Bancroftian filariasis in the Igwun Basin, Nigeria : an epidemiological, parasitological, and clinical study in relation to the transmission dynamics

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Bancroftian filariasis in the Igwun Basin, Nigeria

An epidemiological, parasitological, and clinical study in relation to the transmission dynamics

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Summary

A 12-month field and laboratory study was carried out to determine the epidemiology, clinical features, and transmission dynamics of bancroftian filariasis in the Igwun Basin, Nigeria. A total of 1,418 individuals (768 males, and 650 females) were examined for clinical signs of filariasis. 690 day provocative blood samples (DPS), and 728 night blood samples (NBS) were examined for microfilaremia. 14.3% of males and 11.1% of females were mf positive. 5.8% of DPS, and 19.5% of the NBS were mf positive. An overall microfilaria rate of 12.8% was recorded in the basin. Prevalence and microfilarial density increased with age. The highest average density of 35 mf/20 ml NBS occurred in the 40–59-year-old male individuals. The mean microfilarial density in DPS and NBS were 7.9 and 28.0 per 20 ml blood in males, respectively, and 6.2 and 20.0 per 20 ml DPS and NBS in females, respectively. – Disease rates of 55.5% were recorded for males, and 68.1% for females. The clinical signs observed were: Chyluria (9.1% for males, 16.7% for females); hydrocele (15.5%); elephantiasis (15.5% in males, 29.2% in females); and enlarged groin glands (15.5% in males, 22.2% in females). All clinical signs were associated with microfilariae. – *Anopheles gambiae s.l.*, and *Culex pipiens s.l.* were the two mosquito vectors identified. The estimated mean annual biting rates were 5508 and 10448 for *A. gambiae s.l. and C. pipiens s.l.*, respectively. Their respective mean infection rates were 21.7% for *A. gambiae s.l.* and 22.7% for *C. pipiens s.l.;* with microfilarial densities of 4.1 and 6.6. Mean annual transmission potentials (ATP) of 42 and 72 were recorded for *A. gambiae s.l.* and *C. pipiens s.l.*, respectively. These parameters suggest that *C. pipiens s.l.* may be more important in the disease transmission than *A. gambiae s.l.* and may to a greater extent account for the high prevalence, the diversity of clinical signs, and the high morbidity rates.

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Key words: bancroftian filariasis; microfilarial density; *Anopheles gambiae s. l.*; *Culex pipiens s. l.*

Introduction

In the recent past, very few studies on filariasis have been carried out in the eastern coast of Nigeria. In the Niger Delta, Arene and Atu (1986) studied cases of *Mansonella perstans* among the Bori people, while Udonsi (1986) described the presence of *M. perstans, Loa loa, Wuchereria bancrofti,* and *Onchocerca volvulus* and their clinical signs in the Niger Delta. In the latter study, diesease rates due to *W. bancrofti* reached 59.6%.

In a preliminary study of helminth infections in the Igwun basin (Fig. 1), in addition to *Paragonimus uterobilateralis* infections, Udonsi (1987) noted widespread clinical evidence of bancroftian filariasis, and large populations of mosquitoes. This observation necessitated further and detailed study of bancroftian filariasis in the basin. The study was aimed at determining among others, the epidemiological, parasitological, and some human factors that are associated with the high disease rates, and to ascertain the transmission dynamics, and the identity and role of the mosquito vectors. The findings are presented in this paper.

Participants, Materials and Methods

The ecological and geographical features of the Igwun Basin have been described previously (Udonsi, 1987). Its most remarkable features are the numerous tributaries and small water bodies (Fig. 1) which form breeding grounds for potential arthropod vectors.

Collection and examination of blood samples

Prior to the arrival of the field team, consent was obtained through the community heads who urged volunteers to report at their different community halls between 20.00 and 06.00 h for the night blood samples (NBS). A promise to treat infected individuals was made, incentives such as milk, soap, cans of pressurized insecticides etc. were given to volunteers. As volunteers turned up, two 20 ml finger prick blood samples were collected from each male and female volunteer of known age after sterilization of the thumb with cotton pads soaked in methylated aspirit. These constituted the night blood samples (NBS).

The first 20 ml NBS was drawn into heparinized tube containing 0.5 ml of acetic acid, and was used for microfilaria counting using the method of Denham et al. (1971). From the second 20 ml NBS, thick smears were prepared on grease-free glass slides, dried overnight, dehaemoglobinized, dried again, fixed in methanol, and stained in 8% phosphate-buffered (pH 7.2) Giemsa.

