

FRAMBOESIA TROPICA (YAWS) ; WITH SPECIAL REFERENCE TO CASES
TREATED IN THE KIGOMA DISTRICT OF TANGANYIKA TERRITORY.

Being a Thesis for the Degree of Doctor of Medicine

by

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FRAMBOESIA TROPICA (YAWS), WITH SPECIAL REFERENCE TO CASES
TREATED IN THE KIGOMA DISTRICT OF TANGANYIKA TERRITORY.

The medical officer in Tanganyika territory who casts his eye around in search of a subject suitable for a thesis such as this is at once met with an almost bewildering wealth of material from which to choose. In our knowledge of diseases such as malaria, blackwater fever, trypanosomiasis, relapsing fever, ankylostomiasis, schistosomiasis, and yaws, to mention only a few of the diseases found, lacunae still exist, in spite of the ever-increasing amount of attention which has been directed to them. A former teacher of the writer used to say that the obvious diagnosis was the correct one. This, no doubt, he did not intend to be taken too literally, but as a warning that it was wiser to exhaust the common and usual causes of the condition under consideration before proceeding to explore the rarer and less usual ones. It was on a principle akin to this that the subject of yaws was chosen for the present thesis. For yaws is the most widely treated disease in the territory, accounting for approximately 20% of all cases treated at the Government hospitals, dispensaries, and clinics. Although the mortality associated with the disease is light (28 deaths among 5,982 cases treated as in-patients of government hospitals in 1925, or 0.47%, compared with a general in-patient rate of 2.80%),¹ yaws is the cause of a vast amount of ill-health, suffering, crippling, and deformity. Further, our knowledge of the disease is still very incomplete; it offers, indeed, some almost unexplored ~~avenues~~ avenues of research; and on certain aspects of the disease, as, for example, the tertiary manifestations, and the differential diagnosis of the disease from syphilis, wide diversity of opinion exists.

The writer's first-hand acquaintance with yaws began in may 1925, when he joined the staff of Sewa Hadji Hospital, Dar-es-Salaam; at this, the largest native hospital in the territory, it was found possible, owing to pressure upon in-patient accomodation, to admit to the wards a comparatively small proportion of the yaws cases applying for treatment. In practice this generally meant that severe tertiary cases incapable of making a twice-weekly journey from their homes to the hospital for out-patient treatment, and other cases from too great a distance were alone admitted. Consequently, much responsibility devolved upon the out-patient department, to which patients, attracted by the success of the "sindanu" or injection treatment, flocked in ever-increasing numbers. Experience thus gained of the methods of handling large numbers of patients effectively and quickly, and familiarity with the clinical aspects of the disease were to stand the writer in good stead when appointed to the medical charge of Kigoma district a few months later.

In the following pages it is not intended to give an exhaustive systematic account of framboesia, but rather to consider the bearing of the writer's own observations on current views, and to compare his findings with those of other recent workers. For the sake of completeness, however, and to assist in gaining perspective, the sections embodying his own work on the clinical aspects of the disease are prefaced by remarks on the history, etiology, geographical distribution, and histopathology of yaws. Tabulated records and other material likely to break the continuity of the work are reserved for the appendices, but are referred to in the text

DEFINITION.

A specific infectious and contagious non-venereal tropical disease, caused by *Spironema pertense*, Castellani, 1905, characterised by a primary lesion or framboesoma, a secondary granulomatous eruption, and a tertiary stage affecting chiefly the integument, bones, and joints.

history. The first description of a disease which was undoubtedly yaws was that of Oveodo y Valdez (1478-1557), who, in his "Historia General e Natural de las Indias", gave an account of it as seen in the West Indies. Hunt and Johnson (2) state that yaws was endemic in the South Sea Islands in 1796, and that the natives trace it back to the 15th century. Tropical America is thought to have been the endemic home of the disease, and it is believed that West Africa became infected from that quarter. The discovery of America was followed by many new voyages in all directions, and slave trading between West Africa and South America is known to have taken place soon after the voyage of Columbus in 1492, if not, indeed, as recent etymological research suggests, even before that date. The disease may have spread from America to West Africa in this way.

Dontius, in 1718, found the disease endemic in Java, Sumatra, and other Dutch colonies in the East Indies, and the Portuguese may have introduced it into Ceylon at an earlier date. Credence is given to this belief by the fact that the local synonym for yaws, parangi, is stated to mean foreigner, and was the name applied to the Portuguese navigators. Powell (3) gives an account of the introduction of the disease into Assam, which he dates back to the arrival, in 1887, of a coolie woman and her three daughters from Ceylon, the youngest daughter being infected with yaws.

GEOGRAPHICAL DISTRIBUTION. Framboesia is essentially a tropical disease. It encircles the globe in the torrid zone, and, although there are a few isolated records of cases contracted outside the tropics, the disease does not gain a foothold when introduced into temperate climates. It has been stated in reputable text-books, such as Lyam and Archibald (4), Stitt (5), and Castellani and Chalmers (6), that it is not found in mountainous districts, but recent work has shown that this statement requires modification, and the present thesis contains a record of cases seen at an altitude of 5,000 ft. and over. Gilks (7) states that, although found

both at sea level and at an altitude of 5,000 ft., the disease would appear to be more prevalent among the inhabitants of low-lying areas. Table I of the appendix shows the number of cases of yaws treated during the year 1935 at the various stations and sub-stations of Tanganyika Territory, as given in the Annual Medical report; the writer has added the approximate altitude of each station where available. This table appears to support Gilks's remark.

In Africa, cases have been reported from Tripoli, Algeria, and the Sudan, but the disease is much more prevalent in the equatorial belt. The West Coast, Congo Free State, Angola, Nigeria, Madagascar, Portuguese East, Comoro Islands, Nyasaland, Tanganyika Territory, Uganda, Kenya, and Northern Rhodesia are all heavily infected.

In Asia, the main endemic foci are the Malay Peninsula, Assam, Upper Burma, Siam, Java, Sumatra, Ceylon, and the Philippines. It is not found in Japan.

In America, the West Indies, the Guianas, Venezuela, Colombia, Brazil, and the southern states of U.S.A. are the main endemic foci.

The disease has been reported in Northern Australia, but not in other parts of that island, or in New Zealand.

ETIOLOGY. Before Castellani (8) in 1905 discovered *Treponema pertenue* in yaws lesions, some authorities, especially J. Hutchinson, thought that the disease was syphilitic. Working in Ceylon, Castellani found that this was the only organism seen in non-ulcerating parangi or yaws lesions. It is now known as *Spironema pertenue*, Castellani, 1905. This organism Castellani isolated in the spleen, lymphatic glands, and bone marrow, but not in the blood, although he stated that it must be present in the blood, as monkeys could be infected with yaws by the inoculation of blood from a yaws case. He reproduced the disease by inoculating monkeys with material containing the specific organism, and excluded this organism by filtration and failed to reproduce the disease.

Spironema pertenuis can easily be seen in the juice of non-uncerated papules, when examined by dark-ground illumination, as an extremely delicate, often actively motile organism measuring from 4 to 30 microns in length, the average being about 18 to 20 microns, and possessing 6 to 20 uniform, small, rather rigid undulations about 1 micron in depth. The width of the organism is extremely minute.

Cultivation can be effected by the method of Noguchi as applied to *S. pallidum* of syphilis, although Knowles⁽⁹⁾, who also studied the dark-ground illumination appearances and serological reactions failed.

When inoculated into man, it is capable of producing the disease. After an incubation period varying from 12 to 28 days, the primary lesion appears at the ~~sight~~ of inoculation. X Charlotis (10) inoculated 32 Chinese prisoners with scrapings from yaws lesions; the disease developed in 28 of them, first showing at the sight of inoculation. Sellards, Lacy, and Schobul (11) in the same way produced yaws in 6 volunteers who had never lived in a yaws district, in whom there was no suspicion of syphilis, and in whom the Wassermann reaction was negative. The incubation period was $3\frac{1}{2}$ to 4 weeks.

The disease can be conveyed from monkey to monkey, and the bone marrow of an infected monkey has reproduced the disease in another monkey after an incubation period of 44 days. These observations are in line with the known fact that man can become infected through skin abrasions coming into contact with yaws lesions.

Coloured races appear to be vastly more susceptible than white races. There is no evidence to show that the disease is congenital or transmitted by sexual contact.

It has been contended that *S. pertenuis* is only a variant of *S. pallidum*, and that yaws and syphilis are the same disease. Pearce and Brown (12), carrying out a long series of intra-testicular inoculations of yaws virus into

rabbits, on the lines of similar experiments done in relation to the virus of syphilis, have demonstrated what they consider to be a characteristic tissue reaction differentiating yaws from syphilis. Further reference to this question will be made.

MODE OF INFECTION Infection frequently takes place by direct contact. The classical example given is that of a breast-fed infant, infected with yaws, transmitting the disease to the mother, the primary sore appearing near the nipple. This point is referred to later in considering the distribution of the primary lesion, but it was the writer's experience, in a heavily endemic area, where most of the population becomes infected sooner or later, that the reverse process was more usual- a nursing mother, infected with yaws, usually tertiary, transmitting the disease to her infant, the primary lesion appearing near the muco-cutaneous junction of the mouth.

Flies are also believed to be important agents in the transmission of the disease. The writer can testify to the avidity with which non-blood-sucking flies settle upon exposed yaws ulcers at a dressing station. Flies of the genera *Sarcophaga* and *Hippelates* have been suspected. Castellani (13) in 1907 showed that *S. pertenuis* was easily taken up by *Musca domestica*, the common house fly, and positive transmission was obtained from infected flies; and Nicholls (14) showed that *Ascinus pallipes* carried the organism to surface sores. Ticks and other blood-sucking arthropods have come under suspicion, but no definite evidence in support of this suspicion has been obtained. At Lusimbi, in the Kigoma district of Tanganyika Territory, where a series of cases, details of which are given later, was seen, *Musca domestica* was overwhelmingly the most common fly found, and one frequently saw natives with multiple tertiary yaws ulcers making their way to the clinic, vainly endeavouring all the while to prevent these flies from settling on the exposed sores.

A point of interest is that the organism cannot penetrate the unbroken skin.

PREDISPOSING CAUSES.

Yaws is typically a disease of native villages in areas far removed from civilisation. In common with other infectious diseases, dirt, insanitary surroundings, and a primitive mode of life are factors. Liability to skin abrasions is cited by most observers to be important; in a bare-footed native population these are extremely common, for example, wounds, ankylostome vesicles, tick and mosquito bites, and the lesions of scabies. Sex has no influence, nor has age per se. In areas where the disease is hyperendemic, the average age of the primary cases is less than that of the secondary cases, and of the secondary cases less than the tertiary (Tables II and III). The greater the incidence of yaws in a given population, the greater will be the percentage of infection in childhood, and the disease might almost be looked upon, as Sellards suggestively remarks (15), as one of the exanthemata of childhood. No period of life is immune, however; the writer has seen the florid granulomatous secondary eruption in infants a few months old, and advanced tertiary ulceration with contractures and crippling in children a few years old, while he has a note of a case of primary and secondary yaws in a very old man.

