

# WARNING

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BOOMERANG LEGS AND YAWS  
IN  
AUSTRALIAN ABORIGINES  
WITH  
A DESCRIPTION OF BONE LESIONS  
RESULTING FROM YAWS.

- b y -

Cecil John Hackett.

In two volumes.

VOLUME I.

(THESIS)

(With illustrations and two maps).

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C O N T E N T S .

C O N T E N T S.

	<u>Page.</u>
I. Introduction.	1
II. Description of cases observed in Alice Springs and the Musgrave Ranges, and thesis.	3.
Area in which investigations were carried out in 1934.	7.
III. Yaws and/or syphilis.	9
1. Clinical evidence.	9
2. Experimental evidence.	11
3. Histological evidence.	12
4. Historical evidence.	14
5. Summary and conclusion.	18
IV. Historical evidence in parts of Australia.	20
1. References to syphilis and venereal disease.	20
2. References to yaws.	39
3. References to "irkintja".	40
4. Summary.	44
V. Definition of terms.	46
1. "Boomerang legs".	46
2. "Scars".	47
3. "Pains".	49
VI. References to "sabre-tibiae" in yaws, and radiography of bone lesions in yaws.	51
Summary.	58
VII. References to "Boomerang legs" in the literature.	60
Summary	66
VIII. Study of 50 cases at Alice Springs, clinically, serologically and radiologically (see also Section XII and Volume II).	67

	<u>Page.</u>
1. Introduction.	67
2. Material.	68
3. Birth places of subjects.	69
4. Blood relationships of subjects.	69
5. Age at onset of "Boomerang legs".	71
6. Variation of deformity.	72
7. Results of Wassermann reactions on sera.	75
8. Incidence of histories of "irkintja" and "pain" and of the presence of "scars".	77
9. Association of "irkintja", "pains", "scars", and the results of Wassermann reactions.	81
10. Summary.	84
IX. Study of the association of "Boomerang legs" and "scars".	87
1. Observations in the Victoria River District.	87
2. Observations at the Bathurst Island Mission.	90.
3. Summary of data from Victoria River District and Bathurst Island Mission, and conclusion.	94
4. Distribution of "scars" among natives at the Bathurst Island Mission.	95
5. A note on the perpendicular forehead scars observed on the natives of Bathurst Island.	97
X. Study of the association of "Boomerang legs", "scars", and positive Wassermann reactions among inmates of the Half-Caste Institution at Darwin.	100
XI. Studies at Ooldea.	107
XII. Radiographs.	110
1. Attempt at diagnosis of aetiology from radiographs.	110
2. (a) Cases with marked "Boomerang legs"	113
(b) Cases with moderate "Boomerang legs".	117
(c) Cases with slight "Boomerang legs".	120

	<u>Page.</u>
3. Summary.	123
(a) Suggested pathogenesis.	123
(b) Transverse bones in long bones.	125
(c) Differential diagnosis	129
Appendix:-	
Doubt as to the existence of bone lesions in yaws.	130
{III. Study of some aboriginal bones.	133
1. Sources of material.	133
2. Tibiae with "boomerang leg" deformity. Summary.	134 155
3. Skulls with pathological changes. Summary.	157 163
4. Other bones with pathological changes. Summary.	164 173
5. General Summary	174
{IV. Geographical distribution of "Boomerang legs".	176
1. Localities in the Northern Territory of the Commonwealth of Australia.	176
i. Localities where cases were observed.	176
ii. Localities from which cases came.	177
(a) Kahlin Beach Native Compound, Darwin.	177
(b) Fanny Bay Gaol, Darwin.	178
iii. Localities from which cases were reported.	179
iv. Other manifestations of yaws that were observed.	181
2. Localities in other parts of Australia.	184
3. Localities out of Australia.	185
4. Native names for the conditions under discussion.	187
5. Conclusion.	188
XV. General Summary.	189

	<u>Page.</u>
XVI. Appendix A.	193
Appendix B.	198
Appendix C.	200
XVII. Authors' Index.	201
XVIII. Bibliography.	206

SECTION I.

I N T R O D U C T I O N .





Fig. I.

SECTION I.I N T R O D U C T I O N .

One is often surprised, on becoming interested in some aspects of a problem, to find that although many years may have elapsed since its existence was noted, little progress has been made towards its elucidation. This has occurred in the etiology of "Boomerang leg". This condition, as far as one can ascertain, was first reported by Stirling (1894). He had seen natives with this condition in Central Australia while he was a member of the Horn Scientific Expedition. Watson knew of the condition both in Central Australia (Gardner, 1895) and in the New Hebrides (Stirling, 1894 and 1896).

Since that time many interested people have observed the condition, as would be expected. So characteristic is the appearance in marked cases and so wide the distribution that many who have lived in the Central or Northern areas of Australia for any length of time have seen one or more examples. The popular explanation of the condition, sometimes attributed to the natives themselves (Basedow, 1932), is that the growing child's legs protrude over the end of the wooden vessel in which it is carried, and gravity brings about the bending (Fig.1). This mechanism does not take into consideration the fact that the deformity is rarely seen until the child has reached an age when it has far outgrown this means of transport. The natives account for the condition in many ways, attributing it in some localities to snake bite (or evil influences) and in others to failure of the mid-wife to straighten the shins properly at birth.

In Section VI, dealing with references in the literature to "Boomerang legs", it will be seen that the first to offer a reasonable suggestion of the etiology of

this condition was HERMANS (1928), who compared the sabretibia of yaws seen in Equatorial Africa with "Boomerang legs" in Australia.

The studies, which are outlined below, were undertaken with the purpose of testing the validity of the association of certain pathological changes with "Boomerang legs".

SECTION II.

DESCRIPTION OF CASES OBSERVED IN ALICE SPRINGS  
AND THE MUSGRAVE RANGES,  
AND THESIS.

AREA IN WHICH INVESTIGATIONS WERE CARRIED OUT IN 1934.



Fig. 2.



Fig. 3.

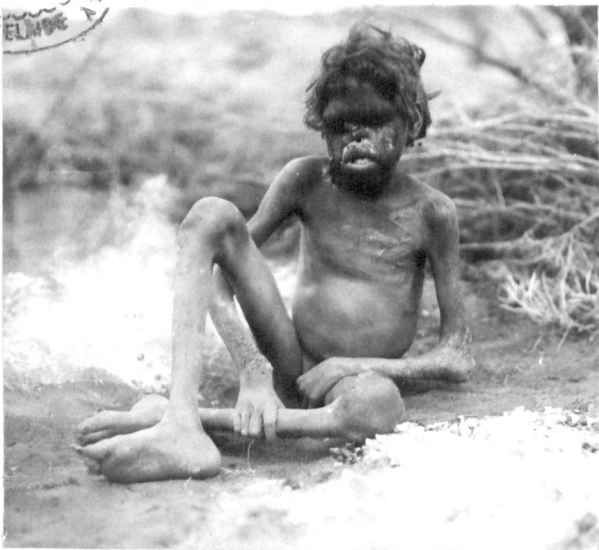
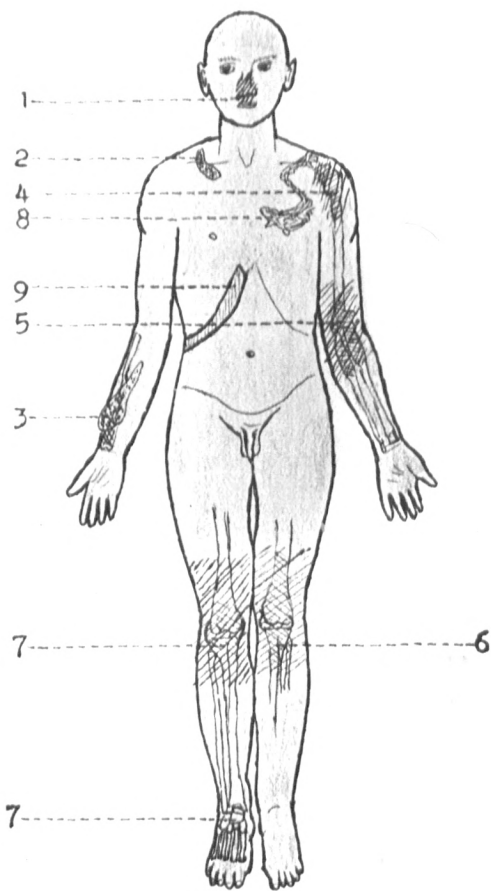


Fig. 4.



Fig. 5.



FIRST CASE

Fig. 6.

SECTION II.DESCRIPTION OF CASES OBSERVED IN ALICE SPRINGS  
AND THE MUSGRAVE RANGES,  
AND THESIS.

I first saw cases of "Boomerang legs" in Central Australia during the course of anthropological investigations as a member of a party from the Adelaide University in 1927.

One marked case of a lubra was seen at Alice Springs, who, with the extreme bowing of thighs and lower legs and debility, walked with difficulty. Her forearms were also bowed (Figs. 2 and 3). She died in 1933, and fortunately her skeleton was obtained at Alice Springs in 1934.

In 1933, while engaged in anthropological work in the North-Western Aboriginal Reserve of South Australia with Mr. N. B. Tindale, further cases were seen, three of which appeared to offer new lines for investigation.

The first case was that of a boy aged about 14 years, seen at Konapundi in the Musgrave Ranges (Figs. 4, 5 and 6). He showed the following lesions:-

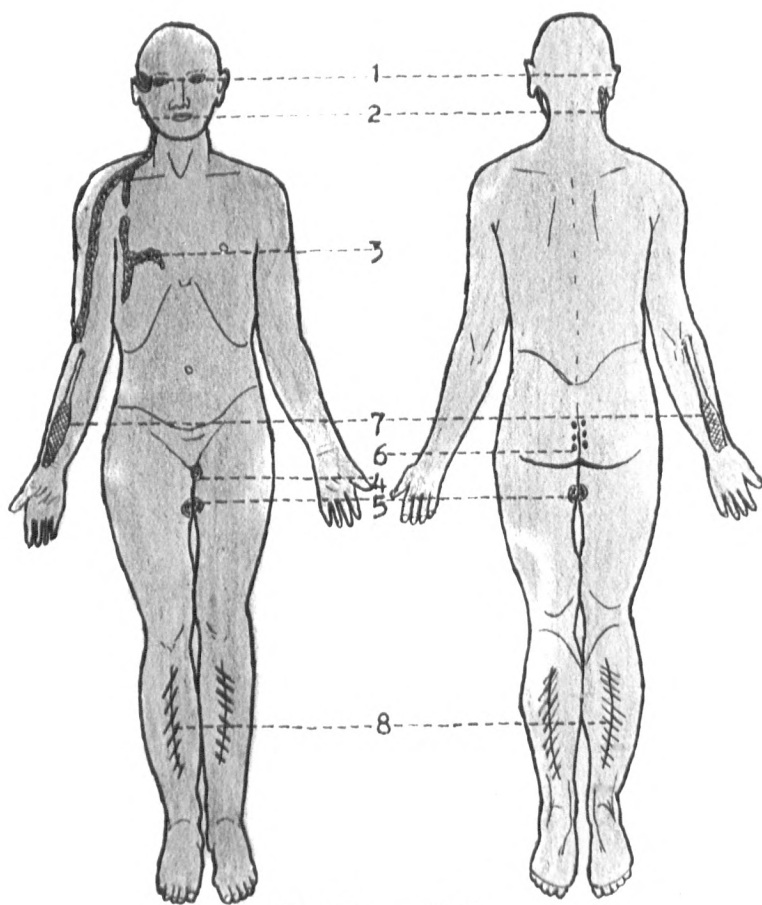
- (1) Absence of the lower part of the nose with scabbing of the surrounding area; drawing up of the upper lip, flattening of the anterior part of the dental arch with some displacement downwards. The lower teeth were anterior to the upper teeth. His palate was not perforated.
- (2) Scabbing over middle of the right clavicle, not attached to the bone.
- (3) Scabbing over the radial side of the right wrist and forearm with bony involvement; movement was limited and painful.
- (4) Left shoulder was held in moderate abduction, movement was limited and painful. A sinus opened posteriorly. Probably both scapula and humerus were involved.
- (5) Left elbow was painful, and was practically fixed at a right angle. The overlying skin was swollen, unhealthy and desquamating. A sinus opened posteriorly on the medial side. The upper two-thirds of radius and ulna were thickened.



Fig. 7.



Fig. 8.



THIRD CASE

Fig. 9.



- (6) Left knee was flexed to an angle of 30-40 degrees. It was swollen and painful on movement, which was limited. A sinus opened on the medial side with adjacent scabs, - greyish-yellow pus was exuded.
- (7) Swelling, with pain and fluctuation of right knee and tarsus, probably due to bony changes in earlier stages.
- (8) Over the left shoulder and spreading downwards irregularly over the left side of the chest was an irregular linear low keloid scar, said to be due to an earlier attack of the present condition.
- (9) The lower edge of the liver was palpable about 2.5 cm. below the right costal margin.

Order of involvement:- 8, 7, 1, 2, 3.

He sat in the position shown in the photograph, unable to walk. When the camp was moved his sister carried him on her back. He was thin and somewhat underdeveloped and showed marked wasting of the limb segments above and below the diseased joints. His finger nails projected 1 cm. beyond the nail bed. His genitalia were small but healthy.

Scant history could be obtained - none of duration except "little bit long time".

The condition of the tibiae was not noted so the only datum on that point available is from the photograph. The condition was attributed by the natives to "snake bite". His parents were both dead. The three elder children in the family were said to be healthy.

SPITTEL (1923) speaks of similar cases in yaws in Ceylon.

The second case was also seen at Konapundi, where many natives were gathered to perform initiation ceremonies and to circumcise two youths.

This was a boy of about 6 years of age who was well developed and active. The right foot in the region of the tarsus was swollen and a sinus opened on the medial aspect of the upper surface. The left leg showed definite boomerang deformity, but the right shin appeared straight.

The third case was that of a girl of about 4 years of age, seen at Wiliwiluru, in the sandhill country south of the western end of the Musgrave Ranges (Figs. 7, 8 and 9). She was moderately well nourished and was able to walk short distances.

In this case the following lesions were found:-

- (1) On the right side of the face was a thin, smooth scar about 6 cm. in diameter, roughly circular. This extended forwards from the ear (the upper third of which was missing) towards the orbital fossa. It was probable that the zygomatic arch

was also affected for the face was flattened and the arch was not readily palpated.

- (2) There was a linear scab about 1 cm. broad extending from behind the right ear, downwards over the neck, out and over the anterior part of the shoulder, then down the left arm towards the outer condyle of the humerus where it ceased; a spur was given off at the level of the clavicle. It did not appear to have any deep attachments.
- (3) There was a similar condition, with a bifurcation, over the right side of the thorax anteriorly - from the medial branch of which thick, yellow pus was exuded - this part appeared to be fixed to the deeper tissues.
- (4) There was a protrusion from the pudendal cleft with a scabbed surface, this was presumed to be an enlarged left labium minorum.
- (5) On the medial sides of the two thighs at the junction of the upper and middle thirds were scabbed areas extending more posteriorly than anteriorly.
- (6) The buttocks towards the natal cleft showed small areas of scabbing and several sinuses.
- (7) There was a deep swelling in the right forearm round the radius which was tender.
- (8) Both tibiae showed definite bending, which is not shown well in the photograph.

It was considered that the lesions of the face present in the first case constituted what is known as Gangosa. This, for many years, was described in text books as a separate entity, but it is now known to be a tertiary manifestation of yaws. SCHOEHL (1928) has produced Gangosa in monkeys by superinfection with yaws material. The bone and joint lesions and the scars in this case were thought to be due to the same process which had been active in the face. The scars seen in this case were not of the character of those which will be frequently referred to as "scars" in this paper. Those present in this case were the results of more destructive lesions.

In the second case bony disease of the tarsus was associated with one "Boomerang leg".

In the third case the "Boomerang legs" were associated with extensive scabbing and bony disease of the radius.

From these facts it is deduced:-

Firstly, that the "Boomerang legs" and the scabbing areas were associated and had a common causal factor. Secondly, that on account of the presence of Gangosa this common factor was the *Treponema pertenu* (CASTELLANI, 1905) of yaws [Framboesia, Pian (French), Boubas (Portugese), Parangi (Ceylon)].

Mr. Allan Brumby, who was our guide through the Musgrave and Mann Ranges, on hearing the suggestion that these scabs or their scars and "Boomerang legs" were associated, said that, if sought, scars of the earlier disease could be found on all natives who had bent legs.

The Pitjanjara word for the scabs, as differentiated from lesions due to trauma, was "minki". Later, at Ernabella (Musgrave Ranges, South Australia) three youths were seen with "Boomerang legs", each of whom had scars. These scars were situated on the lips, neck, antecubital fossae and groins. They accounted for both these conditions by "lerutja" or "snake bin bite 'm". These scars were quite different from those seen in the other cases. They were the result of much less tissue damage and consisted more of an alteration of surface texture than of a change of tissue structure. This type, which is referred to in this paper as "scars", results from secondary rather than tertiary lesions of yaws.

Thus the thesis for further study became:-

Firstly, that "Boomerang legs" were associated with scars resulting from slight destruction of the shin, and that both conditions had a common causal factor. Secondly, that this factor was the *Treponema pertenu* of yaws.

On returning to Adelaide only two articles were found which dealt in any way with the etiology of the condition. BREINL & PRIESTLEY (1915) contributed a useful paper

illustrated with photographs of a case, of radiographs, and of a longitudinal section of the bones. They also gave a brief clinical history of the progress of the disease and suggested the pathological course in the bones, which are fundamentally correct. They conducted an autopsy in the case described, and could find no evidence of syphilis, tuberculosis or rickets, and in their conclusion excluded the first two as etiological factors (see Sections VII and XIV).

It was not until I was in the field in 1934 that I received a letter from Dr. N. Hamilton Fairley (London) which referred to an article by HERMANS (1928). In a paper on *Framboesia tropica*, after illustrating the condition of "sabre-tibiae" which occurs in that disease, he says he thinks it may be identical with the "Boomerang leg" as reported by Breinl & Priestley.

#### AREA IN WHICH INVESTIGATIONS WERE CARRIED OUT IN 1934.

The studies outlined in this paper were carried out with the aid of a grant from the Sheridan Research Fund of the University of Adelaide, and were conducted in the Northern Territory of the Commonwealth of Australia during the months of March-September, 1934.

This area lies between the latitudes of 11° and 26° S. and longitudes 129° and 138° E. and can be arbitrarily divided by the 20° S. latitude. The southern country is acacia semi-desert and shrub steppe (PRESCOTT, 1931) and is elevated in parts to 1,000 feet above sea level, with some low mountain ranges. Here the climate is hot and dry for part of the year and cold and dry at other times. Day temperatures of over 100° F. are frequent in summer, and night temperatures well below 32° F. occur in winter. The annual rainfall in this area is under 12 inches. The bush

life of the aborigines subjects them to extremes of temperatures. In the hot periods of the year food and water are scarce, and bad seasons for game occur from time to time (see also STIRLING, 1896, p. 127).

North of the 20° S. parallel of latitude the country changes until at the north coast it assumes a tropical savannah woodland type. The climate becomes definitely tropical with a dry and wet season corresponding to the winter and summer climates of the more southern area. The rainfall reaches 60 inches per annum at the coast where seasonal temperatures range between 60-90° F. In this area life is not so grim for its inhabitants, food and water being more abundant throughout the year.

Work was commenced from Alice Springs, thence the overland route to Darwin was taken.

Visits to the Victoria River District and to Bathurst Island were made.

SECTION III.

YAWS AND/OR SYPHILIS.

GENERAL SURVEY.

1. Clinical Evidence.
2. Experimental Evidence.
3. Histological Evidence.
4. Historical Evidence.
5. Summary and Conclusion.

SECTION III.YAWS AND/OR SYPHILIS.GENERAL SURVEY.

It is unavoidable that some reference be made to the problem of the separate identities of yaws and syphilis. I have had no clinical experience of yaws apart from that gained in Northern Australia, where I saw only two cases of the secondary eruptions and many cases of what I consider as tertiary manifestations, so that for much of this discussion I have had to rely on published articles.

1. Clinical Evidence.

BLACKLOCK (1932), in an interesting and stimulating paper discusses the points commonly used in textbooks to differentiate these two diseases, and throws considerable doubt on most of them. He points out that "fallacies have been introduced chiefly owing to comparisons being made between things which are not properly comparable". He brings forward arguments "against comparing yaws, which is mainly a non-venereal disease of children in rural areas of the tropics and which begins by an extra-genital primary lesion, with adult venereal syphilis of Europeans. The accounts of adult venereal syphilis as it affects natives in the tropical countries are not complete, but so far as they go they indicate that syphilis varies as greatly in many respects, from venereal syphilis in adults in temperate climates, as does yaws. The evidence that yaws is other than syphilis modified by age, race and various local conditions, does not appear convincing; the onus of proof rests on those who maintain that there are two distinct diseases".

He maintains that to compare syphilis with yaws, one requires data regarding non-venereal syphilitic infections in native children of the area from which the yaws data are obtained and living in every way comparable to the yaws-infected children. Although such a series of syphilitic cases is not obtainable, he endeavours to get some indication of this aspect of the disease from various data, such as reports of hereditary syphilis, of endemic syphilis in Bosnia and Herzegovina, of French reports of colonial syphilis and of syphilis among negroes in the United States and in the Panama Canal zone. He does not take into consideration the evidence of experimental infection of animals with material from cases of the two diseases.

HEWER (1934), after reporting, in an unbiased way, his investigations, concludes, "..... on reviewing the situation in the Southern Sudan one is forced to the conclusion that it is impossible to differentiate clinically between yaws and syphilis. It then follows that the proper comparison of the two diseases in one locality, which BLACKLOCK rightly considers essential, cannot be made".

"The only means by which it may be possible to discover any specific difference between yaws and syphilis is to establish a number of strains of spirochaetes from different types of the disease and from different districts and see whether any of them produces constantly, in experimental animals, lesions fundamentally different from those due to another strain".

BUTLER (1914 and 1928) states the case for the unity of the two conditions, but on neither occasion is he very impressive, appearing to be more witty and emotional than sound. He makes no reference to recent experimental work.

PARHAM (1922), speaking of the absence of syphilis in American Samoa says, "as the only protection against syphilis is *T. pallidum* in the body and as yaws protects against syphilis in Samoans, *T. pertenuis* is doubtless a strain of *T. pallidum*".

BUTLER (1922), in the discussion of PARHAM'S paper, says "that if differences exist (i.e., if there are separate viruses) that these differences cannot be worked out upon animals other than man". He concludes, "I would say that under stone age conditions of sanitation, syphilis constitutes one of the exanthemata of childhood".

STRONG (1911) says, "although some writers hold that yaws and syphilis are merely two manifestations of the same disease, it can now be stated that the weight of opinion is against that view and in favour of the view that they are distinct diseases".

MOSS & BIGELOW (1922) state, "the impression gained from a fairly close study of over 1,000 cases", in the Dominican Republic, "leaves no doubt in our minds that yaws and syphilis are separate diseases".

HUNT & JOHNSON (1923) maintain, as do other authors, that no syphilis exists among the Samoan natives, whereas yaws has long been known. They describe cases of "parenchymatous or interstitial keratitis" and also speak of "the number of children having an excessive secretion from the nose ("snuffles") during the secondary stage".

"In our opinion the only sure differentiation in difficult cases is through histological examination", but they do not say how this is to be done or give any references.

SPITTEL (1923) writes, "the one disease most apt to be confused with parangi (yaws) is syphilis. They are intimately related, but quite distinct clinical entities".

"The differential diagnosis between parangi and syphilis then rests entirely on two factors: (1) the history of the case, (2) the clinical signs". He enlarges upon these under the following heads:- (a) the type of patient, (b) the tertiary lesions of parangi show evidence of greater chronicity and less active destructiveness than those of the more poorly resisted syphilis, (c) the tertiary signs of parangi (osseous nodes particularly) are apt to be more abundant than in syphilis. "It is, however, no exaggeration to say that a practised eye can, apart from any considerations of history, discriminate at a glance between the two diseases - a feat bewildering to incredulous Westerners conversant with only the one disease".



van NITSON et. al. (1930 and ARNAUD et al. (1931) bring forward evidence in favour of the existence of two diseases.

HERMANS (1931) writes, "gathering all the arguments and knowledge together I consider that we have every right to look upon lues and framboesia as two distinct diseases. It is now not difficult to ascertain whether lues or framboesia or both occur in a certain district. And as far as we can look back into history we find these two diseases alongside each other, the one never passing over into the other. The fact that framboesia is only a tropical and lues a cosmopolitan disease is of essential importance". "It is not impossible that framboesia and syphilis have generated from the same form of disease".

## 2. Experimental Evidence.

NICHOLS (1925) concludes, "the experimental suggestion is that long infection with yaws may partially protect against syphilis and a long course of untreated yaws in childhood may produce some true immunity to syphilis". "As to the identity of the disease the experimental protection of syphilis against itself is so much stronger than that of yaws against syphilis that the argument" (that any immunity between yaws and syphilis is the result of one organism *T. pallida* being the causal factor of both conditions) "fails".

He quotes CASTELLI (1912), who says that framboesial lesions in rabbits are characteristic both macroscopically and microscopically and that he has never seen the same in rabbits with syphilis, also that framboesia heals with a much smaller quantity of salvarsan.

NICHOLS (1925) speaks of strains in yaws and syphilis in rabbits which can be maintained for years and says, "it is much more likely that there is a series of strains of each which grade into each other at some point".

He states that the human case, from which he obtained yaws material for his early rabbit inoculations, has since been reported as having developed a "positive spinal fluid" - but he could not trace the subject. Later work with material from undoubted cases of yaws showed some differences from the earlier work.

PEARCE & BROWN (1925), using the material obtained later by NICHOLS, in the conclusion of a paper on rabbit inoculations, say, "the granular periorchitis which was a particularly constant feature of the infection and was unlike any lesion of the tunic observed in experimental syphilis of the rabbit".

REASONER (1929), towards the end of his article on Experimental Yaws and Syphilis, says, "all available evidence indicates there is a certain amount of cross immunity between yaws and syphilis". He believes that "syphilis and yaws are totally different diseases, though it is very probable that they originated from a common stem".

MIYAO (1930), speaking of the identity of syphilis and yaws says, "the two diseases belong to one group and show close relationship, but are fundamentally distinct".

SCHOMBL (1931), who has been engaged in experimental inoculation of yaws and syphilis in Phillipine monkeys for many years, and to the authority of whose statements all respect

is due, draws this conclusion. "The experimental evidence that has come to light through our researches and which shows that reciprocal immunity exists between yaws and syphilis, does not prove that the two diseases are one and the same, as it appears to at first sight. On the contrary, the difference in immunologic conditions existing in yaws and in syphilis, both in animals and humans, as well as the difference in the behaviour of the two infections with regard to cross immunity, shows plainly that fundamental immunologic differences exist between yaws and syphilis. These differences, like those of the tissue selectivity of the respective parasites, the pathology, pathogenesis, clinical course, transmission, geographical and age distribution stand in complete agreement with the fundamental biologic distinction between the parasite that causes yaws and the parasite that causes syphilis".

HASSELMANN (1931) comes to the same conclusion as SCHOEBL. He emphasizes the Ectodermotropic character of *Treponema pertenue* as compared with the Mesodermotropic character of *Treponema pallidum*.

### 3. Histological Evidence.

MACLEOD (1901) had obtained his material from Ceylon and at the conclusion of his paper he makes a "Summary of the histological changes which suggest that yaws and syphilis are different histological entities.

- (a) Cellular infiltration. - The plasma cells are not so definitely clustered around the vessels in yaws as they are in syphilis, nor do they ever form foci suggesting a tuberculous nodule, as they occasionally do in the latter disease. They are seldom arranged in rows which frequently occurs in syphilis. Large multinuclear cells (chorioplques) and true giant cells, which may be present in syphilis are absent. No hyaline degeneration, such as may be found in syphilis, is detected in the plasma cells.
- (b) Fibrous stroma. - The rarefaction of the collagen is more marked in yaws than in syphilis; organisation is not detected, and colloidal degeneration such as occurs in syphilitic gumma is absent.
- (c) Blood vessels. - There is no tendency to thickening of the vessel wall or to endothelial proliferation such as so frequently pertains in syphilis.
- (d) Epithelium. - The proliferative changes in the epidermis in yaws are only equalled in syphilis in the condylomata, while the marked tendency of the stratum corneum (hyperkeratosis), which is an invariable characteristic in yaws, is unusual in syphilis".

MARSHALL (1907) writes, "We may conclude from a study of these specimens (an early papule of a human case and ulcerative yaws nodules from an inoculated monkey) that we are dealing with a primary degenerative change resembling colliquative necrosis affecting the epithelial structures and caused by spirochaetae, which are very abundant in the necrotic material at least at some stage of the disease. The degeneration leads to ulcer formation. Following the

degeneration there is irregular, new formation of epithelium in the form of downgrowths, which, in turn, often degenerate. Accompanying these changes vascular dilatation, oedema and leucocytic infiltration occur in the corium, with a minor degree of new formation of capillaries and connective tissue. There is no endarteritis, nor are there any changes suggestive of syphilis. The majority of the infiltrating cells are polymorphonuclears at an early stage of the lesion, while mononuclears, many of which are of the plasma cell type, are almost equally abundant.

He quotes PLEHN (1906), UNNA (1894) who differentiate the yaws lesion from that due to syphilis.

HALLENBERGER (1916) comes to the conclusion that if the structure of a syphilitic condoloma and that of a yaws papilloma be compared it is found that the epithelial proliferation of the latter far exceeds that of the former, but this and other usual differences are not without exception. The cellular infiltration in yaws tends to be less well defined than in syphilis and giant cells are not so frequent. The spirochaetes in framboesial lesions are limited to the epidermal layers, while they are more numerous in the deeper layers in syphilis. The only constant difference is the classical syphilitic change in the vessels, shown in the condyloma as in every other syphilitic manifestation.

CASTELLANI & CHALMERS (1922) write, "the histological differences between framboesia and syphilis may be recapitulated. In framboesia the proliferative changes of the epidermis are much more marked, the granulomata present a diffuse plasma cell infiltration, and the thin blood vessels have no tendency to the thickening of their walls, which is so characteristic of syphilis. Giant cells are generally absent. Naturally these differential histological details must be considered collectively, as there is no individual histological character which exceptionally may not be present in both syphilis or framboesia".

GOODPASTURE (1927), under the heading of the "Histology of Yaws", writes, "the presence beneath the epidermis of treponemata of the species *Treponema pertenu* has not, to my knowledge, been observed before; and it is indeed a curious fact that their distribution in demonstrable numbers, is practically always limited to the epithelial layer". "This strict limitation in distribution is a noteworthy contrast to the disposition of the closely related *Treponema pallidum* which seems to find a more favourable environment in connective-tissue spaces".

Later, he writes, "Capillaries are dilated; their walls are injured, and haemorrhage and cellular exudate ensue".

In the whole paper he mentions vascular thickening on one occasion only, that is, at the end of his discussion of the literature where he writes, "several observers note the absence of vascular thickening and of definite perivascular cellular infiltration in the corium, in contrast to cutaneous lesions of syphilis". From the thoroughness of his recorded observations one can only conclude that endarteritis was absent in the sections he examined.

From the above quotations it is gathered that the pathological appearances seen in the secondary yaws lesions

differ from those present in syphilitic skin lesions, of which the condylomata bear the closest macroscopical resemblance to the yaw, in the absence of endarteritis, the absence of any extensive new tissue formation, and the concentration of organisms in epithelial tissue. The absence of gross tissue destruction in the cutis vera and the presence throughout the deeper layers of the surface of the lesion of epithelial islands, no doubt account for the insignificant resulting scar. Unfortunately no reports of the cellular pathology of the bony lesions of yaws were found in which the picture must differ as no epithelial tissues are present.

#### 4. Historical Evidence.

MAJOR (1932), in his book "Classic Descriptions of Disease", speaks of the following authors as having given the earliest descriptions of syphilis (the date following each name indicates when the accounts were published):-

Niccolo Leonicensi, 1497 - insisted syphilis was a disease of great antiquity.

Jacques de Bethincourt, 1527 - said it started in December, 1494, and that as all the remedies known at that time failed in its treatment, it must have been of recent origin.

Ulrich von Hutten, 1519 - wrote that it started in 1493 or thereabouts at Naples.

Villalobos, 1498 - stated it was a new disease.

No mention is made of an American origin of the disease.

CAPPER (1925) concludes that the weight of evidence seems to favour the view that syphilis was unknown in the Old World, except perhaps in Eastern Asia prior to the latter part of the fifteenth century. It appears that there is little or no evidence of the presence of the disease among ancient Egyptian remains. Quoting from the review of this article by Colonel L. W. Harrison, "Turning to America, we at once get evidence in prehistoric bones, of the existence of syphilis in the New World long before the time of Columbus. Bruehl says that the Mexicans understood syphilis so well that they were able to instruct the Spaniards in its management. The author is opposed to the argument that syphilis was imported into Europe by the crew of Christopher Columbus's vessel. These 82 sailors, with 9 Indians, landed at Palos, Portugal, on 13th March, 1493. They remained in their country until 1495. The crews of the remaining vessels of the Columbus expedition, under Pinzen, landed at

Bayonne in March, 1493. Roy Diaz de Lala states that he treated some of Columbus's crew for syphilis on the voyage home. The great outbreak of syphilis in Europe is commonly believed to have started at Naples in the army of Charles VIII of France, who entered this city on 21st February, 1494. Capper thinks it hardly likely that so few men as those constituting the crews of Columbus's vessel could have originated such a wide-spread epidemic. (As to this the reader will probably agree that a disease starting from even so few as 91 men could spread very rapidly on a virgin soil, and it is inconceivable that, if the men of Columbus's vessel were infected, Pinzen's crews had escaped)".

WILLIAMS (1927) publishes a translation of an article by Montejo, in which are quoted passages from the writings of observers living during the period 1474-1590. The evidence appears to be wholly in favour of an American origin for syphilis.

SHATTUCK et al. (1933) say, "it appears almost certain then that syphilis existed at widely separated points in both North and South American Continents before the discovery of America by Columbus and that equally convincing evidence of its existence at so early a date in the eastern hemisphere is lacking".

GANN (1901) gives a short account of the early history of syphilis which is overwhelmingly in favour of its American origin. He then reports the opening by him of a (pre-Columbian) mound in British Honduras, where he found clay figures (now in the British Museum) with enlarged penises, and which were apparently intended to represent some diseased condition. In the same tumulus were found bones, which showed no sign of cremation but changes which he considers probably syphilitic (he does not take yaws into account). He emphasises that all bodies save those dead in war or of disease were cremated before interment, and this neglect of cremation was practised on the corpses of syphilitics in early historic times.

MOODIE (1923), in his "Paleopathology", writes, "Syphilis among pre-Columbian races of North and South America is still a mooted question, and has been discussed by a number of writers. Jones (in 1876) suggests this disease as the cause of certain pathological changes in bones of the aborigines of Tennessee. Bloch has reviewed the entire question of prehistoric pre-Columbian syphilis, with no definite conclusion reached. Hrdlicka regards the evidence as still inconclusive".

From his copious illustrations little can be gained owing to the lack of descriptive notes of the specimens. It would be of value to examine critically some of the bones with lesions which he describes as "syphilitic (?)".

JAHNAL & LANGE (1928) find that historical material yields no conclusive evidence that syphilis reached Europe from America, or that yaws was conveyed to America from West Africa by slaves.

BUTLER & HERNANDEZ (1929) set out to prove by historical facts that the syphilis recorded in France and Germany in 1495 cannot be laid to the charge of Gonzola's Spaniards; Charles VIII, with one half of his army, quitted Naples for France in May, 1495, but at that time the Spaniards had not

yet arrived in Italy. The reviewer of this article, Colonel W. P. MacArthur, points out that Charles' retreating troops after leaving Naples were delayed in Northern Italy until October, 1495, whereas a printed edict of the Diet of Worms dated 7th August, 1495, shows that syphilis was then widespread in Germany and generally recognised, that is two months before the return of the first contingent of Charles' troops. The remainder of Charles' army did not leave Naples until July, 1496. MacArthur is of the opinion that the "leprosy" of medieval times included a large element of syphilis. It is, he writes, not surprising that the fifteenth century extension was generally, though not universally, regarded as a new disease, for the age accepted a similarly erroneous belief regarding the recent origin of typhus fever. The positive and repeated assertions of early medieval writers that "leprosy", in part, was of venereal origin cannot be dismissed as mere theoretical pre-conceptions. MacArthur continues, "due mainly to the advocacy of Osler, and to the uncompromising assertions in D'Arcy Power and Keogh Murray's "System of Syphilis", the theory of the American origin of syphilis is generally accepted by medical men in this country. In the last-named work the writer of the historical section declares, 'All available statements and facts point to the last decade of the fifteenth century - particularly the years 1493-1500 - as the time when syphilis first appeared in the Old World. There is not a particle of evidence to show that the disease existed in Europe before that time'.

LANCEREAUX (1868) deals fully with the history of syphilis and, although he includes framboesia in this disease, he is quite definite that syphilis had been existent in Europe from ancient times. He gives an extensive bibliography.

BLOCH (1908) has not the slightest doubt that syphilis was a disease new to Europe in the fifteenth century, and that it was imported from America.

COUTTS (1929) writes, "I suppose that few occurrences in the history of medicine have provoked more acute differences of opinion (than what he describes as the epidemic of syphilis in Europe at the end of the fifteenth century). So far as I can gather syphilologists are mainly of opinion that syphilis appearing at the end of the fifteenth century was a new disease so far as Europe was concerned, and that it was introduced from the New World by the sailors of Columbus on their return to Spain in 1493. Epidemiologists, on the other hand, seem mostly to have little doubt that syphilis existed in the Old World long before the time of Columbus, and that the epidemic in question was merely the blazing up in a virulent form of a disease which had been smouldering for years previously and had been obscured from notice from the fact that its manifestations (less severe probably in type and virulence) had been included under the generic name of Lepra. Medical historians have been inclined to the same view.

SIR W. KINSEY (1901) writes, "in the early years of the last century yaws prevailed in some of the country districts of Scotland and Ireland. It was one of the diseases included under the term "sibbens" or "sivvens", the other diseases being syphilis and lupus". In Ireland yaws was described by Dr. (afterwards Sir Dominick) Corrigan (1835) as prevailing in some country districts under the name of "Button scurvy of Ireland", and WALLACE (1827) under the name of a "fungous eruption curable by mercury, but not of

venereal origin". "CARMICHAEL (1842) gives the differential diagnosis between button-scurvy and syphilis".

MANSON-BAHR (1928) writes, "possibly, too, yaws was at one time prevalent in Europe - Sir Patrick Manson frequently used to refer to a disease known as "sibbens" or "sivyens" which occurred as an outbreak in Scotland in August, 1769, which was thought to have been imported by sailors coming from the West Indies, while in an old book, SWEDIAUR (1821) writes that yaws never attacks the same person twice, and is comparable with what the Scots believe of their 'sibbens'."

CASTELLANI & CHALMERS (1913), in the section on yaws, write, "The study of the disease began to engage the attention of European physicians after the discovery of America. Oviedo y Valdez (1476-1557) describes it in his work "Historie General e Natural de las Indias". Piso (1648) refers to the malady in his work "De Medicina Brasiliensis". Rochefort (1656), Raymond Breton (1665), and Labat (1694), report it from the West Indies, stating that it occurs frequently among the natives (Caribs), who call it 'pyans' or 'yaga'. Bontius, in 1718, reports that Framboesia was endemic not only in the West Indies, but also in Java, Sumatra, and the other Dutch colonies of the East". "In the days of the slave-trade, outbreaks of framboesia frequently occurred in the crowded ships carrying African slaves to America".

It must be borne in mind that in 1503 the Spaniards had already imported negro slaves into their American Colonies from Portugese settlements in Africa and were working their mines in Hispaniola with them. Negroes acted as porters for Cortes and Balboa during their explorations in 1513 and 1519 [CLARKSON (1808)].

"It has been suggested that 'saraat' in Leviticus XIII was yaws, not leprosy, and that the 'safat' or 'sahafati' of Arabian tenth century physicians was also yaws". They refer to the following conditions which they say have been thought to have been yaws; 'sibbens' or 'sivyens' in Scotland, 1769, button-scurvy in Ireland in the eighteenth century, radesyge in Norway and Sweden, 1710, and mal de chicot in Canada. More recently a disease not unlike yaws has been reported from Greece.

HUNT & JOHNSON (1923) state that in Samoan genealogy the first traditional case of yaws occurred sixteen generations ago, which they assess at 440 years or about 1482 A.D., and "supa" which they say is either tertiary yaws or leprosy has been known traditionally among the Samoans for twenty-eight generations.

ARAUJO (19 ) comes to the conclusion that neither the "Zaraath" of Leviticus nor the "Sahafati" of Avicenna and Hali Abbas can be considered as yaws. He also holds the view that Oviedo's description applied to syphilis and not to framboesia.

ARAUJO (1928) is opposed to the idea that yaws existed in Brazil at the time of the discovery of that country by the Portuguese in 1500, and is of the opinion that it was introduced later with African slaves.

COOK (1790), writing of his visit to Tongatabu in 1776, says, "They have a disease of a more mischievous consequence, which is also very frequent, and appears on every part of the body in large, broad ulcers, discharging a thin, clear pus, some of which have a very virulent appearance, particularly on the face. Some, however, appear to be cured of it and others mending; but it was generally attended with the loss of the nose or a considerable part of it. It being certainly known and even acknowledged by themselves that the natives were subject to the disease before they were visited by the English, it cannot be the effect of venereal contagion, notwithstanding the similarity of the symptoms, unless we adopt a supposition that the venereal disorder was not introduced here by our people in 1773. It was certainly amongst them at this time, for soon after we arrived some of our people received the infection".

POWELL (1923) writes, "the history of yaws in India taken alone seems to be sufficient to prove that syphilis and yaws are two distinct diseases. Syphilis has existed in India for centuries and is specially prevalent among the coolies recruited from distant parts of India to the tea estates of Assam. In the estates under my care from 7 to 10 per cent. of the population were syphilitic. Although prevalent in the Dutch Indies, Malaya and Ceylon, no case of yaws had been observed among the three hundred million inhabitants of British India till in December, 1899, after a residence of one and a half years in Assam, I met my first two cases. From these two cases the disease spread by direct contact, till in ten years I personally observed and treated in a narrow strip of land 22 miles long by 4 miles wide, 653 cases in a population of about 6,000."

CHESTERMAN (1928) said that in the Belgian Congo the natives "stated that yaws had been with them from time immemorial and that 95% of the people get it in infancy or at least before puberty." "It was recognised there that syphilis was a different disease, having been introduced into the territory by the Arabs, who reached Central Africa about 1850. Syphilis was given a different name by the natives, and it ran a course different from that of yaws."

BUTLER (1929) writes, "it is our belief that the Portuguese infected the "slave-bearing" fringe of Africa with their venereal type of syphilis and that the 75 years of their contact with the coast through the slave trade before they began sending slaves to America (1442-1517) was sufficient to give the negroes Portuguese syphilis. The negroes interpreted the white-man's syphilis in terms of yaws and when the West Indian slave trade began, passed it back to them as such."

##### 5. Summary and Conclusion.

Summarizing the above quotations, one forms the impression that to differentiate yaws from syphilis is often possible by clinical methods.

Experimental and histological evidence appears to be completely in favour of the existence of two distinct



diseases, although they may bear some relationships to each other.

On approaching the historical aspect of the problem one meets difficulties. I have not gone to original sources for the early history of syphilis in Europe, which, from the quotations given, appears indefinite. Accurate diagnosis is difficult from the early descriptions, which allow of considerable latitude in interpretation.

Perhaps syphilis existed in America in pre-Columbian times, while yaws was absent. The existence of syphilis in Europe before the end of the fifteenth century is probable. An American origin for syphilis is certainly "not proven".

There is evidence that in some countries a disease, which is now generally regarded as yaws, existed before the arrival of the first Europeans, and that, in others, syphilis has been introduced recently into communities where yaws had been known for a long time previously.

In view of these conclusions, yaws will be considered as distinct from syphilis for the purpose of the problem under consideration.

The disease, yaws, will be understood to include those conditions described under that name in the standard textbooks, with additions or modifications recorded in more recent articles.

SECTION IV.

HISTORICAL EVIDENCE IN PARTS OF AUSTRALIA.

1. References to Syphilis and Venereal Disease.
2. References to Yaws.
3. References to "Irkintja".
4. Summary.

## SECTION IV.

HISTORICAL EVIDENCE IN PARTS OF AUSTRALIA.1. References to Syphilis and Venereal Disease.

I have not attempted to deal exhaustively with the medical literature of the whole of Australia, which would necessitate considerable study in the capital cities of the other States. I have taken chiefly those articles dealing with South Australia and the Northern Territory which refer to any disease that may have been yaws. This applies to the early diagnoses of venereal disease and syphilis. Until 1911 the Northern Territory was included in the State of South Australia.

BROMLEY (1837) says he learns from Cooper (a European drunkard) that at Encounter Bay the sailors cohabit with and infect the natives with the venereal disease, and six of them (the original is indefinite) were coming to Adelaide for treatment.

McFARLANE (1837), in a letter from Rosetta (whaling) fishery at Encounter Bay, complains of men infecting natives with venereal disease. He says that one European youth, whom after great trouble he had cured, had again consorted with the native women and became reinfected.

WYATT (1837) made a report to the Governor on his return from Encounter Bay, where he had been to investigate the murder of a European by a native. The European, while drunk, had molested two lubras, the native husband had attacked him, and in the melee which ensued the offender had been killed. He says, "this native is afflicted with the venereal disease and many other natives are known to be in the same wretched condition."

LEIGH (1840), writing of his experiences as a ship's surgeon from 1836-38, during which time he visited South Australia, reports seeing a native at Adelaide, "nearly eaten away by a virulent species of syphilis, which seems to be indigenous." In an accompanying illustration, purporting to be that of an Australian native, the lower part of the subject's trunk is covered, so perhaps it was the penis that was eaten away. If this surmise is correct the disease may have been granuloma pudendi. This was probably the native referred to by WYATT (1837).

NASH (1840), Colonial Surgeon in Adelaide, in reply to a request from Captain Sturt for medicines for the treatment of natives at Encounter Bay, writes - "although the name of the malady they are suffering from is not mentioned" [STURT (1840) had used the term "state of disease"] "I suppose it to be syphilis and am sending Blue Pills."

It is quite possible that already two fallacies have crept in.

Firstly, the rough seafaring population engaged in the whaling industry at Encounter Bay would most probably have contracted syphilis fairly early in life and have become non-infectious before they arrived in Australia. Many authorities believe that the chances of an untreated syphilitic infecting his partner three years after his primary infection are small, and diminish rapidly as time progresses. It is more probable that the Europeans would have infected the natives with gonorrhoea, which is notorious for its long infectious period. This is still further supported by the report of a cure and reinfection.

The second doubt is whether NASH was correct in his supposition. This doubt is supported in the report of Dr. MOORHOUSE (1840). He speaks of a disease of a specific venereal character which, for the previous three months, had raged extensively amongst the aborigines of whom nearly one half had been affected. It had not been introduced by the colonists, but had spread its ravages before they came. The Adelaide natives said it came from the East. He suggests that it may have come from visiting whalers. "I can trace little connection between it and the European disease, it is greatly modified in its appearance by transmission from a white to a black race."

BASEDOW (1932), in quoting this passage verbatim, omits the word "little", which changes the original meaning.

MOORHOUSE quoted by EYRE (1845) thought at first the glans penis and groins were never affected, but later thought that this occurred very frequently.

STURT (1833), in the description of his journey down the River Murray, when just east of the present South Australian border, writes, "The most loathsome disease prevailed among them, several were disabled by leprosy, or some similar disorder, and two or three had entirely lost their sight."

On page 124, Vol. ii, when above the position where is the present township of Waikerie, he records, "The most loathsome of diseases prevailed through the tribes, nor were the youngest infants exempt from them. Indeed, so young were some, whose condition was truly disgusting, that I cannot but suppose they must have been born in a state of disease; but I am uncertain whether it is fatal or not in its results, though most probably it hurries many to a premature grave. How these diseases originated it is impossible to say. Certainly not from the colony, since the midland tribes alone were infected. Syphilis ranged amongst them with fearful violence, many had lost their noses and all the glandular parts were considerably affected."

On page 148, Vol. ii, after passing the North-West Bend, he makes the following statement:- "leprosy of the most loathsome description, the most violent cutaneous eruptions and glandular affections, absolutely raged through the whole of them."

BASEDOW (1932) makes no special reference to STURT's reports.

CLELAND (1928), however, raises the question of the accuracy of the use of the terms "syphilis" and "leprosy" and suggests it may have been syphilis which had spread up the River Murray, having originated from visiting whalers from Encounter Bay or Kangaroo Island. He admits there is no record of such having occurred. He thinks STURT would have recognised it had it been small-pox and adds - "No trace of yaws has ever been found among the natives of South Australia."

For my part, I feel that the description might very well be that of a widespread epidemic of yaws among the aborigines. The extensive skin lesions, the incidence among the children, and with his statement that it was not associated with the colony, support this conclusion. His use of the word "syphilis" I would disregard. The lost noses might quite well have been "gangosa", which is valuable evidence of the presence of yaws in a native community. That "all the glandular parts were considerably affected" would quite well agree with the secondary yaws eruption which in dryer climates tends to affect the moister parts of the body, i.e., round the mouth, the neck, the axillae, the anticubital areas, the groins and gluteal cleft [RAMSAY (1925)].

I will deal later (Section XII) with the examination of aboriginal bones found in the Murray area, which I consider show changes due to yaws rather than syphilis.

EYRE (1845) reached Murundi (Morrundi or Moorundee, near Blanchetown, and about 50 miles below the North-West Bend of the Murray) in 1841, and found the natives well developed and almost free from disease. By October, 1844, however, "from frequent intercourse with the town and neighboring station they had contracted the most horrible diseases. From that time on many were in a dying condition, some already dead, and but a few of those who had frequent intercourse, of every age and both sexes, were wholly free from this disease." He describes "round pustules, commonly of the size of an ounce weight" which "rise from the skin". "The centre of these is gradually filled with flowing pus, then as they grow larger and larger and disperse, the surface of the whole body is affected with wasting and scab, which cause horror and disgust to those near them. These

ulcers sometimes may persist for six or eight months; but generally when irritants or caustics are applied locally they are cured within three weeks." "After the first or second year the disease disappears, but sometimes causes death. But the unfortunate victims always suffer great torture and continuous pain." He says he has seen the glans penis and groins affected in natives on the banks of the Murray. In the same part of his book EYRE says, "Of the diseases from which they" (the natives) "suffer since the arrival of the Europeans by far the most frequent and most deadly is the venereal stain. It can now by no means be decided whether this disease was known to the natives before the Europeans mingled with them. They, themselves, say that it was long before brought from the East, from which it seems very probable that it had its origin in Europe, and from hence tribe to tribe was carried throughout the whole continent." He says the disease was less frequent and severe among tribes which do not mingle with Europeans. "Moreover, the habits of the natives are such that, whenever the disease appears in its worst form, it spreads with a swiftness and virulence found nowhere else." He says, "these tribes well know that this disease, like other diseases of the same kind, is contracted by contact."

In EYRE's book the above descriptions are in Latin; CLELAND (1928) has kindly published a full translation of them.

BASEDOW (1932) considers this a description of lues venerea, and adds, "some of the lesions and conditions observed by Eyre were, no doubt, of the nature of a soft chancre."

