



### African Programme for Onchocerciasis Control: Ophthalmological Findings in Bushenyi, Uganda

*Le programme africain pour le contrôle de l'Onchocercose : Les constatations ophtalmologiques a Bushenyi en Ouganda*

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#### ABSTRACT

**BACKGROUND:** The overall prevalence of blindness from Onchocerciasis in Bushenyi is relatively low, most of which is to be found in the elderly. Onchocerciasis is a major health problem in Africa. The Community-Directed treatment with ivermectin is a control strategy to address the problem, but baseline data are generally lacking in several countries.

**OBJECTIVE:** To describe baseline ophthalmological data in order to assess the impact of Community-Directed with Ivermectin (CDTI) in Uganda.

**METHODS:** The study site was in Bushenyi, Western Uganda. In a cross-sectional study, 367 persons aged 10 years or older from seven selected villages received eye examination using a standardised protocol and Wu-Jones Motion Sensitivity Testing (MSST). Besides MSST, other information sought included visual acuity, slit lamp examination, testicular opacities and intraocular presence.

**RESULTS:** Of the 367 subjects, 219(57.2%) were males. Subjects less than 25 years of age were 104(28.3). The prevalence of blindness were 1.9% while 4.1% was visually impaired by acuity criteria alone. A further 9.1% had moderate visual field loss while 2.8% had severe field loss. There was no case of anterior chamber microfilaria but dead microfilariae were seen in two cases. Punctate keratitis was present in 1.8% with sclerosing keratitis was twice as common at 3.8%. Optic atrophy was also relatively common at 12.4%, while chorioretinitis was present in 3.3%.

**CONCLUSION:** There was an apparent paucity of acute onchocerciasis-related lesions but a significant presence of irreversible onchocerciasis-related lesions. The most significant problem requiring intervention would appear to be cataract. *WAJM* 2011; 30(2): 104–109.

**Keywords:** APOC, onchocerciasis, impact assessment, ophthalmology, baseline study, Uganda

#### RÉSUMÉ

**CONTEXTE:** La prévalence générale de la cécité liée à l'Onchocercose est relativement basse à Bushenyi, et est notée le plus souvent chez les sujets âgés. L'onchocercose est un problème majeur de santé publique en Afrique. Le traitement dirigé à l'Ivermectine est une stratégie de contrôle pour régler le problème, mais pour en juger, les données manquent dans plusieurs pays.

**OBJECTIF:** Décrire les données ophtalmologiques de base en vue d'évaluer l'impact du traitement dirigé à l'Ivermectine (CDTI) en Ouganda.

**METHODES:** Le site de l'étude était à Bushenyi dans l'Ouest de l'Ouganda. Dans une étude transversale portant sur 367 sujets âgés de 10 ans et plus, originaires de sept villages, qui ont bénéficié d'un examen des yeux, avec un protocole standardisé et un test de sensibilité au mouvement de Wu-Jones (TSM). Les autres informations relevées comprenaient l'acuité visuelle, l'examen à la lampe à fente, la recherche d'opacités intraoculaires.

**RESULTATS:** Sur les 367 sujets, 219 (57.2%) étaient des hommes. Ceux qui étaient âgés de moins de 25 ans étaient au nombre de 104 (28.3%). La prévalence de la cécité était de 1.9%, tandis que 4.1% avaient un déficit visuel sur le seul critère de l'acuité. Aussi, 9.1% ont eu une perte modérée du champ visuel, et 2.8% présentaient une perte sévère du champ visuel. Il n'y avait aucun cas de microfilarie notée dans la chambre antérieure mais des microfilaries sans vie étaient visualisés dans deux cas. Une kératite sclérosante était présente dans 1.8% des cas, avec une kératite sclérosante deux fois plus fréquente à 3.8%. L'atrophie optique était également relativement fréquente à 12.4%, pendant que la chorioretinite était présente dans 3.3%.

