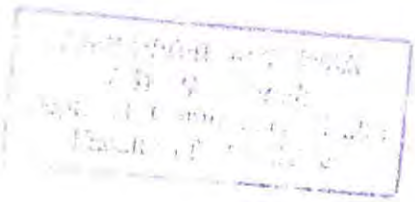
DETERMINANTS OF ONCHOCERCIASIS INFECTION AND ITS IMPACT ON HEALTH AND PRODUCTIVITY IN TEPPI COFFEE PLANTATION FIELD WORKERS



A THESIS
SUBMITTED TO THE
SCHOOL OF GRADUATE STUDIES OF
ADDIS ABABA UNIVERSITY
IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF PUBLIC HEALTH

BY
WONDIMU WORKNEH, B.Sc.

March, 1992

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

Determinants of onchocerciasis infection and its impact on health and productivity in Teppi Coffee Plantation field workers

By

Wondimu Workineh, BSc

Department of Community Health
Faculty of Medicine, Addis Ababa University

Approved by the Examining Board

Dr. Derege Kebede _____
Chairman, Department
Graduate Committee

Dr. Madeline Fletcher _____
Advisor

Prof. Nicholas Cunningham _____
Examiner

Ato GebrAmanuel Teka _____
Examiner

Dr. Asfaw Desta _____
Examiner

ACKNOWLEDGEMENTS

This research was funded by the International Development Research Center of Canada (IDRC). I am very grateful to this organization.

I am highly indebted to Dr. Madeleine Fletcher, my primary advisor, who was very enthusiatic on the research work, for her heartful assistance since the inception to the completion of the study. I am also very grateful for her advice which influenced me to work hard. I also thank Dr. George Olwit for his considerate help and advice and for his on-site supervision of the research project.

I Am greatful to the health workers at Teppi Coffee Plantation Project, specially to Ato Yilma Dellelegne, who were helpful in the data collection process.

The National Research Institute of Health and the National Organization for the Control of Malaria and other Vector Borne Diseases deserve gratitude for their material help.

Dr. Seyoum Taticheff is also to be thanked for his valuable assistance in the course of the research work.

I am highly grateful to the Coffee Plantation Development Corporation for sponsoring me,and to the managment and staff of Teppi Coffee Plantation Project, especially of Baya Farm,for their help in the course of the research work.

Last but not least I am indebted to Etaferahu Ayalew, who at the highest time shared my family responsibility.

LIST OF CONTENTS

LIST OF TABLES

ABSTRACT

A cross-sectional survey of onchocerciasis in male field workers was conducted in Teppi Coffee Plantation Project, Baya Farm, in November-December 1991.

The objectives were to assess the magnitude of the problem, to measure the sensitivity of various diagnostic procedures, to assess the effect on onchocerciasis infection of various exposure factors, and to determine the effect of the disease on work productivity.

A total of 196 study subjects participated in the study. They were interviewed to assess their exposure status and complaints of rheumatism. Physical examination was conducted and measurements on weight and height, and on visual acuity were taken. Parasitological diagnosis was based on skin biopsies from the calf, hip, and scapula bilaterally. Labor cards were reviewed over the previous twelve months to assess various indicators of work productivity. A case-control analysis was performed.

It was found that the prevalence rate of onchocerciasis was very high (82.8%), as compared to other studies conducted in Ethiopia. This was ascribed to the selection of the study population, whose age, gender, and exposure status made it prone to contract the disease. No study subject had any detectable visual impairment and other chronic manifestations were few. This was attributed partially to the "healthy worker effect".

Parasitological diagnosis detected 93.8% of the cases while clinical diagnosis only detected 35.8% of the cases.

In this study it was not possible to establish the protective effect of being always fully clothed at work and having less river-associated activities. This was attributed to the cumulative effect of exposure to many different sources due to the long sojourn of study subjects in endemic areas.

Workers with onchocerciasis were significantly more likely to be absent from work due to illness and other reasons, and earned significantly less wages than workers without onchocerciasis, thus demonstrating that non-blinding onchocerciasis has a negative impact on work productivity.

INTRODUCTION

Onchocerciasis is a disease with serious socio-economic consequences caused by a nematode, Onchocerca volvulus. It is known by different names in different communities, either after one of the first scientist to describe the diseases, as "Enfermedad de Robles" in Latin America (1), or based on the sequelae or symptoms of the disease, as "river blindness" (lay term in general use), "Wara" in some parts of Gondar, Ethiopia (Mesfin Addisie, personal communication), and "Yemiyasakik Yekoda Beshita" in the area where this study was conducted (author's personal communication with study subjects), both the latter terms meaning pruritic skin disease.

This disease remained rampant in West Africa until the advent of the Onchocerciasis Control Program 1974 and in Latin America until nodulectomy brigades were established. By carrying out vector control and recently introducing mass treatment with ivermectin, the Onchocerciasis Control Program has succeeded not only in reducing severe ocular involvement including blindness, but in bringing down the prevalence rate from about 25-30% at the beginning of the program to below 5% (2). Though the impact of nodulectomy in reducing the prevalence of the disease is still controversial, studies conducted in Guatemala and other Latin American countries have established its effect on the reduction in microfilarial density (3).

According to currently available reports, 17.8 million people are victims of the disease globally, of which 336,400 are blind. It is believed that this is an underestimate because of the disease being an "out of the road" one. Africa takes the lion's share among the victims: ninety-nine percent of the global total is in the region of tropical Africa, while the remaining is shared between the Arabian peninsula and six Latin American countries (4).

The African region carries the onus of 17.7 million cases and 335,000 blind people, with nearly the same number of people afflicted with severe visual impairment (5). The severe form of the disease is known to be limited to the Sudano-Guinean savannah belt. The mild form occurs in tropical forest and East Africa, including in Ethiopia.

Onchocerciasis in Ethiopia is said to be meso- and hypo-endemic in southwestern and northwestern regions (6,7). Recently new foci are being uncovered in Sidamo and Shewa Administrative regions, increasing the area under risk to over 132,000 square kilometers (8).

According to one estimate (7), 7.3 million people are at risk in Ethiopia, out of which 1.4 million are already infected, about 20,700 with loss of vision. As there is no nation-wide survey conducted to date, the reliability of this report is doubtful and is probably an underestimation.

Various surveys conducted in different parts of the endemic regions of the country have revealed hyperendemic, mesoendemic, and hypoendemic regions in the West (6), Southwest (7, 30) and

Northwest (8), defined according to the WHO standard of endemicity,60% and above as hyperendemic,below 40%hypoendemic and between 40-60% mesoendemic(3). Prevalence rates range from as high as 84%, through 56%, to 19.5%.

The disparity in reports of onchophtalmia among recent investigators in Ethiopia span from denying its existence (52,8,30) to reporting the occurrence of the pathology, though rare (6, 65). In the light of many high microfilarial density carriers, the probability of ocular pathology and existence of ocular microfilaria is high, had the search been made in accordance to the WHO standard methodology of ophthalmological examination for Onchocerca microfilariae (21). The author has witnessed one ophthalmological survey which was conducted at Bebeka. Study subjects were called to the slit lamp examination after visual acuity test without either bending their head to their knee or Mazotti test. The degree of partial visual impairment attributable to this disease has not been documented to date in Ethiopia. Little atention has been given to document partial visual impairment, even in other parts of Africa where the disease is of paramount public health importance as a cause of blindness (40). Early detection of partial visual impairment helps the prevention of blindness, which is a severe socio-economic burden.

The impact of the disease, especially that of blinding onchocerciasis, on socio-economic variables has been thoroughly investigated after the inception of the Onchocerciasis Control

Program (10). But that of the non-blinding one has been neglected despite its significant contribution to reduced work efficiency and debility (3). Little attention has likewise been given to the effect of onchodermatitis, underestimating the intolerable misery it causes and its social stigma. The misery is not by any means comparable to the infirmity caused by intestinal helminthiasis (2). Debility and reduced work efficiency means a lot in a community with subsistence economy or marginal income. Further, the burden of those affected on the health services is also of major concern. The disease, mostly affecting the productive age group, makes the matrix of the socioeconomic problem more complex.

Risk factors associated with onchocerciasis infection include age, man-vector contact, exposure to breeding site, vector density, and endemicity of the area (11). It is known that the immune response plays a big role in the course of the disease. The intensity of infection and the severity of the disease is also dependent on the duration and extent of man-vector contact, which is determined by different patterns of exposure due to occupational and other activities.

Fishermen, ferry-men, and people engaged in coffee cultivation have relatively higher exposures to the breeding sites of the vector than people engaged in other occupations.

The bio-climatic factors which are needed for coffee cultivation, such as lower altitude, thick bush, shade trees, perennial streams, and heavy rainfall, make good habitat for the Simulium vector. Demographic dynamics, such as migration from non-

endemic areas and high population density, enhance the transmission and increase the prevalence of the disease.

Onchocerciasis, besides resulting in dermal, ocular, lymphatic, and systemic morbidity in its own right,has been associated with rheumatism (12), pulmonary tuberculosis, lepromatous leprosy, and persistence of malaria parasitemia. Ecological and nutritional factors also affect the course of the disease (3). A preliminary study on the association of the disease with weight loss has documented marked weight loss in those with high intensity of infection (21)

This study investigated determinants related to exposure and the effect of non-blinding onchocerciasis on health and productivity, in male field workers in Teppi Coffee Plantation, southwestern Ethiopia. The findings from this study were expected to make relevant contributions to the design of an integrated approach to the control and prevention of the disease. They also contributed baseline information for future control programs by documenting the effect of non-blinding onchocerciasis.

OBJECTIVES

The general objectives of the study were:

1. to assess the magnitude of onchocerciasis as a health problem among male field workers of Teppi Coffee Plantation, Baya Farm.
2. to assess the sensitivity of various diagnostic procedures.
3. to study the effect on onchocerciasis infection of selected factors related to exposure to the vector, so as to recommend preventive measures.
4. to assess the effect of non-blinding onchocerciasis on work productivity.

The specific objectives were:

1.1. to estimate the prevalence of infection with Onchocerca volvulus among male permanent field workers of Teppi Coffee Plantation, employed for at least three years, so as to assess the current level of endemicity.

1.2. to establish the clinical profile of signs and symptoms for infected workers.

1.3. to assess the effect of onchocerciasis on visual acuity, nutritional status, and complaints of rheumatism.

2.1. to assess the sensitivity of clinical diagnosis of onchocerciasis as compared to combined clinical and parasitological diagnosis.

2.2. to assess the sensitivity of parasitological diagnosis based on skin biopsies from various locations, as compared to combined clinical and parasitological diagnosis.

3.1. to assess the effect on onchocerciasis infection of being fully versus partly clothed at work.

3.2. to assess the effect on onchocerciasis infection of the frequency of river-associated activities.

4. to determine the effect of non-blinding onchocerciasis on income, sick leave, and total leave, including non-authorized leave, as indicators of work productivity.

LITERATURE REVIEW

Historical Background

A young Irishman who was serving as a surgeon on a ship was visiting the then Gold Coast (Ghana). He examined six patients with irritation and skin eruption by snipping the skin with a sharp scalpel and placing the skin snip in a few drops of water. This was John Agnail (1875) who reported his finding to Lancet by illustrating the microfilaria which were later known to be the pathogenic parasite (1).

A few years after Agnail's discovery, Leuckart (1883), a German parasitologist, examined a nodule sent from West Africa by an anonymous missionary and found the adult worm. This worm was found to be different from W. bancrofti and Loa loa by Patrick Manson who had a chance to see the material sent by Leuckart.

