PROPHYLAXIS, AND CONTROL OF THE SPREAD OF ONCHOCERCA VOLVULUS.

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m. D., 1936
It may yet be necessary to organise a campaign against *O. volvulus* since it will be seen how truly terrible the results of a heavy incidence of infection in a native population can be. It is believed that the present – one might almost say epidemic – prevalence of the disease is increasing and it might be as well to be ready to combat it in the near future. The writer thinks that it is scourges such as that under discussion that has led in the past to wholesale migration or extermination of populations. One has only to consider the complete depopulation caused by trypanosomiasis, to foresee the possibilities of a spread of blindness in a people dependent on agriculture, fishing and the chase for their food.

**METHODS OF CONTROL WHICH MIGHT BE USED.**

First and foremost in the means at the disposal of a government should come education. The children at schools and missions should be taught to recognise the disease, understand its mode of transmission, the habits of its vector and the necessity of doing what is required of them to prevent its spread. This alas! seems to be too Utopian an idea to yield the rapid results that are required. The main opponents to education would be the kajours, especially in the Zande and Bellander countries.

Other alternatives are the bodily moving of infected tribes, the sterilising of carriers, regulating the distance from streams at which dwellings may be built, and the extermination of the vector itself.

The latter measure may be ruled out at once, as the rivers in which the simulidae breed are often of greater size than the Thames, and equal to the Spey or Tummel in spate in volume and velocity. Fish that feed almost exclusively on pupae and larvae abound in shoals in these rivers, and the application of oil, as tried in some of the small South American streams, would of course be useless.

The other alternatives might be tried separately, but the writer believes that they could, and should be used together.

**SEGREGATION OF TRIBES.**

The Zande tribe are already congregated along the roads so that the people may be inspected at frequent periods for the eradication of sleeping sickness. It is only the minute attention to detail, and the cooperation/
co-operation of medical and political services with chiefs and sub-chiefs, that has led to the almost complete disappearance of the disease in the areas originally infected. The treatment of carriers of O. volvulus collected during sleeping sickness parades might go a long way to control the disease in the Zande country from Meride and Yambio to Tambura. The Bellander of the Bo road are already on the road.

The congregation of people on roads for any length of time has serious disadvantages. The cultivation of the same ground year after year soon exhausts the soil. Repeated contamination of the soil is apt to lead to very heavy infections with hook worm, whilst S. mansoni infection of the common pools and springs dammed for water supplies might well become a grave problem.

The people dealt with above are cattleless, but in the Dinka country the breeding places of simuliidae are few and could be put out of bounds, but the segregation of these great nomadic cattle owners would be impossible.

STERILISATION AND TREATMENT OF INFECTED PERSONS.

The surgical removal of all nodules in a population, which it is desired to free of onchocercal infection, might at first sight seem a simple and efficacious step. It must be remembered however that Silva (1932) reported the appearance of fresh nodules eighteen months after the patient had resided in a non-endemic area after the removal of tumours, and noted that microfilariae were numerous in the skin.

Account must also be taken of the work of Dyce Sharp which has already been quoted in which he found more people showing embryos in the skin than those actually with tumours. Again the writer and other workers as has been said before, have seen cases of elephantiasis and the skin swarming with larvae but in which no nodules could be felt.

To sterilise a community then, surgical removal must be combined with treatment which will kill the larvae in the skin, and so prevent the infection of the simulium.

THE USE OF Filaricidal DRUGS.

Strong and his co-workers in Guatemala, tried a number of drugs in an attempt to find one which would kill/
kill microfilariae. The most efficacious of these were plasmochin, fuadine, and tartar emetic. In a few cases they administered plasmochin in rather heavier doses than those used in malaria and found that the embryos disappeared for a period but then returned in the skin. This meant that the larvae had not been killed, or that unencapsulated adults were still in the body, or that deep seated or very small tumours had escaped detection. The experiments with fuadine and antimony were performed in vitro. It is unlikely that toxic drugs such as the antimony group would be able to penetrate the thick fibrous capsule of the worm cyst in sufficient concentration to do any damage to the adults. The replacement of the aqueous from the anterior chamber with 1/1000 plasmochin simplex by Toroella and Silva (1932) was seen when using the corneal microscope to cause the death of the parasites. The writer has himself run a little 1/1000 plasmochin beneath a cover glass and watched the motile larvae accelerate their movements, stiffen suddenly, appear to shrink and die in a very short time.

Hissette suggests that the puncturing of nodules is in itself enough to kill the adult worms, and the writer agrees with him. It must be remembered though that as noted in the section of this thesis devoted to the nodule, that tumours are, as often as not multiple, and very closely adherent to each other, and that if puncture and cutting up the adults inside the nodule is resorted to instead of removal, many tumours will be missed.

The sterilisation of carriers then resolves itself into the wholesale removal of cysts, and the systematic treatment of infected persons with some suitable drug such as plasmochin. These in themselves demand the congregation of a tribe in easily accessible villages, the taking of a complete census, periodic examination of the whole tribe in its sub-groups, and the declaration of the infected country as a closed area into which no person either European or native may go without a pass, and similarly out of which no one may go. In fact the extremely efficient measures taken by the Sudan Government against sleeping sickness would be put into operation in endemic areas.

HOUSING, CLEARING OF FOREST, AND REMOVAL OF HOUSES BEYOND THE USUAL RANGE OF FLIGHT OF SIMULIUM DAMNOSUM.

It will be many years before the tribes under discussion have reached a sufficiently advanced state of prosperity to be able to mosquito proof their dwellings. As/
As at present many observers believe that the range of flight of *S. damnosum* is very limited - Blacklock (1927) did not think it exceeded 150 yards - it would be best to state now that the writer has seen these insects 1 kilo:from the river Naam at Mvolo, one and a half kilos from the Blue Nile at Khartoum, and over a mile from the Nile in Dongola Province. It has usually been the writer's experience to find the insects biting in the shade of the forest at any time of the day but on the whole preferring to bite in the late afternoon until dusk along the rivers. This is not true of Dongola however where the flies may be a pest throughout the day. As would be expected flies follow natives from the river to their homes especially if the path is through heavy cover as it so often is in Equatoria, and once having reached the huts they seek shelter in them and become truly domestic.

To discourage the flies from entering houses, and to deprive them of shade, it would be best to clear all forest for a radius of 150 yards of dwellings and forbid the planting of corn or anything higher than ground nuts and creeping beans within that radius. Here again we stumble against the ever present but usually ignored danger of soil erosion, and the destruction for ever of what was once rich and fertile ground.

Many of the tribes infected depend for much of their food on fish and real hardship would be imposed on them if this was denied them by orders to keep away from rivers. The constant stream of women and children carrying water from the rivers which is such a typical part of the scenery of Africa as a whole, could be overcome by the sinking of wells in close proximity to huts, the location of houses being largely determined by the presence of water at a reasonable distance from the surface. Huts should be at least 2 kilometres from a breeding place of *S. damnosum*.

**Simulium damnosum. Some Brief Notes on Its Habits in the Sudan.**

It is not intended in this thesis to give a detailed account of the biology of the simuliiidae. The work described here has most of it been done personally, and for reasons already stated it has been impossible to spare the time to feed, breed and dissect large numbers of flies. The writer experienced the same difficulties as other workers in keeping the flies alive.
Simulium damnosum is an insect that needs a great deal of oxygen in its larval state; it therefore breeds in rapidly flowing streams. The female crawls down a reed shaft, a bubble of air attached to her body, and deposits her sticky eggs as much as a foot below the surface, or she may choose a rock, or the branch of a fallen tree. Her eggs laid, she comes rapidly to the surface borne by the bubble of air, rests on the water for a second or two and then flies off in search of shelter or a feed of blood.

In a day or two in the tropics (and several months in the arctic circle for some species) the eggs hatch. The larvae spin a network of silken threads on the rock or reed to which they are attached and become fixed to it by the concentric rings of hooks at their tail end. When they wish to move they bend their heads down, spin some silk threads and move their tails on to new network. It is interesting to put some larvae attached to a piece of waterlogged wood into a glass jar, and blow air into the water at some distance from the larvae which are usually in little colonies as they hatched. It will be seen that the whole colony bends towards the air bubbles, and then very slowly starts to move forward giving the impression of a band of tiny "looper" caterpillars advancing in slow time.

The mouth parts are provided with wide and rapidly moving mouth brushes which waft passing food particles into the oesophagus in much the same way as does a mosquito larva. Their food consists almost entirely of algae such as euoglia and spirogira.

The pupal stage is passed in an envelope resembling very much the case of skins in which an Eskimo mother carries her baby. The eyes of the fly are seen above the thicker parts of the covering, and the respiratory apparatus consists of two branching tufts that protrude from the head. Unlike the larva, the pupa does not need a great quantity of oxygen and can be kept alive in a tin box in which a piece of plain lint is kept permanently moist.

The skin splits, and the young simulium rises to the surface on a bubble of air which has been secreted towards the end of its development beneath the pupal covering. Or it merely crawls up the grass stem to the top.

During the course of one's studies as a student and as a post-graduate there are always some lectures that stand out like light houses in a sea of monochrome monotony. Such a lecture was one that the late Dr. Sambon/
Sambon delivered at The Old School of Tropical Medicine in Endsleigh Gardens in the winter of 1928. Little then did the writer think that in the future he too like the lecturer would some day lie face down above a stream and watch fascinated the nuptial dance of the male simuliidae waiting in a little revolving cloud above the water ready to seize their slower hatching partners for the dance.

Fertilisation takes place soon after emergence from the pupa, but as in the mosquitoes the development of the ovaries does not take place until a blood meal has been ingested.

**NOTES ON THE TRANSMISSION OF ONCHOERCA VOLVULUS.**

The distances that simuliidae will travel from water have been discussed under the heading devoted to prophylaxis, when it was mentioned that in the Southern Sudan these insects preferred to bite in the cool of the evening or in the dense shadow of the forest. As a matter of interest the writer and others exposed themselves to the bites of many simuliidae. As controls we had standing by us natives in an even greater state of undress than ourselves. It was soon very noticeable that the flies bit the natives almost exclusively about the legs, especially the shins and calves. In the Europeans however the flies seemed to dislike our hairy legs and bit on the iliac crests, beneath the patella, and below the maleoli, and on the trunk under the cover of the elbows. If a hat was worn they bit beneath the shelter of the brim.

If the mouth parts are examined with the microscope the observer is astonished that such a small beast should possess such a truly formidable armoury in its coarse and heavily serrated maxillae and mandibles. These were never intended to pierce skin, but to rake and scarify.

Now Blacklock in 1926, knowing that the microfilariae of *O. volvulus* were found in the skin and not in the blood, set out to find a vector that scarified the skin before engorging itself with blood. He ruled out the Congo floor maggot and commenced his experiments with the simuliidae which he was soon able to prove were the real vectors. The insect sometimes takes as long as three to five minutes to feed, during which time it is raking the skin, and ejection saliva containing an anti-thrombotic substance on to the wound, which is almost certainly chemiotactic in action on microfilariae in the skin, and possibly anaesthetic also.
He found that by feeding flies on a narrow belt of skin in the region of nodules on the hips he could produce an infective rate of 82%. The microfilariae entered the mid gut measuring on an average about 7μ by 250μ. These passed from the mid gut to the thoracic muscles where they went through all those stages seen in mosquitoes infected with F. bancrofti and called the sausage stages. By about the 8th day they had reached the head and measured 760μ in length by 20μ in breadth. The parasites were now ready to pierce the membranes of the head and emerge at the base of the labium when the fly fed.

This work was confirmed by Strong and his team of workers in Guatemala in 1932 and 1933.