HISTOPATHOLOGY

In the development of the primary lesion the characteristic processes are the downgrowth of the epithelium into the cutis, and the degeneration of the epithelium itself, many of the cells showing a swollen and vacuolated appearance. Later, the cutis becomes vascular and oedematous, the capillaries are dilated, and cellular infiltration with polymorphonuclear, large and small mononuclear, and eosinophil leucocytes, mast cells, connective tissue cells, and extravasated erythrocytes is seen. Still later, the oedema disappears, the cellular infiltration increasing. *S. pertenuis* may be seen, in sections stained by the silver method of Levaditi, especially in the malpighian layer, although Goodpasture (16) has also demonstrated *S. pertenuis* within the perivascular connective tissue of the papillae. When the

lesion is fully developed, marked hyperkeratosis of the epithelium is seen. In framboesia the proliferative changes are more marked in the epidermis than in syphilis; cellular infiltration rather than oedema marks the fully developed nodule, which is therefore drier than the syphilitic lesion, and there is no tendency to the thickening of the walls of the blood-vessels which is so characteristic of syphilis.

MacLeod (17) in 1901 published work of pioneer importance on the histopathology of yaws, and Castellani (15) in 1908 proved beyond reasonable doubt that the eruptive secondary granulomata are due to localisation in the skin of treponemata (spirochetes) from the circulating blood. Goodpasture (16), whose delightful work on the histology of healing yaws is worthy of close attention by all interested in the subject, thinks it probable that the secondary yaw begins with a lesion in the papillae, which spreads from there to the epidermis, where conditions are subsequently more favourable for growth. Microscopically, the epidermis is greatly thickened, swollen with fluid, and infiltrated with leucocytes distributed diffusely and as military abscesses. The epidermis prematurely desquamates, undergoes degeneration, and, subsequently, hyperkeratosis. The elongated papillae are oedematous, haemorrhagic, and infiltrated with cells of various types, and deeper in the corium are dense aggregations of mononuclear cells. Histologically, therefore, there is a close resemblance between the primary and the secondary yaw, although the path of entrance of the organism is in the one case from without and in the other from within.

Comparatively little work has been done on the pathology of the tertiary lesions of yaws. An investigation of this subject, and a comparison with the findings in cases of tertiary syphilis among the same race, would be of immense value, when co-related with the work of those who are endeavouring to differentiate the two diseases on clinical grounds.

Spittel (18), working in Ceylon, described two manifestations, 1, fibroid induration, 2, gummatous infiltration, each the result of proliferative inflammation in response to a slow,

persistent biological stimulus. If there are manifest degenerative changes the result is gummata, if not, fibroid induration. Clinically, gummatous infiltration, localised in bones, fasciae, etc., leads on to ulceration, and, when localised in the nose and palate, produces all degrees of destruction, from yielding of the septum to extreme forms of gangosa.

Very great interest attaches to the work of Maul (19) in the Philippines on the radiological aspects of tertiary bone and joint lesions in yaws. In the majority of cases, Maul states, the lesions show as rarified areas, irregularly oval or elliptical in shape, with the long axis parallel to that of the bone in which the lesions are localised. Most of the lesions appear to originate in the interior of the bone, while a number can be seen as small excavations on its outer surface. When the lesion is on the surface the periosteum is usually destroyed. In the chronic lesions, marked irregularity of the bony outline is evident. The bone as a whole becomes more deformed, and its growth is interfered with in length and breadth. Within the joints, the destruction is most frequently seen on the parts of the articular surfaces most exposed to trauma, as oval or irregularly shaped excavations, making the outline of the articular surfaces rough and uneven. The X-ray appearances differ from those of syphilis in that 1, the periosteal proliferation is absent, 2, the thickening of the cortex is absent (exceptions noted). The shaft of the bone is the most frequent seat (80%). The tibia is the bone most frequently affected, then, in order, the tarsals, fibula, phalanges, metatarsals, metacarpals, radius, patella, humerus, femur, ulna, etc. The lesions are multiple in 75%. Observing the effect of treatment radiologically, the writer states that they clear up if not of too long standing, but take longer than the clinical manifestations.

Although these observations were conducted upon a limited number of cases, they are extremely interesting, in view of the frequency with which the bony lesions of tertiary yaws have been described by clinical observers in

in the past as "periostitis".

As regards pathogeny, the superficial situation of the specific organism in the primary stage has been remarked on, but the development of secondary and tertiary stages, with the production of a positive Wassermann reaction, indicates that generalised infection of the body takes place. Up to the present time there is no reliable evidence of visceral or nervous lesions.

SYMPTOMATOLOGY AND CLINICAL MANIFESTATIONS.

The foregoing sections have been in the main introductory. In the succeeding sections it will be the writer's aim to review more fully the results of his own observations, and to compare them with those of other recent workers.

PRIMARY STAGE.

The incubation period may be given as from 2 to 4 weeks. It is stated (4b) to be characterised by malaise, rheumatoid pains, headache, and irregular pyrexia. In dealing with the African native, clinical histories as elicited from the patients are notoriously unreliable, more especially in the case of raw tribesmen. The writer, however, confesses that he has been unable to obtain confirmation of the above statement in his cases. When questioned on the subject, none of his cases of primary yaws admitted to any of these symptoms; further, the writer had the opportunity on several occasions of observing the development of a primary yaw in patients admitted to hospital for other diseases. Temperature charts of all in-patients were kept, but pyrexia in such cases has never been noted. It would be rash to assert dogmatically that constitutional disturbance during the primary stage is absent, but perhaps too great stress has been laid upon it in the past. If present at all in the African native, it appears to be so slight as to escape the patient's notice.

The writer is in agreement with Powell(3) of Assam, who states that glandular enlargement is not noticeable in any case unless complicated by sepsis or recent syphilis, that prodromal furfuraceous eruptions do not occur, and that fever as a symptom is absent in children, and occurs "more rarely than some writers state" in adults.

In practice, the primary stage is comparatively seldom seen alone (Tables II^{and III} of the appendix, 0.97% of cases in the Lusimbi series, and 1.9% of the Kigoma Hospital series, as compared with 8.4% and 14.2% respectively in which the primary and secondary were seen together.) The probable reason for this is that the native is very/upset by the primary stage, and does not ordinarily trouble to seek treatment until the more alarming generalised secondary eruption makes its appearance. In the Lusimbi series, the primary stage by itself was seen only in children; the primary and primary plus secondary stages were seen in 39 children out of a total of 52 patients in these stages.

The situation of the primary sore was determined in 119 cases (Table IV). These results are in fairly close agreement with other similar records. Callanen (20), in Kenya, for example, found the primary lesion on the lower extremity in 68% (Table IV, 75.6%), on the trunk 10%, nipples 8.6%, upper extremity 9.1%, head 3.3% (Table IV, thorax and abdomen 5.9%, upper extremity 14.3%, head and neck 4.2%). Moss and Bigelow (21) found the primary lesion on the lower extremity below the knees in no less than 705 out of 803 cases or almost 88%, and, from this relatively limited distribution, infer that trauma is a more important factor than flies in the transmission of the disease.

Table IV bears out the rarity with which the primary lesion is found on the genitalia. It was noted once on the scrotum, and once on the skin of the penis near the root. The former case was an infant, who was carried astride his mother's hip to the clinic; she was infected with tertiary yaws; the

latter was an adult, who stated that he had been infected by his wife, and that she was first infected with yaws a few years previously. Taking into consideration, however, the part of the penis on which this lesion was found, the case does not appear to be an exception to the rule already stated that infection may be transmitted by ordinary as opposed to sexual contact.

A noteworthy point of difference between Callanan's observations and those recorded in table IV is the much higher percentage of cases in which the Kenya writer found the primary near the nipples. (8.9% and 0.84% respectively). Callanan also remarks that in 25% of cases in which both mother and child are infected the infection was from mother to child, and in 75% from child to mother. The present writer's experience was almost exactly the opposite, namely one definite instance of child to mother infection, with the primary on the nipple, and four of mother to child infection. The primary lesion, in two of these instances, was on the skin of the mouth near the mucocutaneous junction, in one case, already mentioned, on the scrotum, and in the fourth on the lower part of the abdomen just above the groin, in an infant carried astride the mother's hip. In districts where the disease is heavily endemic, and where a high proportion of the population has been infected by the time adult life is reached, this is not an unexpected finding.

The primary may develop on the site of an abrasion or ulcer, ankylostome vesicle, scabies pustule, jigger sore, or vaccination mark, although the present writer has not observed an instance of the last. In Ceylon it is stated to occur frequently on the skin of the trunk just above the hip in women, owing to their method of carrying the child astride (see above).

In a number of cases of secondary yaws it was found impossible to elicit a history of any primary lesion, and, even making allowance for lack of intelligence among the raw natives, and a want of observation which is sometimes simply astounding,

it would appear that occasionally the primary may be abortive or atypical, or even fail to appear entirely.

The lesion is usually single, appearing as a raised papule, which becomes moist with yellowish secretion, and later develops a dry crust. Several smaller contiguous papules may coalesce. The size varies greatly, from $\frac{1}{2}$ up to 2 inches in diameter, and the colour ranges from a yellow bees-wax-like shade to almost black. In the fully developed stage it may be painful, especially when situated in a part liable to trauma, as in the feet, and when covered with exuberant fungating crusted granulations, with numerous cracks and fissures penetrating to the cutis vera.

SECONDARY STAGE.

As already mentioned, the secondary eruption generally appears before the primary lesion has faded. Constitutional disturbance is seldom complained of. Callanan states that it is frequently heralded by vague pain in the limbs and headache. The lesions have the same general appearance and histological structure as the primary. The essential feature (Goodpasture(16),) is a small papule or papillary framboesiform granuloma, irregularly round or oval, discrete or confluent, elevated a few millimetres to a centimetre or more above the surrounding skin, and covered in its earlier stages by a soft yellow scab, beneath which is a granular, seropurulent, sometimes haemorrhagic surface formed of elongated papillae, almost reaching the exterior, and bleeding easily, with the thickened epidermis beneath. Later, the surface is drier, and covered with keratinised epithelium.

The eruption is a generalised one. Its distribution was recorded in 60 cases (Table V). As Callanan observes, the lesions are frequently seen in the vicinity of the muco-cutaneous junctions of the mouth and nose. The present writer failed to find a single instance of a secondary lesion originating on a mucous membrane. They were most frequently

noted on the head and neck (48.7%), next on the thorax and abdomen (20%), and about equally on the lower and upper extremities (19.19% and 18.2%). Thus the distribution of the secondary lesions is quite different from that of the primary. This is only to be expected, since the organism is carried by the blood stream in the one case and implanted from without in the other.

Very great interest attaches to the observations of Sellards (15), and of Ramsay (22) in Assam, on the effect of altitude upon the distribution and appearance of the secondary lesions. The former suggests that the restriction of yaws to warm climates may have to do with the effect of surface temperature upon the development of the granulomata, which show a preference for muco-cutaneous junctions and regions which are protected by clothing, and he instances the observation that in the mountainous province of northern Luzon (2,500 - 5,000 ft.), the lesions are largely limited to the mouth, anus, and vulva, suggesting that the low temperature inhibits their appearance on the skin. Ramsay in Assam found that florid yaws was only common among the plain-dwellers in the warm season; in the cold season, these people, and the hill-dwellers at all seasons, showed only condyloma-like lesions in the warm, moist region of the axilla, between the nates, etc., while with the return of the hot weather, or if the hill-dweller came down to the plain, the disease again became florid. The present writer has these interesting observations in mind when setting out to open a yaws treatment centre at Lusimbi, (5,000 - 5,500 ft.), but he was successful in finding only 4 cases in which the condyloma-like lesions were present, mostly between the nates. Florid secondary yaws appeared just as common at the higher altitude as at Kigoma (2,500ft.), and Table V shows how general was the distribution of the lesions. The writer regrets that he has not records of the temperatures prevailing, as possibly, in spite of the altitude, the temperature may have been higher than in the district in which Ramsay made his observation, but it can be stated that

during the day, in spite of the sunshine, warm European clothes, supplemented by a sweater, were found necessary, and, at night, every available article of clothing was called into use to supplement the blankets.