The association between these two findings remained obscure until a Guatemalan medical practitioner, Rodolfo Robles, clearly demonstrated the relation of nodules and skin lesions. He also described anterior ocular lesions and postulated simuliids to be the potential vectors in his account "A new disease in Guatemala" in 1917. Blacklock in 1926 confirmed that Simulium was the vector for onchocerciasis.

In West Africa the disease was ascribed to divine curses, though the fetishes of statuettes, masks, and pagan dances illustrate the association of the disease, vector, and breeding

sites. The blackflies were regarded as "Children of the gods" in ancestral times (38).

In Kenya, people were well aware, as early as 1921, about the association between breeding sites, Simulium bites (called "kikonjeck bites"), and blindness. The inception of vector control using chemicals started in this country after the incidental observation of the killing effect on vector larvae of D.D.T. emulsion which fell into a river from a donkey carrying the chemical for a malaria campaign.

G. Bucco, an Italian Missionary, was the first to detect thirteen cases at Bonga, southwestern Ethiopia, in 1939 (13), and the vector was found in the same year by Giaquinto Mira (14). Since then studies were conducted by A. Barkhuus (1947), B. Cosar (1948, 1951), P. Grenier (1956) and A.A. Buck (1965), most of them in Kaffa administrative region (15).

A.P.Oomen was the first to make an extensive study in the administrative regions of Kaffa, Illubabor, Gamu Gofa and Wollega from August 1967 to July 1968 (15). His findings heralded the public health importance of the disease and generated interest in more recent investigators.

THE PARASITE

Biology

Onchocerca volvulus is a nematode, believed to be an exclusive parasite of man sustained by interhuman transmission. In recent investigations, however, the adult worm has been found in gorillas

under natural conditions (16), although the epidemiological significance of this finding has not been assessed.

The adult is found encysted in nodules over the areas of broad bones (skull, ribs, pelvis, and lower extremities). Microfilariae are located in subcutaneous tissues or in a free state as bundles in hardly accessible connective tissues, blood, and urine. The number of adult worms in a nodule commonly range from 1 to 10 with a male-to-female ratio of 1:1 to 2:1 (3). The males are short and fat. They are actively mobile, migrating from female to female to fertilize them. The females are inactive most of the time (2,17).

The lifespan of the adult worm is estimated to range from 12 to 15 years (2). The lifespan is affected by host immune mechanisms (17). The average reproductive lifespan ranges from 6 to 9 years (19), with a maximum of 11 years (18).

The fecund adult female worm discharges embryos known as microfilariae. This discharge from the female uterus is suspected to be sporadic (20) and by analogy with other filarial worms each female worm emits about 50,000 microfilariae daily (1). They are finely tapered at their posterior end with terminal nuclei arranged in a single row and have a longer caudal free end, relatively longer than Dipetalonema streptocerca, which has a blunt caudal end. Its lifespan ranges from 6 to 24 months (2,21).

These microfilariae are widely distributed in the skin and eye, and are also present in the blood and other tissues including the urinary tract. Their natural or chemotherapeutic death actuates the pathology of the disease. Their antigenic surfaces and

secretions/excretions which have immunosuppressive factors are important in the causation of host pathology (17).

The diversity in clinical presentation, which cannot be explained either by differences in parasitic load or by intensity of transmission, but is consistent with differing bioclimatic conditions, has suggested the idea of strain differences. To this effect, a study conducted in the early 1970s demonstrated several strains associated with Simulium complex vectors (22). Investigators have witnessed antigenically-distinct Onchocerca volvulus parasites in West Africa savannah and forest regions (23,24).

Life Cycle and Mode of Transmission

The development of the parasite involves the Simulium vector and the human host.

The progeny resulting from the fertilization of the adult female worm by the male, lie at the right depth in the skin of the human host so that they can be easily ingested by the short proboscis of the Simulium vector. The mechanism of microfilarial uptake is facilitated by the evolutionary adaptations of position in the skin, abundance in the anatomical site favorable to the biting habit of the respective vectors, and the attraction faculty of the vector to the biting site (1). This can be substantiated by the high microfilarial load below the waist in Africa, where the dominant vector species belong to the Simulium damnosum complex, which mostly bite the lower extremities, and above the waist in

Central America, where Simulium ochraceum is the predominant species, with a biting habit of above the waist (1, 3, 15). The use of Simulium for xenodiagnosis in the detection of low microfilarial densities, which are hardly possible to detect in skin snips (1, 26), favor the notion of the ability of the vector to attract microfilaria to the site of the bite by chemotactic secretions and to ingest many more than can be seen in skin snips.

The development of the parasite in the vector is governed by temperature and humidity. Studies conducted in Tanzania revealed the favorable optimum temperature to be 24°C, with no development at 18°C (27, 28).

Ingested microfilariae undergo three molts in the flight muscle of the vector before they reach the infective stage (third stage larvae). The larvae at this stage leave the flight muscle and migrate to the proboscis, ready to enter the human host during the vector's blood-meal. The blood meal helps in the development of the egg of the vector (15).

When infected flies imbibe blood from man, third stage larvae make their way into the human host. Due to meagre autopsy studies and lack of animal models, the development of microfilariae in man is not well known. But there is a general consensus among many researchers that the larvae further undergo two more molts before they reach the adult stage.

The life cycle is completed when the adult parasites are encapsuled in a nodule after fertilization. The site of mating for both sexes is the subcutaneous tissue over bony prominences. The

tissue here is thin, capable of blocking the migration of the adult and developing microfilariae (15). Juvenile filariae are found to have difficulties in locating the opposite sex during their migration in the subcutaneous tissue, but once united they remain fertile and stay permanently at the site of mating (15, 29).

The concept that all adult filariae will eventually be caught in nodules is refuted by their free existence in other tissues and by the non-existence of nodules in some infected patients. The discovery of a non-gravid adult female filaria in the wall of an aorta supports the above statement (21).

The existence of microfilariae in the blood (microfilaremia), urine (microfilaruria), and deep organs has initiated the concept of the possibility of transplacental transmission. Studies conducted in Ecuador, West Africa, and Ethiopia have revealed the presence of skin microfilariae and nodules in underfives, including neonates (15, 30-32). In a study done in one hyperendemic area it was found that 3% of newborns delivered by heavily-infected mothers were skin-snip positive; microfilariae were isolated from umbilical cord blood and in the tissues of the cord (3).

The intensity of transmission is related to the proximity of breeding sites. Studies conducted in West Africa have documented a prevalence gradient: high within a 10 km radius from a known breeding focus and thereafter decreasing (33). Another study conducted in North Cameroon revealed marked differences in the Annual Biting Rates, one of the indicators of transmission intensity, in relation to distance from river banks (34). Moreover

the intensity of transmission determines the severity of the disease, along with other determinants such as age and duration of exposure.

The disease

The disease is established when an infected blackfly is feeding for the third time on human blood. The larvae that were taken in during the first blood meal will develop to the infective stage (third stage larvae) in six to eight days. There is no clear-cut agreement reached on the exact prepatent and incubation periods for the disease. But generally the incubation period is longer and more variable than the prepatent period, which is said to last from 12 to 15 months (3). An immunological response is elicited even at the invasion of immature worms which is manifested by pruritis.

The diagnosis of the disease is based on parasitological, immunological, and clinical examination. The parasitological examination is said to be the best (21), although other methods of diagnosis should not be undermined.

Parasitological Diagnosis

Skin Snip

This is a method whereby diagnosis is established by observing microfilariae from skin snips. The preferred site for skin biopsy in Africa is the iliac crest, which is standard methodology for simple epidemiological evaluation in Onchocerciasis Control Programs (4), and because it is the most common site of

positivity, as compared to the calf and scapula (30). This method of diagnosis is further advocated to be useful in assessing the intensity of transmission and in evaluating the interruption of transmission (18). It can also be used for qualitative and quantitative assessment after standardization (21).

The standard procedure recommended for quantitative assessment is taking six snips, one from each scapula, iliac crest, and calf, placing them in distilled water and counting the emerging microfilariae with a tally counter after 30 minutes. By this time 50% of the microfilarie will have emerged, but the plateau is reached after 90 minutes (21).

The Mazotti test

This test, named after Dr. Mazzotti who first described the allergic reaction after a single dose of diethylcarbamazine, is characterized by pruritis and papular eruptions. The reaction starts as early as 15-30 minutes or as late as 24 hours or more. It is dependent on the microfilarial density, with the higher the density, the more positive and severe the reaction (21).

The reaction is not only limited to edematous changes of the skin and tender, painful, swollen inguinal plus femoral lymph nodes, which incapacitate the patient, but also involves ocular pathologies such as optic neuritis, chorioiridoretinitis, which are at times irreversible (21,11,42). Therefore, the use of the drug either in the diagnosis or treatment of onchocerciasis nowadays

involves ethical considerations, and some authorities strongly recommend not to use the drug for diagnostic purposes (42).

Urine and blood examination

Microfilariae of Onchocerca volvulus have been isolated from the blood, urine, synovial fluid, cerebrospinal fluid, vaginal smears... etc. The occurrence of systemic microfilariae is closely associated with intensity of infection(43). In hyperendemic areas microfilaremia and microfilaruria can be detected in about a third of the infected population.

Clinical signs, symptoms and diagnosis

Microfilarial death causes most of the clinical manifestations. Intensity of infection, bioclimatic zone, host immune mechanisms, and duration of infection are factors which influence these manifestations (17). There are people with high microfilarial density and no clinical manifestations, and those with low microfilarial density but severe manifestations. A varied degree of severity between individuals and between different bioclimatic zones can be inferred based on the above-mentioned facts. The diversity in clinical manifestations has made it difficult to describe clear patterns characteristic of a certain bioclimatic zone. However, the manifestations are categorized into onchodermatitis, onchocercoma, lymphatic onchocerciasis, onchophtalmia, and systemic onchocerciasis.

Onchodermatitis

It is classified as early and late skin manifestations. The early skin manifestations are characterized by pruritis and pigment changes. Pruritis at first is localized to certain anatomical regions and is intermittent, but later becomes generalized and permanent, resulting in insomnia and reduced productivity (2,3,21). It has nocturnal severity (15) and involves commonly the lower trunk, gluteal regions, and skin in Africans (21). Pruritis is a common subjective complaint, not necessarily related to microfilarial load (3). It is difficult to differentiate this complaint due to onchocerciasis from that caused by lice, fleas, or bed-bug infestations in a rural community.

Changes in pigmentation are the first objective signs of the disease. They manifest as hyper and hypopigmentation, with the latter being mostly confused with leprosy (3). Hyperpigmentations are characterized by macular, papular, and urticarial changes.

Late skin diseases are characterized by structural changes of the skin, except for leopard skin. The latter is a spotty depigmentation with a wide area of hypopigmentation and spots of hyperpigmentation confluently distributed. It mimics vitiligo but here the spots of hyperpigmentation are discretely distributed. It is usually seen on the skin but is also detected over the genitalia, iliac crest, and inguinal folds (3,47). The controversy about its etiology remains unsolved. Some authors attribute the condition to the parasite (46) and others to the bite of the blackfly vector (45,48). Studies conducted in Nigeria indicate that

it can serve as an index of endemicity. The prevalence of leopard skin up to 1% suggests sporadic infection, 1-6%, hypoendemicity and greater than 6%, meso or hyperendemicity (44,47).

The other variety of late skin disease manifests itself as structural changes of the skin. There is a notion that these structural changes ensue after repeated attacks of microfilarial death (17). The signs included in the category are diffuse swelling(peau d'orange), lizard skin, pachydermia, and atrophy (3).