To anybody who has attempted to keep these insects alive, the heartbreaking difficulties of obtaining living specimens of infected flies for dissection after eight days will be too well known to need mention. It is also exceedingly difficult to get them to feed in captivity, and the writer never succeeded in keeping one alive in a large test tube for a night. The best method of getting infected specimens is to sit by the river side with several heavily infected people, let the flies gorge themselves, cover them gently with a big tube and release them in a finely meshed meat safe. The writer collected some two hundred by this method and kept a large number alive for three days at Mvolo in 1933. A violent storm during the night created such havoc in the mud rest house that all the flies were killed and soaked with rain. No further time or opportunity was available to repeat the work, and so no sections of infected flies are available to illustrate this thesis.

Should it be necessary to know if an insect is in the infective stage, a drop of blood serum is placed on a slide and the head of the fly is held so that it just touches the drop. If infective larvae are present they will immediately leave the head and be seen wriggling about in the serum. Similar treatment with saline does not cause the larvae to emerge.

The writer tried this experiment of Blacklock's with a number of flies caught in the rest house kitchen at Mvolo, and actually saw three parasites emerge. The appearance of the microfilariae was most remarkable as they were about three times as big as the ones in the skin and exceedingly active.
SIMULIUM DAMNOSUM.

LINES WRITTEN AFTER SEVERAL TRYING DAYS ON THE RIVER NAAM ATTEMPTING TO BREED THESE INSECTS.

Onchocerca volvulus a worm surpassing slim,
The cause of cyst and tumour on chest and pelvic brim
Is found along The Sueh, rivers Tonj and Naam,
Is carried by simulium,
The damnable simulium,
The biting, fierce simulium
That causes all the harm.

Elephantoid scrotum, hydrocele and craw,
Lymphangitis, keratitis, thickened skin and more,
Tumours neath the occiput, swellings hind the knee, (*)
Are caused by a simulium. A wicked, wee, simulium,
A savage, dark, simulium
That harries us at tea.

In far Guatemala, the swellings on the head,
Caused by quite another worm (caecutiens) 'tis said, (**)
Give rise to bone erosion and make the people blind.
The buffalo simulium, the ravenous simulium,
A dirty, grey, simulium's
The vector you will find.

Larvae like medusae swaying in the stream,
Hooklets fixed in silken webs spun on rock and beam,
Adults up the grass stems crawling from the flood,
The newly winged simulium,
The dapper, gay, simulium,
The vampire, young simulium,
Flies forth in search of blood.

Oh! Hunter when you wander, rifle in your hand,
Up the winding river Rholl, past its rocks and sand
Watch the herds of waterbuck at gaze along its brink
Lower their shaggy muzzles to the water for a drink.
You will see a kind of halo around their ears and eyes,
It's not a saintly aura but a swarm of tiny flies,
They are known as the simulidae,
The hump-backed, squat, simulidae,
The damnable simulidae,
In them the danger lies.

(*) Believe this to be an error copied down from one
text book to another.

(**) Poetic licence. O. volvulus and O. caecutiens now
believed to be the same parasite.

J. E. Mvolo.
March, 1933.
ONCHOCERCAL KERATITIS.

THE FOLLOWING SERIES OF FIVE CASES ARE ALL FROM ONE FAMILY WITH WHOM IT HAS BEEN POSSIBLE TO KEEP IN TOUCH FOR THREE YEARS, AS THEY ARE ALL RELATED TO A RUMBEK HOSPITAL DRESSER.

The family from whom these cases were taken live on the river Naatn near Tonyia. They occupy a little group of huts on a piece of rising ground near the river and their cultivations are around their dwellings in the forest. They also have tobacco gardens on the river bank, and are hunters and fishermen as well. Several more of this family are blind or are going blind.

The following points should be noted in these cases.

(1). The very severe pain at the onset of the disease.
(2). The long period of pain and lachrymation compared to Sudan Blindness.
(3). The steady deterioration of vision instead of the rapid climax and non-progression of Sudan Blindness.
(4). The opacity of the media of the eye.
(5). The changes in the iris.
(6). The improvement of vision at the beginning of the disease in the evening.
(7). The downdrawing of the pupil.
(8). The constant involvement of the lower part of the cornea.
(9). The presence of microfilariae in the anterior chamber.
(10). The possibility in certain cases of restoring vision, for at least two years.
(11). The appalling effects of a nematode which has been regarded as a rather interesting academic curiosity until comparatively recently.
(12). The terrifying possibilities of a spread of the worm to those districts bordering the Nile cataracts in Dongola and Halfa, where the whole population lives on the river on account of the desert nature of the country. The swarms of simuliiidae in Dongola have to be seen to be believed. Chickens are killed by these pests, young babies left in the cultivations have been bitten to death, and the provincial headquarters at Dongola had to be moved to Merowe because life became unbearable. H.G. Wells's brilliant fantasy "The Country of The Blind" might have a counterpart in dreadful reality should ever this disease become prevalent in the northern Sudan.
CASE. I.

ACHAK MAKEIX. Aet: 35. JUR Woman. TOYNIA Jan: 1933.

Two years history of eye trouble commencing with very acute burning pain in the eyes "as if chillies had been rubbed into her eyes". At first she saw best in the evening and early morning as the sun later in the day hurt her eyes and made them water worse than ever. As the pain decreased in intensity her vision gradually failed, and now she cannot see anything but light and has to be led. She, her husband, her father, her son aged 15, a sister, and two aunts are blind. Excessive fish eating is the cause of the disease. About a year after the eye symptoms started she started to have swellings on iliac crests and ribs. These never hurt her.

The woman had constant lachrymation, and sat in the shade covering her eyes with her hands shielding them from the light. The irritation was eased by an instillation of 5% cocaine.

Her eyes were injected, the conjunctiva was pigmented around the limbus, and both corneae showed a brownish white haziness at the lower becoming less dense towards the centre. Fine vessels could be seen in and on the opacity.

The left pupil resembled that of a cat, was very narrow and slit-like. The right was almost entirely occluded and the lower end was hidden by opacity of the cornea.

The condition was typical of that described by Colonel Elliot in his "Tropical Ophthalmology" on page 178.

Her discomfort was greatly relieved after the removal of all the O.V. tumours and her lachrymation almost ceased.

Feb. 1934.

Examined again, with Dr. A.R. MacKelvie at Tonyia.

No new tumours found.

Lachrymation almost ceased. Perception of light good./
good. Ophthalmoscope light makes her eyes water. Opacity of both cornea more marked. Pupils about the same. Both pupils adherent to lens capsule.

OPERATION.

Double optical iridectomy under cocaine and morphia. Patient described instant improvement of vision on the table.

An average of three M.F. of O.V. were seen in each field of the microscope using the low power, in aqueous aspirated through the incision; the cell content of the fluid was much raised also.

Mar. 1934.

Can see to go about alone, and distinguish fingers at 25 feet. 1/1000 plasmochine simplex injected into both anterior chambers to kill any embryos of O.V.

Mar. 1935.

Vision remains quite good.

Mar. 1936.

Cataract removed through old iridectomy opening in iris. No parasites in aqueous from left eye at time of second operation. Vision returned and section healed well.

NOTE:-

It is generally regarded that operative measures are of no avail in onchocercal keratitis, and that they are a waste of time. The writer does not agree entirely, and believes that occasionally the sight of a patient can be restored and preserved, especially if plasmochine simplex is administered during and after operative treatment.
CASE II.

JUR BOY. Aet: 15 TONYIA. SON OF CASE No. I.

Eight months ago he had pains in his eyes so severe that he frequently threw himself about in agony. The pain remained very severe for three months when a swelling appeared over his left eye and the pain started to decrease. His eyes continued to water and he now found he was unable to see. At first he could see best in the evening and early morning as the sun did not hurt his eyes, but now he can see nothing at all but his eyes still water.

A typical Guatemala swelling the size of a blackbird's egg was removed from above the left eyebrow under local anaesthetic. There was a deep hollow in the frontal bone, the base of which was of cancellous bone and the edges markedly lipped.

Lachrymation almost ceased within two days of removal.

EYES.

Right eye shows a semi-opaque, brownish opacity in its lower 3/4 which is becoming vascularised. Two narrow extensions of this opacity extend upwards to the equator where they become slightly broader.

The pupil is irregular semi-dilated, and the crypts of the iris show as little, grey, atrophic spots. The lower edge of the pupil is adherent to the anterior capsule for about two millimeters, and is a pale blue grey, where it has become atrophic.

The conjunctiva is injected, and thickened in the position where a pterygium is usually found.

There is no reaction to light or atropine.

O.E.R: Fundus invisible owing to vitreous opacity. Anterior capsule shows a granular deposit using + D.16.

O.E.L: Much the same as the right except that the pupil is drawn down and piriform in shape.

VISION.

Right eye completely blind. Left eye, hand movements only.

Operation.

A left optical iridectomy produced no improvement in vision. The aqueous of the left eye swarmed with M.F. of O.V. and F. perstans, the latter having escaped from the cut iris.
Mar. 1935.

Completely blind. Fresh tumours on right trochanter. No lachrymation.

Mar. 1936.

No change.

CASE III.

MALENGA CHELO. JUR MAN. Aet: 40. HUSBAND OF CASE I, AND FATHER OF CASE II.

Two years ago he developed very severe pain in his eyes as if thorns were piercing his eye balls. He often felt giddy from pain. Photophobia was intense and he could not look out of the hut in the daytime on account of lachrymation and pain. He saw best in the early morning and in the evening as the light was less strong. He developed the tumours on his iliac crests about the same time as his eye trouble. Magic is the cause of both conditions.

Skin.

Thick, inelastic, deeply wrinkled, dry.

Right eye. Conjunctiva thickened and injected. Thickening most marked at equator of cornea where it extends on to it for about a tenth of an inch. The lower half of the cornea is covered by a pearly blue opacity with small spots of more opaque consistency scattered here and there and surrounded by a brown haziness. The keratitis in this case is of the true punctate nature typical of this condition in its less advanced stages.

The pupil is very small and pyriform in shape, the upper part only dilating slightly with atropine. The iris is flat and atrophic and adherent in its lower pole to the lens capsule posteriorly, and the cornea anteriorly. The anterior chamber is very shallow, and the intraocular tension is raised.

O.E.R: /
O.E.R: Impossible owing to small pupil and opacities.

VISION.

Hand movements at a meter only.

Left eye.

Very much the same as right but can count fingers at a meter and a half.

Operation.

March 1934. Double iridectomy under cocaine and morphia the iris being torn from its upper attachment. Diminution of pressure was noticed after two days. Plasmochine simplex administered after operation and a week later. Vision of left eye slowly started to improve. Right eye no improvement.

The aqueous of both eyes contained many M.F. of O.V.

A very large mass of tumours was excised from the right iliac crest. There were 27 nodules in all, the two biggest the size of a pigeon's egg and cystic in nature, the rest varied in size, the smallest being the size of a pea.

The mass is now in the museum of the Kitchener School of Medicine at Khartoum.

Mar. 1935.

Can see to go about by himself. No extension of opacities. No new tumours. The vision of his right eye has improved.

Mar. 1936.

Blind in right eye. Left eye as before and can still walk about alone.

CASE IV.
CASE IV.

ARANIGA MOONIE. JUR: Aet: 60. FATHER OF CASE No. I, GRANDFATHER OF No. II.

Three years history of steady diminution of vision,
commencing with intense "like hot snakes running about beneath the lids". The usual symptoms of photophobia
and lachrymation accompanied the onset.

O.V. tumours on both sides of chest, on pelvic
brims, both trochanters, and on the mastoid processes.

Many of the nodules have been present for years
but some are of more recent development.

Vision, nil in both eyes.