It would appear that the epidemic that STURT reported had subsided by the time EYRE reached the locality ten years later; then after three years, perhaps on account of poor seasons, the general health was lowered and the disease became again evident in quiescent cases, and children were infected.

The early records of rainfall for Adelaide kept by KINGSTON (1861) give the following values:-

Average annual rainfall -

1839-45	19.303 inches on 111 days
1841	17.95 93
1842	20.32 119
1843	17.19 105
1844	16.88 135
1845	18.83 124
1846	26.88 114
1846-52	25.27

Earlier publications of these records include an error in the values for 1844, which was not corrected until 1861.

When Mr. E. Bromley, the Divisional Meteorologist for South Australia, was approached regarding the climate of these years he said that the winter rains of 1843 and 1844 were good, but there was undoubtedly a dry season from September, 1843, to June, 1844. Although Murundi is 70 miles from Adelaide and lies to the east of the system of ranges which has an influence on the rainfall of Adelaide, he thought it was possible that there may have been a poor season in that district during the summer of 1843-44. The average rainfall at Blanchetown is about 10 inches.

That this description might well be considered that of a secondary yaws eruption is supported by the account of the duration of the disease. The "great torture and continuous pain" may refer to the bone pains of yaws.

A small percentage of primary genital lesions are reported in most extensive investigations in yaws-infected communities and eruptions on the groins often occur in yaws. If one recalls MOORHOUSE'S findings on this point it may be presumed that it was not of frequent occurrence and may possibly be accounted for by a few cases of granuloma pudendi.

The natives say it came from the East - which gives EYRE no ground for concluding that it came from the Europeans. I presume he refers to the settlers in Sydney, which would mean an overland spread of nearly 500 miles. He speaks of the intense infectiousness of the disease, - this is well known in yaws, for in many communities where yaws is rife it is found that nearly all over 4 years of age have been infected with the disease [LAMBERT (1929) for Samoa].

PENNY (1841), writing from the elbow of the lower Murray, says, "there are few individuals amongst the natives who have the disease severely, but the larger proportion are only slightly affected and are anxious for medical relief." He asks for further supplies of copper sulphate and potassium nitrate.

A popular remedy in Central Australia among the settlers for the disease "irkintja" in the natives is copper sulphate (blue stone) and vaseline - and apparently it hastens healing.

HUTT (1844) speaks of two reports of a disease in the native camps "far beyond York" in Western Australia, where "38 cases, male and female, were found suffering from a loathsome venereal disease." A hospital had been established there 6 months previously (May, 1842) and in one month, of 17 cases treated 10 were cured. He says a similar disease was present at King George's Sound. This might well be yaws. It is improbable that it was syphilis.

WILMOT (1842), in his report to Robinson, Chief Protector, gives an account of what he calls syphilis at Nerre Nerre Warrew (Narre Warren at the foot of the Dandenong Ranges, Victoria). "The natives declared the disease was unknown before they had intercourse with the white people. It generally originates with a small cluster of irritable papules on the inside of the thigh or scrotum and perineum, which rapidly coalesce, and degenerate into foul ulcers, terminating ultimately in a warty excrescence; in a few weeks it spreads very widely, and the skin becomes at length affected with a scaly eruption of a circular form, with a well-defined margin, giving it much the same appearance as lepra vulgares. The action of the virus is singularly modified by the habits and constitution of the native, as it does not appear to pass through the ordinary channel of the lymphatic system into the constitution, but directly through the general circulation or capillary vessels, as only in one instance, and that of a dubious kind, did I meet with any appearance of specific glandular affection. In no case did I find any other than the inguinal glands affected, in no case was there any ulceration of the fauces, nor did I meet with a single instance of a venereal node." "Although it no doubt arises from a specific virus, still the disease is much aggravated by their filthy habits." "I expect in the arsenical solution to find a valuable remedial agent in the treatment of this form of disease. In soundness of your expressed opinion before I proceeded to the station, of the inapplicability of mercurial medicine to the circumstances of the natives I entirely accord."

Referring to the last statement, BASEDOW (1932) wonders "whether possibly some of the cases recorded by the early observers were yaws and not syphilis." This doubt does not influence his readiness to diagnose syphilis on slight evidence as is shown on the same page of his paper.

It is difficult to interpret WILMOT'S statements; he is not quite satisfied that it is syphilis; his description, together with his remarks about treatment, applies more aptly to yaws than to any other disease, except for the native belief that it was not present before the Europeans came.

TUCKFIELD (1842) writes that the natives of Geelong (Victoria) "were entirely free from those loathsome diseases under which vast numbers of those who are associated with Europeans groan, and which have, in so many instances terminated in death."



ROBINSON (1844), in a report of a journey to the eastern coast and interior of Victoria when near Omeo, writes, "A loathsome disease (syphilis) among the natives, imported by the Europeans, is making ravages."

ROBINSON (1845), on a journey to Wimmera (Victoria), writes, when near Mt. Cole, "visited natives suffering from a loathsome disease, the effect of illicit intercourse of white men with native women - one woman was in the last stage of suffering."

From Lake Hindmarsh (Victoria) he reports, "two men afflicted with venereal disease could scarcely walk, an additional proof of the baneful effects of syphilis among the Aborigines of the Interior."

Near Glenelg River, South Australia, he reports "several natives afflicted with syphilitic disease." He writes, "a plague, the consequence of a dispute with a neighbouring tribe who had the power, they said, of inflicting it, was apprehended."

In the Medical Officer's report for the Goulbourne River District (Victoria), which ROBINSON (1848) includes in his report, is found: "March 3, visited large numbers of natives at Seymour and at Cameron's Well, on the Sydney, as usual a great number were suffering from syphilis." In Appendix B, by John Walton, surgeon, of ROBINSON'S Report (1848) it is said that at Mount Rouse "syphilis less frequent than formerly."

TUCKFIELD'S and ROBINSON'S statements are all, probably, influenced by the opinion of WILMOT (1842), so the literal diagnosis cannot necessarily be accepted. The statement that two men with the "venereal disease could scarcely walk" may, perhaps be correlated with the grossly pathological bones which have been found in Victoria. All indications point to these bony changes being the result of yaws (see Section XIII). That one tribe should have had the power of inflicting a "plague" on offenders is similar to the Aranda people's 'power' of disseminating "irkintja", which is their name for yaws (see below and Section VIII).

HULL (1858) says syphilis existed among the aborigines before the Europeans came to Australia. Earlier he had said the disease the natives suffered from was like syphilis but indigenous. He refers to WILMOT'S statements.

If HULL is correct that the disease was present when the Europeans arrived it is almost certain, from the findings in the Northern Territory to be detailed later, that it was not syphilis.

BEVERIDGE (1889), writing of the aborigines of Victoria and the Riverina between 1845-68, says venereal disease "long before the advent of the white man, was one of the greatest scourges this primitive people had to bear." He suggests that the Malay and Chinese trepang hunters brought it to the northern coast centuries ago, from whence it spread from one tribe to another, until the disease became a national calamity." Later he says there was an absence of "contagious" disease except "occasional visits from influenza, which often has a fatal termination." "During winter they, 'tis true, are very much subject to a kind of scurvy which, from its prevalence, might be deemed contagious, but we are inclined to imagine that it partakes more of a venereal character, and each break-out is due to lack of nutritious food, combined with cold, wet lodgings. As the mild spring advances, and food becomes plentiful, this distemper gradually leaves them, and by summer their skins have returned to their normal sleekness, with a glossiness truly wonderful, considering the blotches with which they were marred during winter."

What has been said of HULL'S statements apply also to those of BEVERIDGE. As yaws is prevalent in Malaya, it is more probable that they would have carried that disease to Australia rather than syphilis. It is not certain if syphilis existed in China prior to European contact. His description of a 'contagious venereal scurvy' is rather indefinite, but there are sufficient grounds for considering the diagnosis of yaws more probable. Despite what he says of the effects of climate, the winter would be the best season for food, the chief influence of the cold season would be the wearing of body covering and closer contacts to maintain warmth.

BARRINGTON (1802), in his History of New South Wales, writes, "the venereal disease, there is every reason to imagine they were not ignorant of before they knew us, but if they were, our arrival will account for its appearance shortly after, though every care on the part of the Governor was taken to prevent it."

Here is another opinion that the disease was present before European settlement. The diagnosis cannot be taken as definite.

HANDT (1842), reporting on the conditions of the natives in the Province of Moreton Bay (Queensland), writes, "the sicknesses they are subject to are chiefly consumption and rheumatism; and many of them, children not excepted, are infected with the venereal disease."

As the climate of this area is definitely tropical and children were also affected, this condition is also probably yaws.

As an indication of the value of medical diagnoses in the early days by laymen and others, reference might be made to the reports of smallpox in South Australia in the early '40's. A report was found in the Archives at Adelaide which has been missed by reviewers:-

MOORHOUSE (1845) speaks of the Itch (scabies papuliformis) as universally affecting the natives. It had made its appearance nine months previously and had spread over a range of 400 miles. On account of the great tendency to pustule formation it "was formerly mistaken for smallpox, but yields readily to treatment with sulphur ointment."

MOORHOUSE (1848), speaking of native school children in Adelaide, says that when "a child lived with its parents for a few days the itch is sure to show itself."

Yet at this time smallpox was reported from a large area east and west of Adelaide.

TATE (1881) records that Dr. Gething, who was at Streaky Bay in 1866, told him that "he treated the disease as smallpox, to which it had a close similitude, presenting similar symptoms". The natives at Streaky Bay declared that it came from the north.

Doubtless many references of interest to the present problem have been missed, for much time and energy would be required to comb the early records of this State alone.

Confusion of nomenclature of disease continued through the literature, as is shown in FOELSCHE'S (1881) paper dealing with the native tribes east of Darwin. "Syphilis is occasionally met with, but it is by no means common among the natives. I have seen only a few cases during the eleven years I have been there." Again, - "Venereal disease is rather prevalent and they have some means of curing it." Later he confuses arteries with veins when speaking of blood letting for ceremonial purposes.

WOODS (1879), after quoting the following as a footnote from EYRE (1845), (ii, 239), "to this must be added, from time to time when the Europeans mingled with them, venereal stain. Mothers communicate the disease to the infants, and a great number perish every year from that cause," (Translation from CLELAND (1928) ), continues, "in this it is probable that Eyre has been to some extent mistaken. The effect of the ailment to which he refers, according to statements gathered from a variety of quarters, was never

so widely disseminated as his note would indicate. It is of course impossible to assert that it has not had some influence over the aborigines, but proof is wanting that it has been sufficiently wide-spread to justify its being regarded as one of the primary causes of the dying out of the tribes. It is not known whence it was derived, or whether it existed among the tribes before the advent of the Europeans. He states, however, as a fact, that in 1841, when they assembled at Moorundi, there was but little sickness amongst them, but after visiting the town and adjacent stations, they appeared to have contracted some horrible disorders. He describes certain appearances which are known to be produced from other causes. It is remarkable that if the case was as represented by Eyre, the Narrinyeri tribe must have been particularly exposed to its influence, and it must have left its traces amongst them. Mr. Taplin, however, makes no mention of it, and he would scarcely be likely to pass over such a circumstance if it existed. The natives of some tribes suffer from a sort of leprous or scrofulous disease, which exhibits many of the characteristics mentioned by Eyre, but this disorder seems to afflict individuals and not families." He refers to GASON'S description given below. "One complaint may thus have been, and not improbably was, mistaken for the other. A friend of mine (F. Marchant of Arkaba, in the Flinders Ranges, S. Aust.) "first called the attention of the writer to the existence of this malady. At the same time he mentioned what would seem a certain cure for it." He describes how a native at Canowie "in a deplorable condition of suffering from this disease" was "dipped like a sheep". "The dipping mixture (for scab) was composed of water, soft soap, tobacco and arsenic - the last in the proportion of one ounce to the gallon of water." After becoming much worse "he lost his hair and his finger- and toe-nails," and then "his skin came off", but "eventually he got quite well". He says that "other blacks who had heard of the circumstance came to Canowie and begged to be dipped," but no one had the courage to repeat the experiment lest "a trial for murder or manslaughter" ensue.

That WOODS should question the accuracy of some of EYRE'S statements is interesting. I have been told that many of the early shepherds on Flinders Range sheep stations were there for the benefit of the more settled areas, and it is more than likely the native was as thoroughly immersed in the dip as were the sheep (scab is a condition occurring round the mouth of the animal). The general shedding of the epidermal structures was probably the result of direct action, but it is possible that some of the mixture was swallowed. Probably his recovery was hastened by the arsenic. One is inclined to regard this disease as yaws.

GASON (1879) writes, page 283, "Mirra. - A disease which every native has once in his life, sometimes at three years of life, but more frequently at fourteen, or thereabouts. The symptoms are large blind boils, under the arms, in the groins, on the breasts or thighs, varying in size from a

hen's egg to that of an emu's egg. It endures for months, and in some instances for years, before finally eradicated. During its presence the patient is generally so enfeebled as to be unable to procure food, and in fact is totally helpless. It is not contagious, and is, I surmise, peculiar to the natives, whose only remedy is the application of hot ashes to the parts affected."

GASON was a Police Trooper and it is difficult to reconcile the large size of the lesions, if they were swellings, with any disease of such wide-spread distribution, and apparent chronicity. He must have intended that it was not contracted by Europeans. It is also difficult to picture the condition of a native population among whom, at some time of life, every individual was incapacitated for months or years. If instead of "blind boils" one assumes granulomata, and tempers other parts of the description, it is possible that the disease was yaws.

TAPLIN (1886), speaking of the Murray Lakes area, says, "I have seen cases, even bad ones, of syphilis amongst the natives. I am sure the disease was imported among them; they knew nothing of it before the advent of the whites - this is the testimony of the natives. I have known fatal cases, also cases where the tibia was affected, and bony excrescences on the skin, with atrocious neuralgic pain. I have also seen buboes in the groin. Venereal disease is not very prevalent; I am persuaded that sometimes cases of impetigo have been mistaken for it."

This article was published after WOODS' (1879), and could not be regarded as an authentic statement that syphilis occurred among these natives.

MACKILLOP (1892-93), referring to the Daly River tribes, says cases of cancer were frequent and syphilitic diseases seem to have gained upon them - there was no word in their language for it so he believed syphilis was of recent origin.

Cancer is very rare among the aboriginals; it is quite possible that cases of gangosa or other tertiary yaws lesions were misdiagnosed cancer or syphilis.

SCHULZE (1890-91), speaking of the Finke River natives, says, "the worst disease among them is syphilis, with which everyone is more or less tainted. From the first we have had to treat this disease and several natives have died of it. It appears to be coming more common, due probably to general prostitution." (See BASEDOW (1932) below).

STIRLING (1896), page 127, says, "venereal diseases are extremely rife amongst the natives, undoubtedly largely owing

to infection by the whites. In a few instances I observed the characteristically disagreeable facial aspects due to destruction of the nasal septum and falling in of the bridge of the nose resulting from syphilis. In other cases there were the usual ulcerative affection of the soft palate or loss of voice from Laryngeal invasion." "It is still a moot point whether these diseases existed before the advent of Europeans. I can see no reason why the causes, whatever their precise nature, which first gave origin to them elsewhere may not have also operated here endemically." He refers to Plate XII, Fig. 13 - "a naturally unprepossessing countenance - the effects of this disease are probably apparent."

HARLEY (1933b), page 252, writes, "chronic laryngitis is ... a prominent symptom in hidden gangosa", and he includes ulcerated soft palate in the same category.

STIRLING'S statements are sufficiently loose to allow of a safer diagnosis of yaws.

PRINSEP (1899), in his annual report speaks of the "growing prevalence of venereal diseases amongst the aborigines in some places." He quotes the Police Report for Wyndham (W. A.), "Syphilis becoming very prevalent." From Hall's Creek (W. A.), 1898, natives were reported to be disabled by blindness, locomotor ataxia and syphilis.

ROTH (1901) writes, "by the term venereal as commonly employed, must be understood at least three distinct diseases, gonorrhoea, venereal sore and syphilis." "Syphilis may answer to ordinary drugs, mercurials and iodides, but unfortunately this disease takes on very often a malignant or galloping form, running a rapid destructive course. Phagedena appears to be a comparatively common complication of venereal disease." He noticed comparatively few cases of hereditary syphilis. "I have met with two cases in private practice where European children have been accidentally infected with syphilis." "Natives as a rule do not seek European advice until they have exhausted their own remedial measures, and the disease has already got a firm hold on them."

ROTH does not attempt to differentiate yaws from the "venereal" group nor does he take into consideration granuloma pudendi which might possibly account for the phagedena cases.

That mercurials are not wholly satisfactory is a frequent statement concerning yaws [GOODPASTURE & DeLEON (1923)], although United States naval workers at Gaum and Haiti state that mercury will cure yaws [BUTLER (1928)].

Of potassium iodide FITZGERALD et al. (1934) say that at one time it was used fairly extensively in the treatment of yaws, as in Castellani's mixture, but as far

as they could ascertain it was entirely inactive. ROTH may have confused mild gangosa with hereditary syphilis.

SMITH (1906), in discussing errors of diagnosis, is careful to differentiate certain conditions from leprosy. He speaks of several instances of mottling of the skin of the hands and feet which he says are "of a specific nature."

This is probably the result of yaws (vide infra).

He speaks of "specific disease of the mouth and nose in the blackfellow." "In one woman I saw that the cartilages of the nose were gone, and the skin was cicatrised in the neighbourhood, including the upper lip." This might safely be considered as gangosa. "I saw one man with an extensive wound in the sole of the foot and part of the toe was lost, two of his fingers also were contracted. There was indistinct history of specific disease." This also might have been due to yaws.

EYLMANN (1908), p. 438, writes, "Syphilis is spread all over the Colony. According to my observations there are only few among the natives whom it has spared. Quite frequently it appears in very serious forms. Thus, for example, one can meet more frequently than among ourselves, people who are extremely disfigured by the loss of their noses, or in whom it had led to the destruction of the hard palate and a connection between the mouth and nasal cavity. Affections of the bones are not rare. Cutaneous tumour does not often occur. However I do not wish to leave unmentioned that I met a native at Tennant Creek who suffered from freely suppurating syphilitic ulcers, and who asserted that he had become infected with the disease in an Eastern tribe, the majority of whose members suffered from it.

We may perhaps assume that syphilis would, in most cases, run as serious a course among the natives as it does among the Germans. This however is not the case because it has not been in the country for long. At any rate the number of serious cases would be much smaller, were medical treatment so readily procurable and were it as frequently taken recourse to as among ourselves. We must likewise not forget that the native who lives in a chronic state of hunger in all probability has less power of resistance against disease than the well fed white man.

I need not stress that the number of children who suffer from hereditary syphilis is not small. As among ourselves, syphilitic women after a few years often give birth to quite healthy children. Thus, for example, I treated at Barrow Creek Station a lubra, twenty to thirty years of age, whose palate and throat were covered with syphilitic ulcers which had already destroyed the uvula and pierced the hard palate. Her two small daughters (the father of the youngest one was an Englishman) however were among the strongest and most healthy native children I saw.

I should not like to leave unmentioned that bushmen who had contracted syphilis from lubras seldom developed severe lesions in spite of the fact that they received no medical treatment. This contradicts the supposition that the disease usually appears in more serious forms when Europeans become infected from people belonging to an alien race. Whether the climate and the mode of living have a good influence on the course of the disease I am uncertain. Usually the bushmen of the inland do not often become infected, which may be explained by the fact that as

a rule they only find opportunity for sexual intercourse with the older lubras, the greater majority of whom have contracted syphilis years before and are no longer infectious.

Where and when syphilis for the first time appeared in Australia no one, of course, can tell us. However, we seem to be compelled to assume that it was imported by Malays and Papuans a long time ago. The greatest number of syphilitic cases were at Hermannsburg Mission, in the environment of townships and on the gold-fields. Here, where almost all lubras are prostitutes, syphilis naturally occurs more often than among the tribes who still severely punish an unpermitted breach of marriage (if I may say so). The number of syphilitic persons would however be somewhat smaller near the settlements if the boys and lubras in the service of Europeans did not have many sick relations or friends." (Translation).

The wide-spread distribution, and the occurrence of facial destruction is more suspicious of yaws than of syphilis. This also applies to the native whom he saw at Tennant Creek and most probably to the lubra at Barrow Creek.

Speaking of the absence of severe infection among the "bushmen" (i.e. Europeans) his explanation gives one the impression that infection was extremely uncommon. That the Europeans have intercourse chiefly with the older lubras is quite contrary to what one sees and hears in the interior.

That the Malays and Papuans imported syphilis into Australia is not probable as among both these peoples yaws is prevalent. There is no proof either that syphilis occurred prior to European contact - or that syphilis is or was at any time prevalent among the aborigines.

Syphilis does not exist at Hermannsburg (1934) - this is more than 30 years later. Pathological conditions occur there which probably Eylmann would have considered syphilitic, but which, from their rapid response to N.A.B., has led to the diagnosis of yaws.

HERBERT (1910) says, of 100 aboriginal females examined by the Government Medical Officer only one was free from traces of venereal trouble.

This probably refers to gonorrhoea, as will be emphasised later.



BREINL (1912) gives a table (4) of statistics of the Darwin Hospital from 1897-1910, which deals mainly with non-aboriginal patients. Of 1284 cases only 24 cases of syphilis were treated, and in 8 years of this period there were no cases of syphilis. Gonorrhoea was not included and only one case of yaws is mentioned.

In Table 3, of 2335 certified deaths of non-aboriginal population from 1871-1910, 11 were due to syphilis, 1 to gonorrhoea and 3 to granuloma.

If syphilis was present to any extent among the natives one would expect to find more evidence of it in these statistics.

He refers to the case illustrated in his Fig. 19 as the result of syphilis which is probably due to yaws - being a minimal case of gangosa. He reports yaws as being prevalent among the native children in some localities.

BREINL & HOLMES (1915) report that yaws is "fairly prevalent amongst the children" of the Daly River tribes so that it "may be safely assumed that practically every child suffers from the disease in a mild form at one time or another during its youth." "In later life, as a rule, only a few scarcely perceptible scars, sometimes round the mouth, or in the genital region, bear testimony to the previous illness." They saw several cases suspicious of tertiary yaws. They refer to a case similar to one seen in New Guinea, "which has been described as a 'peculiar disease characterised by arthritis, osteitis and periostitis'," in which the "upper part of the right tibia was considerably swollen and curved forwards, with fistulous openings discharging a light amber-coloured clear fluid." The left tibia and both ulnae were affected. "The genitals appeared normal, and no history of previous attack of yaws or syphilis could be obtained."

They say several authors consider this as a tertiary manifestation of yaws but they consider it a "disease sui generis."

The evidence of BAHR (1914), SPITTEL (1923) and KNOTT (1931) would indicate these were cases of yaws. I saw a similar case on the south side of the Mann Range in 1933 (vide supra). In other cases I have known great improvement in similar but less numerous lesions to follow the exhibition of modern arsenicals.

"One case of advanced syphilis was seen" (Anson Bay), a boy aged about 19 years in a comatose condition. His disease was supposed to have begun from the time he was employed by white men. "He showed the typical lesions of tertiary syphilis. His outer nose had disappeared, his soft palate was perforated as the result of a large gumma and pus was exuding from his mouth."

It is highly probable that this was a case of tertiary yaws with gangosa, especially as it occurred in an area where they record "yaws is fairly prevalent amongst the children", (as previously quoted).

Before referring to the more recent papers of CLELAND (1928) and BASEDOW (1932) it might be emphasised that one is not interested in the occurrence of syphilis among the relics of native tribes existing as islands in the sea of European settlement at the present time.

CLELAND, p.141, after referring to the early records which have been dealt with above, reports statements received from medical men in various localities.

"Atkinson (Perth, W. A.) states that syphilis and gonorrhoea are particularly prevalent where Asiatics mix with aboriginals, as in pearling areas."

Junk (Wondai, Q.) says syphilis was at one time very prevalent at the settlement. The lesions were mostly extensive and chiefly involved the genital region in both sexes. They yielded readily to mercurial treatment, but most cases died from other contributing factors before the tertiary stage was reached.

Leighton Jones (Darwin, N. A.) says he has met with congenital lesions such as keratitis in several cases. He has seen perforating ulcers of the palate similar to those in Europeans.

Leahy (Innisfail, N. Q.) considers that syphilis among natives is similar to that in Europeans, but more chronic.

Illingworth (Taroom, Q.) says 20% of natives of the settlement were probably affected with venereal disease and that syphilis spread very rapidly. The chancre was of the same type as in Europeans. He had only seen one case of a secondary syphilitic rash and that resembled scabies. He considered the disease less grave than in Europeans. He had never seen any case of syphilis of the nervous system. He mentioned one case of gumma of a cervical gland, two of severe heart disease, none of aneurysm, one case of rupture of aorta from syphilitic atheroma and six cases of gummatous vulvitis of which two had been cured. Congenital syphilis was commonly causing the deaths of a "fair number of children up to the age of six or seven years." "These cases showed a trophic rhinitis with sunken bridge of the nose, mental backwardness and stunted growth, and were rather puny."

Vernon (Thursday Island) states syphilis is undoubtedly common.

Basedow's cases will be dealt with under his own paper.

Cilento (Townsville) considers syphilis uncommon and has never seen a primary chancre, he states that it has been suggested that this is due to the presence of yaws among the natives.

In the section of CLELAND'S paper dealing with insanity (p.262) there are six cases of general paralysis of the insane and two doubtful ones of a total of 110 cases.

Cases of general paralysis would be more numerous both relatively and absolutely if syphilis were common

among the natives and ran a course similar to that in Europeans.

Some of the above reports are probably syphilis, but others are open to grave suspicion.

BASEDOW (1932), p. 194, deals firstly with the early literature then adds his own experiences.

"I have found syphilis most common among those tribal groups which are resident along the beaten tracks of European and Afghan travellers" (the latter are camel teamsters). According to the natives "neither syphilis nor gonorrhoea was known prior to the occupation of their country by Europeans. There still exist a few communities such as the Western Aluridja and Wongapitcha, inhabiting the Mann, Tomlinson and Petermann Ranges in the Lake Amadeus region, who so far have not come into much contact with civilisation; and these, when last I visited them in 1928, were happily free from venereal diseases."

(I saw cases of "boomerang leg", yaws and granuloma pudendi, in the Mann and Musgrave Ranges in 1933).

Speaking of the Lutheran Mission Station at Hermannsburg, he says in 1920 when he visited it "venereal troubles were practically unknown locally; only two or three cases of tertiary syphilis were registered." He speaks of the natives camping at Alice Springs as "positively reeking with disease at the time", leaving one to infer that the disease was syphilis, but this year I saw no evidence of syphilis among them, though the same cannot be said for gonorrhoea. There is no syphilis at Hermannsburg.

BASEDOW continues, "Great contrasts are observed in any such districts as have been victimised by the vices of civilisation for any appreciable time. Hereditary syphilis then manifests itself in many forms in the children, most conspicuously perhaps in the form of the almost ubiquitous "snuffles", and objectionable nasal catarrh with a sero-purulent discharge."

Mucopurulent nasal discharge is common in native children and adults in Central areas and in the Mann Ranges (observed in 1933). It was so markedly influenced by the climatic conditions and in every way resembled a "cold in the nose". It is of interest to note that despite its frequency among the natives with whom we were in close contact, neither Mr. Tindale nor myself contracted any respiratory infection. This may be due to the lower virulence of the local causal organisms. We both contracted "colds" when, after two months' isolation, a party arrived from Adelaide.

HUNT & JOHNSON (1923) record, "It is interesting to note the number of children having an excessive secretion from the nose ("snuffles") during the secondary stage of yaws." They are speaking of Samoans among whom, they say, syphilis does not exist.

Later BASEDOW (1932) says, "Such a hold, indeed, has the disease in certain tribal localities that it would be a difficult task for anybody to attempt to draw a hard and fast line of discrimination between the congenital and acquired form. Syphilis in the acquired form presents certain peculiarities in the aboriginal. Its primary and secondary manifestations are, generally speaking, less conspicuous than in the European". "The affections of the third period are, however, both typical and severe, but it might be mentioned that in spite of the disease being so rampant, none of the so-called para- or meta-syphilitic conditions have come under my personal observation." "By far the most common manifestations of the disease in its tertiary stage are gummatous ulcers on the lower extremities, gummatous periostitis on the tibiae, and the destructive processes in the nasal organ which eventually give rise to the characteristic "saddle nose". He refers to two figures which could be quite reasonably considered cases of yaws. "The frequency of corneal opacities is no doubt in large measure a sequel to an interstitial keratitis of syphilitic origin."

Leucomata, except of obviously traumatic origin, were non-existent in the tribes of the Mann and Musgrave Ranges in 1933. Those opacities which are so commonly seen in the corneae of natives in more settled areas of the Centre and far North, and occasionally associated with staphyloma or rupture, are undoubtedly gonorrhoeal in origin. I saw over a hundred cases of gonococcal ophthalmia (confirmed by microscopical examination) in 1934 at Alice Springs and at Victoria River Depot.

"A well-marked icterus is often recognised by the yellow coloration of the conjunctiva." [BASEDOW (1932)].

I saw no indication of this in the eyes of over 300 natives and Professor J. B. Cleland and Dr. J. H. Gray (personal communications) say they have never observed this at the various localities they have worked in Central Australia.

"The tongues of adult sufferers are not infrequently covered with pinkish, warty papules; this being particularly noticed in persons whose teeth are decayed."

This condition was seen in a child and a youth in the Musgrave Ranges (1933), both of whom appeared quite healthy.

"Condylomata generally appear about the anus, especially in children; in the case of children small ulcerations and fissures also occur around the mouth."

These are probably metastatic (secondary) skin lesions of yaws.

"The periostitis and osteitis following the gummatous lesions on the tibiae often produce a thickening and curving of the bone, known as the "sabre-blade" deformity, which is at times wrongly referred to locally as the "boomerang leg"."

This is a very subtle differentiation which unfortunately he does not complete.

On discussing the problem of the existence of syphilis in the Northern Territory with Dr. C. E. Cook, the Chief Medical Officer and Chief Protector of Aborigines, he was quite definite that in eight years' experience in Northern Australia he had seen no evidence of syphilis among the natives. Only five or six cases of primary chancre had occurred in Europeans, and most of these had arrived from outside the Territory during the previous few weeks.

From the Chief Medical Officer's Reports of Health, 1929-33 [COOK (1929-33)] the following table can be drawn up from data of the Kahlin Beach Aboriginal Hospital:-

	<u>1929</u>	<u>1930</u>	<u>1931</u>	<u>1932</u>	<u>1933</u>
Gonorrhoea	93	59	38	66	33
Granuloma	37	16	29	34	23
Yaws	22	12	6	11	5
Syphilis	Not-men- tioned.	Not men- tioned.	Not men- tioned.	Not men- tioned.	Not men- tioned.
Total cases -	369	289	213	207	155

Dr. Cook's opinion is supported by that of the other officers in the Northern Australian Medical Service.

Many cases of gonorrhoea in Europeans, contracted from native women, occur each year; if syphilis existed to any great extent among the aborigines, primary chancres and later lesions would have been seen among Europeans.

Professor J. B. Cleland assures me that (taking into consideration the existence of yaws among the natives of Central Australia) he has seen no condition among them which he would consider as definitely syphilitic in origin.

The case reported by CLELAND (1934) as possibly syphilitic is more likely to be one of yaws.

In concluding this section one may quote KOCH (1900) who, in his report to the German Government, says, "in the Bismark Archipelago I have seen places in which almost all the children were affected with yaws", "even the children of Europeans occasionally suffer from it. Very often framboesia is mistaken by laymen, and even by medical practitioners, for syphilis, and I feel warranted in assuming that the statements as to the great diffusion of syphilis in the South Sea, and particularly in the German colonial region are based on the confusion of syphilis with framboesia."

I am in complete agreement with this statement if it be applied to the Northern Territory of Australia.

There is no proof that syphilis occurred in Australia prior to European contact, or that syphilis is, or was at any time, prevalent among the aborigines.

## 2. References to Yaws.

On coming to the direct references to yaws there is less difficulty. From the reports of BREINL (1912), HOLMES (1912), and BREINL & HOLMES (1915) one learns that yaws was prevalent in the coastal country of the Northern Territory. At the present time the presence of yaws among the natives in this area is well recognised and its treatment is one of the duties of Police Officers.

BASEDOW (1932) writes, "Yaws is widely distributed over Northern and Central (i.e. tropical and sub-tropical regions of Australia) Australia. I regret to record that during the years of personal observation, I have been able to record a perceptible increase in the number of cases met with in the camps. I found the disease particularly rampant in the Northern Kimberleys of Western Australia and in the western rivers district of the Northern Territory. In Central Australia it is less common and sporadic in its appearance. It was surprising to me to find a case in the extremely arid country immediately south of Lake Amadeus. Yaws particularly affects aboriginal children of tender years." Speaking of the secondary lesions, he says, "the face, neck, chest, legs and anal cleft are particularly favoured by the disease."

"The patients, especially the children, are very uneasy, complain of the irrepressible itch and pains in their bones when attempting to sleep at night." He writes of chronic ulcers, "where the limbs have been affected, the scar which is formed after the sores have healed becomes very tense and glossy." He disagrees with BREINL & HOLMES (1915) when they say that the disease is of little practical importance among the natives, although they recognise its prevalence.

He reports having seen cases of gangosa in the northern tropical belts and also over a considerable part of the arid Central area. He speaks of the popular misdiagnosis of cancer for gangosa and "cannot recall a single case of face cancer from any tribal district." He describes and illustrates the case of a boy aged 15 years from Port George IV with active gangosa and says "other manifestations of disease were several prominent gummatous ulcers upon the anterior crest of each tibia which were characteristic of those seen in cases of yaws." (Compare BASEDOW'S description of tertiary syphilis above.)

Mr. N. B. Tindale (personal communication) says that he saw natives with fissured and sore feet at Groote Eylandt and Roper River (N.T.).

CLELAND (1933), writing of natives seen at Mt. Liebig, says, "the skin and subcutaneous tissues of a number of individuals were thickened and coarse, and tended to crack, giving a kind of crocodile-skin appearance. Probably the extremes of temperature (the days being often in early spring 32.2° C. or 90° F. or more, and the nights perhaps being below freezing point) account for this."

These cases resemble those that I observed in the Musgrave Ranges (vide infra). It is probable that these lesions resulted from yaws.

It may not be out of place here to call attention to a paper by HALE & TINDALE (1934) in which they write, "many of the Kokolamalama people talk rather indistinctly, with markedly aberrant aspirated 'd' and 'w', strongly voiced 'th' and 's' and 'f' sounds which are absent in their neighbour's speech. It was noticeable that several individuals of this tribe suffered from palatal abnormalities, and the above-mentioned modification may be due to this factor, the manner of speech of the abnormal individuals having become the norm for the others of the group." They say (personal communication) that yaws was seen at Princess Charlotte Bay (N. Queensland) where this tribe lives, and also that some natives had facial disfigurement which they would now recognise as gangosa.

### 3. References to "Irkintja".

In 1934, at Alice Springs I found that the natives (Aranda tribe) attributed the scars which were associated with "Boomerang legs" to a previous attack of "irkintja", and by further enquiry satisfied myself that this was a specific term and not used for sores in general.

BASEDOW (1932) refers briefly to the description of the tradition of irkintja given by SPENCER & GILLEN (1899), which is as follows:-

In the Alcheringa (mythological, distant times) one of the wandering parties of the Achilpa, or wild cat men, coming from the south, were under the guidance of a famous old man renowned for the size of his penis. He was always gorgeously decorated with down, especially about his penis. This party camped near the Ooraminna rockhole and performed certain initiation rites. They discovered a group of wild cat men suffering from the disease called Erkontja, who smelt most offensively. The southern Achilpa men had intended to settle there, but the presence of these men frightened them and they hurried northwards. Shortly after the wild cat men had gone a party of men belonging to the Arwarlinga (a species of Hakea) totem, who dwelt close by in the sandhills, came in, and went to the top of the Ooraminna rockhole and made a drink by steeping Hakea flowers in water. Then, opening veins in their arms, they allowed the blood to flow into the vessels containing the drink and mix with it, until the vessels overflowed to such an extent that the Ooraminna Creek became flooded and all the Erkontja men were drowned. A stone arose at the spot. Since the days of the Alcheringa this stone has been known as the Alperta atnumbira (the stone of the diseased growth issuing from the anus). Ever since that time the Erkontja has been prevalent amongst the natives. It is believed that old men visiting the stone can, by means of rubbing it and muttering a request to the contained evil influence to go out, cause the disease to be communicated to any individual or even group of men whom they desire to injure.

In a footnote, p.444, they write, "The disease is common amongst the young people only attacking each individual once. It affects only the glands of the part of the body in the neighborhood of the sore. At first sight it has much the appearance of being syphilitic in nature, but Dr. Eylmann, who had studied it, is of the opinion that it is distinct from syphilis. It usually appears in the anal region, under the arms or legs, or close to the mouth."

Mr. T. G. H. Strehlow, who has recently been working among the Aranda tribe, confirms the above tradition and I obtained confirmation of that part dealing with the spread of the disease.

From the footnote it appears the disease is not syphilis and all the evidence is overwhelmingly in favour of it being yaws.

EYLMANN (1908), on p. 441 writes, "One kind of ulcer is the most interesting of all cutaneous diseases among the natives. The Arunta call it "irrakintja" or simply "mamma" (wound). The bushmen of the interior use the first name for it. The natives say that they could contract it only once, usually during childhood. At times the cases in one place increase in a conspicuous manner. Thus, at Daly River Mission three out of four children between the ages of 1½ to 3 years suffered from these ulcers. Usually the



parts of the skin affected are those exposed to the macerating effect of sweat or other fluids; in the majority of cases, therefore, the perineum together with the genitalia and parts round the anus have become diseased. Other regions frequently affected are the axillae and the lips. Often the disease is confined to one place; it rarely occurs in more than three or four separate regions; originating on the outer skin of the genitalia, at times it spreads to the mucous membrane of the penis or the labia pudendi. In the early stages a few various-sized ulcers on an area of skin which can be covered with one's hand are often found. Later they coalesce to form a single ulcer, which in the course of years may become 15-20 cm. in diameter. I have unfortunately not been able to discover how the infection commences. The smallest ulcers I saw were approximately the size of a lentil. The base of the ulcer is bluish red and from some there is a scanty, purulent secretion, from others, however, there is considerable discharge. In the course of time conspicuous, extremely red granulations frequently develop. In an elderly Waramunga who had come to see me on account of a disease of the bladder the granulations had completely filled the artificial fissure of the penis. The largest lesions of this kind which I saw were 1 cm. in height and 10-12 cm. in circumference. The margin of the ulcer is slightly raised and in most places is well defined. At first it is circular but later it becomes scalloped. The ulcer feels hard and the base does not lie deeper than its surroundings, which are slightly or not at all altered. The neighboring lymphatic glands, however, are swollen. If the ulcers are small and not numerous, they have, in adults, an insignificant influence on the general health. Pain is present but it does not appear to be very severe. If the ulcer surrounds the anus, the pain often becomes very acute at defecation. Cure takes months or years, and in some cases is never effected. At Kilalpanina Mission I saw an elderly man who had an extraordinarily large ulcer of this kind round the anus. As Missionary O. Siebert told me. it shortly after led to the man's death. The cicatrices lie on a level with the skin and show no tendency to retraction. In exceptional cases they are so insignificant that they escape the eye, but a deeply pigmented stain remains.

"With which kind of ulcer do we have to class "irrakintja"? In the interior a kind of ulcer called "barcoo rot" is found occasionally among the whites which is said to become rapidly larger, and is not very distinct from simple cutaneous ulcers. We find in many hot parts of the earth similar ulcers which have probably been caused by infection of quite insignificant skin injuries; under the influence of the climate and of manifold irritations they assume an obstinate nature. A marked inflammatory infiltration which occasionally persists till the death of the person concerned, accompanies many skin diseases of this kind, as for example the "ulcer of Aden" and the "Malabar ulcer". They do not spare those who have suffered from them previously. The two cases of "barcoo rot" which I saw (they were pointed out to me as such by bushmen), also had caused a swelling of the affected part of the body; however, I believe that they were not at all typical. I am unable to say if this skin disease of the whites is identical with that of the natives. "Irrakintja" differs perceptively in some points from the ordinary cutaneous ulcer. The main difference consists in that one can be taken with the latter more than once. "Irrakintja"

also unmistakably resembles lupous ulcers, but it only spreads on the surface and does not penetrate into the deeper tissues. It resembles an ulcerous syphilide when its base lies deeper than usually and has a definitely purulent investing layer. The "tumours of Aleppo", "of Biscara", and "of Delhi" which endemically occur in Syria, North Africa and India seem to be closely related to it. Natives contract these "tumours" (boils) only once, usually during the first years of life. Foreigners likewise have a great predisposition to them. "Irrakintja" however usually spares white people, provided that it is not identical with "barcoo rot". Two Irishmen of my acquaintance maintain that they have suffered from it. It is, however, not unlikely that they had eczema. As domestic animals are also taken with the "tumours" I shall not leave unmentioned that I saw a dog at a Diari camp on whose genitalia was an ulcer the size of a crown, which could in no way be distinguished from an "irrakintja" ulcer.

"As the reader can see I have not succeeded in identifying "irrakintja" with any known disease. I have to leave undecided whether it is an hitherto unknown cutaneous disease. Naturally one could consider it a simple eczema which has acquired unusual characteristics owing to climatic influence and so on. According to my own convictions the statements of the keenly observant native that anyone who had got over "irrakintja" does not have it a second time, deserves fully to be taken into account.

"In the northern coastal districts, which have good rainfalls, a skin-disease frequently occurs associated with itching, and often covering great portion of the body. The formation of scales may be so extensive that the affected portions of the skin appear a dirty grey colour. In old people the wrinkles of the skin become strongly marked, and slight fissures may develop so that the disease resembles ichthyosis. Occasionally I have also observed in the North a papular exanthema which causes irritation and moderate desquamation. I think it is infectious. In Rum-Jungle an old Wulwanga native who suffered from it, often visited me. While we sat talking he used to place one of his hands on one of mine. A few weeks after his first visit I noticed on the back of my left hand some irritating scaly papules which with a vitriol ointment, however, disappeared in a few days. I think it is probable that here we have not two different diseases, but two stages of the same disease."

The occurrence of irkintja (irrakintja) only once in each individual, and then in childhood, the distribution of the lesions and Eylmann's identification of this condition (the name is only used by the Aranda tribe) with a similar one at the Daly River Mission (in the coastal belt) where yaws is common [BREINL & HOLMES (1915)] gives the impression almost amounting to conviction that irkintja is yaws. His description of the character of the scars also supports this conclusion. Later, in his description, he becomes confused with granuloma pudendi and dermal lieshmaniasis.

Barcoo rot occurs in Europeans only, and the opinion at present is that it is probably dietic in origin.

Professor J. B. Cleland tells me that at one time it was thought that dogs suffered from granuloma pudendi.

The skin disease which he saw in the coastal areas is still common and is an epidermophyton infection (Tinea).

The "ulcer of Aden" and "the Malabar ulcer" are conditions more commonly known as Ulcus Tropicum, the etiology of which is not definitely known - but it is in no way associated with yaws. That EYLMANN makes no mention of syphilis bears out the note by SPENCER & GILLEN (1899) that he differentiated irkintja from it.

BASEDOW (1932), in his introduction, writes, "the dreaded yaws .... throughout those parts of the great interior where the Arunnda tongue prevails is known as larrekincha or errekincha." In the sections on yaws he writes, "the lesions (of yaws) in obstinate cases become deep ulcers which eat their way deeply into the subjacent and surrounding tissues and discharge a putrid serum. The natives do not discriminate between this and that of typical gangosa." He deals with gangosa under a separate heading and writes, "gangosa is well known too, and dreaded by the Arunndtka, and other tribes of the interior, who have given it the name errkincha (often wrongly pronounced larrekincha), the derivation of the word being from the Arunnda erreka, meaning 'to itch'." He makes no definite reference to the yaws etiology of gangosa. He brings forward no evidence to demonstrate the identity of irkintja and yaws.

In the pages which follow, the spelling "irkintja" is used on the advice of Mr. T. G. H. Strehlow, who has studied the Aranda language. This is an agreement with the system of phonetics he uses. It is pronounced "air-kintcha", where the "r" is trilled.

#### 4. Summary.

In this section it is indicated:-

- (1) That many of the early reports of syphilis among the natives should be considered as yaws.
- (2) That many of the descriptions of tertiary syphilis among the natives are probably misdiagnoses of yaws.

(3) That "Irkintja" of the Aranda is probably yaws.

(4) That the existence among one tribe of a name for the disease and of a tradition dealing with it, is strong evidence of the presence of yaws among them before contact with Europeans.

SECTION V.

DEFINITION OF TERMS.

1. "Boomerang leg".
2. "Scars".
3. "Pains".

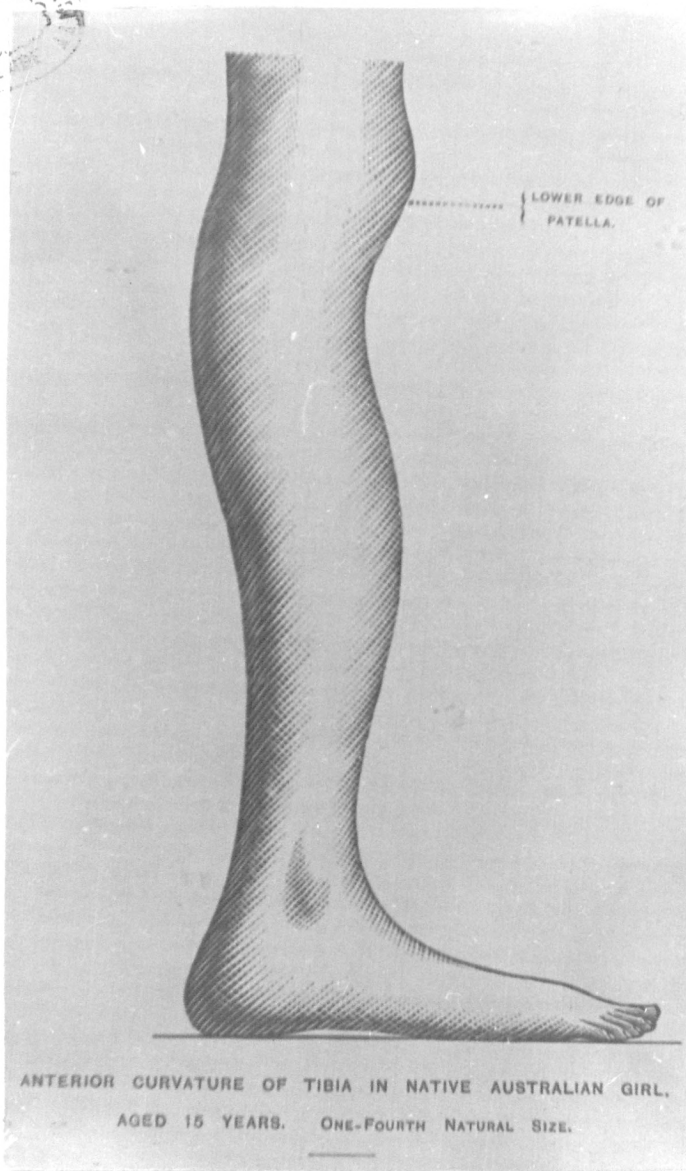


Fig. 10.  
(Intercolonial Quarterly  
Journal of Medicine and  
Surgery. Vol.I, 1894)

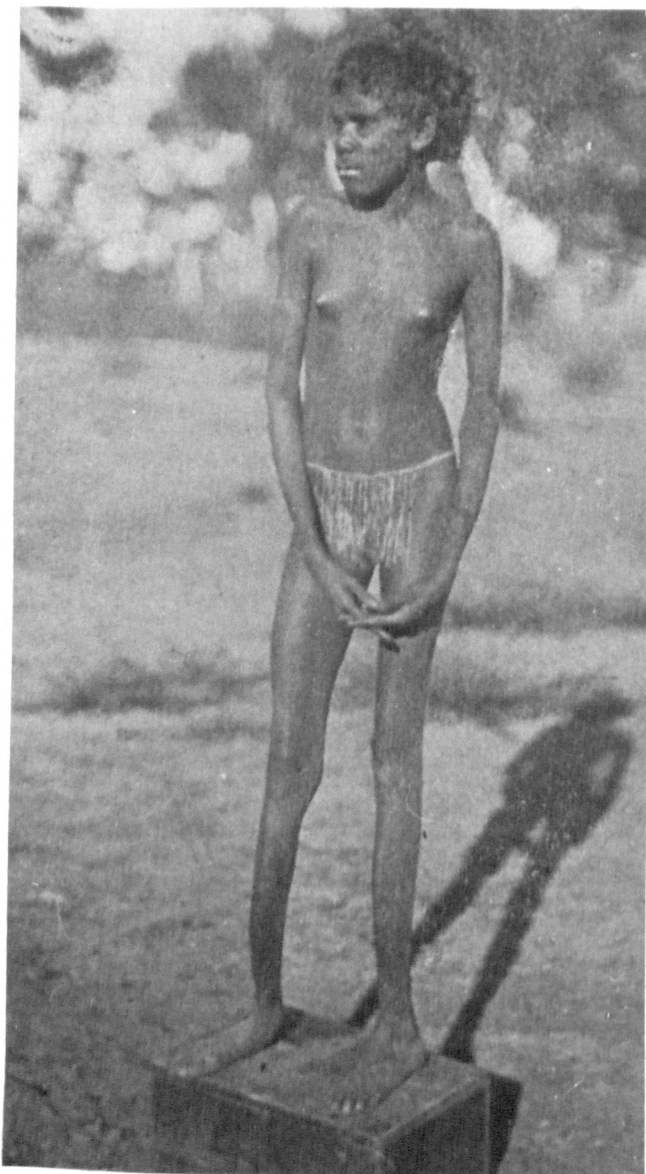


Fig. 11.  
(Report of Horn Scientific  
Expedition, Pt.IV. 1896)



Fig. 12.  
Slight Boomerang legs  
(B.L. + )



Fig. 13.  
Medium Boomerang legs  
(B.L. ++ )

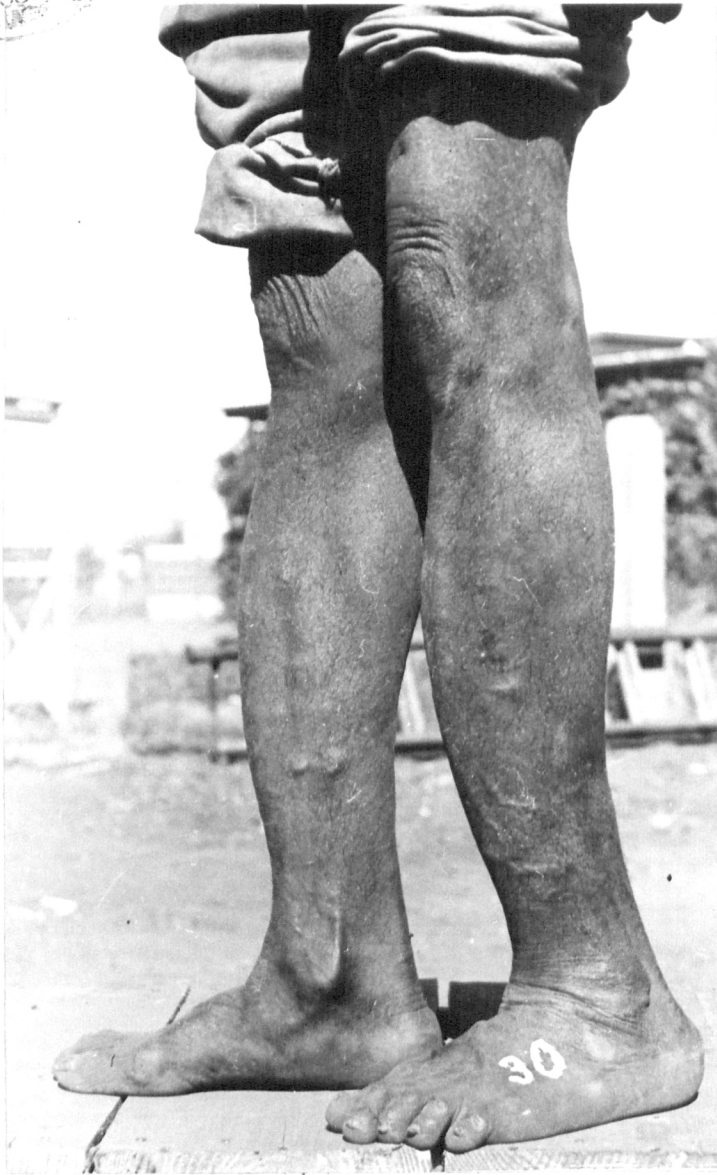


Fig. 14.  
Marked Boomerang legs  
(B.L.+++)



SECTION V.DEFINITION OF TERMS.