Sowda is a chronic, hyperreactive, localized manifestation first seen in foci in Yemen. These days the condition is known to occur in Africa and America with low prevalence. There were two suspected cases seen in one of the surveys in Ethiopia(9).

Onchocercoma

These are subcutaneous tumors also known as nodules which result from the strong reaction of the host towards the parasite (17). The thin area of the subcutaneous tissue over the bony prominences cause limitation of movement of the macrofilariae, making this environment the place for copulation. There is a notion that the macrofilarial wander-lust terminates after copulation, making the parasite dwell permanently at these sites. The immunological response of the host at these concentrations of adult worms is strong and envelopes them in fibrous tissues mass which is known as onchocercoma (nodule) (15,17).

There is clear geographical variation in the distribution of palpable nodules; mostly on the pelvic girdle, iliac tuberosities,

sacrococcygeal area and a few on the head in Mexico and Guatemala(3).

The size varies from as small as 0.5 cm in radius to a mass of about 10 cm (21). A typical nodule is firm, elongated, often lobulated, non-tender, easily mobile. The palpable nodules are few as compared to those which are deep and impalpable. Count of palpable nodules and recording their distribution on the body provide an index of the intensity of infection (3). Asking patients to indicate their nodules is paramount in the detection of nodules, helping to locate otherwise impalpable nodules. It is found that the average number of palpable nodules in hyperendemic regions of Africa ranges from 5 to 10, whereas the individual load is much higher (3). However the number of palpable nodules does not relate with microfilarial load or clinical manifestations (17).

The occurrence and anatomical distribution on the body of nodules in Ethiopia is comparable to that in the Nigerian and Cameroon savannah (49). Most studies conducted in Ethiopia have not reported nodules on the head but one study in northwestern Ethiopia claimed three out of 21 palpable nodules(8).

Extirpation of nodules has long been practiced as a treatment for onchocerciasis, especially in Latin America. Its role in the reduction of microfilarial load is well documented in these countries (39) but its efficacy is still not established (2,50).

Onchophthalmia

This is a term which refer to the ocular involvement of onchocerciasis. The ocular pathology is a late effect which follows onchodermatitis. The prevalence and intensity of onchophtalmia is directly related to the prevalence and intensity of infection and specifically to the microfilarial load in the head and eye region (22).

The earliest sign of ocular involvement is the invasion of the eye by the parasite. As is common elsewhere in the body, the live microfilariae are not recognized by the immune system, and it is their death which triggers the immune response which is responsible for the pathology.

The reversible punctate keratitis is the earliest pathology observed to ensue from the localized inflammatory reactions. These reactions are due to the dead or dying microfilariae from either natural or chemotherapeutic death (2,11). The irreversible ocular pathology results from heavier and prolonged involvement, appearing first as severe visual impairment and terminating in total blindness eventually (2,3,11,22,50).

Blindness due to onchocerciasis is seen in hyperendemic areas (prevalence greater than 60%) and the rate ranges from 0%-15% (50,51), the highest being in Sub-Saharan Sudano-Guinean belt. It is the severest complication, with harsh socio-economic repercussions and with increased mortality rate among blind people in the productive age group, leading to decreased life expectancy of the adult population and cessation of economic viability by

depopulation of fertile lands (2,38,40,50). Mostly, males in the reproductive age group are at risk (2).

Risk factors for blindness include the prevalence and intensity of onchocerciasis infection in a community, occupations that increase man-vector contact, age 30-39 years, gender (male), head nodules, existence of 50 or more microfilariae in the cornea and appearance of signs and symptoms of irreversible ocular pathology (eg. night blindness, uveitis, edema of the optic disc or retina).

The Ethiopian version of onchophtalmia is an unsettled controversy. Woodruff et al have documented ocular pathology associated with the infection (49), but Yeneneh H. et al denied even the existence of microfilariae in the eye (52).

Systemic onchocerciasis and relation with other diseases

The significance and public health importance of systemic onchocerciasis is not clearly understood, but the finding of microfilariae in deep tissues, such as the liver, kidney, lungs, spleen, aorta, cerebro-spinal fluid... etc. (3,21), points to a gap in knowledge in clinical, epidemiological, and public health aspects.

Nevertheless, associations of the infection with loss of weight, dwarfism, increased frequency of epilepsy in hyperendemic areas, and delayed sexual development, exist. There is also a notion that the disease is associated with immunosuppression. Its immunosuppressive action with respect to the tuberculin test,

tetanus toxoid, and persistence of malaria parasitemia should be further investigated (3).

Diagnosis

Diagnosis is mostly established by the detection of microfilariae in skin snips. But a consensus has not been reached to date on how many skin snips to take, and from which anatomical site. The geographical variation of the disease, the host-vector complex, and the dependence of the disease on the immune system has compelled investigators to include some of the clinical signs into the picture of diagnosis (53,54). Most investigators include nodules and leopard skin as diagnostic signs (45,55) to increase the sensitivity. Roentgenographic diagnosis in the detection of impalpable nodules was used in a study in Chad to increase sensitivity (43).

Sensitivity of clinical and parasitological diagnosis

Epidemiologists have long used a combination of diagnostic procedures in order to increase the sensitivity of the diagnosis of onchocerciasis. The commonly-used diagnostic procedure is a combination of parasitological and clinical examination.

Parasitological examination, especially skin biopsy, has remained the mainstay in establishing the diagnosis of onchocerciasis. Its quantifiability in terms of microfilariae count per snip or per mg of skin has made the procedure popular in epidemiological investigations (18).

Due to the geographical variation of the vectors, with different biting habits, and the extent of migration of the parasite in the skin, it is found difficult to locate the exact anatomical site with frequent and high microfilariae concentration. Thus, combinations of skin biopsies from different anatomical sites are recommended, not only for the sake of increased sensitivity, but for purposes of epidemiological surveillance, evaluation of control programs, and comparability of different investigations (21,22).

Most studies in Africa concur on the sensitivity of hip biopsies as compared to those taken in other anatomical sites, but a combination of biopsies from this body region with calf and shoulder increased the sensitivity to 94% (56,57). But no significant change in sensitivity is observed in conditions of high microfilariae density. Studies in Ethiopia support sensitivity of the hip vis-a-vis other body regions (30,41).

Despite its severe reactions, the Mazotti test used to be carried out in order to increase the sensitivity of parasitological diagnosis. And truly it has a significant use, but false negatives were observed in Ethiopia, and false positive results were found in other parts of Africa, in patients with Dipetalonema streptocerca(21). But these days the Mazotti test is not recommended in ocular microfilarial carriers, because of the risk of exacerbating ocular pathology leading to blindness.

Besides the existence of microfilariae in the eye, the density of microfilariae in skin snips can predict ocular involvement.

Skin snips from the outer canthus has long served as index of ocular involvement. But a recent study conducted in Sudan found a better correlation of microfilariae in the eye with microfilariae load in shoulder skin snip (58).

Although the relatively short prepatent period as compared to the incubation period had made parasitological diagnosis vital in the early diagnosis of the infection, the evolutionary nature and extreme chronicity of the disease require more than parasitological diagnosis. Therefore clinical diagnosis has an important role in establishing the diagnosis of onchocerciasis.

Most of the clinical manifestations are due to the inflammatory reactions of dead or dying microfilariae (3). In clinically prominent conditions, the microfilariae density is often either low or totally absent (17,55).

Pruritis and nodules are the two most common early signs and symptoms (17). The finding of complaints of pruritis implicate the possibility of stimulus of the immune response by developing macrofilariae (3), but it remains the only early symptom until other objective signs appear. The prevalence of pruritis with or without dermatitis among skin snip positives ranges from 35% (36), through 50% in studies conducted in Ethiopia (49), through 63% in Ecuador (59).

The finding of a true onchocercal nodule is an incontrovertible sign. Variation in prevalence ranges from 23% in Colombia to 100% in some endemic foci in West Africa (22).

Investigations in Ethiopia reported onchocercoma carrier rates ranging from 0 to 36.7% (8,36,49).

Depigmentations which follow pruritis are other objective signs of the infection. Leopard skin serves as an index of prevalence in a community. The sensitivity of this index is claimed to be high by some authors (47).

Enlarged inguino-crural lymph nodes have myriad causes, ranging from local trauma to infections and lesions of the genitalia. They are mostly constitutional signs and not of diagnostic value (60).

Treatment with microfilaricidal drugs make inguino-crural lymphadenitis due to onchocerciasis tender, painful, and containing increased numbers of disintegrated microfilariae (3). Though they have high prevalence, they lack specificity. Fibrosis of these lymph nodes, resulting in adenolymphocele or hanging groin, has better diagnostic efficacy (3).

Except nodules and leopard skin, other clinical manifestations are either subjective or lack specificity. Even the detection of leopard skin, though it increase the sensitivity of onchocerciasis diagnosis, is not very helpful in the early diagnosis of the infection.

Infection gradient in relation to proximity to breeding sites

Transmission is influenced by factors which enhance man-fly contact. Duration and extent of exposure to Simulium breeding sites is found to have close association with the infection (22).

Studies conducted in Guinea and Senegal revealed that a high intensity of infection occurs in first-line villages which are found within three km. from potential breeding sites, no other village in between. Prevalence gradient was observed as distance from breeding site increased (33). This is also substantiated by findings in the Sudano-Guinean Savannah area. But on the other hand these findings are refuted in studies conducted in a forest village in Sierra Leone. Here risk of infection increases away from the riverside, in open farmlands. Little risk of infection was observed by the riverside, where shade cover was heavy (61).

Socio-economic effects

Interrelated factors, such as systems of land use, environment, economic organization, and migration, influence the socio-economic effect (3). In a very low man-to-land ratio, people are obliged to cultivate lands near river banks, where the transmission will be intense. This pattern of land use has led people to blindness and forced depopulation of fertile lands (38). It has also decreased the life expectancy of the blind (3).

Though the economic effect of non-blinding onchocerciasis is not properly documented, it is apparent that the debilitating effect of the disease decreases work efficiency and increases the burden to health services (3).

The environmental modification for coffee cultivation is found to increase the intensity of transmission. Besides the coincidence of optimum conditions for coffee cultivation with optimum

conditions for transmission, the migration of workers from non-endemic areas and back again increase the chance to propagate the disease to new foci (35,36)

Prevention and Control

The current strategies of control and prevention are oriented towards therapy and vector control. Nodulectomies were used in Latin America as both control and treatment strategies since the 1930's (3).

The effect of nodulectomy in the control of the disease is controversial. Some authors state that there is improvement in clinical manifestations and suppression of microfilaria for about two years (47,62), others claim that it has no significant effect in skin snip counts and the chance of new nodules appearing is high in hyperendemic areas (11,63).

Therapeutic control appeared in the scene after the advent of ivermectin. This is a macrocyclic lactone which was primarily in use as a veterinary antihelmentic. In the treatment and control of onchocerciasis, this drug has the advantage of being issued as a single dose with minimal Mazotti reaction and other side effects, and is capable to reduce dermal microfilarial density near zero for up to 12 months (63).It has the ability to act on the female uterus resulting in incapacitated progeny. Trials in West Africa have proved to be promising and further community-based trials are being conducted in other parts of the world to establish its control

efficacy. Currently ivermectine is the established drug of choice recomended by the WHO for the treatment of onchocerciasis.

Vector control by manipulation of biodegradable chemical spray has been the mainstay strategy in the Onchocerciasis Control Program. Due to the inaccessibility of many breeding sites by land, the use of aerial application of larvicides has made the program very expensive and not largely utilizable (11). The emergence of chemical-resistant larvae is also a major problem of the program. Despite this, the program has succeeded in decreasing the prevalence to as low as 5% and a similar drop in severe ocular involvement, including blindness, has occurred.