Eyes show complete leucoma of both corneas; only
the extreme upper edge of the left cornea showing any
translucency. The thickened conjunctiva extends on to
the leucoma on both sides at the equator in both eyes.
There is considerable pigmentation around the limbus
forming a brown ring surrounding the cornea in both
eyes. Small blood vessels are seen, and there are a
number of patches resembling calcareous deposits.

It was found that this man had a large elephanti­asis which when removed weighed thirty pounds. The
tissues beneath the skin swarmed with embryos of O.V.

The right eye was bought for the equivalent of 15
shillings and removed. Unfortunately no embryos were
found in the sections as they had probably died. The
other pathological changes were well marked especially
the fibrosis of the ciliary body, the perivascular
infiltration and "cuffing" of the vessels in the optic
nerve and throughout the eye, and the atrophy and vas­
cularisation of the remains of the iris. The old in­
flammatory changes in retina and choroid were entirely
different to those seen in Sudan blindness.

CASE V.

ZABI TOGO. JUR Aet: 25. SON OF CASE IV, BROTHER OF
CASE I, UNCLE OF CASE II, BROTHER-IN-LAW OF CASE III.

Two years history very similar to previous cases
in this series.
Two O.V. tumours lying on temporal bone behind right ear; these have been here a long time and developed without pain.

VISION.

Can see to get about by himself in daylight now the photophobia has ceased.

Can see fingers at three meters with right eye and at about the same distance with his left.

Right eye shows a whitish blue haziness at the bottom of the cornea of an interstitial nature here and there showing the typical punctate keratitis. The deposit is most marked at the bottom, and extends upwards to the equator in two horns; at the equator the conjunctiva extends on to the cornea. Very fine vessels are seen on the opacity surrounded by a nebulous light brown film of pigmentation.

The pupil reacts to atropine and is bound down inferiorly to the lens capsule. The iris appears normal.

O.E.R: The lens appears as a cart wheel, the hub being black, and the spokes as black triangles attached by their apices to the hub. A glimpse of the fundus is obtained now and then, and shows a very pale disc, a few clumps of coarse pigment, and at least one area of choroiditis.

The left eye has the same general appearance as the right, but the pupil is pyriform in shape, and the iris is flat and atrophic. Poor dilatation to atropine only.

O.E.L: Fundus invisible owing to opacities.

Operation.

Double optical iridectomy. Vision of left eye improved on table. Embryos of O.V: numerous in aqueous. Plasmochine administered as in the previous cases. And the tumours behind the ear removed. O.V: M.F. in aqueous of both eyes.

Mar. 1935.

Vision very much improved in left eye. The opacity has not increased in area, and the iridectomy opening remains patent.

The right eye has not improved like the left and if anything sight is less acute.

Mar. 1936.

He can still get about by himself and can count fingers at five meters. All vision has gone from the right eye, the lens is becoming very opaque, and phthisis bulbi is commencing.
SUDAN BLINDNESS. CASE RECORDS OF A NUMBER OF FAIRLY TYPICAL EXAMPLES OF THE DISEASE IN AN ABBREVIATED FORM AS TAKEN ON TREK.

The following cases are submitted very much as they were taken down on trek. Very little attempt is made to make them resemble case records conforming to usual academic or teaching hospital standards. The people dealt with, and the absence of delicate and expensive apparatus such as the corneal microscope, and slit lamp made the attainment of those standards impossible. The low intelligence of patients also made the examination of fields of vision too trying to both bewildered native and harried investigator. It will be found however that most essential points are recorded, and if the histories appear brief, it is hoped that it will be realised that omissions are due to obvious misstatement of fact or to language difficulties. Fortunately the ophthalmoscopes used for this series behaved well, and the batteries did not succumb to the heat as so often happened in previous attempts to collect clinical material for this thesis. The series contained in the following pages include cases taken from persons from the following tribes, Raik Dinka, Gok Dinka, Rumbek Jur, Atwot DINKA Bellander, Wau Jur, Congo, Moru, and Zande.

NOTE SPECIALLY IN THIS VERY TYPICAL SERIES THE FOLLOWING POINTS IN THE RECORDS COLLECTED AT RAFFILE.

(1) The constant association of night blindness with this disease.
(2) The rapid course of the disease, and its non progression after its establishment.
(3) The youth of many of these cases.
(4) The terrible prevalence of the disease at Raffle.
(5) The clarity of the media in most of these cases.
(6) The commonness of optic atrophy.
(7) The absence of microfilariae in the aqueous tumour.
(8) The remarkable fact that very few cases give a history of more than five years duration.
Pupils.

Equal, very sluggish response to light. Full and equal dilatation after atropine, no adhesions.

O.E.R.&L.

Disc, pink and with rather indistinct edges. Veins engorged, high lights on surface of vessels absent. Mild optic neuritis. Fundus grey, a few scattered patches of pigment of small size seen here and there. In the left eye an area of very thin retina at 9 o'clock displays the choroidal vessels shining through, this patch looks "rough". In the right eye the irregularity in the thickness of the retina is not so marked but is visible.

O.V. Tumour removed from left iliac crest. Had developed without pain three years ago; none on head.

Blood Slide. M.F. of F. perstans present in fair numbers.

May 1935.

Lachrymation ceased. Both optic discs very pale, patches of R.O. in both eyes, in same situations as two years ago. Has night blindness, but his vision has not deteriorated since last seen. Can still lay bricks correctly but most things appear blurred.

April 1936.

Still employed as a builder. Vision the same.

NOTE.

Rapidity with which damage to retina attained its maximum and the way the condition remained stationary afterwards.

YAILO MANGAI

JUR Aet 40 MVOLO I.3. 1933.

Two years ago he had severe bitemporal headache, pain of a burning nature in his eyes, and constant lachrymation.
lachrymation. These symptoms lasted about three weeks and then got better. He now found he could not see in the evening, or in very heavy forest.

His blindness is due to eating fish. He has a blind sister, his father is blind and has a large elephantiasis of the scrotum (later operated upon successfully).

No O.V. tumours found but varicose groin glands present on both sides. Skin of thighs very thickened over extensor aspects.

EYES.
Tension normal. Pupils widely dilated.

VISION.
Hand movements only at half meter.

O.E.R. & L.
No atropine was used in this case and there was no light reflex. Corneae clear. Right lens, clear. Black, refractile ring seen in left lens using Plus D 16.

Discs. Both pink, and hazy, vessels small, arteries look sclerosed with white lines running parallel to them.

Fundus. Disseminated R.C. in both eyes most marked in the right eye which has a very rough, fan-shaped patch of R.C. involving the macula. In both eyes the pigment is in large sooty lumps, and irregularly scattered.

LABO ANANJU. JUR Aet: 40 MVOL 1.3. 1933.

Gives a history of night blindness of two years duration. He developed irritation and mild pain in his eyes four months ago. His poor sight is due to excessive fish eating. His brother also sees very dimly in daylight and cannot see at all in the dusk.

VISION. Can see fingers at three feet and can just get about by himself in daylight.

EYES. /
ADDENDUM TO THE CASE RECORDS HERE PRESENTED UNDER THE HEADING OF "SUDAN BLINDNESS".

It is of special interest that since these notes were written, a case of blindness was seen at Rumbek by Dr A.R. MacKelvie and the writer showing the typical appearances of Sudan Blindness in one eye with very gross retino-choroiditis, and with no microfilariae in the anterior chamber.

The left eye presented the appearances usually associated with onchocercal keratitis. The pupil was pyriform, the lower half of the cornea was opaque and enough of the fundus was visible with the ophthalmoscope to see a quite well marked optic atrophy and retinitis. The aqueous contained many living larvae of Onchocerca volvulus.

This is the first case seen in which the two diseases were present in the same patient. The keratitis started about a year before the retino-choroiditis.

ILLARIA DOGO.


Two months ago he developed sore eyes, he thought he had got some sand beneath the lids. Soon he found that he was unable to see in the twilight, and for the last month his sight has been getting steadily worse. He is very fond of fish and when in Wau fishes each evening with a hook and line in the Jur river.

He has no idea what is causing his sight to fail.

EYES. Both slightly injected, both are reddest where one would expect to find a pterygium, and on turning down the lower lids the conjunctiva is oedematous. Scales of salt cling to his lashes --the dried tears due to his slight lachrymation.

Corneae.

Conjunctiva thickened at equator and projecting on to cornea in both eyes. Both clear.

Pupils. /
EYES.


O.E.R.

Golden refractile opacities in right vitreous obscure most of fundus. Disc appears pink and indistinct during few brief glimpses obtained. Plus D 16 shows a central opacity on the anterior capsule composed of small granules.

O.E.L.

Disc appears normal. Cornea, lens and vitreous clear. Patches of choroidal pigment seen round disc, and the macula is involved in the retino-choroidal degeneration.

ILRAKI MOMI. JUR. Act 70 MVOLO I.3. 1933.

Two years history of night blindness and defective vision commencing with watering eye and irritation.

Cause. Eating salt with the Azande after they had murdered and eaten his relations. He said that this year there were not a great many simuliiidae on the river (The Naam). But in the year The Azande raided them it was almost impossible to fish as these biting pests were so numerous. He and three other apparently sensible old men agreed that this blindness had increased from the day of the raid but the increase had been specially marked in the last four years. Onchocercal tumours had increased very greatly also. Tumours are removed occasionally from young children for cosmetic reasons, but not from old people. The numerous nodules on his own chest are due to having been struck by lightning in his youth.

EYES.

Right. Arcus senilis. Pupil, half dilated regular, immobile. No reaction to atropine.

Left. /
Left. Flat atrophic iris. Pupil fixed to anterior capsule by senechiae, 5mm in diameter, round. Anterior capsule opaque.

O.E.R.
Disc rather pink. Vessels sclerosed (NOTE AGE), vitreous hazy but retino-choroiditis of a disseminated type is present.

O.E.L.
Impossible owing to opacities.

BILLIANG GOLIE. JUR. Aet: 20 (son of last case) Mvolo.
I. 3. 1933.

Two years history of very defective vision and night blindness, commencing with a transient lachrymation.

One day two years ago he had a particularly heavy catch of fish and in celebration held a party for his friends in his house. Late in the following day he awoke to find that his eyes were sore and he could not see properly. He had been mildly bitten by simulidae the day before and so had all his friends. They had had a very heavy meal off a large perch (about 100 lbs in weight) and a young buffalo he had captured on the same morning. His trouble is due to the fish.

EYES.
Pupils half dilated, sluggish response to light only.

VISION.
Can see fingers at two meters and can get about by himself in daylight, but has to be led in the evening.

O.E.R.&L.
Very gross diffuse R.C. white patches in both eyes where retina and choroid have been completely destroyed. Both discs grey and atrophic and ragged round their edges.

O. V. /
O.V. nodules on occiput which developed without pain a month before his eye symptoms.

GADIR DAKARANGA JUR. Aet 17 MVOLO I. 3. 1933.

Three years ago he got a pain in his eyes and water flowed from them. The symptoms started at the beginning of the rains and lasted for a month. He could not see to get about in the evening, but can see fingers at 25 feet in sunlight. The O.V. tumours on his chest have been present since he was a very small boy.

The cause of his trouble is Zande magic. His father whilst hunting with the Azande, killed an elephant with a spear, and later cut off its head to extract the ivory. The totem of his family is the elephant and as a result of the impious behaviour of his father he now cannot see properly, and his father died of a wasting disease. His skin in spite of his youth is taking on the texture of that of an elephant. (Note The boy has the skin of an old man)

No History of blindness in family.

EYES.


After atropine pupil becomes kidney shaped, owing to adhesion between lower edge of iris and anterior capsule. There is a certain amount of pigmentation in the conjunctiva adjacent to the inferior opacity.