Day provocative blood samples were collected from individual volunteers who did not participate in the night sampling. The provocative day test (Sasa et al., 1963; Manson-Bahr and Wijers, 1974; McMahon et al., 1979) was used to obtain the day provocative samples (DPS) as described above. Blood collection was done 50–55 min after the administration of 100 mg diethylcarbamazine (DEC) base to individuals over 15 years old, and 75 mg to those below 15 years. All blood smears were carefully examined to identify the microfilariae.

50% of the individuals who provided DPS were later sampled again at night to obtain their NBS for further examination. Samples of chylous urine were collected and examined as previously described (Udonsi, 1986).

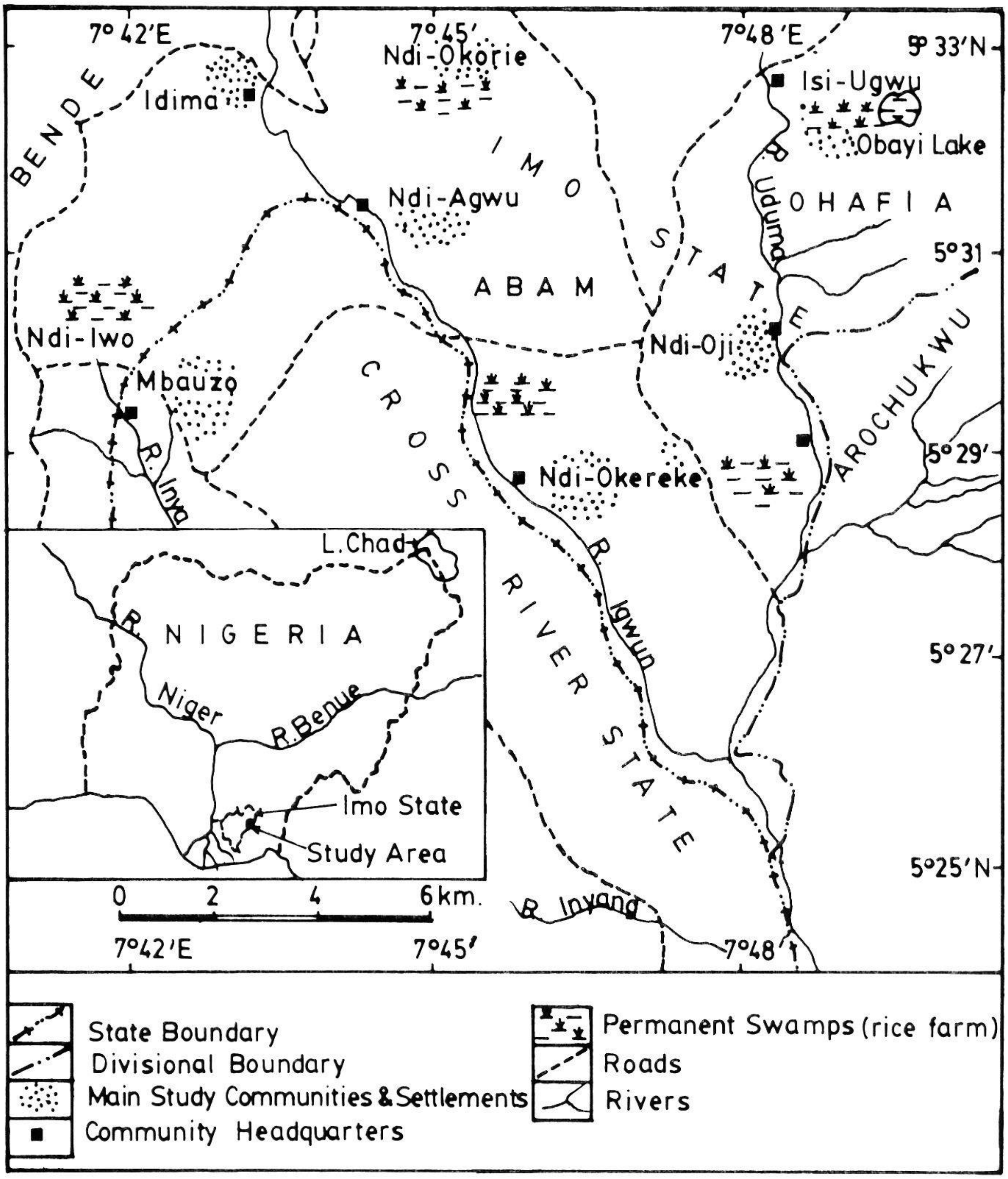

Fig. 1: MAP OF THE IGWUN BASIN SHOWING THE MAIN STUDY AREAS

Physical examination for clinical signs

Microfilaria positive individuals were issued with referral slips to either the Queen Elizabeth Hospital, or the Ohafia General Hospital where a team of medical doctors examined them, compared their observations, and completed the referral slips to indicate their findings. The patients were examined for elephantiasis of the leg, scrotum, breast etc., lymph scrotum, hydrocele, varicose groin glands, lymphangitis, and other clinical signs both at the acute and chronic stages.