The prevention of man-fly contact is another preventive strategy to be considered. Activities that increase exposure to breeding sites need to be reduced and the use of protective clothing by individuals should be practiced through comprehensive community planning and health education. Community involvement is also vital in the prevention and control of the disease.

METHODOLOGY

1. STUDY DESIGN: Cross-sectional with a case-control analysis.

2. SELECTION OF STUDY SUBJECTS

i. Study Site

The criteria for site selection were:

1. Distance of residential and working areas from rivers should be similar for all study subjects, so as to isolate as much as possible the effect of the amount of clothing at work from other exposure factors.

2. Access to health care should be optimal, and similar for all study subjects, to avoid the bias which would result from differential access.

With these criteria in mind, the study site selected was Farm 02 and part of Farm 01 (Baya). This is an area where working and residential sites are located approximately the same distance from rivers. It is close to the central clinic of the project and to Teppi health center (about 10km). These two health institutions have better facilities than other health institutions in the area. Other farms are far from the above-mentioned health institutions, Farm 01 (Shosha & Komee), 20 and 30 kms respectively, & Farms 03 and 04 (Kabo), 37 and 45 kms. respectively.

ii. Study Population

The study population was to be constituted by all male permanent field workers of Teppi Coffee Plantation Project, Baya Farm, who met the eligibility criteria.

iii. Eligibility Criteria

Gender:- Since the study is concerned with the determinants and impact of the disease on productivity, the confounding effect of immunosuppression during pregnancy and the lower prevalence of the disease in females has enforced their restriction. And so male gender was made one of the eligibility criteria.

Age:- The legal age for working on Teppi Project is 15 years and age of retirement is 55 years. The eligible age range for the study was thus 18 - 54 years (taking into account the criterion related to duration of employment, see below).

Duration of employment in Teppi Project:- The incubation period of onchocerciasis as documented in different studies ranges from three to six years. Therefore duration of employment in Teppi Coffee Plantation for three or more years was made one of the eligibility criteria. This was done so as to be able to document the endemic level of transmission of onchocerciasis. Including recent arrivals, having stayed less than the prepatent period for onchocerciasis, would lead to an underestimate of that level.

Employment status:- Only workers with permanent status are eligible for paid sick leave. Their health records were also expected to be better kept than those of temporary workers (the collective

agreement between the organization and the labor union, Article No. 30, makes the proper recording of the health status of permanent employees compulsory). Therefore the study was restricted to permanent workers.

Occupation:- Workers employed in the application of insecticides were excluded, as they may face special health problems related to their occupational exposure, and thus constitute a different group.

iv. Calculation of required sample size:- this was done using the STATCALC function of EPI INFO. It was predicted, based on the author's knowledge of working conditions in the coffee plantation, that 80% of cases would have a low income (less than 50 birr per month, which is the official minimum wage in Ethiopia), as compared to 60% of controls. With a level of significance of 0.05 and a power of 80%, this would lead to a required sample size of 91 cases and 91 controls.

An estimated 375 to 500 male permanent field workers were working in Farm 02, according to the information available during the planning stages. Of these, the proportion of workers who met the eligibility criteria, especially that of duration of employment, was unknown. With an estimated prevalence rate of onchocerciasis of 60%-70% (estimated to be higher than that at Bebeka which was 40%, and since newcomers were to be excluded), one would need 228-304 study subjects to obtain 91 cases and 91 controls. Because of the uncertainty of the actual number of field workers at Farm 02, it was decided to undertake a total coverage of all those eligible for inclusion in the study.

3. ETHICAL CONSIDERATIONS

Information on the purpose and procedures of the study was given verbally to all eligible (see Appendix B for the content of the information given). Only those who gave their consent by signing in a registry book participated in the study. Findings of all participants were kept confidential. Leave with pay for study subjects during the time of their participation in the study was arranged with the organization management. Positive cases were treated with a single dose of ivermectin at 150 microgram per kilogram body weight and were followed up after treatment for 4 days, by asking them to report daily. Nodulectomy was performed by the author for 25-30 of those with nodules. It was not possible to perform nodulectomy on all 36 with nodules because of time constraints. Sterilization of the corneoscleral punches used for skin biopsy was carried out using a spirit lamp. They were kept in the flame until red-hot and then rinsed in 75% denatured alcohol for 2-3 minutes before they were applied to the next study subject. Surgical equipments for nodulectomy were properly washed, boiled at 100^0C for 20-30 minutes and then rinsed in Savlon with a concentration of 1:50.

4. MEASUREMENTS

i. Operational definitions

Case:- A subject who is skin biopsy-positive and/or classified as clinically-positive by the principal investigator, without reference to the parasitological results. All study subjects with nodules, leopard skin, or advanced adenolymphocele (hanging groin) were automatically classified as clinically-positive, these signs being practically pathognomonic for onchocerciasis. In addition, study subjects with signs and symptoms suggestive of onchocerciasis were also classified as clinically-positive, if justified by the extent and severity of the signs and symptoms, based on the clinical judgment of the author.

Control:- A subject who is skin biopsy-negative and classified as clinically-negative by the principal investigator, without reference to the parasitological results.

Questionable:- A subject who is skin-biopsy negative and classified as clinically-questionable by the principal investigator, without reference to the parasitological results.

Visual impairment:- Categorization of visual impairment as recommended by the WHO study group on the prevention of blindness (13).

Nutritional status:- Below, above, or within the acceptable range for weight-for-height according to reference II of the Society of Actuaries (14).

Rheumatism:- Including any mention of rheumatism, myalgia, arthralgia, muscle pain, bone pain, or joint pain in a study subject's medical records during the past twelve months.

Frequency of clinical visits:- The number of clinical visits a study subject made during the past twelve months from the medical records.

Absenteeism due to sick-leave:- Absenteeism due to sick leave given from authorized health personnel in health institutions which are accepted by the organization's policies and recorded on the labor card during the past twelve months.

General absenteeism:- Absenteeism from work for any reason without legal permission in the past twelve months.

Work efficiency:- The indicator used for this was the net pay every month for the past eight non-harvesting months, as recorded on the labor card. This reflects deductions for unauthorized absenteeism and for work which falls short of the daily norm or quota, as well as bonus payments made for extra work.

ii. Data sources

- Interviews: by a questionnaire (see Appendix A) pretested and administered by trained high school graduates.
- Labor card: official individual document where type of operation, amount of hours worked, days of absenteeism, gross pay, deductions, bonus payments, net pay, and days of sick-leave are recorded.
- Physical examination: clinical diagnosis was carried out by the author, who has participated in previous studies conducted on

onchocerciasis in Ethiopia; parasitological diagnosis was carried out by a junior laboratory technician and measurements of visual acuity and anthropometry by health assistants trained for the purpose of the study.

iii. Methods of measurement

- Clothing worn at work: by interview.
- River-associated activities: by interview.
- Visual acuity: measured by a health assistant after given instructions on the use of Snellen's "E" chart, under appropriate light illumination, with proper occlusion of the eye which is not examined.
- Nutritional status: measured with a beam balance by a health assistant trained in the method of measurement. The balance was checked against a standard weight every ten weighings. Weight was taken naked except light underwear and recorded to the nearest 100gm. Height was measured with a metallic scale. Participants stood erect bare-footed and without hats. Heel-crown measurement was recorded. Height was recorded to the nearest centimeter. The health assistant who was measuring the weight also measured the height.
- Presence of skin microfilaria: by skin biopsy from the calf, hip, and scapula bilaterally, using a corneoscleral punch, by a health assistant trained in the technique. Skin snips were placed on a slide in three drops of distilled water. They were examined under a dissecting microscope after 30 minutes. Microfilaria were counted with a tally counter by a junior laboratory technician.

- Rheumatism: by interview, recording complaints of "kurtimat" (a general term for rheumatic pains, including myalgia, arthralgia, muscle pain, and joint pain) over the previous fifteen days by the immediate work supervisor. To minimize response bias, the respondents were also asked about their experience of diarrhea and of cramping abdominal pain over the same time period. Out of the 104 cases and 11 controls, 27.2%(3),54.5%(6) and 18.2%(2) of the controls responded affirmatively for complaints of diarrhea,abdominal cramping pain and rheumatisim respectively.28.8%(30), 37.5%(39), and 40.2%(42) of the cases responded afffermatively for the above mentioned complaints respectively. This shows that there is no information bias.

Frequency of clinical visits: this was to have been abstracted from individual health record cards kept in the project clinic, but this aspect of the study had to be abandoned because of the unexpectedly poor state of record-keeping.

- Absenteeism due to sick-leave: abstracted from the labor card by the author.
- General absenteeism, same as above.
- Work efficiency, same as above.

5. CONTROL OF DATA QUALITY

A general registry was kept in which the registration number, the name of the study subject including his father and grandfather's name (recorded in Amharic), his age, unit farm, residential area, and name of his immediate supervisor were

registered. This was done to facilitate the subsequent retrieval of medical records and labor cards. It also helped in case of need to counter-check the data collection form.

The language of interview was Amharic, as most field workers understood and communicated in the language. For those who could not understand and communicate in Amharic, they were interviewed in Kefegna or Oromegna, which are the commonly-spoken languages in the area. One of the interviewers was Keffa and the other Oromo. Since the interview form was extremely simple (see Appendix A), it was completed by the interviewer in English, except for the name of the immediate supervisor ("kapo"), which was recorded in Amharic.

The flow of the investigation was as follows:
Informed consent _____ Registration _____ Interview_____ Weight and height _____ Visual acuity _____ Skin biopsy _____ Physical examination. Later on the interview was moved to just before physical examination, since it was more time consuming than other investigations.

This flow mechanism was also a mechanism for sequential supervision of proper recording. The one next in the flow were instructed to make sure that the previous one had recorded according to instructions what he should record.

The questionnaire was pre-tested and three interviewers, all high school graduates, were trained. The contents of the training were: polite approach to study subjects, how to ask the questions, and how to fill the form. Each interviewer conducted 15 pre-test interviews as part of the training process.

The research coordinator, a nurse, supervised the interviewers during the actual data collection process. He stood by their side and monitored how they asked the questions and how they recorded the information. He randomly checked completed forms at the site for their appropriateness.

The contents of the training of health assistants on measurement of weight, height, and visual acuity included familiarizing them with the instruments of measurement, informing them of the importance of precise measurement, and techniques of measurement. They also received practical experience as part of their training.

The procedure of supervision of the health assistants by the research coordinator during the actual data collection period included observations on the process of measurement, random remeasurements of study subjects, and checking forms for their appropriate recording.

Clinical diagnosis was carried out by the author, who had experience in diagnosis of onchocerciasis through his participation in prior studies of the disease in Ethiopia (30, 48, 64).

Dermatological disorders which could confuse the diagnosis of onchocerciasis were given due attention. Vitiligo and early leprosy were differentiated from leopard skin by their site of appearance - leopard skin is mostly seen on the skin of the legs, while vitiligo is mostly on the face and hands - and by the nature of altered pigmentation - leopard skin shows dots of hyperpigmentation at the center of the hypopigmented areas while vitiligo has broader area

of hypopigmentation and leprosy the classical cafe-et-latte type of hypopigmentation; the site of hypopigmentation of early leprosy is the back or the hip.

Nodules could not be mistaken for fibromas, as nodules are firm and easily mobile on palpation.

The commonest and earliest symptom of onchocerciasis, itching, could be differentiated from scabies in that scabies is more peripheral in distribution and it affects interdigital clefts, wrists, and ankles, while itching in onchocerciasis is confined to certain areas, the trunk and proximal parts of the limbs.