O.E.R. & L. ALL MEDIA CLEAR.

Both discs atrophic, vessels all very small, both retinas extremely thin so that the choroidal vessels stand out as vermilion streaks. Pigment is irregularly scattered about but in very fine particles.
KOMETAIN KOMBY.  JUR.  Aet:  15.  MVOLO  1.3. 1933.

Two years history of defective vision and night blindness, following a period of acute irritation of the eyes and lachrymation commencing just before the rains. He can see to get about in daylight, but in the evening he cannot see to put his hand into the communal pot to take out food. The O.V. tumours on his chest and the one on his right mastoid process started about the same time as his eye symptoms; they have never hurt him.

Cause.  The picturesque but unlikely misfortunes of his family, and the spell of a Zande Kajour.

EYES.

The external appearance of both eyes, and the appearance of both fundi were so astonishingly like the previous case, that it would have been impossible to tell which was which. One case was examined shortly after the other and the writer thought he was re-examining the last until he looked at the skin.

There is therefore no need to describe this case.

GARANG ADOOT.  ATWOT DINKA.  Aet:30.  KNOP.  2.3. 1933.

About eight years ago he developed watering eyes and it felt as if he had got sand beneath the lids. Shortly before his eyes gave him trouble, he had been raiding fish in the country of the Jur. He and his gol (litt: cattle, fire, circle, family, clan. Actually the centre round which Dinka family life and mythology of ancestor worship revolves) have been there for many years and now they have made an agreement with the Jur whereby his gol may fish in the Mvolo pools without resort to bloodshed as heretofore. He has just returned from the Jur where he has been gathering honey.

CAUSE.  Overwork on the roads of the Government.

(All Dinka loathe work and are unbelievably idle). No blind relations.

O.V. /
O. V. TUMOUR ON right iliac crest. Skin normal.

EYES.

Appear normal Pupils rather dilated, equal, sluggish response to light, widely dilated after atropine.

VISION.

Can count fingers up to 15 feet with his left eye and at 6 only with his right in the shade of the rest house.

Can see at night only if there is a full moon, otherwise he has to be led just before dark and after sundown.

O.E.R.

All media clear. Disc atrophic, vessels small and sclerosed. There is a patch of macula R.C. and choroidal vessels are plainly seen owing to the thinness of the retina, and there is a little pigment lying about.

O.E.L.

Disc chalky white except at convergence of the retinal vessels. Vessels appear normal. Retina thin. There is a white patch of exposed sclera a disc breadth from the disc at 9 o'clock this is crossed by a retinal vessel. There is very little pigment.


This man is a district translator, he has lived in the Jur for many years. Two years ago he developed the usual early symptoms of Sudan blindness. He can now see well in daylight, but cannot see at night. No blind relations.

NOTE

On this occasion the writer happened to be spending Christmas at Mvolo. In the afternoon on the day on which these notes were taken, my medical officer and myself went shooting. Amongst those who came to join in the chase was Karaka. A beast was shot and cut up and the party started home; it was now night but the moon
moon was full. Shortly before reaching the rest house I missed Karaka so sat on a rock beside the forest track and sent the meat and carriers ahead. After ten minutes there was still no sign of him so we started back on our tracks to find him thinking he might have encountered some buffalo and been treed. We found him an hour later a long way off the path completely lost and unable to see. Although it was bright moonlight he had to be led home on a spear shaft. I have shot many times with Karaka but have always found his vision quite good in the rather thick cover in which buffalo are found in the Jur country.

O.E.R.

All media clear. Disc small, vessels small, show signs of an old perivascular retinitis. Retina thin in places and choroidal vessels seen. No black patches.

Mild Sudan Blindness.

O.E.L.

Disc and vessels as in right eye. There is a grey patch a disc's breadth to the temporal side of the disc surrounded by pigment. There is not much to note in the rest of the fundus except the thinness of the retina and the appearance of the choroidal vessels beneath it.

No O.V. nodules found. Skin normal.

GOODIA TEN  JUR.  Aet 30.  TONYIA.  25. 2. 1934.

Two years ago before the rains he developed a pain in his eyes like sand lodged beneath the lids, and his eyes watered; he also had a bad headache. In two months time he could not see in the evening, he still had a dull ache in his left eye with which he could see very little. No blind relatives. Cause of condition said to be due to fish eating.

No O.V. nodules found, skin normal.

EYES.
EYES.

Pigmented ring round the limbus of both eyes. Pupils equal, with very sluggish reaction to light, both 4mm in diameter. Irises normal. All media clear.

O.E.R.

Disc pink, edges rather indistinct, arteries pale pink otherwise normal. Macula normal.

O.E.L.

Disc atrophic. Superior to disc and at 10 o'clock is a patch of R.C. Inferiorly and at 5 o'clock is a large patch of oedematous, greenish coloured retina. In the vitreous, two disc diameters from the disc and between the inferior nasal artery and vein, is a peculiar cyst-like body, oval in shape, and through the ophthalmoscope appeared to be about 3mm broad by 4mm long. It was best seen using plus I.D.

MOLO LAGA. JUR. Aet 35. TONYIA. 25. 2. 1934.

Six years history of night blindness but fair vision during the day. Typical history of Sudan Blindness.

CAUSE. Eating salt with a Zande.

VISION.

Can distinguish hand movements only with his right eye. Counts fingers up to 15 feet with his left eye.

Pupils.

React to light slightly and dilate evenly and widely with atropine.

Media.

All clear.

O.E.R.

Optic atrophy. Gross and diffuse R.C. the choroidal vessels standing out boldly and looking a bright orange, shaggy masses of pigment are widely /
widely scattered over the fundus. Macula involved.

C.E.L.

Disc pink. Vessels trifile sclerotic. A few small patches of pigment here and there, the retina looks thin and the choroidal vessels are visible.

Several O.V. nodules on chest. Have been present for many years.

NYALO ACHO. Aet 30 WAU JUR. WAU. 9. 3. 1934.

Long history of poor vision and night blindness. Impossible to extract reliable particulars.

VISION.

Can see people at 50 feet as blurs with both eyes and fingers at 10.

EYES.

Right eye has a dense white opacity at the bottom of the cornea so dense that at first it resembled a hypopion, but is the type of lesion often seen after the use of highly irritant native remedies placed beneath the lower lid. Streaks of interstitial keratitis radiate from this opacity and reach the equator. Tension to finger very raised. Pupil reacts to light and atropine. There is an adhesion between the opacity and the lower edge of the pupil.

C.E.R.

Disc dead white except at centre. Slight cupping, but not as marked as would be expected. Vessels small. Small pigmented spots seen on anterior capsule, there is a certain amount of choroidal pigment lying about on the fundus but the changes are not very gross.

LEFT EYE.

Practically whole cornea covered by a very faint, blue haziness. Pupil small and immobile. Dilates well after atropine owing to infolding of Iris.
iris.
Tension plus.

O.E.L.
Disc appears normal. Vessels slightly sclerosed. Some R.C. around macula, otherwise not very much change in fundus.
Puncture and aspiration of anterior chamber of right eye showed no M.F. of O.V. M.F. of F. perstans in wet blood slide.

O.V.
Tumours on chest of many years duration.
History of yaws in childhood no history of syphilis.

UNPUR ANUOUCH. WAU JUR Ast 40. WAU. 9. 3. 1934.
Five years history of typical Sudan Blindness.

Right and left corneae show a little interstitial keratitis at the lower limbus.
Tension normal in both eyes.
Pupils equal, react to light and dilate widely and evenly with atropine.

O.E.R.&L.
Both eyes show fine granular deposits on the capsule, otherwise the media are clear.
Both discs appear normal. There is a patch of macular R.C. in the right eye, and the retina of the left is very thin and the choroidal vessels can be seen. A few patches of finely divided pigment are visible.
It is of special interest that this man is almost totally blind although the damage to his fundus is comparatively mild compared to many others with very gross lesions to the fundus.
Puncture of the anterior chamber of the left eye produced a single M.F. of O.V. but the cell content of the aqueous did not seem to be increased. He probably had a mild keratitis which did not develop into the advanced stage to which that condition attains. This is the only case in which such a mild degree of corneal involvement with the symptoms of Sudan Blindness has shown an embryo in the anterior chamber.

UFPIO UKEL.
UFFIO UKEL.  WAU JUR.  Aet 20  WAU. 9. 3. 1934.

Five years history of night blindness and almost total blindness. Lachrymation lasted two years; he has two blind relatives. Very stupid man.

VISION.  Can just distinguish fingers at a meter and a half.

Eyes appear normal but the pupils are rather dilated. Sluggish response to light only, tension normal.

O.E.R.

All media clear. Disc very atrophic with hazy indistinct edges. Fundus has scattered lumps of pigment all over it and especially along the temporal vessels. There is some pigment around the macula, but the macula itself is not affected.

O.E.L.

Much the same as the right.

Puncture of the anterior chamber of the right eye showed no M.F. in the aqueous.

No O.V. nodules found, skin normal.

ABUNDI OKWEILLO.  BELLANDER.  Aet 40.  RAFFILE MISSION.  11. 3. 1934.

Three years history of poor and hazy vision in daylight and night blindness. He came to Raffile three years ago to send his son to school. His small son is blind (next case), and his wife and daughter also.

Eating the head and roe of the nile perch is the cause of his trouble.

O.V. nodules on chest and iliac crests, skin very wrinkled, inelastic and old looking.

O.E.R.

Using plus D. 16, is brown pigmented opacity is seen involving the whole of the lower half of the anterior capsule. Owing to this opacity, a poor /
poor view of the fundus is obtained. The disc is dead white on its temporal side and the vessels are sclerosed. The little seen of the fundus appears normal.

O.E.L.

All media clear. Disc dead white, vessels very sclerosed. The macula shows a surrounding ring of R.C. which does not actually involve it, but the rest of the fundus shows only a very thin retina and no pigment.

VISION.

FINGERS AT three meters only and men as blurs at thirty feet.

12. 3. 1934. No M.F. in aqueous after aspiration, of right eye.

OBOL BIUNDI. BELLANDER. Ad 7. RAFFILE. 11. 3. 1934.

Son of last case. After coming to Raffile he went blind in his right eye, and cannot get about in the evening or see to put his hand into the communal cooking pot at the evening meal. This happened two years ago.

VISION.

4/6 left eye, hand movements only with right.

EYES.

Right pupil widely dilated, no reaction to light. Left good light reflex.

O.E.R.

All media clear. Advanced optic atrophy. Large patch of R.C. between superior and inferior temporal vessels involving the macula.

O.E.L.

Disc not so atrophic as in right eye. There is a patch of R.C. in very much the same position as in the right eye but not involving the macula.

There is a small O.V. tumour on the right side of
his chest, which has never been noticed.
Too young to puncture the anterior chamber.

SALASTINO. BELLANDER Aet. 15. Raffile. 11. 3. 1934.

Three years typical history of Sudan Blindness.

EYES.
Right anterior chamber very deep, pupil adherent all round to anterior capsule. Cornea clear.
Tension plus.
Left cornea clear, iris adherent to anterior capsule from 3 o'clock to 6 o'clock, giving the impression that a persistent pupillary membrane is present. There is a small, refractile ring in the lens about 1 mm in diameter.

O.E.R. & L.
Both discs are atrophic. Both fundi show a diffuse, coarse R.C.
Vision is very poor, he has to be led in the day time and only has perception of light in each eye.
No O.V. tumours found, skin normal.
No M.F. on aspiration of anterior chamber.

VITTORIA ORCHELLO. BELLANDER. Aet 14. RAFFILE.

11. 3. 1934.