Lopez-Rizal and Sellards (23) in a later contribution make further reference to a modification of yaws seen among the Malay population of Ifugoa in the mountains of North Luzon in the Philippines - lesions resembling syphilitic condylomata of the muco-cutaneous junctures around the mouth, nose, anus, and genitalia, to the exclusion of the more generalised eruption. Only 5 of 53 cases showed any evidence of involvement of the skin in areas more or less remote from muco-cutaneous junctures.

TERTIARY STAGE.

The interval between the appearance of the primary lesion and the secondary florid eruption is shorter than that between the florid stage and the development of tertiary manifestations, consequently the secondary eruption has almost invariably faded before tertiary lesions are seen. Spittel (18) gives the quiescent period as from 4 to 12 years, and he has known instances of latent periods of 25 and 30 years. While agreeing with him that the quiescent period may be prolonged, the writer thinks that in the great majority of cases it does not exceed 2 years, and that 6 months to 2 years is about the normal. It is impossible to dogmatise on the subject, for Africans, and particularly raw tribesmen, are extremely vague about time, seldom even knowing their own ages, but the period just given was arrived at as a result of many hundreds of inquiries. It will be noted (Table I) that 57 or 50% of the male children, and 27 or 42.2% of the female children were tertiary cases, and that among the children tertiary cases were actually more numerous than cases in any other stage. In these cases the period elapsing between the secondary and tertiary stages must have been limited to a few

years at most. On the other hand, adult patients in the tertiary stage frequently stated that they were first infected with yaws "zamani sana" ("a very long time ago"), or "zamani kama mtoto" ("long ago when I was a child"). Although in these cases it was impossible to determine definitely when the tertiary lesions first appeared, it was evident beyond reasonable doubt that in some instances the beginning of the tertiary stage was recent, and the quiescent period therefore prolonged.

Van Witsen (24) states that the tertiary period begins either towards the end of the secondary, or 10, 15, or 25 years later.

Only within recent years has the existence of tertiary lesions in yaws been generally admitted to. Powell (3), as late as 1923, states that no tertiary lesions were observed in the 10½ years his cases were watched, though Spittel (18) in 1922 maintained that the time had arrived for speaking authoritatively upon the occurrence of tertiary lesions in yaws, while in 1923 Gutierrez (25) published an interesting paper on the importance of the tertiary manifestations of yaws.

Table VI gives a classification of the symptoms and signs found in 431 cases of tertiary yaws treated by the writer in the Sultanate of Lusimbi (5,000 to 5,500 ft.), and Table VII a similar record of 126 cases treated during the year 1926 as in-patients in Niigoma Hospital (2,550 ft.) Before dealing with each in turn, and making any comparison between the two groups, a few general observations on factors affecting their value for purposes of comparison are given.

In the first place, yaws is not, generally speaking, a hospital disease, and the vast majority of cases can be treated effectively and economically at the out-patient department or field dispensary. Some of the considerations which may make admission to hospital desirable are; (1) The patient's home is too far away for him to attend regularly, and he has not sufficient means to obtain food and shelter near the hospital or treatment centre. (2) The case is a severe one, with, for example, deep multiple ulceration with

secondary infection, or crippling deformity. (3) One or more additional disease is present, for which treatment is necessary.

The commonest example is yaws and ankylostomiasis. On the whole, therefore, one would expect the hospital cases to be more serious than the group from the field dispensary at Lusimbi. Further, it is interesting to remark that if a dispensary is opened up at a remote native village, people with comparatively mild ailments who would not dream of making a long journey to the central hospital, readily flock in for treatment along with the more seriously affected.

Again, the average age of the hospital group is likely to be higher, because, if treatment is available almost at her door, a mother is able to bring her entire family for treatment, whereas she is generally unwilling to disorganise the home by going off with one or more children into hospital, there to remain with them while they are undergoing treatment.

ARTHRALGIA. (Lusimbi group, 74%, Hospital group, 35.7%).

Pain in the joints, without any signs of pathological change apparent to the physician.

As has been mentioned, "rheumatoid pains" are stated to occur in the primary stage of the disease, and Callanan noted vague pains in the limbs in the secondary stage. In the present series of cases, pains in the joints, and in the bones (referred to later under "ostealgia"), were infinitely more common in the tertiary stage. These pains were noted to be particularly common at two different periods, (1) in the early tertiary stage, from the disappearance of the florid secondary eruption up to the appearance of the early tertiary cutaneous lesions, and (2) in the late tertiary stage, when, possibly, they indicated the beginning of active pathological change in the bones and joints. It will be noted that these joint pains were complained of in a much higher percentage of the cases at the higher altitude, where the climate is colder, while definite pathological changes in the joints (see "arthritis") were found in a considerably smaller percentage of cases than among the cases at the lower altitude and warmer climate

of Kigoma. For reasons already given, a higher proportion of the more serious cases is to be expected in the hospital returns, but, even taking this into consideration, it is possible that in some of the Lusimbi cases the pains may actually have been rheumatoid or associated with the colder climate, and may have had no relation to yaws. In every case, however, there was a definite history of yaws, and usually other signs of the disease.

Table VIIIa shows the distribution of the pain in the various joints, while Table VIIIb gives the distribution of Arthritis in the various joints, and a degree of similarity will be noted.

van Hoof (26) refers to "joint troubles" and "synovitis of the wrists and ankles" occurring in tertiary yaws, and van Nitsen (24) to "articular and bone lesions", while Spittel (18) mentions that he saw synovitis and peri-articular inflammation. Maul's work on the radiological aspects of the bone and joint lesions of tertiary yaws has already been referred to.

ARTHRITIS. (Lusimbi, 4.2%. Kigoma Hospital, 9.5%).

A definite pathological condition of the joint, with signs apparent to the physician, such as swelling, effusion of fluid, erosion of articular surfaces, suppuration, or ankylosis. In the majority of cases the condition appears to have begun within the joint, but in a minority it was due to extension of deep ulceration in the neighbourhood of the joint, resulting in suppuration of the joint and sinus formation.

Ramsay (20) in Assam states that arthritis was present in 20% of his cases, chiefly of the fingers. In the present series, the bone and joint lesions of the fingers have been grouped together under "dactylitis", but, if the figures for arthritis and dactylitis are combined, the result is 24.8% in the Lusimbi series and 28.5% in the Kigoma Hospital series, figures which approximate fairly closely to Ramsay's.

On the other hand, Callanan (20) in Kenya states that "synovitis" of the knee and elbow was uncommon.

OSTEALGIA. (Lusimbi, 20.9%, Kigoma Hospital, 10.3%).

Pains in the bones without physical signs of disease.

It is interesting to note that, as in the case of joint pains, this symptom was much commoner at the higher altitude, while actual pathological changes in the bones, "osteitis", was commoner in the hospital series.

Table IX gives the distribution, which corresponds fairly closely with the distribution of osteitis. Pains in the bones of the skull and of the sternum and ribs, which were commonly complained of at Lusimbi, are exceptions, in that actual osteitis of these bones was not seen in any case, and the writer will perhaps be forgiven for suggesting that headache, and chest pains associated with coughing, which was extremely prevalent in the cold climate of the mountains, afford the real explanation.

OSTEITIS. (Lusimbi, 6.5%, Kigoma Hospital, 10.3%).

An actual inflammatory condition of the bone, in some cases apparently originating in the bone itself, and, in others, due to the extension of deep ulceration of the overlying skin and subcutaneous tissues. The vast majority of these were chronic cases, in which, as was observed radiologically, "marked irregularity of the bony outline was evident," - so marked as to produce physical deformity, the extreme example of which was a condition resembling the sabre-blade tibiae of syphilis. Fibroid induration was common, and, in cases associated with ulceration of the soft parts overlying the bone, extensive bony necrosis, with multiple sinus formation, exudation of foul-smelling pus, and emaciation of the patient, was regularly seen. When the bones of the foot and ankle were affected, a condition very closely simulating mycetoma was produced, to which further reference will be made.

The extent of the disease may be enormous; the whole of the leg may ^{be} affected, for example, from foot to knee, including both ankle and knee joints. These cases call for patient and protracted treatment, in which surgery plays a prominent

part, and the ultimate result is often gratifying; but by steady campaigning the ideal will yet be achieved, namely, to reach every case, even in the remotest native location, before the disease has advanced to these disastrous late stages.

In the past, loose descriptive terms have been used in connection with the bone and joint lesions of tertiary yaws, and it is hoped that the attempt to classify them on a pathological basis will prove of some value in their elucidation.

MODULAR CUTANEOUS FRAMBOESIDE. (Lusimbi, 23.2%, Kigoma Hospital, 33.3%). Distribution, Table X.

This is the earliest tertiary cutaneous lesion, and it is worthy of careful study, in view of its important sequelae. Moss and Bigelow (21) are to be congratulated upon an extremely clear and accurate account of this lesion. The authors are not certain whether the nodular cutaneous framboeside should be classed as a late secondary or as an early tertiary manifestation. Although they bear some resemblance to the granulomata of the secondary stage, nodular cutaneous framboesides appear to the present writer to be so definitely linked up, with the succeeding tertiary manifestations that they must be classed as belonging to that stage.

"The individual lesion", to quote Moss and Bigelow, "consists as a moderately hard skin nodule, 1 cm. in diameter, elevated 3 to 4 mm., not painful, unaccompanied by itching, and without striking pigmentary change, until after retrogression, when increase of pigment may mark its former site. These nodules are thickly studded and regularly set over an area 8 to 10 cm. in diameter. Peripherally, there may be an advanced row of nodules, while healing takes place at the centre, and, if they do not ulcerate, retrogression takes place, accompanied by desquamation. There is no vesicular stage, and they are not moist. ulceration if it takes place may be superficial only, or deep, and confluent over a large

area, and extending to the subcutaneous and even deep tissues. The nature of the scar depends upon the depth of the ulceration; there may remain only an increase of pigmentation, or the skin over the entire area involved may be left thin and crinkly; or, if the ulceration has extended to a greater depth, there may result complete leucoderma and sometimes painful keloid".

No apology is made for quoting at length from this valuable paper, since it affords the key to the understanding of the whole tertiary stage of yaws.

Spittel (18) gives the favourite sites as the back, buttock, and limbs, and describes how the initial papule may break down, leaving a shallow ulcer, which may advance, a process of spreading and healing going on for a prolonged time. A nodule may take $\frac{1}{2}$ to 1 year to break down, an area the size of the hand may take a year to be covered, and 15 years may be occupied in the spread of the condition from the arm to the forearm. The scarring and contraction of these lupoid framboesides may lead to crippling deformities.

ULCERATION. (Lusimbi, 19.9%, Kigoma Hospital, 72.2%).

Table XI gives the distribution.

The much higher percentage in the hospital series is striking, but the writer is convinced that this does not indicate an actually greater prevalence of ulceration among the yaws cases at the lower altitude. As has already been explained, severe ulceration is the commonest cause for which a native comes to hospital for treatment, and therefore a hospital series of cases is likely to contain a much higher percentage of cases in which ulceration is found than a series of cases from the general population seen at a yaws clinic in the "blue".