**CONCLUSION:** Nous avons noté une relative rareté de lésions liées à l'onchocercose aiguë, et une présence significative de lésions d'onchocercose irréversible. Le problème le plus important nécessitant une intervention paraît être la cataracte. *WAJM* 2011; 30(2): 104–109.

**Mots Cles:** APOC, Onchocercose, Evaluation de l'impact, Ophthalmologie, Etudes de base, Ouganda.

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**Abbreviations:** APOC, African Programme for Onchocerciasis Control; CDTI, Community-Directed Treatment with Ivermectin; CVFT, Computerised Visual Function Test; MSST, Motion Sensitivity Screening Test; OCP, Onchocerciasis, Control Programme.

## INTRODUCTION

The Onchocerciasis Control Programme (OCP) represents a successful attempt to control the vector of onchocerciasis, a disease which affects over 17.5 million people<sup>1</sup> mainly in sub-Saharan Africa. This programme has been applied in 11 countries in West Africa, but 85% of those affected with onchocerciasis actually live outside the OCP zone<sup>2</sup>. With the discovery in 1987 of a safe microfilaricide (Ivermectin), a new approach to large-scale control of onchocerciasis became available. The African Programme for Onchocerciasis Control (APOC) was launched in 1995 with the manifest goal of eliminating onchocerciasis as a disease of public health importance in 19 none OCP countries. African Programme for Onchocerciasis Control has adopted the control strategy of Community Directed Treatment with Ivermectin (CDTI) in the main, and vector elimination when necessary and when feasible. The objective of CDTI is to put in place a community controlled sustainable mechanism of continuous Ivermectin distribution after APOC programme ends as envisaged in two decades time. The effect of large scale distribution of Ivermectin on transmission of the disease as observed till date suggests that a total interruption may not likely occur without prolonged and sustained mass chemo-therapy<sup>3</sup> and that CDTI may therefore need to be continued for decades in order to control the disease as a public health problem.

In order to determine the long term clinical, epidemiological, entomological, social and economic impact of CDTI, it became necessary for APOC to conduct baseline studies in ophthalmology, dermatology, entomology and the social sciences. To that end, 13 sites in eight countries which on the basis of available information fulfilled certain criteria, were selected for study. These criteria included uniformity in endemicity (meso- or hyper-), adequacy of social and cultural stability, Ivermectin treatment coverage below 25%, accessibility and the availability of Rapid Epidemiological Mapping of Onchocerciasis (REMO) data.<sup>4</sup>

Uganda is administratively divided into 45 districts and Bushenyi, which was

ultimately selected as a site for study, is one of the 17 onchocerciasis endemic districts located to the west of the country along the Rift Valley escarpment.<sup>5,6</sup> Rapid Epidemiological Assessment (REA) and REMO data indicated that nodule prevalences varied between 10–19% in the south of Bushenyi district, and reached up to 40% in the North of the district. The area is characterized by the presence of many crater lakes, crater depressions and cone shaped hills, and drained by several rivers into the lake archipelago. These rivers serve as breeding sites for *Simuliidae*, especially *Simulium neavi* ss.<sup>7</sup> Although the vegetation in Bushenyi used to be rain forest, this has changed due to human cultivation of Banana, tea and Robusta coffee, as well as other settlement activities especially in the south. These deforestation activities may have had an effect on the dominant vector species in the area.<sup>8</sup> Onchocerciasis was said to be endemic in several parts of Bushenyi district<sup>9</sup> and particularly in Kabarole district where Kipp *et al.*<sup>10</sup> had reported prevalences ranging from 8.5% at Katozi to 66.7% at Kakasi. However, since 1992 there has been a vertical Ivermectin treatment programme, supported by the Christoffel Blindenmission (CBM) operating from Mbarara for the two districts of Mbarara and Bushenyi with reported coverage rates from NOTF records approaching 30–40%. Although this site did not quite meet the criteria of < 25% coverage rate in Ivermectin distribution, within Uganda at the time of the study, it was not possible to find sites with lower coverage. A decision was therefore taken to proceed with the study as “Baseline” for future assessments using entomological, clinico-dermatological and ophthalmological parameters. The Entomological studies were carried out in areas within or contiguous to the sites where the clinical studies were done. This communication reports on the ocular findings. The aim of the study was to establish baseline ophthalmological parameters with a view to comparing them in five years time following CDTI. The hypothesis being tested is that CDTI will prevent or delay progression of onchocercal eye lesions and blindness.