A year after he came to the mission three years ago, he developed pain in his eyes which watered and felt as if dust had blown into them. He could see very little in the day and not at all at night, but in the last year his sight has improved very greatly but he still cannot see in the dusk.
He is the brother of the previous case.
O.V. nodule on right iliac crest. Skin normal.

EYES.
Right cornea clear. Iris bound down by annular senecichae. Pupil dilates after atropine owing to infolding of iris.

O.E.R. /
O.E.R.  
Disc appears dead white. There is a patch of R.C. involving the macula, but the rest of the fundus appears normal.

O.E.L.  
Disc atrophic. There is a ring of R.C. around but not involving the macula; the retinal vessels are sclerosed, and the fundus is covered by masses of pigment. There are three small white patches where the sclera has been exposed.

It is almost incredible that the boy can see to get about at all or that his vision has improved as he declares it has. He can count fingers at three meters and can see men as blurs at 15.
No M.F. found in aqueous from right eye.


History of typical onset of Sudan blindness obtained from child's father who is himself totally blind from O.V. Keratitis. The disease commenced when the child was three years old but his mother says that his vision has not got any worse for some time. He led his father to meet the doctor.

VISION.
Can distinguish fingers at two meters and see men in sunlight at ten.

O.V. nodule on right iliac crest which has never been noticed.

EYES:
Both pupils fixed by posterior senechiae. No reaction to atropine. Slight capsular opacities in both eyes.

O.E.R.
Difficult examination owing to small pupil and capsular opacity. Disc dead white. Extensive R.C., especially on nasal side.

O.E.L.
Capsular opacity less marked and a better view of the fundus obtained. Again a coarse roughened, multicoloured,
multicoloured, fundus was seen but the macula was not involved.

NOTE.

Very early age of onset. No M.F. on puncture of left eye.

LINO URO.  BELLANDER (woman) Aet. 20.  RAFFILE
11. 3. 1934.

Eight years history of total blindness with very mild initial symptoms. Impossible to get a good history, as the woman is exceedingly foolish. Large O.V. tumours on mastoids, ribs, iliac crests and trochanters. All these tumours are multiple.

EYES.

Appear normal. Pupils semi-dilated equal, corneae clear. No reaction to light or atropine.

O.E.R.&L.

Both discs dead white: vessels very small and sclerosed. They appear in the words of Bimbashi Burrows of the R.A.M.C. "like a full moon in a red, black, and yellow, ploughed field."

No M.F. in aqueous from left eye.

NOTE.

The above observation in a case literally covered with tumours of O.V.


He developed the disease a year after coming to the mission eight years ago. Typical history of Sudan blindness.

No O.V. tumours could be found.

EYES.

All media clear. No senechiae. No reaction to light or atropine. Irises normal. Pupils half dilated.

O.E.R.&L. /
Gross diffuse R.C. Both discs appear completely atrophic. Both maculas destroyed and white patches of exposed sclera are seen where the maculas should be.

VISION. Totally blind.

No M.F. of O.V. were found in the aqueous from the right eye.

SIKENAI MANZEIN. ZANDE. Aet. 30. RAFFILE. II. 3. 1934.

He was born at Raffile but had no trouble with his eyes until three years ago. His blindness started in the usual way with watering eyes and headache and a feeling as if he had sand in his eyes.

VISION.

Very poor, can only see hand movements at two meters. O.V. nodules removed recently at Wau from chest. There was no improvement in his vision afterwards.

EYES.

Both pupils half dilated, irises normal, corneae clear, Tension normal.

O.E.R.&L.

Both discs chalky white, vessels sclerosed, gross diffuse R.C. involving the whole of both fundi.

No M.F. of O.V. in aqueous from right eye.

OKWATCH. BELLANDER. Aet 35. RAFFILE. II. 3. 1934.

Only six months history of typical Sudan Blindness. He can just get about by himself in daylight, but can see nothing at all in the evening. He has a blind son aged about ten, and his wife started to go blind two months ago. The illness is due to eating a crocodile (his totem).
No O.V. tumours found, skin normal.

**EYES.**

Widely dilated, immobile pupils, irises normal, corneae clear. Lens of right eye hazy blue.

**O.E.R.**

Haze of lens due to granular deposit on anterior capsule seen with +D. 16.

Disc atrophic, vessels atrophic or rather so sclerosed that they look almost white. Macula appears unaffected, but there are extensive patches of R.C. giving the appearance of "Tigroid fundus".

**O.E.I.**

There is a wide pigmentary area all round the atrophic disc. The site of the macula is occupied by a large white area of exposed sclera crossed by retinal vessels, and surrounded by a band of pigment lying on a background of dirty, green, oedematous retina.

Aspiration of the right anterior chamber produced no M.F. of O.V.

**NOTE.**

The short history in this case is very typical, and shows the rapidity with which Sudan Blindness reaches its maximum intensity and then remains stationary.

**VISION.**

Almost totally blind.

**KOTARDO AKOT. BELLANDER. Aet. 30. RAFFILE. 11.3. 1934.**

Five years history of very poor vision without usual initial symptoms. He can see nothing with his left eye, and can just see to get about with his right. No blind relatives. No O.V. tumours found but he has a small hydrocele.

**VISION.**

Blind in his left eye and can distinguish fingers at two meters with his right.

**EYES.**

Right eye shows a deep anterior chamber, and a grey/
grey, atrophic ring round the pupillary margin, which is adherent to the anterior capsule on the whole of its circumference.

The left eye looks normal except for a rather dilated pupil.

O.E.R.

Slight fundus reflex only, owing to capsular and vitreous opacity. +D 16. Opacity of the anterior capsule is due to rather coarse granules bigger than those seen hitherto.

O.E.L.

Cornea, lens and vitreous clear. Disc dead white. The whole of the area between the superior and inferior temporal vessels shows a gross degree of R.C. and the macula is destroyed.

Aspiration of aqueous showed no M.F. of O.V. in the right anterior chamber.

The following cases were seen at Wau on 14. 3. 1934 on returning from the Bellander country.

(1) Zande man aet. 20 giving a four years history of typical Sudan Blindness. Eyes appear normal.

VISION.

Can distinguish fingers at three meters with his right eye and can see men at fifteen meters. His vision with his left eye is about the same.

O.E.R.&L.

Both discs are atrophic; retinal vessels show marked sclerosis and both fundi are covered with patches of R.C.

O.V. tumours on chest. These developed just before his eye symptoms but have never hurt him.

Puncture of right anterior chamber revealed no M.F. of O.V.


He came to Wau four years ago from Wan Alell. After
a year in Wau he developed the usual symptoms of Sudan Blindness. He fishes every evening in the river with hook and line and is very badly bitten by simuliiidae whilst he is fishing. Asked how he got to the river and baited his hooks he said that his small brother led him to the water and he baited the hooks by touch, whilst the small boy took the fish off the hook if he caught anything.

EYES.

Pupils half dilated and immobile. Otherwise they appear normal.

O.E.R.&L.

All media clear. Intense R.C. but in most places there seems to be almost complete retinal atrophy. Discs show entire atrophy.

Aspiration of right anterior chamber showed no M.F. in the aqueous.

No O.V. tumours found, skin normal, no hydrocele.

(3). Bongo Aet. 40 from Tonj district.
Fifteen years history of very poor vision in daylight and complete blindness in the evening.

O.V. Tumours on chest of many years duration.

EYES.

Appear normal. Pupils react well to light and atropine.

O,E.R.

All media clear. Whilst examining this man Dr MacKelvie gave an exclamation of surprise, and handed the ophthalmoscope rapidly to the writer. The patient was highly myopic and whilst arranging the lenses a long, thin, highly refractile body was seen with 0 in the ophthalmoscope crossing the disc and moving in the vitreous. The "head" end, of what the writer took to be a male Onchocerca volvulus, was not visible, but the extremity seen was sharply coiled on itself and resembled the caudal extremity of an adult male of that species of filaria.

O,E.R.&L.

Both discs were pink and hazy, and gave the impression /
impression of suffering from optic neuritis and not atrophy. Both fundi showed marked R.C. Puncture of the right anterior chamber revealed no M.F.

NOTE.

In April 1935, this man brought a friend to Rumbek to be operated on for cataract. His right eye when re-examined after a year, showed a haze of very fine refractile particles in the vitreous. The left eye had not altered at all. This case is identical with one described by Silva (1932) and one by Wilson in 1934. (See under a subheading in the part of this Thesis devoted to "The Nodule".)

It is believed that these are the only cases on record in which it is thought an adult onchocerca has been seen in the eye.

CASE NOTES TAKEN ON TREK IN TEMBURA DISTRICT IN 1933, WITH A BRIEF SUMMARY OF OUR KNOWLEDGE OF THE DISEASE THREE YEARS AGO.

These notes are submitted to show the very rough and ready way in which it has been necessary to do much of this work. More complete and accurate records will be found elsewhere in this thesis. It will be seen that a brief summary is included of the information gained up till November 1933, when this summary was submitted to the Director Sudan Medical Service for his information on the subject.

It is to be regretted that so little advance has been made in our knowledge of this disease.
Imbiri Rest House. 20.10.1933.

Onchocerciasis and Sudan Blindness.

The number of people examined was 750 men, women and children.

Of 195 men 16 showed onchocercal tumours 8.2%
Of 216 women 19 " " 8.9%

One man showed typical onchocercal keratitis.

Four cases of Sudan Blindness were seen which were diagnosed by history alone - no ophthalmoscope being available.

Other cases of blindness were seen but were not considered to be typical enough to record.

These people live along a stretch of the river Sueh. At one place the river falls in foaming cataracts some 400 yards (or more) wide to a considerably lower level. The cataracts when the river is in flood are a magnificent sight, and great rocks appearing high and dry at short intervals enable a nimble person nearly to cross the river. In the spaces between these rocks where the water spouts through with great force, conical wicker-work fish traps are placed. The fish descending the rapids have to make use of these gaps which allow sufficient depth of water to carry them without damage. The traps are of all sizes, little grass traps made by small boys are placed in the smaller passages and soon become full of the fry of the Kawara. This fish looks like a sardine with a red tail. Certain species reach five pounds in weight. Countless thousands of fry are captured and make a most tasty substitute for white bait. Most of the fish caught were Abu Noke of 5 to 10 pounds and Nile perch. Tiger fish, gargur, bayada, buggera, and germut were also captured.
MVOLLO - Jur Country - Rumbek District.
Fishing Pools on River Naam or Rhall.
Tambura District
Zande and Bellanda Gebel and Forest Country.

Bellanda Fish Traps, on the rapids of River Such.
ANALYSIS OF 21 CASES OF RETINO-CHOROIDITIS.

During the Sleeping Sickness inspection of Tembura district I collected as many cases of Retino-choroiditis as possible. Whilst staying at Tembura the post arrived bringing an ophthalmoscope battery and so 16 of the 21 could be examined ophthalmoscopically; one case could not be examined on account of opacities and 4 were seen before the ophthalmoscope arrived. I believe I am justified in including these cases on account of their histories alone.

Most cases were seen at inspections where onchocerciasis was commonest.

Onchocercal manifestations. (Tumours, hydrocele and thick skin).

Cases:

1. 2. 3. 4. 5. 8. 9. 16. 18. 19. 20. 21 = 57.3%.

Those who had previously lived on River Sueh.

Cases:

2. 3. 4. 5. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21 = 60%.

It may be assumed that all those who have lived on the Sueh have been heavy fish eaters in spite of what they say.

Note (1).

The constant association of night blindness. Only one case gave a history of better vision in dim light. (Case No. 1.) Similar histories have been obtained from the Gok Dinka country, the Bellanda on the Bo Road, and the Rumbek Jur. All three cases on ophthalmoscopic examination showed Retino-choroiditis.

Note (2).

The majority believe the disease to be due to eating fish, especially the Nile Perch.