The character of the ulcers varies within wide limits. Some were comparatively small, superficial, and of recent origin, others were extensive, deep, and chronic, with destruction of the skin and superficial tissues, and

even invasion of the muscles and bones beneath. Some were of punched-out appearance with regular non-elevated margins and smooth base covered with healthy granulations, others had irregular, heaped-up margins, in places covered with thickened epithelium, and unhealthy purulent bases, with evidence of repeated partial healing and breaking down. In the great majority of cases the ulcers were multiple, and, in the earlier cases, nodular cutaneous framboesides were still present, these having broken down at the situation of the ulcer or ulcers. It will be noted how closely the order of distribution of the ulcers as regards regions of the body, follows that of the nodular cutaneous framboesides (Tables X & XI), but that, in ulceration, the proportion is much greater on the lower extremity. Ulceration was equally common on the right and left side of the body, but, as regards the lower extremity, the aspects most frequently affected were the anterior and outer. These facts strongly suggest that trauma is a factor in the production of ulceration.

The end results of ulceration are often tragic - wide-spread tissue destruction, hideous deformity, contractures subsequent to healing, and contraction of scar tissue, permanent crippling. Treatment, specific or local, is much more difficult than in the early cases. The plight of many of these natives is indeed pitiable; in their primitive villages far removed from civilisation, enlightenment, and medical help, they wage a losing battle against the advances of the disease, until, crippled, beaten, crushed, they sink with mute resignation into hopeless apathy. The white man's hospital is too distant, their ideas about it too vague, their infirmities too great, for them to attempt the big adventure of their lives, a journey to it for treatment. Humanity demands that, until such time as they can be brought in for treatment, we must seek them out and treat them in their own villages.

DACTYLITIS. (Lusimbi, 20.6%, Kigoma Hospital, 19.0%).

As already mentioned, Ramsay found arthritis present in 30% of his cases, chiefly in the phalanges. Moss and Bigelow (21) refer to spindle-shaped swellings of the fingers, while Hunt and Johnson (2) refer to periostitis of the digits. It would appear that the lesion begins in the bone itself, and is essentially anosteitis of the phalanges and an arthritis of the interphalangeal joints, rather than a periostitis. Maul's radiological work, to which reference has been made, is in keeping with this view.

Commonly the whole finger presents a swollen, spindle-shaped appearance. Reduction in the range of mobility of the interphalangeal joints is frequent, and sometimes complete ankylosis is present, in a position of flexion. Almost always several fingers are affected. There is oedema of the soft tissues, the skin presents a stretched and polished appearance, and, in advanced cases, there is complete destruction of the terminal phalanx, or even of the whole finger.

An exactly analogous condition may be seen in the toes. In extreme cases the hand or foot may be represented by a fingerless or toeless stump, a condition sometimes referred to as gomme. The question of the differential diagnosis from advanced nerve leprosy may arise in such cases.

JUXTA-ARTICULAR NODES. (Lusimbi, 3.7%, Kigoma Hospital, 2.4%).

While this condition is widely distributed and has received much attention, its pathology is still unsettled. In recent years, however, most observers have come to regard it as being due to either yaws or syphilis. Davey (27) in 1913, working in the lower Dedza district of Nyasaland, found this condition to be present in 80 out of 2,378 adults examined, or 3.4%. Yaws was extremely prevalent in this district, and 72 of the 80 cases gave a history of infection. The nodules varied in size from that of a pea to that of a duck's egg, and the favourite site for them was the subcutaneous border of the ulna, about 2 inches

from the tip of the olecranon process. Over the great trochanter of the femur, and over the ligamentum patellae and lower part of the patella were also common sites; in the latter site they were sometimes associated with enlarged prepatellar bursa. Occasionally they were seen near the malleoli, and in one case on the zygoma. The fact that of 394 old cases of yaws 55, or 13.96% had subcutaneous nodules on the ulna, whereas of the remaining 1,984 persons examined only 8, or 0.40% had them, is strong evidence that these nodules are nothing more or less than a manifestation of yaws. more recently, Spittel (18), Egyedi (28), Gutierrez (29), and Dubois (30) attribute the condition to yaws.

A history of yaws was obtained in all the writer's cases.

In the Kigoma district in 1926, 1976 cases of yaws and 162 cases of syphilis were treated, a relative frequency of approximately 81 cases of syphilis per thousand cases of yaws. These figures refer to the whole district, which includes the towns of Kigoma and Ujiji, where there is a relatively dense native population living under comparatively civilised conditions. In the country of the Waha (Lusimbi), the proportion of cases of syphilis was much smaller than for the whole district, while it will be noted that the frequency of juxta-articular nodes was greater among the Kigoma hospital cases. The present writer joins company with those who believe that juxta-articular nodes are a manifestation of tertiary yaws.

The condition appears to originate in the tendon sheaths or bursae, and to be allied pathologically to the condition known as ganglion. The nodules are hard and resistant to the touch, and may attain the size of a golf ball. Egyedi (28) observes that they tend to caseate and calcify, and also that they tend to break down and discharge their caseous contents, an instance of which, however, the present writer has not met. Gutierrez (29), who studied the microscopic appearance of 3 nodules in section, does

not note any appearance of calcification, the nodule consisting mainly of loose connective tissue, with masses of perivascular round cells with uniform dark-staining nuclei peripherally, and dense fibrous tissue somewhat concentrically arranged, in places with a smooth hyaloid appearance, centrally. This recalls the fibroid induration of Spittel. Sobernheim (31) records finding "spirochaetes of pallida type" by the method of Levaditi in sections of juxta-articular nodes.

MOTH-EATEN SOLES (Lusimbi, 12.1%, Kigoma Hospital, 16.1%) and PITTED PALMS (Lusimbi, 6.0%, Kigoma Hospital, 4.8%).

Pitting, irregular destruction of the horny layer of the epidermis, cracks, and fissures are so extremely common in the bare-footed African native that discrimination is necessary. The later stages of the condition produced by severe and prolonged invasion with jigger fleas (*Dermophilus penetrans*, synonym *Sarcopsylla penetrans*), when secondary infection has taken place, yields a ragged appearance of the heels, and plantar eminences, while cracks and fissures are often caused by trauma. The plantar and palmar condition due to yaws is however distinctive. In the early stages the plantar lesion has the appearance of a nail hole, due to the shrinking of a small granulomatous plaque, which becomes a core and finally drops out. These plaques may be confluent, producing a honeycombed appearance of the sole. Trauma in walking no doubt aggravated the condition, so that irregular cracks and fissures eventually appear. The condition may be painful, causing the patient to limp badly. Paraesthesia of various kinds is sometimes complained of, such as that of walking on nails. Moss and Bigelow (21) describe the condition in terms similar to the above, and Spittel (18) makes mention of it, while Dye (32) in Northern Nyasaland saw only one case of pitted palms among several hundreds of yaws patients, although he states that it is common enough elsewhere in that country.

HYPERKERATOSIS. (Lusimbi, 11.6%, Kigoma Hospital, 11.1%).

Powell (3) states that this is commoner in other parts of India where there is no yaws than among his cases, and he has seen persons with this condition develop primary yaws. The present writer considers that this note of scepticism is healthy, since, in the tropics, the causes of irritative skin lesions number legion, micro-organismal, fungal, arthropodal, insectal, and, as the condition generally remains untreated, it reaches a chronic stage in which overgrowth of the horny layer of the epidermis is a natural result. Without wishing to suggest that there is anything specially characteristic about the hyperkeratosis produced by yaws, as a result of tissue reaction to the long-continued stimulus of the specific organism, or that it differs in any fundamental way from the hyperkeratosis produced by other causes, it is nevertheless worth while recording that it is found in a fairly large number of cases of tertiary yaws. Thus, irregular patches of hyperkeratosis may be seen during the retrogression of nodular cutaneous framboesides, surrounding areas of ulceration, covering the site of healed ulcers, or overlying the deformities of bony lesions. Ramsay (22) in Assam found chronic dermatitis common among 1,000 cases of tertiary yaws, and Gutierrez (29) states that 50% of the cases attending a yaws clinic in the Philippines had keratosis. Spittel (18) in his Ceylon monograph, however, does not mention the condition.

LEUCODERMA. (Lusimbi, 2.1%, Kigoma Hospital, 1.6%).

These depigmented patches, resulting as they did from deep ulceration with destruction of the Malpighian layer of the epidermis, are not, as in the case of hyperkeratosis, pathognomonic of yaws. They were noted most frequently on the extremities, the commonest site of ulceration. Their extent varied from a small patch 1 to 2 inches in diameter to a large one covering practically the whole of one aspect of a limb. They are usually seen in old people, in whom the disease has reached a quiescent stage, and, taken in conjunction with the various scars and deformities commonly seen in such cases,

help to complete the clinical picture.

PSEUDO-MYCETOMA. One example was seen at Lusimbi (0.2%) and two at Kigoma (1.6%). In each of these cases the foot and leg were affected, and the resemblance to mycetoma was so striking that a laboratory investigation was undertaken by the writer; no trace of the fungus was found, however, but spironemata of the pallidum type, together with a variety of other spironemata were seen, and numerous cocci and bacilli, including the bacillus fusiformis of Vincent.

A history of yaws was obtained in each case. The lesions appeared to have begun, ^{as ulcers} which invaded the tissues widely and deeply, inviting the ingress of secondary infection, the result being great swelling and deformity of the whole foot, with multiple sinus formation and exudation of foul-smelling pus. Specific treatment, coupled with local treatment on ordinary surgical lines, was eventually successful, although one of the cases remained in hospital over six months. As a point of interest, it may be mentioned that the fusiform bacillus of Vincent has also been found by the writer in advanced jigger lesions, ⁱⁿ and these cases treatment was also difficult, amputation of toes and fingers having to be resorted to in some instances.

GANGLION. (Lusimbi, 3.2%, Kigoma Hospital, 0.8%).

This condition was seen in 15 patients in all. The distribution was as follows: left wrist 8, right wrist 7, left knee 1, right knee 2. In 4 cases, there were ² ganglia, and in 1 instance the site is not recorded.

Franklyn (33) records a case of yaws with large ganglion on the back of the hand, which disappeared under treatment with N.A.B. Egyedi (28) mentions lesions of tendon sheaths. In 1925, the present writer found a case of ganglion on the back of the wrist in a native patient at Sewa Hadji Hospital, Dar-es-Salaam, and, unaware at that time of the possibility of its association with yaws, removed it surgically. It was found to be in relation to the mucous sheath of the tendons of the Extensor digitorum communis and Extensor indicis proprius, and to consist of a thick, fibrous-walled sac,

containing transparent, colourless material resembling glycerine jelly. Ganglion due to chronic inflammation is met with in temperate climates where yaws is unknown, but, in all of the 15 cases recorded above, a history of yaws was obtained, and the condition was never seen in the nigoma district in natives who had not had yaws, a fact which strongly suggests that the localisation of *S. pertenuis* in tendon sheaths may set up a chronic inflammation leading to the formation of these ganglia.

ULCERATION OF THE PALATE. ULCERATION OF THE NASAL SEPTUM.

(Lusimbi, 0.2% and 0.5% respectively, nigoma Hospital, nil.)

GANGOSA. (Lusimbi, 1.2%, Kigoma Hospital, 7.1%).

These conditions are grouped together, since doubtless they are stages of the same destructive process.

