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FILARIASIS IN THE SUDAN

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SYNOPSIS

The author summarizes the available information on *Loa loa*, *Acanthocheilonema perstans* and *Wuchereria bancrofti* infections in the Sudan, with special reference to the prevalence and distribution of the vectors.

There are four species of human filaria in the Sudan: *Loa loa*, *Acanthocheilonema perstans*, *Wuchereria bancrofti* and *Onchocerca volvulus*. In this paper an attempt has been made to bring together and summarize the very scattered information about *loa*, *perstans* and *bancrofti* infections in the Sudan. *O. volvulus* has been omitted because the subject of onchocerciasis in the Sudan has been adequately covered by Kirk,[17] Haseeb,[15] Lewis [a] and Satti & Kirk.[b]

Loa loa

In 1936, Cruickshank [11] reported that, so far as was known, loiasis in the Sudan occurred mainly in the Zande country. This is on the northern edge of the tropical rain forest of the West African sub-region, as defined by Bequaert,[5] to which *Loa loa* is confined (Gordon et al.[14]). Woodman[27] found the distribution of loiasis in the Sudan to be between latitude 4° and 6° N, extending westwards into French Equatorial Africa and southwards into the Belgian Congo. It has not been reported east of longitude 30° E in the Sudan nor has it been authenticated in Uganda. Within the area in the Sudan defined above, about 20% of the indigenous population are infected with *Loa loa* and, in 1934, 23% of the European and Syrian officials were infected. Abbott [1] also reports that loiasis is very common in the Zande area.

The vector

Woodman & Bokhari [29] have shown that, in the Sudan, the microfilaria of *Loa loa* taken up from the human host will develop to the infective stage

[a] See note on page 671 of this number of the *Bulletin*.
[b] See article on page 531 of this number of the *Bulletin*.

in *Chrysops distinctipennis* and *C. longicornis*. The latter species was comparatively uncommon, the proportion of *C. longicornis* to *C. distinctipennis* being 1 : 26. Of the 600 wild-caught *C. distinctipennis* which were dissected, four (0.7%) were found to be infected. *C. silacea*, which Leiper[10] and Connal & Connal[9] had shown to be an efficient vector in West Africa, was found in only one locality (Sources Yubu) during five years' work, and only once in appreciable numbers, when it was taken on cattle during the rainy season. Woodman,[25, 27] and Woodman & Bokhari [29] were inclined to believe that *C. distinctipennis* and *C. longicornis* might not be the only or even the commonest vectors of *Loa loa* in the Zande country. They refer to the furtive habits of these flies, their reluctance to bite man, the rarity with which they are found in or around houses and the relatively long and irregular development of the filaria in them. In the search for an alternative vector, Woodman & Bokhari [29] dissected specimens of *Haematopota decora*, *H. vittata*, *H. brunnescens*, *Stomoxys calcitrans*, *S. nigra*, *Glossina morsitans* and *G. palpalis* after feeding them on infected human volunteers. The results were negative, except in the case of *Haematopota*, which showed development up to the equivalent of the third day in Connal & Connal's [9] experiments. Woodman [27, 28] was inclined to suspect *Hippocentrum* (*H. trimaculatum* and *H. versicolor*), the only remaining Tabanidae in the area known to feed voraciously on man. Next to the possibility of *Hippocentrum* he suggested that there might be a mosquito vector of *Loa loa*.

Bloss,[6] who worked for some years in the infected area, points out that his observations do not coincide with those of Woodman. Bloss found that *Chrysops* sp. did attack man, and could often be found near habitations. He records that the flies were a common nuisance in the Li Rangu leprosarium, and during tsetse-fly surveys carried out on foot they would also attack carriers. According to Bloss, the Azande have a special name for these flies which suggests that they commonly attack man.