STIRLING (1894 and 1896), describing the case of a young native girl whom he saw at Crown Point, says the "tibiae presented a conspicuous and symmetrical anterior curvature. This was associated with a marked platycnemism, a condition in which the tibiae are much flattened as if by lateral compression." He observed this in both sexes, young and adult. "The anterior curvature for which I propose the name camptocnemia, so far as I could see, was not usually associated with any pathological condition visible in the living subject, on the contrary the natives thus affected, with the one exception mentioned", (malnutrition) "were neither more nor less healthy and well nourished than those in which the peculiarity was not observable." (Figs. 10 and 11).

Many degrees of "Boomerang Leg" were seen, ranging from a slight forward bending of the anterior edge of the tibiae, identified most readily with the aid of a straight edge pressed against the bone to remove the occasional apparent forward curve due to the belly of the tibialis anticus muscle, to the marked deformity which has given the condition its name in Australia (Figs. 12, 13 and 14).

A clinical sign of value in recognising slight deformity was a deepening of the leg antero-posteriorly above the malleoli and a flattening of the hollows each side of the tendo Achillis, brought about by the springing of that structure across the bowed tibia. These signs were more manifest in the marked cases, where also the apparent absence of the calf was seen. The situation of maximum deformity was either about or a little above the centre of the tibia. In the slighter cases the anterior edge of the tibia was still fairly sharp, but this was rounded in the more marked cases. Occasionally the curve was interrupted by bosses of localised periosteal thickening. In some cases the tibia did not appear to be very much thickened antero-posteriorly, whilst in others, even with only moderate forward deformity, the bone was greatly



Fig. 15.

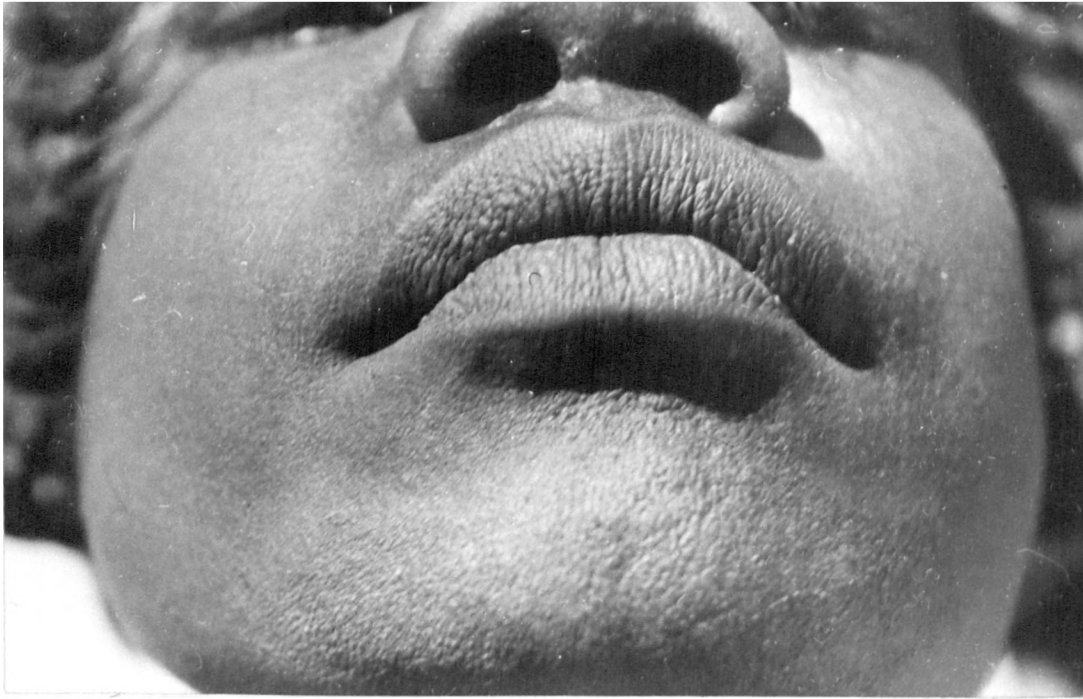


Fig. 16.

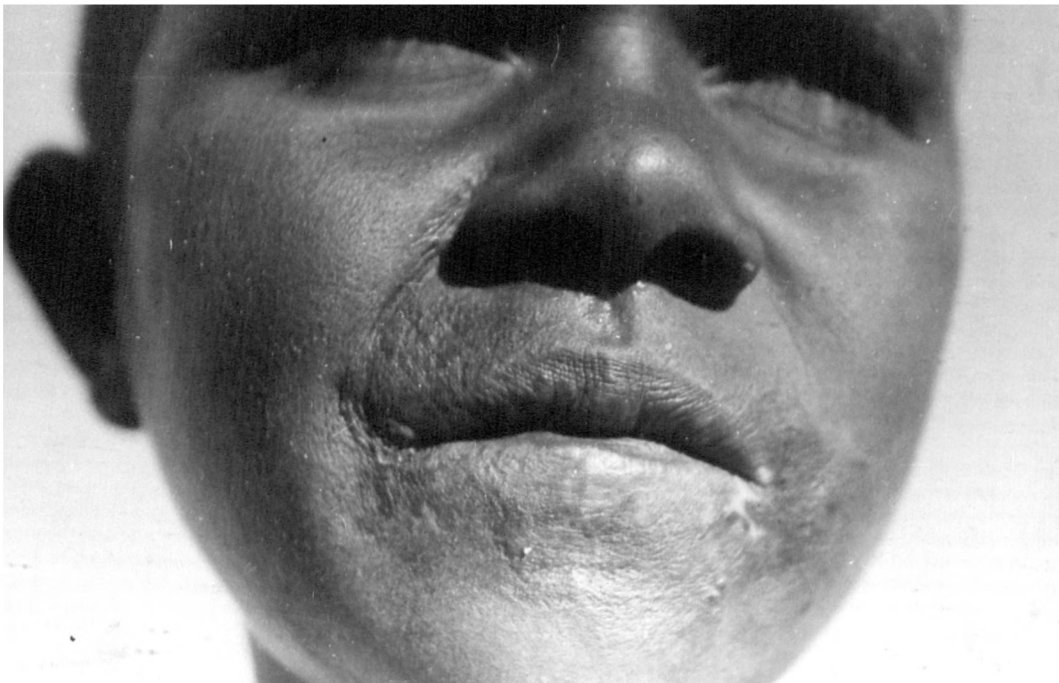


Fig. 17.

increased in this diameter. It is most probable that the full deformity that is going to develop in any given case occurs within a comparatively short time - perhaps a year - of the onset of the pains in the bones. In many cases, especially in young adults, a lengthening of the lower leg was noticed. This may be due to actual increase of the length of the bone brought about by the irritation and the hyperaemia of inflammation during the growing period. No disability was caused except in the most advanced cases, and then only as age advanced and weakened muscles failed to compensate the forward displacement of the centre of gravity.

It was noticed that the marked deformity appeared to predispose the skin on the front of the leg to abrasion. In the pages that follow the term "Boomerang legs" will be used only with the deformity which occurs in Australian aborigines.

## 2. " S c a r s "

The "Scars", which will be frequently mentioned during this paper, varied in degree of cicatricial damage, ranging from indistinct ones to keloid formation. Those most frequently seen were circular or oval with regular edges. The pigmentation of the scar surface was unaltered but its changed texture made it appear to be lighter in bright light and darker when in shadow. The scar surface was less elastic than normal skin so that the minute skin creases were replaced by coarser ones.

On the face the scar surface is slightly lower than the normal skin surface. Fig. 15 shows three variations of skin destruction in the scar on the right cheek, which extends to the angle of the mouth, the upper and lower lips and chin. In the upper part is seen the results of slight skin destruction, while below this a deeper



Fig. 18.

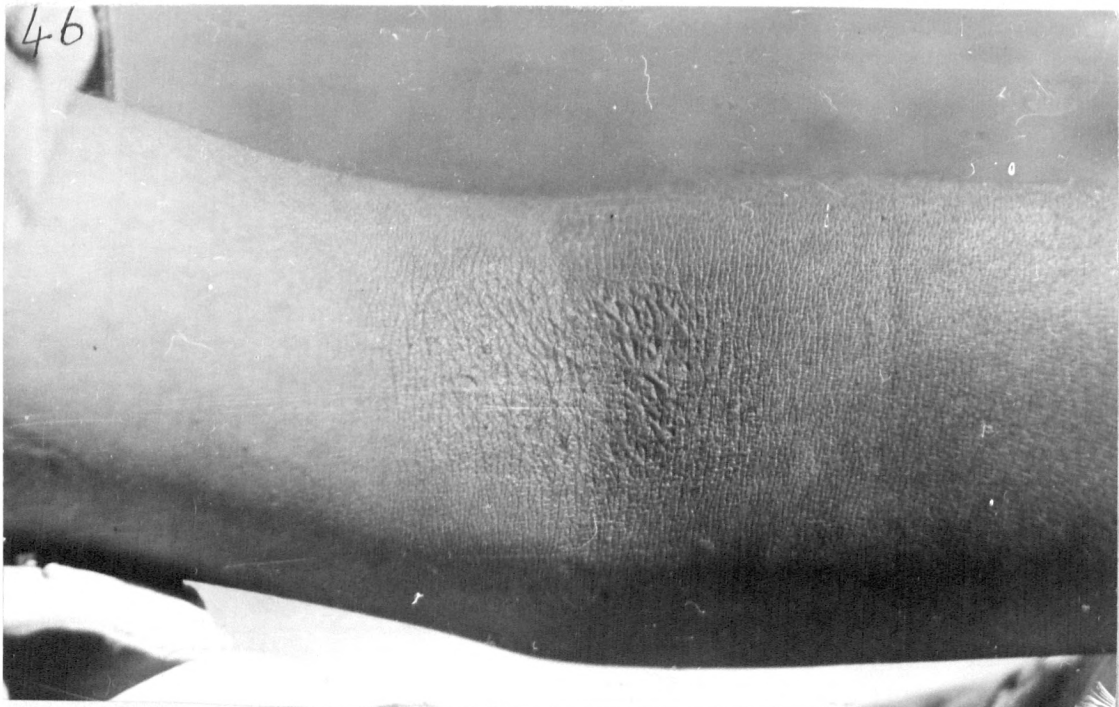


Fig. 19.

destruction had occurred resulting in a smoother and less elastic scar. The loss of elasticity is shown towards the ramus where coarser skin creases appear. In the more anterior part of the scar still deeper destruction had occurred and had resulted in low keloid formation. The scar had encroached on the red margin of the lip, but was found not to extend inside the mouth. On the neck were seen the creases due to further scarring. As this case (23) was only 8 years of age, and they were not present on the left side of the neck, the creases cannot be regarded as normal. This case was a Pitjanjara girl from the far west who had medium boomerang legs.

In Fig. 16, of a young woman with slight boomerang legs, seen at Wave Hill, the more granular type of scar only is present, and in Fig. 17 the smoother type of scar is present. In the latter case (46), a half-caste boy with slight boomerang legs seen at Alice Springs, there is some disorder of pigmentation.

On the face where the subcutaneous tissue is firmer, the loss of elasticity can also be detected by drawing the finger over normal skin on to the scar, when a change from the silky smoothness of the former to the dryer, more resistant surface of the latter is felt. The more granular scar surfaces are perhaps due to changes round the hair follicles or openings of the sebaceous gland ducts.

In no case had a scar of the lip spread into the mouth.

In scars in the joint flexures larger creases occurred because of the looser subcutaneous tissue. This is shown in Fig. 18, of the antecubital fossa of an undernourished young woman suffering from a malignant tertian malaria seen at Wave Hill. Fig. 19, from a well-nourished young half-caste (46), is of another form of scars in these

areas of the body. In both types, by stretching the skin a smooth, shiny scar surface is produced.

In old natives with inelastic skins these scars could not usually be identified with certainty. In some cases there was more keloid formation.

Scars were most frequently seen round the mouth and about the moist crease areas of infancy.

Difficulty was encountered in obtaining details of these scars because of two main causes; firstly, that the lesions from which the scars result occur most commonly in infancy, hence the adult knows only what he or she has been told - be it "fire bin burn 'em", or "snake bin bite 'em"; secondly, in the northern parts of the Territory the natives are very timid of doctors, fearing removal from their locality for treatment or for isolation because of leprosy. This often brought the denial that obvious scars existed, or that the individual had at any time been sick. In few cases was a history of sores in childhood obtained unless the subject was challenged with the presence of the resultant scar. Histories from inmates of the half-caste institutions were practically valueless.

### 3. " P a i n s " .

Soon after work was commenced at Alice Springs, confirmation was obtained of the statement by BREINL & PRIESTLEY (1915) that before the appearance of Boomerang legs, pains occur in the shins. This was a difficult point in history to get from natives of whom not all could speak pidgin - with which at the time I was unfamiliar. For all the subjects in Alice Springs one interpreter, Charlie Cooper, was employed. He had been in contact with Europeans for many years and had not acquired all their virtues; however, on account of his authority among his fellows, his intelligence and unintimidated attitude towards

whites, his services were used. All precautions were taken in placing questions before him, and answers were often checked by further interrogation, but still I would be loath to place full reliance on his replies in some cases. Regarding important points, such as the previous experience of "pain", confirmation was obtained in localities widely separated. He described the pains as rheumatically. They occurred most frequently in the shins, and occasionally in the knees and forearms as well. The severity in some cases rendered walking impossible. It would appear that they were more severe or more frequent at night.

SECTION VI.

REFERENCES TO "SABRE-TIBIAE" IN YAWS,  
AND RADIOGRAPHY OF BONE LESIONS IN YAWS.

SUMMARY.



SECTION VI.REFERENCES TO "SABRE-TIBIAE" IN YAWS,  
a n d  
RADIOGRAPHY OF BONE LESIONS IN YAWS.

Before passing on to the details of the studies undertaken one might deal briefly with the references in the literature to the occurrence of bony changes during the course of yaws - especially those resulting in the deformity of "sabre-tibia". The ultimate conclusion of this thesis is that the "Boomerang legs" are no other than the deformities of the lower legs, known as "sabre-tibiae". Sabres are more generally known than boomerangs, which may be considered as characteristically Australian.

No attempt is made to deal with this aspect of the problem in an historical manner, but merely to draw attention to a few authorities to show that the association of sabre-tibiae and yaws is recognised and to refer to some papers which discuss the radiographic appearances of yaws lesions in bone.

BAHR (1914) believes the deeply excavated ulcers and the bone lesions seen in the endemic zones of yaws in Ceylon to be tertiary yaws and says, "A diffuse yaws osteitis which may result in a sabre-shaped deformity of the tibia, and often of the bones of the forearm as well, is exceedingly common." "Apparently a rarefying process occurs in the centre of the long bones thus rendering them liable to spontaneous fracture with consequent mal-union." He also speaks of the occurrence of epiphysitis, and a disorganising synovitis and gangosa.

MAUL (1918) published a very interesting article on the radiographic findings in 20 out of 100 cases of yaws which were found to have bone or joint lesions.

Diagnosis was made by history, clinical symptoms and manifestations, and the demonstration of treponema pertenu in cases where an open lesion was present. Speaking of the bone lesions, he says, "In the majority of cases the lesions show as rarefied areas, irregularly oval and elliptical in shape with the long axis parallel to that of the bone in which the lesions are located. The size varies from the smallest discernible area to one that is two or three centimeters in length. The rarefication presents moderately well-defined borders separating it from the unaffected bones and varies in translucency from the slightest differentiation of unnatural transparency to one simulating a perforation. 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 of the bone, the periosteum is usually destroyed but occasionally the cortex shows thickening and the periosteum is separated from the bone. In two cases of this series there was a general thinning of the cortex of the bone and a loss of the cancellous-tissue appearance. About two percent. of the cases show a nodular type of lesion, evidenced by swelling over the surface of the bone, with a localised thickening of the cortex, which sooner or later in the course of the disease shows rarefaction in its center. In chronic lesions marked irregularity of the bone outline is evident, and the picture characteristic of the earlier lesions is more or less lost. The bone as a whole becomes deformed and the growth of the bone is interfered with both in length and breadth. This dwarflike picture is most frequently noted in the cases showing the lesions in the epiphyses. 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 surface rough and uneven. It is concluded from this series of cases that the joint pains complained of are due in most part to the presence of the lesions on the articular surfaces.

"With the exception of the 2 per cent. of cases showing as a swelling over the surface of the bone the X-ray picture is different from the bone lesion in syphilis in that: (1) the periosteal proliferation is absent, and (2) the thickening of the cortex of the bone is absent. Also in the 2 per cent. of cases where thickening of the center is present, the thickening remains localised, does not tend to extend along the whole length of the bone, and sooner or later shows rarefaction in the center of the lesion.

"The bone lesions of yaws may simulate:

- (1) tuberculous or septic central abscess
- (2) gumma
- (3) hydatid cyst
- (4) benign cyst
- (5) fibrous osteitis
- (6) enchondroma
- (7) endothelioma
- (8) secondary carcinoma
- (9) myeloma
- (10) sarcoma.

"The differential diagnosis can be made only by combining the radiographic appearances with all clinical data, including the history, physical signs, and evidence of disease or tumour in other parts of the body."

Summarising his findings in the 20 cases, he concludes:-

- (1) The diaphysis is involved in 80 per cent. of cases.
- (2) Tibia and tarsus each in 40 per cent.
- (3) The knee is the joint that is most frequently affected.
- (4) There is no constant relation of the location of the external lesion to the bone lesion.
- (5) The lesions are multiple in 75 per cent of cases.
- (6) The time between the appearance of the primary lesion and bone lesions varied from six months to nine years, with an average of 2.8 years.

Duration since primary lesion in years.	% of 20 cases showing bone lesions.
1	45
2	15
3	5
4	10
5	5
6	15
9	5

The age of the patient when the primary lesion occurs does not appear to have any relation to the time before bone lesions can be found.

HALLENBERGER (1916) in his paper on "Die Framboesia tropica in Kamerun" illustrates (his Fig. 20) a case with deformity similar to Case 30 (see Fig. 13) and described it as "framboesial ossifying periostitis of tibia, sabre-tibia."

CLAPIER (1920) writes, "In 20 months we have examined in French Equatorial Africa, more than 600 cases of yaws. We have sought in these the signs of osseous hyperplasia; we have found much and we have acquired, not only the certitude, but the conviction of this yaws origin - and on the whole it appears that yaws is complicated in certain cases by various bony hypertrophies."

"..... from 18,000 individuals, we have seen 600 cases of yaws and 12 of very characteristic goundou."

"Osteitis of the diaphysis of the long bones. - The long bones may be affected in the surface of their body and present changes in their length, their thickness, their general form, etc.; the lesions may be very localised or generalised over the whole diaphysis, - but the tibia offers a very marked sabre blade curve, and the tibial crest is very blunt, foci of localised osteitid show themselves sometimes in various points forming swellings of various sizes." (Translation.)

He excludes rickets and syphilis from playing any part in the etiology of these lesions and reports the following cases:-

- Case I. Female, aged 10, with goundou, and "numerous black scarred areas (macules) scattered over the whole body."
- Case II. Male, aged 5, multiple characteristic scars on body and limbs, gummata and gondou, "tibiae sabre-shaped, tibial crests attenuated."
- Case V. Male, aged 9, pigmented scars of recent yaws, and yaws ulcers on face and right leg, and gondou; "tibiae slightly sabre-shaped."
- Case VIII. Male, aged 9, "rounded black specific areas (macules) and very numerous and very apparent on the abdomen and chest." "The tibiae are uniformly thickened in their whole length, the tibial crest is rounded; the tibial profile is sabre-shaped. All the bony changes have developed in the course of yaws."
- Case X. Female, aged 10, gondou which developed after yaws, "tibiae sabre-shaped."

- Case XI. Male, aged 11, "general condition good; being younger, he has had yaws, which was accompanied by the deformities in parts of the legs, these his mother cured by massage. Actually the tibiae are slightly sabre-shaped, no stigmata of syphilis."
- Case XIV. Female, aged 12, "had yaws some years ago which had lasted less than a year. The actual deformities developed in the course of this illness." "The right tibia seen in profile is shaped like a Turkish sword (yatagan), very curved, concavity backwards; the curvature is uniform, free of nodosities, malleoli slightly projecting. The left tibia is sabre-shaped, very bent, but instead of the curvature being uniform, there is a marked indentation in the lower third and in which are new projections (scolloped tibia). The internal malleolus is thickened and on the whole the tibia presents a slight lateral curvature (concavity medially)." (Translation).

From CLAPIER'S paper it would seem that sabre-tibiae are often associated with scars of a previous secondary yaws eruption.

HUNT & JOHNSON (1923) in Samoa state that 20 per cent. of over 2,000 yaws cases showed bony involvement, periostitis of the digits, ribs, sternum and long bones.

In April, 1934, while at Alice Springs, I received the following references from Captain Sheppard through Dr. H. H. Scott and Dr. N. Hamilton Fairley, from London:-

"BOTREAU-ROUSSEL (1925) gives photographs of cases of "sabre-tibia" in Africans, e.g. p. 19, Figs. 6 and 7 (les tibias long de 42 cm. ont la form classique "en fourreau de sabre") and p. 30, Figs. 18 and 19.

"HERMANS (1928) gives a short historical account of observations on osteitis and periostitis in yaws with references to SPITTEL, BAHR and others. Figs. 23 and 24 at the end of book illustrate this "sabre tibia" condition in yaws which HERMANS thinks may be identical with the condition reported under the name "boomerang leg" by BREINL & PRIESTLY (1915)."

SPITTEL (1923) writes (p. 26), "periostitis and osteitis (diffuse infiltration), leading to osteo-sclerosis with bowing and deformity, occurs very commonly in the tibia and less frequently in the fibula and ulna. The pathological process is a generalised infiltration progressing without softening towards fibroid infiltration and ossification: under the periosteum it causes thickening of bone; in the Haversian canals and cancellous spaces it leads to increase in density. When both bones of the leg are affected, the clinical picture is very like osteitis deformans. Skiagrams show the periosteum to be thickened and sometimes irregular,

and the entire bone to be enlarged and dense, with perhaps small circular areas of rarefaction."

"The tibia is the bone most commonly affected, especially its middle and its lower end; the upper part is not involved with anything like the same frequency. There may be generalised osteo-periostitis, with bowing (sabre-tibia) or more frequently circumscribed nodes on the subcutaneous inner surface and malleolus."

He takes a typical example (p. 48) "a village girl of twelve in whom there is no question of acquired syphilis, and who shows none of the stigmata of congenital syphilis, comes with bowed tibiae and nodes, and pitted scars in the forehead. Her mother describes an unmistakable secondary eruption when she was two years old."

The radiograph he publishes on page 27 is similar to that obtained in Case 30 of my series (vide infra).

SOETOMO & EICHHORN (1925) report the case of a Javanese boy of eight, with typical sword-shaped tibiae, which affection the author has always considered as a symptom of tertiary syphilis.

The reviewer, Dr. H. S. Stannus, adds, "This condition has, of course, been frequently described as a manifestation of tertiary yaws."

EICHHORN dealt with the X-ray differential diagnosis of framboetic and syphilitic bone lesions. He lays stress upon the bone atrophy, which is common in yaws and rare in syphilis.

KNAGGS (1926) quotes BAHR (1914) and MAUL (1918). Referring to the areas of rarefaction described by MAUL in the shafts of the bones he says, "They are probably some of the earliest manifestations of bone implication, and we may fairly assume that they mark the situation of small granulomatous masses of similar nature to those which constitute the cutaneous eruptions. The multiplicity of the lesions, the wide-spread distribution, and the more frequent implication of the interior of the bone present a striking picture. I know of nothing like this in syphilis."

He refers to bones from Murua and Kwaiawata (Papua) in which there are "Osseous periostitic nodes, and some are quite indistinguishable from syphilis. But others present a curious pitted appearance on the surface of the node, as if a secondary caries had been going on in a considerable number of separate places (compare MAUL'S nodular type of lesion)." "In these tibiae there are appearances on the upper articular surface that would be explained by the articular conditions described by MAUL." "The pitted conditions are quite different from the usual appearances seen in syphilitic affections of the long bones", and he concludes that it is probably of yaws origin.

POLAK (1927) states that an important difference in the radiographic appearance of bone lesions in yaws and syphilis is rarefaction in the former and thickening and sclerosis in the latter.

MANSON-BAHR (1929) says, "a diffuse osteitis may result in a sabre shaped deformity of the long bones especially the tibiae, though occasionally the arms and fingers." "These bone changes are accompanied by intense rheumatic pains and have received distinctive names, such as sasala (Fijian)." He speaks of gangosa as being generally regarded as a sequel of yaws and being often associated with tertiary bone

lesions. "There is a general opinion at present that goundou is a systematized hypertrophic osteitis arising from yaws, and recently spirochaetes have been demonstrated in sections of the bony growth."

FOX (1929) describes the skiagraphic examination made of a case in which there was a sabre-like protrusion of the middle of the tibia on which was a large fungating hemispherical swelling of the soft parts. LeWald & Bucky in this case considered that the protrusion of the marrow against the cortex - although the thickened centre suggested syphilis - and the intact periosteum were against the diagnosis of syphilis.

CHESTERMAN (1927) writing of the Congo Belge, says "anteroposterior bowing of the tibiae is one of the commonest bony lesions of tertiary yaws in this district, and is well recognised by the people who call the condition "matchet leg"."

WILSON & MATHIS (1930) in a study of 1423 cases of yaws, saw six cases of "saber shin", all of which gave a history of yaws in early childhood. But, later they say, "From clinical evidence alone it is believed that yaws in Haiti is endemic syphilis for which the Haitian peasant has developed a fair degree of tolerance."

This is one attitude towards the yaws-syphilis controversy. It should be recollected that the Indian population of the Island of Hispaniola, of which Haiti is the western part, disappeared in an incredibly short time after the Spaniards came to it, and that Haiti is sometimes spoken of as the "Black Republic".

BLACKLOCK (1930) writing of Sierra Leone, gives a table of 38 cases of sabre-tibiae, 3 of which were suffering from yaws and 31 gave histories of having suffered from yaws.

KNOTT (1931) in a paper "Yaws in Liberia", writes that aching of the bones is common and one finds acutely tender swellings on the periosteum of tibia, ulna and humerus, radius and sternum, which if untreated produce permanent periosteal thickening but never ulcerate; "curving of ulnar or tibial crests may become quite marked."

HERMANS (1931), p. 89, quotes NEILEN as describing, in 1780, bending of bones from yaws. He speaks of the sabre tibiae (wrongly translated as sable tibiae) as resulting from "diffuse osteitis and periostitis". He reports the incidence of this condition in the Dutch Indies. He continues, "I should like to refer to a disease in West Australia described by BREINL & PRIESTLEY and called boomerang leg", and quotes their description. "The etiology of this disease is unknown. It is not impossible that it is the same as that of sable bone". His illustrations of "sable bones" show more irregularity than is present in the typical boomerang leg. He also speaks of a gummatous periostitis "attended by loss of tissue and spreading through the bone."

MONTEL & COUPUT (1932) working in Saigon, Cochinchina, write, "The existence of tertiary yaws is admitted to-day by all authors who treat of yaws." "This treponema" (*T. pertenue*) "strikes the bony tissue with particular electivity." "The osteo-periostitic lesions were observed in 10-20 per cent. of cases of tertiary yaws.

"The lesions are seen most frequently in children and especially in adolescents, in probable relation with the exaggerated function of the osteo-periostitic tissue which accompanies growth. They are more frequent among those under conditions of famine, under-nutrition or poverty, and in countries where periodic famines occur (Annam and Equatorial Africa). They appear generally from 3-6 years after the primary infection. . . . . they affect usually the bones of the limbs . . . ." "Clinically they can be considered as two groups.

"Firstly, localised nodular lesions, gummata causing punched-out cavities. These lesions affect, at first, the osteo-periosteal region and progress, generally, along the periosteum and into the skin, where they give rise to interminable fistulae. They often surround the bone, but rarely with a zone of bony condensation and can heal by ossification (?).

"Secondly, diffuse inflammation of the bone:- Due often to progression of nodular lesions towards the cavity of the bone, sometimes to an initial involvement of this cavity. They are characterised by the destruction of the periosteum, with hypertrophy or more often rarefaction of the bony tissue, dislocation of the trabeculae and osteoporosis. This form may also lead to fistulae and involvement of the soft tissues to produce extensive progressive and serpiginous ulceration and an elephantiaform condition of the neighboring soft tissues. In the same ulcerating lesion one may observe areas which are healing adjacent to areas which are extending. "The osteo-periostitic lesions of tertiary yaws progress slowly with little disturbance, and without fever or signs of inflammation. They are accompanied by profound osteoscopic pain. They lead progressively to a veritable state of cachexia.

"If they spread to the joints, arthritis and ankylosis may follow. They produce multiple bony deformities, turnip and spindle fingers, and forms of spina ventosa, swellings in the sheaths of bones, bending of sabre tibiae, disappearance of the anatomical shape of the bone (angles, crests and faces) with increase in diameter and a tendency to an irregularly cylindrical form.

"Apart from the deformities, ankylosis and functional troubles due to destruction of tissues, these cases respond very well to treatment with novarsenobenzol.

"The clinical appearance of these lesions does not allow of confusion with other bony lesions due to microbic infection such as tuberculosis, actinomycosis, cysts, fibrous osteitis or tumours.

"The diagnosis of these lesions from syphilitic conditions is more difficult.

"In the course of yaws, the Bordet-Wassermann serum reaction is always positive and microscopical examination will not allow of distinction between *T. pertenue* and *T. pallidum*. The diagnosis must depend on endemicity of yaws and the clinical history. I believe, meanwhile, that we can say that syphilitic bony lesions are never so diffuse, so extreme, so numerous or so generalised as the bony lesions of yaws that are shown by our radiographs. Finally, the periosteal proliferation and the thickening of the cortical zone of the bone, which are the rule in

syphilis, are not observed in yaws, in which the bony lesions resemble more closely the localised forms of Recklinghausen's disease." (Translation).

They report having seen in three years of practice in Cochinchina, only one case of gangosa and none of goundou, although they have examined thousands of cases of yaws. They suggest that perhaps goundou is a special manifestation of African yaws and gangosa a manifestation of yaws in Malay and the Phillipines.

This is an interesting and useful paper, and is illustrated with eleven radiographs to demonstrate the conditions described. One would have liked more definite criteria for differentiating yaws from syphilis.

HARLEY (1933a) writes that at the Ganta Dispensary in N. E. Liberia rheumatic pains and sores were by far the most frequent complaints. Yaws was probably the underlying factor in both these conditions and also in headache which was severe and persistent. Rheumatic pains caused 44% of cases to attend his clinic, sores 19% and pains in legs and arms 4%. (There were 6291 out-patients.) He states, "It may be safely taken for granted that yaws is very prevalent. But this does not exclude the possibility that there may also be an occasional case of syphilis."

HARLEY (1933c), in a statistical analysis of the symptomatology of yaws in Liberia, writes of the population, "there was no doubt about secondary framboesides, every child had them. Nor was there any doubt about venereal syphilis. No one had that." This would apply to the material of his previous paper (1933a). In the later article, of 5,597 cases of treponematosis [HARLEY (1933b)] he says that rheumatic pain was present in 51.8%, granulomata, ulcers and scars in 37.5% and bone lesions in 35.9%. In 2007 cases with bone lesions 10.8% were sabre tibiae, 3.5% were sabre-ulnae and 1.3% were sabre-radial. On page 223 he points out that rheumatic pain and bone changes occurred in 1007 (17.9%) cases. From Table III, p. 220, it is found that these three sets of symptoms occurred in the same individual on 375 occasions (6.7%).

#### S U M M A R Y.

It may be safely concluded that sabre-tibiae occur during the course of yaws, although the only obvious sign of that disease may be resultant scars, and that osteoscopic pain occurs very frequently with bony involvement. The radiographic changes reported deal mainly with those occurring in the earlier or more active stages of the disease.

Little or no reference is made to the later changes in the long bones, when the acute stage which has given rise to deformity in them has subsided.



HASSELMANN (1931) says that although rarefying osteitis (osteoporosis) and periostitis framboesia have been often claimed by clinical observers as an early manifestation in yaws, experimentally" the latter "has never been observed in humans or monkeys. Nor have pathological changes been found either to be typical for yaws or to contain treponemata pertenuae."

In a letter from him [HASSELMANN (1935)] he says they have never been able to produce bone lesions in experimental yaws, except where there has been an extension from some adjacent skin lesion. He continues, "the lesions described by MAUL in the early days of American occupancy were leprosy, i.e., the typical periostitis and subsequent osteoporosis, as evidenced by the ineffectiveness of Salvarsan treatment in his cases and the follow-up of them." "However, as you will see from my papers, we do not pontifically and a limine deny the theoretic possibility of bone affection in yaws (otherwise as outlined above), but MUST INSIST THAT EXPERIMENTAL EVIDENCE IS BROUGHT FORTH."

As a matter of fact those cases to which MAUL (1918) administered Salvarsan showed definite improvement. There was little response from treatment with Castellani's mixture.

SECTION VII.

REFERENCES TO "BOOMERANG LEG" IN THE LITERATURE.

S U M M A R Y.

SECTION VII.REFERENCES TO "BOOMERANG LEG" IN THE LITERATURE.

It was CLELAND (1919) who called attention to the fact that to STIRLING (1894) is due the credit for the first description of the condition of "Boomerang Leg" among the Australian natives.

STIRLING (1894) records the case of - "a young native girl of about 15 years of age, whose tibiae presented a conspicuous and symmetrical anterior curvature. This was associated with marked platycnemism, a condition in which the tibiae are much flattened, as if by lateral compression. This girl was ill-nourished even to emaciation, but presented no other abnormalities either of bones or teeth as far as I could discover. Subsequently when in the neighborhood of the Macdonnell Ranges, we came into more frequent contact with the natives, I was surprised to find that a very large number of the blacks, both male and female, young and adult, presented the same peculiar tibial conformation as the only observable abnormality, the platycnemism being also well marked. The latter peculiarity has received attention from an ethnological point of view, though it is not confined to the Australian aboriginals. It has also been noticed in the tibiae of palaeolithic man. Its significance is unknown, but it has been suggested that it may have reference to the free movements of the muscles of the leg in people whose feet have not been subject to the confinement of boots and shoes. Probably the estimate of the degree of platycnemism observable in the cases alluded to is exaggerated by the extreme prominence and sharpness given to the anterior edge of the tibia by the curvature. So far I have not had an opportunity of observing the bones themselves. Except in the first case seen at Crown Point, where general malnutrition was a marked feature, I was unable to notice any associated pathological conditions, and the possessors of the curved tibiae were just as well nourished as their unaffected fellows.

"On my return I examined all the available native skeletons, but, though the flattening was usually marked, there was no appreciable curvature, and I do not remember ever having noticed the peculiarity in the more southerly tribes, or in the Northern Territory coasts.

"The question is - to what extent is this to be regarded as a racial characteristic or a pathological condition? It certainly has no resemblance to the ordinary curvatures of rickets, and no other associated rachitic condition could be noticed. As an ethnological character platycnemism has been treated of by various writers, but from a pathological point of view, the only reference bearing on the subject, that I can find in the literature at my disposal is by TOPINARD (1890), who states in his "Anthropology" that in 200 Parisian tibiae collected from the St. Marcel and St. Germain-des-Pres cemeteries, dating from the fourth to the tenth centuries, 5.25 per cent. were platycnemic, and 14 per cent. were bent. The latter peculiarity is not uncommon in old graves. But he does not mention the direction of the curvature," (In another place TOPINARD alludes to an antero-posterior curvature.) "associated with the platycnemism, and the prominent anterior border, as one of the forms of a rachitic condition

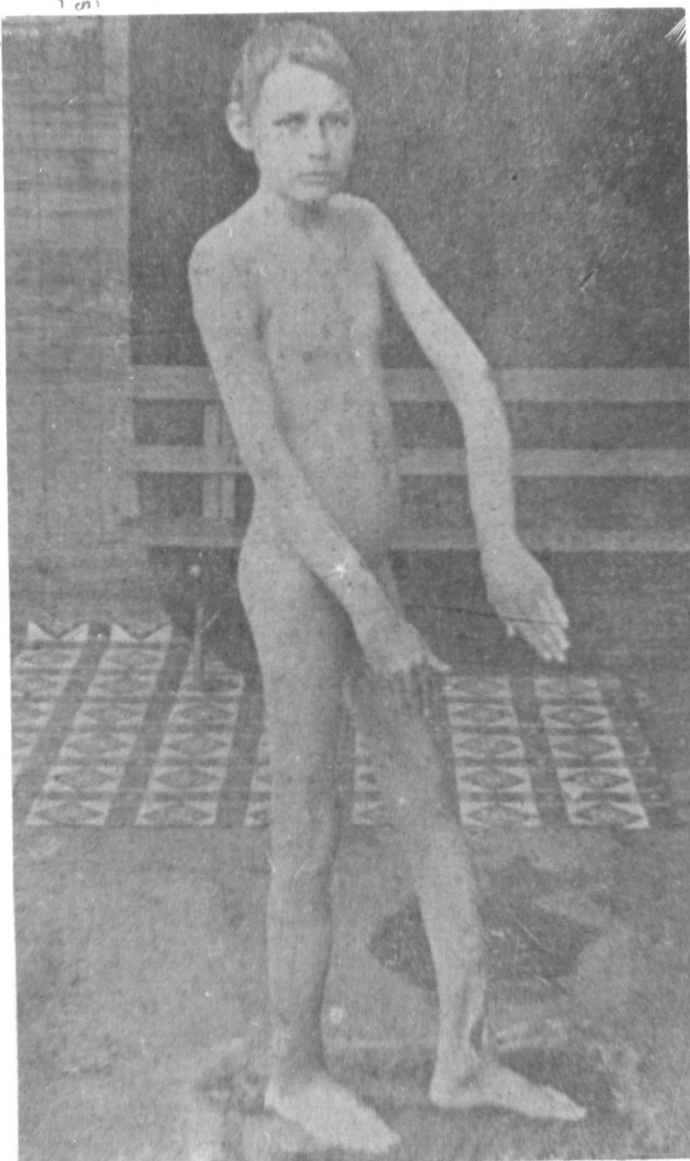


FIG. 20.  
Intercolonial Quarterly Journal  
of Medicine and Surgery.  
Vol. II, 1895.

affecting the tibia, and he figures a section of such a bone which certainly differs from the usual section of an ordinary platycnemic tibia. Professor Watson informs me that he observed a similar anterior curvature in the natives of Mallicolo."

"The condition is well recognised by the residents who, not inaptly, describe the natives so affected as "boom-erang legged"."

He illustrates this article with a diagram of a well marked case, "Though not to such an extreme degree as in the girl at Crown Point" (Fig. 10).

GARDNER (1895) reports the case of a European youth from Meiteum, New Hebrides, who was suffering from Malaria and had bone disease with sores on arms and legs (Fig. 20). He noted a remarkable deformity of both tibiae, especially of the left, the bone being thickened, flattened laterally and bent forwards, so that it was shaped somewhat like a boomerang. Scars of old sores and one unhealed ulcer on the left ankle were found. There were some swelling and deformity of the left radius and ulna, with periosteal nodes, also enlarged and tender parts on the humerus and metacarpal bones.

The medulla of the bone was drained at operation - in parts the bone was sclerosed, and at other parts the compact tissue appeared to be very thin. Considerable improvement followed. The pathological report on bone tissue removed at operation was 'evidence of general osteitis - but no micro-organisms found'.

He quotes Dr. Paton, the missionary, who says that the disease exists in all the southern islands of the New Hebrides and probably throughout the whole group. White children on Aneiteum, Anwa and Nguna have been attacked by it. "In all, 28-30 per cent. of the inhabitants suffer from it. After the children begin to walk, and as they grow heavier, the disease develops with swelling and deformity of the bones of the legs and forearms, and finally progresses to ulceration of the bones of the most prominent part of the anterior curvature of the legs. Children who have been removed from the Islands when young have in some cases developed the disease years later. It always causes much pain similar to inflammation."

GARDNER adds - "Apparently the patient suffers first from a periostitis, and later from an osteitis". He goes on to discuss platycnemism under the following heads:-

- (I) Non-pathological or ethnological (?) in fossil bones, et.
- (II) Pathological
  - (a) rickets
  - (b) as in case under discussion.

It is probable that this was a case of yaws.

Yaws is widely spread in the New Hebrides. A similar case has been reported by me [HACKETT (1935)].

STIRLING (1896) repeats the description given in his earlier paper (1894). He refers "to the explanation that platycnemia may be a modification of form due to the increased area for the origin of the tibialis posticus muscle." "The anterior curvature for which I propose the name camptocnemia, so far as I could see, was not usually associated with any pathological conditions visible in the living subject; on the

contrary the natives thus affected, with the one exception mentioned, were neither more nor less healthy and well nourished than those in which the peculiarity was not observable."

In a footnote he states that Gillen "considers these bent legs are generally associated with delicate physique in both sexes and that he considers them a sign of a constitutional disease." "It certainly has no resemblance to the ordinary curvature of rickets, and no other evidence of rickets, syphilis or tuberculosis could be detected in the cases that came under my notice, even in the emaciated girl referred to."

"While it is possible that disease may lead to a bending of the bones of the ordinary platycnemic type it is difficult to escape the belief that other causes, beyond those obviously pathological must be at work, for in the tibiae of the Alice Springs skeleton the curvature of one end of an apparently healthy bone is as great and of the same character as in the other in which a diseased condition is conspicuous. Moreover, in the few other tibiae of skeletons in which I have observed some degree of curvature, there is no evidence of disease visible and, as I have already said, with one exception, the living subjects of bent shin bones appeared perfectly healthy. On the other hand, it is difficult to assign an ethnological value to a condition which, however common it may be in Central Australia, must be regarded as exceptional amongst Australians as a race." (See Fig. 11).

On page 149, in Watson's report on the skeleton (referred to by STIRLING) of an Alice Springs native, Paddy O'Rafferty, believed to be about 60 years of age, is found "pathological conditions, due to senility, rheumatism, syphilis, traumatism, etc. were apparent in many of the bones. The tibiae were slightly platycnemic: they presented in their upper third a pronounced forward curve, which threw the articular surfaces of the femoral condyles well behind the axis of the shaft. There was no corresponding curve in the fibulae, which were as straight as those of Europeans. It may be mentioned that the tibial curve was not due to disease, as the left tibia was unaffected by the osteo-porotic changes which obtained in its fellow." (Section XIV).

SPENCER & GILLEN (1899) mention "Boomerang leg", and write, "to what extent either or both of these conditions" (platycnemia and camptocnemia) "are racial or pathological it seems difficult to say", and refer to STIRLING (1896).

SMITH (1906), writing of "boomerang tibiae", says he is unable "to say whether it is due to rickets or not". He reported that it was said to be common near the Daly River.

SMITH (1907) again draws attention to the existence of platycnemia and refers to Manouvrier, Topinard and Buckworth. From the last writer's "Morphology and Anthropology", p. 313, he quotes, "The condition was undoubtedly common in some prehistoric races of Western Europe and Egypt. In modern times it runs in a pronounced degree in rickety tibiae, in the tibiae of certain ill-fed and badly nourished Australian aboriginal tribes [SPENCER & GILLEN (1899) Natives Tribes of Central Australia]. Pruner-Bey attributed all platycnemia to rachitis (rickets)." He reports flattening of the tibiae in five cases from the Coorong (S. A.).

EYLMANN (1908), p. 435, writes, "Cases of bent tibia can be found occasionally all over the interior. I have observed them most frequently in the hilly district situated

between the tropic and lat. 25° S. The concavity of the bone is always posterior and frequently the bone is more or less platycnemic; in the case of older persons it sometimes seemed to me to be rather heavy and thick. At times this alteration of shape, which Dr. Stirling has called "camptocnemia", is so considerable that to some extent it influences the gait. As far as my observations go it only affects weak, badly fed children. As in the genu varum it is partly compensated with growth. I believe that it only occurs in cases of the general nutritive disorder, rachitis, which has caused an abnormal softness of the bones, and is brought about by muscular pull and the weight of the body. We may now rightly ask: Why does this rachitic disorder of ossification not lead to bendings and slight fractures of other parts of the skeleton, e.g. of the spinal column? Any why does the tibia bend forwards, and not, like the femur, sideways? Concerning the first question I should only like to say that obvious deformity of the spine possibly does not occur in native children because they do not wear clothes that burden and hamper the body, and do not sit for hours on chairs or forms. My answer on the second question is briefly the following: The native likes to sit in a squatting attitude when he is talking to his fellows, when he is warming himself near the camp fire, when he is taking his meals, and when he is doing certain kinds of work. His attitude is similar to the position of the child in the mother's womb in that the shins are strongly bent and the knees brought near to the chin. As the buttocks do not touch the ground, the upper end of the tibia is naturally subjected to a force pulling backwards and downwards. This at least may well lead to an arched curvature of the bone, when on account of the rachitic disorder it has only slight power of resistance. Where I have observed curvature of the tibia most frequently the nights are cooler than elsewhere in the interior because the ground lies at moderate elevation above sea-level. For this reason the native there squats longer near the fire in the morning and at night than the inhabitants of the other Central Australian districts. Furthermore it is possible that the deformity in children, who suffer from an abnormal softness of the bones, may be caused by frequent climbing in hilly country. Its occurrence is incidentally not confined to Australia. In the Museum for Natural History at Hamburg there is, for example, the skeleton of an old Viti (Fiji) Islander whose shins show it and more conspicuous thickening of the tibial crest. In the small lanes of Hamburg I have met in the last three years about a dozen workingmen's children who were sick with rachitis, and whose shins were bent forwards. It seems to me that it would be well worth the pains to find out if the frequent ascension of stairs may cause the curvature in rachitic subjects. Those children whose parents live just underneath the roof of a high house usually ascend and descend a large number of stairs frequently in the course of a day." (Translation.)

Here EYLMANN records that he has seen the condition "all over the interior" of "South Australia". South Australia at the time EYLMANN writes included what is now known as the Northern Territory. He also tries to trace the etiology to rickets. He reports the case of Boomerang legs in a Fiji Islander - where yaws was prevalent.

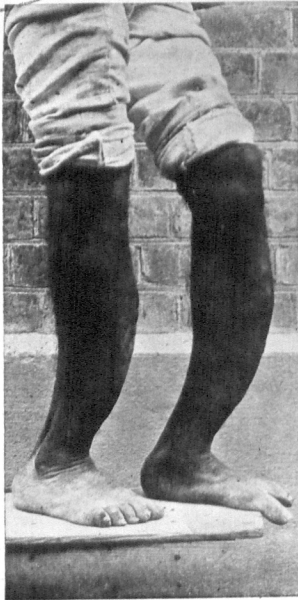


FIG. 1.

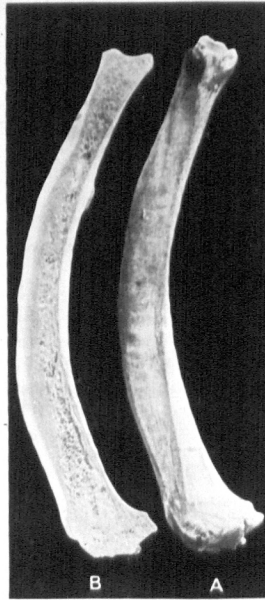


FIG. 2.

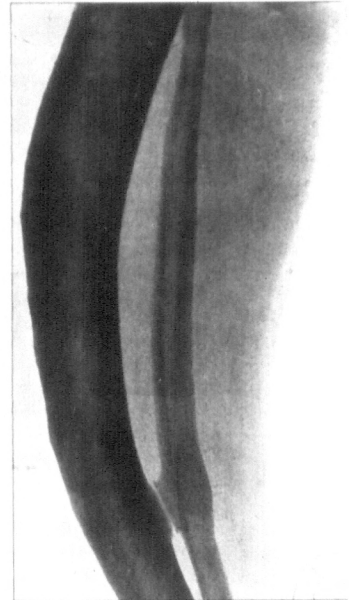


FIG. 3.

FIG. 21.

Journal of Tropical Medicine & Hygiene,  
Vol. XVIII, 1915.



CASTELLANI & CHALMERS (1913) describe the condition from a private communication by Black. They say it occurs among the natives of the north of Western Australia, the Northern Territory and the Torres Straits Islands. They write, p. 1447, "It runs its course in young natives during the period of growth, but the resulting deformity may be seen at any age. It is quite distinct from rickets and osteomalacia, and is not associated with syphilis or tuberculosis. The cause is unknown. The first symptom is tenderness and pain in the tibia and fibula, which become soft and bend gradually till they assume the 'boomerang' curve, with the convexity outwards. The subcutaneous tissues become inflamed and tender, and there is some febrile disturbance. The progress is slow, but the symptoms disappear gradually, the bones resume their former hardness, but retain the 'boomerang' curve."

BREINL (1912) reported one case of "Boomerang leg" at the Roper River Mission Station and refers to its existence among the natives in the Torres Straits Islands. They say that no cases of yaws were found among the Roper River Mission children who were clean.

BREINL & HOLMES (1915) say that they found "two well pronounced cases of Boomerang leg" among the Daly River natives where they found that "yaws is fairly prevalent amongst the children."

BREINL & PRIESTLEY (1915) state that they observed cases of Boomerang legs amongst the natives of north Queensland and in the western parts of British New Guinea. They continue, "The onset seems to be gradual; the children complain at first of pains in the shins, sufficiently severe to prevent them from walking. The skin over the tibia is tender to pressure, but there is no swelling noticeable. These pains become less severe in the course of time, the children begin to use their legs again, and the tibiae and fibulae bend forward gradually and assume the characteristic shape. In consequence of this the centre of gravity of the body is displaced forward, the patient becomes flat footed, and the gait shuffling. The deformed bones gradually increase in thickness but retain their altered shape."