Callanan (20) states that gangosa was very common in Kenya (4% of adult yaws cases). Spittel (18) refers to gummatous infiltration of the nose and palate, producing all degrees of destruction from yielding of the septum to extreme forms of gangosa. It is self-evident that, if there exists (as these cases of gangosa testify), a condition in which the whole of the soft palate, the greater part of the hard palate, and the nose, including bony and cartilaginous septum and alar cartilages, is destroyed, so that the nasal passages open upon the face as two unsightly apertures, then there is also an early stage of the condition in which the destructive process is but beginning. The writer therefore speaks without hesitation of the occurrence of lesions of mucous membranes in tertiary yaws. Much has been written on this point, and much discussion has taken place. Granulomata of the secondary stage of yaws have been recorded as occurring on mucous membranes, but it now seems clear that these records were based on faulty observation, and that the lesions, which appeared to originate on a mucous membrane, actually originated on the skin, close to the muco-cutaneous junction, a point which has been emphasised in this paper in dealing

with the secondary stage. Thereafter it became heretical to speak of yaws lesions originating on mucous membranes in any stage, it being held that the so-called tertiary yaws lesions on mucous membranes were actually due to syphilis. The real point at issue is whether the end result of these lesions, namely gangosa, is due to yaws or syphilis or some other disease.

Bittner (34) described two cases of rhinopharyngitis mutilans seen in Java, and, about the same time, Winckel (35), working in Java, formed the opinion that the ~~xx~~ cases of gangosa he saw were due to yaws. Ramsay in Assam does not mention gangosa. van Dyke, Bakker, and Holsen (36) give an interesting account of the condition in Java. Finding a case of total destruction of the nose in a patient presenting himself for treatment for an attack of malaria, the authors set about investigating the condition and collecting other cases. As so often happens under these circumstances, in tropical practice, the rarity was found to be common. (For example, malignant disease is frequently stated to be rare in primitive native races; each year in Ranganyika Territory, as the medical staff increases and as the individual worker is able to give closer study and attention to the investigation of his cases, the number of cases of malignant disease recorded increases.) As a result of this study, the authors came to the conclusion that gangosa was a manifestation of yaws.

Waar (37) records a case of gangosa in a Dyak woman at Sintang in Borneo, and describes the process as commencing with ulceration of the palate, later destroying the walls of the nasal passages, and involving the supra-nasal and infra-orbital regions. The woman had previously suffered from yaws, which is very common among the Dyak population, while syphilis is rare, and the author considers the condition to be tertiary yaws, having excluded tuberculosis, leishmaniasis and leprosy. The process was arrested by treatment with neosalvarsan and mercury, without improvement in the

appearance.

In the Belgian Congo, Beurnier and Clapier (47) found that every village had one or two cases, which corresponds with the present writer's experience in Tanganyika territory. They attribute it to syphilis, while Dubois (48) who also found gangosa common in the Belgian Congo, associated it with yaws.

Gangosa appears to be found in all areas in which yaws is endemic, and to-day the majority of observers consider it to be a manifestation of tertiary yaws. Powell (3), however, who wrote authoritatively on yaws in Assam believes it to be due to syphilis. The low relative prevalence of syphilis in the Nigoma district, the absence of any other clinical signs of syphilis in the cases of gangosa, the presence of a history of yaws in every case, and the coming to light of a few cases of unmistakable tertiary yaws in which early lesions of the palate and septum were present, seem to the writer to be facts which afford strong support to the view that gangosa is due to yaws.

CONTRACTURES. (Lusimbi 2.1%, Kigoma Hospital, 7.1%).

The higher percentage of cases in the hospital series is probably to be explained in the same way as the higher percentage of cases of ulceration. Table XII gives the distribution, and shows that the commonest conditions were talipes equinus, deformity of the hand, and flexion contracture of the knee and elbow. In every case the cause appeared to have been severe deep ulceration, followed by contraction of fibrous tissue in the process of healing. Immobilisation and binding down of tendons and muscles by the scar tissue no doubt contributed. Among a native population there are few more pathetic sights - a young boy or girl with extreme talipes, limping slowly along with the aid of a stick, the toes alone of the affected foot reaching the ground, or, when there is a *varus* element, hobbling on the outer side of the foot; a woman huddled on the ground with both knees doubled under her, fixed for life in a position

of extreme flexion; an old man with both elbow joints fixed, both hands terribly deformed, and with his features distorted and hideous from gangosa. The tragedy is that every case is preventible. As anti-yaws campaigns among native communities develop such cases are certain to become rarer, but at the present time there are thousands of natives condemned to life-long suffering in their remote locations.

LATENT CASES. (LUSIMBI 3.2%, Kigoma Hospital, nil.)

These were natives, usually adults, who gave a definite history of yaws, and who, in addition, showed definite signs of active disease in the past, but who complained of no symptoms, and who presented no signs of active disease. The impression gathered from these cases was that the disease may undergo arrest or even spontaneous cure after the secondary stage, or even after the tertiary stage has been reached.

Instances of long latent periods after the secondary stage have already been mentioned, but, without fuller investigation such as by the Wassermann reaction, one cannot say whether

in these cases spontaneous cure has taken place, or whether the disease is only latent and liable to light up into an active tertiary stage at some future period. The cases which have reached the tertiary stage before the disease became inactive are on a somewhat different footing, but even in them one could not be certain that actual cure had taken place. Unfortunately Wassermann reactions could not be carried out under the circumstances.

The writer has not yet met a case of goundou, which has been classed as a manifestation of tertiary yaws by some observers, and he has no definite evidence to submit upon the occurrence of lesions of the nervous system, which are held by some to be found in yaws. "Evidence is accumulating of the occurrence of paraframboesial nervous conditions, similar to general paralysis of the insane and rabes dorsalis, which clear up after a short course of Bismuth in quantity much less than is required for syphilitic lesions" (1). This question is certainly worthy of very careful investigation.

DIFFERENTIAL DIAGNOSIS FROM SYPHILIS.

Clinically there is no difficulty in differentiating the two diseases in the primary and secondary stages, the primary or mother yaw and the florid secondary eruption being quite characteristic and without counterpart in syphilis; in the tertiary stage it may be difficult or even impossible.

Lory (38) considers that yaws is syphilis as manifested in primitive tropical races, among whom the disease has remained dermatropic, but which, since since the beginning of civilisation, has developed into syphilis as we know it, the virus becoming neurotropic. Muller (39) is impressed with the same idea, stating that the spirochete of yaws is found in the epidermis, that of syphilis in the dermis; that the mucosae are affected in syphilis and spared in yaws; and that congenital transmission occurs in syphilis but not in yaws. In cold climates, the virus, instead of being shed by the skin, becomes mainly restricted to the mucous membranes, and, to compensate for this handicap, it becomes able to attack the ovum. The fact that a syphilitic may be infected with yaws, and vice-versa, is held by most observers as sufficient to differentiate them as two separate diseases. The present paper has endeavoured to show that even in relatively cold climates yaws may exhibit the florid granulomatous dermal eruption just as profusely as in warm climates, and that in tertiary yaws the mucous membranes are not spared. An interesting field of speculation is however opened up by these views.

Powell (3) believes that the history of yaws in Assam is sufficient to prove that the two are distinct diseases. Syphilis had been rife in India for centuries, especially among the coolies of Assam, where the first case of yaws followed on the arrival of a family from Ceylon, the youngest of three daughters being infected with yaws, which thereafter spread rapidly, and became known as "the new disease".

The writer was extremely interested to find that

the natives of Manganyika territory recognised a difference between the two diseases. Williams (40), in connection with his work on venereal diseases, wrote from the Lukoba district: "Confusion of yaws with syphilis. From repeated conversations with intelligent natives, I have gleaned several items of interest with regard to these diseases. Some of these natives know of buba (yaws) as a separate disease from kaswendi (syphilis), and they say that they learnt of it from the Germans. I have also learned that the natives, some of them, distinguish between two kinds of syphilis, which they call kaswendi ndogo and kaswendi kubwa. The former, the Lesser Syphilis, they recognise as:-

1. Hereditary or
2. Connected with sexual intercourse, and they do not seem to know of its general infectivity.

The latter, the Greater Syphilis:-

1. Not hereditary.
2. Not necessarily connected with sexual intercourse per se, but very infective generally, i.e., it is dangerous for anyone with a cut or scratch to go near another infected person.

It seems to me that they have recognised the difference between the two diseases, and have called yaws the Greater Syphilis, on account, perhaps, of the very large scabs one sees."

The present writer interrogated a number of intelligent natives on the subject, and translations of some typical replies are appended:-

1.R-----. Syphilis is contracted from women. Yaws is contracted from dirt. Syphilis begins as a sore on the penis or the nose, then there is a rash like scabies. Yaws begins as a big hard scab on various parts of the body. Afterwards there are ulcers in both syphilis and yaws. The ulcer of syphilis is round, with clean edges, and bleeds if you touch it. The yaws ulcer does not bleed. The syphilitic ulcer becomes coloured on healing.

2. A----- . Syphilis begins with only 2 or 3 sores, yaws with many. (He has apparently missed the primary yaw, and refers to the secondary granulomata.) The sores of syphilis bleed easily, but yaws sores do not. Gangosa is due to yaws.

3. J----- . Syphilis begins with pain and swelling of the groin, and a sore on the penis or nose. These sores are hard, and if squeezed water comes out. Yaws begins as a big sore on the leg or arm. Afterwards the sores of syphilis are fleshy, and bleed easily; the yaws sores are white, with crust. Afterwards, in yaws, there are pains in the limbs, and sores come out all over the body. A man who has had yaws may afterwards get syphilis.

(The reference in each of these replies to syphilitic sores bleeding easily is explained by the fact that a typical hard Hunterian chancre is seen with extreme rarity; almost invariably it is masked by soft chancres, which are prone to bleed on manipulation. Hence A's statement that syphilis begins with 2 or 3 sores, the chancroids being multiple).

These replies show that, in the earlier stages at least, yaws and syphilis are quite definitely differentiated by some of the natives.

Yaws, as the writer has seen it, is not capable of hereditary transmission, and is not a venereal disease, does not produce lesions of the viscera or nervous system, nor a tendency to recurrent abortion or stillbirth. It is a disease of primitive tropical communities, and not a disease of civilisation; cross-infection with syphilis is possible (MacKenzie (41) records an instructive case); although the specific organism is morphologically indistinguishable from the specific organism of syphilis, inoculation experiments have demonstrated what may be a characteristic tissue reaction.

Under treatment with neosalvarsan, the lesions of yaws disappear, and the Wassermann reaction returns to negative

much more rapidly than in the case of syphilis. Taken in conjunction with the clinical picture, a detailed clinical history may be of the greatest value, but in dealing with primitive people it is often extremely difficult to secure a clear account.

It is submitted that a district such as Lusimbi, in which the incidence of syphilis is low, presents a valuable opportunity for the investigation of the subject. In the preparations of the records of the tertiary cases dealt with in this thesis, the greatest care has been taken to exclude any who gave a history of syphilis, and it is hoped that these records will prove of some slight value on that account.

TREATMENT.

The use of mercury, potassium iodide, and antimony in the treatment of yaws has been abandoned almost entirely, and a description of the application of these drugs would be of historical interest only, and is therefore omitted.

It is true, as Stannus (42) states, that the introduction of neosalvarsan, following its use in syphilis, revolutionised the treatment of yaws; but the introduction of bismuth salts, on account of their very much smaller cost, was an event of equal if not of greater importance.