Note (3)./
Note (3).

Defective vision and blindness does not bear any direct relationship to the extent of visible damage to the fundus. Some cases with the grossest changes had fair vision. Others with milder changes were totally blind.

Note (4).

Only 9% of men and women in this district had onchocercal tumours or other manifestations such as elephantiasis, hydrocele and thick rough skin and yet it is significant that 57% of the cases of Retinochoroiditis had visible lesions due to *O. Volvulus*.

CASE I. /
CASE 1.
MOPOI REST HOUSE 18.10.1933.

BEAMO. Zande man aged 40.

Four years ago his sight gradually began to fail. He had watering eyes but not much discomfort.

When he gets up in the early dawn he can see better than in the bright sunlight, and again in the evening he sees better than during the day.

He does not connect the onchocercal tumours on his chest as having anything to do with his vision.

When asked the cause of his blindness he said he was suffering from the blindness of the frog.

Some twenty years ago he was lying dozing in his hut during the heat of the day, when he saw a snake crawling down between the wall and the thatch.

This gave him such a fright that he started violently and reached for a stick. The snake immediately spat at him, the venom entering both eyes caused intense pain and blinded him completely. He gave a good and accurate description of a long black snake with a hood and a yellow throat with black bands across the yellow.

Note.

A snake killed at Rumbek by the M.I. was identified as Naja nigricollis. This was a small specimen but had a distinct hood but not nearly so wide as in Naja haje the Egyptian cobra. It is usually thought that N. nigricollis has no hood but Dr. Corkill confirmed the identification and said that occasionally the spitting cobra was capable of erecting a small hood.

He was blind and in acute pain for six or seven days. He went to a witch doctor who urinated in his eyes twice a day and eventually completely cured him after seven days of this delightful therapy.

EYES.

At first sight appear normal: cornea etc. clear.

Left /
Left pupil irregular, half dilated and fixed to lens capsule: anterior chamber deep. Can distinguish fingers at 15 feet.

Right eye much the same appearance.

NOTE.

Although no ophthalmoscope was available, the appearance of the eyes was that of Sudan blindness.

Of special interest is the improvement of vision in the evening. This is unusual when the almost constant association of night blindness with this condition is considered. However three other similar cases have been seen.

One in the Bellanda country on the Bo road, one in a Gok Dinka on the Gell river and another in a Jur girl at Tonia. All these were examined with the ophthalmoscope.

The fact of being blinded by a spitting cobra 20 years previously is an interesting example of the African's association of cause with effect.

The treatment used by the Kajour is also of interest; as in India the urine of a young pure virgin (surely a rarity in that country) is considered of great efficacy in ophthalmic conditions. Its use is followed by a surprisingly frequent gonorrheal conjunctivitis leading usually to the loss of both eyes.

This case has been written at length to demonstrate the verbosity of the Zande and the welter of irrelevant detail from which the essentials of a case history must be sifted.
CASE 2.

UMBOFFI REST HOUSE. 19.10.33.

Zande Man age 40.

Five years history of poor vision and night blindness with no initial history of lachrymation.

No onchocercal tumours on body. Skin has the typical appearance of O.V. infection.

He could just see fingers at 10 feet when he was examined at 5.45 when the light was not good owing to clouds and gathering dusk.

Eyes appear normal at first. Corneae clear, pupils regular, equal, \( \frac{1}{2} \) dilated, sluggish reaction of a very slight nature to a candle held near his eyes.

He has been a very heavy fish eater, being by trade a manufacturer of wickerwork fish traps. He made his living by bartering dried fish which he captured in every way i.e. poison, traps, nets, spearing and with hooks. Three of his co-workers have gone blind. Eating the roe of the nile perch is said to be the cause.
CASE 3.

UMBOFFI REST HOUSE. 19.10.33.

BUNGUA Bellanda man age 60.

Two years history of complete blindness following the usual lachrymation and night blindness. The lachrymation lasted for 3 months, there was about a month of rapidly increasing night blindness and then complete blindness.

By profession he is a fisherman and previously he and the previous case used to work together at their trade. Now both are blind and many others to the North are also blind.

The blindness is said to be due to eating Nile perch. If they are taken by poison the roe is specially apt to cause blindness. If fish killed by poison are properly cleaned no ill results will occur, but if people do not clean the fish, and eat them entrails and all, they go blind.

Note.

The Gok Dinka on the Gell River in Rumbek district told me the same.

He has always lived in the same neighbourhood. In his youth only a few people were affected. The disease has long been known as the blindness of the frog. Its name is such because a frog cannot see in the evening.

He said that during the last 7 or 8 years the disease had increased a very great deal especially to the north. On being asked how he knew, he said people talked about it.

The onchocercal tumours on his chest and iliac crests were said to be due to magic.

EYES.

Slight onchocercal keratitis of many years duration in typical situation at bottom of cornea; pupils elongated vertically to a very slight extent. This eye trouble said to date from young manhood, but never affected his sight after the burning pain ceased.

Nothing further to note.

A very intelligent old man who was willing to do his best to tell what he knew about the disease.
AGOLO. Bellanda man age 60.

Three months ago - end of July - he developed an irritation of the eyes as if sand had been thrown into them. He had profuse lachrymation followed by night blindness.

He was a partner in the firm of fishermen consisting of the last two cases and himself.

His theories regarding the cause of the disease are those of Pungua, to which is added magic.

EYES.

Considerable photophobia. He can see near objects at 6 feet only and then very dimly.

LIDS.

Slightly swollen along tarsal margin.

CONJUNCTIVA.

Slightly injected but has the general appearance of oedema and not inflammation.

This swelling is specially marked at the canthi. The conjunctiva looks as if some clear fluid had been injected beneath the membrane.

Two small yellow nodules present at lower and lateral part of lower lid of right eye.

ANTERIOR CHAMBERS.

Both very deep. No headache. Pupils, equal, regular, half dilated, no response to light.

CORNEAE.

Very faint pearly blue haziness equally distributed over both corneae. The appearance is again that of oedema and not inflammation. The corneae had lost a little of their lustre.

LENSES CLEAR

Onchocercal tumour on chest.

This is the first case that has been seen during the beginning of the disease. It is likely that the destruction of the fundus has reached its maximum.

No amount of bribing, cajoling or entreaty would persuade him to come to hospital for investigation.

Five years ago at the beginning of the rains he developed an acute irritation of the eyes as if sand had got under the lids. At times the pain became burning.

There was profuse lachrymation which lasted for one month; night blindness followed and in three months he could only just see to get about in day light.

His condition has remained the same since. It has not got any worse.

EYES.

All media and cornea normal. Pupils half dilated equal, regular. Lids healthy.

No onchoercal tumours. Skin normal. Poor response to light. Type of blindness that of the frog.

Cause, eating excessively of nile perch.

No ophthalmoscope.
CASE 6.

IMBIRI REST HOUSE. 20.10.1933.

BUGGU. Bellanda man age 50.

Five years ago he had swelling of eye lids and lachrymation. Typical history.

EYES.


Ophthalmoscope.

Owing to two or three lenses having fallen out of the ophthalmoscope during cleaning and since their order was unknown, difficulty in using 0. on the dial was experienced as I was unable to focus on the fundus. The disc was grey but out of focus but on the periphery of the fundus enough was visible and in focus to determine the presence of Retino-choroiditis. Vision - faint perception of light only.

Onchocercal tumours on right iliac crest, which developed a year after the eye symptoms.

EYE REMOVED for pathological examination.
CASE 7.

MYANI. 21.10.1935.

MACKENZIE. Zande man age 45.

For the past year he suffered from very poor vision seeing near objects only as blurs in the bright sunlight, but when in shadow or in the evening he has to be led. Typical history of lachrymation etc. at beginning of rains.

Recently he went with a party of hunters to help carry game nets. After reaching their destination he left them to return home. Rain was coming on and it was evening, the sky being covered with black clouds.

He could not see to continue his journey and sat in the grass in the gathering darkness and shouted till somebody found him and took him home. The shouting was probably to frighten the devils and spirits of the forest as well as to attract attention.

Shortly after the blindness started he consulted a witch doctor who put some medicine in his eyes which greatly relieved the irritation but did not improve his vision.

He is not a fish eater, has never lived near a river and has never captured fish. If anybody offered to barter fish with him he would eat it but not otherwise. He suffers from the blindness of the frog which is not due to fish eating but to a spell cast by a Kajour.

The following is a typical example of the way in which magic is woven into the every-day life of the Azande.

One day an evilly disposed person saw him working in his extensive cultivations. "That's a fine, strong, hard-working fellow, if he goes on extending his clearing like that he will soon want my cultivations too", said the evil wisher.

The jealous one then went to the witch doctor who for a consideration (not specified) arranged to deal with the case.

One /
One night whilst the unsuspecting cultivator slept the witch doctor crept to his hut and placed some "dawa" in his eyes. This is the cause of his blindness.

A fine-looking, well set up man of above average intelligence who did his best to give a good history.

EYES.

Appear normal. Can see my hand at 6 feet in the gloom of the rest house but cannot distinguish fingers.

No family history of blindness. No history of headache. No onchocercal tumours or hydrocele. Skin normal.
KORAMBUGISH. Zande man age 70.

Two months ago he had acute irritation of the eyes with lachrymation. He soon developed night blindness and can now only see near objects in good light but has to be led in the evening. Previously he had excellent sight.

The disease is not frog blindness but is the result of prophylactic injections of atoxyl five months ago.

Eyes apparently normal except for a mild light green cataractous change in both eyes such as one might expect in a man of 70.

He still has slight bi-temporal and frontal headache.

No onchocercal tumours or hydrocele. Skin normal.

Ophthalmoscope.

Owing to cataractous change only the periphery of the fundus could be examined. The appearance was typical of Jur blindness: the rough patchy "ploughed up" nature of the retina was marked.

Note.

The next case of blindness was in a boy of 15 years of age. He gave a history of dimness of vision going on to complete blindness in three months. There was no pain or lachrymation. This started after one injection of atoxyl. The fundus showed optic atrophy, the retina appeared darker than usual but not unlike any negroid fundus. There were no signs of Sudan blindness.

About 10 cases of optic atrophy resulting from therapeutic doses of atoxyl for trypanosomaisis before the substitution of tryparsamide have been seen. None gave the typical history of Sudan blindness: the process was gradual without initial irritation and lachrymation.
CASE 9.

ABDULLA SADIK REST HOUSE. 24.10.1933.

MACKENZIE. Zande man age about 60.

Three months ago he had profuse lachrymation without much discomfort. He could see things in a haze as if through heavy rain, he then developed night blindness.

He has had injections of atoxyl but does not attribute his frog blindness to them. He says magic is the cause.

He has heard that the disease is caused by fish but does not think so. He used to live on the Suez River and capture fish in traps and with bean poison.

Onchocercal tumours of small size on ribs.

Can see hand and fingers at 20 feet in shade of rest house.

EYES.

Mild cataractous change in both; pupils equal, half dilated sluggish response to light.

On dilation with atropine right pupil adherent in upper and outer part resulting in an irregular pupil. Left pupil evenly dilated.

OPHTHALMOSCOPE.

Right fundus invisible owing to cataract.

Left.

Typical retino-choroiditis. Black pigment plainly seen but no white patches.

Optic nerve very large and dead white. Only a glimpse obtained. Difficult examination owing to cataract.
CASE 10.
No. 1 REST HOUSE - TEMBURA WAU ROAD. 24.10.1933.


One year history of gradually increasing blindness without initial pain and lachrymation but night blindness marked. No atoxyl injections.

He is suffering from frog blindness due to the eating of the Abu Noke. He incriminates this fish and not the nile perch. He used to be a heavy fish eater when he lived on the Suez. No blind relations.