They report the case of a native aged about 40 years at death, who "had developed the disease in his early youth." "The post-mortem did not reveal any obvious signs of syphilis, tuberculosis or rickets. Both tibiae and fibulae were markedly curved, with the convexity forwards and the point of maximum curvature lay between the upper and middle thirds. The tibia was heavier than normal, greatly increased in diameter, the crista completely obliterated, and the bone almost circular on cross section at the middle of the shaft. The fibula did not show any changes beyond a corresponding forward curvature. A longitudinal section through the middle of the tibia shows a complete alteration of the structure of the bone. The compact substance is greatly increased in thickness over the greater part of the shaft and is slightly decreased at both extremities. It is much denser in structure than normal and is of ivory-like appearance. Almost the whole marrow space is filled by compact bony tissue, only here and there are remnants of greatly thickened cancellous tissue. The lamellar structure of both ends of the bone has been completely obliterated, being transformed into compact bony substance. The X-ray picture taken during life shows the same transformation." (See Section XIV).

They suggest the condition is "the result of a chronic osteomyelitis of both tibiae". Commencing as a rarefying osteitis which causes the pain, it leads to softening of the bones which gives rise to the deformity. Then follows a condensing osteitis ending in the changes described above. "A simultaneous progressive periosteal new development causes the increase in the thickness of the shaft."

"The etiology of "boomerang leg" is unknown, but syphilis and tuberculosis can be excluded."

The paper is illustrated with photographs of the legs in life, and the bones radiographed and on section (Fig. 21).

CHRISTOPHERSON (1918) describes the case of an Arab which he thinks is one of "Boomerang leg". He says, "Boomerang leg" appears to be a definite entity. He excludes rickets, achondroplasia, syphilis, tuberculosis and osteomalacia and suggests the name 'osteomalacia sclerotica' for the condition which produces "boomerang leg". He refers to Fig. 216 in GOULD & PYLE (1900) of the "transparent man" and considers it the same condition.

It is, I think, doubtful if either of these are cases of "Boomerang leg", and nothing of value is to be had from them towards the elucidation of the aetiology.

Of the first case CLELAND (1919) says "I think there is little doubt that the case described by Dr. Christopherson is not one of the same diseases as the Australian "Boomerang leg"."

BASEDOW (1925) refers to the condition of boomerang leg and speaks of the part that the tibialis posticus may play in the production of this deformity. He says that "Ramsay Smith points out that there may be a connection between the platycnemic condition and the peculiar method the Australians have of lifting things from the ground with their toes, by which the tibialis posticus is specially involved."

HERMANS (1928 and 1931) suggests that Boomerang legs may be identical with the sabre-tibiae resulting from yaws.

CLELAND (1928) gives a list of references which have been dealt with above.

SPENCER (1928) writes, "a flattening of the tibial bone is often met with, and also a curious condition called Camptocnemia by Dr. Stirling. The latter consists in an anterior curvature of the shin bone and gives rise to what the white settlers have described by the apt term 'Boomerang leg'. In some cases (Fig. 103) it may be very noticeable. To what extent either, or both, of these conditions are pathological it is difficult to say. They do not seem to be associated with any indication of debility in the man or woman in whom they are present."

BASEDOW (1932) says, "Curiously the condition is not peculiar to sickly and under-nourished individuals. I have observed it in comparatively robust and healthy-looking types." "As a matter of fact, the Arundta natives do not look upon "boomerang leg" as a disease. They attribute its formation to the custom their women adopt of carrying their children in oblong, wooden food vessels known as "mika". As the

child grows, they maintain, its legs hang over the side of the vessel and, being soft, assume the curved shape of a boomerang." "The arunnda refer to the "boomerang leg" as ingordingorda."

He reports having seen cases of this condition at Crown Point, and "in several Central and Northern Australian localities, although the condition appears to be more common in the former than the latter region." Earlier in his paper he says that at times boomerang leg itself is confused with the sabre-tibia of syphilis (see Section IV).

GRAY & CLELAND (1933) report having seen three cases of "boomerang leg" and two of gangosa at their Cockatoo Creek Camp (C. A.).

WOOD (1920) discusses and illustrates a condition he calls "retroflexion of the tibia", which he had found in Australian bones. From his illustration it is probable that he is referring to the deformity of boomerang leg. He deals with it from the point of view of a racial characteristic.

#### S U M M A R Y.

From the above authors some information is obtained regarding the geographical distribution and development of the deformity, but references to aetiology are mainly conjectural.

SECTION VIII.

STUDY OF 50 CASES AT ALICE SPRINGS,  
CLINICALLY, SERIOLOGICALLY, AND RADIOGRAPHICALLY.

(See also Section XII and Volume II)

1. Introduction.
2. The material.
3. Birth places of subjects.
4. Blood relationships.
5. Age at onset of "Boomerang legs".
6. Variation in deformity.
7. Results of Wassermann reactions on sera.
8. Incidence of histories of "irkintja" and "pains" and the presence of "scars".
9. Association of "irkintja", "pain", "scars", and the results of Wassermann reactions.
10. Summary.

SECTION VIII.STUDY OF 50 CASES AT ALICE SPRINGS,  
CLINICALLY, SERIOLOGICALLY, AND RADIOGRAPHICALLY.(See also Section XII and Volume II).1. I n t r o d u c t i o n .

Alice Springs is situated in the MacDonnell Ranges, Central Australia, 1,000 miles from Adelaide. The surrounding country is upwards of 1,000 feet above sea-level and consists for the most part of acacia semi-desert and shrub steppe [PRESCOTT (1931)].

The work at Alice Springs was greatly facilitated by the willing assistance of many gentlemen. Among these were Dr. McCann, the resident Government Medical Officer, Mr. Kramer, the representative of the Aborigines Friends Association, Mr. Adamson, Postmaster, Mr. Tuthill, the telegraph engineer, and the Police and Civil Authorities. Mr. Albrecht, of the Hermannsburg Mission, also gave me every assistance in his power. Professor J. B. Cleland had suggested that an X-ray plant be taken to Alice Springs; Mr. Marshall carried out the necessary arrangements. Messrs. W. Watson & Sons Ltd., of Melbourne, kindly lent a "Caldwell Portable" X-ray plant and Kodak (Australasia) provided a generous supply of radiographic films. Watson & Sons. Ltd. also provided an outfit for developing the exposed films. I was, indeed, fortunate in having had the excellent services of Mr. C. H. Marshall of the Adelaide Hospital, who, during his annual leave, came to Alice Springs to take charge of the radiographic part of the work. The sterling quality of the "Caldwell Portable", Kodak films, and of Mr. Marshall's technique can be judged from the uniformly high standard of the completed films. To the South Australian and the Commonwealth Railway Commissioners we were indebted for the free transport of Mr. Marshall and the apparatus. Through the kind interest of the South Australian Deputy Director of

Posts and Telegraphs electrical power was obtained from that Department's generator at Alice Springs, and rooms were made available for apparatus. The films were developed, fixed and partly washed, under considerable difficulties, by Mr. Marshall, as the exposures were made, thus satisfactory results were assured. The lateral radiographs of the lower legs were taken with the lateral surface of the limb towards the film.

## 2. M a t e r i a l.

The subjects studied were drawn from the native population round about Alice Springs, although some were brought from Napperby and the Hermannsburg Mission. They were all full-blood aborigines with the exception of three inmates of the Half-Caste Institution. All were clothed and their diet was, in various degrees, influenced by European contact. The lives they led varied from those of nomadic hunters to those of detribalised 'settled' nomadic hunters.

The material consisted of natives, of any age or sex, with boomerang legs who would come for study. Nine subjects who, in the field, were considered to have straight legs, were intended for controls. The ages varied from 3 to 60 years. The total number examined was 47 and 9 'controls'. For the present purpose the following have been omitted:-

- (A) Cases 20, 24 and 25, as no radiographs were taken. They had only slight cases of deformity, and it was considered prudent not to use too many X-ray plates in the earlier stages. By the end of Mr. Marshall's stay in Alice Springs all the films available were used in a vain search for normal legs.
- (B) Case 33, as the radiographs had become mislaid. This case was of a woman of 60 years of age with slight boomerang legs, who gave a history of irkintja when a child, and also of "pains" in the legs. She had scars of the earlier irkintja round her mouth.
- (C) Case 42 was one of goundou and Case 43 was of gangosa. Both were omitted in this series.

These discards reduced the series for study to 50, and in only one case (41) was no evidence of tibial deformity, either clinically or radiographically, found.

### 3. Birth Places of Subjects.

The natives dealt with in this series gave the following localities for their places of birth. In most cases the names are those of stations about Alice Springs.

From Bond Springs eleven came - Cases 8, 9, 11, 12, 13, 15, 26, 27, 28, 29, C VI.

From Hermannsburg ten came - Cases 2, 34, 35, 36, 37, 38, 39, 40, 41, C II.

From Napperby six came - Cases 1, 2, 17, 19, 47, C VII (the last two belonged to the Ilpirra tribe).

From Owen Springs four came - Cases 10, 16, 30, 32.

From Ryan's Well two came - Cases 4 and 5.

From the Far West two came - Cases 22 and 23 (these were of the Pitjanğara tribe).

From Tempe Downs one - Case 18 (a Luritja native).

From Glen Helen one - Case 21.

From Ulluru one - Case 7.

From Alice Springs two - Cases 6 and C V.

From Teatree Well, Tennant Creek and Powell Creek came one each (these were half-castes) - Cases 44, 45, 46.

In seven cases (14, 31, C I, C III, C IV, C VIII, C IX) no data of place or origin were recorded. C I and C III were Luritja natives. Except where otherwise noted above the subjects were full-blood natives of the Aranda tribe.

### 4. Blood Relationships.

Details of close relationships such as parents, consorts and children were relatively easy to obtain; in many cases the relations were among those natives studied. In 40 of the 50 cases of the series such data were recorded; 21, or 53%, gave histories of relatives with boomerang leg or gangosa (one instance).

One woman, Case 15, had four sons with boomerang legs - Cases 12, 26, 28 and 29. Her husband, another son, parents, brothers and sisters were said to be normal. Her age was estimated to be about 45 years; she had a positive Wassermann reaction; one son, Case 12, gave an anti-complementary reaction, and no blood was collected from the others. Her four sons had definite boomerang legs; she, herself, had only a slight degree of the deformity.

Three cases, 29, 4, 5, were grandmother, daughter and grand-daughter. The first and last had moderate boomerang legs and the other had marked deformity and a positive Wassermann reaction.

Case 9 had a daughter, C VI (B. L. +) and a son (not seen) with boomerang legs. Case 9 had a positive Wassermann reaction.

Case 3 had a daughter, Case 24 (not included in series B. L. +). Case 3 had marked boomerang legs and a positive Wassermann reaction.

Case 8 had an half-caste child with gangosa (not seen).

Cases 16 and 30 were half-brothers and Case 30's wife (Case 32) had a chronic bony disease of her left forearm, in addition to moderate leg deformity.

The father of Case 40 and the mother of Case 39 were said to have boomerang legs, but neither were seen. Case 40 gave a negative Wassermann reaction.

Cases 34 and 37 were brothers and both gave positive Wassermann reactions.

Cases 22 and 23 were sisters from whom no serum was collected.

It will be pointed out below that in every case of which the details were recorded, with the exception of Case I, the history was obtained that the onset of the boomerang legs and of the eruption of the irkintja or "sores",



which preceded the deformity, was some time after birth. Hence it may be concluded that the data above, rather than pointing to any hereditary tendency, indicate foci where the infective principle of irkintja is endemic. These foci cover an extensive area round Alice Springs. The existence of the Aranda legend concerning irkintja [SPENCER & GILLEN (1899), vide Section IV] would indicate that this disease has been endemic in this area for a long time.

##### 5. Age at Onset of Boomerang legs.

In the following Table the statement of "little feller" is understood to mean early childhood. Although every effort was made to obtain this information, in some cases with no success, I am not certain that Charlie Cooper, the interpreter, did not occasionally exceed his office. The individual was encouraged to indicate his height, as time has not been mechanised or reduced to figures by the native. The mass of data rather than the details must be considered here.

T A B L E I.

Group	Infancy	Childhood.		Adolescence.	Adults	Others	No data.
		Early	Late				
- 15 yrs. <u>Males.</u>		2 34 40	47			1 born with Boomerang legs (vide infra.)	37 38 46 C VII
<u>Females</u>	5	23 35 36 39	22				(41) 45 C I C III
16-30 yrs. <u>Males.</u>		12 17 26 28 29					C IX
<u>Females</u>		4 7 18 44		6	21		
Over 30 yrs. <u>Males.</u>		13 16 30					C IV C V C VIII
<u>Females.</u>	27 31 32	8 10 14 19	15	11 (young woman).	9 after having children.	3 not at birth.	C II C VI
<u>Totals.</u>	4	23	3	2	2	2	14 (=50)

Of 34 cases in which data were obtained, in 23, or 68%, the onset was in early childhood. If full allowance is made for the difficulty in obtaining this information the "infancy" and "late childhood" groups might well be combined with the "early childhood" group to form a "childhood" group, when it is found that 30 cases, or 84%, fall in that period.

#### 6. Variation in Deformity.

By classifying the deformity into three grades the following Table can be drawn up from records of clinical observations in the field:-

T A B L E II.

	Under 16 years.					16-30 years.					Over 30 years.					All ages.				
	+++	++	+	Nil	Total	+++	++	+	Nil	Total	+++	++	+	Nil	Total	+++	++	+	Nil	Total
Male	3	2	4	0	9	2	2	1	1	6	2	1	0	3	6	7	5	5	4	21
Female	0	3	4	3	10	2	1	3	0	6	2	6	3	2	13	4	10	10	5	29
Total	3	5	8	3	19	4	3	4	1	12	4	7	3	5	19	11	15	15	9	50

+++ = Marked deformity,

++ = Moderate,

+ = Slight,

Nil = Straight legged.

In those cases which were considered as straight legged in the field (including those intended for controls) all except one (Case 41 in group "under 16 years - females) became "+" on radiographic examination.

From these figures no data regarding the incidence among the community can be obtained as it was not possible to make a survey or to take a census of the population from which the subjects were drawn. This population was probably in the region of 400 individuals.

No conclusion regarding the progressive development of the deformity can be drawn from the small numbers in the groups, though it would appear that no increase in bending occurs after the age of 30 years. In those cases in which the onset is in childhood, I doubt if much increase of deformity occurs after the fusion of the epiphyses at about the age of 16 years.

In the "under 16 years" group

	<u>Males.</u>	<u>Females.</u>
the cases with +++ were aged	14, 12, 12	
" " " ++ " "	11, 8,	14, 10, 3,
" " " + " "	10, 9, 8, 9	11, 10, 8, 6,
" " " Nil " "		15 (Case 41), 10, 7,

which suggests that the deformity may progress until the age of 16 years.

In the group "16-30 years"

	<u>Males.</u>	<u>Females.</u>
the cases with +++ were aged	28, 18.	22, 20
" " " ++ " "	25, 22	18
" " " + " "	20	30, 20, 18
" case " Nil was "	16.	

The scatter in the age distribution would suggest that, during this period, age had little influence upon the extent of deformity.

### 7. Results of Wassermann Reactions on Sera.

By grouping the cases radiographed according to ages (only approximate in most cases) it is found that all those in whom the epiphyses are not fused were under 15 years. Those over 30 years of age were treated as a separate group (the lowest age in this group was 35 years). All the analyses below are based upon radiographical diagnoses of boomerang legs, so that only one subject (Case 41) was negative.

T A B L E III.

Wassermann Serum Reactions Grouped by Age and Sex.

	Under 16 years				16-30 years				Over 30 years				All ages			
	WR+	WR-	No WR	To-tal	WR+	WR-	No WR	To-tal	WR+	WR-	No WR	To-tal	WR+	WR-	No WR	To-tal
Male	5	2	2	9	0	0	6	6	0	0	6	6	5	2	14	21
Female	2	2	6	10	3	0	3	6	6	0	7	13	11	2	17	29
Totals	7	4	-	-	3	0	-	-	6	0	-	-	16	4	-	50

+ = positive  
 - = negative  
 0 = no test conducted.

It will be seen that of the 20 cases (40% of total) on whose sera the Wassermann reaction was carried out, 16, or 80%, gave positive results. The sera of 5 out of 7 males tested gave positive reactions, and 11 of 13 females gave the same results.

The following cases gave positive reactions:-

2, 3, 4, 6, 7, 9, 11, 14, 15, 34, 37, 47, C I, C II, C III, C VII.

The cases which gave negative reactions were:-

1, 35, 40, 41.

The serum of Case 12 was anti-complementary and the sera of Cases 36 and C V were lost in transit.

Of those cases that gave negative results, Case 1 had marked boomerang leg deformity and scars of previous irkintja. There is no doubt that his condition was of the same etiology

as other cases which gave a positive Wassermann reaction. He said he was born with the deformity and had the "sores" later.

Many individuals only knew the time of onset of the condition from hearsay, and in view of the evidence of many other cases that the deformity commenced in childhood, I would disregard the statement made by Case 1 and post-date the development until 'after the "sores"'. .

From the children 35 (B. L. + and "pain"), 40 (B. L. + and "pain") and 41, little history of value could be obtained owing to their bashfulness in the presence of strangers. Cases 35 and 40 show in radiographs some slight degree of bending of the tibiae and show changes comparable with those present in their associates, Cases 34 and 37, whose sera gave positive Wassermann reactions.

Mr. F. V. Albrecht, the missionary in charge of Hermannsburg, spoke of an adult native who, six years ago, came to the Mission with "sores all over his body. He had married a few weeks previously to the outbreak of that trouble and blamed his wife for it; he thought she had not been clean. He had most of his sores around his genitals, but also some on his legs, hands and all over the body. These sores did not grow too big, looked a little red right round with a white pusy head. If one of such boils disappeared, others would come up instead. The man looked very miserable and I tried to keep him away from the rest of the natives. However, as usual with natives in such cases, they found it all the more interesting and went to his camp. Soon most of the children had sores, mostly only on their hands. These sores, better eczemas, were first noticeable on their hands, fingers and between the fingers. For a time I thought it was scabies, but it wasn't that. I also had a feeling as if they had, contrary to those on that man, a more "watery" appearance. His seemed to be drier. Part of the legs of the children were covered too. Traugott" (Case 34) "was one of the worst among about 30 children. He got very weak and for a time we were afraid of losing him. He took about six months to improve."

Mr. Albrecht was unable to give me any details of Cases 35 and 40. It is probable that these two children contracted this disease at the same time. Mr. Albrecht thought at the time the native was suffering from "larrakintja", which is a synonym of "irkintja", and from the account above it was more probably yaws than any fungoid condition (which is not often seen in the dry Central areas).

For ætiological purposes the same reasoning would be applied to Case 41 (no B.L., "pain" or "scars"), although there are bony changes of a mild degree present, in view of the absence of any bending - which is the present interest - it will be taken as a negative case. Even if the interior of the bone does not appear radiographically normal, the general outline shows how straight the tibiae can be.

Taking these considerations into account it may be presumed that of the 20 cases examined by the Wassermann reaction, while only 16, or 80%, gave positive results, 19, or 95%, had suffered from the disease, irkintja, which had caused positive Wassermann reactions in 16 cases. No clinical evidence of syphilis was seen among the native population.

This was the first time that sera for diagnostic purposes had been sent from Alice Springs to Adelaide, a train journey of 1,000 miles. Previous arrangements had been made with Dr. E. McLaughlin, Director of the Adelaide Hospital Laboratory, for Mr. S. F. Tee to conduct Wassermann reactions on sera that I should send to them. I am indebted to these gentlemen for their willing co-operation. On arrival in Adelaide the sera were contaminated. They had been subjected to heat owing to a fire breaking out in that part of the train where they were stored.

#### 8. Incidence of Histories of Irkintja and "Pains", and of the Presence of "Scars".

In all cases where the history of these symptoms were obtained it was stated that they preceded the onset of the tibial deformity - except in Case 1 who said he was born with the condition (vide supra).

The natives dealt with at Alice Springs were sophisticated as regards bodily exposure, for all wore clothing of sorts. As work was being carried out in the Post-office yard, only in exceptional cases was any effort made to overcome their objections

on this matter. On account of the limited time Mr. Marshall and the X-ray set were to be in Alice Springs, nothing was done which was thought might discourage the appearance of new subjects. Hence only those parts of the body that were uncovered by clothes could be examined; this excluded the trunk and thighs.

An endeavour was made in each case to ascertain the aetiology of all scars and those obviously due to fire or trauma were disregarded. In most cases the scars due to trauma differed from the irkintja scars in that they showed evidence of damage to the deeper layers of the skin, thus there was more cicatrisation, and they had less tendency to be round or oval. From scars due to burns it was not so easy to distinguish in all cases, although often the shape was rounded, there was usually evidence of more extensive skin damage and they were not often found where irkintja most frequently occurs, i.e. round the mouth, infantile skin folds in the neck, and moist joint flexures. In cases of doubt these scars were disregarded.

Some individuals volunteered that a scar indicated to them was the result of irkintja, while others maintained that the characteristic circumoral scars were due to fire. Some even denied the existence of characteristic irkintja scars when these were pointed out to them. These incidents led one to regard with caution the statements elicited as history.

To the pain, often associated with irkintja or with the onset of boomerang legs, the natives at Alice Springs (Aranda tribe) gave the name of "ARADULKA". They, or rather Charlie Cooper, described it as "rheumatically" in character and said it occurred most frequently in the shins and to a less extent in the forearms.

The Aranda term for boomerang legs was "UNGWANA ULBARINGA". The unreliability of medical histories has been



has been mentioned, but attention may be drawn to those cases in which some attempt at aetiology was made by the subjects.

Cases 3 and 4 attributed the boomerang legs, which were marked, and had apparently developed in early life, to "stuff getting into bone when camping along old camp".

Case 4 indicated a route via the mouth. The sera of both cases gave positive Wassermann reactions.

The mother (4) of Case 5 said that the boomerang legs began the previous year when the child was sick. At the time of observation the child had an abscess behind its left ear and was too irritable to allow the collection of a specimen of serum.

Case 7 attributed the leg deformity to the severe pains which had preceded it in childhood. Wassermann reaction positive.

Case 9 said the deformity commenced after she commenced having children. She had severe pain in the legs which prevented her from walking. Wassermann reaction positive.

Case 11 considered the bending of her shins due to pains in her legs when she was a young woman. She had scars or irkintja and a positive Wassermann reaction.

Cases 13, 16 and 17 attributed their deformities to trauma.

Case 16 gave a history of irkintja.

Case 18 thought her boomerang legs were due to a little water insect ("ruer ab in bueringa") ingested with water and causing pain in her legs and the deformity.

Case 20 attributed her condition to an insect ("irabma") in the leg causing pain.

Case 22 said drinking swamp water was the cause.

T A B L E IV.

Incidence of Histories of Irkintja and "Pain",  
and the Presence of "Scars".

Age Groups	Totals	History of Irkintja			History of "Pain"			Presence of "Scars"		
		+	-	0	+	-	0	+	-	0
To 15 years.	9 ♂	4	3	2	4	2	3	6	3	0
	10 ♀	2	6	2	5	1	4	3	4	3
16-30 years.	6 ♂	1	4	1	2	3	1	1	4	1
	6 ♀	1	3	2	3	2	1	1	5	0
30 years and over.	6 ♂	2	2	2	3	0	3	2	2	2
	13 ♀	8	4	1	9	1	3	7	5	1
Total.	50	18	22	Total = (40)	26	9	Total = (35)	20	23	Total = (43)
		45%	55%	80%	74%	26%	70%	46%	54%	86%

+ = presence,

- = absence of symptom or sign,

0 = no record made.

These results are included in the discussion under the next sub-section.

T A B L E V.

9. Association of Irkintja, "pain", "Scars", and the Results of Wassermann Reactions.

Sex	Irkintja, "pain" and "scars"			Irkintja and "pain"			Irkintja and "scars"			"Pain"			"Scars"			Negative or no data			
	No.	WR	Age	No.	WR	Age	No.	WR	Age	No.	WR	Age	No.	WR	Age	No.	WR.	Age	
Males.	34	+	11	16	0	55	1	-	12	37	+	9	2	+	12	12	Anti-c	22	
	30	0	55				47	+	14	38	0	8	46	0	10		17	0	20
	29	0	25				C VII	+	6	40	-	8	C IV	0	35		26	0	28
										28	0	28					C IX	0	16
										13	0	55					C V	0	55
													C VIII	0	35				
Females.	22	0	14	14	+	55	6	+	20	35	-	11	45	0	6	5	0	3	
	23	0	8				27	0	40	36	0	10				41	-	15	
	11	+	40				C II	+	50	39	0	10				C I	+	7	
	15	+	45							7	+	18				C III	+	10	
	19	0	50							18	0	20					+	22	
	31	0	60							21	0	30					+	18	
	32	0	45							8	0	55					+	50	
										9	+	50					C VI	0	35
										10	0	50							
Grouped totals.	3	WR +		1	WR +		4	WR +		3	WR +		1	WR +		4	WR +		
	7	WR 0		1	WR 0		1	WR -		2	WR -		3	WR 0		1	WR -		
							1	WR 0		9	WR 0					1	WR Anti-c		
																8	WR 0		
Totals	10			2			6			14			4			14			

No. = Case number.  
 WR = Result of Wassermann reaction.  
 + = Positive; - = Negative; 0 = no test conducted.

Age is given in years.

In those cases in which positive findings are present in one or two items, the results of enquiry regarding the others were either negative or unsatisfactory. Associations of symptoms other than recorded above were

A statistical analysis of the data in Table V, kindly carried out by Mr. E. A. Cornish of the Waite Agricultural Research Institute, Glen Osmond, showed that in one case only could a definite association be demonstrated (statistically) - namely, that between irkintja and "scars".

Although in the others there are no significant associations from the data, I am not satisfied that this would be so if more complete data were available. In the pair irkintja and "pain", for example, any association is hindered by the 12 subjects, who gave a history of "pain" but denied having suffered from irkintja, although three gave positive Wassermann reactions. The question of "pain" was one in which I suspected the integrity of the interpreter, to which attention has already been called. In fact all items of history are unreliable, both on account of the subject and the interpreter. They may have remembered the past irkintja by associating it with the "scars" on themselves or on others. Even with an objective factor such as "scars" in clothed natives, it will be pointed out later (Section X) a negative finding does not necessarily mean that no "scars" are present; they may be present in the groin or gluteal cleft and so not observed. In other instances the absence of records of all items reduced the number of observations on some points.

The following deductions are, therefore, made more as indications than as definite conclusions.

#### Irkintja.

Of 40 cases (80% of series) in which records were made 18, or 45%, admitted having suffered from irkintja. Of these, 10 had also had "pain" in the legs and had "scars", three of these cases gave positive Wassermann reactions and no serum was taken from the remainder. Of the same 40 cases two had suffered "pain" but no "scars" were found; one of these had a positive Wassermann reaction and no serum was

taken from the other. In six cases "scars" only were associated with a previous attack of irkintja; four of these gave positive Wassermann reactions; one a negative result, no serum having been collected from the other.

No case had suffered from irkintja without having experienced "pain" or bearing "scars".

Of the 9 cases which gave a history of irkintja and on whose sera the Wassermann reaction was conducted, 8, or 89%, gave positive results. Case 1 gave a negative reaction and, as pointed out above, can be considered as one of the other eight for purposes of aetiology. Thus it may be said that 100% of cases which gave a history of irkintja also gave positive Wassermann reactions.

#### "P a i n".

Of 36 cases (72% of the series) in which records were made 26, or 72%, had suffered from "pain". Of these, 12 also admitted having suffered from irkintja, and in 10 of these "scars" were present. Of these 12 cases 4 gave positive Wassermann reactions and from 8 no serum was collected.

Fourteen cases had experienced "pain" but denied having had irkintja, and bore no "scars"; three had positive Wassermann reactions, 2 negative, and from 9 no serum was collected.

Of the 9 cases which had suffered "pain" and on whose sera the Wassermann reaction was conducted, 7, or 78%, gave positive results. The two cases that gave negative results were Cases 35 and 40. From what has been said of these cases they might be considered from an aetiological point of view together with the other seven, thus raising the 78% to 100%.

#### "S c a r s".

Of 43 cases (86% of the series) in which records were made 20, or 46% showed "scars" resulting from previous

attacks or irkintja. Of these, 16 admitted a previous attack of the disease - 10 of these had also suffered "pain" in the legs; of these 16 cases 7 gave positive Wassermann reactions, one a negative, and from 8 no serum was taken.

"Scars" alone were found in four cases, one of which gave a positive Wassermann reaction; no serum was collected from the others.

Of the 9 cases in which "scars" were found and on whose sera the Wassermann reaction was performed, 8, or 89%, gave positive results. From what has been said above of Case 1, which gave the negative result, this case (1) might be considered for aetiological purposes along with the other 8 cases, thus raising the 89% to 100%.

The cases in the "Negative or no data" column either gave negative findings for the three pathological items just discussed or no records were made concerning them. In only three cases were data for all three items not recorded, Cases 5, C VII and C IX, and from none of these was serum collected. Of the other cases, four gave positive blood Wassermann reactions, one a negative, one was anti-complementary and from five no serum was collected.

The cases dealt with in the preceding discussion with one exception were subjects with boomerang legs, either clinically or on radiographic examination.

Case 41 had straight legs but no "scars" were found. She denied having suffered irkintja or "pain". Her serum was Wassermann negative.

#### 10. S u m m a r y.

In this section observations on 50 natives with boomerang legs from the Alice Springs area are recorded and discussed.

It would appear that the course of the disease is as follows:- Within the first few years of life the individual contracts a disease, called by the Aranda people irkintja, which is characterised by lesions in flexure areas of the body. The resulting "scars" can be found throughout life in some cases. There is then a quiescent period, terminated by the onset of "pains" of a rheumaticky nature in the lower limbs (aradulka), which is followed by the development of the leg deformity.

In but few cases does this occur after puberty and probably no increase in the deformity occurs after the epiphyses are fused. The kinship possessed by some of the subjects is probably accounted for by the presence of irkintja as an endemic disease rather than that the deformity is inherited. In many instances the serum Wassermann reaction was positive, those that were negative can be disposed of.

There is definite association between the presence of "scars" and the history of a previous attack of irkintja. Although no other association can be demonstrated from the data available, it is felt that this is not a true statement of the position and certain indications are noted.

It is shown that the majority of those cases which gave a history of irkintja or "pain", or which showed the presence of "scars" due to that disease, gave positive Wassermann reactions. It is suggested that those giving negative reactions (except Case 41) can be considered for aetiological purposes with the preceding cases.

In view of the absence of syphilis among the natives of the Northern Territory, which has been discussed above, I venture to put forward these deductions as strong evidence in support of the essential rôle played by yaws in the aetiology of Boomerang leg.

It was unfortunate that, despite every endeavour, no satisfactory controls were obtained in this series. An attempt to provide control observations is made in the two following sections, IX and X.



SECTION IX.

STUDY OF THE ASSOCIATION OF  
"BOOMERANG LEGS" AND "SCARS".

1. Observations in the Victoria River District.
2. Observations at the Bathurst Island Mission.
3. Summary of data from Victoria River District and Bathurst Island Mission, and conclusion.
4. Distribution of "scars" among natives at Bathurst Island Mission.
5. A note on the perpendicular forehead scars observed on the natives of Bathurst Island.

SECTION IX.STUDY OF THE ASSOCIATION OF  
"BOOMERANG LEGS" AND "SCARS".1. Observations in the Victoria River District.

Leaving Darwin 23rd May, 1934, I proceeded to 'the Katherine'. Through the kindness of Dr. C. E. Cook, I was to be a passenger on a medical service truck during a malarial survey carried out by Mr. G. Anson. We left the Katherine on the 25th and visited Manbulloo, Willeroo and Delamere Stations, reaching Victoria River Downs on the 27th. On account of Dr. Fenton's accident and the disablement of his aeroplane, Anson, in the truck, took Drs. Fenton and Woolnough back to the Katherine. For further transport I was indebted to Mr. Martin of Victoria River Downs, Mr. Mathieson of Manbulloo and Mr. McLennon, the mail contractor. I had travelled over 750 miles by the time I returned to the Katherine on the 6th July, 1934. I was also indebted to the above gentlemen and Mr. Moray and Mr. Newmarch of Wave Hill, and Constable Pfitzner of Timber Creek, for their kind hospitality.

My objective in this trip was to make a statistical survey of the occurrence of boomerang legs and "scars" in a large number of natives. No attempt was made to obtain medical histories on account of the difficulty and their unreliability.

The material studied consisted of full-blooded natives of both sexes and of ages from 2 to about 60 years. Very old people, whose skin was so atrophic that it would have been impossible to identify the slight changes characteristic of the "scars", were disregarded. Within these age limits no selection was exercised.

The subjects were for the most part "station blacks", that is, those in employment and their dependants.

The natives live in camps near the stations except during those times of the year when they are on "walk-about" or in stock camps. They appeared to be well nourished with the exception of a few very old folk.

The country consists of grass downs and savannah woodlands [PRESCOTT (1931)], sparsely wooded in the south and more densely wooded in the north, with the Victoria River and its influents draining into the sea at Queens Channel. Malignant tertian malaria is endemic in this area, and a number of cases in this series were infected.

I had examined the natives at Wave Hill before Anson arrived and, on receiving his microscopical findings, I was surprised to find the very high percentage of his positive cases that could be diagnosed by splenic palpation. In fact, most cases of undernutrition in younger natives were due to infection with *Plasmodium falciparum*.

It was of interest to note that in some cases the station manager's wife would say that she had never seen certain children of house lubras with sores, while on examination these same children would be found to have "scars". This may indicate that the children suffered from the disease very early in life, before they were brought often from the camp to the house. The natives, with few exceptions, were clothed.

The excess of females is of no significance since most of the younger adult males were away from the homesteads in stock-mustering camps. This time of the year (May to September) is the dry season when stock are moved. The area lies north of the 18° S. latitude, and it experiences a definite wet season with a rainfall from 15-30 inches during a few months of the year, usually from November to March. The more "tropical" climatic conditions may account for the more frequent findings of "scars". I had by this time increased my experience by observations made

in the Kahlin Beach native compound, so probably I was more cunning in identifying the "scars" than I had been in Alice Springs, until which time I had only seen "scars" on four individuals in the Musgrave Ranges in 1933.

Those natives with gangosa and other manifestation of jaws seen in this area, will be referred to later.

T A B L E VI.

Survey of Natives - Victoria River District.  
(All natives clothed).

	<u>Total.</u>	<u>B.L. and "Scars".</u>	<u>B.L. only.</u>	<u>"Scars" only.</u>	<u>Nil.</u>
<u>26. V.34 - Willeroo</u>					
Male	7	2	0	0	5
Female	15	4	0	1	10
	22	6	0	1	15
<u>26. V.34 - Delamere</u>					
Male	2	1	0	0	1
Female	5	1	0	1	3
	7	2	0	1	4
<u>29. V.34 - Victoria River Downs.</u>					
Male	17	2	4	1	10
Female	24	7	1	1	15
	41	9	5	2	25
<u>3.VI.34 - Timber Creek and Victoria River Depot.</u>					
Male	21	7	3	0	11
Female	35	10	1	0	24
	56	17	4	0	35
<u>10 and 11.VI.34 - Wave Hill.</u>					
Male	28	16	4	0	8
Female	42	22	8	1	11
	70	38	12	1	19
<u>3.VII.34 - Manbulloo.</u>					
Male	5	1	1	0	3
Female	6	1	3	0	2
	11	2	4	0	5
<u>T o t a l s:</u>					
Males	80	29	12	1	38
Females	127	45	13	4	65
	207	74	25	5	103
	100%	36%	12%	2%	50%
		75%	25%		

From the above table it will be seen that the percentage of cases of Boomerang legs in the two sexes are practically the same. Of the series of 207 subjects, 99, or 48%, had Boomerang legs, and of these 74, or 75%, also had "scars". Of the whole series, while 25, or 12% (or 25% of cases with Boomerang legs), had Boomerang legs and no associated "scars", only 5, or 2%, had "scars" and no leg deformity. It is quite possible that some of the "Boomerang leg only" cases would have shown "scars" had complete skin examination been possible.

Further discussion of these findings is postponed until the Bathurst Island observations have been dealt with.

## 2. Observations at the Bathurst Island Mission.

Through the courtesy of Father Henschke at Darwin I was given the facility of visiting the Bathurst Island Mission. Leaving Darwin 21st July, 1934, and travelling in the Mission lugger, St. Francis, I spent a useful and very pleasant week at the Mission and returned to Darwin on the 28th July.

Of Father Gsell and the sterling work he and his staff are doing on Bathurst Island I will say no more than is necessary in dealing with the present subject. I am indebted to Father Gsell and his staff for their hospitality and the willing co-operation. The island is for the most part covered with a fairly dense tropical savannah woodland [PRESCOTT (1931)]. The rainfall is monsoonal in character and the annual average is about 60 inches.

The natives, when at the Mission, live in (or near) huts by the shore of Apsley Strait or in camps in the nearby scrub. They usually spend some months each year in nomadic fashion "living on the country". While at the Mission the males wear triangular cloths covering their genitalia and the women wear a strip of calico round the waist which

reaches to the knees. In these natives a large area of body surface was thus offered for examination.

They feed well, whether at the Mission or in the "bush". When at the Mission they are given employment, chiefly in the production or gathering of food. While a family is at the Mission the boys attend a school during the mornings, these constitute the "school boys" in the Table below.

For many years, in order to check the extensive practice of polygamy which was the custom, Father Gsell has been "buying" young girls from their parents, from the men to whom they are promised as wives, and from the men to whom their female children are promised as wives. On reaching maturity they enter into monogamous marriage with men of about their own age and by mutual choice. According to native custom, when a girl has matured, her man is often twice her age. This policy appears to be working very successfully, as the Father's "ownership" of the immature girls and the monogamous marriages are well respected.

The girls leave their parents when 4 to 6 years of age and live in the convent. Their life is free, and they gave the impression that they were happy and well cared for. They are not completely isolated from their parents and often go "walk-about" with them for a month or more at a time. These constitute the "Convent girls", and, for the most part, they were under the age of 16 years.

The "older girls" were from 16 to 18 years of age, and were employed on the Mission while awaiting marriage.

Upon examining a number of Bathurst Island natives for the presence of "scars" one immediately notices the almost universal multiple vertical scars on the forehead - these are self-inflicted and will be discussed below.

They attribute the boomerang leg deformity to the failure of the mid-wife to straighten the shin properly at birth. For this and information regarding the native language I am beholden to Father McGrath.

T A B L E VII.

Survey of Natives on Bathurst Island  
(Lower part of body covered).

	<u>Total</u>	<u>B.L. and "Scars".</u>	<u>B.L. only.</u>	<u>"Scars" only.</u>	<u>Nil.</u>	<u>Cases with "scars"</u>
<u>Schoolboys -</u> 23.VII.34	19	17	0	2	0	100%
<u>Convent girls -</u> 24.VII.34	48	34	0	8	6	87%
<u>Older girls -</u> 25.VII.34	10	8	1	0	1	80%
<hr/>						
<u>Adults -</u> 22.VII.34						
Male	23	15	3	0	5	65%
Female	15	10	0	1	4	73%
	38	25	3	1	9	68%
<hr/>						
<u>T o t a l s:</u>						
Male	42	32	3	2	5	81%
Female	73	52	1	9	11	84%
	115	84	4	11	16	
	100%	74%	3%	9%	14%	83%
		95%	5%			

The sex ratio in the adult group is of no value as more Island men than women are employed in Darwin, and in the back country of the Island a war of sorts was engaging the attention of some of the men. Some women were food gathering when the camps were visited, and they were missed.

The Convent population brings about the female predominance among the children. There is little difference in the incidence of Boomerang legs in the various groups.

Of this series of 115 cases 88, or 77%, had "boomerang legs" and of those 95% also had "scars". Of the whole series only 4, or 3% had "boomerang legs" and no "scars". Of the series 11, or 9% had "scars" and no "boomerang legs", and it will be seen that 10 of these cases occurred in those groups where the youngest subjects were to be found.

It was noticed at the time that the two schoolboys with "scars" only were the youngest present. It may be that many of these 11 children would develop some degree of leg deformity before they reached maturity.

That there were more negative findings among the girls would be expected from the more sheltered life they lead.

Discussing the presence of yaws among the natives with Father Gsell, he said that when he opened the Mission over 20 years ago cases of this disease were frequently seen. In recent years he had been administering N.A.B. and he now saw few cases.

He pointed out several cases which had been brought to the Mission by their parents and he had treated with success. These showed the characteristic "scars" and some had a slight degree of leg deformity. This may be taken as an indication of the yaws origin of the "scars" and "boomerang legs".

From the absence of any increase in the incidence of "scars" in the various age groups, it may be assumed that the "scars" were the results of lesions acquired in early life.

It will be noticed that 83% of 115 natives bore "scars", which I suggest result from yaws.



3. Summary of Data from Victoria River District  
and Bathurst Island Mission,  
and Conclusion.

If the two series from the Victoria River District and Bathurst Island are combined the following figures are obtained:-

TABLE VIII.

	<u>Total.</u>	<u>B.L. and "Scars".</u>	<u>B.L. only.</u>	<u>"Scars" only.</u>	<u>Nil.</u>
Victoria River District.	207	74	25	5	103
Bathurst Island Mission.	115	84	4	11	16
	322	158	29	16	119
		49%	9%	5%	37%
		84%	16%		

In combining these observations it has been assumed that there is no difference in incidence of boomerang leg and "scars" due to sex or locality.

Of the total of 322 cases 58% had "boomerang legs" and 84% of these had "scars", while only 5% of the total cases had "scars" only.

C o n c l u s i o n .

These figures are large enough to warrant definite conclusions being drawn. In view of the fact that 84% of 187 cases of "boomerang legs" had "scars", while only 5% of 322 cases had "scars" and no leg deformity, and 9% of 322 cases had "boomerang legs" and no "scars", together with the deductions from the analysis of the data obtained in the Alice Springs series, it may be concluded that the association of "boomerang legs" and "scars" is of more than casual occurrence.

From the Alice Springs series it was suggested that "boomerang legs", "scars" and "pain" are directly associated with a common factor - a disease called by the Aranda people "Irkintja".

The validity of the first part of the thesis outlined at the commencement has now been demonstrated - that "boomerang legs" and "scars" are associated in that they are both the result of one and the same disease.

4. Distribution of "Scars" on the Body.

This study is of the 95 cases on Bathurst Island on whose bodies "scars" were found. In many cases "scars" were found in more than one region of the body. In this series the groins, genitalia, gluteal cleft and upper thighs were not examined.

T A B L E IX.

	<u>Lips</u>	<u>Axillae</u>	<u>Arms</u>	<u>Neck</u>	<u>Chest</u>	<u>Trunk</u>	<u>Thigh</u>
Schoolboys	19	8	5	2	-	1	1
Convent Girls	33	22	15	3	3	3	1
Older Girls	8	1	3	-	-	-	-
Adults	21	2	2	3	-	-	-
95 subjects	{ 81	33	25	8	3	4	1
	{ 85%	35%	26%	8%	3%	4%	1%

From the above Table it will be seen that 85% of cases had "scars" round the mouth. This is greatly in excess of what was seen in the mainland natives.

From the records of 20 subjects of the Alice Springs series with "scars", the following figures are obtained.

	<u>Lips</u>	<u>Axillae</u>	<u>Arms</u>	<u>Neck</u>	<u>Chest</u>	<u>Trunk</u>	<u>Thigh</u>
20 subjects	7	0	10	4	0	1	6
	35%		50%	20%		5%	30%
			<u>Lower leg</u>	<u>Cheek</u>	<u>Chin</u>		
			1	1	3		
			5%	5%	15%		

Here it will be seen "scars" occurred most frequently on the arms (50% of 20 cases) and on the lips in only 35% of cases.

In the present uncertainty regarding the actual means of transmission of the causal organism to healthy individuals and the factors concerned in the distribution of the secondary lesions of yaws on the skin no definite explanation may be given.

RAMSAY (1925) states that in cool, less humid seasons in Assam the condylomatous lesions (of yaws) tend to occur most frequently in the warm, moist regions of the axillae, and between the nates, while during the warm, moist season these skin lesions tend to be more generally distributed over the body surface

It has been suggested that the distribution of secondary lesions on the skin is associated with the multiple minor injuries to which a naked body would be exposed in bush life.

On the day of my arrival at the Mission, Father Gsell took me to see a sick child. It was a little girl of about 3 years of age. Her mucous membranes were very pale and her limbs oedematous. On examination fluid was detected in the pleural and peritoneal cavities. Her liver was greatly enlarged and firm, and her spleen was palpable. She died next day. I was told that one of her sisters and several other children had died in a similar manner. While examining the convent girls I found several who had pallid mucous membranes. Then Father Gsell said that three years ago the hookworm infection rate among the natives at the Mission was 50%. I took back to Darwin six specimens of faeces from cases with anaemia, and all were found to contain hookworm ova. The next week Dr. Cook sent Anson to Bathurst Island and he found the stools from 65 to 67 cases contained hookworm ova.

Father Gsell remarked upon the frequency of earth eating among the children, and we wondered if it were associated with the ancylostomiasis. This earth eating may be connected with the high incidence of circumoral scars, as it might be a source of infection, or the abrasions to the

skin occasioned by this practice may lead to the localisation in this region of the *Treponema pertenue* from the blood stream. Of course it may be that the hands carry infective material from elsewhere on the body to the mouth region and thus lesions result from auto-infection. In this series the "scars" occurred most frequently round the mouth, but one does not know in how many cases there had been pudendal or circumanal lesions.

Father Gsell pointed out several children who were under-developed for their age and several adults whose growth in childhood had been slow for some years, but who, during adolescence, had overcome this defect. It is probable that this is due to ancylostomiasis.

Returning to the figures shown in Table IX, it will be seen that the axillae are the second most frequent region in which "scars" were found.

In both series (B. I. and A. S.) "scars" were often found on the arms; the most usual place was in the flexure of the elbow.

The "scars" in the neck occurred in the lower part where skin creases are often found in infancy. It may be assumed that in these cases the scars were the results of infantile infections.

Other regions where "scars" were present were the chest, trunk, thighs, lower legs and face; the number of cases in which "scars" occurred in these areas is given in the Table.

##### 5. A Note on the Vertical Forehead Scars Observed on the Natives of Bathurst Island.

The almost universal existence of vertical scars on the forehead has been noted above. These scars were found in small numbers on the foreheads of children aged 2 to 3 years. The scars are most marked at their lower



Fig. 22.



Fig. 23.



Fig. 24.

ends which are often on the supra-orbital ridges. They are irregular in length and are more concentrated about the midline. The number of scars on the forehead appeared to depend upon the age of the individual. Figs. 22 and 23 are from adults and Fig. 24 from a young girl. I was told by all from whom I enquired, both Europeans and natives, that a native would cut his forehead when he suffered from headache. Malaria is not present in this Island. HARLEY (1933a) says that severe and persistent headaches occurring among the natives in N. E. Liberia are probably yaws in origin. As yaws is of frequent occurrence among the natives of Bathurst Island, the possibility that these scars are the results of incisions made for the relief of headaches due to yaws must be considered. From observations made with this point in mind, in a series of 46 convent girls, the following Table may be drawn up:-

T A B L E X.

Scars of Yaws Scars on Forehead	Scars of Yaws but no scars on Fore- head.	Neither type of scar present.
40	3	3

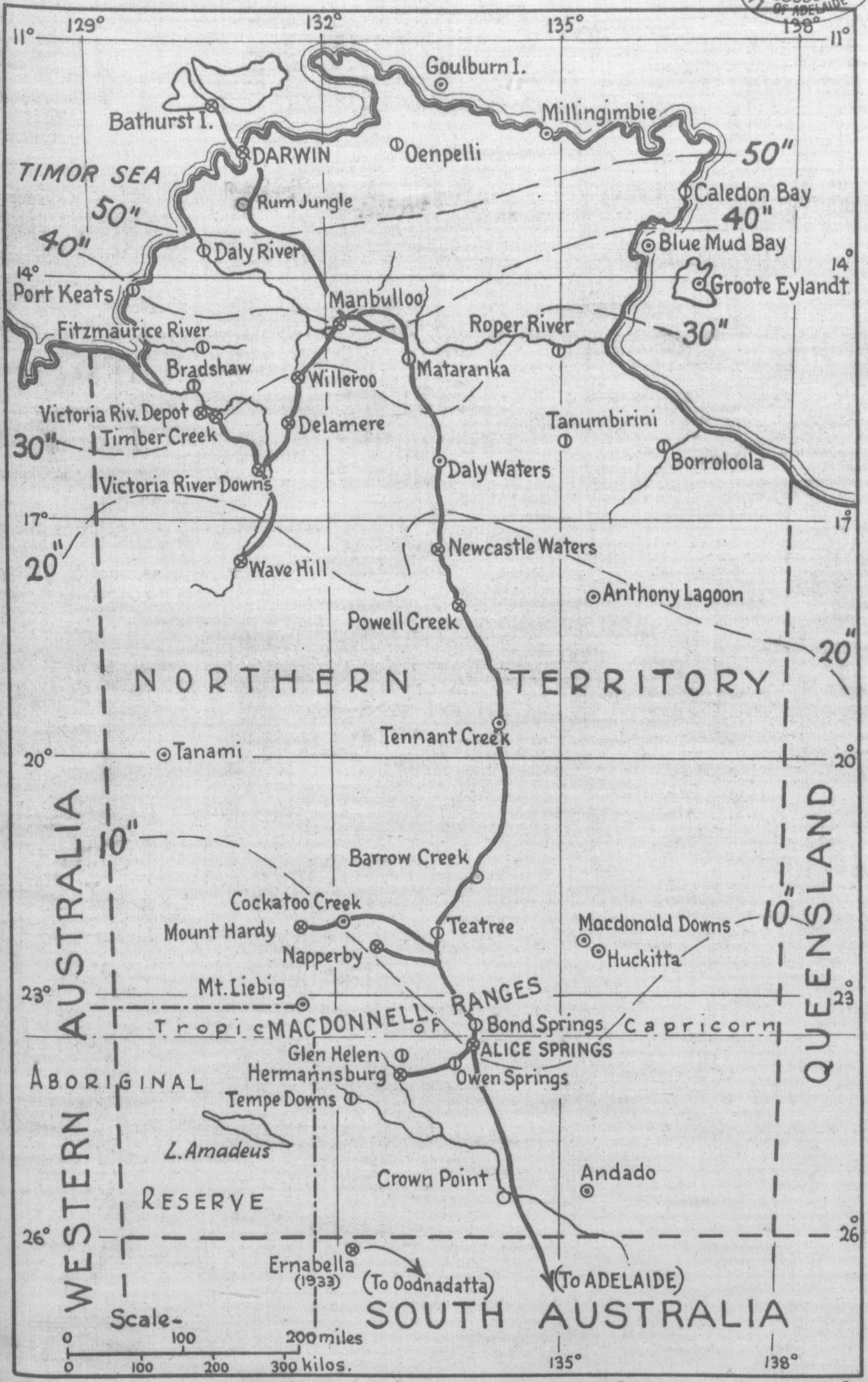
From these figures it will be seen how general is the practice of incising the forehead. The association of these scars and those resulting from yaws may be taken to indicate the indirect yaws origin of the former. If it were the custom to incise foreheads on occasions which came often to all individuals, children and adults, females and males, similar figures would be obtained. I doubt if these two items can be treated in this way, so I would leave this point unsettled. One might stress the absence of a similar practice on the mainland in areas where yaws is common. The scarring is not associated with grief, for the two adults illustrated here had just lost their youngest

daughter from the anaemia of ancylostomiasis, and though overcome with grief showed no recent incisions.

BASEDOW (1913), speaking of scars among the Bathurst Islanders says, "occasionally a horizontal row of short vertical scars is cut upon the forehead immediately above the eyes." (In a diagram he makes the row quite regular.)