The rapidity with which secondary lesions disappear under treatment with these drugs is dramatic. Goodpasture (16) states that within 40 hours after the injection of a therapeutic dose of neosalvarsan, all treponemata (spironemata) demonstrable by Levaditi's method had disappeared from early yaws. The remarkably rapid healing of secondary cutaneous lesions, he continues, consists essentially in an almost immediate suppression of acute exudation, and the removal of excessive fluid and cellular exudate, by surface evaporation, by absorption, and by phagocytosis. The thickened epidermis quickly resumes normal differentiation, with hyperkeratosis for a while until the

epithelial layer becomes again of a normal width and rapidity of growth. He thinks it probable that neosalvarsan is destructive of polymorphonuclear leucocytes in the lesion, and this may favour the rapid disintegration of the treponemata. The older secondary nodular lesions have a more permanent architecture, and probably offer greater protection to treponemata, consequently they require more care in effecting a cure.

It would be extremely interesting to have the result of similar observations on the histology of healing yaws under treatment with bismuth salts.

Dye (32) reported that 2 injections of neosalvarsan, 0.3 and 0.6 gm. respectively, given intravenously with an interval of 1 week between them, were sufficient to produce a clinical cure in secondary cases, and that no recurrences were observed within a year. In tertiary cases a third injection (0.6 gm.) was necessary to give good and rapid results.

Navarro (43) gives information regarding the rapid disappearance of the positive Wassermann reaction in secondary cases treated with neosalvarsan. Three to three and a half months after cessation of treatment, 82% gave negative reactions, of which 51% had received only a single injection. Moss (44), along with Sellards and Bigelow, visited Santo Domingo as a commission to study yaws in 1920. In 1925 Moss returned to observe the results of treatment, and had the opportunity of examining in 1925 419 of 1,046 cases treated in 1920. The results suggest that about 50% of a miscellaneous series of yaws cases in various stages may be cured by a single injection of neosalvarsan (0.6 gm.), and that the percentage is not much increased by 2 injections, but is considerably increased by 3.

These are brilliant results. Such was the financial position of Tanganyika Territory, however, that a wholesale anti-yaws campaign with neosalvarsan as the main armament was impossible. Even to the present day, the

outlook would have been gloomy, but for the discovery of the value of bismuth salts, which can be utilised at a cost of a fraction of a penny per dose compared with several shillings in the case of neosalvarsan. In the Annual Medical Report of the Territory for 1921, some notes on the results obtained by the use of bismuth sodium potassium tartarate (B.S.P.T.), chiefly in cases of yaws, were published by the Acting Principal Medical Officer, Dr. J.O. Shircore (45). The attention of the latter had been attracted by the discovery by Dr. Roux, Director of the Pasteur Institute at Paris, of this salt, which on trial had given good results in the treatment of syphilis. The late Mr. McGowan, a Dar-es-Salaam chemist, was approached, and he produced a similar salt from bismuth oxide, which, on trial by Dr. Parry at Sewa Hadji Hospital, gave most encouraging results. The original substance was neutral, but there were difficulties in the way of preparation, and a second batch, prepared from the carbonate, and acid in reaction, was, after trial, distributed to several of the medical officers in districts where yaws was common. This was at the end of the year 1921. Subsequently, supplies of bismuth sodium tartarate (B.S.T.) and bismuth potassium tartarate (B.P.T.) were obtained from home, and distributed to the various stations in the Territory. At the outset, there was uncertainty as to dosage, while the intravenous route was employed, a method now abandoned as dangerous, in favour of the intramuscular one. Experience has now taught that an intramuscular dose of 5 grains for an adult male of average body weight, and 4 grains for an average adult female, can be given without fear of untoward consequences, provided care be taken to ensure that the injection is actually intramuscular, and that the point of the needle does not enter the lumen of a vein.

What the introduction of these salts meant to the development of the anti-yaws campaign in Tanganyika Territory can be seen at a glance from the following figures:-

Yaws Cases Treated in Tanganyika Territory.

| <u>Year.</u> | <u>Cases Treated.</u> |
|--------------|-----------------------|
| 1921 | 1,109 |
| 1922 | 3,123 |
| 1923 | 3,616 |
| 1924 | 20,714 |
| 1925 | 75,689 |
| 1926 | 100,000 [*] |

* Annual Report for 1926 not yet published. Approximate figure, given by the courtesy of Dr. Shircore, Director of Medical and Sanitary Services.

Bismuth sodium tartarate (B.S.T.) was the salt used by the writer in the treatment of his cases at Kigoma. In early cases it appeared to be little, if any, inferior to neosalvarsan. In tertiary cases the results were less dramatic, but in the end extremely satisfactory. In advanced cases of deep ulceration and extensive tissue destruction, 4 to 6 injections of 2 grains each intramuscularly into the gluteal region, at the rate of 2 per week, were sufficient to arrest the progress of the disease. The subsequent healing process in these cases occupied several weeks longer. Occasionally more refractory cases were met with, when it was noted that, after a course of about 10 injections, further injections of B.S.T. did not improve matters, and that ordinary surgical dressing alone was quite as effective as dressing plus continuance of injections.

A short course of neosalvarsan was sometimes beneficial at such times, but the impression gathered was that delay in healing was not due to failure of the bismuth to destroy the specific organism, but to the presence of secondary infection and poor tissue reaction on the part of a debilitated patient, and that the salvarsan was beneficial on account of the tonic effect of its arsenical content rather than on account of its specific action.

bismuth-iodoform-paraffin paste (B.I.P.P.),

which earned such a high reputation during the war, was found to be the most useful local application. Skin grafting can be resorted to with advantage in cases of delayed healing where the granulating surface is large. Other surgical measures are scraping and cauterisation of ulcers, transplantation and lengthening of tendons, followed by massage and movement, for the undoing of contractures, and plastic operations for facial deformities. Ectropion, and entropion with trichiasis, are commonly seen in association with ulceration of the face in the orbital region, and call for surgical treatment. Gangosa responded well to treatment with bismuth, but great scarring and deformity remained after healing.

The dose of B.S.T. used by the writer at Kigoma Hospital, namely 2 grains twice weekly for an adult, was considerably less than the maximum dose which can be given with safety. Larger doses (3 grains) were given at the Lusimbi clinic, while in charge of Sewa Hadji hospital in 1927, the writer used 5 grains for an adult male and 4 grains for an adult female without any immediate untoward results whatsoever.

The reason for the employment of the smaller dose was the prevalence of stomatitis, one of the disadvantages of the bismuth treatment. The development of stomatitis causes interruption in the course of injections, and a consequent lengthening of the stay in hospital. While not usually serious, it is uncomfortable and annoying to the patient; severe cases do occasionally occur, in which the discomfort is extreme, and, speaking generally, it is a factor calculated to militate against the popularity and success of the campaign.

The writer investigated the incidence of this complication in 1925, with the results given in table XIII. Impressed with the fact, which is contrary to popular belief, that the majority of natives admitted to hospital suffered from pyorrhoea alveolaris and carious teeth,

the writer, during the first 6 months of 1926, instituted the routine practice of having the mouths of all yaws patients examined on admission, all septic teeth and stumps extracted, and the gums treated with tincture of iodine, before their course of injections was begun. During the second 6 months of 1926, in addition to the above, the yaws cases were put on a potassium chlorate mouth wash 4 to 6 times daily from the day of admission until the completion of their course.

The results on the whole were disappointing (Table XIII). Some improvement certainly was obtained. Although the percentage of those undergoing treatment who developed stomatitis was not reduced, the average time at which stomatitis did develop was postponed (1925, after an average of 3.00 injections; 1st $\frac{1}{2}$ 1926, 3.12 injections; 2nd $\frac{1}{2}$ 1926, 4.00 injections). In addition, an appreciably higher average number of injections per patient was attained, without greatly increasing the incidence of stomatitis. (5.20, 5.76, and 6.45 injections per patient for the three periods). Thus the figure for the first half of 1926 shows an increase of 10.8% in the average number of injections given, with an increase of only 2.6% in the incidence of stomatitis, and the figure for the second half of 1926 an increase of 24.00% in the average number of injections, with an increase of only 9.5% in the incidence of stomatitis.

Surveyed generally, however, these results seem to indicate that the solution of the problem of the prevention of stomatitis is to be sought in some other direction, as they hardly appear to justify the amount of time and trouble expended.

During 1926, medical officers received a circular from headquarters recommending the addition of 1 to 2 grains of magnesium sulphate per dose of B.S.T., as a means of reducing the pain at the seat of injection. At first it was found that if the two salts were put into solution together a white precipitate came down during sterilisation by boiling, and it was feared that the composition of the bismuth salt

was being altered in such a way as to throw the bismuth out of solution. Later it was found that if the B.S.T. and magnesium sulphate were prepared as separate solutions, boiled, and then mixed, no precipitation took place, and this solution was used by the writer at Sewa Hadji Hospital, Dar-es-Salaam in 1927.

Although no opportunity presented itself of making a statistical investigation, the writer formed the impression that stomatitis was not any commoner in Sewa Hadji Hospital, where 5 and 4 grains were given twice weekly as the adult male and female doses, than in Kigoma, where only 2 grains were given, and three possibilities occurred to him:-

1. The magnesium sulphate had a prophylactic action against stomatitis.

2. The supplies of B.S.T. varied in toxicity.

3. The maximum safe dose is not necessarily the most toxic as regards the production of stomatitis.

The writer hopes to have the opportunity of investigating these questions later. For the present, let it be said that another magnesium salt, the thiosulphate, enjoys a reputation as a prophylactic and therapeutic agent in stomatitis, and there is on the market a proprietary preparation for intramuscular injection which is stated to be effective in this way. If a cheap and effective substance could be obtained which could be combined with or added to B.S.T. without interfering with its solubility or spiro-nemicidal power, the main difficulty in the bismuth treatment of yaws would be overcome.

As it is, however, the stomatitis is seldom alarming or protracted. Heimburger (46) has recorded a severe case of bismuth poisoning with stomatitis, bleeding from the mouth, petechiae on the thorax, abdomen, and limbs, albuminuria, haematuria, and bloody sputum, after 4 injections of 2 ccs. of a 10% emulsion of bismuth salicylate in olive oil at 3-day intervals. Sodium thiosulphate by the mouth and intravenously successfully relieved the condition. The present writer has not met with cases of such severity, but has seen a number of cases with swelling of the gums and lips, excessive salivation,

and slight bloody oozing from the gingival margins.

On the whole, the natives are little perturbed at the appearance of stomatitis, and endure its discomforts without complaint; it does not appear to have detracted greatly from the popularity of the bismuth treatment in their estimation; if an out-patient develops stomatitis, he simply does not turn up for the next injection or two, but comes again as soon as it has cleared up. In hospitals, however, where the pressure upon in-patient accommodation is always great, it not only lengthens the stay in hospital, and therefore adds to the cost per patient, but keeps a bed occupied that may be required for a more urgent case. It is thus an undesirable complication, and we must make every effort to overcome it.