Diffuse swelling of the skin in onchocerciasis (called "peau d'orange") has the appearance of the skin of an orange, shiny and with dialated pores and normal pattern of skin folds (8).

In lizard skin, the skin is dry, scaly, and inelastic.It shows coarse skin folds where it hangs down in thick folds at the lower back and buttocks. It appears more like the skin of an elephant.

Pachydermia is a true hypertrophy of the skin.The skin folds are lost and it cannot be bent between finger and thumb. It is seen as small islands surrounded by normal or atrophic skin or in large skin patches.

Coding was carried out by the research supervisor and checked by the principal investigator. The data collection form was designed in such a way as to facilitate coding and minimize coding errors (see Appendix A).

Potential Biases in Study

"Healthy worker effect": those who are most incapacitated by onchocerciasis and its effect on other diseases will have stopped working or died and therefore would not be part of the study population. This bias was expected to lead to an underestimate of the effect of onchocerciasis on health and productivity.

"Shadow effect": this refers to labor compensated by a member or members of the family. All activities except harvesting are not compensated or supplemented by family members because they are too physically-demanding to be carried out by females and children.

The "shadow effect" was thus expected to affect net pay (as an indicator of work efficiency) during the harvesting months (July to October), and therefore these months were excluded from the analysis of net pay.

Non-response bias: healthy workers were expected to be less interested in participating in the study and this was expected to result in an overestimate of the prevalence of onchocerciasis. Attempts were made to minimize this type of bias by offering study subjects the incentive of receiving full pay during the time they were examined and of being treated if found to be infected. The author contacted supervisors and farm managers at the work site, visiting each two to three times, to remind them to send their permanent field workers for examination.

Investigator bias: the laboratory findings were recorded on a separate registry and transferred to the data collection form at the end of the day, thus they were not available at the time of clinical diagnosis

Records retrieved from the labour card were recorded on a separate form, making inaccessible the physical examination and laboratory findings to the recorder.

6. ANALYSIS

The analysis of potential determinants and outcomes of onchocerciasis was made by comparing cases and controls with respect to their socio-demographic characteristics, exposures, clinical profile, and the various indicators of productivity. Those classified as "questionable" were excluded from this comparison. Odds ratios were calculated and tests of statistical significance performed using EPI INFO. Proportions and/or means were compared, as appropriate. Yates' corrected Chi-square was calculated, except when one or more of the expected values were less than 5, in which case the Fisher exact test was used, with a one-tailed P-value.

The analysis of the effect of protective clothing was conducted by comparing those who are fully protected by clothing (i.e. who always wear shirts and long trousers at work) and those who are partially protected by clothing (all others). Since manual weeding is an activity which is more physically-demanding and therefore more conducive for workers removing some of their

clothing due to hot climatic conditions, clothing habits were considered separately for manual weeding and for other field activities.

In order to determine the effect on infection of exposure to the vector in relation to river-associated activities, a composite score for river-associated activities was calculated (see Appendix C). First different weights were assigned to each type of activity, based on the duration of exposure each would typically involve. Weights were also assigned for the frequency of carrying out each activity. For each study subject a separate score for each type of activity was then calculated, by multiplying the factor for type of activity by the factor for frequency of carrying out the activity. Finally the individual scores for each type of activity were summed up for each study subject to give the total score for river-associated activities, taking into account both the types and frequency of exposure to the river.

In the analysis of the effect of the disease on productivity, it was not found possible to collect data on the previous 12 months for all subjects, because of incomplete records. The data available for each subject related to differing periods of time and different months. Therefore the analysis was conducted using person-months.

RESULTS

A. Study population

It proved difficult to carry out the study during the time period allocated, because of labor unrest and labor outmigration following the recent change of government. There was also intense dissatisfaction with the fact that only permanent workers were to receive the benefit of being examined and treated for onchocerciasis. These factors resulted in delays in carrying out data collection and in the enrollment of far fewer study subjects than were needed to meet the sample size requirements. Thus an attempt was made in the last month of data collection to increase the sample size by recruiting temporary workers. The labor outmigration also made it difficult to know the exact number of field workers employed in Farms 02 and 01 during the study months (November-December 1991 for 132 permanent field workers and February 1992 for 10 permanent field workers and 54 temporary workers). According to management records, male permanent field workers, excluding 26 employed in chemical spraying activities, numbered 199 in October, 190 in November, 149 in December, 124 in January, and 74 in February. Temporary male field workers numbered from 464 to 425 during the same time period. A total of 196 field workers (142 permanent and 54 temporary) who met the enrollment criteria and consented to participate in the study were examined.

Considering only the 132 permanent field workers examined in November-December 1991, and approximating the total population of

permanent male field workers as the average for the two months, or 170, this would give a minimum response rate of 77.6%. This represents a minimum, since the proportion of workers who had been less than three years on the plantation, and thus not eligible to participate in the study, was not known. The prevalence rate of onchocerciasis was determined both for this subpopulation and for the total study population.

The mean age of the study subjects was 27.9 (S.D.8.1). The distribution of the study population by age, place of residence, and place of work, is shown in Tables 1-3 (also see the map).

A total of 127 (64.8%) study subjects were below the acceptable range with respect to weight-for-height. There were 116 (59.2%) study subjects with average per capita household incomes of less than 50 Ethiopian Birr per month. No study subject had any detectable visual impairment (i.e. less than 6/18).

Tables 4 and 5 depict years lived in Teppi plantation and duration of stay in endemic areas, respectively. For most study subjects the duration of stay in the plantation was short -60.9% stayed 3-5 years - but most stayed long in endemic areas - 58.7% stayed 21-30 years -. This is due to the plantation being young as a project (established in 1988) and because much of the labor forcecomes from Kaffa administrative region, a known endemic focus.

TABLE 1. Age distribution of study subjects, Teppi Coffee Plantation, November to February 1992

Age in years	Number	Percent
18-29	136	69.4
30-39	39	19.9
40-49	15	7.7
50-59	6	3.1
Total	196	100.0

TABLE 2. Study population by working area, Teppi Coffee Plantation, November to February 1992

Working area	Number	Percent
01-01	63	32.1
02-02	2	1.0
02-01	69	35.2
02-02	62	31.6
Total	196	100.0

TABLE 3. Study population by residential area, Teppi Coffee Plantation, November to February 1992

Residential area	Number	Percent
Baya	67	34.2
Korcha	11	5.6
Tsanu	118	60.2
Total	196	100.0

TABLE 4. Study population by years lived in the plantation, Teppi Coffee Plantation, November to February 1992

Years lived	Number	Percent
3-5	119	60.7
6-10	33	16.8
11-15	19	9.7
16-17	25	12.8
Total	196	100.0

ABLE 5. Duration of stay of study subjects in onchocerciasis-endemic areas, Teppi Coffee Plantation, November to February 1992

Duration in endemic area (years)	Number	Percent
3-5	11	5.6
6-10	2	1.0
11-20	44	22.4
21-30	115	58.7
31-50	24	12.2
Total	196	100.0

B. Prevalence rate of onchocerciasis

A total of 162 cases of onchocerciasis were identified, of which 152 (93.8% of the cases) were parasitologically positive and 10 (6.2%) were clinically positive but parasitologically negative. This makes the prevalence rate of onchocerciasis to be 82.7%, and the prevalence rate of detected microfilarial carriers to be 77.6%. A total of 152 (93.8%) of the cases were determined parasitologically, while 58 (35.8%) were diagnosed clinically. These results are summarized in Table 6.

Considering the subpopulation of 132 permanent field workers who were examined in November-December 1991, 111 of them or 84.1% were diagnosed as cases of onchocerciasis, and 107 or 81.1% were detected to be microfilarial carriers. Based on tests of statistical significance, these results were not significantly different from those for the total study population.

C. Sensitivities of clinical and parasitological diagnosis as compared to combined clinical and parasitological diagnosis

Parasitological diagnosis was highly sensitive, detecting 152 (93.8%) of the cases. By anatomical site of the skin biopsy, the hip had the highest sensitivity (84.0% for a single snip), followed by the calf (75.3-76.5 for a single snip),then the shoulder (50.0-53.7 for a single snip), as shown in Table 7. Clinical diagnosis on the other hand had very low sensitivity, detecting 58 (35.8%) of the cases. No difference was observed in mean microfilaria load per skin snip between calf and hip. But the load for scapula is found to be low. These results are summarized in Table 8.

TABLE 6. Comparison of parasitological and clinical diagnosis Teppi Coffee Plantation, November to February 1992

Parasitological diagnosis	Clinical diagnosis Positive(%)	Questionable(%)	Negative(%)	Total
Positive	48(82.8)	45(73.8)	59(76.6)	152(77.6)
Negative	10(17.2)	16(26.2)	18(23.4)	44(22.4)
Total	58(100.0)	61(100.0)	77(100.0)	196(100.0)

TABLE 7. Sensitivity of skin biopsy from different anatomical sites in detecting parasitologically-positive study subjects, Teppi Coffee Plantation, November-February 1992

Parasitological result	Right calf(%)	Left calf(%)	Right hip(%)	Left hip(%)	Right scapula(%)	Left scapula(%)
Positive	122 (78.2)	124 (79.5)	136 (87.2)	138 (88.5)	81 (51.9)	87 (55.8)
Negative	30 (21.8)	28 (20.5)	16 (12.8)	14 (11.5)	71 (48.1)	65 (44.2)
Total	152(100.0)	152(100.0)	152(100.0)	152(100.0)	152(100.0)	152(100.0)

TABLE 8. Mean microfilarial load for different biopsy sites in study subjects parasitologically-positive for the respective sites, Teppi Coffee Plantation, November-February, 1992

Anatomical site	Mean (per skin snip)	Standard deviation
Right calf	32.89	46.57
Left calf	34.77	52.71
Right hip	32.82	38.89
Left hip	35.23	37.29
Right scapula	9.91	12.39
Left scapula	11.49	14.33

D. Clinical profile of signs and symptoms

Frequencies of clinical signs and symptoms were compared between cases, controls, and questionables (Table 9). Cases were significantly different from controls with respect to the presence of nodules, itching, itching with sleep interference, itching with scratch marks, macular dyspigmentation, and femoral and inguinal lymphadenopathy. Cases were significantly different from questionables with respect to the presence of nodules, itching, and macular dyspigmentation.

Intesity of infection

For ease of comparison the with other studies in Ethiopia, the microfilaria load per skin snip of both hips was considered.the average microfilaria load in this study was found to be 35/snip. The result is shown in table 9a.

TABLE 9. Prevalence of clinical signs and symptoms of onchocerciasis infection, Teppi Coffee Plantation, November to February 1992

Variables	Cases No.	Cases %	Controls No.	Controls %	Questionables No.	Questionables %
Total subjects	162	(100.0)	18	(100.0)	16	(100.0)
Nodules	36	(22.2)	0**		0**	
Leopard skin	8	(4.9)	0		0	
Itching	121	(74.7)	5	(27.8)*	16	(100.0)**
Itching with sleep interference	97	(59.9)	4	(22.2)*	11	(68.8)
Itching with scratch mark	56	(34.6)	1	(5.6)*	10	(62.5)
Macular dyspigmentation	66	(40.7)	0*		12	(75.0)*
Papular rash	30	(18.5)	1	(5.6)	4	(25.0)
Diffuse swelling (peau d'orange)	2	(1.2)	0		0	
Lizard skin	5	(3.1)	0		1	(6.3)
Pachydermia	6	(3.7)	0		1	(6.3)
Atrophy	14	(8.6)	0		1	(6.3)
Femoral lymphadenopathy	52	(32.1)	1	(5.6)*	8	(50.0)
Inguinal lymphadenophathy	91	(56.2)	5	(27.8)*	9	(56.3)
Adenolymphocele (hanging groin)	4	(2.5)	0		0	
Scrotal elephantiasis	1	(0.6)	0		0	
Elephantiasis of the leg	10	(6.2)	1	(5.6)	0	

* difference with cases is statistically significant at 0.05 level, Yates corrected chi-square.