Onchocercal tumours on right iliac crest. Eyes appear normal. Pupils half dilated, regular equal, fair reaction to light and good dilation from atropine.

OPHTHALMOSCOPE.

Intense changes in retina which seems almost to have disappeared except on periphery and on lateral and upper quadrant.

The general appearance of the fundus is a dirty greenish-white grey, with lumps of brown and black pigment lying about. The optic nerve is not dead white. There is a well marked pink tinge round the convergence of the retinal vessels which are particularly small.

Left Eye.

No white patches but the usual ploughed up appearance is seen with irregularity; scattered lumps of pigment here and there.

The disc has the appearance of optic neuritis, being poorly defined and very pink.

Note.

The intense changes in right eye - see sketch in case of Angaka but here the whitish area is very much larger.

In spite of this he can just see to get about in daylight and can see people at 40 feet with his left eye and distinguish fingers at 3 feet with his right.
CASE 11.

No. 1 TEMBURA WAU ROAD.

BAKADI. Zande man age 30.

Four years typical history of Sudan blindness.

He used to live on the Sueh river catching fish by poison and traps.

He considers he caught the disease from eating a large frog and not from fish. People consider fish eating as the cause of blindness but he does not.

No onchocercal tumours. Skin normal, no family history of blindness.

EYES.

Both appear normal. Can see people at 40 feet and fingers at 15 but not beyond.

Poor response to light full dilation with atropine.

OPHTHALMOSCOPE.

Discs appear normal.

Usual appearance of retina in Sudan blindness but not as marked as usual. Pigment in fine spots and scattered.
CASE 12.

No. 1 TEMBURA WAU ROAD. 24.10.1933.

ZANIA. Zande man age 40.

Four years ago he had failing sight which commenced with night blindness. No lachrymation or irritation. No atoxyl injections. Left eye destroyed by a burst gun years ago.

He used to be a fisherman and lived on the Sueh river. His illness is due to eating the head and roe of a large *aigle (probably about 80-100 pounds).

Right Eye.

Pupil half dilated, fair response to light irregular dilatation with atropine. No onchocerca.

OPHTHALMOSCOPE.

Disc dead white. Little change in retina except for large white patch on the lateral side. The patch is ill defined, and of a greenish white colour, with patches of pigment lying about round the edges and centre.

He can see people outside the rest house at about 40 to 100 feet and distinguish fingers at 15 feet.

How he can see so much, with a disc the colour of chalk and a large area of the fundus apparently denuded of retina, I fail to understand.

*Nile Perch.
CASE 13.
NEAR TEMBURA. 23.10.33.

Name BAKAI. Zande man age about 50.

A year ago, before the rains, he developed acute burning pain in both eyes which watered profusely.

This lasted for several months. He still has slight lachrymation but nothing like the initial condition.

In two months he developed night blindness and soon could only see near objects dimly. He had and still has slight bi-temporal headache. He says that his blindness is due to the bite of a snake on his right index finger 15 or 20 years ago. His finger subsequently fell off. He killed the snake which was about 18 inches long, green with black stripes (almost certainly V. causus).

He says that his blindness is that of the frog but only associates it with snake bite. He has never heard of fish eating as a predisposing cause.

No family history of blindness. He used to live on the river Such 2 years ago.

He used to be a heavy fish eater using traps and poison bean. He received no local treatment.

No onchocercarial tumours - skin normal.

EYES.

Very slight corneal opacity in centre of both eyes. Slight calcareous, deposit along medial margin of left cornea. Can see fingers at 10 feet.

Pupils irregular, unequal right, half dilated left, very small. No reaction light or atropine conjunctiva slightly swollen on lower lid.

OPHTHALMOSCOPE.

Left eye could not be examined owing to small pupil. Right only ½ dilated. Typical retinal changes of Sudan blindness. Several extensive whitish grey patches containing black pigment. Disc very large and pale.
CASE 14.
NEAR TEMBURA. 23.10.1933.

Name RISENA. Zande man about 20.

Six months ago he had acute burning pain in both eyes with lachrymation followed by night blindness. He went to a witch doctor who put some medicine in his eyes which hurt a great deal. The name of the medicine was Renza the small black bean used as food by the Azande.

If a man is very near in bright sunlight he can see him but if about 40 feet away he appears as blur. He can distinguish fingers at 10 feet in shade.

He attributes the disease to the curse of the aged husband of a young woman with whom he had a liaison.

He used to live near the Sueh river and was a heavy fish eater. He used bean fish poison. He has not heard that fish is the cause of his affliction. Occasional headache. No onchocercal tumours - skin normal.

EYES.

Slight cloudiness over centres of both cornea. Probably due to native therapy.

Pupils regular, equal, slight reaction to light both widely dilated after atropine.

OPHTHALMOSCOPE.

Typical retinal appearance with deposits of black pigment but no white patches. Disc pale but not dead white - yellowish.

NOTE.

Shortness of time for the development of retinal destruction which in this case has attained its probable maximum intensity within 6 months of first symptoms.
CASE 15.

TEMBURA. 25.10.55.

ANGARA. Zande man aged 50.

4 years ago he was attacked by the blindness of the frog. He suffered severe irritation of the eyes as if sand had been thrown into them. His eyes watered a great deal. This was during the rains and the lachrymation lasted about 3 months and when it ceased he found he could not see in the heavy forest. He now has to be led and can just see my hand at 3 feet.

He used to live on the Sueh river. He believes the disease is due to eating nile perch because the eyes of this fish are red. He was a hunter and not a fisherman.

No family history of blindness. No hydrocele, no onchocercal tumours - skin normal.

EYES.

Appear normal except for pale green cataract.

Ophthalmoscopic Examination.

Pupils widely dilated by atropine.

Fundus well seen. Optic disc dead white. Usual "ploughed up" appearance of Fundus, black pigment scattered about in lumps and a large white patch seen in both fundi.
CASE 16.

TEMBURA. 23.10.33.

NKABI. Zande woman age about 20.

When she was a little girl of about 2 years old, she had a severe irritation of the eyes and lachrymation. She does not remember it but her mother (dead) told her about it. Since then she has only been able to see a very little in the day but does not have to be led; she cannot see so well in the evening. She can go about in the evening without being led if somebody walks a few yards ahead of her.

She is suffering from frog blindness which is caused by magic. Her family lived near the Sueh.

Eyes appear normal, except for rather dilated regular equal pupils. There is a pupillary adhesion on the infero-medial edge on the left side.

No reaction to atropine or light.

OPHTHALMOSCOPE.

Intense destruction of retina. Big white patch in lateral lower quadrant of left fundus with black mottling round the periphery.

Scattered areas and spots of black pigment.

Discs large and dead white.

NOTE.

The early age of onset and the fair amount of vision retained in spite of gross retinal changes and atrophy after 18 years. Again this points to the disease progressing rapidly to a maximum and then ceasing. In this case there appears to have been no increase in blindness since infancy.

This girl developed the disease at an earlier age than anyone hitherto seen.
CASE 17.

GHOR REST HOUSE. 25.10.1933.

TABANAWERRY. Zande man aged 40.

4 years history of complete blindness with typical onset with night blindness. Perception of light only remains. Establishment of complete blindness 2 months from date of onset. No headache. No blind relatives.

Onchocercal tumours on chest and iliac crests.

When the sickness took him he was living on the river Sueh. He was a heavy fish eater using bean poison and traps.

He is suffering from frog blindness which is characterised by night blindness at first and then very poor vision or complete blindness. Good history.

Pupils equal and regular. Widely dilated. No reaction to light. Atropine instillation not necessary slight green opacity of both lenses. This did not interfere with ophthalmoscopic examination, a good clear view being obtained.

OPHTHALMOSCOPE.

All retinal vessels small.

Choroidal vessels mixture of vermilion and chrome yellow. Very brilliant. Great shaggy masses of black pigment like soot-lying all over the place and covering retinal vessels in places. See sketch.

Disc.

Ill defined, white, surrounded by spots of black pigment. No white patches; changes most marked in left eye which was removed on Oct. 31st. for pathological examination.
CASE 18.
GHOR REST HOUSE. 25.10.1933.

OBUKU. Zande man about 60.

Seven years ago during the sowing of the durra crop he developed irritation and pain in the eyes, "like hot snakes running about under the lids". He had profuse lachrymation.

He used to live on the Sueh river where he was a great fish eater using traps and bean poison for fishing. He is now completely blind.

He has heard the blindness of the frog is due to eating fish but does not think this is so. Asked why? he replied "Why then are not all the people blind"? - A very sound reply. No family history of blindness.

No onchocercal tumours or hydrocele. Skin normal.

LEFT EYE.

Cornea clear. Anterior chamber very shallow iris pushed up against cornea. No pain on pressure.

Pupil small, fixed to capsule of a cataractous lens.

RIGHT EYE.

Anterior chamber very deep, appears conical. Pupil small fixed. Lens and cornea clear. No reaction to atropine.

OPHTHALMOSCOPIC EXAMINATION.

Difficult to see anything in right eye owing to small pupil. Left eye too cataractous to examine.

RIGHT EYE.

Disc. not seen. Only an occasional glimpse of fundus showed typical ploughed up multi-coloured appearance.
CASE 19.

NANZI REST HOUSE. 25.10.1933.

ANGAMBO. Zande man aged 50.

4 years ago he developed the signs and symptoms of typical Sudan blindness. He is an incredibly silly man and a good history cannot be extracted from him.

Both eyes have pin-point pupils, both lenses are cataractous. Both anterior chambers are very shallow. Onchocercal tumours on chest.

OPHTHALMOSCOPIC EXAMINATION.

Impossible owing to opacities etc.
CASE 20.

No. 2 REST HOUSE - TEMBURA YUBO ROAD. 27.10.1933.

BEAMO. Zande man aged 30.

Two years ago he developed severe irritation of the eyes, bi-temporal headache and lachrymation.

The lachrymation has lasted to a mild degree until the present time. He soon developed night blindness and then complete blindness. He has faint perception of light only.

Three years ago he lived near the Sueh but two years ago he moved to No. 1 Rest House on the Tembura Yubo road where the eye condition started. He was not a heavy fish eater being a cultivator and hunter. He ate fish if it came his way.

He is suffering from frog blindness which he says is due to eating the head and roe of the Nile perch.

He has a small onchocercal tumour on the side of his chest which appeared a year after his eye condition developed. Before its appearance he had great pain and fever. He saw a Kajour who treated him for pneumonia and pleurisy with hot poultices and incantations. Many people have these tumours which often appear without pain. Others have severe pain and fever. They are due to magic.

He has a typical onchocercal punctate keratitis in the left eye. This commenced 5 years before his present affliction. When he developed Sudan blindness the right eye hurt and watered together with the left. He had no pain and lachrymation since the original keratitis 7 years ago.

RIGHT EYE.

Pupil widely dilated. Sclera and lens clear conjunctiva of lower lid oedematous and folded on itself.

LEFT EYE /
LEFT EYE.

Pupil pin-point, lens capsule opaque, anterior chamber very shallow. Pupil adherent below to edge of the portion of the cornea affected with keratitis. Conjunctiva as in left eye.

Ophthalmoscopic examination of right eye.

Complete optic atrophy. Very little deposit of pigment and then only in small spots. No white areas. There is a big black patch at 9.30.

The retina is not so "thin" looking as usual and although streaked and unevenly coloured the changes are not very severe. He is completely blind.

NOTE.

Complete blindness with comparatively mild changes compared to some cases with a fair amount of vision and intense destruction of fundus.

Very intelligent man who gave a good history.
CASE 21.

No. 2 REST HOUSE - TEMBURA YUBO ROAD. 27.10.1933.