I cannot recollect having seen such scars. He makes no reference to any other scarring of the forehead.

OF ADELAIDE



Reference: — Route followed.    20" — Isohyets.    ⊕ Boomerang legs seen from.  
 ⊗ Localities visited.    ⊙ Cases reported.    ○ Mentioned in literature.



SECTION X.

STUDY OF THE ASSOCIATION OF BOOMERANG LEGS,  
"SCARS" AND POSITIVE WASSERMANN REACTIONS AMONG  
INMATES OF THE HALF-CASTE INSTITUTION AT DARWIN.

SECTION X.STUDY OF THE ASSOCIATION OF BOOMERANG LEGS,  
"SCARS" AND POSITIVE WASSERMANN REACTIONS AMONG  
INMATES OF THE HALF-CASTE INSTITUTION AT DARWIN.

There still remained one aspect of the work done at Alice Springs to be completed, that was the reaction of Wassermann test in the sera of cases with "scars" and boomerang legs.

It was thought that if a series of cases could be subjected to complete skin examination combined with observations and radiographs of their legs, groups could be chosen of cases with boomerang legs and "scars", with "scars" only, with boomerang legs only, and of cases in which neither were present. The results of the Wassermann reaction on the sera of the cases in each group would be taken as an indication of the aetiology of the conditions present, provided the cases in the control group gave negative reactions. For this purpose Dr. C. E. Cook kindly placed the inmates of the Half-caste Institution in Darwin at my disposal.

Under the present policy for the treatment of the half-caste problem, the children are taken from their mothers in the native camps when about 3-5 years of age. The boys are admitted to the Institution at Alice Springs, while the girls are segregated at Darwin. At the age of 16 years positions of suitable employment with approved individuals are found for them and they leave the Institutions. Hence the material for this study consisted of half-caste girls of ages from 5 to 15 years from various parts of the Northern Territory.

There were 85 children in the Darwin Institution.

Dr. Cook kindly undertook to radiograph a limited number of cases which I should choose, - but I have not yet received the films.

A parcel of 12 sera was sent to the Commonwealth Health Laboratory at Toowoomba by air-mail on 7th August, 1934. Unfortunately two tubes were broken in transit, and this rendered the names on some of the other tubes undecipherable despite the care taken to avoid this misfortune.

Of the 10 sera that reached the laboratory five gave positive and five negative reactions. As four of the names were quite lost, it was decided to collect another series of specimens of sera (August 27th) and bring them overland to Adelaide. When the specimens were tested in Adelaide (September 14th) and in Melbourne (27th of the same month) they were found to be in sound condition. In Adelaide the tests were carried out through the kindness of Dr. E. McLaughlin, Director of the Adelaide Hospital Laboratory, by Mr. S. F. Tee, and in Melbourne, through the kindness of Professor H. A. Woodruff, of the Melbourne University, Dr. Gunsen carried out Wassermann and Kahn reactions. The results of these independent examinations agreed entirely.

This is, I believe, the first occasion on which the Wassermann or Kahn tests have been carried out on the sera of cases residing in Darwin.

In the first instance observations were made of the legs of all the children, then certain individuals (25) were subjected to examination of the entire skin surface.

Among these 25 children, although cases with boomerang legs and definite "scars" were frequent, only one case (VII) with what were considered to be slight boomerang legs and no "scars" could be found. Case VII, with the five cases, VIII, IX, X, XI and XII who showed leg deformity and "scars" were grouped together. The last two cases, XI and XII, were not inmates of the Half-caste Institution.

Case VI, who on account of being straight legged and on whom only one small "scar" was found, was grouped

with the five cases, I, II, III, IV and V, who showed neither deformity nor "scars". No other cases showed the presence of "scars" with no leg deformity.

FEMALE HALF-CASTES FROM DARWIN.

(Complete skin exposure).

- CASE VIII Aged 14; European/native from Daly Waters.  
 "Boomerang leg" - slight.  
 "Scars" - angles of mouth and chin,  
 right axilla.  
 More extreme in groin and left labium  
 majus.  
 Left calf.
- CASE IX. Aged 9; European/native.  
 "Boomerang leg" - slight.  
 "Scars" - mons veneris,  
 left labium majus posteriorly,  
 no scarring elsewhere.
- CASE X. Aged 11; European/native from Barrooloola.  
 "Boomerang leg" - slight.  
 "Scars" - angle of mouth and neck,  
 both axillae,  
 lower abdomen,  
 upper thighs at pudenda,  
 left calf.
- CASE XI. Aged c20; Chinese/native half-caste from  
 Tanumbirini near Borrooloola.

Personal History:-

"Sores" round mouth when a baby;  
 When about 6-8 was very ill for nearly a year -  
 could not walk because of pain in legs; had  
 sores on legs at same time; and left elbow  
 was later affected.

Examination:-

Boomerang legs - right marked, left slight.  
 On right leg at upper part of  
 lower third was a scar fixed  
 to the underlying bone.

Forearms - left slightly bowed.  
 Complete extension of right elbow  
 prevented by bony obstruction.

Face - Left internal strabismus.  
 Nasal bridge low, - said she had  
 trouble there when young.

"Scars" - angles of mouth and lower lip,  
 right forearm and both lower legs,  
 both labia majora and upper thighs.

CASE XII. Aged c30; Chinese/native half-caste from Victoria River.

Personal History:-

Had two children - both dead;  
had extensive "sores", later pains in legs  
and developed boomerang legs when about  
4-5 years of age.

Examination:-

Boomerang legs - marked. Right greater  
than left. Maximum curve  
is below centre of leg.

Forearms - slightly bent.

"Scars" - circumoral; chin, cheeks, nose  
and forehead, both axillae and  
left upper arm medially. Over  
lower abdomen, groins, thighs  
and pudenda skin surface greatly  
changed and thinned; pigmen-  
tation slightly increased; ad-  
hesion of anterior part of  
right labium majus to thigh  
forming cul de sac opening up-  
wards, both labia majora showed  
scarring. Posteriorly both  
thighs at and above gluteal fold  
showed scars, left more extensive  
than right.

T A B L E XI.

Results of Serum Examinations of Half-castes in Darwin.

In the following five cases neither boomerang legs nor "scars" were present, although the whole skin surface was examined and the Wassermann reactions were expected to be negative.

		<u>W.R.</u>	<u>KAHN.</u>
Case I	European/native	-	-
" II	" "	-	-
" III	" "	-	-
" IV	" "	-	-
" V	Chinese/native	-	-
" VII	European/native. Legs showed slight deformity but no "scars" were found. The Wassermann reaction was expected to be positive.	-	-
" VI	European/native. Legs straight, but in upper third of R. lower leg was a tender swelling over tibia which had been present for three months to my knowledge. She said it was the result of a knock. One small "scar" on lower lip was seen, but in the absence of any others it was disregarded. The Wassermann reaction was expected to be negative.	+	+

In the following five cases both boomerang legs and "scars" were present, and the Wassermann reactions were expected to be positive.

Case VIII		+	+
" IX		+	+
" X		+	+
" XI		+	+
" XII		+	+

It will be seen in Table XI that the five cases in which neither "scars" nor boomerang legs were found, all gave negative reactions; thus the controls are sound. Of the five cases in which both "scars" and boomerang legs were present, positive results were obtained in all.

In Case VI it would appear that the significance of "one small "scar" on the lower lip" was not appreciated at the time. The "scar" was characteristic but the absence of others and of any leg deformity led one to disregard its presence.

From the above it is apparent that all the cases with "scars" gave positive Wassermann reactions.

In Case VII no "scars" were present, for her skin surface was examined several times on account of the finding of the leg deformity. This deformity was slight but of the same degree as that of Cases VIII, IX, and X, and many of the cases in the Victoria River District and Bathurst Island natives. Her calf muscles were more developed than those of most natives and many half-castes (excluding Asiatic mixtures). Perhaps the deviation from the stright tibial crest found in this case was due to muscular development in a healthy individual.

In view of the conclusion that boomerang legs and "scars" are associated, and of the finding of positive Wassermann reactions in those cases in this series which showed this symptom complex, it must be assumed that the leg deformity present in Case VII is not of the same nature as that dealt with here as "boomerang leg". If this assumption is allowed, it may be said that all cases with boomerang legs gave positive reactions.

Case IX is an individual on whom, had she been clothed, no "scars" would have been observed.

Dr. Cook, on being shown the characteristic "scars" seen in these cases, was definite that they resulted from yaws lesions. This is in agreement with my personal impression and considered in conjunction with the fact that syphilis does not exist among the aborigines and the evidence that has already been brought forward, it may be concluded that the cause of the positive Wassermann reaction and of the boomerang legs and "scars" is infection with the *Treponema pertenue* [CASTELLANI (1905)] of yaws. Thus the validity of the second and final part of the thesis in support of which these studies have been undertaken, has been demonstrated.



SECTION XI.

STUDIES AT OOLDEA.

SECTION XI.STUDIES AT OOLDEA.

It was reported that natives had gathered at Ooldea for initiation rites, so Mr. N. B. Tindale and I proceeded there in November, 1934.

Some were living more or less 'settled' lives wandering between various mission stations, while others were visiting the locality in the course of much more extensive annual migrations from the north. All natives were more or less clothed.

We were indebted to Miss Lock and Miss Tyler for assistance and hospitality. These two ladies are performing a good service to the natives and deserve assistance and recognition.

Specimens of sera were obtained from 54 subjects on whom observations regarding boomerang legs and "scars" were also recorded. Of these specimens nine gave positive Wassermann reactions. In four of these nine cases boomerang legs and "scars" were present, in four, boomerang legs but no "scars" were found, and in the remaining case neither "scars" nor leg deformity were present.

The first four cases were as follows:-

A female, aged 3 years, with moderate boomerang legs. Scars were present on the lower lip, neck, axillae, abdomen, groins, buttocks, perineum and thighs.

A female, aged 3 years, with moderate leg deformity. Scars were found on the lower lip, axillae, left breast, abdomen and left thigh.

A male, aged 35 years, with slight boomerang legs, and scars on chin and neck.

A female, aged 35, with slight bending of the shins and scars on upper lip.

The second four cases were:-

Females aged 18, 35 and 60 years, and a male aged 30. In all these the boomerang legs were of slight degree. Only in children was a complete skin examination

possible. In the last of these cases a doubtful "scar" was present on the lower lip.

The remaining case was a bush native (male, aged 28 years), whose legs were doubtfully boomerang and on whom no scars were found. His left radius and ulna were thickened in their lower thirds, where there were several small abscesses in the subcutaneous tissues which had not yet opened. The bony condition resembled that present in Case 45 (Alice Springs).

On eleven occasions it was noted that in the freshly collected specimens of serum the corpuscles sedimented before clotting occurred. In four of these cases the Wassermann reaction was positive.

It was unfortunate that en route for Ooldea I met with an accident that involved a certain amount of cerebral trauma and caused me to spend several days in the Port Augusta Hospital. While at Ooldea, in addition to suffering from a headache, I contracted an intestinal infection which further incapacitated me. It was some weeks after my return to Adelaide before the effects of the cerebral contusion cleared up.

In my notes made at Ooldea certain data are to be found which, in the light of the previous work, could only be attributed to misjudgement. I have, therefore, only taken those cases with positive Wassermann reactions and disregarded the others.

One point of interest in the cases here discussed is that cases of yaws occur as far south as Ooldea.

MANSON-BAHR (1928) writes, "The home of yaws at the present day is within the tropics, between Capricorn and Cancer."

STANNUS (1928) also writes, "I should like to emphasise the fact that yaws is strictly a tropical disease," "limited by Cancer and Capricorn." "It is doubtful if any territory lying within the tropics is free from the disease."

The migrations from the north of some of these natives has been mentioned. The native whom Mr. Tindale found had been farthest north was an old man who, in his youth, had visited the Musgrave Ranges (300 miles north)

which are, however, over 200 miles south of the Tropic of Capricorn. Their terrain is well outside of the tropics defined either by latitude or climate, for it is of the semi-desert sandhill type of country. This is, I believe, the first record in Australia of the occurrence of yaws at the present time so far out of the Tropics.

## SECTION XII.

(See Section VIII and Volume II).

### RADIOGRAPHS.

1. Attempt at diagnosis of Aetiology from Radiographs.
2. (a) Cases with marked Boomerang legs.  
(b) Cases with moderate Boomerang legs.  
(c) Cases with slight Boomerang legs.
3. Summary -
  - (a) Suggested Pathogenesis.
  - (b) Transverse bones in long bones.
  - (c) Differential diagnosis.

#### Appendix:-

Doubt as to existence of bone lesions in yaws.

SECTION XII.

(See Section VIII and Volume II).

RADIOGRAPHS.1. Attempt at Diagnosis of Aetiology from Radiographs.

Before describing the radiographic appearances of Boomerang legs an attempt may be made to diagnose the aetiology from radiographic evidence.

(The lateral radiographs of the lower legs were taken with the lateral surface of the limb towards the film.)

Considering firstly Case 36 (a full-blood female), both tibiae and one fibula show changes identical with the multiple small areas of rarefaction described by MAUL (1918) as yaws lesions in bone (see MAUL'S Plate vi, Fig. I). Similar lesions are seen in the first metacarpals. Both tibiae are somewhat bowed and clinically were considered as showing "moderate deformity". This girl had suffered "pain" but no "scars" were observed.

In the forearm bones was a more advanced degree of this same alteration. These bones show both cortical and subperiosteal lesions and some areas of low periosteal swelling - in short a generalised osteitis.

The bones, especially those of the upper limb, have the appearance of increased vascularity and softness.

There is no indication that diet played any part in this case as there were other children from the same Mission in this series in whose bones these changes were absent.

In Case 45 (a half-caste female) there are doubtful lesions of both first metacarpals.

On both radii and ulnae and the left fifth metatarsal are changes which agree with those found by MAUL (1918) "When the lesion is on the surface of the bone, the periosteum is usually destroyed, but occasionally the cortex shows thickening, and the periosteum is separated from the bone." (See MAUL'S Plate iii, Fig. I).

The multiplicity of these lesions, their localised nature and the absence of any extensive periosteal growth is against a syphilitic origin. "Scars" were present.

Both lower legs and forearms are bowed probably due to an earlier change such as that seen in Case 36. Clinically a slight degree of Boomerang leg was present. No serum was collected but there was a rapid response to N. A. B.

Case 44 (a half-caste female) with clinically slight Boomerang legs shows nodes on the surface of both tibiae and fibulae. There is more periosteal deposition of bone in this case - perhaps a later development since the pain and tenderness present in the previous case were not observed here. No serum was collected. "Scars" were present and she had experienced "pain".

Case 32 (full-blood female), with moderate Boomerang legs, had a swelling of her left forearm in the lower third. This appeared to be of some duration; she gave a history of about six years. On the skin were closed and still draining fistulae. It is a condition more advanced than any illustrated by MAUL (1918), or MONTEL & COUPUT (1932), but KNAGGS (1926), Fig. 59, illustrates a tibia of which he

says "a curious pitted appearance on the surface of the node, as if a secondary caries had been going on in a considerable number of separate places." "The pitted condition is quite different from the usual appearances seen in syphilitic affections of the long bones."

She gave a history of having suffered from "irkintja" and pain, and "scars" were observed.

It would appear to be a further stage of that present in the forearms of Case 36.

Case 6 (full-blood female) developed Boomerang legs a few years ago with "sores". An earlier lesion in her nose had left some deformity and a scar extending out of her right nostril [c.f. SCHOEBL (1928)]. There was a healing lesion on her right thigh just below Poupart's ligament and

a recently healed scar on the right side of the neck. There was swelling with tenderness of the left claviculo-sternal joint. She denied limb pains but had become deaf recently. The radiograph shows a condition resembling a bone abscess in the upper end of one tibia. The nasal bridge was slightly depressed and the nasal processes of both maxillae were slightly expanded, producing a mild degree of goundou. Her serum gave a positive Wassermann reaction.

Cases 42 and 43 are of gangosa, clinically their shins were straight.

The presence of gangosa and goundou in a community is definite evidence of the existence of yaws therein.

In the series of 50 cases, there were 4 cases (females) of healed fracture of the forearm and in each case it was on the left side. These were C I aged 7, 8, 14, 55 and 31 and 60 years. The first two gave positive Wassermann reactions. Spontaneous fracture is said by BAHR (1914) to occur in cases of tertiary yaws bone lesions. I cannot recollect having seen any other cases of this fracture among the natives seen at Alice Springs. Perhaps one may attribute this 8% incidence to some predisposing pathological factor.

It will be seen from the above cases that there is much evidence for the yaws origin of the bony changes.



2 (a). Cases with Marked Boomerang Legs.

In studying the radiographs of tibiae taken at Alice Springs it was thought advisable to commence with those cases that show marked deformity as in them would be found the greatest deviations from the normal.

T A B L E X I I .

Summary of Clinical Findings in Ten Cases  
with Marked Boomerang Legs.

	No.	Sex	Age	W. R.	History of			Age at onset of B. L.
					"Sores"	"Pain"	"Scars"	
Epi-physes not fused.	5	F	3	0	0	0	0	Previous year
	1	M	12	-	+	-	+	"Born with them"
	2	M	12	+	0	0	+	Early childhood
Epi-physes fused.	26	M	18	0	0	0	-	Early childhood
	12	M	22	Anti-C.	0	0	-	Early childhood
	28	M	28	0	0	+	-	Early childhood
	3	F	50	+	0	-	-	"Not at birth"
	30	M	55	0	+	+	+	Early childhood
	16	M	55	0	+	+	-	Early childhood
13	M	55	0	0	0	+	0	Childhood.

For the discussion of these cases and the significance of the findings, reference should be made to Section VIII.

If these be arranged in order according to their ages, it is found that in the first three cases, 5, 1 and 2, the epiphyses are still unfused. They appear normal.

In Case 5 it is found that although the bone is bent, there is very little, if any, actual increase of the antero-posterior diameter. The shadows of the cortex are heavy, and thicker than normal so that in the middle third the lighter

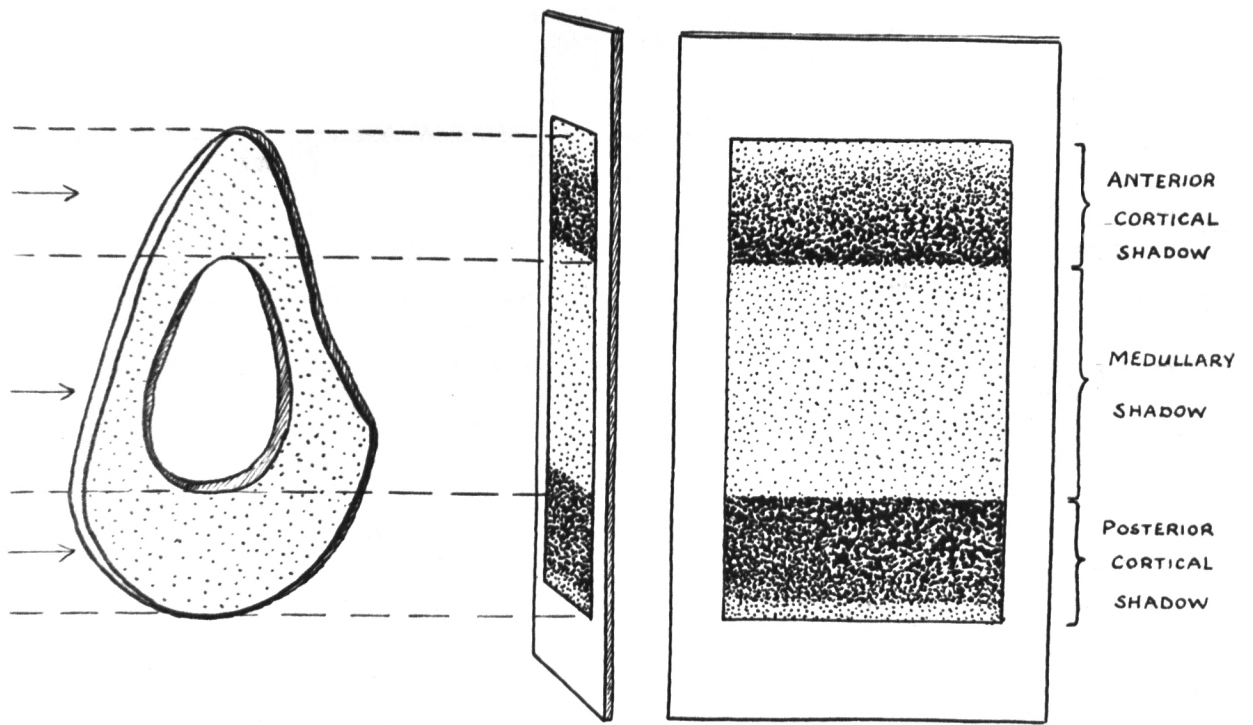


FIG. 25.

medullary shadow is reduced to one third of the antero-posterior breadth of the bone. Towards the end of the diaphyses there are transverse lines of arrested growth, indicative of previous ill-health. There is probably no cancellous tissue in the medulla of the middle third of the shaft.

In Case I there is considerable bending with slight broadening antero-posteriorly. The shadows of the cortex are moderately heavy and the medulla is much encroached upon, being only about a quarter of the antero-posterior diameter of the bone, and in places even less. The maximum breadth of the medulla is below the entrance of the nutrient canal. Parts of the medulla appear cancellated. At the ends of the diaphyses are a few lines parallel with the epiphyses. The cortex is faintly patched. The nutrient canals are enlarged.

In Case 2, with the bowing is some broadening. The cortical shadows, while increased in size, leave the medullary space nearly half of the diameter of the bone. There are transverse linear shadows in the shaft of the bone and faint "lines of arrested growth" at the epiphyseal ends of the right tibia.

The anterior edge of the left tibia is irregular beneath the scarring ulcer present on the left shin. This is an example of secondary involvement of mesodermal tissues from an adjacent lesion of ectodermal structures which is referred to by SCHOEBL (1928). Boomerang-legged subjects often had scars on the skin over the tibial crest, probably resulting from trauma. In the middle third of this bone are more numerous transverse lines and the cortex appears more disordered.

In considering the cortical shadows seen (Fig. 25) in lateral radiographs of the tibia it should be remembered that the posterior one is heavier, since it is cast by the posterior surface of the roughly triangular bone, while the

character of the anterior shadow will depend on the acuteness of the anterior angle, and the thickening of the anterior crest. The central or medullary shadow is due to the lateral and medial cortical walls and the contents of the medullary cavity.

The sharpness of the posterior margin of the anterior shadows in the above three cases may be interpreted as an indication that these anterior shadows are for the most part cast by that part of the bone anterior to the medulla and that there is relatively little thickening of the lateral and medial surfaces of the bone. Similar conclusions apply to the posterior shadows. Hence it may be presumed that the encroachment of the cortex on the medullary cavity is real rather than apparent. The lines of arrested growth show that periods of ill-health had been experienced previously. [See HARRIS (1933)].

The bone on both sides of the epiphyseal cartilages appears normal thus excluding rickets from playing any part in the conditions present in the diaphyses - which bear no resemblance to rickets.

The absence of any extensive periosteal deposit is not what would be expected if syphilis were the cause of the other changes present.

In the remaining cases of this group the epiphyses and diaphyses have fused and in all cases considerable bending is present. It is also noticed that the fraction of the antero-posterior diameter (in the middle of the shaft) occupied by the medulla increases from one half in Cases 3, 26, 12 and 28 to three-fifths in Cases 3, 30, 16 and 13.

As the cases are examined in order of age, namely 26, 12, 28, 3, 30, 16, 13, it is noticed that the posterior cortical shadows become relatively only slightly narrower.

In the three Cases 26, 12 and 28, although the anterior cortical shadows are increased in size both

in a vertical plane and antero-posteriorly, they are relatively narrower than in the preceding three cases. The medullary shadows show trabeculation of various degrees of texture, most marked along the anterior cortex, and are crossed by transverse lines. A certain amount of haziness is present in the middle thirds of the shafts. The nutrient canals also appear enlarged.

In the radiographs of the four oldest Cases, 3, 30, 16 and 13, the narrowing of the anterior shadows has progressed still further. The medullary shadows are fainter and wider and the fine transverse lines are almost obliterated. The nutrient canals are enlarged, especially in Case 30. In Case 13 the right tibia is much more bowed than the left; this was definitely associated with trauma in childhood. The medullary shadows in this case are probably due to the patchy sclerosis which resulted from the earlier lesions.

In some of these cases there is considerable thickening in the antero-posterior diameter of the tibia. This is most noticeable in Cases 3, 16 and 30.

#### S u m m a r y.

From the above findings it may be presumed that the increased breadth of the cortical shadows is due to actual thickening of the cortex itself, resulting from the lesions which, previously, had so changed the bony structure as to allow the bending to take place. The enlarged nutrient canals may be taken as an indication of the increased blood supply at that time. The narrowing of the cortical shadows - the anterior one especially - and the decrease in density of the medullary shadows with increasing age, may be interpreted as the result of gradual bone absorption from the interior which has taken place during many years.

From the degree of bending present in these cases it may be supposed that no increase in the deformity occurs after the epiphyses have fused, although the onset of the deformity was, in most cases, in early childhood.

2 (b). Cases with Moderate Boomerang Legs.

There were 16 subjects with moderate deformity.

T A B L E XIII.

Summary of the Clinical Findings in Sixteen Cases  
with Moderate Boomerang Legs.

	No.	Sex	Age	W.R.	History of		"Scars"	Age at onset of B. L.
					"Sores"	"Pain"		
Epiphyses not fused.	38	M	8	0	-	+	-	0
	23	F	8	0	+	+	+	Early childhood
	36	F	10	0	-	+	-	Early childhood
	34	M	11	+	+	+	+	Early childhood
	22	F	14	0	+	+	+	Early childhood
	47	M	14	+	+	-	+	Childhood
Epiphyses fused.	44	F HC	18	0	0	0	0	0
	18	F	20	0	-	+	-	Early childhood
	4	F	22	+	0	0	-	Early childhood
	29	M	25	0	+	+	+	Early childhood
	CVIII	M	35	0	0	0	0	0
	CV	M	55	0	-	0	0	0
	8	F	55	0	-	+	-	Early childhood
	14	F	55	+	+	+	-	Early childhood
	31	F	60	0	+	+	+	Early childhood
9	F	60	+	-	+	-	Early adult life	

The significance of these findings has been discussed in Section VIII.

In surveying this group it is found that although the cortical shadows are not so markedly increased in breadth, yet they become narrower with increasing age as in the previous group. There appear in some cases indications of thickening of the lateral walls of the tibiae. Some radiographs show areas of increased shadows in the medullary space, probably due to localised sclerosis resulting from earlier lesions.

Case 36 will be considered first, as it shows evidence of the changes of active disease. The lesions in this case appear to consist of irregular patchy areas of rarefaction with slight condensation round them. They are most frequently situated in the central part of the shadow (perhaps medullary cavity), but in one tibia the anterior cortex is involved. These lesions are identical with those illustrated by MAUL (1918) which he attributed to yaws. There is some increase of the cortical shadows, such as was observed in the younger cases of marked boomerang leg. Definite bending is present.

The medical history of this case is unfortunately scanty but it may be safely assumed from Mr. Albrecht's statements that this case was infected with yaws six years previously. From MAUL'S conclusions it is probable that the bone lesions would have commenced during the previous three years. The presence of condensation round the rarefied areas may indicate that resistance to the noxious factor has appeared and, the most active stage having been passed, the condition is resolving. If this be true it is impossible that any increase of deformity will occur. It may be assumed that the full extent of any bending, which is going to develop as a result of the disease, does so during the active stage which is shown in the radiographs of this Case 36. To account for the general character of the tibial bowing it must be assumed that the lesions in this case have been either more

extensive and numerous, or that there has been at the same time, a general absorption of inorganic salts from the bony tissue.

If this resolution of the lesions continues it is probable that a stage would be reached which, in a radiograph, would approximate to that seen in Cases 5 and 1, except that the changes from the normal would be less marked. If areas of rarefaction similar to those present in Case 36 had been recently present in these two cases, the rarefied areas in the medullary shadows may have resulted therefrom.

If, in some of these rarefied foci, the tissue destruction were more extensive, evidences of scarring in the form of sclerotic areas would result. This may account for areas of increased density in the medullary shadows of some cases.

Returning to the group with moderate deformity, Case 38 is of interest as the left tibia shows greater deformity than the right. Behind the right knee and extending up and down the lower rib was an extensive webbed scar which was the result of a burn in earlier life. He said he received the burn before the boomerang leg developed. The scar limits the extension of the leg at the knee at an angle of approximately  $120^{\circ}$ . The subject walks on the heads of the metatarsals and the foot is extended at the ankle to compensate the shortening due to the incomplete extension of the knee. The right heel is not put to the ground. It may be that the bones were affected before the burn had healed, and through not putting weight on his right leg, because of the ulceration, less deformity resulted.

In the preceding Cases 36 and 38, and in Cases 23, 34, 22 and 47, the epiphyses have not fused with the diaphyses. In these cases (excluding Case 36), although the posterior cortical shadow is of considerable breadth, the anterior one



is less marked and its posterior border tends to be obscured by longitudinal wavy hatching. This hatching is probably due to a layer of trabeculae on the inner surface of the anterior cortex.

In Cases 23 and 34, areas of sclerosis are seen in the medullary cavity. In Cases 38, 34 and 47 a few transverse lines occur in the shaft of the bones. In these five cases the nutrient canals are seen, but only in Case 47 is the enlargement significant.

In most of the above cases the middle third of the medullary cavity appears free of cancellous tissue.

In the remaining cases in this group, namely Cases 44, 18, 4, 29, CVIII, CV, 8, 14, 31 and 9, there is but little density in the anterior shadow and a large part of the shadow shows hatching. It may be assumed that the cortex anterior to the medulla is thinned and the lateral and medial cortical walls and medulla assume a more normal appearance as age increases. In Cases 29, 14 and 31, patches of sclerosis, and in most cases a few transverse lines, are present.

The periosteal changes present in Case 44 will be referred to later. None of the other cases call for particular mention except Case 9 in which there is an apparently normal bone showing anterior bowing.

There are no lines of arrested growth in these cases which may indicate that the active stage had less deleterious effect on the individual as a whole and on the bone in particular than on the individuals with marked deformity.

## 2 (c). Cases with Slight Boomerang Legs.

The subjects with slight deformity form a group containing twenty-three cases.

T A B L E XIV.

Summary of Clinical Findings in Twenty-three Cases  
with Slight Boomerang Legs.

	No.	Sex	Age	W.R.	History of		"Scars"	Age at onset of B. L.
					"Sores"	"Pain"		
Epiphyses not fused.	CVII	M	6	+	+	-	+	0
	45	F	6	0	0	0	+	0
	CI	F	7	+	-	0	0	0
	40	M	8	-	-	+	-	Early childhood
	37	M	9	+	-	+	-	Recently
	46	M H/C	10	0	0	0	+	0
	CIII	F	10	+	-	0	0	0
	39	F	10	0	-	+	-	0
	35	F	11	-	-	+	-	Few years ago.
	CIX	M	16	0	-	0	0	0
Epiphyses fused.	7	F	18	+	-	+	-	Early childhood
	17	M	20	0	-	-	-	Early childhood
	6	F	20	+	+	-	+	Few years ago.
	21	F	30	0	-	+	-	Womanhood.
	CIV	M	35	0	-	0	+	0
	CVI	F	35	0	-	0	0	0
	11	F	40	+	+	+	+	Young woman
	27	F	40	0	+	-	+	Baby
	15	F	45	+	+	+	+	Young girl.
	32	F	45	0	+	+	+	4 years old.
	10	F	50	0	-	+	-	Early childhood
	CII	F	50	+	+	0	+	0
	19	F	60	0	+	+	+	Early childhood

The significance of these clinical findings has been discussed in Section VIII.

In all cases some degree of bending is present. In the first ten of these the epiphyses are not fused.

Surveying the whole group, no regular progression of changes is found as was noticed in two previous groups. The cortex is slightly thickened. The medulla appears free of cancellous tissue in its middle third but in many instances trabeculae are present along the posterior surface of the anterior cortex.

In Case 45 (half-caste) there is a periosteal lesion of the left fifth metatarsal. At the lower end of each tibia is a line of arrested growth; 8 mm. above the epiphyseal plates. Similar lines are present in the ulnae of Cases 40 and 45; the latter is a half-caste.

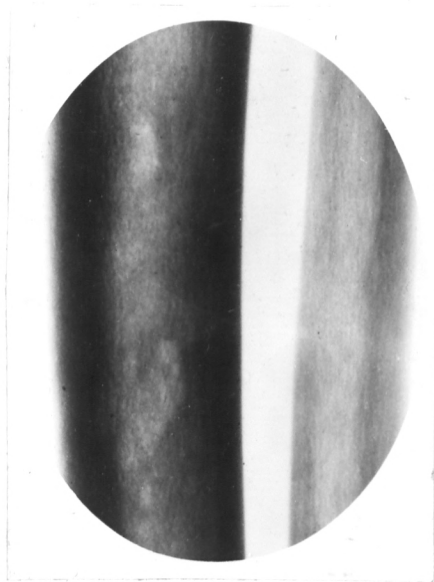
In Case 21 the whole cortex appears to be thickened, forming bosses; most of this thickening is due to periosteal deposition. There is some mottling of the cortex in the lower parts of both tibiae which may indicate that there is still some activity going on. She said her shins had only become affected in womanhood. There is no evidence of vertical striation such as is often seen in syphilitic changes. Scars were present on the shins; probably the bony changes represent a late sub-acute stage.

In "Control" IV, although considerable bony change is present, there is little bending. In this case the bony changes may have commenced later in life than in the other cases.

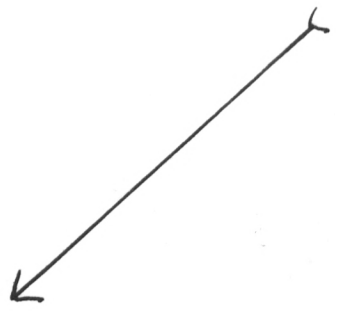
In "Control" VI there are small localised nodes on the fibulae.

In cases 15 and 10 there are sclerotic areas in the tibiae. No definite lines of arrested growth are present but in several tibiae transverse lines are present in the shaft.

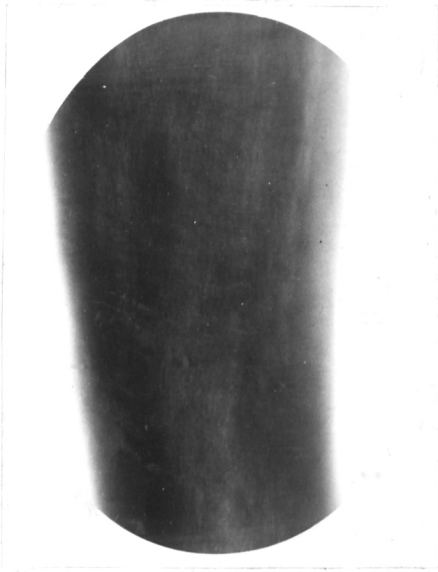
Schema showing the course of bone lesions in jaws.



Earliest Stage.

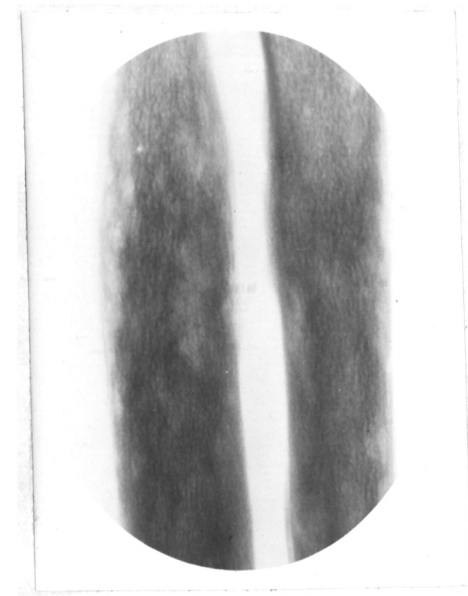
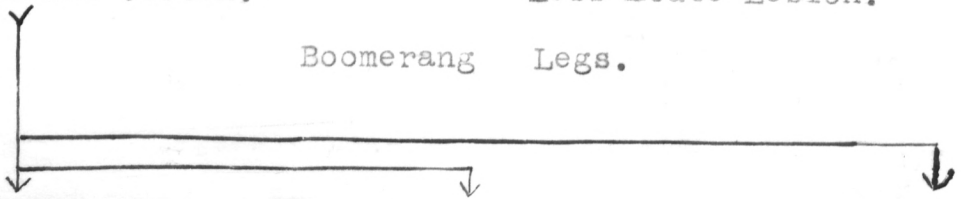


Thickened Cortex.

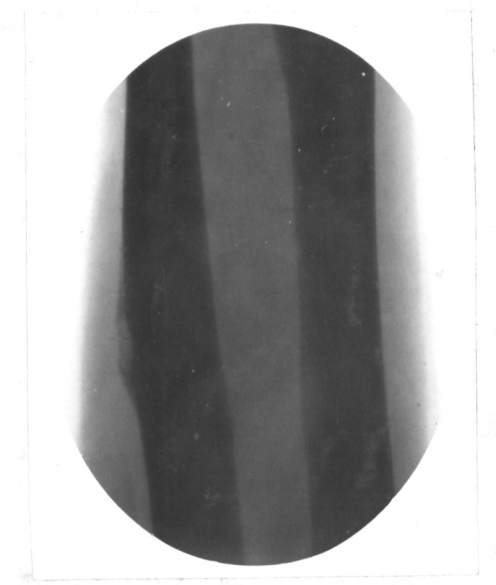
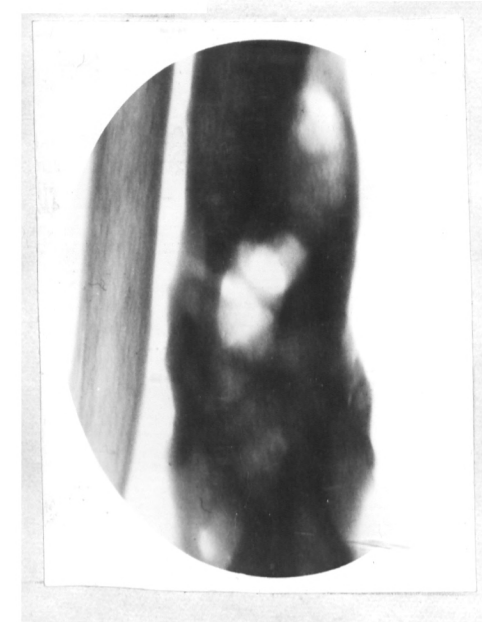


Less Acute Lesion.

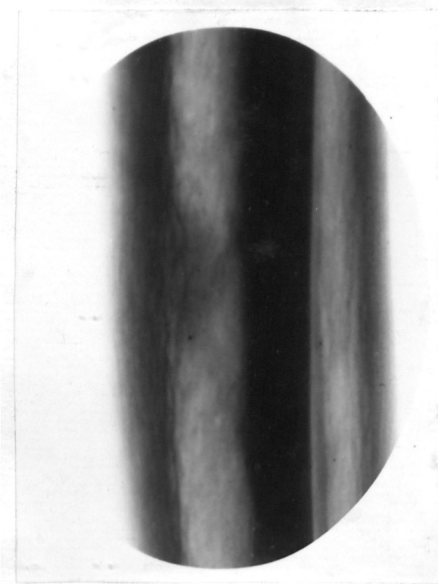
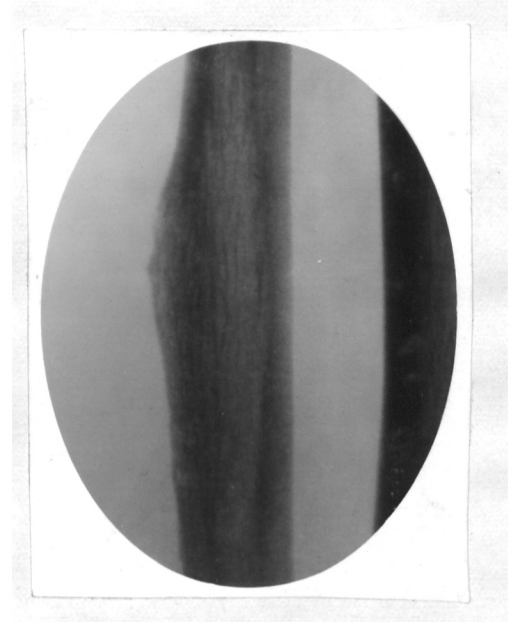
Boomerang Legs.



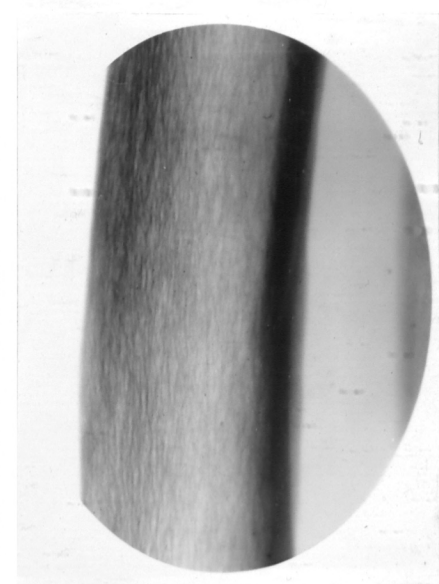
Necrotic Lesions.



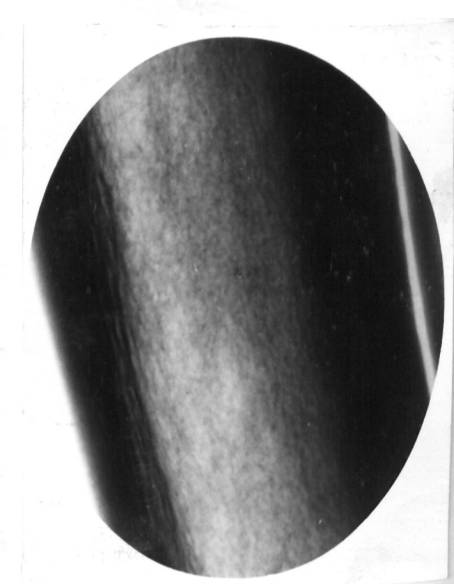
Periosteal Nodes.



Bent Tibia



Cortical Thickening Resolving.



Broadened Tibia.

Considering this group it will be seen that the changes present are of the same character as those which have been found in the previous two groups.

The increase in breadth of the anterior cortical shadow is not so extensive and on the whole there is less tendency for the breadth of this shadow to decrease as age progresses. In many cases there is little disturbance of the medullary changes, which may be an indication of the less serious nature of the previous acute changes and is supported by the minor degree of the bending.

### 3. S u m m a r y.

#### (a). Suggested Pathogenesis (See Schema)

In summarising the lesions shown in the radiographs, the course of pathological changes in bone due to yaws may be tentatively outlined, despite the fact that many of the suggested "stages" are represented by only one example.

Case 36 will be taken as a starting point. The tibiae and first metacarpals show changes identical with those found by MAUL (1918) in cases of yaws in the Philippine Islands.

In these bones it is probable that the pathological process is waning since some general bending of the bone has occurred. In the anterior cortical shadow of the right tibia are areas of rarefaction which may have been more general. The weakened bone is deformed by body weight and muscular action. In some cases although the tibia is bent the fibula is straight; this may indicate that increased tibial growth may play a part in the production of the deformity. That there are medullary lesions is shown by the thickened trabeculae found throughout the narrow spaces in sections of some boomerang legs. There is also some thickening of the cortical shadows which is shown in other cases to be due

both to encroachment on the medullary space and superficial bony deposition. This is probably the result of earlier patchy lesions in the cortex, or of the response to toxic damage continuing for some time as a chronic inflammation after the acute stage has subsided. That there is considerable increase in the vascularity of the bone is shown by the enlarged nutrient canals seen in some of the radiographs.

As the assumed more acute stage resolves several courses may be followed. The rarefied areas may clear up leaving only the deformed bone and the thickened cortex, as is shown in the tibiae of Case 1, where these changes are more marked than would perhaps result from those in Case 36.

Then would follow a stage such as that seen in the tibiae of Case 26, where the cortical thickening is resolving and the medulla of the shaft is trabeculated. Finally a condition, as in the tibiae of Case 30, may result in which the cortex is relatively not unduly thickened.

If there is no broadening of the bone antero-posteriorly it will appear normal on superficial inspection, except that the bone is bent. This may account for the observations of earlier writers. During this course other alterations may result as the lines of arrested growth seen in the tibiae of Case 46 or the areas of sclerosis seen in the tibiae of Case 29. It is this course that results in the condition of boomerang legs. The radiographic appearances would depend on the severity of the initial lesion and the time which has elapsed since the onset.

Returning to Case 36, the radiographs of the fore-arms show what might be interpreted as another development from the changes seen in the tibiae of the same case. Here the rarefied areas seen in tibiae are more numerous and many are more superficial. In some areas the periosteum is thickened. The epiphyses are normal but the diaphyses appear

weakened and vascular. This stage resembles the illustration by MAUL (1918) of chronic yaws lesions of bone. The changes in the left radius of Case 32 may represent a further development of those present in the radii of Case 36. This may be taken as the lesion which KNAGGS (1926) describes as "a curious pitted appearance on the surface of the node."

In Case 45 there is a slight degree of boomerang deformity in the tibiae. On the left fifth metatarsal and on the left radius and both ulnae are crater-like projections associated with some localised periosteal deposition and cortical thickening which resembles lesions described by MAUL (1918). Whether these nodes result from subperiosteal lesions of the generalised changes seen in the tibiae of Case 36 or from isolated periosteal lesions it is impossible to say with certainty, but the presence of some tibial bending may indicate the former course.

The changes present in the leg bones of Case 44 may represent a further stage of the nodes present in Case 45, when the active process has subsided.

The condition seen in the radiographs of the tibiae of Case 21 may result from generalised bone lesions of a less acute nature occurring after puberty. It is not likely that the bone changes are secondary to skin involvement. She said her leg trouble did not commence until she was a woman.

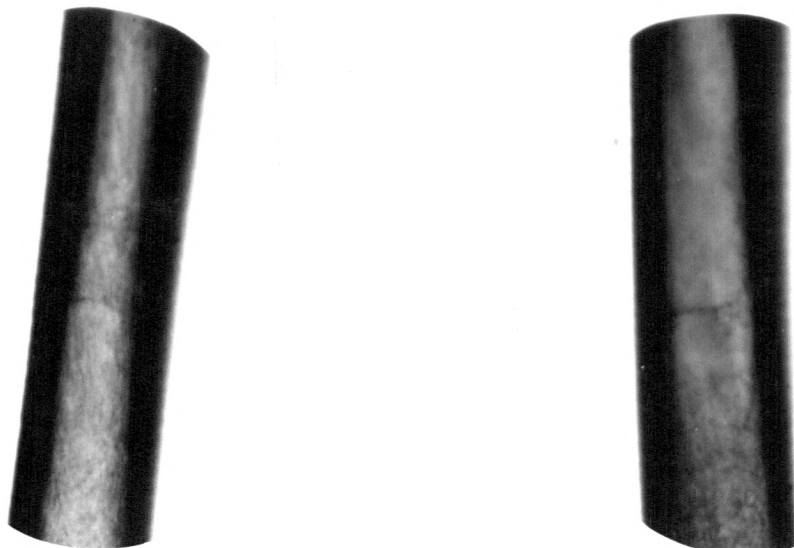
Further details of these cases are to be found earlier in this Section and in Section VIII.

### 3 (b). Transverse Lines in Long Bones.

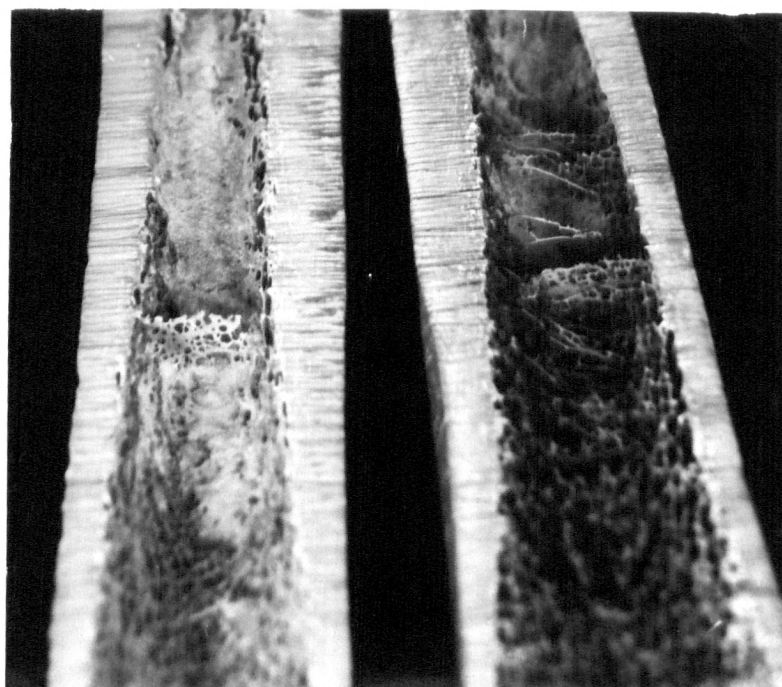
(See illustrations facing this page).

The lines of arrested growth which are present in some of the tibiae are identical with those described by HARRIS (1933) as occurring at the epiphyseal cartilage in conditions of ill-health. He says (p. 23), "the presence

Transverse Lines in Radiographs.



Cribriform Plates in  
the Corresponding Bones.





of the lines is positive evidence of arrested growth in the past. The absence of lines of arrested growth indicates that either there has been no severe illness or that the subsequent life has been of such activity as to remove all trace thereof." Most of the cases in this series have lead lives of roughly equal activity, with the possible exception of the half-caste children and Mission natives. As a bone only increases in length by epiphyseal deposition, it should be possible to obtain the approximate distances from some point such as the epiphyseal plate, or the articular surface, at which lines would occur, corresponding to the age of the subject when they were laid down. For instance, by measuring the radiographs, reproduced by HARRIS, from the lower tibial articular surface, it may be said that for adults, from

1st year of life	11.4 cm.	of bone are deposited
6th " " "	8 cm.	" " " "
9th " " "	6 cm.	" " " "
12th " " "	5 cm.	" " " "
15th " " "	3 cm.	" " " "

(These values are only approximate).

Those shadows to which I have referred in this Section as transverse lines in the shaft, may occur 12 cm. or more from the lower articular surface and so probably date at least from the very early years of life (Fig. 64). On examining sections of dry bones which had previously been radiographed, these shadows were found to be thrown by delicate, horizontal cribriform plates. It was observed that in the radiographs the lines did not extend across the whole of the medulla but tended to bifurcate or flare at the ends. In the sections it was found that the plates were attached at their periphery to the cortex by trabeculae, so that the actual plate was of less area than the transverse section of the medullary cavity. From the few bones in which this was studied, it was found that the farther the plate was situated from the lower end the smaller was the area of the plate. In one bone, 38 cm. in length, a plate 0.4 cm. in antero-posterior diameter, was present 15.5 cm. from the lower end. There is no apparent reason why these

plates should not be formed in the same way as the lines of arrested growth, namely by increased ossification at the epiphyseal plate during a period of delayed growth. The perforations are possibly caused by erosion by vessels and marrow which would occur when growth proceeded. It may be concluded then, that these lines indicate previous severe illness. However in Case 41, which I have regarded as a negative (many unsuccessful efforts were made to obtain control negative cases) these transverse lines are present at 12.5 cm. and 11.5 cm. from the lower end. These lines are absent in some cases, so it is not possible to attribute them with certainty, to the yaws infection in early childhood. There is no doubt that dietary insufficiencies occur among the natives as an outbreak of scurvy occurred at Hermannsburg in 1929 [see CLELAND & FRY (1930)]. This was during a severe drought when native food had become very scarce. Bush natives arriving at the Mission were emaciated and Mr. Albrecht, the Missioner, told me that some of these were suffering from scurvy. BASEDOW (1932) speaks of the occurrence of scurvy in Central Australia, but his diagnosis must be received with caution. During the summer months, especially if drought is present, native food may become very scanty. These "transverse lines" may have been laid down during such periods of food deficiency occurring in the early years of life.