Abscesses and necrosis at the seat of injection have been recorded as occurring after B.S.T. injections. Patients usually complain of a certain amount of pain for a day or two after injection, and occasionally redness and localised swelling and tenderness are seen. This subsides in the course of 2 to 4 days as a rule, and the writer has not yet seen a case in which suppuration took place, over many thousands of injections. The best prophylactic is scrupulous asepsis: thorough preliminary sterilisation of the needles, syringes, and solution, the hands of the injector, and the skin at the site of injection. It is convenient, in dealing with large batches of patients, to use several sets of needles, one set being used for the injections while another set is being re-boiled in the steriliser, and it is wise to train the assistants to a system in which each performs his task at the proper time and in the proper way, so ensuring thoroughness and despatch.

The introduction of the bismuth treatment has proved an event of signal importance in anti-yaws work in Tanganyika Territory. It has made possible tremendous expansion of the campaign, and thousands of natives who otherwise would have remained untreated have with its assistance received the priceless benefit of restored health. That

expansion is not yet ended. The work cannot be said to have reached a successful conclusion until the last case of active yaws has been cured, and there is reason to hope that this object will be achieved within the lifetime of the present generation.

APPENDIX.

I.

Notes on the Geography and Population of Kigoma District.

The Medical headquarters of the district are in the town of Kigoma itself, the terminus of the Central Railway, which connects Dar-es-Salaam with Lake Tanganyika. Kigoma is beautifully situated at the head of a picturesque bay, and is the largest British port on the lake; the hospital and administrative buildings stand on a hill overlooking the township.

In former years, Ujiji, deriving its importance from its situation on the slave caravan and ivory trade routes between Central Africa and the headquarters of these trades at Zanzibar, was the largest native town in the area now known as Tanganyika Territory, with a population estimated at 25,000.

It was here that Stanley succeeded in finding Livingstone in 1871, and the mango tree under which the historic meeting took place is still to be seen.

Of recent, and especially since the Central line was pushed as far inland as Kigoma, which was reached by the Germans in 1914, the native population commenced to drift towards Kigoma, settling in large villages within easy reach of the European township, in which they sought employment. At the present time the population of Ujiji has dwindled to about 7,000. The native villages round Kigoma, and Ujiji itself, have come under the influence of Western sanitary ideals to a much greater extent than other parts of the district. Their dwellers are largely Swahilis of coastal origin, with a mixture of Wafipa from the Ufipa province to the South, immigrants from the Belgian Congo, and a few Waha tribesmen from the higher altitudes to the East. They are better clothed, more enlightened, and less primitive in their mode of life than the tribesmen of the Lake Hinterland.

North-East of Kigoma the land rises sharply from lake level (2,550 ft) to a wide plateau 5,000 to 6,000ft above

sea level, which extends from a few miles inland from the Lake as far as Kibondo. The Kigoma-Kasulu-Kibondo road roughly indicates the South-Western boundary of the plateau, and, incidentally, the limit of the great *Glossina morsitans* belt, which stretches from Ujiji northwards towards Lake Victoria.

The people of the plateau mentioned are of the tribe Waha, a primitive pastoral people living for the most part in small scattered groups of huts, rearing cattle and tilling small patches of soil around their homes. The herds are free from trypanosomiasis, as the fly does not reach these altitudes. Of sanitation and personal hygiene they are almost entirely ignorant, and their clothing consists of goat or ox hides. Their language, *Waha*, is quite different from *Kiswahili*, the lingua franca of the East coast and most inland centres, including Kigoma and Ujiji, and very few of them speak or understand *Kiswahili*. But for the unpleasant necessity of having to procure a few shillings annually to pay their hut and poll tax, which they often do by coming in to Kigoma for a month or so and obtaining labouring or porter-work, they would make little contact with the larger world outside. It is true that trading stations are now being pushed out into their country, opening up a market for their produce and creating a demand for articles like calico cloth and blankets, and that a few are seeking permanent employment in the towns. But on the whole they appear to prefer the primitive life to which for generations they have been accustomed, and to contemplate with supreme indifference the gradual infiltration of civilising influences.

Sultan Lusimbi, the supreme chief of the Waha, has his headquarters at Akalinzi (5,000ft., see map.). This chief has enormous influence over his people, and was of very great assistance to the writer in his effort to push the van of the anti-yaws campaign out into the country of the Waha. The two groups of cases dealt with in the text were (1) cases treated at Kigoma hospital, comprising mostly Swahilis from the

villages around Kigoma and Ujiji, at an altitude approximately that of lake level (2,550 ft.), and (2) cases treated at Makalinzi, and at Mkingo (5,500 ft.), some 12 miles beyond, and comprising Waha tribesmen.

TABLE I.

Table of Cases of Yaws treated in Tanganyika Territory
in 1925 by Stations, with Approximate Altitude of Stations.

| STATION | NO. OF CASES | ALTITUDE ABOVE SEA LEVEL IN FEET. |
|----------------------------------|---------------|--------------------------------------|
| Arusha | 959 | 4,732 |
| Mbulu | 192 | |
| Kibaya | 20 | |
| Bagomoyo | 796 | 0 |
| Bukoba | 115 | 3,726 |
| " District | 6,980 | 3,726-5,000 |
| Dar-es-Salaam | 4,529 | 0 |
| Mafia | 207 | 0 |
| Dodoma | 183 | 3,713 |
| Manyoni | 2 | |
| Singida | 588 | 4,000 |
| Iringa | 40 | 4,500 |
| Kigoma | 920 | 2,550 |
| Ujiji | 491 | " |
| Kasulu | 271 | 4,500 |
| Kilwa | 1,807 | 0 |
| Kibata | 120 | 600 |
| Liwali Sleeping Sickness area | 467 | 1,000-2,500 |
| Kondoa-Irangi | 4,268 | 4,625 |
| Mkalama | 2,112 | 4,000 |
| Lindi | 4,784 | 0 |
| Mikindani | 3,799 | 0 |
| Tunduru | 61 | 0 |
| * Masasi | 2,584 | 1,200 |
| Lushoto | 106 | 4,221 |
| Mahenge | 1,263 | 3,200 |
| District | 68 | 3,000-4,000 |
| Morogoro | 694 | 1,708 |
| Kilosa | 547 | 1,950 |
| Kisaki | 121 | |
| Moshi | 3,402 | 2,657 |
| District | 32 | |
| Mwanza | 2,692 | 3,726 |
| Maswa | 4 | |
| Musoma | 726 | 3,726 |
| Namanyere | 101 | 4,000 |
| Kasanga | 420 | 2,550 |
| * Kasanga | 1,007 | 2,550 |
| Pangani | 479 | 0 |
| Handeni | 1 | 0 |
| Songea | 1,041 | 3,500 |
| Tabora | 266 | 3,680 |
| Nzega | 360 | |
| Negezi | 85 | |
| Kahama | 298 | |
| " District | 1,404 | 3,000-4,500 |
| Shinyanga | 175 | 3,200 |
| Tanga | 631 | 0 |
| * Korogwe | 254 | |
| * Msalabani | 843 | |
| Tukuyu | 355 | 5,000 |
| Mwaya | 4,548 | 1,645 |
| Utete | 12,781 | 500 |
| " District | 4,680 | 400-1,200 |
| | <u>75,689</u> | |

* Cases treated on behalf of govt. by Missionary Medical Staff, with bismuth sodium tartarate supplied by govt. Medical Service.

TABLE I (Continued)

Summary.

| | No. of Cases. | Percentage. |
|-----------------|---------------|-------------|
| Below 2,500 ft. | 44,733 | 59.1 |
| Above 2,500 ft. | 30,956 | 40.9 |

TABLE II.

Classification of 559 Cases of Yaws treated at Lusimbi

(5,000 to 5,500ft) in 1926.

| Stage | Adults | | | | Children | | | | Total | |
|---------------|--------|--------|------|--------|----------|--------|------|--------|-------|------|
| | Male | Female | Male | Female | Male | Female | Male | Female | No. | % |
| Primary, I | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 3.1 | 5 | 0.9 |
| I & II | 7 | 6 | 3.5 | 3.4 | 20 | 14 | 17.5 | 21.9 | 47 | 8.4 |
| Secondary, II | 7 | 14 | 3.5 | 7.8 | 34 | 21 | 29.8 | 32.8 | 76 | 13.6 |
| Tertiary, III | 187 | 155 | 92.6 | 86.6 | 57 | 27 | 50.0 | 42.2 | 426 | 76.2 |
| Gangosa, IV | 1 | 4 | 0.5 | 2.2 | 0 | 0 | 0 | 0 | 5 | 0.9 |
| | 202 | 179 | | | 114 | 64 | | | 559 | |

Average Ages in Years

| | |
|--------|------|
| I | 5.4 |
| I & II | 11.8 |
| II | 11.5 |
| III | 24.9 |
| IV | 41.0 |

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TABLE III.

Classification of Yaws Cases Treated at Kigoma Hospital
During the Year 1926.

| Stage | Percentage of cases to total cases | Average age in years |
|---------------------|---------------------------------------|-------------------------|
| Primary | 1.9 | 9.0 |
| Primary & Secondary | 14.2 | 16.3 |
| Secondary | 10.4 | 20.0 |
| Tertiary | 71.6 | 33.2 |
| Gangosa | 1.9 | 44.0 |

TABLE IV.

Distribution of the Primary Sore. (119 cases)

| Situation | Right side | Left side |
|-----------------------------------|-----------------|--------------|
| Foot | 16 | 10 |
| Ankle | 15 | 14 |
| Leg | 9 | 7 |
| Knee | 3 | 2 |
| Thigh | 5 | 4 |
| Hand | 3 | 1 |
| Wrist | 1 | 4 |
| Elbow | 3 | 4 |
| | <u>55</u> | <u>46</u> |
| Chest | | 2 |
| Abdomen | | 2 |
| Mouth(muco-cutaneous junction) | | 2 |
| Scalp | | 1 |
| Buttock | | 5 |
| Back | | 1 |
| Scrotum | | 1 |
| Arm & forearm | | 1 |
| Pinna of ear | | 1 |
| Nipple | | 1 |
| Penis | | <u>1</u> |
| | | <u>18</u> |
| | <u>Summary.</u> | |
| Right side | 55 | Left side 46 |
| Upper extremity | 17 or 14.3% | |
| Lower extremity | 90 or 75.6% | |
| Thorax & Abdomen | 7 or 5.9% | |
| Head & Neck | 5 or 4.2% | |

TABLE V.

Distribution of the Secondary Eruption in 60 Cases (Lusimbi)

| | | |
|--------------------|--------|--|
| Skin around mouth | 26.... | (Especially at angles of mouth and Muco-cutaneous junction). |
| Scalp | 22 | |
| Buttocks | 19 | |
| Arms | 17 | |
| Face | 14.... | (Other than parts specially mentioned). |
| Legs | 13 | |
| Elbows | 12 | |
| Axillae | 9 | |
| Feet | 8 | |
| Hands | 8 | |
| Popliteal space | 7 | |
| Back | 7 | |
| Thighs | 7 | |
| Skin over nose | 7 | |
| Pinna of ears | 7 | |
| Back of neck | 6 | |
| Forehead | 5 | |
| Chest | 5 | |
| Knees | 5 | |
| Skin over eyelids | 3 | |
| Eyebrows | 2 | |
| Abdomen | 2 | |
| Shoulder | 2 | |
| Anti-cubital space | 1 | |
| Beneath chin | 1 | |
| Ankles | 1 | |
| Penis | 1 | |
| Scrotum | 1 | |
| Sole of foot | 1 | |

220.... (This number refers not to the total no. of Granulomata but to the no. of times they were found in the situations given).