## SUBJECTS, MATERIALS, AND METHODS

This cross sectional study was carried out in the Bushenyi district, which is one of the 17 identified onchocerciasis endemic districts in South-western Uganda. The terrain is generally hilly and is traversed by many streams which drain into Lakes Edward, George and other lakes in the area. These streams tend to support breeding of *Simuliidae*. Following an enumeration exercise, the total population in the target area covered was determined to be 1580, the stated objective being to recruit at least 1500 subjects in contiguous villages into the study. After obtaining informed consent, subjects from the seven villages within the subsequently identified area were enrolled into the study. According to the protocol, all those five years or older were eligible for skin examination, while those ten years or older were eligible for eye examination. Seven hundred and fifty persons were randomly selected and enrolled into the study. Of these subjects, 367 persons of both sexes and in various age strata of ten age years and above were again randomly selected and had eye examination.

Team members (Ophthalmologists and ophthalmic nurses) were trained on the standardised protocol and especially the Motion Sensitivity Screening Test aspect of the Computerised Visual Function Test (CVFT). For the Wu-Jones Motion Sensitivity Screening Test (MSST), six points within the central field of vision were repeatedly tested at 1/3 meter from the screen of a laptop computer with vertical moving oscillating targets as described by Wu *et al.*<sup>11</sup> Each point was tested either six or ten times. The patient's ability to detect the motion was automatically recorded in the computer system. Detection of motion only between 0 to two times out of six or 0 to three times out of 10 as the case may be, was categorised as a severe defect, while 3–4 or 4–7 was taken as moderate defect, and 4–6 or 8–10 was taken as normal. These scores were then aggregated for each eye to give an overall impression of the visual field. Hence, a total score of 12 (i.e., 2 x 6) or less (18 or less in cases where stimuli were repeated ten times) was taken as a severe field

defect, and 24 (4 x 6) or less (42 or less) as moderate field defect, and scores above these as normal. Apart from this artificial categorisation, the actual motion sensitivity was also computed as a percentage of the maximum possible score of 36 (or 60).

The other variables examined for included visual acuities using Snellen "E" chart optotypes in available outdoor light; Slit lamp assessment for presence of microfilaria in the cornea, sclerosing keratitis, microfilaria within the anterior chamber following a two-minute head down posture, and evidence of acute or torpid uveitis. Intraocular pressure was measured using Schiøtz tonometry. Glaucoma was suspected if intraocular pressure was > 22 mmHg in the presence of a pathologically cupped disc (cup/disc ratio > 0.5). The presence of lens opacities was noted and scored using proportion of red reflex obscured. Following assessment of pupillary responses, the posterior segment was examined. After dilatation of pupil with short acting mydriatics, direct or indirect ophthalmoscopy was carried out for presence of onchocercal chorioretinitis and optic atrophy. Optic atrophy was regarded as 'early' if there was no associated subjacent vascular sheathing, and 'late' if there was. Mottling of the retinal pigment epithelium (RPE) was regarded as 'early' chorioretinitis, while confluent RPE, atrophy, and /or choriocapillary atrophy was regarded as 'late'. Blindness was regarded as vision <3/60 in the better eye, while visual impairment was vision between <6/18 and 6/60. Vision between < 6/60 and 3/60 was regarded as severe visual impairment.