Dr. H. Sear, of Sydney, made the suggestion to me that perhaps these cribriform plates may result from the ossification of blood clots which had filled slight incomplete cracks in the bone.

MONTEL & COUPUT (1932) illustrate only localised lesions and do not deal with resolution.

MAUL (1918) says one of the points differentiating yaws lesions of bone from those due to syphilis is the absence of cortical thickening in the former, except in 2% of cases with swelling over the surface of the bone. His cases are of acute or active bony disease and he did not follow up the changes that occur during resolution without treatment.

It will be noted that in the present series generalised cortical thickening is the rule in those cases in youths and young adults where no acute lesions are found.

MAUL (1918) reproduces several radiographs. Plate V, Fig. 1 and Plate VI, Fig. 1 are from his Case 8, who had contracted the primary lesion in August, 1916, the secondary rash appeared in October and joint pains in December of the same year. The radiographs were taken in February, 1917. This case, a Filipina aged 27, had the most recent lesions in his series and from it he described the bone lesions. The radiographic changes are characterised by the areas of rarefaction to which he calls attention, but there is no alteration of the outlines of the bones. His Plate VII, Fig. 1 is from his Case 1, a Filipina aged 8, in which the duration of bone trouble from his Table 1 (p. 66) is seven years, but from his case notes (p. 70) it is only three years (the primary sore and secondary rash occurred in infancy); his Plate III, Fig. 1 is from his Case 3, a Filipina aged 15, in which the primary sore and secondary rash developed six years previously and joint pains began a year later. While these illustrations show rarefied areas similar to those seen in his Case 8 these areas tend to have more defined margins and there is more bony destruction and alteration of the bone outline. I think that the lesions of his Case 8 may be taken as the earliest changes, while those in the other two cases may be regarded as a later stage.

KNAGGS (1926), referring to MAUL'S description, says "they are probably some of the earliest manifestations of bone implication, and we may fairly assume that they mark the situation of small granulomatous masses of similar nature to those which constitute the cutaneous eruptions."

In view of the large part played by the epithelial tissues in the cutaneous lesions, this assumption is unallowable. I have been unable to find any reference to the histopathology of bone lesions in yaws.

3 (c). Differential Diagnosis.

Coming to the problem of the differential diagnosis of the radiographic appearances which have been discussed above, I feel this requires a more extensive experience of bone pathology and radiography than I, at present, possess. Dr. H. Sear, of Sydney, kindly examined a number of films representative of the whole series and I will take the liberty of quoting from a letter from him dealing with this point. He writes:-

"While in Paget's disease, which is so prevalent in Australia, one may have, especially in the later stages, a stringy type of bowed bone, nothing similar to the preceding more vascular stages of Paget's is present in these bones.

"I cannot see the changes in these films are due either to leprosy, or to deficiency diseases - they do not suggest either rickets or scurvy.

"The differentiation from syphilis would have to be discussed under separate heads -

- (1) Newly-born infants, with congenital syphilis, show a typical picture which is quite different from this.
- (2) Young children show a specific periostitis, which is very dense and is sometimes accompanied with gumma formation. It is usually a fairly wide spread and fairly even type of dense osteosclerosis.

"Case 32 is quite distinct from syphilis. Although changes somewhat similar to those in the forearms of Case 36 might possibly be seen in syphilis in infants, this would be most unusual at the age of this subject. The legs of Case 36 are, of course, diagnostic. An appearance such as the forearms in Case 45 would be unusual in syphilis; to have syphilitic gummata one would expect much denser periostitis."

A P P E N D I X.Doubt as to existence of bone lesions in yaws.

SCHOEBL (1928), p. 297, stresses the fact that in his experimental studies he found no evidence of latent infection, that is a "stage of treponematous infection when the clinical manifestations and other symptoms have disappeared, either spontaneously or as the result of treatment, but the treponemas have survived within the tissues of the body and again produced later, after a period of latency, clinical manifestations and symptoms." On page 308 he writes, "We must bear in mind that framboesia tropica is primarily and in the majority of cases exclusively, a skin affection, and that spontaneous healing and therapeutic cure are far more rapid and complete in yaws than in syphilis. Furthermore a permanent localisation of *Treponema pertenu* in the internal organs has not been demonstrated satisfactorily. It is certainly not the rule. It is an open question whether or not the bone lesions in yaws, either early or late, are always due to actual localisation of *Treponema pertenu* in the bones or whether it is a process analogous to that of *Keratoderma plantare*." On page 25 he writes of *Keratoderma plantare*, "the callous thickening of the plantar skin has been associated with framboesia as its late manifestation. This condition exists in the Philippines. Its etiologic affiliation to yaws rests on purely clinical grounds. Treponemas have never been found in those lesions." "The main feature of the *Keratoderma plantare* in monkeys was that the lesions developed very slowly and were of long duration. . . . They consisted in a horny thickening . . . . . These lesions represented from the beginning a purely hypertrophic process, without any inflammatory reaction whatever." He describes them as "late persisting framboesides" and says "that the search in them for *Treponema pertenu* was futile." On page 283 he says, "with regard to the results of superinfection three types of conditions were observed", and coming to Type C he continues, "animals in which inoculation resulted in local lesions of long standing with occasional mild local exacerbation, and in which the yaws process was further kept alive by repeated superinoculation, did not develop generalised metastatic eruptions of typical yaws or early framboesides, but developed in due time late persistent framboesides (*keratoderma plantare*) gave repeatedly positive though not typical takes, and sooner or later the inoculation resulted in a deep ulcerative lesion, slowly spreading, not healing while active, and when healing took place it was from the periphery of the lesion. Very few treponemas were found in these lesions." The "later persistent framboesides . . . . are signs of partial immunity." On page 309 he writes, "the patients, like the experimental animals, who develop late ulcerative so-called 'tertiary' lesions, have not gone through crops of generalised yaws manifestations at all, or not a sufficient number of them, to develop such a degree of immunity as is conferred on patients who went through a typical initial yaw and had repeated crops of generalised manifestations . . . . The initial yaw not infrequently turns into an ulcerative chronic lesion." On page 254 he says, "In monkeys that have been kept constantly infected by superinfection I have repeatedly seen *keratoderma plantare* develop from the very beginning as a hypertrophic, diffuse, persistent process that responded promptly, even though slowly, to specific treatment with neosalvarsen."

On page 290 he says, "as a phenomena of immunity, in the broad sense of the word, two allergic states exist; .... the second allergic state is of the character of an anaphylactic condition in which the body tissues react to superinoculation by excessive granulation and ulceration at the place of inoculation or at the place of the residual local yaw, and by hypertrophic or atrophic skin lesions in places remote from the point of inoculation."

In a letter dated 22nd March, 1935, from Tokyo, Dr. Schoebl writes;

"My impression with regard to late bone lesions is that the interpretation of their pathogenesis and the direct proof of their etiology meets in the majority of cases with great difficulties. Among my more than 500 yaws monkeys I observed late bone lesions, mostly of necrotic type, exclusively as an extension of late ulcerative or fungoid skin lesions, which in spreading involved the cartilage and even the nasal bones resulting in the so-called gangosa. Involvement of long bones or others distant from the skin ulcer was never observed among my experimental animals possibly for the reason that inoculations having been made on the eyebrows or scrotum the late ulcerative lesions invariably developed at the site of initial lesions which may in their course have travelled some distance from the place of inoculation, but not very far, for instance from the eyebrow on to the nose. In looking over the clinical material I found in a vast majority the bone lesions, ulcerative, hyper- or atrophic combined with skin ulcers either extant or healed and located in parts of the body which are affected by initial lesions with preference, that is lower extremities and the face. Bringing these two kinds of findings, experimental and clinical together I believe that as a rule the late bone lesions are extensions of late yaws skin lesions and may frequently be more conspicuous than the original skin lesions particularly when healing has set in, for the reason that the ability of the skin to heal almost ad integrum is far greater than that of the bones where inevitably a deep periosteal or osteal process will persist as a considerable thickening or rarefaction of the bone while the likewise destructive process in the skin will heal merely by scar which at that is apt to atrophy in due time. I consider any late ulcerative, hypertrophic or atrophic yaws lesion as an allergic condition. They develop in animals only round deposits of treponemas during healing of the initial lesion or round dormant nests of parasites. The allergic process extends far beyond the area where the parasites are deposited, extends over tissues which primarily are not affected by initial lesions, their development is rapid and healing slow and they show histologically a great resemblance to lesions produced by parasites of other chronic infections such as syphilis, tuberculosis and leprosy, that is to say necrosis, hypertrophy of connective tissue, local changes on the blood-vessels and giant cells. Like an anaphylactic shock so here also the sensitisation is specific, but the symptoms and other findings are very similar, whatever the sensitising agent may have been I admit that it may be at times difficult to apply this interpretation to every given case, but it seems to be the fate of medical research that one is at times confronted with a fait accompli the past history of which is beyond human ken. We know, however, that late ulcerative lesions in experimental animals may by extension from the skin, involve mucous membranes, cartilage, muscles and bones, all tissues which cannot be infected primarily with yaws even by direct inoculation.

"Coming to Maul's work, it was done while I was in Manila and I saw his photographs and attended his lecture. My experience in the line of X-ray work is practically nil, so I am not in a position to pass judgement. He found some changes on the long bones and claimed them to be different than the findings on syphilitic patients made by others elsewhere. I thought that a sufficiently large series of findings made on Philipinos not suffering from yaws would have made his argument stronger. He apparently did not consider the possibility of co-existent nutritive condition unrelated to yaws which consideration seemed to me of some consequence in a country where malnutrition abounds."

SECTION XIII.

STUDY OF SOME ABORIGINAL BONES.

1. Sources of material.
2. Tibiae with boomerang leg deformity.  
Summary.
3. Skulls with pathological changes.  
Summary.
4. Other bones with pathological changes.  
Summary.
5. General summary.

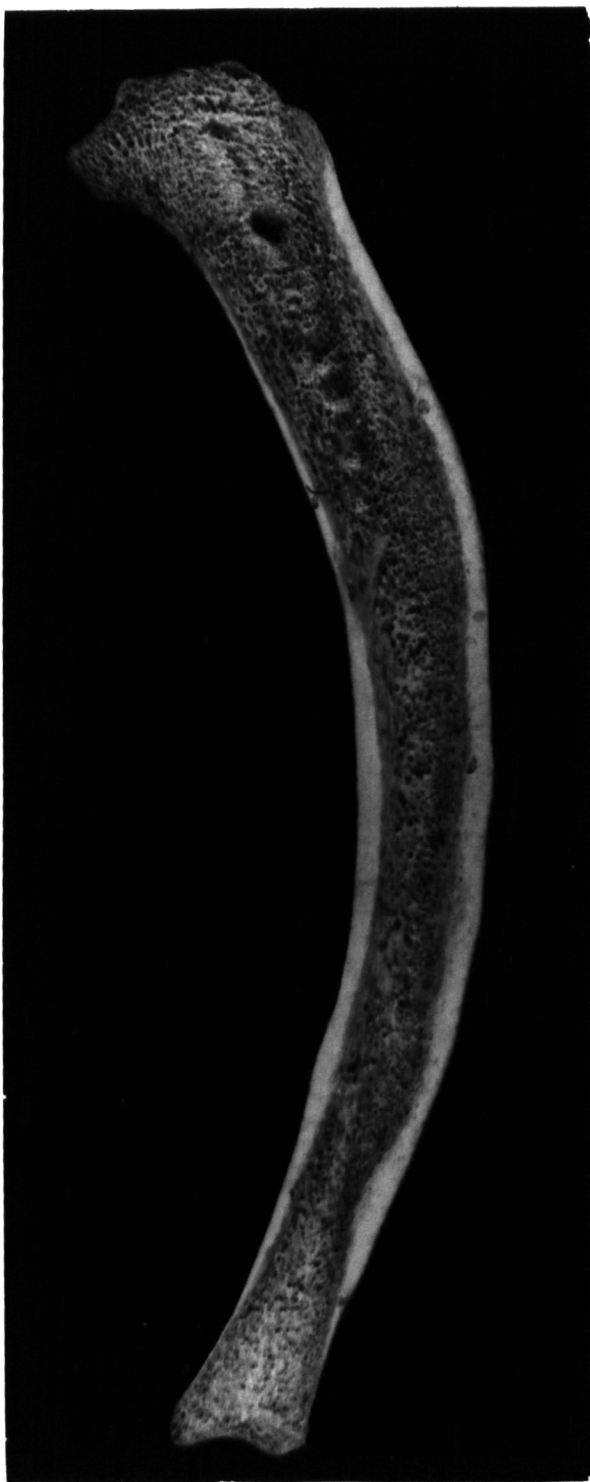


SECTION XIII.STUDY OF SOME ABORIGINAL BONES.1. Sources of Material.

The material dealt with in this section is from the South Australian (Adelaide), National (Melbourne) and Australian (Sydney) Museums, and from Museums of the Universities of Melbourne, Sydney and Adelaide. In the following descriptions the numbers are those of the institution in which they are lodged. Those with single numerals and no museum name are from my own collection. Specimens from the Northern Territory were, with exceptions, disregarded as the deformity had been seen in living subjects. No bones from Tasmania or Western Australia were seen.

The descriptions are mainly of bones showing boomerang leg deformity and do not constitute a complete pathological survey of the collections examined, although the other conditions described give a fair indication of the pathological changes to be found among the bones of Australian Aborigines in the Museums visited.

In the sub-section below, those bones which have been radiographed are dealt with first, then brief notes on other specimens are given for their interest in ascertaining the geographical distribution.



Specimen described by  
BREINL and PRIESTLEY.

## 2. Tibiae with Boomerang Leg Deformity.

Attention may be drawn to the description of their specimen by BREINL & PRIESTLEY (1915) (see Section VII). This bone is now in the Museum of the School of Public Health and Tropical Medicine, Sydney. Through the kindness of the Director it was sent to me and permission was granted for a new description to be made. There can be no doubt that the specimen is that which BREINL & PRIESTLEY have described, for it is recorded in the Museum as such and it corresponds exactly with the photograph they have published. It was from a Queensland native.

The specimen is the lateral half of a left tibia. There is marked anterior bowing with practically no lateral bending. There is considerable increase of the antero-posterior diameter of the bone, with flattening medio-laterally. The exterior of the bone is roughened below the middle, and 10 cm. above the lower end, on the posterior surface, is a bony deposit 3 x 1 cm.; otherwise there is no obvious pathological change present. The cortex is thickened along the diaphysis but is thinned at the epiphyses. The anterior curve consists of four minor ones. The thickening is not uniform but encroaches upon the medulla in some places. The whole of the medullary cavity is filled with thickened, coarse trabeculae. The lamellar structure of the epiphyses is also coarser and thicker than normal. The architecture of the trabeculae in the anterior part of the diaphysis is closer than that in the posterior part. The line bounding these areas joins the cortex where that structure thins towards the epiphyses. It may be that the closer trabeculae result from the absorption of the earlier more thickened anterior cortex, as will be outlined below (Section IV). The radiograph shows the gross changes detailed above. The cancellous tissue has been damaged in places since BREINL & PRIESTLEY'S photograph was taken.

One is at a loss to account for that part of their description which states, "almost the whole marrow space is filled by compact bony tissue, only here and there are remnants of greatly thickened cancellous tissue." "The lamellar structure of both ends of the bone has become completely obliterated, being transformed into compact bony substance."

One presumes that there is some misunderstanding in the use of the term "compact bony tissue".

Before describing the following specimens I have convinced myself, both by clinical observation and by their presence in the museum collections, that straight tibiae do not occur among Australian aborigines. With regard to the relative thickness of the anterior and posterior cortex of the shaft as shown by sections or by radiography, I cannot be so definite. I would disregard with suspicion any bone in which, at the middle of its shaft, the medullary cavity (A.-P.) is less than one half of the antero-posterior diameter of the bone. Any bone in which the proportion of the antero-posterior diameter of the shaft, at its middle, to the length of the bone is much larger than 6.5% I have regarded as flattened.

All the radiographs are lateral aspects. In no case was any epiphyseal abnormality observed.



A 25493.

A. 25493 (a and b) - (South Australian Museum), tibiae;  
Alice Springs, (N. T.).

STIRLING (1896) referred to these tibiae (see Section VII)  
as belonging to the skeleton of "Paddy O'Rafferty".

Right tibia (b):-

This bone is 25% heavier than the left. It appears normal in the middle third except for some flattening. The whole bone is slightly bowed anteriorly. In the upper third, on the medial side, is an expansion, 9 x 6 cm.; its upper and medial surfaces are irregular, suggestive of more active inflammation. On the medial surface of the middle third of the bone are numerous fine longitudinal grooves. The lower third is generally expanded and shows some modelling, but on the upper medial and the lateral aspects, the surfaces are rougher. The popliteal line is exaggerated. The interosseous ridge is marked in its upper third. The articular surfaces appear normal except for some lipping of the medial edge of the inner condyle.

Radiograph of right tibia:-

The cortex is thickened so that anterior cortex equals posterior cortex and one-third of the antero-posterior diameter of the bone; the medullary cavity is thus only one-third. The whole medullary cavity is filled with cancellous bone. The upper expansion consists of laminated bone deposited externally to the original bone surface. This also applies to the lower node, although there the bone is more compact. The tissue in the medullary cavity at the site of the lower node is denser than elsewhere; this is below the entrance of the nutrient canal to the medulla. There is one transverse line visible in this sclerosed area.

Left tibia (a):-

Structurally the bone appears normal except for some anterior bowing and slight increase in the antero-posterior diameter. There is some slight lipping of the condylar edges, most marked on the medial side. There is an irregular flattened area on the surface of the lateral condyle which appears to be the result of healing that has occurred in an eroded area [c.f. MAUL (1918)]. There are numerous fine longitudinal grooves on the shaft, especially on the medial surface.

Radiograph of left tibia:-

The cortex is thickened, most markedly in the posterior part. The thickening of the anterior cortex is less defined though perhaps more extensive; the shadow appears laminated and merges with that of the cancellous tissue

which appears to fill most of the medullary cavity. There are two transverse lines in the middle third of the bone; the nutrient canal enters the medulla between them.

Both these bones show slight boomerang leg deformity. Considering the locality from which they came and the appearance of the left tibia, it is probable that the changes in the right bone are the result of yaws.

Right.



3

Left.

Right.



5

Left.

"RANDA".



"Randa" - (private collection); skeleton of aboriginal female; Alice Springs, (N. T.).

She was approximately forty years of age when she died in 1933. The skeleton was exhumed in April, 1934. Photographs during life were taken at Alice Springs in 1927. I have not seen any native with such marked deformity; both her legs and arms were bowed (see Figs. 2 and 3).

Right tibia:-

This bone is bowed to a marked degree.

Measurements:-

- A. Distance from postero-lateral projection of medial condyle to posterior margin of lower articular surface, lateral to malleolus is 36 cm.
- B. Distance from anterior condylar edge to anterior margin of lower articular surface, along the anterior edge of the bone is 43.6 cm.
- C. The maximum departure of the arc of the bone (posterior articular border) from the chord (A) is 7 cm. at 13 cm. from upper end of chord.
- D. Maximum antero-posterior diameter in the middle third is 3.3 cm.

Measurements taken from an apparently normal bone

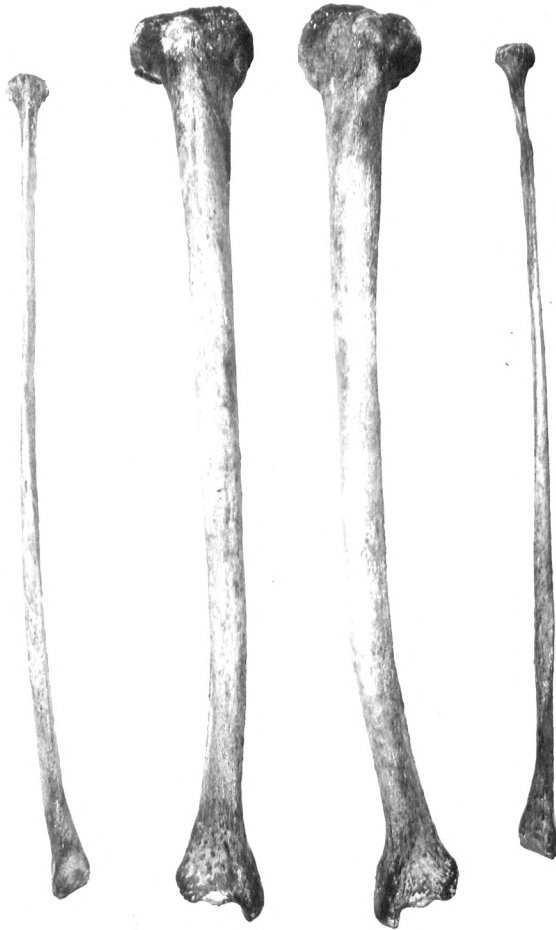
were:- A. 36 cm.; B. 36 cm.; C. 1.5 cm.; and D. 2.7 cm.

It will be seen that the bone is bent and flattened. The anterior border is rounded. The lower third of the bone is slightly bowed laterally. On the medial surface are numerous fine longitudinal grooves. On the lateral surface, anteriorly to the nutrient foramen, are several irregular bony deposits. The popliteal line is very oblique and extends below the middle of the bone. The posterior surface of the tibia is, in part of its extent, a ridge. The interosseous ridge is an arc (of a larger circle than that of the bone) and approaches the posterior ridge in the middle third. The nutrient foramen is enlarged. There is some lipping of the upper articular margins.

Radiograph:-

The altered shape is at once seen. The cortical shadows are not increased in their densest part, but their inner borders merge into the sclerosed medullary cavity which is over half the diameter of the bone. The medulla is filled with cancellous tissue in which are numerous faint and irregular transverse lines. There is a distinct transverse line 3 cm. from the distal end of the bone. The nutrient canal is greatly increased in diameter and extends into the anterior half of the bone.

Right.



Left.

Antero-posterior position.



Right tibia sectioned.  
"RANDA".

## On section:-

It is seen that the cortex is not thickened, the anterior cortex in the middle of the bone being only one-eighth of the total diameter. The cortex is coarsely trabeculated on its medullary surfaces.

3 mm. under the postero-lateral margin of the medial articular condyle is a cavity 7.5 mm. in depth and 1 cm. wide, which opens out to the surface by a small pit. Its walls are smooth. On referring to the radiograph the outline of this cavity can be seen.

The medulla is filled with loose cancellous tissue, which, at the metaphyses, appears normal. There is a transverse plate 3 cm. from the lower end. The middle third of the shaft is fitted with coarse and open trabeculae in which the nutrient canal runs 7.5 cm. as a bony tube and opens near the anterior cortex. The intervening medulla is occupied by fine trabeculae which merge into the cancellous tissue of the metaphyses.

## Right fibula:-

This bone is markedly bowed and flattened

The value of the above measurements are:-

- A. 36 cm. maximum distance between ends.
- B. 41.4 cm. length of bone disregarding articular surface.
- C. 6.5 cm. at 18 cm.
- D. 2.5 cm.

(A normal fibula is straight, measurement C is under 1 cm. and D is about 1.5 cm.).

The surface of the bone is roughened and moulded by adjacent structures. The interosseous attachment is flat and represented by a broad roughened area. The lower 10 cm. of the bone is slightly expanded. The anterior crest is sharp in the upper half but becomes almost a surface, 0.7 cm. wide, in the upper part of the lower third.

The radiograph shows some sclerosis of the medulla and several transverse lines in the lower metaphysis.

## Left tibia:-

This bone is almost identical with the right tibia. The measurements are - A. 36 cm.; B. 45.3 cm.; C. 7.7 cm. at 15 cm.; and D. 3.6 cm.

The radiograph is also similar except that the transverse lines are more numerous.

The left fibula is practically identical with the right one.



Right.



Left.

"RANDA".

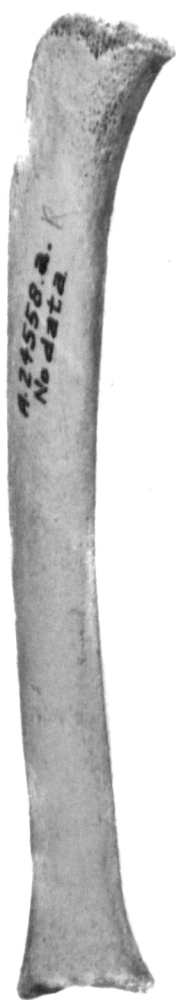
The femora are markedly bowed anteriorly. The linea aspera is raised above the bone in the middle third. There are osteophytic outgrowths along the medial margin of the medial condyle, with some erosion of the upper medial part of the anterior articular surface. Below these areas and anterior to the intercondyloid fossa towards the margin of the articular surface is a depression 1 cm. in diameter on each bone. The cortex is thickened.

The humeri are not grossly altered, but the lower extremity appears to be displaced medially so that the lateral epicondyle is not prominent. This part of the bone appears to be displaced forwards. The olecranon fossa is perforated in the right bone.

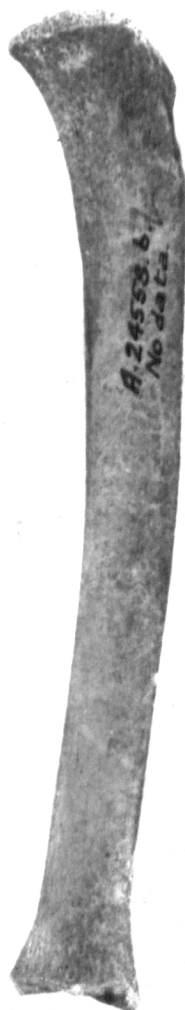
#### Ulnae and radii:-

Both ulnae are bowed laterally; the left one more than the right. In both bones there is a lateral displacement of the shaft upon the upper articular surfaces, as if the former had been twisted on the latter so that the interosseous ridge lies along the volar surface of the bone; this is more marked on the left side. Both radii are also bowed laterally, the left one more than the right. On the right side the radio-ulnar articulation is displaced upwards and a new ulna socket has been formed on the radius. On the left side the greater bowing and rotation of the ulna has resulted in bringing the ulnar articulation of the radius into contact with what should be the lateral dorsal surface of the styloid process of the ulna. Both radii have undergone twisting so that the transverse axes of the lower ends are rotated laterally through a right angle.

This woman, when alive, was renowned in the country round Alice Springs for her boomerang legs, and her tibiae exhibit the deformity to a marked degree.



A 24558.



A 708.



A. 24558 (a and b) - (South Australian Museum); tibiae;  
(Probably South Australian).

Tibiae:-

These two bones (length of diaphysis 17 cm.) are of a child probably 5 years of age. The epiphyses are missing. They are slightly bowed anteriorly. The epiphyseal surfaces of the diaphyses are coarsely pitted.

The radiographs show cortical thickening which reduces the medullary cavities to less than half of the antero-posterior diameter of the bones in the middle of the shafts. The cortical shadows are not dense but show longitudinal lining.

These bones are probably from an early case of boomerang legs.

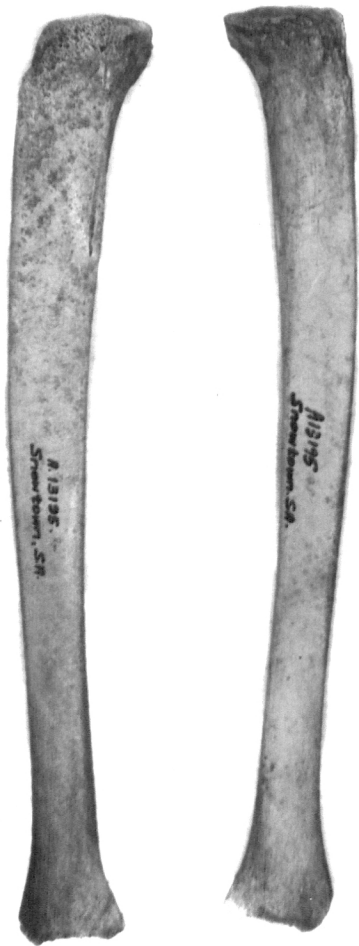
A. 708 - (South Australian Museum), right tibia; Murray Bridge, (South Australia).

Right tibia:-

The chord of this bone is 21.5 cm. The epiphyses are missing; probable age, 8-10 years.

There is marked anterior bowing with a protuberance along the anterior border above the mid-point; otherwise the bone appears normal. The doubt that this deformity may have resulted from a simple green-stick fracture is dispelled by the radiograph, which shows cortical thickening, especially posteriorly, medullary sclerosis and transverse lines. (The fibula is also thickened and bowed).

This bone may be considered as showing boomerang deformity.



A 13195.



A 24302.



A. 13195 ( a and b ) -(South Australian Museum), tibiae;  
Snowtown, (South Australia).

Tibiae:-

These bones are 28.6 cm. in length and are from an individual about 12-14 years of age. The epiphyses are missing. The ends are slightly pitted. Except for some root erosion, these bones are smooth. Both bones are slightly bowed forwards and slightly increased antero-posteriorly.

Radiograph:-

The cortex is thickened, the anterior part more than the posterior. The medullary cavity is reduced to less than a third of the diameter of the bone. The deep surface of the anterior cortex appears trabeculated. The cancellous tissue does not appear unduly extensive. There are faint lines of arrested growth at the lower ends of both bones and also transverse lines in the shafts.

These specimens show slight boomerang leg deformity.

A. 24302 -(South Australian Museum), left tibia; Murray Bridge, (South Australia).

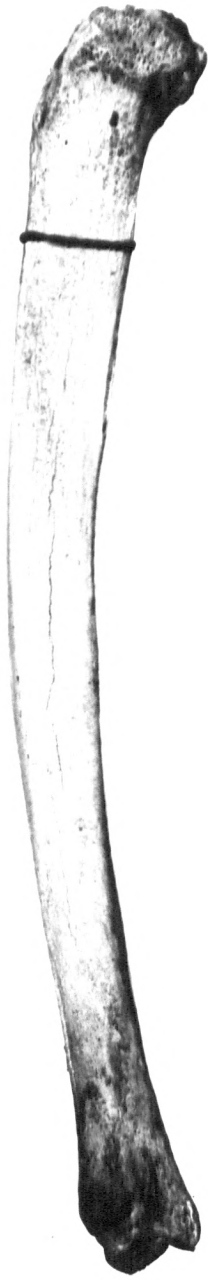
Left tibia:-

The anterior part of the upper end is damaged. The bone is clean and the surface is smooth. There is a moderate amount of anterior bowing present, apart from which it appears normal.

Radiograph:-

The bone is bowed and the cortex is not unduly thickened so that the medulla occupies half of the antero-posterior diameter of the shaft. Probably the middle third of the bone is free of trabeculae, while the remainder is filled with fine cancellous tissue. There is a layer of trabeculae along the cortex which is more marked anteriorly. No transverse lines can be seen.

This bone is an example of moderate boomerang leg deformity.



A 25320.

A. 25320 (a and b) - (South Australian Museum) - tibiae;  
(Probably South Australian).

Both these bones appear normal except for moderate anterior bowing. There is also a small amount of medial bowing present. Although parts of the bones are bleached from exposure, some desiccated soft tissues still adhere to the lower thirds.

The left tibia (b):-

This bone was sectioned antero-posteriorly, but unfortunately the mid-line was not followed in the middle of the bone where the saw passed to the medial side.

The cortex is thickened, especially posteriorly, the medullary cavity is reduced to less than half the anterior diameter of the bone. In the anterior cortex are two nodes which project into the medulla; they appear denser than elsewhere in the cortex. The lower node is associated with trabeculation of the medulla and is situated below the inner opening of the nutrient canal. At this node the posterior cortex is also thickened and denser. The only parts of the medulla which are free of trabeculae are those above and below the lower node. There is coarse and heavy trabeculation along the inner surface of the posterior cortex and the inner surface of the anterior cortex above the upper node. At the epiphyseal ends the cancellous tissue appears normal and the extensions into the shaft are fine and delicate.

Radiographs:-

Left tibia:-

The changes described above are easily recognised. There are some indefinite transverse lines in the upper part of the lower third of the bone in the cancellous tissue - these cannot be easily recognised in the specimen.

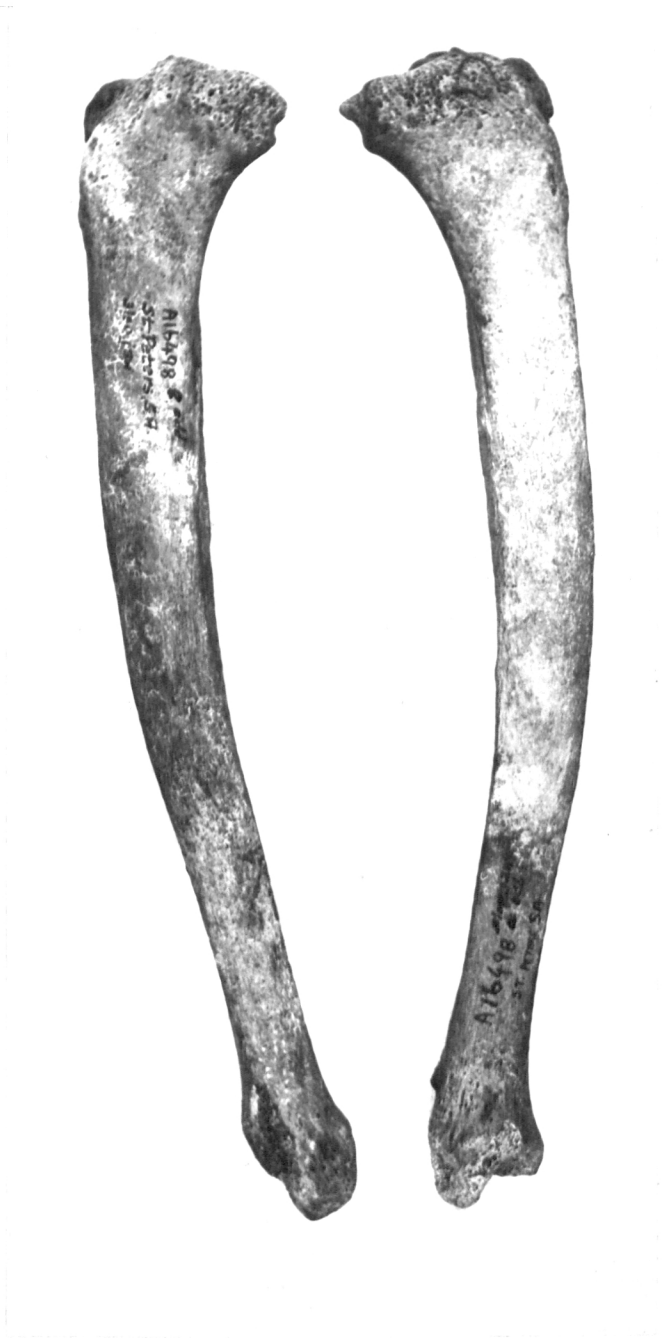
Right tibia (a):-

This bone shows considerable cortical thickening, most marked in its posterior part. The medullary cavity is reduced to one-third of the antero-posterior diameter of the bone and is filled with cancellous tissue except for a small part at the middle of the shaft.

The right tibia was sectioned transversely at quarter lengths of the bone apart. The upper section is of the form of an equilateral triangle with a similarly shaped medullary cavity, the anterior part of which is occupied by coarser trabeculae, a layer of which lines the posterior border of the cortex. The remainder of the medulla is filled by a circular area of finer trabeculae. The middle section presents a right-angled triangle, the hypotenuse of which (the lateral surface, as in the other sections also) is rounded. The cortex here is

rounded and thickened posteriorly, with a narrow layer of coarser trabeculae along the medial and posterior cortical surfaces. The lower section is almost rectangular in outline with a small central medullary cavity which is lined by a layer of coarser trabeculae. The anterior and posterior cortex is thickened.

There is no doubt that both these bones are examples of moderate boomerang deformity.



A 16498.

A. 16498 (a and b) - (South Australian Museum) - tibiae;  
St. Peters, Adelaide (South Australia).

Both these bones are root-eroded and damaged at the ends.

Right tibia (b):

There is considerable anterior bowing present with some increase in antero-posterior diameter. The crest is somewhat rounded. The head of the bone is rotated so that the posterior surface is more lateral than normally. The medial surface is finely grooved. There is a slight expansion of the lateral surface at the level of the nutrient foramen (11 cm. below head). The insertion of the ilio-tibial tract on the head of the tibia is well marked and prominent.

Radiograph:

There is some considerable cortical thickening so that the medulla is reduced to one-third the diameter of the bone. The nutrient canal is enlarged. Cancellous tissue fills the medulla except for a doubtful area 17 cm. below the head of the bone.

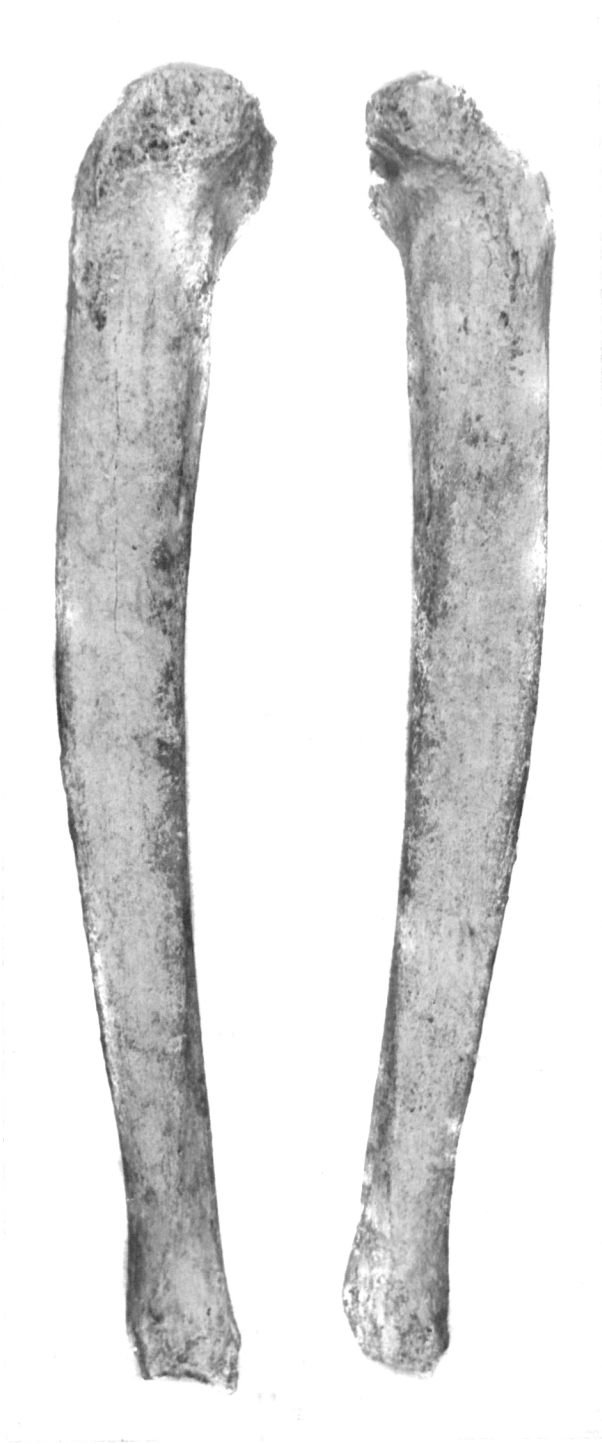
Left tibia (a):

This bone is bowed anteriorly to a moderate degree and is more thickened (A. -P.) than the right. The crest is sharper than that of the right. The head is rotated so that the posterior surface is at an angle of 45° with the antero-posterior axis and faces laterally. The lower third of the bone is bent medially. The insertion of the ilio-tibial band is exaggerated. The medial surface is finely grooved. On the lateral surface in the lowest 6 cm. are two areas of spongy outgrowths. The lower protrudes 1 cm. from the surface. They are suggestive of inflammatory change.

Radiograph:

There is marked cortical thickening so that the medulla is reduced to a quarter of the anterior-posterior diameter. The nutrient canal is obvious, cancellous tissue probably fills the whole medulla except in a situation at the same level as in the right tibia. In the middle third is an area of rarefaction involving the medulla and anterior cortex - it is shown by lesser density of the shadow.

Both these bones show boomerang leg deformity with some flattening.



A 23900.

A. 23900 (a and b) - (South Australian Museum) - tibiae;  
Point McLeay (South Australia).

Tibiae:

Both bones are brittle; the ends have been damaged and the surfaces are root-eroded. They have been impregnated with wax.

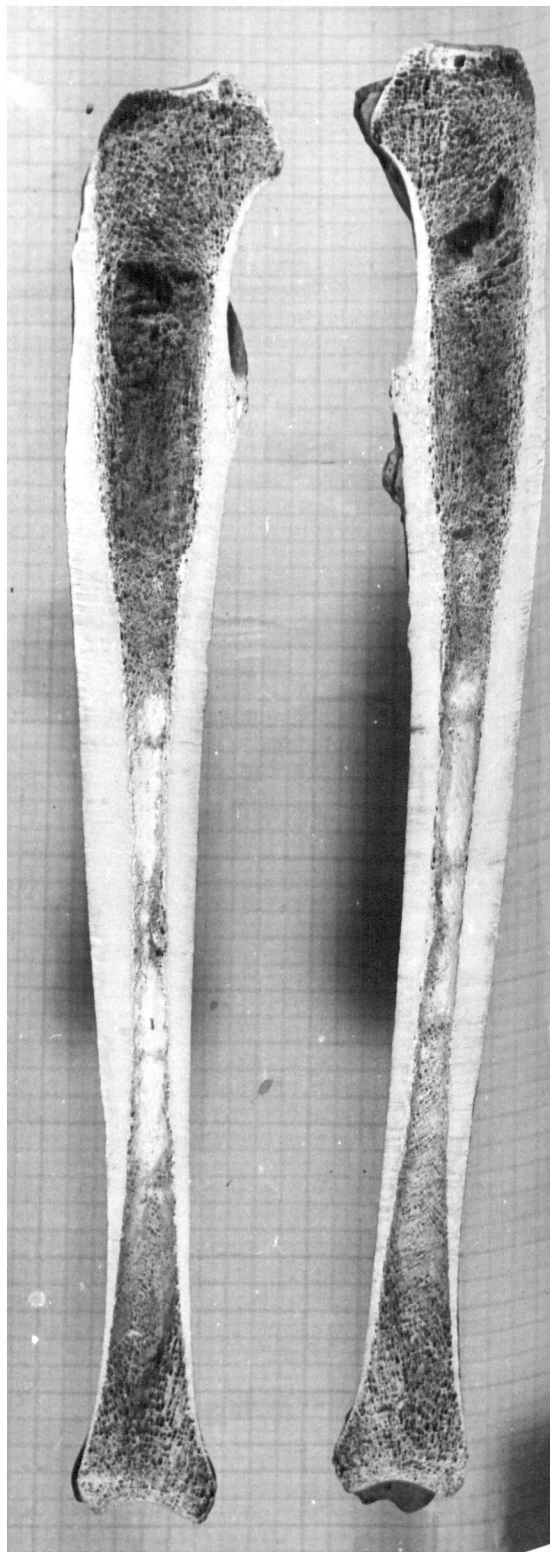
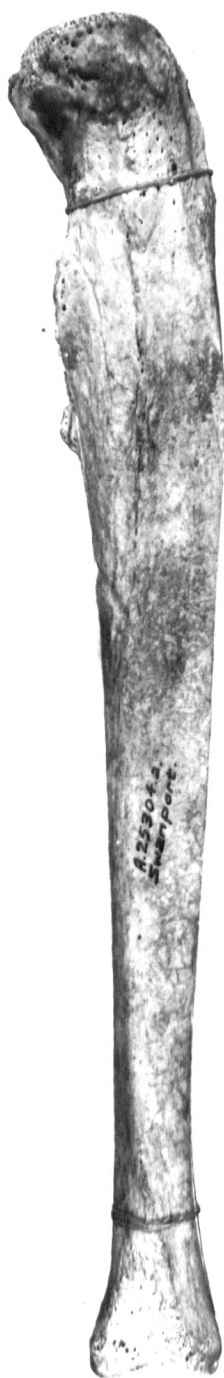
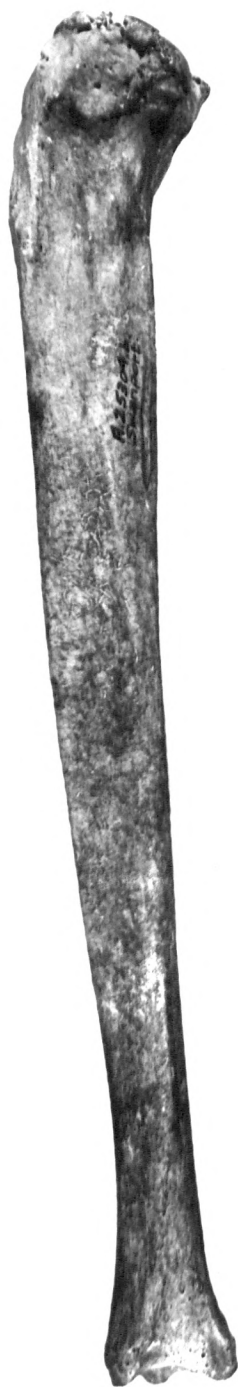
Both bones show little surface change except for fine longitudinal grooves on their medial surfaces. Both bones are bowed anteriorly and the antero-posterior diameter is increased with resulting appearance of flattening. There is a fissure along the lateral surface of the left bone (a).

Radiographs of both bones:

There is considerable cortical thickening which is more marked in the anterior part. The medulla is less than half the antero-posterior diameter of the bone. The medullary shadows are indistinct, but it is probable that there is cancellous tissue in most of the shaft cavity.

These are specimens of boomerang legs of slight to moderate degree with some thickening of the bone antero-posteriorly.





A 25304.

A. 25304 (a and b) - (South Australian Museum) - tibiae;  
Swanport (South Australia).

Right tibia (a):

This bone is practically straight and feels heavy. The lower half appears normal except for some flattening and fine longitudinal grooves on medial side. In the upper third is an expansion on the medial surface, on which there is moulding by adjacent structures, especially blood vessels over some of which arches have been formed. The popliteal line is raised to 1 cm. in places and is irregular. The interosseous ridge is also exaggerated and its upper aspect is irregular.

Radiograph:

Considerable cortical thickening is present throughout the shaft and in lower half the medulla is reduced to one-third. The expansion is seen to enclose an area (6 x 1.7 cm.) of irregularly cancellous tissue. The anterior cortex over it is thickened. The upper half and the lower third of the medullary cavity contains cancellous tissue. There is an area of sclerosis in the medulla at the upper limit of the expansion. Two transverse lines are present in the cavity of the shaft.

On section the cortex is seen to be thickened and the medulla is reduced to a third of the antero-posterior diameter. The upper half of the cavity is occupied by cancellous tissue but this is coarser along the cortical borders. There is an irregular cavity in the cancellous tissue in the upper quarter of the bone above the sclerosed area.

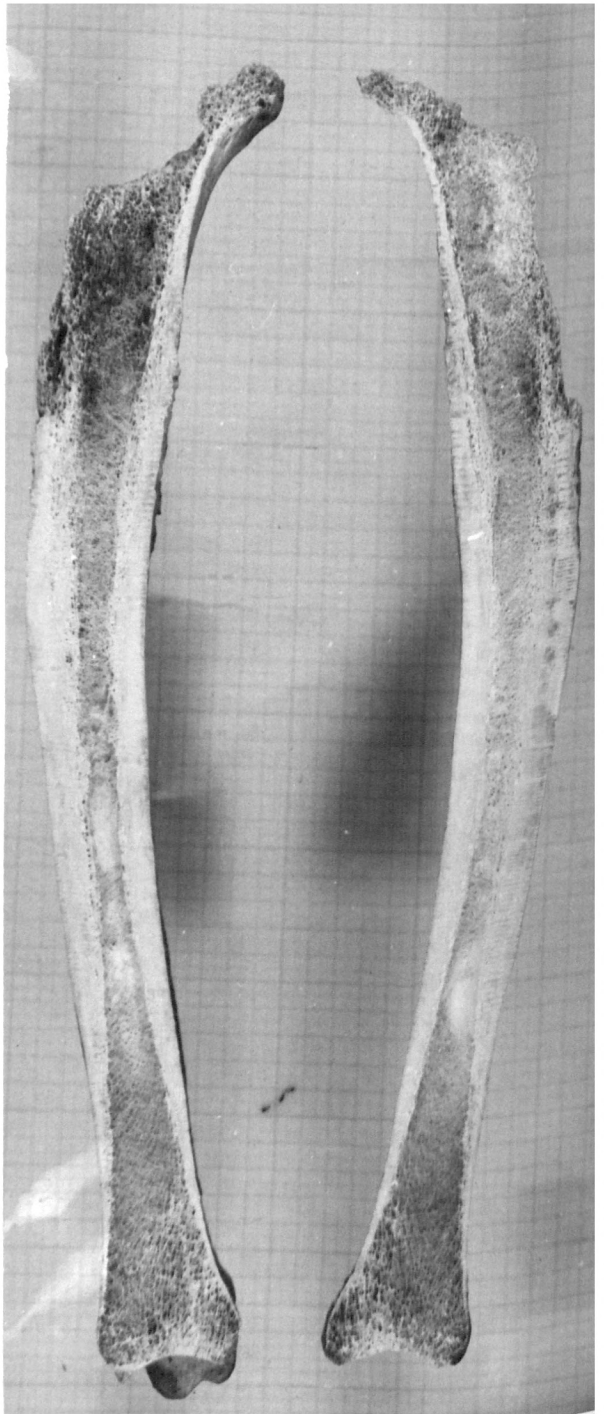
The two transverse lines of the radiograph are represented by delicate plates, 16 cm. from the upper end and 12.6 cm. from the lower end. A third is present 17.5 cm. from the lower end. The lowest one is cribriform while the other two are more lace-like.

Left tibia (b):

The medial surface is finely grooved, otherwise the bone appears normal. There is some lipping of the upper articular edges. On the medial condyle are two eroded areas which obviously occurred during life. These may be comparable with those which MAUL (1918) described.

Radiograph:

The cortex is considerably thickened so that the medulla is reduced to one third diameter of shaft. The cancellous tissue is increased in area and probably fills the medullary cavity, as in the right tibia. There is a layer of trabeculae along the anterior and posterior cortex. No transverse lines are present in the shaft but there are several towards the upper end of the bone.



Vict. (1).

