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Original Article

Sibling species distribution of the vectors of human Onchocerciasis in South East Nigeria, epidemiological implications and the control of Onchocerciasis in Nigeria.

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ABSTRACT

Cytogenetic studies were carried out on the members of the *Simulium damnosum* complex in South East Nigeria. The studies were undertaken for a period of 12 months. Sample collections were carried out in the different bioecological zones (typical rainforest, mosaic forest, mosaic/guinea savanna and forest interphase/transitional zone) to ascertain the geographical distribution and variation in the species composition of the different vectors of Onchocerciasis in the area. *Simulium* larvae were fixed in Carnoy's solution and cytogenetic analysis were carried out. The geographical distribution of the different cytospecies of *Simulium damnosum* complex was mapped. A total of 334 cytological identifications were made. Three out of the 9 West African sibling species, belonging to two of the *Simulium damnosum* complex: the *S. squamosum* sub-complex (228) and the *S. damnosum* sub-complex (56) were observed. The ICb variant of *Simulium squamosum, which* had been described from the River Sanaga (Cameroon), was observed for the first time in Nigeria. This suggests a probable change, in the nearest future, of the epidemiological pattern of Onchocerciasis in the study area.

Key words: Simulium damnosum, cytogenetic, polytene chromosomes, epidemiology.

INTRODUCTION

Human Onchocerciasis, more commonly known as river blindness, is a chronic parasitic blinding disease of man [1]. It is endemic in 38 countries worldwide, including areas of Africa and the Middle East [2, 3]. About 123 million people live in endemic areas and an estimated 18 million people are currently infected, out of which about 270,000 are blind and an additional 500,000 have visual impairment [4]. Nigeria is an African country with the largest people blinded by Onchocerciasis, accounting for over 40% of the world's cases of the disease [5, 4, 6, 7].

The sibling species composition and distribution of the vectors of human Onchocerciasis and also the clinical features of the disease have been known to vary considerably from one geographical region to another and even between different bioclimatic zones within a single region [8].

This in turn affects patterns of epidemiology which are associated with different strains of the parasite (forest v. savanna) [9, 10] and different vectors (cytospecies or species)[11], the abundance of the vectors and degree of variation in composition, their vectorial and migratory capacity. [12] It is therefore imperative that the taxonomy, ecology and behaviour of the *Simulium* vector species and their relationship to the parasite they transmit and the environment be properly understood. The bioecological structure, the South eastern Nigeria is quite varied [13, 14] and not much is known about the role of the different sibling species of the *S. damnosum* complex in Onchocerciasis transmission in this region in particular and in

Nigeria in general. Although the Rapid Epidemiological Mapping of Onchocerciasis (REMO)/Atlas geographical information system (GIS), developed by WHO in collaboration with the Nigerian National Onchocerciasis Programme (NOCP) is good at assessing the current status of the disease in the human population through the analysis of easily detected symptoms, [15, 16] they are less efficient at rapid detection of changes in the epidemiology of the disease. Early detection of such changes requires information on the vector cytospecies composition, seasonal abundance and geographical distribution, which will be provided by cytotaxonomic identifications. The accurate and reliable identification of *Simulium* species transmitting the different species and strains of *O.volvulus* and their distribution in studies of epidemiology of Onchocerciasis vectors and in the planning and execution of control measures has therefore been repeatedly emphasized. [17, 18] The aim of the present study is to use cytotaxonomy to identify and determine the identities of the different strains of vectors of human Onchocerciasis in the study area. The variation in their seasonal and geographical distribution will be determined and such will be related to the disease epidemiological pattern and potential for consequent control by vector eradication. It is hoped that this will also allow the filling in of the obvious gap in the understanding of the Onchocerciasis vector ecology and dynamics in Nigeria, and also contribute to the rapid accumulation of baseline data on which a nationwide Onchocerciasis control can be based eventually.

MATERIALS AND METHODS

For the purpose of clarity in this research, the study area is divided into three natural zones. Zone A consists of the coastal areas i.e. Cross River and Akwa Ibom States (mainly forest), zone B consists of Imo and Abia States (a mixture of mosaic and degraded forest) while zone C comprises of Enugu, Ebonyi (forest-savanna, mosaic/guinea savanna) and Benue (forest interphase and a transitional zone between forest and savanna bioclimes) States. Vector breeding sites were selected from the different bioclimatic zones based on available prevalence data [16, 18] and preliminary sampling for *Simulium* in the area.

The collection of *S.damnosum* complex larvae for cytogenetic determination of sibling species were carried out, between December - March for the dry season and May - October for the wet season, from ten sites in eight endemic communities in the study area. Final and penultimate stage larvae were collected from their riverine breeding sites and fixed in Carnoy's solution (3:1 absolute ethanol: glacial acetic acid) and polytene chromosome preparations were made by dissection and staining in FLP-Orcein according to standard procedures [19]. Chromosomes were mapped and cytospecies identifications were made according to previously described criteria [19]. Autoshapes in Microsoft Word were employed to indicate the geographical distribution of the different cytospecies of *Simulium damnosum* complex in the study area and this was related to the known epidemiological pattern of Onchocerciasis in the South east of Nigeria.

RESULTS

A total of 334 cytological identifications were made. These new identifications, together with details of the geographical location of sampling sites, their bioclimatic zones and season are presented in Table 1. The new cytological identifications consisted of *S.squamosum* and *S.yahense* belonging to the *S.squamosum* sub-complex and *S.damnosum* belonging to the *S.damnosum* sub-complex. No new fixed inversion differences were observed. *S.squamosum* was recorded from all the bioclimatic zones, breeding in alongside *S.yahense* or *S.damnosum* in most areas. Two variants of *S.squamosum*, ICs and ICb were observed and the latter is being observed in Nigeria for the first time. [20] *S.yahense* was found breeding in the mosaic forest and forest areas, alongside *S.squamosum* in all cases. An allopatric breeding situation was observed to be exhibited by the *S.squamosum* species at only one sample site, the Atan River.