#### Statistical Analysis

The data were entered in the field using Epi info version 6.4. Cleaning and analysis using SPSS were done at APOC headquarters in Ouagadougou.

#### RESULTS

A total of 367 subjects were fully examined. Their ages ranged from 5 to 99 years of which 210 (57.2%) were male and 157 (42.8%) female (M:F = 1:0.7) (Table 1). Unless otherwise stated, the right eye was used as sentinel.

#### Ocular Pathologies

Ocular morbidity, inclusive refractive errors, was identified in 86 subjects, giving an ocular morbidity rate of 23% in these communities (Table 2). The commonest single cause of pathology was cataract (4.4%). Onchocerciasis in general was responsible for 4.1%, with anterior segment lesions being responsible in 8 out of 15 cases. Primary optic atrophy was next with 10(2.7 %) subjects and this was followed by 5(1.4%) cases of glaucoma. Trachoma did not appear to be a problem in this community. Other conditions together accounted for pathology in 39(10.7%). individuals. Therefore, onchocerciasis contributed 31% of total eye disease burden. Limiting the analysis to the blind, five of the seven

blind were from cataract; one other from posterior onchocerciasis and one from primary optic atrophy.

#### Onchocercal Ocular Disease Burden

Dead microfilariae were found in two cases; there was no single case in which microfilaria was seen in the anterior segment. Punctate keratitis was present in seven and sclerosing keratitis in 14. Four cases had iridocyclitis, all of which were of the torpid variety. Prevalences of these conditions also generally showed an increase with age.

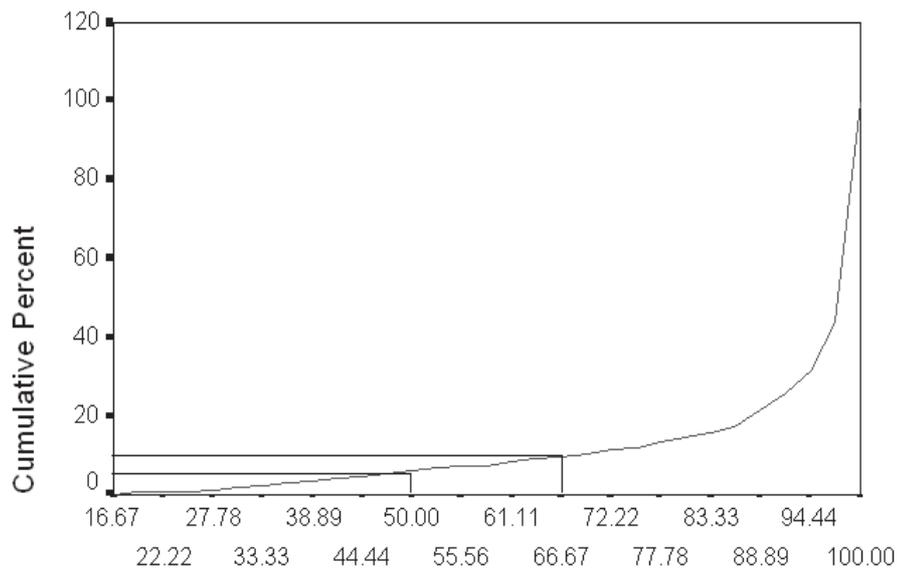
Chorioretinitis was present in a total of twelve cases; it was of the early variety in eight cases and late in four. Optic atrophy was relatively more common, being present in 45 cases and was early

**Table 1: Distribution of Study Subjects by Age and Sex**

Age Group (Years)	Number (%)		
	Male	Female	Total
5 – 14	16(7.6)	24(15.3)	40(10.9)
15 – 24	42(20.0)	22(14.0)	64(17.4)
25 – 34	45(21.4)	26(16.6)	71(19.3)
35 – 44	41(19.5)	17(10.8)	58(15.8)
45 – 54	39(18.6)	27(17.2)	66(18.0)
55 – 64	19(9.0)	21(13.4)	40(10.9)
≥ 65	8(3.8)	20(12.7)	28(7.6)
<b>Column Total</b>	<b>210(100.0)</b>	<b>157(100.0)</b>	<b>367(100.0)</b>