MARITO. Zande man aged 30.

A year ago he developed acute irritation of the eyes and lachrymation and headache. The lachrymation is still present to a mild degree. Night blindness developed rapidly and he soon could only see in bright sunlight.

He consulted a Kajour who placed an extract of musk from the glands of a crocodile in his eyes. This did him no good.

He can see people at 40 feet and distinguish fingers at 20.

He says his disease is called crocodile blindness and it is not due to fish.

He used to live on the Suesh river 3 years ago and was a fisherman using traps and bean fish poison. He was a heavy fish eater. No blind relatives.

Onchocercal tumours on iliac crests which developed without pain a month after his eye condition.

Both eyes.

Pupils equal, regular, half dilated, sluggish response to light, full dilatation after atropine. Conjunctiva slightly congested and oedematous.

Ophthalmoscopic examination.

Both fundi presented similar appearances. Large white patches, splatters of shaggy black pigment looking like lumps of lamp black lying all over the place. Discs pale but still have pink colour in centre.

NOTE.

Gross destruction of retinal structures with fair vision and ability to go about alone in daylight.
The course of the disease has already been described.

It is believed that the toxin completes its work in a comparatively short time - usually from 2-5 months from the beginning of lachrymation. The progress of the disease when it comes to an end and the condition remains stationary.

The toxin appears to attack the uveal tissue, the nervous structures of the eye being affected later, optic atrophy following the choroidal changes.

It is unfortunate that only one case has been seen during the commencement of the disease and it was impossible to get him to hospital for investigation.

Most cases start their symptoms at the beginning of the rains when Medical Staffs are being moved for relief work during the leave season, or are themselves going on leave.

In a busy district the calls of medical and surgical work on a Medical Inspector's time prevent a detailed examination of cases complete with blood counts and blood slides etc.

It will be noted from these records that the changes in the fundus bear no relationship to the degree of impairment of vision. The very grossest changes in the fundus are not necessarily accompanied by complete blindness, neither are the adhesions of the iris an index of the severity of the fundus changes.

An attempt has been made to test the fields of vision of a few cases but language difficulties and the low intelligence of patients have made this line of investigation too difficult and lengthy to be practicable or reliable.

It is hoped that the eye specialist will be able to accomplish something with a perimeter.

The main characteristics of the appearance of the fundi examined with an ophthalmoscope are as follows:

1/
(1) The rough ploughed up appearance of the fundus; the choroidal vessels standing up become brightly illuminated as they shine through the retina which appears either grey or deeply inflamed and very thin. The colour of the fundus is very variable in this condition but then the colour of the normal fundus in Nilotics and the Zande tribe varies greatly also in individuals of the same race.

(2) Black pigment, either in little spots or streaks or great shaggy masses, is scattered about the fundus. The optic disc is frequently surrounded by pigment but this also appears in normal eyes. Large masses of pigment are occasionally seen lying on the retinal vessels but as a rule, the pigment, which resembles soot, is irregularly scattered. Perhaps only one or two small masses are seen in an eye in which all vision has been destroyed - See illustration (1).

(3) The occasional presence of white patches crossed by the retinal vessels. These are due to exposure of the sclera. Black pigment is found in these patches and the edges of the areas are occasionally coloured a dirty green. Again, very large solitary white areas or multiple small ones have been seen where the patient has been able to see people at 40 to 100 feet in good light. Illustration (2) large solitary white patch. Illustration (3) small white patches.

(4) The pallor of the optic disc varies, but a distinct pink tinge is sometimes left round the exit and entrance point of the retinal vessels, which in many cases are much diminished in size.

(5) Two eyes were obtained in the Zande country and were removed under local anaesthesia. These were preserved in 4% formaline in saline and were in good condition on arrival in Khartoum, the changes seen on ophthalmoscopic examination being visible to the naked eye.

It is hoped that these two specimens may give some clue to the nature of the disease when examined histologically.

It is also hoped that further specimens of eyes will be forthcoming from the tribes in Rumbek District.
A SUMMARY SEEMS TO BE UNNECESSARY ADDITION TO AN ALREADY TOO CUMBERSOME COMPILATION IF THE PAGE DEVOTED TO THE CONTENTS OF THIS THESIS HAS BEEN READ. IT ONLY REMAINS TO BE SAID, THAT STRONG AS THE EVIDENCE IS, THAT SUDAN BLINDNESS, IS ANOTHER MANIFESTATION OF ONCHOCERCA VOLVULUS IT CANNOT YET BE SAID THAT THIS IS DEFINITELY SO. THE WRITER HAD HOPED THAT SOME DAY HE MIGHT HAVE SUFFICIENT LEISURE AND LESS ROUTINE SURGERY TO PERFORM, TO ENABLE HIM TO COLLECT MATERIAL FOR A PROPER PATHOLOGICAL INVESTIGATION. OWING TO THE DEMANDS OF GOVERNMENT SERVICE THIS HAS BEEN IMPOSSIBLE AND IT IS FEARED THAT THE WRITER ON BEING TRANSFERRED TO ANOTHER PART OF THE COUNTRY WILL NEVER HAVE THE CHANCE TO COMPLETE THIS WORK.

THIS THEN IS THE REASON FOR SUBMITTING THIS THESIS NOW IN ITS PRESENT FORM, IN WHICH THE PROBLEMS OF TRANSMISSION AND THE BIONOMICS OF THE INSECTS AND WORMS ARE DEALT WITH SO BRIEFLY.
BIBLIOGRAPHY.

A NOTE WILL BE FOUND IN THE INTRODUCTION ABOUT THE BIBLIOGRAPHY OF THIS THESIS.

IT ONLY REMAINS TO SAY THAT A FEW REFERENCES ARE GIVEN TO WORKS THAT HAVE BEEN CONSULTED BUT HAVE NOT BEEN QUOTED IN THE ACTUAL SCRIPT.

AGAIN QUITE A NUMBER OF PAPERS DEALING ESPECIALLY WITH THE ENTOMOLOGY OF THIS SUBJECT, AND THE MORPHOLOGY OF THE FILARIDAE HAVE BEEN CONSULTED. BUT HAVE NOT BEEN INCLUDED ON ACCOUNT OF THEIR IRRELEVANT OR TECHNICAL NATURE.

A SPECIAL WORD OF THANKS IS DUE TO FRIENDS WHOSE KNOWLEDGE OF GERMAN HAS BEEN A GREAT HELP IN THIS WORK.

A DEBT OF GRATITUDE IS OWED TO THE LIBRARIANS OF THE LONDON SCHOOL OF TROPICAL MEDICINE AND HYGIENE FOR ENABLING THE CANDIDATE TO OBTAIN ACCESS TO MANY FOREIGN JOURNALS.
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LIST OF ILLUSTRATIONS TO ACCOMPANY THESIS.

(1) Onchocercal tumours over ribs. Note especially the skin giving the appearance of great age, in a Jur man of about 35 years of age.

(2) Same case showing the very wrinkled skin of the thigh.

(3) Onchocercal tumours at the angle of the jaw in a Jur youth.

(4) Onchocercal keratitis. Copies of water colours. **Originals in thesis.**

(5) Multiple neuro-fibromata. Do not contain microfilariae. **Differential diagnosis.**

(6 & 7) O. volvulus tumour on frontal bone of an Agar Dinka from Rumbek district. Double keratitis and total blindness. In this instance the nodule was "dead" and undergoing calcification. It was subperiosteal, and was lying in a deep hollow in the bone.

(8) Onchocercal nodules on the mastoid process of an old Jur woman.

(9) Acute onchocercal keratitis in a Jur woman. Note typical attitude.

(10) "Elephant scabies." Filarial Craw-Craw, with thickened skin. Agar Dinka from Rumbek District who lives on the boundary of the Jur country. Microfilariae were very numerous in the skin.

(11) Elephantiasis of penis and scrotum in a Jur boy of sixteen. It is believed that this is due to *O. Volvulus.*

(12) Same case ten days after operation using Bryant and Malhamme's method of skin grafting. The oedema of the remains of the prepuce will subside when the new venous and lymphatic returns are established. The penis will be completely covered by skin in less than three weeks from the date of the operation.

(13) Mvolo, Rumbek District, Equatorial Province—Late Bahr elGhazal Prov. Breeding place of *Simulium damnosum.*

(14)/
Illustrations:— continued.

(14) River Naam during a small spate. Simuliidae make fishing here in the afternoon almost impossible.

(15) Heavy forest on the rocky banks of the river Naam. It is in the deep shadow that the simuliiidae bite during the heat of the day.

(16) Deep pool where fish poisons are used at Mvolo. The baskets of crushed Randia nilotica berries are sunk in the narrow entrances (three of them) seen in the mid distance. The fish gradually become blind and intoxicated and run ashore when they are seized and cleaned immediately.

(17) Photograph of coloured sketch of a case of onchocercal keratitis.

(18) Dr. A. R. MacKelvie and writer removing onchocercal nodules from a white eared cob (Cobus leucotis) shot on the Lau River by Dr. A. Cruickshank.

(19) Onchocercal tumours (species unknown) beneath skin of animal seen above.

(20) Onchocercal embryo from tumours seen in illustration No. 19. (By permission of Dr. A. Cruickshank). Magnification 500 diameters.

(21) Fish said to cause blindness. A Nile perch of sixty pounds, and "abu nokes" caught in the battu seen in illustration No. 22.

(22) Fishing battu of the Jur in a pool of the river Naam at Mvolo. The man to the left of the central rock has his spear into a hundred pound perch. 30% of the people in this pool are suffering from some form of eye trouble attributable to O. volvulus, many are nearly blind, and yet nobody was speared during this day's fishing.

(23) Randia nilotica, the ripe, crushed seeds of which are widely used as a fish poison. It was thought at one time that this poison caused blindness.

(24) Three water colour field sketches showing various stages of onchocercal keratitis.
Illustrations:— continued.

(25. 26. 27. 28. 29.) Water colour field sketches of the progress of onchocercal keratitis.

(30) Water colour field sketch of the fundus in a case of Sudan Blindness.

(31) Sketch in oils to show sclerosis of vessels, and the exposure of the sclera. Note the dirty green, oedematous retina around the white patches.

(32 & 33) Original of photo reproduced in printed matter submitted with this thesis, in oils, and a similar sketch of another case.

(34) Water colour sketch to show cuticular thickenings which are the distinguishing feature of the genus Onchocerca.

(35) Water colour sketches of two microfilariae. To show what the writer believes to be merely a short form of the fully developed larva and the immature. Note the segmentation of the body often seen in well stained specimens. Stained with Gemisa. Diagrammatic.

Note Nos. 32 & 33 may have been lost. If unavailable see description of plates in printed text.

It is to be regretted that at the time these sketches were made no drawing paper was available, so they were painted on note paper.
A LIST OF PHOTOMICROGRAPHS TO ACCOMPANY THESIS.

Fig.I. Microfilariae of Onchocerca volvulus in a section of skin.
Haem. & Eos. ×750

Fig.II. Skin, subcutaneous tissues and part of a nodule due to Onchocerca volvulus.
Haem. & Eos. ×25

Fig.III. Microfilaria of Onchocerca volvulus in skin. Note small vessel showing some perivascular infiltration.
Haem. & Eos. ×750

Fig.IV. Section of skin to show microfilariae.
Haem. & Eos. ×250

Fig.V. Section of onchoceracal nodule to show the fibrous tissue wall and microfilariae in the uterine cavity of the females.
Haem. & Eos. ×80

Fig.VI. Section of nodule to show cuticular thickenings, the distinctive feature of the genus Onchocerca.
Haem. & Eos. ×250

Fig.VII. Smear from the cut surface of a nodule to show immature microfilariae and eggs.
Haem. & Eos. ×400