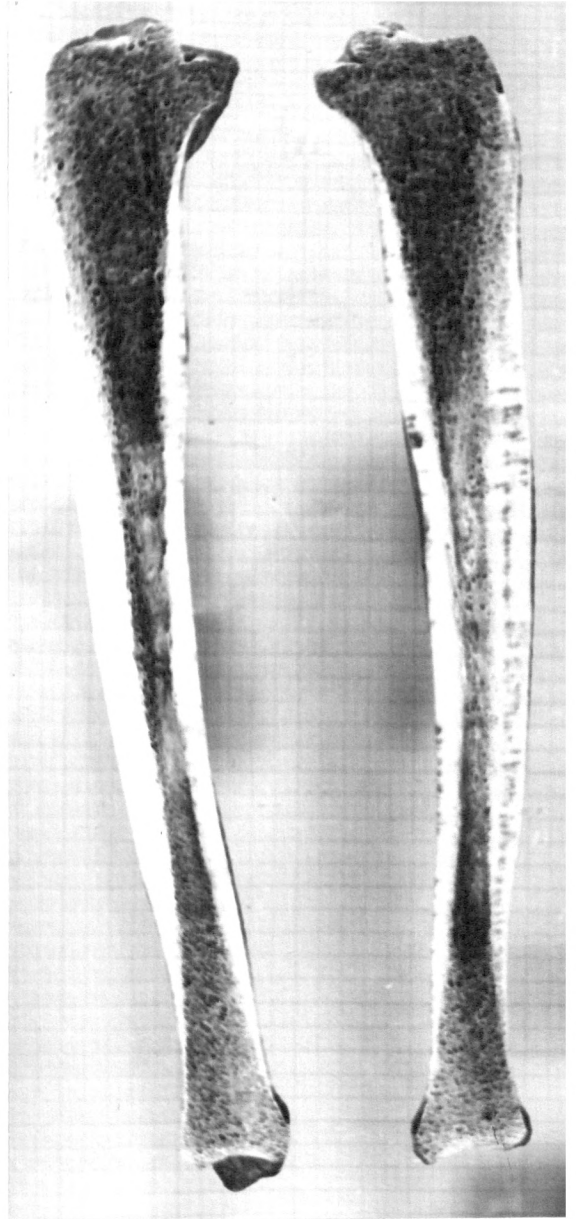
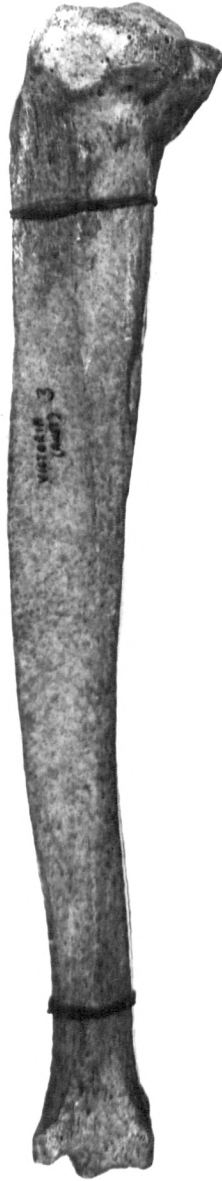
These bones are very similar to STIRLING'S (1896) specimens (A. 25493, a and b). The expanded lesions are probably the result of the same process which may be yaws.

Left tibia (1) - Victoria.

Upper end damaged. Moderate bowing, no marked increase in antero-posterior diameter. Some vertical grooving in medial surface. Over upper third of this surface there is some expansion with slight moulding. The popliteal line is exaggerated. The lower third of the line of attachment of the interosseous membrane is roughened and exaggerated; this is more marked at the lower end where more diffuse periosteal deposits are present.

On section:

The medulla is less than half the antero-posterior diameter of the bone. There is a layer of coarse trabeculae along the anterior margin of the cavity and a less well marked one along the posterior one. Practically the whole of the medullary cavity contains cancellous tissue. The expanded part of the shaft is filled with fine cancellous tissue and is bounded by a cortex thickened both anteriorly and posteriorly, which is cancellated on the inner surface for half its breadth.



Victorian tibia (3).

A 24751.

A. 24751 - (South Australian Museum) - right tibia;  
Darwin (Northern Territory).

Right tibia:

This is heavy ochre-stained bone. It is slightly bowed forwards but there is considerable increase in antero-posterior diameter. The tibial crest presents a right angle with sides anteriorly and laterally. With the exception of the upper two thirds of the anterior surface and upper third of the medial surface, the bone is roughened. About the middle of the medial surface and extending downwards are fine longitudinal grooves; these increase over the lower thirds where they are obviously imprinted on periosteal deposits. Most of the lateral surface of the bone is covered with similar grooved periosteal bone, which is heaped up along the interosseous ridge. Some of this periosteal deposit has been displaced from the antero-medial surface of the lower third. There is a fissure running down the postero-lateral border of the shaft. The whole bone gives the impression of general expansion and modelling by structures in contact with it.

Radiographs:

There is great thickening of the cortex, more markedly in the anterior part. The medulla is reduced to one-third of the antero-posterior diameter and scattered areas of cancellous tissue occur throughout the medullary cavity. Transverse lines are present at each end of the middle third.

This is a specimen of slight boomerang leg deformity with flattening.

Left tibia (3) - Victoria.

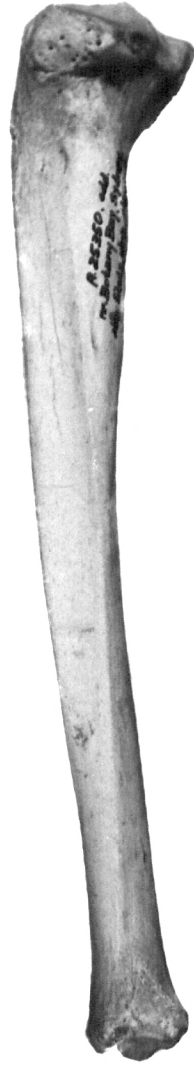
A heavy bone thickened antero-posteriorly, slightly bowed. The medial surface is finely longitudinally grooved and at each end of the shaft, on this surface, are periosteal deposits, which are more extensive in the upper third where they lie under the attachment of the soleus.

On section:

The medulla is reduced to one-third of the antero-posterior diameter. There is anterior trabeculation along the medullary cavity.



A 24749.



A 25350.

A. 24749 - (South Australian Museum - left tibia;  
Ardtornish near Modbury, Adelaide (South Australia)).

Left tibia:

The bone is heavy, with fine longitudinal grooves on the medial surface. There are no gross surface changes except a pit 7 x 4 mm. on the lower articular surface with slight raised smoothed edges [MAUL (1918)]. There is some bowing below the middle of the bone. The anterior crest is sharp and the anterior half of the bone flattened, although the antero-posterior diameter is only slightly increased relatively to the length.

Radiograph:

There is considerable cortical thickening more marked anteriorly where it occupies half the diameter of the bone. The medulla is reduced to a quarter of the diameter. The middle third of the medullary cavity appears free of cancellous tissue; three transverse lines are present out of these limits.

This specimen shows slight boomerang leg deformity.

A. 25350 - (South Australian Museum) - left tibia;  
near Botany Bay (New South Wales).

Left tibia:

This is a smooth, clean bone; it feels heavy. It is slightly bowed forwards. There is no flattening and the tibial crest is sharp. The upper epiphysis is not completely fused with the diaphysis.

Radiograph:

The cortex is thickened, anteriorly more than posteriorly and the medullary cavity is reduced to one-third of the antero-posterior diameter of the bone. The distal thirds of the bone are filled with cancellous tissue and in the middle third there are layers of trabeculae along the anterior and posterior cortex. There is a transverse line in the upper part of the middle third of the medulla, and fainter ones are present in the upper third. The epiphyseal junctions appear normal.

This specimen shows slight boomerang leg deformity.



From the Australian Institute of Anatomy, Canberra.

The following tibiae show boomerang leg deformity:-

SF. 19 : 72,  
SF. 19 : 74,  
SF. 19 : 75,  
SF. 19 : 76 and  
SF. 19 : 81

The two femora SF. 21 : 102 are bowed anteriorly and have a chord-like expansion in the concave posterior surface. These changes are probably the results of yaws.

These specimens are from areas in Victoria and New South Wales, each side of the River Murray between Echuca and Swan Hill.

From Victoria:-

38897 - (National Museum) - Polkemet.

Both tibiae bent and thickened antero-posteriorly. Femora bowed and thickened by chord-like linea aspera.

Compare with "Randa's" femora.

(National Museum) - Banks of Lake Corangamite.

Right tibia and fibula joined in lower third by oneous union - no evidence of fracture - presumably resulting from periosteal outgrowth.

Right humerus markedly expanded over lower three-quarters of shaft.

36587 - (National Museum) - Lake Hattah.

Right and left tibiae from two skeletons (the right one larger than the left); both show slight bowing with increased antero-posterior diameter.

42012 - (National Museum) - Port Arlington.

Tibia slightly bowed and thickened.

(National Museum) - Kyuga.

Two tibiae slightly bowed.

(National Museum) - Tresco.

One tibia flattened and bowed, with lower third expanded and eroded by multiple pits.

From New South Wales.

- A. 11966 - (Australian Museum) - Yass.  
 S. 471 - (Australian Museum) - Wellington.  
 A. 11775 - (Australian Museum) - Cobar.

These bones show slight boomerang leg deformity and no flattening.

- S. 1815 - (Australian Museum) - Tenterfield.

Left tibia has a boss in the middle third of the anterior crest and is slightly bowed and thickened.

- 42066 - (National Museum) - Hillston.

Short tibiae -  
 Antero-posterior diameter increased.  
 Bones heavy and slightly bowed.

Short forearm bones -  
 Right ulna bent dorsally in lower third.  
 Left radius healed fracture in middle third.  
 Left ulna healed fracture in lower third.  
 Bone ends appear large for the length of shafts.

This is an association of fractured forearm bones with boomerang legs and also with stunted bones.

- 42092 - (National Museum) - Baratta Station.

Two long tibiae showing moderate bowing with little or no increase in antero-posterior diameter. Epiphyses just fused. There is pitting of the upper articular surface of the left bone and the lower surface of the right bone.

- (Anatomical Museum, Sydney University) - Kiogle.

Mounted skeleton with slight boomerang legs.

- (Australian Museum) - New South Wales (no locality).

Several tibiae showing anterior curvature.

From Queensland.

- E. 15251 and 15252 (R and L) - (Australian Museum) -  
Cooktown.

Two tibiae, slightly curved but with  
localised nodes.

- E. 15253 - (Australian Museum) - Cooktown.

Tibia, moderate forward bowing with in-  
creased antero-posterior and lateral  
diameters.

ROTH, according to the Museum records, described  
these specimens as being examples of boomerang legs.

- E. 15264 - (Australian Museum) - Mount Cook.

Two tibiae and fibulae showing moderate  
bowing but no increase in antero-posterior  
diameter.

- E. 16395 - (Australian Museum) - Georgetown.

Tibiae with moderate bowing. The popli-  
teal lines are exaggerated. There are  
osteophytic outgrowths at the margins of  
the upper articular surface and periosteal  
deposits at the lower ends of the bones.

- E. 15258 - (Australian Museum) - Rockhampton.

Tibia, moderate bowing and increase in  
antero-posterior diameter.

- E. 15260 - (Australian Museum) - Bathurst Head.

Slight boomerang leg and moderate flat-  
tening.

From Oceania.

(Anatomical Museum, Sydney University) - Mounted skeletons; New Caledonia and New Ireland.

Tibiae showing boomerang leg deformity.

S u m m a r y.

STIRLING'S (1896) specimens are of interest as they were the first bones described as boomerang legs. The expansion in the right shaft is probably yaws in origin. "Randa's" skeleton shows that more bones than the tibia may be deformed. The curved forearm bones and the pilastered femur were at one time considered as racial characteristics, but in this case they are associated with boomerang legs, so are yaws in origin. The tibiae provide typical examples of the marked deformity.

The next three sets of specimens are from children. The bend in A. 708 apparently resulted from some localised lesion which weakened the bone.

A. 24302 from Murray Bridge, is a typical example of a moderately deformed bone, as is the case with A. 25320 (a and b), which on section reveal the alterations in structure.

The two tibiae A. 16498 (a and b) are moderately deformed and on a are periosteal deposits on the lower external surface. As these bones were found in the suburbs of Adelaide, the area in which yaws occurred in the past must have extended as far south as Adelaide.

A. 23900 (a and b) are two bones, slightly but definitely bent and increased in thickness. They were found

on the shores of the lakes at the mouth of the River Murray.

A. 25304 (a and b), from a locality well south of Adelaide, although showing no bending, resemble STIRLING'S specimen on account of the expansion in the upper third of the right tibia.

The Victorian tibia (1) is moderately deformed and shows evidences of expansion and perhaps increased periosteal activity.

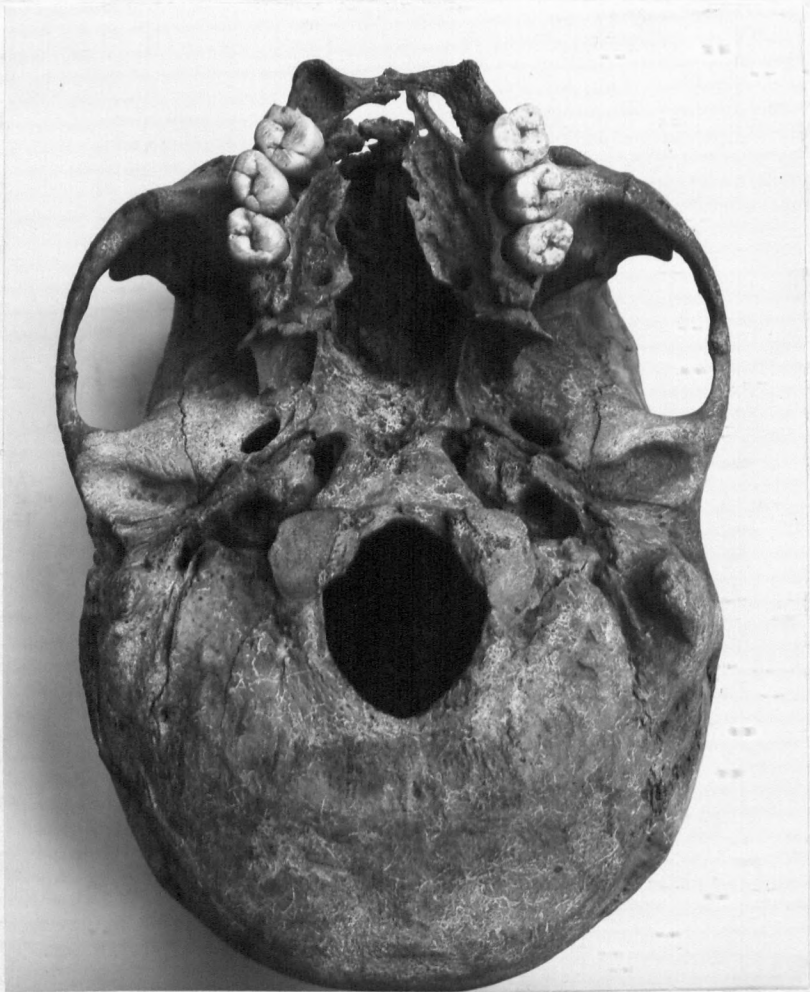
A. 24751, from Darwin, is but slightly bowed but is thickened and heavy and has much periosteal deposition.

The Victorian tibia (3) is also a thick bone and is slightly bowed, as is A. 24749 from near Adelaide, while the Botany Bay tibia, A. 25350, apart from slight bowing appears normal.

In the Barham skeleton (see next sub-section) slightly bowed tibiae are associated with goundou.

Taking the remainder of the specimens into consideration it is seen that the condition of boomerang leg occurred in the southern and eastern areas of Australia.

It is also noted that occasionally areas of expansion of the shafts, nodes and periosteal deposits are associated with the deformity.



Gangosa Skull.

3. Skulls with Pathological Changes.

Victorian Aborigine from burial probably pre-dating European occupation.

From the norma facialis it is observed that the premaxilla is absent except for a narrow bar below the nasal aperture, and the upper surface of the remains of the thickened palate bones can be seen below this bar. The nasal bones and nasal processes of the maxillae are thickened and spongy. The lower part of the inner border of the left orbit has been damaged since death. Both maxillary antra have been opened into the nose and the right cavity is nearly filled with close sponge-like bone; the left is empty but its walls show evidence of inflammation. The ethmoid cells are opened on both sides. The vomer with its attachment to the ethmoid is missing and the surface of the basi-sphenoid is eroded.

The appearance of the bony surfaces and edges which bound this "nasal" cavity show definitely that this damage has occurred during life.

From the norma basalis it is seen that the central part of the palate is absent so that the bony palate is divided into two parts by a fissure, 1 cm. wide at its narrowest part. All teeth except the three molars on each side are missing and the corresponding alveolar process is represented only as a narrow bar of bone below the nasal orifice.

The mastoid region has been damaged by dissection.

This skull shows the lesions of gangosa.

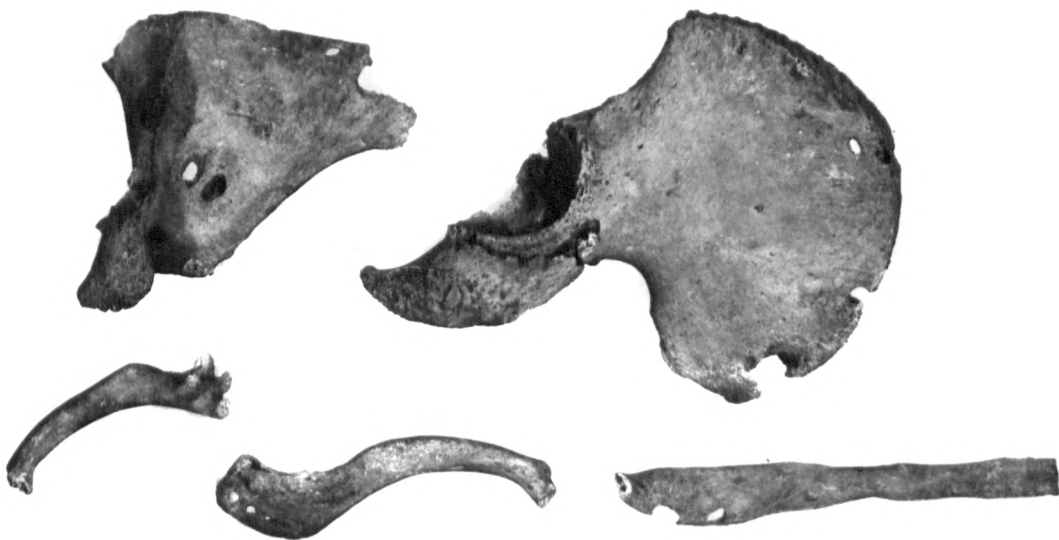




Fibula.



Humerus.



Barham Skeleton.

From Barham, on River Murray, New South Wales. Skeleton of juvenile, aged about 14 years.

The olecranon and lower femoral epiphyses are fusing and the third upper molars are not fully erupted. From the slightness of the bones it is probable that these were from a female. Professor Wood Jones considers that these bones were probably from a burial anti<sup>e</sup>-dating European occupation.

#### Skull:

The inter-orbital bony structures are increased in transverse diameter and the nasal (or frontal) processes of the maxillae present a larger area forwards than normally. The nasal bones are also flattened but inflammatory changes have interfered with their outlines and have led to the fusion of the right bone with the adjacent maxilla. The bony nose appears flattened and below the nasal bones, the maxillae (nasal processes) have rounded edges rather than the edges of bony plates. The bone between the orbital fossae and the nasal cavity is thickened and this cavity in its upper part is encroached upon. The nasal process of the left maxilla is more expanded than that of the opposite side and on a level with the middle of the nasal bones is an opening 3 x 4 mm. leading into a cavity nearly 1 cm. in depth in the expanded process.

The turbinates and perpendicular plate of the ethmoid are missing - apparently due to post mortem damage.

On the palatine process of the maxilla are three areas of erosion which, on account of the changes present in the bone, most probably occurred during life. The anterior part of the bony palate is thickened.

There are two areas (7 x 5 mm.) on the frontal bone, where the surface appears to have fallen in causing central fissures. It is probable that these were present during life.

No other obvious pathological changes were seen in the skull or mandible.

#### Skeleton:

Of the remainder of the skeleton, several bones show lesions which may be described as irregularly tubular erosions from 5-8 mm. in diameter, leading from the surface of the bone towards or into the medulla; more than one such lesion may be present in close proximity, where the bone may be also expanded.

The most extensive lesions are present in the right fibula (27 cm. in length) where, for an area 12 cm. in length, the shaft is fusiform and 3 cm. in diameter (the maximum

diameter of the remainder of the shaft is 1 cm.). The external surface of this expansion is relatively flat; over the remainder of the surface are scattered 14 erosions of various sizes and depths - some have opened into others so that the surface is undermined. The remainder of the surface has an appearance of arabesque tracery.

The left fibula is slightly bowed and at the upper metaphysis a channel has been eroded through the bone so that nearly half the bone is absent.

The tibiae are both slightly bowed. At both upper metaphyses are erosions passing through the epiphyseal plate and involving the epiphysis. This is more marked in the right bone where the cavitation of the epiphysis has caused two perforations in the articular surface of the inner condyle; the more lateral opening probably occurred before death.

In the shaft of the right humerus is a fusiform expansion 8 cm. in length and 2 cm. in breadth; in the antero-medial aspect of this is an opening leading downwards into the medulla.

The lower end of the left humerus is slightly bent forwards and the shaft in its lower half shows some irregularity of its posterior surface. There is a canal 3 mm. in diameter opening in the middle of the posterior surface and leading upwards into the bone.

Both clavicles have multiple lesions in the acromial extremities. The left scapula has several perforations resulting from these erosions. Two ribs have similar changes. Both ilia have perforating lesions toward the crests and near the sacral articulations. There is an eroded area in the right ischium below the acetabular fossa.

The right femur is twisted. The shaft is flattened antero-posteriorly and over the lower two thirds the surface is coarsely irregular and roughened. There is an erosion lateral to and just below the lesser trochanter.

#### Radiographs:

Both tibiae are slightly bowed. There are lines of arrested growth in the lower metaphyses. In the right bone the medulla is encroached upon.

The right humerus shows some sclerosis of the upper metaphysis and epiphysis. The opening in the node on the shaft is seen to lead into a channel running downwards for the length of the expansion (3.5 cm.). There is also a mottled rarefaction in the lower end of the bone.

In the left humerus there is nearly complete obliteration of the medullary cavity. The remainder of the bone below this

is sclerosed and shows rarefaction as is seen in the right bone.

The femur is irregular in shape and the lower half is sclerosed, with a tendency to the formation of rarefied areas 1.5 cm. in diameter.

I believe the skull shows a slight degree of goundou.

The lesions in the other bones result from the extension of small necrotic foci in bone which, in some instances, is already expanded. Since goundou is a manifestation of yaws, the other bony changes must be caused by the same disease.



Adelaide Skull.

From East Parklands, Adelaide, South Australia.

Skull (damaged) of Aborigine.

It was found during an excavation and it is from a burial, probably pre-dating European occupation. The left maxilla, zygoma, temporal and much of the base of the skull are missing.

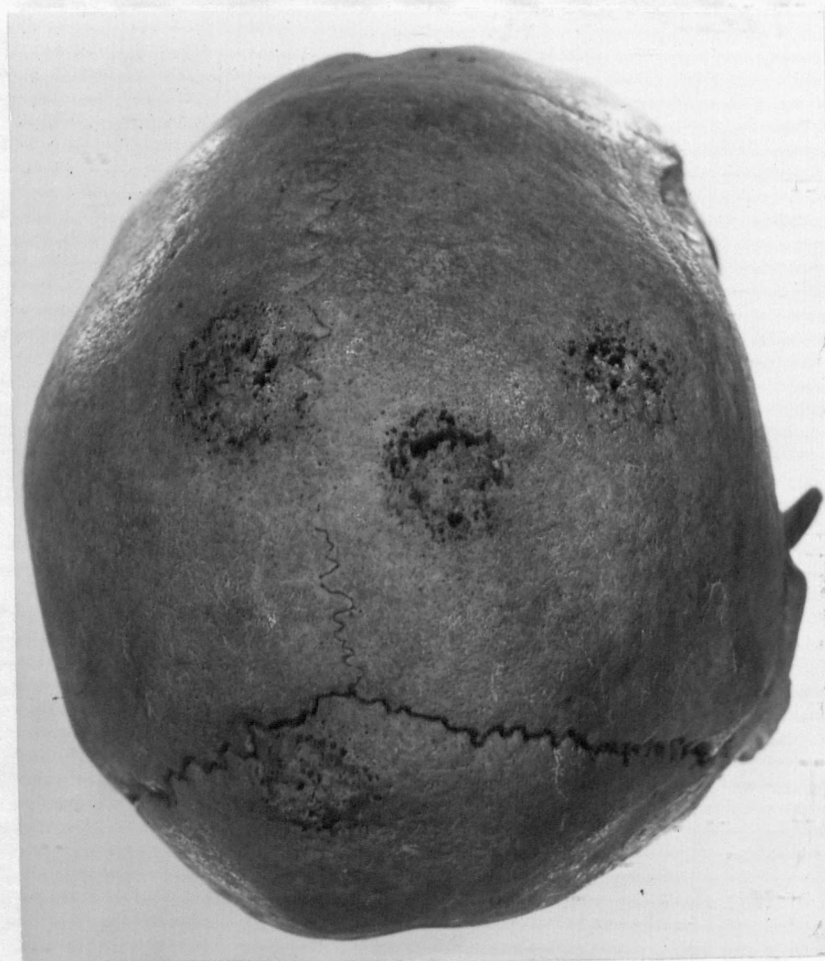
Nearly the whole of the frontal bone above the markings of the temporal muscles is thickened and eroded by multiple pits, under 1 cm. in diameter. There is a similar erosion in the inner surface of the bone so that in several places the bone is perforated. The surface of these lesions is of a minute coralline character and indicates erosion during life. In two places beyond the eroded area are small shallow pits about 2 mm. in diameter - these lesions may have occurred after death. The right orbital plate of the frontal is also eroded and part of the right maxilla shows similar changes.

There are erosions (and also a damaged area) on the outer surface above the occipital protuberance.

There are other scattered erosions on the inner surface of the calvarium, and in parts the diploic canals are exposed.

It may be suggested that the frontal lesions commenced as a thickening of the bone - although the superficial compact layer does not appear increased - then multiple necrotic areas, beginning as minute foci, have developed and have become larger and coalesced.

If this skull is from a pre-European burial, syphilis can be ruled out as the causative factor in these lesions. It is very probable that they resulted from yaws. The lesions are comparable with those present in some of the long bones found in South Australia and Victoria.



River Murray Skull.

From Lower River Murray (South Australia).

Skull with face structures missing.

Pathological lesions of different characters or grades are present in this specimen. They may best be described by commencing with those that appear least advanced.

On the posterior half of the two parietal bones and the upper part of the occipital are four circular areas eroded, 2-2.5 cm. The discolored edges are undermined for several millimetres and there is a suggestion in some areas of central sequestrum formation. The surface of the lesions is irregular with sharp bony points. On the inner aspect of the bones these lesions can be placed by the finely porous surface underlying them. The occipital lesion is marked by a pit 1 cm. in diameter and 2 mm. deep, with undermined edges.

On the frontal bone are six similar lesions varying in size from 1-2 cm. in diameter; in some of these the central sequestrum formation is quite definite. There are other areas where, apparently, the sequestra have separated and the exposed bony surface has become smoothed and resembles the condition present in the Adelaide skull - that is, there is a minutely porous sclerosed diploe exposed. In the upper part of the frontal bone is a delta-shaped area 5.5 cm. in height and 5 cm. in width, on the right edge of which two of the more recent lesions are situated. This area is for the most part depressed 5 mm. below the surface and is limited by rounded apparently sclerosed edges. The base of this depression, while still suggestive of minute pores appears to be of more compact bone, though the surface is irregular. This area is probably due to healing of previous lesions of the character present in other parts of the bone.

It may be suggested these lesions are the result of localised necrosis in which absorption at the periphery has taken place by the surrounding living tissues with the production of central sequestra, which are finally shed so that an eroded depression results. These lesions may have resulted from a more massive or destructive injury than did those of the Adelaide skull.



S u m m a r y.

The first skull is an example of gangosa and as it was found in Victoria demonstrates conclusively the existence of yaws there in the past. The Barham skull exhibits the lesions of goundou - another manifestation of yaws - and thus supplies further evidence for the occurrence of yaws in Victoria. As both of these specimens are probably from burials before European occupation it is a fair deduction that yaws occurred indigenously among the Victorian Aborigines.

Without touching upon race migrations in Australia, it may be mentioned that cultural migrations are generally considered to have taken a southerly direction from the northern and north-western coasts; so for yaws to have been in Victoria, it is necessary to regard a large north-south area of Australia as having been populated by yaws-infected communities. If this should have occurred in the eastern half of Australia it is improbable that the population of the western half did not suffer likewise. Hence it may be assumed that yaws was endemic in the whole continent before the arrival of Europeans.

The lesions in the bones of the Barham skeleton will be discussed in the next sub-section, but attention may be called to the very definite indication of a yaws aetiology for them that the occurrence of goundou in the same skeleton provides.

Of the remaining skulls it is highly probable that the Adelaide one is from a pre-European burial. This may also apply to the River Murray skull. It is a fair assumption that the changes exhibited by these two specimens are the result of yaws, since the individuals from whom they came lived in a population, among which, probably, the only disease able to cause bone lesions was yaws.



4. Other Bones with Pathological Changes.

1277 (a and b) - (Pathology Museum, University of Adelaide) - right femur and right tibia; near Point McLeay (South Australia).

CLELAND (1928) has suggested that these bones show evidence of syphilis. He writes, "no trace of yaws has ever been found among the natives of South Australia." He regards these specimens as ante-dating European settlement. This reference is discussed in Section IV.

## Right tibia (a):

The bone is bowed anteriorly, but the general form of the bone is not greatly altered. The surface is unfortunately eroded (by roots) in parts, especially along its lateral aspect.

In the lower third the lateral and medial surfaces show many fine longitudinal grooves which, on the medial surface, are implanted on periosteal tissue.

Below the middle of the bone of the medial surface is a periosteal node about 0.5 cm. in height and 3 x 2 cm. in area (long axis in long axis of the shaft). On the summit is an opening 1.5 x 0.5 cm. leading into an undermined cavity which has eroded the cortex. 10 cm. below the head is a further area of grooved periosteal deposit. The popliteal line is exaggerated.

## Radiograph:

## Antero-posterior -

The cortex is thinned and slightly depressed under the node.

## Lateral -

Although the cortex is not thickened, the medulla appears sclerosed, particularly at the junction of the upper and middle thirds. There is an erosion of the inner surface of the posterior cortex in the upper third and another less definite area in the anterior cortex of the lower third.

The tibia shows slight boomerang leg deformity. In view of the absence of syphilis among bush natives to-day and the widespread distribution of yaws in Australia, it is probable that the lesions present in these bones are the results of the last-named disease.

Compare with Cases 44 and 45 (Alice Springs).

## Right femur (b):

Probably from the same skeleton as the right tibia. It shows similar changes to those present in the tibia but they are much more

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Vict. (2).

extensive. These changes might be characterised as periosteal depositions with multiple necrotic foci which have resulted in pitting and tunnelling towards the interior of the bone. The exposed medulla appears densely sclerosed. The radiograph supports this.

Right tibia (2) - Victoria.

Both ends of this bone are damaged. Slight bowing is present. The popliteal line is exaggerated. At the limits of the middle third the bone is expanded; on each side of the upper expansion is a shallow eroded pit. At the lower expansion on the lateral surface is an opening about 7 mm. in diameter, which leads into an undermining cavity, 17 mm. in depth. There has been considerable periosteal activity on the surface of this expansion, especially posteriorly. At the lower end of the bone the surface is formed by finely grooved periosteal deposits. From the lateral surface is an erosion 14 mm. in its narrowest part, which extends half way through the bone, just above the articular surface.

These lesions appear to have developed from a central necrosis with absorption of surrounding bone.

Radiograph:

This shows some sclerosis of the middle third of the shaft which is most extensive at the eroded areas. The lower area is seen to contain two rarefied areas roughly 1.5 cm. in diameter. The lowest erosion is not seen distinctly as the internal malleolus is broken off.



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A 11421.

Right humerus (4) - Victoria.

Upper half appears normal. Just below the middle of the shaft on the posterior aspect commences an area of periosteal deposit which, 5 cm. lower, covers an expansion of the bone. Here there is an extensive erosion which, in its lower part, extends two-thirds through the bone exposing a heavy but fine trabeculation in the medulla. There is a similar but less extensive area lower down the shaft on the lateral edge and a shallower one on the anterior surface just above the lateral erosion. On the lateral condyle of the lower end is an erosion, probably pre-mortem.

**Radiograph:**

This shows rarefied areas corresponding to the erosions above. The lower third of the shaft is sclerosed.

A. 11421 - (South Australian Museum) - femur; Cooper Creek, (South Australia).**Femur:**

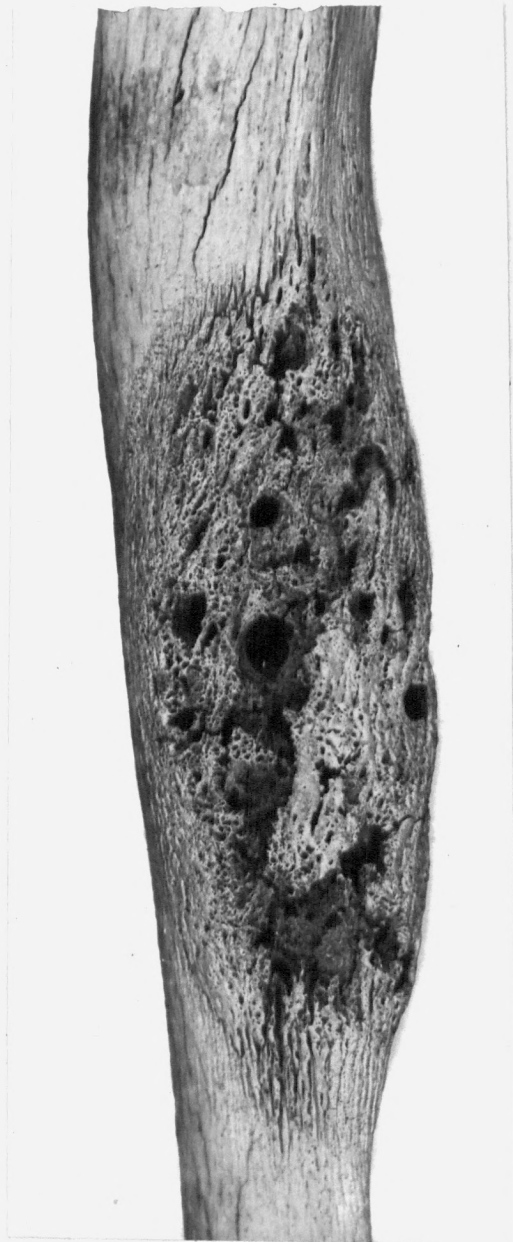
This femur is included as its lesions resemble those present in the preceding femora. Both ends of the bone have been damaged. Below the lesser trochanter there is some expansion on both sides of the bone for about 5 cm. The posterior surface is irregular and the linea aspera is replaced by two pits, the upper one tunnelling upwards into the bone and the lower one pointing towards the medulla. There is some periosteal deposition round these pits.

**Radiograph:**

The upper half of the bone is sclerosed, although the cortex is only thickened in the medial aspect of the expansion. The two erosions are seen as areas of lighter shadow in the sclerosed medulla.



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1031 - (Pathological Museum, Adelaide University) - tibia;  
(South Australia).

Right tibia:

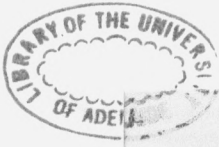
This bone has a moderate anterior curve which is most accentuated in the upper part of the middle third. The surface of the medial condyle of the upper articular surface is grooved by two furrows (2 mm. wide and 3 mm. deep) which form a V; in its opening is the internal inter-condyloid tubercle.

The lower part of the middle third of the shaft is expanded and on its postero-medial surface is a node 11 cm. in length and 1 cm. in thickness. This node appears to be of periosteal origin and is honey-combed with multiple tubular cavities about 5 mm. in diameter. At the lower margin are deep narrow longitudinal grooves. It is comparable with the right fibula of the Barham skeleton (vide infra) and is doubtless the result of the same type of lesion. The remainder of the bone appears normal.

Radiograph:

The node appears as an expansion of the bone with multiple areas of rarefaction through all except the anterior fifth. The tissue of the expansion is sclerosed.

In this bone there is boomerang leg deformity with an expanded eroded node.



1273 - (Pathological Museum, Adelaide University) - tibia;  
from South Australia.

Left tibia:

The only apparently normal parts of this bone are the upper 4 cm. and the articular surfaces. From above downward the shaft becomes increasingly expanded until at the lower end it is nearly 5 cm. in all diameters (normal for a bone of the same length at the same level is 2.5 cm.). The changes are characterised by periosteal proliferation and multiple pit-like erosions (measuring up to 1 cm. in diameter). Two channels mark the course of the extension-flexor tendons; here pitting is less frequent.

These lesions are comparable with similar lesions of other long bones already described.

Radiograph:

This emphasises the expansion and shows many areas of rarefaction. There are some areas of sclerosis.

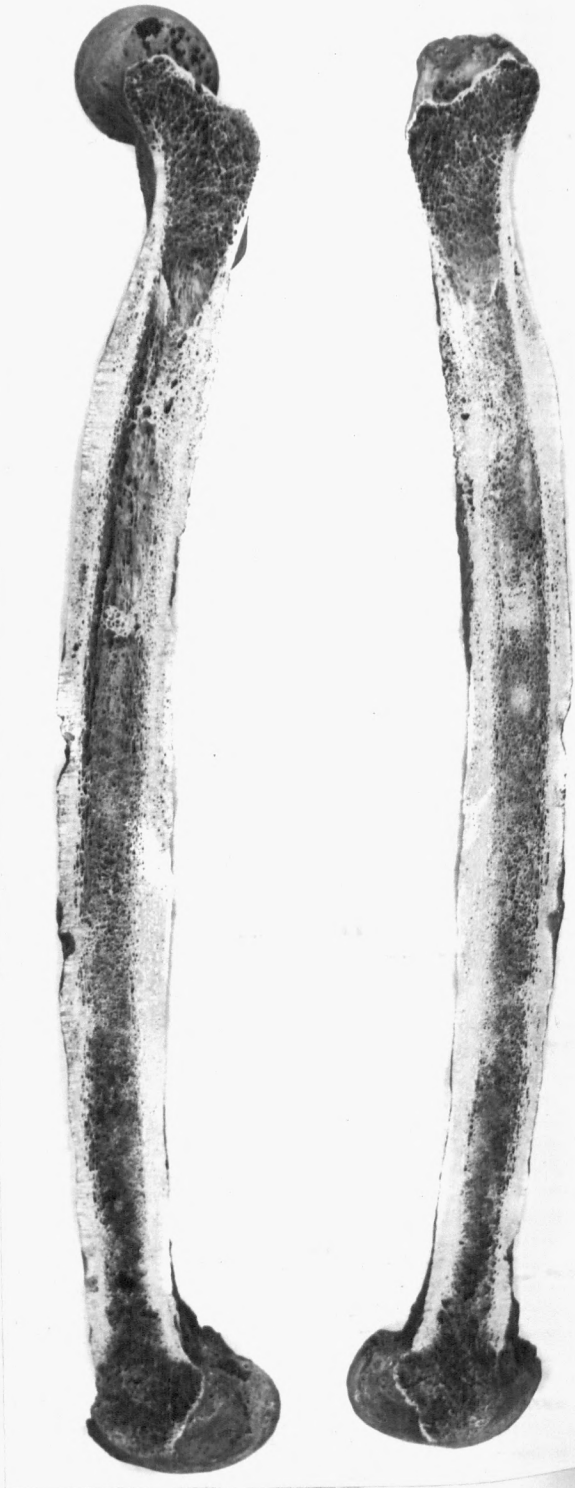
1278 - (Pathological Museum, Adelaide University) - fragments of tibiae, humerus and ribs; Aboriginal kitchen midden, Wellington, (South Australia).

Fragments of tibiae, humerus and ribs:

These bones, though much changed from burying and exposure, show lesions identical with those described above, that is expansion and eroded pits. The ends of the fragments show that the whole bone, except for a narrow surface layer, is porous, and that the medulla is filled with close trabeculae.

These fragments are almost certainly from a burial pre-dating European occupation.

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Vict. (5).

Right and left femora (5 a and b); Koondrook, Victoria.

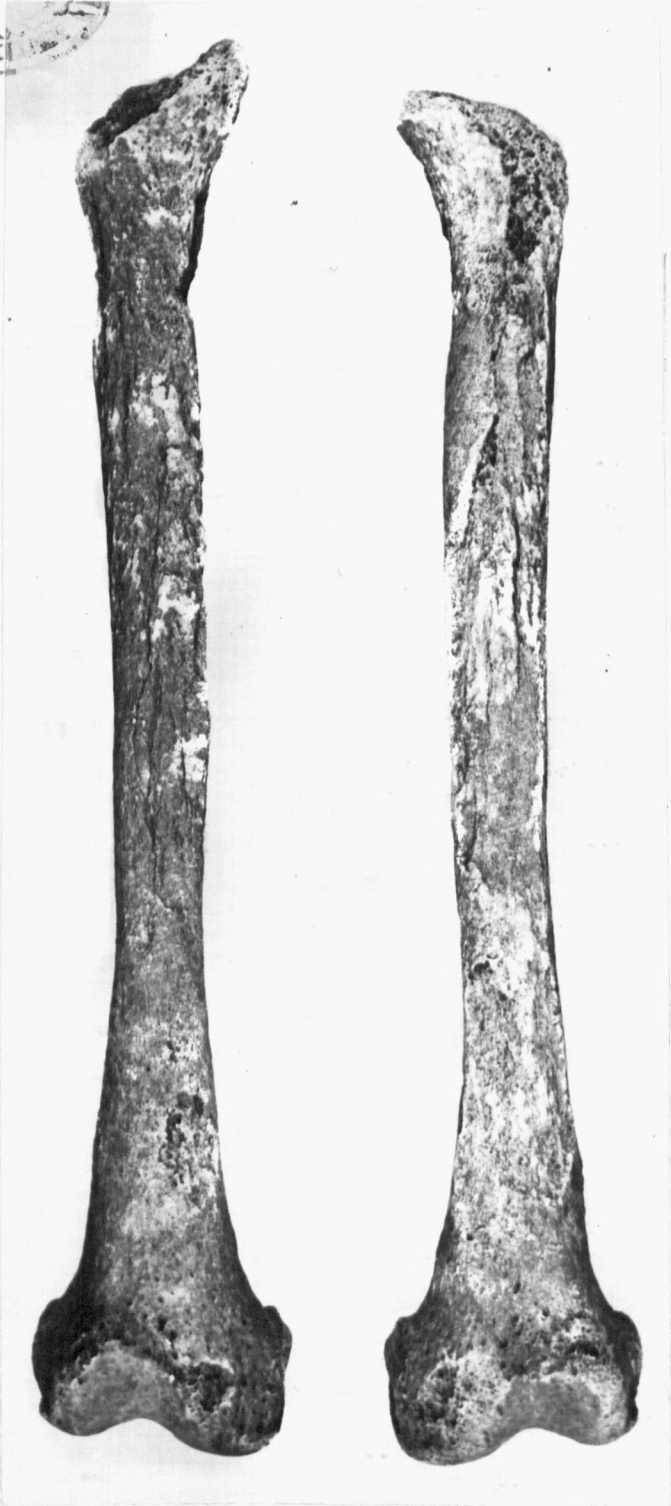
Both these bones present a similar type of lesion. These may be summarised as a general expansion of the bone below the lesser tuberosities with flattening of the posterior surfaces. The lineae asperae are present as a rough groove. Practically the whole of the surface of the expanded bone is eroded in very numerous places and in some areas there is definite undermining. The erosions appear as pits of varying depth from 7-15 mm. in diameter and none are more than 1 cm. in depth, even where they undermine the bone, as in the right femur.

## Radiographs:

There is expansion and considerable cortical thickening, especially on the medial side of the left bone with very numerous areas of rarefaction. Much of the cortex appears canaliculated. In the lower thirds of the bones there is sclerosis of the medullary canal, the whole of which contains trabeculated tissue.

## Left femur sectioned:

The cortex is seen to be canaliculated and the inner surface in places merges into coarse trabeculae; it is most compact in the lower third. The medullary cavity is filled with cancellous tissue which, in the upper half of the shaft, is coarse and in the lower half very fine.



A 23411.

42066 - (National Museum) - Hillston (New South Wales).

Larger tibiae:

Heavy bones, no bowing, but antero-posterior diameter increased. There are small osseous nodes in the upper thirds, the middle thirds of both bones are expanded and show multiple superficial erosions.

Larger forearms, right:

Both bones are expanded in the shaft, the radius markedly so (comparable with the Darwin tibia), with irregularities as seen in some bones in Adelaide.

Larger forearms, left:

Some erosion of both bones (probably post mortem), the ulna is slightly expanded, with some ossification along the attachment of the interosseous membrane.

A. 23411 (a and b) - (South Australian Museum) - femora;  
Normanville (South Australia).  
(Probably ante-dating European settlement).

Femora:

These damaged bones show changes resembling those present in the femur 1277.

Radiographs:

These show cortical thickening, periosteal deposition and medullary sclerosis. In parts erosion (probably during life) has exposed the sclerosed medulla.





Left tibia and fibula.



Sectioned.

From Cook, Darwin.

Specimens presented to me by Dr. C. E. Cook; Two tibiae and fibulae belong to the same skeleton (probably from Aborigine) found near Darwin (Northern Territory).

Right tibia:

The head is damaged and roots can be seen in the cavity. There is slight anterior bowing. The bone is not particularly heavy. The upper third appears normal but below this the bone is generally expanded so that it is almost cylindrical. The lateral and posterior surfaces show moulding by adjacent structures while the medial surface is rough and porous. The lower third in the anterior, lateral and medial aspects, shows these changes most markedly and is suggestive of suppuration. There is no obvious nutrient foramen.

Radiograph:

There is cortical thickening over the expanded part of the bone, but this is dense only in the upper and posterior parts; below this the cortical shadows tend to merge with those of the sclerosed medulla which is very much reduced in diameter. The superficial part of these shadows appears to be periosteal. There are two transverse lines in the lower part of the upper third of the shaft.

Left tibia:

The head of the bone is damaged and hollowed. There is some anterior bowing about the middle of the bone, where the bone is thickened antero-posteriorly. There is also a posterior thickening above the point of bending. The medial surface has fine longitudinal grooves and in the upper part is rough and porous (suggestive of active inflammation). There is a periosteal deposit on the lateral surface of the lower third.

Radiograph:

The cortical shadows are increased posteriorly and over the above expansion. The medulla is encroached upon. The anterior cortical shadows over the expansion merge with those of the sclerosed medulla, and appear to be periosteal in the superficial part. Cancellous tissue probably fills the medulla, and in the upper third appears irregular and sclerosed. This tibia resembles that seen in Case 21 (Alice Springs series).

On section:

The radiographic appearances are confirmed. The most interesting point is that the

expansion is found to be covered with compact bone over-lying thick trabeculae, whose interstices become larger as the cavity of the bone is approached. One cannot avoid the explanation that bone has been deposited by the periosteum and later absorption has taken place from the medullary cavity with the formation of this trabeculation. The transverse lines are caused by cribriform plates 12.5 cm. from the upper and 11 cm. from the lower end of the bone. In sawing this bone it was found to be very hard.

#### Right fibula:

This bone presents changes similar to those in the right tibia but less marked. There is some roughening of the medial surface of the lower third where it is close to the roughened area of the tibia.

The radiograph indicates that much of the swelling is periosteal.

#### Left fibula:

The whole bone is expanded, especially below its mid-point so that it is spindle-shaped. The interosseous ridge is exaggerated and coarsely dentate in profile. There is a roughened area in the antero-medial border opposite to the periosteal deposit on the tibia. There are numerous mouldings on the surface of the bone.

#### Radiograph:

The cortex does not appear thickened and the expansion is filled with cancellous tissue.

I would regard these bones as examples of slight boomerang leg deformity together with other framboesial lesions.

S u m m a r y.

Referring back to the Barham skeleton, it was noticed that many of the bones had eroded pits associated with some degree of expansion. Commencing with the right Barham humerus, there is a node on the shaft, apparently a periosteal deposition, which is deeply penetrated by a tubular erosion.

1277 (a) shows an earlier stage of this lesion, the periosteal character of the node is obvious and the erosion has only involved part of the cortex. The femur from the same specimen shows gross periosteal changes and older erosions.

The Victorian tibia (2) has the bowing of boomerang leg, together with eroded nodes. The cavitation appears to have commenced from a deeply situated necrotic lesion and is associated with some expansion of the bone. Later stages of these lesions are shown in the Victorian humerus (4) and the femur A. 11421 from north-eastern South Australia.

If the right tibiae of the Barham skeleton is again examined the lesion is found to consist of an expanded area of the shaft with periosteal deposition and multiple erosions, some of which have opened into each other. One then passes on to the specimens from the Pathological Museum of the Adelaide University, 1031 and 1273, the lesions of which are identical in character with those of the Barham fibula. 1031 is also bowed. Unfortunately there is no locality data with these bones, but they are probably from South Australian Aborigines. The fragments 1278, showing the same type of lesion are definitely localised to the Murray Lakes district. The Victorian femora (5 a and b) exhibit the same type of lesions. If one pictures the condition of the individual in life from whom these bones came,

it is easy to imagine how an untrained observer of a hundred years ago would attribute these and other conditions to syphilis. The tibiae 42066B from New South Wales have similar changes.

The South Australian specimens A. 24311 (a and b) have been included as the conditions they present may be those under consideration, but they are much eroded and one cannot be definite.

These specimens show similar lesions in bones from the three south-eastern States, where, it has been concluded, yaws occurs. The yaws origin of these lesions is further supported by the association with goundou in the Barham skeleton.

The remaining specimens from Darwin show expansion of bones such as were seen in the New South Wales radius (42066 B) (right Darwin tibia) and in the Alice Springs Case 21. These probably also represent yaws lesions without necrotic areas having occurred.

### 5. General Summary.

In this section, boomerang-leg tibiae are described from localities covering practically the southern half of Australia.

Other lesions of skulls and long bones, which are at present generally regarded as syphilitic, are described. Evidence is brought forward which indicates the yaws origin of these conditions.

SECTION XIV.

GEOGRAPHICAL DISTRIBUTION OF BOOMERANG LEGS.

1. Localities in the Northern Territory of the Commonwealth of Australia.
  - (i) Localities where cases were observed.
  - (ii) Localities from which cases came.
    - (a) Kahlin Beach Native Compound, Darwin.
    - (b) Fanny Bay Gaol, Darwin.
  - (iii) Localities from which cases were reported.
  - (iv) Other manifestations of yaws that were observed.
2. Localities in other parts of Australia.
3. Localities out of Australia.
4. Native names for the conditions under discussion.
5. Conclusion.

SECTION XIV.GEOGRAPHICAL DISTRIBUTION OF BOOMERANG LEGS.1. Localities in the Northern Territory of the Commonwealth of Australia.i. Localities where cases were observed:

The incidence of this condition in the Alice Springs, Victoria River District and Bathurst Island has been dealt with already (Sections VIII and IX).

At Mt. Hardy cases of boomerang legs were seen, some of which showed the characteristic "scars".