**Table 2: Main causes of Ocular Disease in Bushenyi, Uganda**

Disorder	Individuals with condition (N)	Percentage	
		Total Population	Eye Disease Burden
Cataract	16	4.4	18.6
Anterior Onchocerciasis	8	1.6	
Posterior Onchocerciasis	7	1.4	
Total Onchocerciasis	15	4.1	17.4
Primary optic atrophy	10	2.7	11.6
Glaucoma	5	1.4	5.8
Phthisis Bulbi	1	0.2	1.7
Trachoma	0	0.0	0.0
Others	39	10.7	45.3
<b>Total</b>	<b>86</b>	<b>23.4</b>	<b>100 %</b>



**Figure 1: Motion sensitivity test scores scores in Bushenyi, Uganda**  
 Motion sensitivity test scores as a percentage of maximum possible score.  
 6.4% of the population scored 50% or less on MSST and can be considered abnormal.

**Table 3: Ocular (Anterior Segment) Disease Indicators in 367 Inhabitants of Bushenyi, Uganda**

Age group (Years)	N	Indicator N(%)				
		DMFC*	Punctate Keratitis	Sclerosing Keratitis	Iridocyclitis	Cataract
N(M/F)	210/157	2(1/1)	7(5/2)	14(8/6)	4(3/1)	23(10/13)
5 – 14	40	0	0	0	0	1 (2.6)
15 – 24	64	0	2(3.2)	0	0	0
25 – 34	71	0	1(1.4)	1(1.4)	1(1.4)	0
35 – 44	58	0	1(1.7)	3(5.2)	0	0
45 – 54	66	1	1(1.5)	4(6.1)	2(3.0)	5(7.6)
55 – 64	40	0	1(2.6)	2(5.1)	1(2.6)	5(12.8)
65+	28	1(3.6)	1(3.6)	4(14.3)	0	12(42.9)
<b>Total</b>	<b>367</b>	<b>2(0.6)</b>	<b>7(1.8)</b>	<b>14(3.8)</b>	<b>4(1.1)</b>	<b>23(6.3)</b>

\*DMFC, Dead microfilaria in cornea. There was no case of microfilaria in anterior chamber.

in 26 and late (accompanied by vascular sheathing) in 19 cases. Intraretinal deposits were found in a total of 10 cases, being “oncho-related” in four cases and of other varieties in six cases.

**Visual Performance in Study Population**

Seven(1.9%) individuals were blind in both eyes, and 15 (4.1%) were visually impaired in both eyes. For the right eye, there were nine (2.6%) blind and 29 (8.4%) visually impaired. Visual impairment and blindness appear to increase with age (Table 4) and blindness was indeed not encountered at all until the sixth decade.

The motion sensitivity screening test was carried out on 353 subjects. Moderate visual field loss was detected in 33 (9.3%) and severe field defects in 10 (2.8%). Overall therefore, 43 (12.1%) persons had some degree of field defect. Motion sensitivity ranged from 16.7% to 100%, with a mean 90.2(18.1%). A cumulative frequency chart of motion sensitivity for Bushenyi is shown in Figure 1. It indicates that 6.3% of the population had subnormal field test based on the 50% cut-off point, while about 12% had subnormal field defects based on the 66.6% cut-off point.