Later observations (Lewis [19]) suggest that *Chrysops silacea* may be more widely distributed in the loiasis area than is suspected. Gordon et al.[14] found that in West Africa this species normally inhabits the forest canopy and attacks man when he is exposed to view—for example, where the trees are low or where there are small clearings among tall trees. In the Zande country the thick forest grows in strips along streams, and there may be only certain places where man comes into view of the canopy. Recording the distribution of the six species of *Chrysops* which have been found in the Sudan, Lewis [19] points out that " *C. silacea* is the only species confined to the loiasis area except *C. funebris*, which has only been found once, and *C. longicornis*, which is seen in small numbers. *C. distinctipennis* occurs mainly outside the loiasis area and, if it is an important vector, it is surprising that the disease is not more widespread." Oldroyd's [22] comments are interesting on this point. He includes *C. silacea* among the species of the forest canopy, but not *C. distinctipennis*, which he regards as a species

of the savannahs. *C. longicornis* is one of the few species occurring in both rain forest and savannah, and Oldroyd notes that although Crewe [10] found that this species would not bite human volunteers in the laboratory, it often bit humans readily enough in the open. Oldroyd was bitten by *C. longicornis* on a fairly open site near Victoria and quotes Neave, who wrote that this species " seems to bite with some freedom, perhaps more so than most species of *Chrysops* ".

Gordon [13] states that no evidence has been produced to incriminate any genus of Diptera other than *Chrysops* in the transmission of *Loa loa*. He admits, however, that while fairly large numbers of mosquitos, midges (Ceratopogonidae) and black flies (Simulidae) have been tested, the number of Tabanidae used in such experiments has been too small to rule out the possibility of their being vectors. Hence it seems unlikely that mosquitos or other biting insects, excluding Tabanidae, will be found to be vectors of *Loa loa* in the Sudan. As regards the Tabanidae, it seems unlikely that species of the genus *Hippocentrum*, suspected by Woodman [27] as possible vectors, will prove to be of any great importance. In his classic studies which incriminated flies of the genus *Chrysops*, Leiper [18] tested, among other insects, *Hippocentrum trimaculatum* in which he observed only partial development of the worm, similar to that seen in *Haematopota*. It is possible that further work may show *Chrysops silacea* to be the principal vector of loiasis in the Sudan, as in West Africa.

Pathogenicity

Loa loa sometimes crosses the front of the eye and may give rise to the transient swellings known as " Calabar swellings ". Crossing of the eye by the adult worm may be a very unpleasant and alarming experience for the patient. Nervous patients in out-stations who have experienced this and who get repeated Calabar swellings, with the sensation of worms creeping about in the tissues, and other real or imaginary symptoms, may be reduced to a state of anxiety neurosis in consequence.

Woodman & Bokhari [29] inclined to the belief that in the Sudan *Loa loa* might be responsible for hydrocele, lymphocele, hernia and elephantiasis. This is contrary to the experience of workers in other places. In the area in which Woodman and Bokhari worked, both *Wuchereria bancrofti* and *Onchocerca volvulus* were known to be present. The fact that neither of these worms, though diligently searched for, were ever found in elephantiasis cases is not enough to preclude them, as it has often been found in other places that the most marked cases of elephantiasis are usually the ones in which it is most difficult, and sometimes impossible, to demonstrate the worms. Bryant,[8] working in an adjacent area to that of Woodman and Bokhari, remarks that the places where nearly all the cases of elephantiasis are found are those where *Simulium damnosum* exists. The present writer [16] has recorded that hydrocele and scrotal elephantiasis are extremely common

in the areas of onchocerciasis in the Sudan, while *W. bancrofti* infection is extremely rare.

Acanthocheilonema perstans

The distribution of *A. perstans* is wider than that of *Loa loa*, but less precisely known. In the Bahr el Ghazal province it occurs throughout the areas of distribution of *Loa loa* and *Onchocercus volvulus*, but is more common in the former, restricted, south-western area.[27] Balfour [3] reported *A. perstans* in a Ugandese in Taufikia, and Wenyon [24] reported the same parasite in Wau, in a patient with leukaemia. Archibald [2] found *A. perstans* in a case of kala-azar, a boy from Kurmuk on the Abyssinian frontier.