DISCUSSION

The correct identification of individual member species of the *S.damnosum* complex in any locality is needed for a better understanding of epidemiology and also in the practice of control operations. In the latter case, precise identification can be important for inferring the possible provenance of flies and for delimiting control zones.

The map that emerged from the nationwide Rapid Epidemiological Mapping of Onchocerciasis (REMO) in Nigeria [16] was reasonably detailed and was consistent with the known disease pattern particularly across the international border with Cameroon in South eastern Nigeria.[21] The result showed that the South eastern part of Nigeria is hyperendemic [18] and most of the area is included among those for which *mectizan* treatment is definitely required. However, the level of endemicity has not been precisely ascertained in most communities in the area as the above result is based on REMO. An exception is the communities around Enugu, Udi and Oji River where the disease is known to be mesoendemic.[13]

Again, the result of the strain distribution of *O.volvulus* in Nigeria had suggested that the non-blinding strain is found mainly in southern Nigeria while in central and northern Nigeria, the blinding strain predominates.[22] This pattern of distribution follows the local ecology of the area. An attempt is being made from the findings of this study to correlate the known epidemiological pattern of Onchocerciasis in the study area with the presence of different species of the *S.damnosum* complex at the different locations.

The South east of Nigeria is a rainforest bioclime, which begins to change to a forest savanna mosaic just north of Enugu. In the typical forest areas of zone A, where the epidemiology of Onchocerciasis is known to be forest type,[23] *S.squamosum* and *S.yahense* appear to be the dominant vectors although it is not certain which of them is the more efficient and important vector.

The situation is similar in the degraded mosaic forest area in zone B which has also been known to show a predominantly forest-type epidemiology.[18] It seems however that there is a gradual invasion of these areas by the savanna species, *S.damnosum*, probably as a result of the ongoing forest degradation in these areas. If continued, this will pose a great risk because it is possible that a savanna blinding Onchocerciasis could get down into this bioclimatic zone. The obvious mixture of savanna and forest vectors, *S.squamosum* and *S.damnosum* in zone C correlates well with the known disease pattern in this transitional zone.[24]

The allopatric breeding situation observed in Atan River could be significant in the provision of sources of "pure" larvae with which larvicidal and transmission experiments could be conceived, tested and successfully applied in the campaign against Onchocerciasis as was the case in the OCP area.[2] The movement of the ICb variant of *S.squamosum* across the Cameroonian border as far as Idodo river (Emene) in zone C, a distance of about 750km should also be of a great concern not only because *S.squamosum* had been known to be seldom migratory and the great possibility of re-invasion from Cameroon in the event of a nationwide vector control, but because the northern part of Cameroon is infested with a serious blinding form of Onchocerciasis.[25] There is a great probability that this form of Onchocerciasis could sooner or later gradually invade the South eastern part of Nigeria through the Cameroonian border.

The evidence that migratory movement of adult females of the *S.damnosum s.l.* occurs over hundreds of kilometers, at least under some meteorological conditions, makes it essential to consider the situation of any country where control is planned in relation to its neighbouring areas. When considering a national vector control programme, Nigeria has the advantage that on the whole, she is free from the possibility of re-infestation of controlled areas from either the south, i.e. the Bight of Bonny or the north.

This is because there is no known breeding site of *S.damnosum s.l.* in the semi-desert areas of the Republic of Niger lying to the north of Nigeria. Again, the Benin Republic on the west of Nigeria and also the Republic of Chad has already been covered by the OCP.[3, 2] The nation is however vulnerable to re-infestation at least on the long run, from the East because of the existence of breeding foci in the Republic of Cameroon. In view of all these, the South - east of Nigeria becomes a very important zone to watch in the event of a nationwide Onchocerciasis control, especially with regards to the break in transmission through vector control.

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Table 1: Cytospecies identification and geographical distribution of *S.damnosum complex in the study area.*

LOCALITY					CYTOSPECIES				Number
Site No.	Name of River	Geographical coordinates (Lat./Long.)	Bioclimatic Zone	Season	*squa*		*yah*	*dam*	(n)
					ICs	ICb			
1	ATAN	7°50',5°08'	Forest	D	27	-	-	-	27
2	AKPA-IKPONG	8°05',5°04'	Forest	D	19	-	-	4	23
3	IMO	7°23',5°42'	Mosaic Forest	D	39	-	-	3	42
4	IBII	7°22',5°55'	Mosaic Forest	D	5	1	18	-	24
				W	9	2	14	-	25
5	IBII	7°23',5°57'	Forest	D	9	17	-	-	26
				W	14	4	-	-	18
6	IBU	7°22',5°57'	Forest	D	7	-	13	-	20
7	UGBI	7°18',5°56'	Forest	D	14	4	2	-	20
				W	4	-	6	2	12
8	IYI-AKA	7°20',6°00'	Forest	D	10	-	14	-	24
9	IDODO	7°42',6°35'	Mosaic/Guinea Savanna	D	10	5	-	17	32
10	OKPOKWU	7°52',6°50'	Forest Interphase/Transitional Zone	D	5	-	-	7	12
				W	6	-	-	23	29

(D) = dry season, (W)= wet season, (squa) = squamosum, (yah) = yahense, (dam)=damnosum, (ICb) = short asynaptic centromeric region and (ICs) = synaptic centromeric region.

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