**DISCUSSION**

The overall prevalence of ocular morbidity (23%) and blindness (1.9%) cannot be regarded as high for a community supposedly hyper-endemic for onchocerciasis. Onchocerciasis contributed 17.4% to the total eye disease burden but only to one case in seven blind. It is of course possible that the case of optic atrophy may be attributed to onchocerciasis but this cannot be readily proven. Rapid Epidemiological Mapping of Onchocerciasis data collected earlier had classified the Bushenyi area where these tests were carried out as hyper endemic on the basis of skin nodule prevalence. It must however be borne in mind that a vertical Ivermectin programme had been in place, supported by an non-governmental organization (NGO), since 1992 with a reported coverage of eligible community of about 40% in 1998. This fact may account for the paucity of acute oncho-related lesions, such as punctate keratitis of 1.8% and a total absence of anterior chamber microfilaria. The presence in significant proportions of irreversible lesions such as sclerosing keratitis (3.8%), oncho chorioretinitis (3.3%), and optic atrophy (12.4%), especially in the older age groups, suggests however, that onchocerciasis may have been a problem in that area in the past. The low prevalence of lesions may also be attributable to the effect of treatment if claims of prior treatment are true

The MSST pattern for this community is very interesting, being more similar to the ‘non onchocercal-endemic’ community of Fatika in Northern Nigeria as published by Wu *et al* in 1992.<sup>11</sup> In Bushenyi, 6.4% of the population had MSST scores at or below 50% cut-off point similar to the figure obtained for a ‘normal’ population in Fatika. This suggests that Bushenyi may be presently hypo- endemic although the area might have been hyper- endemic in the past. A ‘shift to the right’ in the cumulative frequency curve for motion sensitivity in communities following Ivermectin treatment is not altogether unexpected, because Abiose *et al*<sup>12,1</sup> have shown clearly that there is a tendency for improvement in optic nerve function

Table 4: Ocular Disease Indicators in Inhabitants of Bushenyi, Uganda

Age group (Years)	Disease Indicator, N(%)								
	N	Glaucoma	MSST: Field Defects	Optic Atrophy	Intra-retinal Deposits	Oncho- chorioretinitis	Visual Impairment	Overall Blindness	Onchocercal Blindness
M/F	210/157	2/3	22/21	27/18	4/6	2/10	4/11	2/5	0/1
5–14	40	0(0.0)	3(5.7)	0(0.0)	0(0.0)	0(0.0)	1(2.6)	0(0.0)	0(0.0)
15–24	64	1(1.6)	8(12.1)	5(7.9)	0(0.0)	0(0.0)	2(3.2)	0(0.0)	0(0.0)
25–34	71	1(1.4)	6(9.0)	8(12.8)	0(0.0)	1(1.6)	0(0.0)	0(0.0)	0(0.0)
35–44	58	0(0)	4(7.4)	5(8.6)	2(3.4)	1(1.7)	2(3.6)	0(0.0)	0(0.0)
45–54	66	1(1.5)	8(13.8)	12(18.2)	1(1.2)	3(4.5)	5(7.9)	0(0.0)	0(0.0)
55–64	40	2(5.3)	5(21.7)	9(23.1)	4(10.3)	3(7.7)	4(11.1)	2(5.3)	1(2.6)
65+	28	0(0.0)	9(25.7)	6(22.2)	3(11.1)	3(11.1)	1(4.2)	5(18.5)	0(0.0)
Total	367	5(1.4)	43(12.1)	45(12.4)	10(2.8)	12(3.3)	15(4.1)	7(1.9)	1(0.27)

in communities that are so treated to occur. These issues are discussed in more detail in another paper. There was little or no breeding of *simuliids* or transmission in the rivers immediately adjacent to the area where the clinical work was done. However, it must be noted that monthly transmission potentials based on third stage infective larvae in the head of parous flies and measured in breeding sites in neighbouring Kabarole district were sometimes as high as 292. This cannot be regarded as a 'safe' range and suggests that after about seven years of Ivermectin distribution, transmission was yet to be brought under control. It will be interesting to see how these variables and interplay of factors will change over the next five years. There have also been fears expressed concerning the sustainability of the CDTI after the cessation of involvement by APOC.<sup>5</sup> It is hoped that these fears will prove unfounded in the interest of the people at risk.