** difference with cases is statistically significant at 0.05 level, Fisher exact test, one-tailed P-value.

Table 9a. Intesity of infection in positve study subjects based on skin biopsies from both hips, Teppi Coffee Plantation Project,November - February 1992.

Microfilaria Load	Bebeka (%)	Teppi (%)
Average MF load		35mf/snip*
0.1 - 10	87 (60.4)	39 (27.1)
11 - 50	52 (36.1)	59 (41)
>50	5 (3.5)	46 (31.9)
Total	144 (100)	144 (100

* A skin snip is approximately weighs 1 mg.

E. Effect of duration of exposure on onchocerciasis infection

As seen in Table 10, cases tended to be older than controls, although the difference was not statistically significant. Cases were significantly more likely than controls to have lived for more than 5 years in Teppi Plantation (43.8% versus 16.7%), and for more than 5 years in endemic areas (96.3% versus 83.3%).

F. Effect of protective clothing on onchocerciasis infection

The findings revealed no protective effect of being always fully clothed when carrying out field activities (Table 10).

G. Effect of river-associated activities on onchocerciasis infection

The findings revealed no statistically significant association (Table 10).

H. Effect of onchocerciasis on nutritional status and complaints of rheumatism

As is depicted in Table 10, there was no statistically-significant difference in nutritional status between cases and controls. Cases were more likely to complain of rheumatism (40.4%) than controls (18.2%). This association is not statisticall significant, but the width of the 95% confidence interval favours an association, had the study population been larger.

TABLE 10. Differences in selected variables between onchocerciasis cases and controls based on interviews of study subject, Teppi Coffee Plantation, November-February 1992

Variable	Cases No.	Cases %	Controls No.	Controls %	Odds ratio	95% Confidence interval	P-value
Total	162	100.0	18	100.0			
Age in years							
18-29	110	67.9	16	88.9			
30-59	52	32.1	2	11.1	0.26	0.03-1.20(1)	0.116(2)
Years lived in Teppi Plantation							
3-5	91	56.2	15	83.3			
6-17	71	43.8	3	16.7	0.26	0.05-0.96(1)	0.049(2)
Years lived in endemic areas							
3-5	6	3.7	3	16.7			
6-50	156	96.3	15	83.3	0.19	0.04-1.33(1)	0.048(3)
Always wear shirt and long trousers for manual weeding							
Yes	90	55.6	10	55.6			
No	72	44.4	8	44.4	1.00	0.32-2.98(1)	0.803(2)
Always wear shirt and long trousers for field activities other than manual weeding							
Yes	137	84.6	15	83.3			
No	25	15.4	3	16.7	1.10	0.19-4.30(1)	0.556(3)
Score for river-associated activities							
0-249	127	78.4	12	66.7			
250-800	35	21.6	6	33.3	1.81	0.52-5.67(1)	0.120(3)
Nutritional status							
accept.range	59	36.4	6	33.3			
below accept. range	103	63.6	12	66.7	1.15	0.37-3.92	1.000(2)
Complaints of rheumatism(4)							
Yes	42	40.4	2	18.2			
No	62	59.6	9	81.8	3.05	0.58-30.14(1)	0.131(1)
Monthly household income in Eth.Birr							
50-149	147	90.7	12	66.7			
150-467	15	9.3	6	33.3	4.90	1.30-16.57(1)	0.009(3)
Monthly per capita income in Eth.Birr							
11-49	102	63.0	6	33.3			
50-103	60	37.0	12	66.7	3.40	1.10-11.56(1)	0.029(2)

1. Exact 95% confidence interval
2. Yates corrected chi-square
3. Fisher exact test, one tailed P-value
4. Total cases are 104 and controls 11

I. Effect of onchocerciasis on self-reported household income

As seen in Table 10, cases had significantly lower self-reported household incomes than controls, both in terms of total household income (90.7% versus 66.7% with household incomes below

150 Ethiopian Birr) and of average per capita income (63% versus 33.3% with per capita incomes below 50 Ethiopian Birr).

J. Effect of non-blinding onchocerciasis on work productivity

The results, summarized in Table 11, indicate that cases are significantly more likely to be absent from their work for reasons of sick-leave and unauthorized leave than controls. Over a period of one year, the per capita increase in leave for cases would amount to 1.5 days of sick leave, 9.2 days of unauthorized leave, and 10.7 days of total leave. These findings are statistically significant. Controls had higher incomes per person-month than cases (12 birr more on average).

TABLE 11. Differences in selected indicators of work productivity between onchocerciasis cases and controls, based on retrospective analysis of monthly labor cards of study subjects, Teppi Coffee Plantation, November-February 1992

Variables	Cases Total (per person-month)	Controls Total (per person-month)	Rel.risk	95% Confidence interval	P-value
Subjects	99	13			
Person-months of follow-up	676	80			
Days of leave					
1. Sick leave	82 (0.1)	0	1.12	1.11-1.12	0.002
2. Unauthorized leave	2327 (3.4)	214 (2.7)	1.03	1.01-1.04	0.0002
3. Total leave	2409 (3.6)	214 (2.7)	1.03	1.02-1.04	0.00002
Person-months of follow up for income	388	40			
Income(Ethiopian birr)	17484(45.1)	2283(57.1)			

Note: uncorrected chi-squares and odds ratios were calculated after converting person-months of follow-up to person-days of follow-up

DISCUSSION

In this particular study, the prevalence rate of onchocerciasis (82.7%) was found to be higher than reported from other parts of the country. Most prevalence studies conducted in Ethiopia report the endemicity to either meso or hypoendemic (8,15,30,36,49,52). But in this study it is found to be hyperendemic and close to that of the Cameroonian forest (49). Reasons for this are several. The study has dealt with a sub-population whose gender and occupation make it prone to the infection. Also, it has excluded newcomers who would still be in the prepatent and incubation periods for the disease, so that the true level of endemicity could be determined. Another explanation for the high prevalence is the methodology employed. Unlike most prevalence studies conducted in Ethiopia, this study based its diagnosis on six skin biopsies from different anatomical regions to increase the sensitivity (21).There is a possibility of underestimation of the prevalence rate due to the exclusion of chronically ill individuals. Taking all these factors into account, it is still apparent that the magnitude of onchocerciasis infection is extremely high in Teppi Coffee Plantation Project, Baya Farm.

From the literature, it is apparent that clinical manifestations of oncherciasis are highly diversified and are dependent on the host immune response, bioclimatic zone, and duration of exposure (3,21). Table 12 compares the prevalence rate of microfilarial carriers in males and the prevalence of clinical manifestations in infected people foundin the various surveys.

Table 12. Comparison of the prevalence of microfilarial carriers among males aged 15-60 years and of clinical manifestations among microfilarial carriers of both sexes and all ages in different surveys conducted in Ethiopia, 1969-1990

	8	15	30	36	49	52	64	This study
Geographic location	Humera, Northwest	Southwest (Keffa, Illubabor, Gamu Gofa)	Bebeka, Keffa	Gamu Gofa	Bedele, Illubabor	Bure, Illubabor	Bebeka Keffa	Teppi
Age range	20-59	15-30+	-	16-60	not given	20-59	15-45+	18-59
Methodology*	1	2	3	4	5	4	1	3
Microfilariae carriers**	34.7%	29.7%	-	35.2%	33.8%	50.6%	69.8%	77.6%
Clinical manifestations								
Onchocercoma	7.9%	12.8%	-	0	36.7%	0	-	22.4%
Itching	-	56.0%	-	34.9%	50.0%	20.8%	-	73.0%
Leopard skin	-	8.0%	-		18.0%		-	3.9%
Macular dyspigmentation	-	33.3%	-			13.4%	-	39.5%
Papular rash	-	25.8%	-	9.3%	54.0%	20.8%	-	15.1%
Skin hypertrophy	-	26.2%	-		-	-	-	2.6%
Lizard skin	-	-	-		-	-	-	2.0%
Atrophy	-	22.8%	-		-	1.0%	-	8.6%
Femoral lymphadenitis	-	29.6%	-	-	-	13.4%	-	32.9%
Inguinal lymphadenitis	-		-	-	-		-	56.6%
Adenolymphocele (hanging groin)	-	1.2%	-	-	0	-	-	2.0%

* 1. skin snip from hip and calf bilaterally
2. 1-2 snips from hip and calf
3. two snips from each calf, hip, and scapula
4. two snips from hip
5. one skin snip from hip

** The proportion of microfilariae carriers is calculated out of the total population of males in the age range specified while the proportion with various clinical manifestations are calculated out of microfilariae carriers of both sexes and all ages.

conducted in Ethiopia. Early manifestations (itching, lymphadenopathies, macular dyspigmentation and onchocercomas) are more prevalent in this study as compared to other studies, but chronic manifestations are rare. This may be due to most of the study subjects being young. The "healthy worker" effect may also shadow the prevalence of chronic manifestations as those debilitated and incapacitated workers are not engaged in field activities. Using the prevalence of leopard skin as an index of endemicity, the area is hypoendemic. Probably this index is not appropriate in the context of this study. Intesity of infection is higher when compared to a study done at Bebeka. (3.5% versus 31.9% with microfilaria load of >50/mg.) (48). The average microfilaria load is also higher when compared to othe studies in ethiopia. Here it is 35/mg.,in a study conducted at Burie it ranges 10-16.2/mg.skin (52),at bedele 13.9/mg.skin (49) and in north western Ethiopia,the mean number is 3.6/mg skin (8).

Despite the notion that onchocerciasis is associated with cachexia (22) and weight loss (1), this study has demonstrated no significant association between the disease and nutritional status. However, the fact that a considerable proportion of the study subjects are below the acceptable range for weight-for-height makes it difficult to show a significant difference between those with the disease and those without. Further, the standard is set for Westerners, who are at a better nutritional status than the study subjects, who suffer from chronic malnutrition and stunting from childhood. The "healthy worker" effect may also account for the

lack of significant association because field activities are physically demanding, those who are weak might have already transferred to less physically demanding jobs or stopped working.

The possible association of onchocerciasis with rheumatism, especially in the Third World, was mentioned by C.A.Pearson (12). This notion is denied by some investigators, due to the constitutionality of the symptom (15) and others make no mention at all (49, 52). In this study, complaints of rheumatism were more than twice as frequent among cases than among controls, but the association, although in the right direction, was not statistically significant. Lack of statistical significance may be explained by the small number of study subjects,and the high prevalence rate of the complaint.

The importance of sensitivity of diagnostic procedures in prevalence studies is incontrovertible (22). Biopsies from different anatomical regions are recommended to increase the sensitivity (21). In this study, the sensitivity of parasitological diagnosis based on six skin snips from different anatomical regions was seen to be high. The low sensitivity of clinical diagnosis alone is close to the findings of Tesfaye et al (64). As in this study, the high sensitivity of hip biopsies in Africans has been established by many studies (15,30,49,52,54,55,57). But there is no clear-cut explanation as to why this is so. Possible explanations may be the vector biting habit and the extent of migration of microfilariae in the body during the prepatent period (1,3,22).

