

## The Distribution of Leprosy in the Sudan with Reference to Climate and Diet.

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### INTRODUCTION.

THE Sudan as regards climate can be divided roughly into three zones : 1, A northern desert zone extending from the Egyptian border (about the 20th parallel) to the 15th parallel just south of Khartoum. 2, A central pampas zone, extending from the 15th parallel to the 12th parallel, with a short, well-defined rainy season of from three to four months. 3, A southern tropical zone extending from the 12th parallel south to the Uganda border at about the 4th parallel.

The northern and central zones are for the most part inhabited by Arab tribes or by Hamitic tribes approximating the Arab in race and culture, but the central zone also includes localised areas of hill-dwelling Negroes that are few and widely separated in the northern part but form large agglomerations as the 12th parallel is approached. The southern tropical zone is inhabited by Negroid tribes, though the Arabs in their seasonal migrations penetrate this area as far as the 10th parallel.

As regards the northern and central zones the inhabitants can be divided into two main classes, the nomads and the settled population. The former live in goat-hair tents or in shelters of grass mats, and their seasonal migrations are regulated by the rains, the grazing and the fly. Their staple diet is milk, grain is available in limited quantity, and meat is eaten on festive occasions. The amount of milk consumed is very great, and is larger among the camel-owning nomads of the north than among the cattle owning nomads of the central zone.

The settled population in the northern area is almost entirely confined to the banks of the Nile, where they cultivate by water wheel. They have considerable numbers of sheep and goats, but camels and cattle are few as there is little grazing away from the river. The staple diet here is grain ; milk is drunk but is available only in limited quantities, and meat is eaten occasionally. In the central zone the settled population is not limited to the river, but permanent villages are formed near wells in areas where the soil is good for rain cultivation. Here also the staple

diet is grain, but there is grazing for a considerable part of the year and in consequence flocks and herds are numerous, so more milk is drunk and meat is more frequently eaten.

As regards the southern zone the population can again be divided into the agricultural and the pastoral, but south of the 8th parallel there are large areas where cattle cannot live and where goats can be kept only with difficulty and in very small numbers. In these areas milk is not drunk and meat is eaten only when game or vermin can be killed.

TABLE 1.—MEAN ANNUAL RAINFALL (IN INCHES) AT CERTAIN OF THE PRINCIPAL TOWNS IN THE SUDAN.<sup>1</sup>

<i>Town.</i>	<i>Province.</i>	<i>Rainfall.</i>
Suakin <sup>a</sup>	Kassala	7.17
Kassala	Kassala	12.68
Khartoum	Khartoum	6.22
Wad Medani	Blue Nile	15.63
Ed Dueim	White Nile	11.85
El Obeid	Kordofan	13.82
Singa	Fung	21.97
Kodok	Upper Nile	28.50
Malakal	Upper Nile	34.49
Gambeila	(Abyssinia)	48.11
Wau	Bahr el Ghazal	43.50
Juba	Mongalla	35.71

<sup>1</sup> Arranged geographically, from north to south.

<sup>a</sup> On the Red Sea littoral.

#### GENERAL DISTRIBUTION OF LEPROSY.

In the northern and central zones leprosy is uncommon except among the hill-dwelling Negroes referred to. It is rare among the nomads, very rare among the camel owners, and rare also among the cattle-owning nomads. Among the settled Arabs the disease is found more commonly than among the nomads. It is commoner among the settled Arabs of the northern zone where the grazing is very limited, than among the settled Arabs of the central zone where the grazing is plentiful for a considerable part of the year. Among the hill-dwelling Negroes in the south of the central zone the disease is common.

In the southern zone, south of the 12th parallel, the incidence of leprosy is considerably increased, but the increase is for the most part restricted to the areas infested with the tsetse fly (*Glossina morsitans*). The cattle-owning Negroids inhabiting the Nile basin between the 12th and 6th parallel and extending east to the Abyssinian border are remarkably free from the disease. On the other hand it is common in the fly-infested country to the east of the river valley, and the incidence becomes increasingly severe as the heavily infested fly area adjacent to the Nile-Congo divide is approached. On the eastern side of the river valley, as the country stretches up to the Abyssinian plateau, the fly

disappears and cattle and game become very numerous ; with this leprosy becomes increasingly rare.

The detailed distribution and incidence of leprosy in the Sudan, as far as it is known, is given below.

#### INCIDENCE OF LEPROSY, BY PROVINCES.

##### NORTHERN SUDAN.

*Berber Province.*—Latitude 22° to 16° N. Rainfall very slight. Population 175,186 ; settled riverain cultivators and camel-owning nomad Arabs. Leprosy : 42 cases, 35 male and 7 female, all of whom are settled Arabs.