In summary the study has described a group of communities in the Bushenyi District of Uganda, where vertical Ivermectin treatment programme, with a relatively high coverage, had been in place for about seven years. The overall prevalence of blindness is relatively low, most of these occurring in the older age groups. The most significant problem requiring intervention appears to be cataract, which was responsible for five of the seven cases of blindness. This indicates quite clearly that there is a cataract backlog in parts of south-western Uganda and these cataracts from

our observations are not secondary or associated with onchocerciasis, especially since the prevalence of iridocyclitis is low at 1.1%. It is therefore necessary to put in place horizontal eye treatment intervention measures that will include cataract extraction and optical rehabilitation. It appears that some NGOs have already begun mobile eye unit services, but it was not clear at the time of our study whether modalities for eye surgery were included in the overall plan. Onchocercal eye disease although still present, was associated with only one case of blindness and significantly, no case of anterior chamber microfilaria was detected. The Ivermectin distribution programme must therefore be kept in place and strengthened, especially following the disengagement of African Programme for Onchocerciasis Control.

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#### REFERENCES

1. Abiose A. Onchocercal eye disease and the impact of mectizan treatment. *Annals of Tropical Medicine and Parasitology*. 1998, **92**: S11–S22.
2. APOC Impact Assessment Data Analysis Workshop, September 6–17, 1999. Ouagadougou, Burkina Faso. Report No. 2, page 3.
3. Boatin BA, Hougard JM, Alley ES, Akpoboua LK, Yameogo L, Dembele N, *et al*. The impact of mectizan on the transmission of onchocerciasis: *Annals of Tropical Medicine and Parasitology*. 1998, **92**: S47–S60.
4. Whitworth JAG, Gemade EII. Independent evaluation of onchocerciasis rapid assessment methods in Benue State, Nigeria. *Tropical Medicine and International Health* 1999, **4**: 26–30.
5. Mutabazi D, Duke BOL. Onchocerciasis control in Uganda: How can self-sustaining, community-based treatment with Ivermectin be achieved? *Annals of Tropical Medicine and Parasitology*. 1998, **92**: 195–203.
6. Walsh JF, Garms R, Lankwo TL. Planning of focal vector eradication in onchocerciasis in Uganda – report to WHO/TDR, 1996. 33pp.
7. Raybould JN, White GB. The distribution, bionomics and control of onchocerciasis vectors (Diptera: Simuliidae) in eastern Africa and the Yemen. *Tropenmedizin und Parasitologie*. 1979, **30**: 505–547.
8. Walsh JF, Molyneux DH, Birley MH. Deforestation: effects on vector-borne disease. *Parasitology* (supplement) 1993. 106, pp. S55–S75.
9. Ndyomugenyi R. The burden of onchocerciasis in Uganda. *Annals of Tropical Medicine and Parasitology* 1998. vol. **92**: 133–137.
10. Kipp W, Bamuhiga JT, Kwere EM. Onchocerciasis prevalence in previously known foci in western Uganda: results from a preliminary survey in Kabarole district. *Tropical medicine and Parasitology* 1992, **43**: 80–82.
11. Wu JX, Jones BR, Cassels-Brown A, Murdoch I, Adeniyi F, Alexander N, *et*

*al.* Preliminary report on the use of a laptop computer perimetry with a motion sensitivity screening test to detect optic nerve disease in onchocercal communities of rural Nigeria and in Western countries. 1992. Perimetry

update 1992/93, pp. 323–329. Proceedings of the Xth international perimetric society meeting, Kyoto, Japan, October 20–23, 1992. Edited by Richard P. Mills. © 1993 Kuger Publications, Amsterdam/New York.

12. Abiose A, Jones BR, Cousens SN, Murdoch I, Cassels-Brown A, Babalola OE, *et al.* Reduction in incidence of optic nerve disease with annual ivermectin to control onchocerciasis. *Lancet.* 1993; **341**: 130–4.