This is the first study conducted in Ethiopia in which case detection was based on combined clinical and parasitological diagnosis. However, the sensitivity of parasitological diagnosis based on six skin biopsies was already so high that clinical diagnosis only contributed 10 additional cases, or 6% of the total cases. Half of these (5) had one or more of the following easily-detectable and pathognomonic signs for onchocerciasis: nodules, leopard skin, and/or an adenolymphocele.

Considering the results of examination of bilateral skin snips from the hips only, 145 positives were detected out of the total 152 microfilarial carriers detected. Therefore, the sensitivity of bilateral skin biopsies of the hips was 89.5%, as compared to 93.8% for biopsies taken from all six sites, using combined parasitological and clinical diagnosis as the standard. Adding to the cases detected by the bilateral skin biopsies 6 cases who were negative by hip biopsy but positive for one or more of the pathognomonic signs gave a sensitivity of 93.2%, or equivalent to that of six skin biopsies. These results suggest that the sensitivity of diagnosis based on pathognomonic signs and bilateral hip biopsies may equate that of six skin biopsies, at a lesser discomfort to the examinees.

The protective effect of being always fully clothed in accomplishing field work could not be demonstrated in this study. The lack of significance can be explained due to the method of investigation which tried to scrutinize the recent experience of clothing habit, while the study subjects had long sojourn in

endemic areas. The role of protective clothing in reducing man-fly contact has been documented (3,22).

In order to see a demonstrable effect, the study should be repeated on recent migrants from non-endemic areas, or after mass treatment with ivermectin, to see if the suppression of microfilariae stays longer with protective clothing.

The effect of river-associated activities on onchocerciasis was also not significant, unlike other studies conducted in West Africa (33,61). These studies had documented that distance from breeding sites and decreased frequency of exposure are associated with low risk of infection. Again, the long duration of stay in endemic areas of study subjects and the fact that only recent experience of exposure to river-side activities was investigated in this study may be the reasons which cause failure to demonstrate significant difference. Further, controls are somewhat younger than cases (although the difference is not statistically significant), and therefore more likely to be single, thereby increasing their river-associated activities, such as collecting water and washing clothes. This may account for the fact that controls have higher scores for river-associated activities than cases, although not significantly so.

Major activities which exposed subjects to riverside were bathing, washing clothes, and for the purpose of collecting water. These activities need not necessarily be accomplished at the riverside, they can as well be performed away, in order to decrease the risk of onchocerciasis infection.

There exists a notion that the prevention of non-blinding onchocerciasis would increase the effective supply of labor (40), but a systematic and quantitative approach even to establish baseline information has been lacking. In this study, the negative effect of onchocerciasis on work productivity and income was statistically-significant. The strictness of health workers in relation to granting sick leave has underestimated absenteeism due to sick leave, thus contributing to an overestimate of unauthorized leave (i.e. for non-health reasons). The narrow difference between cases and controls can be explained by the high prevalence rate of the disease, which suggests that some of the controls may in fact be undetected or prepatent cases.The "healthy worker" effect is also able to narrow the difference.From the point of view of productivity,what has not been addressed by this study is the effect of early loss of experienced workers due to incapacitation by the disease.

CONCLUSIONS AND RECOMMENDATIONS

The magnitude of the problem of onchocerciasis is found to be very high among Baya field workers in Teppi Coffee Plantation Project.Its effect on decreased work productivity and on decreased incomes is clearly demonstrated. Based on these and other findings the following recommendations are drawn.

Recommendations

The recommendations below pertain to Teppi Coffee Plantation Project population and do not include the surrounding indigenous population.

1. The Planning of Coffee Development Projects in onchocerciasis endemic areas should consider the prevention of the disease. Working premises and residential areas need to be ten or more kilometers away from a potential breeding site. Safe and adequate water supply, washing and bathing facilities should be established close to residential areas in order to decrease exposure to breeding sites.
2. Studies which are concerned with determining endemicity level need to exclude newcomers, to avoid underestimation due to the inclusion of subjects in the prepatent period.
3. For optimal sensitivity, diagnosis should be based not only on parasitological examination, but should also take into consideration the following easily-detectable and pathognomonic signs: nodules, leopard skin, and adenolymphocele.
4. Further studies on recent migrants from non-endemic areas or on

ivermectin-treated people are required to establish whether being fully clothed while conducting field activities and avoidance of river-associated activities have a protective effect in reducing the intensity of infection or reinfection.

5. Mass treatment with ivermectin giving priority to field workers should be started as early as possible in Teppi Coffee Plantation.

6. The Coffee Plantation Development Corporation should obtain ivermectin in sufficient quantity to periodically treat all its field workers.

REFERENCES

1. Nelson G.S. (1991) Human Onchocerciasis: notes on the history, the parasite and life-cycle. Annals of tropical medicine and parasitology, Vol.85, No.1, P.83-95.
2. Duke B.O.L. (1990) Human Onchocerciasis: an overview of the disease, Acta Leiden, Vol.59, No.1-2, P.9-24.
3. WHO Expert Committee on Onchocerciasis, (1987) 3rd, report Technical Report Series No.752, WHO Geneva.
4. Zein,A. Z. and Helmut Kloos, (1988): The ecology of health and disease in Ethiopia. P.168-174; Ministry of Health, Addis Ababa.
5. Saba M.(1976) Human filariasis, a global survey of epidemiology and Contol, University Park Press, P.316-318.
6. Gundersen, S.G. Schinuit-Lechncer, A. and Bjorvantan, B.(1988) Onchocerciasis in the Blue Nile Valley of Western Ethiopia, Trans.Roy.Soci. Trop. Med. Hyg. 82:122-127.
7. Iwamoto I., Tada I., and Wonde, T.(1973) Incidence and clinical manifestations of onchocerciasis in endemic foci of Illubabor province, Ethiopia. Tropi. Med. 15:36-45.
8. Zein, A.Z.(1986). The epidemiology of onchocerciasis in North Wester Ethiopia. Trop. Geogr. Med. 38:33-37.
9. Taticheff S.(1988) Immune response to simulium bites and their relationship with the pathology of onchocerciasis in Bebeka, Ethiopia, Ph.D Thesis, Michigan State University, East Lansing, Michigan U.S.A.

10. Karam M.,Schulz-key H., Kemme J. (1987) Population dynamics of onchocerciasis after 7-8 years of vector control in West Africa, Acta Tropica 44 P.445-7.

11. HELEN KELLER International, Research priorities in developing countries, P.80-100. (undated)

12. Pearson C.A. (1988) A major cause of third world rheumatism largely overlooked-onchocerciasis. British Journal of Rheumatology Vol.22 No.5.

13. Bucco G.(1965) L'Organization Sanitaria la Africa Orientele I. Poligrafico dello Stat, Roma, P.148.

14. Giaquinto Mira, M.(1939) Fresenza del Sidamnosum Theobol in varie localita del fieritoraroo dei Galla e Sidama e possible esistenza difocola, di onchocercosi fra le populazioni indegeni di alcune regions del A.C.T. Arch.Ital.Sci.Med.Colo.20:855.

15. A.P.Oomen (1969) Studies on Onchocerciasis and elephantiasis in Ethiopia, De erven F. Bohn N.V. Haarlem.

16. Van Der Berghe, L. Cherdoma M. PEEL, F.(1964). The filarial parasite of the eastern Gorilla in the Congo. Journal of Helmentiology, 38:349-368.

17. Mackenzei C.D., J.F.Williams, R.H. Guderian and J. O'Day (1987) clinical responses in human onchocerciasis: Parasitization and immunological implications, Ciba foundation symposium 127, P.46-72.

18. Southgate, B.A.,(1988) some unsolved problems in the epidemiology of onchocerciasis, ciba foundation symposium, 127:32-45.

19. Schulz-key H., Jean B., Albez EJ(1980) Investigations on female Onchocerca volvulus for the evaluation of drug trials, Tropenmed. Parasitol. 31:34-40.

20. O'Day J. Mackenzei CD(1985) Ocular Onchocerciasi, Diagnosis and current clinical approaches. Trop. Doct. 15:87-94.

21. Buck A.A.(1974) Onchocerciasis, symptomatology, pathology, diagnosis WHO, Geneva P.47 and 71.

22. WHO (1976) Epidemiology of onchocerciasis. Report of WHO expert committee WHO Technical Report Series 597:1-94.

23. Bryeeson ADM, Van Vean KS., Odoloju AJ. BOL Duke (1976) Antigenic diversity among O.volvulus in Nigeria. Immunological differences between onchocerciasis in Savana and forest Cameroon. Clin.Exp.Immunol.24:168-176.

24. Lobos E. Weiss N. (1985) Immunological comparison between worm extracts of O.Volvulus from Savana and rainforest. Parasite Immunol. (Oxf) 7:333-347.

25. Nelson G.S(1970) Onchocerciasis. Advances in parasitology. 8:173-224.

26. Wilkinson, P.R.(1949) Some observations in Africans at Jinja. East Africa Medical Journal, 26:344-46.

27. Nelson G.S & Pester, F.R.N (1962) The identification of filarial larvae in simulidae. Bulletin of WHO, 27:473-81.

28. Wegesa, P.(1966) Some factors influencing the transmission of O'volvulus by simulium woodi. Annual report of the East African Institute, Malaria and vector borne diseases. PP.14-17.

29. Roberts, J.M.D., Neumann E., Gockel, C.W. & Highton, R.B.(1967) Onchocerciasis in Kenya, 9,11 and 18 years after elemination of the vector. Bulletin of WHO, 37:195-212.

30. Taticheff S., Workneh W., Abebe M., Gebrehana N., (1982) Onchocerciasis: a prevalence study in Bebeka, Ethiopia. Trop.Med.Parasitol. 38:279-82.

31. Guderian RH., Beck B., Weibs CS., Mackenzie CD (1986b) Onchocerciasis in Ecuador, Infection in children in the Santiago basin focus, province of Esmaraldas - as quoted by C.D. Mackenzie et al in clinical responses in human onchocerciasis: Parasitological and immuniological responses.

32. Prost. A., Gorim de Ponsay E. (1979) Importance epodemiologique du parasitisme neonatal par microfilaires d'onchocerca volvulus. Tropemed parasitol 30:477-81.

33. De sole G.,Giese J.,Keira F.M., and Remme J.(1991) Detailed epidemiological mapping of three onchocerciasis foci in West Africa. Acta Tropica 48:203-13.

34. Renz A., Wenk P. (June 1987) Studies on the dynamics of transmission of Onchocerciasis in a Sudan-Savana area of north Cameroon I. Prevailing simulium vectors, their biting and age composition at different distances from their breeding sites Ann.Trop.Med. parasitol, 81(3) P.215-28. Abstract.

35. Vazquez Castellanos JL, (1991) Coffee tree cultivation and the social history of onchocerciasis ion socorusco, chiabas state, Mexico, Salud-Publica-Mex; Mar-Apr, 33(2), p-124-35).

36. Desole G, J.C. Walton, (1976) Onchocerciasis in Gemu Gofa, an anthropological and ecological survey, Ethiop. Med. J. 14:37.

37. Ufimadou GO, Sato Y., Takahashi H. (Jan.1990) Possible transplacental transmission of onchocerca colvulus. Trop-Geogr.Med.2(1) P.69-71.

38. Senghor J.E, Senghor and Samba E.M. (1988) Onchocerciasis Control program. The human perspective, parasitology today, 4 No.12.

39. Guderian RH., Parano R., Beck B. and Mackenzei CD.(1987) The reduction in microfilariae load in the skin and eye after nodulectomy in ecuadorian onchocerciasis. Trop. Med. Parasitol. 38:275-278.