Mosquito biting rates

Five field collectors were assigned to each of the eight study communities to trap mosquitoes. In each community, twenty volunteers served as human baits for each study week. Each field collector was responsible for catching mosquitoes biting four human baits during each week of study. Mosquito collection was done from 20.00 to 06.00 h from Monday to Friday. They were caught with glass tubes, and brought to the laboratory in gauzed cages at the end of each sampling night.

In the laboratory, they were separated into genera after identification based on Gillett (1972). After separation, daily catches of the collectors were pooled according to the genus, and the value averaged to obtain the daily biting rate (DBR) of each study area. Monthly collections were also pooled to obtain the monthly biting rate. Annual biting rate (ABR) were obtained by pooling the catches for the twelve months and averaging the value for each study area.

Mosquito infection rates and annual transmission potential (ATP)

After identification, and whenever possible, all mosquitoes were dissected in 0.9% saline under stereomicroscope within 24 h of collection. The microfilariae recovered were stained in phosphate-buffered (pH 7.2) Giemsa. They were identified and counted to obtain the microfilarial density. The number of infected mosquitoes was expressed as a percentage of the number examined to obtain the infection rates.

The annual transmission potential (ATP) of each mosquito genus was estimated by the methods of Duke (1968) and Walsh et al. (1978) using the values of microfilarial density. The ATP represents an estimate of the mean number of *W. bancrofti* microfilariae transmitted to one individual fully exposed by one mosquito per year (Duke, 1968). This value was determined for each study area according to the genus of the mosquito.

Results

Prevalence of bancroftian filariasis

The age and sex related distribution of bancroftian filariasis, and the microfilarial density are summarized in Table 1. There were 14.3% and 11.1% male and female microfilaria rates, respectively, with an overall rate of 12.8% in the entire study population. Microfilarial density increased with age in both sexes, with the highest figures of 35 mf/20 ml NBS, and 24 mf/20 ml NBS recorded in 40–59-year-old males and females, respectively. Night blood samples showed higher microfilarial rates and microfilarial density in both sexes than the day provocative samples. 50% of the DPS which were negative on first examination were found positive when their NBS were examined. The night blood samples of 20 mf positive DPS when re-examined showed higher mf density.

Clinical signs

61 (55.5%) males, and 49 (68.1%) females had clinical signs of lymphatic filariasis (Table 2). All clinical signs were associated with microfilaremia. The following clinical signs were observed:

1. *Chyluria.* 9.1% and 16.7% of mf positive males and females showed respective signs of chyluria with microfilariae.

2. *Hydrocele.* 15.5% of male patients had hydrocele of different grades. The size range from 6 cm to 12 cm in longitudinal axis. Hydroceles of less than 8 cm diameter were regarded as pre-stages. While those 8 cm and above were grouped as mature cases (Tishler, 1971; Wijers, 1977). 26.3% of the hydrocele cases were mature.

Table 1. Age and sex-related distribution of microfilaria positive and microfilaria negative individuals based on day provocative samples (DPS) and night blood samples (NBS) and median microfilarial density

Age*/blood samples	Males			Females		
	No. exam.	No. (%) +ve	Median mf density	No. exam.	No (%) +v	Median mf density
0–19	258	31 (12.0)	15.5	174	19 (10.9)	13.4
DPS	108	6 (5.6)	5.8	80	4 (5.0)	5.1
NBS	150	25 (16.7)	17.3	94	15 (16.0)	14.8
20–39	202	35 (17.3)	20.8	199	21 (10.6)	15.6
DPS	103	8 (7.8)	8.8	112	5 (4.5)	6.8
NBS	99	27 (27.3)	28.6	87	16 (18.4)	19.0
40–59	203	32 (15.8)	34.4	184	18 (9.8)	23.6
DPS	92	4 (4.3)	11.5	82	7 (8.5)	7.0
NBS	111	28 (25.2)	36.3	102	11 (10.8)	24.4
60+	105	12 (11.4)	33.0	93	14 (15.1)	19.8
DPS	63	2 (3.2)	8.2	50	4 (8.0)	6.8
NBS	42	10 (23.8)	31.5	43	10 (23.3)	22.4
Total	768	110 (14.3)	26.8	650	72 (11.1)	18.0
DPS	366	20 (5.4)	8.9	324	20 (6.2)	6.9
NBS	402	90 (22.4)	28.0	326	52 (16.0)	20.2