This parasite has been known for longer than any other human blood filaria in the Sudan. In spite of claims from time to time attributing various clinical signs and symptoms to the presence of the worm, the consensus of opinion in the Sudan is that *A. perstans* is non-pathogenic. In Li Rangu, Woodman [27] reports that *A. perstans* infection is found in over 50% of adults.

The vector

Sharp [23] has demonstrated that *A. perstans* will undergo development up to the infective stage in *Culicoides austeni*, which he considered to be the main vector in the Cameroons. He also found that the worm would develop equally well in *C. grahami*, but this species was not very prevalent. He remarks that *C. grahami* would be as effective a vector as *C. austeni* in any place where it was prevalent. Woodman [27] considered *C. grahami* to be the probable vector of *perstans* in the Li Rangu area. It was by far the commonest species found in collections made there and identified by the late Dr J. W. S. Macfie.[20] *C. austeni* has been found in one locality (Rier) in the Upper Nile province, but the writer knows no records to indicate whether *A. perstans* is found there or not. The known distribution of *Culicoides* in the Sudan can be summarized as follows (Macfie [20]):

C. pallidipennis: Erkowit, Lagawa, Rier.
C. pycnostictus: Wad Medani.
C. schultzei: Lagawa, Merebea, Wad Medani.
C. similis: Katena, Wad Medani.
C. fuscicandae: Wad Medani.
C. austeni: Rier.
C. bedfordi: Wad Medani.
C. distinctipennis var. *egypti*: Rier.
C. fulvithorax: Li Rangu.
C. grahami: Li Rangu.
C. milnei: Lagawa, Li Rangu.
C. neavei: Fanjak.

Wuchereria bancrofti

During their studies of *Loa loa* in the Zande country, Woodman & Bokhari [29] discovered typical *W. bancrofti* in about a dozen cases between the years 1937 and 1938. The only previous record of the occurrence of this parasite in the Sudan was in a slide made by Sir Robert Archibald on the Abyssinian border before the First World War. This record was not published and the particulars were lost. The microfilariae in the cases of Woodman & Bokhari [29] had the typical morphological appearance of *W. bancrofti*, and the identification was confirmed without hesitation by Professor R. T. Leiper, to whom slides were sent. Three cases of the day or non-periodic type were observed; the remainder showed nocturnal periodicity. More often than not there was a mixed infection with *Loa loa.*

In this limited area, where infections with *Loa loa*, *Acanthocheilonema perstans* and, in places, *Onchocerca volvulus* are fairly prevalent, cases of *Wuchereria bancrofti* infection were found only after intensive search, and only the microfilariae have been seen.[27]. No adults have been found, and apparently no case of this infection has been reported from the Zande country since the 12 cases reported by Woodman and Bokhari in 1937 and 1938.[27]

These findings are difficult to explain. So are the findings of Woodman and Bokhari, summarized later by Woodman,[27] who writes that " these microfilariae (*W. bancrofti*) have not been found in any case of elephantiasis. So far there is no evidence that elephantiasis, hydrocele, or lymphadenitis cases are caused by *W. bancrofti.*" Nevertheless these conditions are relatively common in the Zande country. Woodman and Bokhari, the only workers to have reported *W. bancrofti* in this area, were so impressed by the scarcity of this infection, and the difficulty of proving it, that they concluded that *Loa loa* must be responsible for the clinical manifestations. These opinions are so different from the findings and opinions of workers in other parts of Africa that more work is required to confirm them.

In 1944, Dr Mohi Din Mahdi found that *W. bancrofti* was not uncommon in the Nuba mountains, in the area round Kadugli. Although the existence of occasional cases of elephantiasis in the Nuba mountains had been known for years, this was the first identification of the causal filaria. The diagnosis was confirmed in the Stack Laboratories, Khartoum, and blood films taken at intervals throughout 24 hours exhibited the classical nocturnal periodicity of the species. This discovery indicates the need for similar surveys in other areas where clinical filariasis exists, particularly the country along the Abyssinian border, where cases of hydrocele and elephantiasis are frequently reported by administrative officers. These are extremely primitive areas and medical knowledge about conditions in them is still deficient. Onchocerciasis and *Simulium damnosum* have recently been found there (Bloss [6]), and there are the old records of Sir Robert

Archibald which indicate that *A. perstans* and probably also *W. bancrofti* are present, but nothing is known about the prevalence of these infections.