TABLE 2.—AVERAGE RELATIVE HUMIDITY, OCTOBER TO MARCH, AT CERTAIN PLACES IN THE SUDAN.<sup>1</sup>

Place	Province.	Humidity.					
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Wadi Halfa	Halfa	34	41	49	47	37	29
Khartoum	Khartoum	30	28	30	29	22	16
Wad Medani	Blue Nile	43	32	33	33	26	20
Wau	Bahr el Ghazal	76	67	50	41	39	43
Mongalla	Mongalla	77	71	59	48	49	53

<sup>1</sup> Arranged geographically, from north to south.

*Dongola Province.*—Latitude 20° 15' to 17° 30' N. Rainfall negligible. Population 187,346 ; settled riverain Arabs and camel-owning nomads. Leprosy : 52 cases, 43 male and 9 female, of whom 51 are settled and one is a nomad.

*Halfa Province.*—Latitude 22° to 20° 15' N. Rainfall negligible. Population 60,900 ; sparse, isolated and riverain. Leprosy : 1 case, male.

*Khartoum Province.*—Latitude 17° 30' to 16° 45' N. Rainfall 6.2 inches. Population 278,594. The town population is very mixed and drawn from various parts of the Sudan. Leprosy : 22 local cases were reported during the last five years.

*Red Sea Littoral.*—Latitude 23° to 18° N. Rainfall at Suakin 7.17 inches. Population 23,788 ; camel-owning nomads and mixed town population. Leprosy : 11 cases, all males, of whom 5 are Arabians (from Arabia), 2 West Africans, one a Negroid from Darfur, and one a nomad Arab.

##### CENTRAL SUDAN.

*Blue Nile Province.*—Latitude 15° to 14° 30' N. Rainfall 15.6 inches. Population 453,950 ; settled and nomad Arabs and immigrants. Leprosy : 16 cases, 12 male and 4 female, of whom 3 are foreigners, 4 Negroids, 4 nomad Arabs and 5 settled Arabs. None of these are native to the province.

*Darfur Province.*—Latitude 17° 30' to 10° N. Population 712,191 ; settled Arabs and camel-owning nomad Arabs in the north, settled Negroes and cattle-owning nomad Arabs in the south. Leprosy : no detailed figures are available, but the disease is reported to be (a) almost unknown among the camel-owning nomad Arabs of the north ; (b) rare among the cattle-owning Arabs of the south ; (c) uncommon among the settled Arabs ; (d) very common among the Furs, a Negro race owning few cattle ; (e) common among the Masalit, a Negro tribe who are also settled agriculturists but who own more cattle than the Furs.

*Fung Province.*—Latitude 14° 30' to 10° 30' N. Rainfall in the northern part 21.9 inches. Population 237,127 ; settled Arab, nomad Arab and Negro. Leprosy : the figures for northern part of the province are fairly comprehensive ; there are 7 cases, 6 male and 1 female, of whom 5 are Arabs and 2 Negroes, all settled. The figures for the southern part of the province, mainly inhabited by hill-dwelling Negroes, are very incomplete ; 43 cases are reported, of whom 41 are hill-dwelling Negroes and 2 settled Arabs.

*Kassala Province.*—Latitude 18° to 12° 40' N. Rainfall 12.6 inches. Population 364,481 ; nomad Arab and a mixed settled population, largely Negroid but with some settled Arabs. Leprosy : 26 cases, 20 male and 6 female, of whom 15 are Negroes and 11 settled, detribalised Arabs.

*Kordofan.*—Latitude 17° 30' to 10° N. Rainfall in northern part 13.8 inches. Population 1,120,507 ; camel-owning nomad and settled Arabs in the north, cattle-owning nomads and settled, hill-dwelling Negroes in the south. Leprosy : 66 cases, of whom 56 are hill-dwelling Negroes, 8 settled Arabs, and 2 nomad Arabs. The figures for the Negro population are very incomplete.

*White Nile Province.*—Latitude 15° to 12° N. Rainfall 11.8 inches. Population 431,913 ; mainly nomad and semi-nomad, with a small definitely settled riverain Arab population. Leprosy : 2 male cases, of whom 1 is a settled Arab and 1 a hill-dwelling Negro from southern Kordofan.

#### SOUTHERN SUDAN.

*Bahr el Ghazal Province.*—Latitude 10° to 5° 30' N. Rainfall 43.5 inches. Population 675,111. It is divided into :—

(1) Northern, Eastern and Rumbek districts in the river valleys lying between the Bahr el Ghazal and Bahr el Jebel. Population 354,392 ; cattle-owning Negroids (Dinkas), rich in cattle. Leprosy : 20 cases.

(2) Western and Central districts. Population 88,553 ; settled agricultural Negroids. A fly area stretches up to the Nile-Congo divide ; no cattle except a few in the extreme east of the area. Leprosy : 567 cases reported, but there are said to be many more.

(3) Southern districts. Population 232,166 ; settled agricultural Negroids (Landi). Fly country adjacent to Nile-Congo divide ; no cattle. Leprosy 4,734 cases, or 2.39 per cent. of the population.