* in years

3. *Elephantiasis and lymph scrotum.* There were 17 (15.5%) male elephantiasis cases, with 8 (47.1%) and 9 (52.9%) elephantiasis of the leg (EL) and scrotum (ES), respectively. Many cases of lymph scrotum were associated with groin gland enlargement in males. There was elephantiasis of the breast (EB), and the rest were elephantiasis of the leg and hand. No mf-negative individuals showed any signs of elephantiasis.

4. *Enlarged groin glands.* Groin glands which were 3 cm or more in length were regarded as enlarged. 17 (15.5%) and 16 (22.2%) varicose groin glands were associated with lymph scrotum in males over 40 years old. Two cases of enlarged inguinal glands were recorded in females over 40 years old. No cases of chyluria were associated with enlarged groin gland. In all cases microfilariae were present.

Mosquito biting rates, infection rates, and annual transmission potential. The daily biting rate (DBR), annual biting rate (ABR), and the annual transmission potential (ATP) of the two genera of mosquitoes are shown in Table 3. The two genera of mosquitoes identified were *Anopheles gambiae s. l.* and *Culex pipiens s. l.* In each of the eight study areas, there was evidence of higher biting rates (DBR and ABR) with *C. pipiens s. l.* than *A. gambiae s. l.* Table 4 shows that mosquito infection rates were also higher in the *C. pipiens s. l.* than in the

Table 2. Age-related distribution of clinical signs in microfilaria positive males and females in the study population

Age*/sex	Mf. rate No. (%)	Number (%) with clinical signs			
		Chyluria	Elephantiasis	Hydrocele	Varicose groin gland
0–19					
Male	31	0	0	2 (6.5)	4 (12.9)
Female	19	0	0	0	4 (21.1)
20–39					
Male	35	4 (11.4)	2 (5.7) (ES)	5 (14.3)	7 (20.0)
Female	21	5 (23.8)	5 (23.8) (EL)	–	5 (23.8)
40–59					
Male	32	4 (12.5)	10 (31.3) (3 EL, 7 ES)	8 (25.0)	4 (12.5)
Female	18	4 (22.2)	9 (50.0) (2 EB, 7 EL)	–	3 (16.7)
60+					
Male	12	2 (16.7)	5 (41.7) (EL)	2 (16.7)	2 (16.7)
Female	14	3 (21.4)	7 (50.0)	–	4 (28.6)
Total					
Male	110 (14.3)	10 (9.1)	17 (15.5) (8 EL, 9 ES)	17 (15.5)	17 (15.5)
Female	72 (11.1)	12 (16.7)	21 (29.2)	–	16 (22.2)

* in years
EL = Elephantiasis of the leg; ES = Elephantiasis of the scrotum; EB = Elephantiasis of the breast.

Table 3. Daily biting rate (DBR), annual biting rate (ABR), and annual transmission potential (ATP) of *Anopheles gambiae s.l.* (= Ag), and *Culex pipiens s.l.* (= Cp) in study areas of the Igwun Basin

Study area	Daily biting rate (DBR)		Annual biting rate (ABR)		Annual transmission potential (ATP)	
	Ag	Cp	Ag	Cp	Ag	Cp
Idima	18	29	5,387	8,351	40	60
Isi Ugwu	15	35	3,387	10,318	36	72
Ndi Iwo	21	27	6,450	13,487	45	78
Mbauzo	23	28	7,630	10,378	56	84
Ndi Agwu	13	21	3,490	9,418	48	80
Ndi Okorie	19	23	3,600	7,531	40	78
Ndi Okereke	19	31	5,670	11,778	38	66
Ndi Oji	24	33	7,450	12,319	36	60
Mean	19.0	28.4	5,508	10,448	42	72

Table 4. Monthly infection rates of *Anopheles gambiae s. l.* (= Ag) and *Culex pipiens s. l.* (= Cp) involved in the transmission of *Wuchereria bancrofti* in the Igwun Basin