No studies have been made to determine the vectors of *W. bancrofti* in the Sudan. It is known that this parasite can be transmitted by many different mosquitos, including species of *Anopheles*, *Culex* and *Aëdes*. In all places in the Sudan where *W. bancrofti* has been found, several species of mosquitos, proved vectors in other places, were known to be present.

Faunal and Avian Filariae

Neave [21] found microfilariae in guinea-fowl (*Numida ptilorhynchus*), the common vulture (*Neophron percnopterus*), the marabou stork (*Leptopilos crumeniferus*), the shrike (*Lanius excubitorius*) and a hornbill (*Lophoceros nasutus*).

Wenyon [24] reported filaria in toads (*Bufo regularis*), lizards (*Agama colonorum*), a bat (*Megaderma frons*), francolins, guinea-fowl and a donkey.

Bousfield [7] found filariae in a domestic dog; the condition is not uncommon in dogs in the northern Sudan. Balfour [4] records microfilariae in a horse, a camel and a hare. Davis [12] found filariae in an ox, and Woodman & Bokhari [29] found them in doves (*Stigmatopelia passerina equatorialis*) and a parrot (*Poicephalus crassus*).

So far as the writer is aware, no filariae have been found in monkeys, which are now suspected by Gordon [13] of being a reservoir host of loiasis, but no monkeys from the loiasis area in the Sudan have been examined.

RÉSUMÉ

On rencontre quatre espèces de filaires parasites de l'homme au Soudan: *Loa loa*, *Acanthocheilonema perstans*, *Wuchereria bancrofti* et *Onchocerca volvulus*. Cette étude porte sur les trois premières.*

La filariose à *Loa loa* affecte la région située entre le 4e et le 6e degré de latitude N, qui s'étend à l'ouest vers l'Afrique Equatoriale Française et au sud vers le Congo Belge. La population indigène est affectée à raison de 20% et la population non autochtone dans une proportion légèrement plus forte. La question des vecteurs de *Loa loa* dans cette région est encore controversée. Il se confirmera peut-être que la mouche *Chrysops silacea* est le principal vecteur de cette filaire dans l'Ouest africain.

A. perstans est plus largement répandue que *Loa loa*, mais son aire de répartition est moins bien délimitée. De l'avis général, ce ver n'est pas pathogène pour l'homme. Certaines espèces de *Culicoides* sont considérées comme vecteurs réels ou potentiels de cette espèce.

W. bancrofti a été trouvée dans douze cas, en 1937-38, au cours d'études sur *Loa loa* dans la région de Zandé. Depuis lors, on n'a pas trouvé d'adultes de cette espèce et ce n'est qu'après de minutieuses recherches que l'on a découvert des microfilaires. Ce fait est difficile à expliquer, et l'on se demande quel est l'agent causal de l'éléphantiasis, de l'hydrocèle et des lymphadénites, qui sont fréquents dans la région de Zande. Il est

* La question d'*Onchocerca volvulus* est traitée en détail aux pages 531-540 et 671-674.

connu que *W. bancrofti* provoque ces lésions dans la région des Nuba Mountains, où des examens de sang, pratiqués à intervalles pendant 24 heures, ont montré la périodicité nocturne caractéristique de cette espèce. De semblables enquêtes devraient être faites dans les zones très peu développées, près de la frontière éthiopienne, pour déterminer l'agent causal des manifestations cliniques d'origine filarienne qui y ont été observées. L'étude du vecteur n'a pas été entreprise encore. Mais on sait que les espèces de moustiques qui, ailleurs, sont les vecteurs de cette filaire existent au Soudan, partout où l'on a trouvé *W. bancrofti*.

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