in Achi there should be both the control of the disease and the vectors. The present continued chemotherapeutic control by the use of the good, safe, Nobel and efficient drug, Ivermectin, should go on for 15 years, which is the life span of the adult worms in the nodules, under the skin of human and be complemented with the entomological control of the flies population in the area. In other words, vector control should form a component of the control programme in Achi. . This will not only augment the laudable effectiveness found in Ivermectin chemotherapy, but also prevent the resurgence of the disease in the future. The main problems in treatment had been compliance in the part of the patient, which is questionable and the logistics in the drug distribution and coverage.

For vector control, an Integrated Vector Control (IVC) along the breeding sites of the associated rivers is recommended. While the drug, Ivermectin, the microfilaricide lowers the affected communities' microfilarial load, the IVC lowers the population density of the flies to a minimal level and thus reducing the man-fly contact. Both control strategies would break the transmission cycle of the disease.

For the Integrated vector control, larviciding with Temophor and mopping up with biological control with Tecknar (*Bacillus thuringiensis* H - 14) are recommended. However, after larviciding, there could be problem of re-invasion from neighbouring communities. Larviciding in itself is expensive, results in environmental pollution and indiscriminate destruction of non-target organisms and aquatic fauna, but the treatment instead could be continued with *B. thuringiensis* to maintain control. Integrated Vector Control strategies were found to be very effective in the Volta River Basin experience

and resulted in the reduction of transmission of the disease to a minimal level (WHO, 1983). *B. thuringiensis* attacked the *Simulium* larvae in the breeding sites when applied continuously, thus effectively suppressing the vector population (Gangler and Molloy, 1982). It can be obtained through WHO and it has been found to do no harm to non-target organisms, man and predaceous fauna, and can be used as a good substitute for broad - spectrum chemical larvicides (Huffaker and Messenger, 1976). Since there are several breeding sites, specific control methods could be adopted depending on the location of the breeding sites. The areas to be controlled could be mapped out and be divided for specific treatment times, that can still allow the villagers in the endemic areas the use of the rivers and streams for domestic purposes or household chores, particularly, where they have no portable pipe borne water delivery. In so doing strategies are to be evolved through advocacies in the Local Government Areas, whereby some of the rivers are to be involved while others not treated and be used alternately. In the above practice public awareness campaign must be done to enlighten the villagers both for the period of the implementation and the elapsing period. IVC is also more appropriate for endemic countries, where resources for sustained vector control programmes are meager or limited, like in Nigeria. Vector resistance is usually ruled out by this procedure. For IVC methods to be successful it must be kept simple, economical and the strategies should be implemented at the local level, preferably with community participation. Impacts of the control measures will ultimately be assessed by measuring disease prevalence, which should be done through the primary health care system.

CONCLUSION

The above studies show Achi to need this good and concerted control. Programme for Onchocerciasis disease, which is found to exist in a hyper-endemic condition. These more specific and direct implementation control strategies need to be monitored closely for greater effectiveness.

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