40. Prescott, N., Prost, A. and Le Berre,R. (1984). The economics of blindness prevention in Upper Volta under the onchocerciasis control program, Soc.Sci.Med.Vol.19 No.10, P.1051-1055.

41. Prost, A. and Prodion, J. (1978) Le diagnostique Parasitologique de l'onchocercose, revue critique des methods en usage, Med.Trop.38:519-32.

42. Mackenzie CD. Koon MA, (1985) Diethylcarbamazine, in review of its action in onchocerciasis, lymphatic filariasis and inflamation.Trop.Dis.Bull.82 R1-R37

43. Buck A.A.,Robert J.Anderson,Kazuvoshi Kawata and James C.(1986)Onchocerciasis:Some new epidemiological and clinical findings,Am.J.Trop.Med.& Hyg.vol.18 No.2 p217-30.

44. Edungbola,d.,Alabi To;Oni Ga;Assaolu So,Oganboji Bo;Parakoyi Bo;(1987)Leopard skin as a rapid diagnostic index for estimating the endemicity of African Onchocerciasis.Int-J-Epidemol-16(4)590-4.

45. Fuglsang H. (1985) Leopard skin and onchocerciasis. Trans.Roy.Soc.Trop.Med.Hyg. 77:881.

46. Cooner, D.H. and Palmarei(1985) Onchocerciasis, blackfly bite and Leopard skin. Trans.Roy.Soc.Trop.Med.Hyg.79:415-17).

47. Brown S.G(1964) Onchocerca depigmentation. Trans.Roy.Soc.Trop.Med.Hyg.54:325-34.

48. Taticheff S. J.F. Williams, W. Workneh, Longitudinal study of onchocerciasis in Bebeka, Ethiopia (unpublished)

49. Woodruff, A.W., Ten Eyeck A.R., Anderson J.and Pettitt L.E. Pettitt, (1977) The clinicopathological picture of onchocerciasis in Ethiopia, Journal of Tropical Medicine and Hygiene, 80:74-77.

50. World Health Organization (undated) Strategies in the prevention of blindness in National Programmes. A primary health care approach, WHO, P.57-66.

51. Remme, J. Dadzie, K.Y., Roland, A. Thylefors, B. (1989) ocular onchocerciasis and intensity ofinfection in the community I. West African Savana, Tropical Medicine and Parasitology 40:251-390.

52. Yeneneh, H. Mengistu, F. Ayele, T., (1989). A multidesciplinary study of onchocerciasis in Bure area, Ethiopia. Ethiop.Med.J.27(121-128)

53. Gemade EI, Utsalo SI, Onchocerciasis in Banu state, Nigeria (1990) vi. The prevalence and distribution of the disease among the human population in Sati-Ikyov village, Acta-Leiden; 59(1-2) p.51-8

54. Taylor HR, Hunoz B., Keyvan-Larijani E. Greene BM. 1989 Oct. Reliability of detection of microfilariae in skin snips in the diagnosis of onchocerciasis. Am-J-Trop -Med-Hyg 41(4)p467-71.

55. Williams JF; Abu Yousif AH; Ballard M;Awad R;el Tayeb N;Rashid M(1985),Onchocerciasis in Sudan:the Abu Hamed Focus. Trans.R.Soc.Trop.Med.Hyg.79(4),p.464-8.

56. Ufamado GO, Eno RO, Akoh JI, Takahashi H, Uchida A, Hayakawa H, Watanabe M. Sato Y, Ekejindu GO, Onwuluri CO, et al (Sept.1988) Evaluation of skin biopsies from different sody regions of onchocerciasis patients in Nigeria, Acta-Tropica (Based) 45(3), P.257-62

57. Taylor HR, Keyvan-Larijani E: Newland HS, White AT, Greece BM, (Jun 1987), sensitivity of skin snips in the diagnosis of onchocerciasis, Trop-Med.Parasitol 38(2), P.145-7.

58. Meckenzie C.D. Williams JF, O'Day J, Chalil I, Flocklars HA, Sisely BM, (Mar 1982) Onchocerciasis in Southwestern Sudan: Parasitological and clinical characteries AM-J-Trop-Med-Hyg; 36(2), P.371-82.

59. Aruzbe ME, Onchocerciasis in Ecuador, first endemic focus discovered in the country, clinical, parasitological and entimological findings (author's trans.) 1982 Mor.Tropenned-parasitol 33(1) 45-50.

60. Harrison's principles of internal medicine,(1980) Macrow hill brook company, 9th edition p.280-82.

61. Bockarie MJ, Daview JB, The transmission of onchocerciasis at a forest village in Sierra Leone II. Man-fly contact, human activity and exposure to transmission. Ann.Trop.Med.Parasitol, 1990. Dec.84(6), P.599-605.

62. Albiez EJ., Effects of a single complete nodulestomy on nodule burden and Microfilarial density two years later, Trop.Med.Parasitol 1985 Mar.36(1) 17-20.

63. Giuderian RH, Effects of nodulectomy in onchocerciasis in Ecuador, Trop-Med.Paristol. 1988 Dec. 39 Supp.4, P.356-7.

64. Tesfaye Bulto, Wondimu Workneh, Seyoum Tatichef, Amha Kebede, Degene Tilahun, (1990) study of community based mass treatment of onchocerciasis with Ivermectin, findings of a preliminary observation, paper present at 1st public health conference.

65. Buttner Dw; Laer G, Mancueiler E, Buttner M,(1982) Clinical,Parasitological and serological studies on onchocerciasis in the Yemen Arab Republic. Tropenmed-Parasitol;33(4) p 201.

APPENDIX A

Interview Form

Registration Number_____

1. Age in years_____ 1.
2. Unit farm _____Subunit_____ 2.
3. Name of KAPO _____ 3.
4. Residential area _____ 4.
5. How long in total have you lived in Teppi plantation project? ____ Years and ____ Months 5.
6. How long have you been working on other farms in the project? ____ Years and ____ Months 6.
7. How long have you been working on this particular farm? ____ Years and ____ Months 7.
8. Previous residential areas (from present back to birth)

A. Locality	B. Years lived
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

8A. endemic=0, non endemic=1

8B. Years lived in endemic

9. How many people live in your household? _____ 9
10. How many are dependents (not earning income)? _____ 10.
11. How many earn incomes? _____ 11.
12. Occupation and income of those who earn incomes

Occupation	Estimated Monthly Income
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Total	_____ 12.

13. How often do you wear a shirt while you work?

	A. for manual weeding	B. for other occupations
1. Always		
2. Usually (half of the time)		
3. Sometimes (less than half of the time)		
4. Never		

13A.

13B.

14. How often do you wear long trousers while you work?

	A. for manual weeding	B. for other occupations
1. Always		
2. Usually (half of the time or more)		
3. Sometimes (less than half of the time)		
4. Never		

14A.

14B.

15. For which of the following purposes do you go to the river side?
(D = Day W = Week M = Month)

Purpose	>1/D (6)	1/D (5)	2-6/W (4)	1/W (3)	2-3/M (2)	1/M or less (1)	Never (0) 15
A. Bathing							A.
B. Swimming							B.
C. Fishing							C.
D. Washing clothes							D.
E. Collect water							E.
F. Cross river							F.
G. Specify							G.
H. Specify							H.

II. PHYSICAL EXAMINATION

1. Weight_____._____ Kg. Height_____._____ Cm. 1.

2. Visual Acuity

If best eye is less than 1/60, check light perception:

below range=1
acceptable=2
above range=3

Visual Acuity	Yes	No
Right eye		
Left Eye		

2.
up to 6/18=0
6/60=1
3/60=2
1/60=3
light perception=4
no light perception=5

3.Skin biopsy

	After 30 minutes		Present on day 2	
Site	Yes (count)	No	Yes	No
Right calf				
Left calf				
Right hip				
Left hip				
Right scapula				
Left scapula				

3.
absent=0
present=1

Total mf = _____

A.mf/skin snip = total mf/6 = _____ 3A.

4. Physical findings

A. Nodule, Yes _____ No _____ A1.

if yes:

Site	Number	
_____	_____	A2.
_____	_____	
_____	_____	

A1. Total number. _____

B. Itching, Yes _____ No _____ B

B1. If yes, does it interfere with sleep?
Yes_____ No_____ B1.

B2. Is there sign of scratching? Yes_____ No_____ B2.

C. Pigmentation changes

C1. Leopard skin, Yes_____ No_____ C1.

C2. Macular Dyspigmentation, Yes_____ No_____ C2.

D. Papular rash Yes_____ No_____ D.

E. Structural changes

E1. Diffuse swelling(Peau d'orange) Yes_____ No_____ E1.

E2. Lizard skin? Yes_____ No_____ E2.

E3. Pachydermia? Yes_____ No_____ E3.

E4. Atrophy? Yes_____ No_____ E4.

F. Lymphadenopathy

F1. Femoral lymphadenitis? Yes_____ No_____ F1.

F2. Inguinal Lymphadenitis? Yes_____ No_____ F2.

F3. Adenolymphocele? Yes_____ No_____ F3.

G. Elephantiasis

G1. Scrotal elephantiasis Yes_____ No_____ G1.

G2. Elephantiasis of the leg Yes_____ No_____ G2.

H. Others (specify)

_____
_____ H.
_____

I. Clinical impression I.

1. Onchocerciasis
2. Questionable
3. Otherwise normal

MEDICAL RECORDS

1. Frequency of clinical visits from Nehassie 1983 back to Meskerem 1983 and complaints of rheumatism, arthralgia, myalgia, muscle pain, joint pain, or bone pain

Date of visit	Complaint Yes	No	Date of visit	Complaint Yes	No
1.			11.		
2.			12.		
3.			13.		
4.			14.		
5.			15.		
6.			16.		
7.			17.		
8.			18.		
9.			19.		
10.			20.		

A. Total No. of visits_____ A.

B. Total no. of complaints_____ B.

II LABOR CARD

1.Days of unauthorized absenteeism from Nehassie 1983 back to Meskerem 1983

Dates of episode	No. of days	Dates of episode	No. of days
1.		7.	
2.		8.	
3.		9.	
4.		10.	
5.		11.	
6.		12.	

A. Total episodes_____

A.

B. Total days_____

B.

2.Days of sick leave from Nehassie 1983 back to Meskerem 1983

Dates of episode	No. of days	Dates of episode	No.of days
1.		7.	
2.		8.	
3.		9.	
4.		10.	
5.		11.	
6.		12.	

A.Total episodes_____ A.

B.Total days_____ B.

3. Net pay from Sene 83 back to Hidar 83
(Round off to nearest Birr)

Eg. Birr 50.01 to 50.49 = 50
50.50 to 50.99 = 51

Month (83)	Net pay
Sene	_____
Ginbot	_____
Miazia	_____
Megabit	_____
Yekatit	_____
Tir	_____
Tahsas	_____
Hidar	_____
Total	_____

Average/month = Total/8 = _____._____ 3.

APPENDIX B

INFORMATION GIVEN TO SECURE INFORMED CONSENT

Onchocerciasis is a disease caused by worms which enter the body by a flybite. The fly is black in color, much smaller in size than the ordinary fly we know. The disease is able to cause blindness eventually, if not treated.

The purpose of this study is to see which of the factors that are related to your daily activity make you more prone to the disease and how much does the disease affect your health.

The investigation involves males only. The examination procedure includes taking small bits of skin from the calf of the two legs, the right and left hip, and the two scapula. This will be fairly painful. All the findings during the examination are confidential.

All those who have the disease will be treated. Those who participate in the study will be given their normal pay during the time they are examined.