Summary.

| | | | |
|--------------------|----|----|-------|
| Lower extremity | 42 | or | 19.1% |
| Upper extremity | 40 | or | 18.2% |
| Head and neck | 94 | or | 42.7% |
| Thorax and abdomen | 44 | or | 20.0% |

TABLE VI.

Classification of Symptoms and Signs in 431 Tertiary Cases
treated at Lusimbi.

| | No. of cases in which found. | % |
|-------------------------------|---------------------------------|------|
| Arthralgia | 319 | 74.0 |
| Arthritis | 18 | 4.2 |
| Ostealgia | 90 | 20.9 |
| Osteitis | 28 | 6.5 |
| Nodular cutaneous framboeside | 100 | 23.2 |
| Ulceration | 86 | 19.9 |
| Dactylitis | 89 | 20.6 |
| Juxta-articular nodes | 16 | 3.7 |
| Contractures | 9 | 2.1 |
| Leucoderma | 9 | 2.1 |
| Pseudo-mycetoma | 1 | 0.2 |
| Moth-eaten soles | 52 | 12.1 |
| Pitted palms | 26 | 6.0 |
| Hyperkeratosis | 50 | 11.6 |
| Latent | 14 | 3.2 |
| Gangosa | 5 | 1.2 |
| Ganglion | 14 | 3.2 |
| Ulceration of septum nasi | 1 | 0.2 |
| Ulceration of palate | 2 | 0.5 |

TABLE VII.

Classification of Symptoms and Signs in 126 Tertiary Cases
Treated at Kigoma Hospital during 1926.

| | No. of cases in which found | % |
|--------------------------------|--------------------------------|------|
| Ulceration | 91 | 72.2 |
| Arthralgia | 45 | 35.7 |
| Nodular cutaneous framboesides | 42 | 33.3 |
| Dactylitis | 24 | 19.0 |
| Moth-eaten Soles | 21 | 16.7 |
| Hyperkeratosis | 14 | 11.1 |
| Osteitis | 13 | 10.3 |
| Ostealgia | 13 | 10.3 |
| Arthritis | 12 | 9.5 |
| Contracture | 9 | 7.1 |
| Pitted palms | 6 | 4.8 |
| Juxta-articular nodes | 3 | 2.4 |
| Gangosa | 3 | 2.4 |
| Leucoderma | 2 | 1.6 |
| Pseudo-mycetoma | 2 | 1.6 |
| Ganglion | 1 | 0.8 |

TABLE VIIIa

Arthralgia. Distribution of Pain in the various joints.

(Lusimbi, 319 or 74.0%, Kigoma Hospital, 45 or 35.7%).

| Joint | Lusimbi | Kigoma Hospital. |
|---------------------|---------|------------------|
| Elbows | 207 | 19 |
| Knees | 187 | 29 |
| Shoulders | 135 | 16 |
| Wrists | 122 | 9 |
| Ankles | 102 | 15 |
| Sacro-iliac & spine | 33 | 3 |
| Hips | 24 | 6 |
| Sterno-clavicular | 1 | 0 |
| Temporo-mandibular | 1 | 0 |

TABLE VIIIb

Arthritis. Distribution in the various Joints.

(Lusimbi, 18 or 4.2%, Kigoma Hospital, 12 or 9.5%).

| Joint | Lusimbi | Kigoma Hospital. |
|--------|---------|------------------|
| Knees | 17 | 5 |
| Elbows | 2 | 1 |
| Ankles | 0 | 4 |
| Wrist | 0 | 2 |

TABLE IX.

Ostealgia and Osteitis. Distribution in the various joints.

| | Lusimbi. | | Kigoma Hospital. | |
|------------------|----------------------------|--------------------------|----------------------------|---------------------------|
| | Ostealgia (90 or 20.9%) | Osteitis (28 or 6.5%) | Ostealgia (13 or 10.3%) | Osteitis (13 or 10.3%) |
| Tibia | 27 | 24 | 8 | 9 |
| Bones of Skull | 24 | 0 | 0 | 0 |
| Radius and Ulna | 10 | 2 | 5 | 1 |
| Humerus | 7 | 0 | 6 | 0 |
| Femur | 6 | 1 | 3 | 2 |
| Sternum and ribs | 27 | 0 | 0 | 0 |
| Os calcis | 0 | 4 | 0 | 1 |
| Mandible | 0 | 0 | 0 | 0 |

TABLE X.

Distribution of Nodular Cutaneous Framboesides.

A. Lusimbi. 100 or 23.2%

| | | | |
|-----------|-----------|----------|-----------|
| Right leg | 15 | Left leg | 17 |
| " thigh | 5 | " thigh | 9 |
| " ankle | 6 | " ankle | 3 |
| " arm | 8 | " arm | 12 |
| " foot | 10 | " foot | 11 |
| " elbow | 4 | " elbow | 7 |
| " wrist | 4 | " wrist | 5 |
| " knee | 6 | " knee | 6 |
| " hand | 3 | " hand | 2 |
| | <u>61</u> | | <u>72</u> |
| Shoulders | 6 | | |
| Buttocks | 21 | | |
| Chest | 3 | | |
| Neck | 1 | | |
| Face | 4 | | |
| Scalp | 5 | | |
| Back | 3 | | |

Summary

| | | | |
|-----------------|----|----|-------|
| Right side | 61 | or | 46% |
| Left " | 72 | " | 54% |
| Upper extremity | 45 | " | 25.6% |
| Lower " | 88 | " | 50.0% |
| Thorax & abd'n | 33 | " | 18.7% |
| Head & neck | 10 | " | 5.7% |

B. Kigoma Hospital. 42 or 33.3%

| | |
|-----------------|----|
| Buttocks | 18 |
| Thighs | 10 |
| Elbows | 10 |
| Legs | 8 |
| Arm & forearm | 8 |
| Back | 7 |
| Feet | 7 |
| Ankles | 5 |
| Chest | 5 |
| Shoulders | 3 |
| Knees | 3 |
| Axillae | 2 |
| Wrists | 2 |
| Neck | 1 |
| Popliteal space | 1 |
| Forehead | 1 |
| Scrotum | 1 |
| Scalp | 1 |
| Face | 1 |
| Hand | 1 |

Summary

| | | | |
|------------------|----|----|-------|
| Upper extremity | 21 | or | 22.1% |
| Lower " | 34 | " | 35.8% |
| Thorax & abdomen | 36 | | 37.9% |
| Head & neck | 4 | | 4.2% |

No record as to right or left side was kept.

TABLE XI.

Distribution of Ulceration. (Lusimbi, 86 or 19.9%, Kigoma Hospital, 91 or 72.2%).

| | LUSIMBI | KIGOMA HOSPITAL |
|----------------------------|-----------|-----------------|
| Right leg, anterior aspect | 23 | 14 |
| " " posterior " | 3 | 1 |
| " " internal " | 1 | 0 |
| " " external " | 6 | 3 |
| | <u>32</u> | <u>18</u> |
| Left leg, anterior | 18 | 9 |
| " " posterior " | 4 | 2 |
| " " internal " | 2 | 0 |
| " " external " | 6 | 2 |
| | <u>30</u> | <u>13</u> |
| Right ankle, anterior | 11 | 0 |
| " " posterior " | 5 | 2 |
| " " internal " | 2 | 1 |
| " " external " | 6 | 3 |
| | <u>24</u> | <u>6</u> |
| Left ankle, anterior | 3 | 2 |
| " " posterior " | 5 | 2 |
| " " internal " | 0 | 1 |
| " " external " | 4 | 4 |
| | <u>12</u> | <u>9</u> |
| Right foot | 5 | 18 |
| Left foot | 9 | 12 |
| Scalp | 3 | 3 |
| Arms | 3 | 6 |
| Forearms | 3 | 5 |
| Scrotum | 2 | 8 |
| Buttocks | 1 | 4 |
| Penis | 1 | 2 |
| Pudenda | 0 | 1 |
| Perimeum | 0 | 1 |
| Elbows | 3 | 5 |
| Knees | 1 | 9 |
| Wrist | 2 | 6 |
| Axilla | 1 | 0 |
| Thighs | 0 | 11 |
| Shoulders | 0 | 7 |
| Face | 0 | 6 |
| Chest | 0 | 4 |
| Hands | 0 | 4 |
| Forehead | 0 | 3 |
| Back | 0 | 3 |

SUMMARY

| | | |
|------------------|-----|----|
| Right side | 61 | 45 |
| Left side | 51 | 43 |
| Lower extremity | 113 | 86 |
| Upper extremity | 11 | 26 |
| Thorax & abdomen | 5 | 31 |
| Head & neck | 3 | 12 |

TABLE XII

Contractures.

| | Lusimbi (9 or 2.1%) | Nigoma Hospital (9 or 7.1%) |
|--------------------------------------|------------------------|--------------------------------|
| Flexion contracture of elbow | 2 | 1 |
| Talipes equinus | 2 | 2 |
| Talipes equinovarus | 1 | 2 |
| Flexion contracture of foot | 1 | 1 |
| Hyperextension of toes | 1 | 0 |
| Claw hand | 1 | 1 |
| Flexion contracture of both knees | 1 | 2 |

TABLE XIII.

TABLE SHOWING THE INCIDENCE OF STOMATITIS IN AFRICAN NATIVES
TREATED WITH INTRAMUSCULAR INJECTIONS OF B.S.T., 2 GRAINS TWICE
WEEKLY FOR YAWS.

I. 1925.

| | | | |
|---|-----|----------------------------|-------------|
| Cases recorded | 87. | Number of injections given | 452 |
| Average number of injections per patient | | | 5.20 |
| Number of patients who developed stomatitis once, | 47 | or | 54.02% |
| " " " " " " | | twice, | 16 " 18.39% |
| " " " " " " | | thrice | 5 " 5.75% |

Average number of injections after which stomatitis developed:-

| | |
|--------|------|
| Once | 3.00 |
| Twice | 5.19 |
| Thrice | 7.00 |

Note- the development of stomatitis twice and oftener refers to patients who, having had their course of injections interrupted by the development of stomatitis, resumed their course on recovery and developed it again.

TABLE XIII (Continued).

2. First 6 months of 1926.

(Dental treatment carried out before course)

| | | | |
|--|--------------|----------------------|--------|
| Number of cases recorded | 92. | Number of injections | 530 |
| Average number of injections per patient | 5.76 | | |
| Number of patients who developed stomatitis once, | 51 | or | 55.43% |
| " " " " " " | twice, | 23 " | 25.00% |
| " " " " " " | thrice, | 10 " | 10.87% |
| " " " " " " | 4 times or/5 | more | 5.43% |
| Average number, of injections after which stomatitis developed:- | | | |

| | |
|--------------------|------|
| Once | 3.12 |
| Twice | 5.22 |
| Thrice | 6.10 |
| 4 times or more | 7.80 |

3. Second 6 months of 1926.

(Dental treatment plus routine mouth wash)

| | | | |
|---|--------------------|----------------------|--------|
| Cases recorded | 49 | Number of injections | 316 |
| Average number of injections per patient | 6.45. | | |
| Number of patients who developed stomatitis once, | 29 | or | 59.18% |
| " " " " " " | twice, | 13 " | 26.53% |
| " " " " " " | thrice, | 5 " | 10.20% |
| " " " " " " | 4 times or more | 1 " | 2.04 |

Average number of injections after which stomatitis developed:-

| | |
|--------------------|------|
| Once | 4.00 |
| Twice | 5.31 |
| Thrice | 5.00 |
| 4 times or more | 6.00 |

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