Year/month	Number examined		Number (%) positive		Mean mf density	
	Ag	Cp	Ag	Cp	Ag	Cp
1985						
June	580	645	95 (16.4)	168 (26.0)	3.6	5.4
July	380	773	124 (32.6)	155 (20.1)	3.8	6.8
August	690	1,003	193 (28.0)	254 (25.3)	4.3	7.8
September	875	1,156	201 (32.0)	305 (26.4)	4.5	7.0
October	568	933	108 (19.0)	207 (22.2)	5.3	8.3
November	446	630	83 (18.6)	135 (21.4)	4.8	7.3
December	130	297	29 (14.6)	63 (21.2)	3.3	6.2
1986						
January	250	456	53 (21.2)	98 (21.5)	4.1	5.8
February	198	247	28 (14.1)	57 (32.1)	3.8	6.1
March	300	457	63 (21.0)	87 (19.0)	3.5	4.9
April	225	439	49 (21.8)	66 (15.0)	4.0	6.3
May	480	559	93 (19.4)	128 (22.9)	4.1	6.8
Total	5,122	7,595	1,109 (21.7)	1,723 (22.7)	4.1	6.6

A. gambiae s. l. throughout the year (not significant in t-test). The mean microfilarial density was higher in *C. pipiens s. l.* than in *A. gambiae s. l.* examined throughout the year (not significant in t-test). An estimation of the annual transmission potential (ATP) of each genus of mosquito showed a significantly (P = 0.01) higher ATP for *C. pipiens s. l.* than *A. gambiae s. l.* in all study areas (Table 3).

Discussion

Bancroftian filariasis in the Igwun Basin is characterized by an apparently low density of microfilaremia, high morbidity rate, and diversity of clinical signs. The microfilaria-positive individuals were more or less evenly distributed in the male and female populations of the 8 study communities. This even distribution is probably due to the uniform occurrence of factors that influence prevalence, the most important of these being the interaction of human behaviour and transmitting mosquito vectors. In all the study areas, however, one may expect slight variations in prevalence rates, depending on the number of the night blood samples examined in relation to the day provocative samples. This difference would arise because there was evidence of lower mf-counts in day provocative samples than in the night blood samples. This observation is consistent with that of Sasa et al. (1963).

The presence of many clinical signs may be the result of continuous exposure by which large numbers of microfilariae build up over a long period of time. Susceptible individuals may thus show clinical signs with increasing length of exposure and age. The age-related distribution and appearance of the clinical signs show that varicose groin glands and hydrocele (the latter at pre-stages) could appear at the early age even in patients with low microfilarial counts. Chyluria and elephantiasis of all forms seem to appear later in life when higher microfilarial counts are reached, and perhaps when individual resistance declines. Interpretation of the data is, however, complicated by the selection of the study population which is non-random.

A high intensity of transmission is apparent from the daily and annual biting rates of both mosquitoes, their infection rates, microfilarial counts, and the annual transmission potentials observed for each study area. The higher values of these transmission parameters recorded for *C. pipiens s. l.* seems to suggest that this mosquito may be more important in the transmission of bancroftian filariasis in the basin, than *A. gambiae s. l.* This is consistent with the observations elsewhere along the West African coast (Gelfand, 1955; Kuhlow and Zielke, 1976).

Previous studies along the coastal zone (Maasch, 1973) and the savannah areas (Zielke, 1974) of Liberia showed a direct relationship between prevalence of infection and the population density of vectors. The abundance of *C. pipiens s. l.* and *A. gambiae s. l.* with high biting rates and transmission potentials may count for the high mf rates. The higher microfilarial density of *C. pipiens s. l.* may suggest that transmission by this mosquito may be largely responsible for the high disease rates associated with high microfilaremia. The wider range of breeding sites of this mosquito (including drains, domestic water containers, motor tyres, old coconut shells, foul waters, etc.), as opposed to the more restricted breeding sites of *A. gambiae s. l.* (including borrow pits, open ground pools) may be an additional transmission advantage of *C. pipiens s. l.* over *A. gambiae s. l.*

It is necessary to remark that apart from the transmission parameters of the mosquitoes, there are a number of other unquantifiable environmental and human behavioural factors that may affect transmission, prevalence, and perhaps the disease rates. Such environmental factors would include housing and settlement patterns, low environmental sanitation, and the nature of the terrain, human behavioural factors would include the differences in the level of body exposure (males tend to expose body parts more than women), the use of some local insect repellants (burning of palm kernel shells in rooms at night), and the individual response to the presence of mosquitoes and their bites.

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