*Mongalla Province.*—Latitude 6° to 4° N. Rainfall 35.7 inches. Population 322,598 ; Negroid cultivators on the western side of the river, Negroid cattle-owners on the eastern side, the cattle increasing as the river valley is left. Leprosy : 1,643 cases reported. The great majority of these are from the western side of the river, and they increase as the river is left and the heavily infested fly area is entered. By far the heaviest incidence is in Meridi district, which lies along the Nile-Congo divide. There are a few cases on the eastern side of the river in the river valley and the neighbouring hills, but as the country stretches up towards the Abyssinian border the cattle become numerous and leprosy is rare or absent.

*Upper Nile Province.*—Latitude 12° to 6° N. Rainfall 34.5 inches. Population 581,121 ; cattle-owning Negroids. Investigations concerning leprosy in the various tribes give the following figures : Shilluk, from 90,000 persons 16 active cases and 24 burned-out ; Nuer, from 9,500 persons, 2 active cases ; Shish and Atwot Dinkas, from 30,000 persons 10 active cases, 29 burned-out ; Twi Dinkas, from 11,643 persons, 1 case ; Northern Dinkas, from 20,000 persons, 2 cases. It is to be noted that the 9,500 Nuers examined constitute only a small part of a very large tribe. The Nuer and the Dinka are pastoral and nomadic to a greater extent than the Shilluk, who, though they have considerable herds of cattle occupy settled villages along the river and do considerable cultivation.

#### SUMMARY OF INCIDENCE.

In examining this statement of incidence there are certain features worthy of note :—

(1) That leprosy is almost completely absent among the camel-owning nomad Arabs. There are two relevant facts about these nomads, namely, (*a*) their isolation from external contacts, and (*b*) the very large quantity of milk at their disposal—more than they can drink. This is their staple diet, and often for long periods their only diet.

(2) That the incidence is very low among the cattle-

owning nomad Arabs, who have large quantities of milk but not the unlimited supply of the camel-owning nomads.

(3) That there is a definite but low incidence among the settled Arabs of the north, where the grazing is confined to the river edge.

(4) That this incidence is markedly diminished among the settled Arabs of the central zone where there is a definite rainy season and extensive grazing for a large part of the year.

(5) That there is a high but not yet determined incidence among the Negro races of the central zone. These people are hill-dwellers, this until recently being to gain refuge from the Arabs, but now from habitude. Their villages are cramped and overcrowded, and the grazing for their cattle is very limited. Grain is their staple food, and milk enters into their diet to a very limited degree. Salt is very expensive and is rarely eaten, but whether this is to a less extent than among the surrounding Arabs who are relatively free of the disease it is not possible to say at present.

(6) That in the southern zone, among the Negroids of the river plains who are herdsmen and whose staple food is largely milk, the incidence of leprosy is low, while on the other hand among the inhabitants of the fly country, where there are no cattle, its incidence is very heavy indeed, as high as 2.39 per cent. in the country adjacent to the Nile-Congo divide.

It is of interest to note that in this area of exceptionally heavy leprosy incidence the people are adequately lodged, and are well fed except for the absence of milk and the scarcity of meat and salt. There is an abundant supply of fresh vegetables and fruit, and fish are caught from time to time. The villages are well separated and each dwelling (of one or more huts) stands in its own plot of land.

#### CAUSATIVE FACTORS.

Is there any single factor that governs or predisposes to this distribution?

(1) *Dryness and Rainfall*.—These afford no explanation. The settled Arabs of the dry and arid north are more heavily infected than the settled Arabs of the central zone with its definite rainy season. On the other hand, the camel-owning nomads of the north are freer from the disease than the cattle-owning nomads of a more southern latitude with a definite rainy season. Again, the Negroid herdsmen south of the 6th degree in the country east of the river stretching up to the Abyssinian and Kenya borders, are free of the

disease, while the Negroid cultivators living in the same latitude near the Nile-Congo divide are very heavily infected.

(2) *Altitude*.—This does not affect the issue. The hill-dwelling Negroids are more heavily infected than the surrounding Arabs of the plains, while the inhabitants of the high land on the Nile-Congo divide are much more heavily infected than the Negroid herdsmen of the Nile Valley.

(3) *Salt*.—There is a definite shortage of salt in the heavily infected Nile-Congo divide area, and the people show great eagerness to obtain it. It has been suggested that this deficiency of salt may be a predisposing cause towards leprosy. On the other hand, salt is probably as hard to come by among the Negroid herdsmen on the Abyssinia-Kenya-Sudan border, who are free from this disease, or among the Dinka herdsmen of the Bahr el Ghazal, who are only slightly infected with leprosy. Again, the Fur hill Negroes of Darfur, who make their own salt in plenty, suffer heavily from leprosy.

(4) *Milk*.—The one single factor which seems to correspond with the incidence of leprosy among the tribes of the Sudan, situated as they are under varying physical conditions of height, moisture and temperature, seems to be the presence or absence of cattle, sheep and goats and the use of their milk for food and drink.