One case with "scars" also had thickened forearm bones and ill-developed transversely grooved upper central incisors, but there was no suggestion of peg teeth. In this locality I was told by men who had been working there for some time that owing to the dearth of women, the men were "married" to boys. This was supported by the evidence of an Aranda native who was their "No. 1 Boy". From what I saw in the few hours I was there, I could not definitely deny this. These natives had come from the west; two came from Tanami.

The overland trip was made without much delay so that observations were possible at only few localities.

At Powell Creek Telegraph Station a woman was seen with marked boomerang legs and "scars". Her two children, aged 6 and 3 years, appeared normal.

A stay from 3rd. to 10th. May, 1934, was made at Newcastle Waters. The native camp was visited and I was present at the rationing of the older natives by Mounted-Constable Reid. Three cases of boomerang legs were seen, in none of which were "scars" found. A young full-blood female, with an unusually round face, showed "scars", but her legs appeared normal. A native boy, aged 6 years, to whom Mounted-Constable Reid had given several injections of



N. A. B. for yaws about a year previously, had slight boomerang legs. No "scars" were seen in this case, but when he was treated lesions were present about the gluteal cleft.

Three elderly males had cataracts and two other natives had extensive leucomata, probably gonococcal in origin. One felt fairly certain of this diagnosis as 70 cases of gonococcal ophthalmia had been seen with Dr. McCann in Alice Springs during the previous month, and 30 more cases were found later at Timber Creek.

ii. Localities from which cases came.

(a) Kahlin Beach Native Compound: At the Kahlin Beach Compound the following cases were seen:-

A male, aged 16 years, from Caledon Bay had B.L.++ and "scars" behind the knees. He said he had also had sores in the gluteal cleft when he had those from which the above "scars" resulted.

Two males from the Fitzmaurice River district had B.L.+ and "scars" in the anti-cubital fossae and had had sores in the gluteal cleft.

These three natives were witnesses in two murder cases.

A male, aged 16, from Borroloola had B.L.++ and "scars" in the anti-cubital fossae and neck.

A female from Roper River had B.L.+, but no "scars" were seen.

A woman, aged 30, of the local Wargite tribe, was seen who had B.L.++ and "scars".

A male, aged 45, was seen with marked boomerang legs and marked bowing of the forearms. I met him in the street; ten days later after my return from Bathurst Island, I traced him by name, only to find that following a conflict with the law he was out of town; enquiries were made without success at four native camps.

The reference to these few cases gives no indication to the population in the compound. It was difficult to see the natives who lived there as most of them were in employment in the township during the day.

The half-caste girls with boomerang legs seen in the Institution came from various localities, from all of which natives with the same deformity were either observed or reported.

(b) Fanny Bay Gaol, Darwin: On the afternoon of 21st May, 1934, through the kindness of the Police Department, I visited the Fanny Bay Gaol.

Of the 35 well-fed native prisoners examined, the following were found to have boomerang legs:-

<u>Place of origin.</u>	<u>Degree of B.L.</u>	<u>"Scars"</u> (Trousers worn)
Daly River	+	Nil
Daly River	+	Circumoral
Daly River	+ +	Nil
Port Keats	+ +	Nil
Port Keats	+ +	Anti-cubital fossa.
Port Keats	+	Nil
Mataranka	+ +	Nil
Mataranka	R ++, L +	R. anti-cubital fossa and circumoral.
Oenpelli	?	Anti-cubital fossa.
Bradshaw	+ + +	Anti-cubital fossa.
Bradshaw	+ +	Circumoral.
Caledon Bay	+ +	Anti-cubital fossa.
<u>Total 12.</u>		

In six prisoners "scars" were found, but the legs appeared normal and in 17 neither "scars" nor boomerang legs were observed.

One achondroplastic native was also seen here.

In the cases with "scars" in the anti-cubital fossae care was necessary to differentiate them from the skin changes due to chafing from the fibre arm bands often worn by natives of the northern parts of the Territory. Extension below the main skin crease and vertical long axes were considered to rule out the chafing.

iii. Localities from which cases were observed.

At Alice Springs, before I had visited the native camp and had found, on casual observation, 17 natives with the deformity, I was told that I had come to the wrong place for boomerang legs as there were very few in the "Centre". I should have gone to the "Top-end". In Darwin I was told, "you will find no boomerang legs here, you should have gone to the 'Centre' ". I am at a loss to find a simple explanation for these statements, unless it lie in the human tendency to rely on the statements of others rather than to make observations for one's self.

While at Newcastle Waters I heard on good authority that two natives with boomerang legs were at Anthony Lagoon.

At Daly Waters I was told that several cases of boomerang legs were in the local camp. As it was 10 p.m., and we only stopped for a few minutes, no opportunity was available to see these natives.

The Rev. Dyer said that he had seen a few cases of boomerang legs at Oenpelli Mission.

Mr. Webb from Millingimbie Mission, said he had heard children crying in the native camps at night on account of pain in their shins. Yaws occurred there, and he had seen boomerang-legged natives.

Mr. Goldsmith, the missionary from Goulburn Island, said he had seen cases of the condition at the Mission.

Mr. N. B. Tindale said he had seen cases of boomerang leg on Groote Eylandt and the Roper River. He said

that yaws was seen at both these places and also at Blue Mud Bay (Gulf of Carpentaria).

Speaking to W. E. Harney, who knows the Gulf of Carpentaria very well, of boomerang legs he told me he had seen the deformity develop in an adult female, one of whose breasts was diseased. Her legs were so tender that she resisted the approach even of a dog lest her shins were touched.

Major Cobb told of three natives with boomerang legs at Tennant Creek.

Mr. McDill, who had been at Andada Station for many years remembered having seen boomerang-legged natives there years ago.

Mr. F. H. Gray, who had been trepanning in the Caledon Bay region for some time, and who was there when the five Japanese were murdered in 1933, spoke of several cases of boomerang leg among the local natives; he had also seen cases of yaws, and since his return (1934) he has treated cases with N.A.B. successfully.

I heard that boomerang-legged natives had been seen at Huckitta and at Tanami.

GRAY & CLELAND (1933) report cases of boomerang leg in children and adults which were seen at Cockatoo Creek. They say,

"on watching natives sit down, it is seen that they so fold their legs under them that they sit upon the heels with the toes turned inwards and the thighs resting upon and pressing the underlying tibiae. It seems possible that this attitude and the pressure on the developing bone may account for the extraordinary broadening and flattening of the tibia."

CLELAND (1933), reporting studies carried out at Mt. Liebig, writes, "several individuals showed a definite but slight degree of boomerang legs (platycnemism of the tibiae)."

CLELAND (1934) reports natives with boomerang legs and flattened tibiae at Mt. Liebig.

Photographs taken at McDonald Downs by Professor H. J. Wilkinson show natives with boomerang legs. One of these photographs is reproduced by DUBOIS (1933) in which, of six natives in the group, three at least have this deformity.

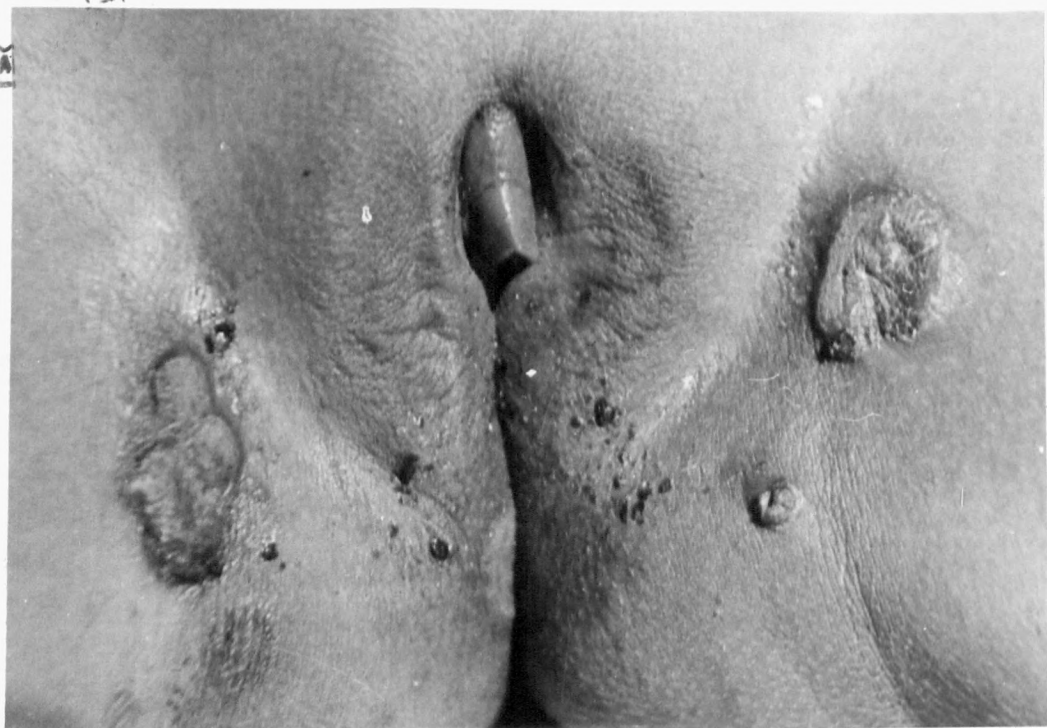


FIG. 26.



FIG. 27.



FIG. 28.



Fig. 29.



Fig. 30.



FIG. 31.

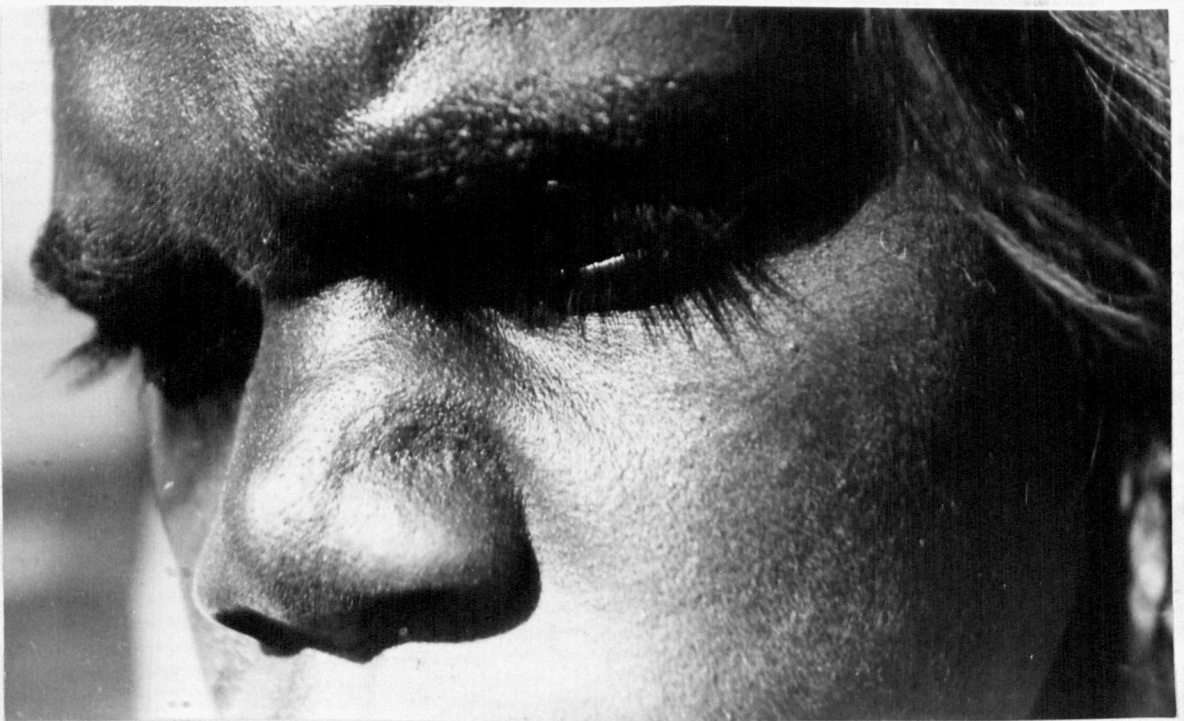


FIG. 32.



FIG. 33.



FIG. 34.



FIG. 35.



STIRLING (1894) and BASEDOW (1932) record cases from Crown Point.

The above reports were all from men who had seen the cases. Reports were received of less definite character of the existence of the condition in other areas, but these have not been included owing to their uncertainty.

iv. Other manifestations of yaws that were observed.

Only two cases of what I considered were metastatic yaws eruptions were seen.

One was a half-caste girl at Alice Springs who had granulomatous lesions of her scalp and about the pudenda and anus (Fig. 26). Unfortunately no smears were made, but the rapid response to N.A.B. left little doubt as to the nature of the lesions. Dr. McCann, Medical Officer at Alice Springs, diagnosed it as yaws. This girl came from the northern part of the Territory and had only been at Alice Springs a few weeks.

The other was a native baby, about 10 months old, seen at Mount Hardy. This child had healing granulomatous areas on her scalp, abdomen and thighs (Figs. 27 and 28). These had been present for several months. The natives named the condition "widgena", which I learnt was the Il-pirra word for "irkintja".

In neither of these cases could any primary sore be identified, nor was I able in any case to attribute any of the "scars" seen to the primary lesions. This is a difficulty that has been found by other observers.

Cases of tertiary yaws were seen at Wapperby, in a native with arthritis of the knee, and at Wave Hill in a native with disease of his tarsus.

At Alice Springs was seen a case of gangosa in a half-caste (Figs. 29 and 30), who had extensive scarring on his chest. He was about 35 years of age. The condition,

which had developed during the last five years, responded to N.A.B. Other cases of gangosa were seen at Alice Springs, Owen Springs and Timber Creek (all these were healed). One case of unhealed gangosa was seen in 1933 at Konapundi in the Musgrave Ranges (vide supra).

A woman (Case 6), aged 20 years, was seen at Alice Springs, with slight boomerang legs and a small scar on her right cheek at the nostril. The bridge of her nose was slightly depressed and the nasal processes of both maxillae were thickened (Figs. 31 and 32). These changes had occurred during the last few years. There was a fluctuant swelling over her left claviculo-sternal joint and also a healing ulcer over the right ramus of the jaw, and another, which had been present for two years, on the right thigh below Poupart's ligament. She had recently become deaf. Her serum gave a positive Wassermann reaction. I consider she is a case of goundou. I have not found any references to this condition among the Australian natives. HALLENBERGER (1916), in his Fig. 18, illustrates a similar nasal condition as goundou.

An elderly woman was seen at Alice Springs, the right side of whose face was extensively scarred (Fig. 33). Comparing this case with others definitely of yaws, and published illustrations, it is probable that the scarring was the result of late yaws lesions. A younger woman also showed scarring round the right eye (Fig. 34). She also had a recent depigmented scar on the left side of the neck (Fig. 35). Dr. McCann had treated this case with N.A.B. and the rapid response clearly indicated the yaws nature of the lesions.

At Victoria River Depot two cases were seen in which the skin of the hands and lower forearms showed a peculiar patchy depigmentation resulting in the skin being

divided about equally into irregular areas, roughly 0.75 x 1.25 cm., with rounded margins of normally pigmented and pinkish-white skin. No loss of sensation was detected. Yaws was prevalent in this locality. SPITTEL (1923), p.45, illustrates a similar condition in the hands of Singhalese and considers it the result of yaws. SMITH (1906) refers to the same condition as syphilitic. It has been pointed out above that KNOTT (1931) describes and illustrates a condition resembling this, and considers it as yaws in origin.

HALLENBERGER (1916) illustrates a similar condition in his Fig. 23 and describes it as "mbelung; (resulting from a healed pustulo-ulcerous framboesial process)."

STANNUS (1928), p.72, said, "It was well known that some extensive ulcerative lesions of yaws when healed left unpigmented scars. Another lesion associated with loss of pigment, one first described by Ziemann, consisted of a patchy depigmentation about the hands, wrists and feet and ankles. Its aetiology was then unknown and he called it "Melung"; it is now considered to be due to yaws."

In the Musgrave Ranges in 1933 several natives were seen with deep, very painful fissures on the soles of their feet. This condition was said to occur chiefly during the cold weather. Cases of sore fissured feet were also reported from Hermannsburg and Groote Eylandt. These may have been caused by yaws.

No cases of juxta-articular nodes were seen.

In no native was an inactive pupillary light reflex found. Dr. J. H. Gray confirms this. He and I have examined the eyes of several hundred natives in the course of anthropological observations.

Although no special search for cardiac lesions was made, in those cases in which the chest was examined, no evidence of syphilitic heart disease was found.

One remarked the relative absence of active yaws lesions in a community in which so many individuals showed evidence of previous active lesions as well as tertiary

manifestations. It may be that during the cooler season of the year, when I was in the field, new infections do not readily occur, or, as Mr. E. E. Kramer, who has had many years of experience among the aborigines, suggested, that there are years when the active disease is more often seen; these years, he says, are associated with drought and famine.

## 2. Localities in Other Parts of Australia.

Note has already been made of three cases of boomerang leg which were seen in the Musgrave Ranges, South Australia (Section II).

A native from the district west of Oodnadatta (South Australia), who was brought to Adelaide for treatment for multiple fractures inflicted by two Europeans in "self-defence", had boomerang legs and a positive Wassermann reaction, but no "scars" were found.

A native from the Kimberly District (Western Australia) was seen in Adelaide who had slight boomerang legs and "scars". His serum was Wassermann positive.

Mr. D. D. Smith reported having seen some natives with bent legs in the northern part of Western Australia.

Rev. A. S. Webb saw cases at Forrest River Mission, Western Australia.

Dr. J. D. Rice saw a case at Meekatharra, Western Australia.

BREINL & PRIESTLEY (1915) report a case from North Queensland.

SMITH (1907) reports five cases of platycnemia from the Coorong, South Australia.

Dr. E. E. Broadbent of Bordertown, South Australia, informs me that he has seen tibiae shaped like boomerangs among bones of aborigines which have been found in the district.

Mr. G. Jaensch of Taillem Bend, South Australia, has seen bent shin bones in that district.

The occurrence of boomerang legs among the natives at Ooldea has been noted in Section XI.

Bent tibiae from South Australia, Victoria, New South Wales and Queensland have been described in Section XIII.

### C o n c l u s i o n .

It may be concluded that boomerang legs at one time occurred among natives in many widely separated localities in Australia.

#### 3. Localities out of Australia.

EYLMANN (1908) speaks of a skeleton from Fiji which showed boomerang legs.

STIRLING (1894 and 1896) says Watson had seen the condition in the New Hebrides.

GARDNER (1895) reports the case of a European from the New Hebrides, with a condition that was probably boomerang legs, and I have seen a similar case [HACKETT (1935)].

Mr. F. G. Filmer said he has seen boomerang-legged natives in the New Hebrides and that yaws was prevalent there.

BREINL & PRIESTLEY (1915) speak of natives with this deformity in most parts of British New Guinea, where yaws also occurs.

MANSON-BAHR (1929) speaks of the "sabre-shaped deformity of the long bones", especially of the tibiae, which result from yaws.

In the following localities sabre-tibiae in yaws cases are reported by various authors (see Section VI):

Ceylon -	BAHR (1914) SPITTEL (1923)
French Equatorial Africa -	CLAPIER (1920)
Tropical Africa -	BOTREAU ROUSSEL (1925) HERMANS (1928)

Sierra Leone -	BLACKLOCK (1930)
Liberia -	HARLEY (1933)
Haiti -	WILSON & MATHIS (1930) FOA (1929)
Cochin China -	MONTEL & COUPUT (1932)
Dutch East Indies -	SOETOMO & EICHHORN (1925) HERMANS (1931).

No attempt has been made to deal completely with the distribution of sabre-tibiae and yaws, but from this list it may be safely concluded that these two conditions are found widely spread through the Tropics.

This fact, in conjunction with the conclusions arrived at in this section, indicates that the boomerang legs of the Australian Aborigines are identical with the sabre-tibiae of yaws occurring in native races in other parts of the world.

4. Native Names for the Conditions  
under Discussion.

<u>Locality.</u>	<u>Tribe.</u>	<u>Boomerang legs.</u>	<u>Sores.</u>
Alice Springs	Aranda	Ungwana ulbarinja	Irkintja
Mt. Doreen	Ilpirra	Meritja-guri	Widjena
Banka Banka		Nunindulin	
Newcastle Waters	Tjingali	Buda guma	Mundura
Darwin	Larakia Worgait	Ner-er-minge-eka Wudi-wudi	
Bathurst Island	Kulunglutji	Fitheruela	Ampamari
Caledon Bay	Bulamuma	Djarpi	Durga
Delamere	Waduman	Oidoiman	
Victoria River Downs.	Heineman Tjambitjina	Wuliya-drego Furi-puri	Gunburra
Wave Hill	Kwiringi Mullingin	Dir-pur-wari or Kuridi	Tjunga Mundura
Timber Creek and Victoria River Depot		Ulu wiru Maring Kitil wara	
Bradshaw	Moyle Brinkin	Wel-pan-tar-mu	
Musgrave Ranges	Pitjandjara	Tjirara-kali- kali.	Minki

5. C o n c l u s i o n .

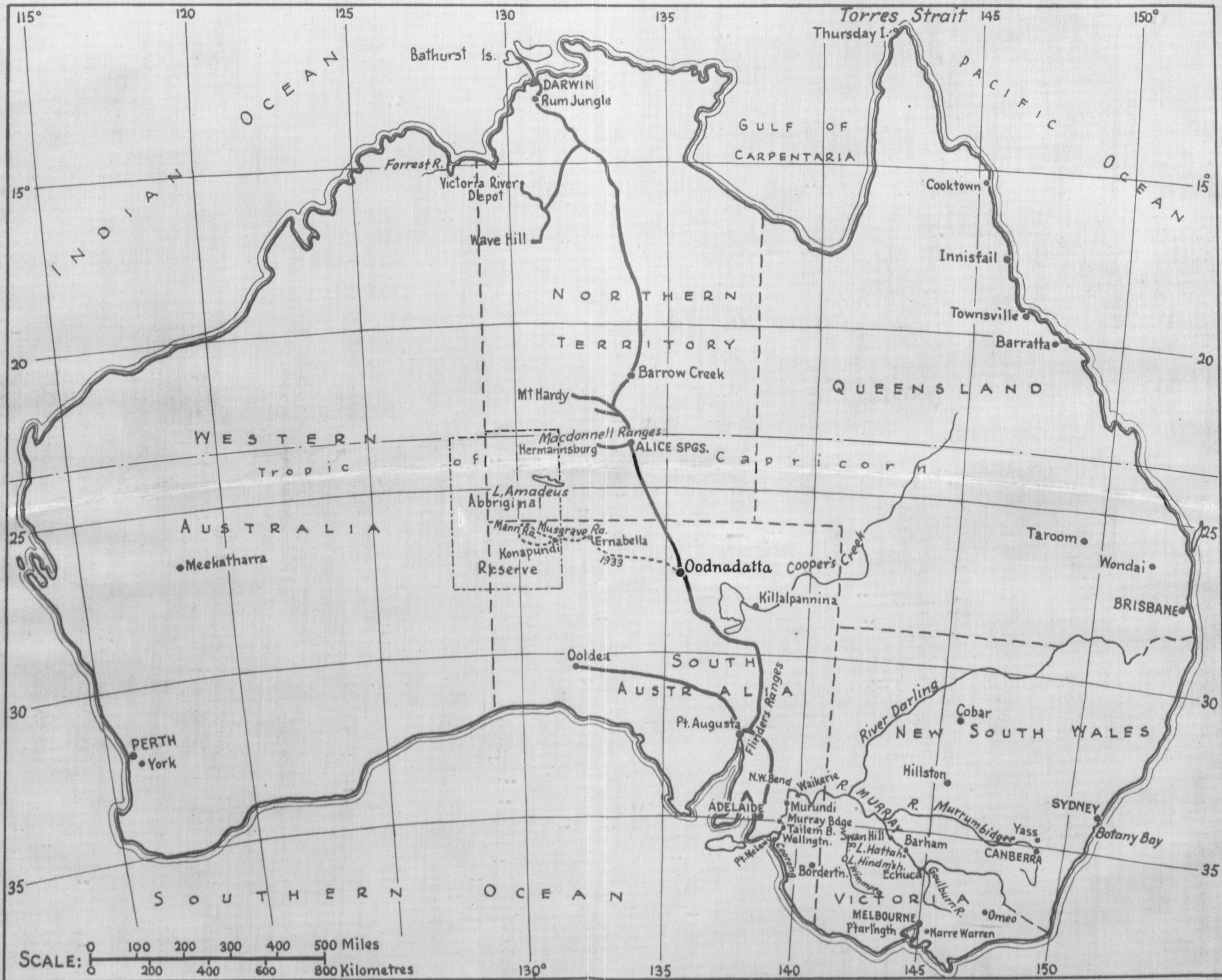
The existence of native names in widely separated localities for the cause of "scars" which result from yaws, indicates a wide distribution of that disease and probably that it has been endemic in the country for a long time. Further support for the wide distribution of yaws is provided in the evidence of the members of the Northern Territory Medical Service and by the fact that police officers in the Northern Territory receive instructions and N.A.B. for the treatment of this disease. Further references are given in Section IV. It can be safely concluded that yaws is present in practically all groups of natives in the Northern Territory.

From the data brought forward in this section a similar conclusion is reached regarding the distribution of the deformity of boomerang legs (see maps).

The co-equal distribution of yaws and boomerang legs in the Territory under consideration, is further evidence of the causal relationship of the former to the latter. These conclusions can be extended to the whole of Australia.

It can also be said that the boomerang legs are really the sabre-tibiae resulting from yaws.





SECTION XV.

GENERAL SUMMARY.

GENERAL SUMMARY.

This thesis is the result of field work conducted among the aborigines of the Northern Territory of Australia.

The initial object was to test the validity of the suggestion that certain scars present on some natives were associated with the deformity of boomerang leg and that both were the result of yaws. The study was later extended to early descriptions of disease among Australian natives and to bone specimens in the museums of Adelaide, Melbourne and Sydney.

This work was undertaken with the assistance of a grant from the Sheridan Medical Research Fund of the University of Adelaide.

At the outset it became necessary to reach some decision regarding the separate identity of yaws and syphilis. After surveying the evidence from the clinical, experimental, histological and historical aspects it was decided that it is most logical to regard these two conditions as different diseases.

After critically reviewing descriptions of "syphilis" and "venereal disease" among the natives, the conclusion is reached that the condition referred to was most probably yaws - after excluding gonorrhoea and granuloma pudendi.

Before proceeding further the terms used are defined. Boomerang leg is a deformity in which there is a forward bowing, with more or less flattening, of the lower limb below the knee. It is found in various degrees of severity. The scars are characterised by the small amount of tissue destruction from which they have resulted. They occur most frequently in the skin flexure regions or other moist areas. The pains, said by the natives to precede the development of the deformity, were described as "rheumaticky" in character.

On referring to the literature of yaws it was found that from practically every country in which that disease occurs sabre-tibiae are reported.

The references to boomerang leg give some indication of the geographical distribution; the problem of its aetiology is either neglected or approached on hypothetical grounds.

At Alice Springs fifty natives with boomerang legs were studied, radiographic films exposed and, from some, serum for the Wassermann reaction collected. From the rather unsatisfactory data obtained there, it was possible to show that the scars were associated with the previous attack of a disease, called by the Aranda folk, irkintja. Indications were also found that boomerang legs and scars were associated and that both were associated with positive Wassermann reactions in the sera. The former was demonstrated to be true by observations made in the Victoria River District and Bathurst Island Mission. The latter was confirmed by the study of inmates of the Half-Caste Institution at Darwin.

Attention is drawn to the absence of syphilis among the natives of the Northern Territory, whereas yaws is widely distributed. From this and other indications it is concluded that boomerang legs, the scars and the positive Wassermann reactions are the results of yaws.

The course of a typical case of boomerang leg is as follows:- In early childhood yaws is contracted and with the eruption of the metastatic lesions the Aranda people recognise the disease irkintja. This, after a time, resolves leaving the scars already mentioned and for some years the child is apparently in normal health. However, sooner or later, pains (aradulka), which are worse at night, are experienced in the shins, and the deformity commences. The degree to which the deformity develops depends on the severity of the underlying osteitis. Probably no increase in the bowing occurs after the epiphyses are fused.

At Ooldea, near the coast of the Great Australian Bight, natives were seen with boomerang legs, scars and whose sera gave positive Wassermann reactions. These are of yaws origin. The observations are emphasised as the area is distant from any tropical influences. Yaws has not previously been reported in South Australia.

From the study of the radiographs taken at Alice Springs further support is to be had for the yaws aetiology of the changes present. It would appear that the initial lesion of yaws in bone is a multiple focal rarefaction. This apparently weakens the bone and deformity takes place, although increased growth by hyperaemic epiphyses may play some part. After the acute initial stage subsides the consequent inflammation leads to a thickening of the cortex. When the pathological activity ceases there may be some absorption of the cortex from the medullary surface, so that, finally, a bone may result which, apart from its bowing, may appear normal.

Another course which may be followed, is that the rarefied areas increase in size and produce necrotic foci in an expanded bone.

At Alice Springs several cases of gangosa and one of goundou were seen; this is good evidence that yaws exists in the community. Goundou has not previously been reported among the Australian aborigines.

Comparing the pathological conditions found in the bones of living natives with those in aboriginal bones preserved in museums, similar lesions are found. Hence these lesions, which are now generally regarded as syphilitic, are probably the result of yaws. It is significant that bones with these changes have been found in localities, from which, a hundred years ago, reports of "syphilis" among the natives were made.

It was found that in the Northern Territory boomerang legs and yaws were present in all groups of natives. This co-equal distribution can be extended to the whole of Australia, so that in reality the boomerang leg of the Australian Aborigine is none other than the sabre-tibia of yaws which is found in tropical countries.

That yaws occurs at present, and has occurred in the past, in areas experiencing no tropical climate, supports the contention that its presence in a community is related more to cultural status than to climate conditions.

Suggestions are made, in Appendix A, regarding the possible yaws origin of the platycnemia in early and prehistoric human remains in Europe, and of the retroversion of the upper end of the tibia in Australian Aborigines and other primitive peoples.

SECTION XVI.

APPENDICES A, B and C.

SECTION XVI.APPENDICES A, B and C.Appendix A.

In concluding this paper reference may be made to several points for which place has not previously been found.

At Alice Springs and Darwin blood was collected from veins and allowed to clot in sterile test tubes; the clot was soon separated and the serum transferred later by sterile pipettes to further sterile test tubes which were sealed by heat. The syringes and needles were sterilised by boiling in hypertonic saline. At Ooldea the procedure was the same, except that the syringes and needles were sterilised by chloroform. Any opportunities to keep the serum cool were accepted. The sera from Darwin <sup>were</sup> were carried overland to Adelaide, a journey of 2,000 miles, occupying eight days, in a cooled vacuum flask and were found to be uncontaminated. This is emphasised, as there are few places in Australia, where a medical man is practising, which are more than a week's journey from an organised laboratory; so there are no reasons apart from financial ones, why ser/o-logical investigation should not be used in the diagnosis of any case requiring it.

If the native population of Central Australia, where malaria and ancylostomiasis do not occur, is considered one remarks that, if introduced diseases are ruled out, the main cause of morbidity is infection with yaws. It is probable that malaria did not exist in Australia before European occupation [see CLELAND (1912) and CILENTO (no date)]. It is also probable that ancylostomiasis was introduced into Australia during the last century. If yaws was not introduced into Australia by the early Malay visitors, one can only suggest the first Australian must have brought the infection together with his wife and dingo when he arrived in his new land.



From experience in the Musgrave Ranges in the cold season, it is doubtful if the natives in their original condition suffered, to any serious extent, from respiratory infections. Although numerous cases of upper respiratory infection were seen, the severity of which appeared to vary with the atmospheric temperature, no native had a cough comparable with that occurring in the "common cold" which is so frequent among Europeans in the settled areas during the winter.

It would appear that the distribution of yaws is not so much governed by the Tropics of Capricorn and Cancer, as some writers state, as it is associated with a primitive mode of living. Although there are few countries within the Tropics in which yaws does not occur, perhaps it is the mode of life rather than any property of the climate which is the determining factor. The things in primitive life that most favour the spread of this infection are perhaps the scantiness of clothing with consequent exposure of a large proportion of the skin surface, ignorance of the principles of hygiene and inaccuracy of reasoning between cause and effect.

Just as the marsupial population of Australia is regarded as a relic of a once world-wide mammal fauna, so one may look upon the mode of life and customs of the Australian Aborigines as similarly related to those of the early human occupants of Europe. The Aranda legend of the Achilpa men and irkintja would indicate that yaws has been among them for a long time. Is it permissible to suggest that the chief cause of morbidity among the prehistoric and, perhaps, early historic Europeans may have been yaws?

One pauses to wonder if by any chance the platycnemia described by TOPINARD (1890) may not have been caused by yaws. [TOPINARD (1890) writes, "in platycnemia, the tibia

has only two surfaces in its three upper fifths, an external and an internal. The anterior border is thin, the internal and external borders occupy the centre of the two surfaces, and the new posterior border corresponds to the above lines of insertion of muscles. . . . . Platycnemia is noticed here and there in many of our graves, but with variable frequency. The first time it was observed was in the tibiae of the family buried at Cro-Magnon, at the Ancient Stone period. It has been frequently described as existing in England, both at the Pre-Gallic and the Polished Stone periods. In 200 Parisian tibiae, which we have collected from the St. Marcel and St. Germain-des-Prés cemeteries, dating from the fourth to the tenth century, 5.25 per cent. were platycnemic, and 14 per cent. were bent" (forward). "This latter peculiarity is not uncommon in old graves, as well as the channelled fibula, that is to say, fibula with enormously large longitudinal grooves for the insertion of muscles, the ulna incurvated forwards in its upper fourth, and the 'fémur à colonne'. . . . . We have observed platycnemia, the incurvated ulna, and the pillar-like femur in other races, notably in skeletons from Oceania."

As has been mentioned above some cases of boomerang leg have flattened tibia and bowed ulnae.

TURNER (1886) writes, "The investigations both of Mr. Busk and of Mr. Broca demonstrated some years ago the tendency in primeval man, as shown in skeletons obtained in sepulchral caves in various parts of Western Europe, to have the shaft of the tibia laterally compressed. Conjoined with this lateral compression the posterior surface of the tibia was no longer flattened, but convex from side to side. To this form of tibia the term platyknemic has been applied. Similar observations have been made by Professor Jeffries Wyman on tibiae from ancient mounds in the United States. Virchow has also called attention to the platyknemic type of tibia (although with certain differences) in an Oahuan, a native of New Britain, and in some skeletons from the Philippine Islands, including Negritos. M. Hamy recognised a lateral flattening in the tibiae of his Aëta Negrito, although by no means so strongly as in European skeletons of the Stone Age. The occurrence of platyknemia in various races of men has recently been discussed by M. Kuhff. In the tibiae of the skeleton from the Oban bone cave, referred to in a preceding paragraph (p.97), the shaft was decidedly platyknemic; the breadth of the middle of the shaft from the interosseous to the inner border was 19 mm. and the antero-posterior diameter at the same spot was 29 mm., the index was therefore 65.5, a proportion a little higher than that obtained by M. Broca as the mean, 64, of the tibiae from the Caverne de l'Homme-Mort, Lozère, but not so high as the mean, 66, of the Guanche tibiae from the Great Canary Islands.

"I examined the tibiae in my series of exotic skeletons with reference to the platyknemic form, and compared them with a well-formed European tibia.

In the Oahuans, adult Andaman Islanders, and Bushman the tibial shafts were decidedly compressed, and the posterior surface convex, so that they were platyk-nemic, although not in the same marked degree as in the tibia from Cro-Magnon, near Les Eyzies, described by M..Broca, but more like those from Perthi-Chwaren figured by Mr. Busk. In many of the other skeletons also, as the New Zealanders, Lapps, Esquimaux, Hindoos, Sikh, and Malay, a tendency to the platyk-nemic form was distinctly recognisable. In some of the Australian skeletons, in one Hindoo, and in the Chinese the fibular articular area on the external tuberosity of the tibia was indistinct, and the same remark applies to the corresponding surface on the head of the fibula. In the Anthro-poid apes the shaft of the tibia also possesses a certain amount of lateral compression, and the posterior surface is somewhat convex, but the anterior border of the bone is not sharp but rounded." ]

From the study of the radiographs taken at Alice Springs a good indication of the radiographic appearances of boomerang legs has been gained, so that by examining radiographs of such bones as those referred to by TOPINARD it should be possible to say whether or not yaws had played any part in the production of the deformity. Rickets would have to be excluded. That syphilis could be ruled out on historical evidence, I am not prepared to say. This aspect of deformed bones is a study I wish to continue when I return to Europe.

A problem of similar nature is presented by the retroversion of the upper end of the tibia among primitive peoples. It will be noted that the greater the degree of bending of the tibia the greater is the angle between the plane of the knee joint and the horizontal. Both platycnemia and retroversion of the knee have been dealt with by various authors as an anthropological character. They have traced diminishing degrees of both deformities from the higher apes through the primitive human races to modern man.

One wonders if a disease which can have such an influence on the skeletal structures, as yaws, would lead to any deviation in the individual from the normal; for instance in stature. KNOTT (1931), indeed, refers to the

stunting of growth that occurs in some cases of yaws. This raises the question of the validity of anthropometric observations made on random samples of populations among which yaws is prevalent, when one wishes to compare the massed results with those of other races. An interesting study would be the correlation of some anthropometric observation, such as stature, with the serum Wassermann reaction in a group of Australian natives.

There is a large collection of aboriginal bones in the South Australian Museum, many of which show pathological changes. I have only picked out a few specimens to indicate the geographical distribution of boomerang leg deformity and to study other bone lesions. This has not been a complete survey of this collection, which is one of the largest in Australia. Radiographic examination would be a valuable aid in the study of these bones.

This is a field awaiting a student who should at the same time visit Alice Springs with radiographic facilities and make a more complete study of the skeleton of the native. By making a more complete study, the condition of the bones of the living could be compared with that of those of the dead (and extinct) preserved in museums, and thus further indications of the health of the original inhabitants of Australia would be obtained.

Appendix B.

When one comes to the pleasant duty of expressing one's gratitude for assistance received in the course of the studies above outlined, it is no easy matter. So many and so various are the influences that bear upon one, that he would be a bold or rash fellow who would say from which individuals he received the most extensive or most important assistance. To those many individuals in various parts of the world whose help over many years has been of value in the immediate past, one can only express gratitude in silence, as one remembers those not present at the Christmas board when toasting "Absent Friends". Of those whose assistance has been more recent and tangible I can truly say that the willing manner in which their services have been offered has been a great pleasure to me.

I have taken the opportunity where it has offered, during the course of the thesis, to thank individually those who, in their kindness, gave me their assistance. To the Chief Medical Officer and Chief Protector of Aborigines for the Northern Territory of the Commonwealth of Australia, Dr. E. C. Cook, and the officers of the Northern Territory Medical Service, to the Superintendent of Police, Mr. A. V. Stretton, and members of the Northern Territory Police Force, I was in many places and on numerous occasions indebted. To the staffs of Vestey's and Bovril Australian Estates I am indebted for assistance and hospitality in the Victoria River District.

On my return to Adelaide I received every assistance from the staffs of the Barr-Smith and Medical Libraries of the Adelaide University, the Public Library of South Australia, the Library of the Adelaide Hospital Laboratory, and the officer in charge of the South Australian Archives Department. Willing assistance was also given by the staffs

of the National and Australian Museums and the Melbourne and Mitchell Libraries.

I would like to emphasise the value of the Tropical Diseases Bulletin which I found of great assistance when searching the medical literature of yaws.

To Dr. N. Hamilton Fairley of London I am indebted for advice and interest from the inception of the thesis.

Professor J. B. Cleland kindly lent me reprints of various papers relative to the study undertaken and helped me in other ways.

Professor F. Wood-Jones of Melbourne drew my attention to several specimens under his charge, and kindly supplied me with photographs of them.

Dr. Harvey Sutton, Director of the School of Public Health and Tropical Medicine, Sydney, kindly loaned me BREINL & PRIESTLEY'S specimen and several books from that library.

Sir Colin MacKenzie, Director of the Australian Institute of Anatomy, Canberra, kindly provided me with photographs and data of specimens in that museum.

Dr. E. McLaughlin and the staff of the Adelaide Hospital Laboratory gave me every assistance in their power.

Mr. N. B. Tindale, Ethnologist of the South Australian Museum, has assisted me on innumerable occasions in various aspects of the work. Figs. 7 and 8 are from his negatives.

Dr. T. D. Campbell and Mr. H. M. Hale, Director of the South Australian Museum, gave me valuable assistance.

To the Sheridan Committee of the Adelaide University, I am deeply indebted for their assistance in making me a grant from the Sheridan Research Fund to defray expenses incurred in the undertaking of these studies.

Appendix C.

As required by the regulations for the Degree of Doctor of Medicine, the following is submitted as indicating the advances in medical knowledge and practice which are embodied in this thesis:-

The aetiology and pathogenesis of boomerang leg and its widely spread distribution in Australia.

The association of superficial scars, found on natives in the Northern Territory, with boomerang legs.

The yaws nature of irkintja of the Aranda tribe and boomerang leg.

That yaws exists and has existed in the past in areas remote from the Tropics - that is, over the southern and eastern States of Australia.

That cultural status, quite apart from tropical conditions, may determine the presence of yaws in a community.

The first record of yaws in South Australia and gondou in Australia.

The pathogenesis of yaws lesions in bone.

That a critical survey of early and recent descriptions of "syphilis" or "venereal disease" among the aborigines shows that the disease referred to is not syphilis but yaws.

A brief pathological survey of the aboriginal bones in the Museums of Adelaide, Melbourne and Sydney.

That the lesions of long bones and skulls, which, up to the present, have been generally regarded as syphilitic are yaws in origin.

That radiography is possible in an isolated settlement such as Alice Springs.

That sera collected at Ooldea, Alice Springs and Darwin can be transported to Adelaide in a condition satisfactory for the conduction of the Wassermann reaction.

Since the most frequent disease among bush natives is yaws, the problem of rendering medical aid to the population of the Central Aboriginal Reserve is simplified.

SECTION XVII.

AUTHORS' INDEX.



SECTION XVII.AUTHORS' INDEX.

	<u>Page number.</u>
ARAUJO (19 -)	17,
---- (1928)	17,
ARNAUD, et al. (1931)	11,
BAHR (1914)	34, 51, 55, 112, 185.
BARRINGTON (1802)	27.
BASEDOW (1913)	99
----- (1925)	65
----- (1932)	1, 21, 22, 23, 25, 35, 36, 37, 39, 41, 44, 65, 127, 181.
BEVERIDGE (1889)	27
BLACKLOCK (1930)	56, 186
----- (1932)	9
BLOCH (1908)	16
BOTREAU-ROUSSEL (1925)	54, 185
BREINL (1912)	34, 39, 64
BREINL & HOLMES (1915)	34, 39, 43, 64
BREINL & PRIESTLEY (1915)	6, 49, 54, 64, 134, 184, 185
BROMLEY (1837)	20
BUTLER (1914)	10
---- (1922)	10
---- (1928)	10,31
---- (1929)	18
BUTLER & HERNANDEZ (1929)	15
CAPPER (1925)	14
CARMICHAEL (1842)	17
CASTELLI (1912)	11
CASTELLANI & CHALMERS (1913)	17, 64
----- (1922)	13
CHESTERMAN (1927)	56
----- (1928)	18
CHRISTOPHERSON (1918)	65

CILENTO (no date)	193
CLAPIER (1920)	53, 185
CLARKSON (1808)	17
CLELAND (1912)	193
----- (1919)	60, 65
----- (1928)	22, 23, 28, 35, 65, 164
----- (1933)	40, 180
----- (1934)	39, 180
CLELAND & FRY (1930)	127
COOK (1929-33)	38
COOK (1790)	18
CORRIGAN (1835)	16
COUTTS (1929)	16
DUBOIS (1933)	180
EYLMANN (1908)	32, 41, 62, 185
EYRE (1845)	21, 22, 28
FITZGERALD, et al. (1934)	31
FOELSCH (1881)	28
FOX (1929)	56, 186
GANN (1901)	15
GARDNER (1895)	1, 61, 185
GASON (1879)	29
GOODPASTURE (1927)	13
GOODPASTURE & deLEON (1923)	31
GOULD & PYLE (1900)	65
GRAY & CLELAND (1933)	66, 180
HACKETT (1935)	61, 185
HALE & TINDALE (1934)	40
HALLEMBERGER (1916)	13, 53, 182, 183
HANDT (1842)	27
HARLEY (1933)	31, 58, 98, 186
HARRIS (1933)	115, 125, 126

HARRISON (1926)	14
HASSELMANN (1931)	12, 59
HERBERT (1910)	33
HERMANS (1928)	2, 7, 54, 65, 185
----- (1931)	11, 56, 65, 186
HEWER (1934)	9
HOLMES (1912)	39
HULL (1858)	26
HUNT & JOHNSON (1923)	10, 17, 37, 54
HUTT (1844)	25
JAHNAL & LANGE (1928)	15
KINGSTON (1861)	23
KINSEY (1901)	16
KNAGGS (1926)	55, 111, 125, 128
KNOTT (1931)	34, 56, 183, 196
KOCH (1900)	39
LAMBERT (1929)	24
LANCEREAUX (1868)	16
LEIGH (1840)	20
MAJOR (1932)	14
MANSON-BAHR (1928)	17, 108
----- (1929)	55, 185
MARSHALL (1907)	12
MAUL (1918)	51, 55, 59, 110, 111, 118, 123, 125, 127, 128, 136, 147, 150
MIYAO (1930)	11
MONTEL & COUPUT (1932)	57, 111, 127, 186
MOODIE (1923)	15
MOORHOUSE (1840)	21
----- (1845)	28
----- (1848)	28
MOSS & BIGELOW (1922)	10
MACARTHUR (1931)	16

	<u>Page.</u>
MACKILLOP (1892-93)	30
MACLEOD (1901)	12
McFARLANE (1837)	20
NASH (1840)	20
NICHOLS (1925)	11
van NITSEN, et al. (1930)	11
PARHAM (1922)	10
PEARCE & BROWN (1925)	11
PENNY (1841)	24
PLEHN (1906)	13
POLAK (1927)	55
POWELL (1923)	18
PRESCOTT (1931)	7, 67, 88, 90
PRINSEP (1899)	31
RAMSAY (1925)	22, 96
REASONER (1929)	11
ROBINSON (1844)	26
----- (1845)	26
----- (1848)	26
ROTH (1901)	31, 154
SCHOEBL (1928)	5, 111, 114, 130
----- (1931)	11
SCHULZE (1890-91)	30
SHATTUCK, et al. (1933)	15
SMITH (1906)	32, 62, 183
--- (1907)	62, 184
SOETOMO & EICHHORN (1925)	55, 186
SPENCER (1928)	65
SPENCER & GILLEN (1899)	41, 44, 62, 71
SPITTEL (1923)	4, 10, 34, 54, 183, 185
STANNUS (1928)	108, 183
STIRLING (1894)	1, 46, 60, 181, 185.
----- (1896)	1, 8, 30, 46, 61, 136, 148, 155, 156, 185

	<u>Page.</u>
STRONG (1911)	10
STURT (1833)	21
--- (1840)	20
SWEDIAUR (1821)	17
TAPLIN (1886)	30
TATE (1881)	28
TOPINARD (1890)	60, 194
TUCKFIELD (1842)	25
TURNER (1886)	195
UNNA (1894)	13
WALLACE (1827)	16
WILLIAMS (1927)	15
WILMOT (1842)	25, 26
WILSON & MATHIS (1930)	56, 186
WOOD (1920)	66
WOODS (1879)	28, 30
WYATT (1837)	20

SECTION XVIII.

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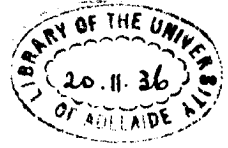
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On the Carriage of Serum  
for the Wassermann Test.

By CECIL J. HACKETT, M.D., M.R.C.P.,  
Adelaide.

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ON THE CARRIAGE OF SERUM FOR THE  
WASSERMANN TEST.

By CECIL J. HACKETT, M.D., M.R.C.P.,  
*Adelaide.*

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It has been thought worth while to record the following experiences in the transport of serum over long distances. In 1934 serum collected in Darwin, Northern Territory, was carried overland to Adelaide in an initially cooled vacuum flask. The journey occupied eight days, and on arrival the specimens were found to be in satisfactory condition for examination. Venous blood was collected into sterile test tubes; the clot was separated and the serum transferred by sterile pipettes into sterile test tubes, which were sealed by heat. The syringes and needles were sterilized by boiling in hypertonic saline solution. Similarly serum was successfully carried from Ooldea, South Australia, to Adelaide. On this occasion the syringes and needles were sterilized with chloroform.

In July, 1935, fifty specimens of serum were collected from natives in the Warburton Ranges, Western Australia, carried by motor truck 350 miles to Laverton, thence by train, via Kalgoorlie, to Adelaide. The syringes and needles were sterilized by boiling in hypertonic saline solution. The serum was treated as before, except that it was finally sealed in sterile ampoules, as this was easier. Some of the specimens were then placed in a water bath at 55° C. for thirty minutes, but this did not appear to be an advantage. For transport the specimens were wrapped in a thick layer of cotton wool. On arrival in Adelaide the sera were in an entirely satisfactory condition, although some of the specimens had been collected three weeks previously.

On these occasions no high atmospheric temperatures were experienced. These facts are recorded as there are few places in Australia, where a medical man is practising, which, with modern air services, are more than a week's journey from an organized laboratory; so there are no reasons, apart from financial reasons, why serological investigation should not be used in the diagnosis of any case requiring it.

**Acknowledgements.**

These observations were made in the course of studies which were undertaken with the assistance of a grant from the Sheridan Research Fund of the University of Adelaide. I am also indebted to the Director of the Adelaide Hospital Laboratory and Mr. S. F. Tee for carrying out the Wassermann tests for me.

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Interstitial Keratitis, Boomerang Legs and Yaws in a  
European Boy From the New Hebrides.

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By C. J. HACKETT,  
*Adelaide.*

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## Interstitial Keratitis, Boomerang Legs and Yaws in a European Boy From the New Hebrides.

By C. J. HACKETT,  
*Adelaide.*

THIS case is reported as it was thought that perhaps it might throw some light upon the present uncertain association of interstitial keratitis and yaws and on the larger problem of the identity of yaws and syphilis. For the purpose of the present paper it will be assumed that these conditions are two separate diseases, as recent experimental work indicates: Pearce and Brown (1925), Nichols (1925), Reasoner (1929), Miyao (1930), Schoebel (1931).

### Clinical History.

The patient was a European male, aged fourteen years. He was born at Epi, New Hebrides, and soon was taken to Ambrim, where he lived for two and a half years; the next two and a half years of his life were spent in South Australia. Then he spent another period in the New Hebrides, six months in Epi, and two and a half years in Ambrim. He has been in South Australia for the past six years.

The history of his mother's pregnancies is as follows: The first ended in a miscarriage. From the second was born a female, now twenty-three years of age. The third pregnancy produced a male, now twenty-one years of age. The fourth produced a female, who died in South Australia, aged nine years, of complications of measles. The fifth pregnancy ended in a stillbirth "caused by severe malaria and quinine". The sixth produced a male, now fifteen years of age. The seventh pregnancy produced the patient, now fourteen years of age. The father at the time of the child's birth was aged thirty-six and the mother thirty-seven years.

The mother died having had no further pregnancies. No medical man was in attendance at the mother's death; the father considers it was due to severe malaria. For some time she had suffered from high fever (40° C. or 104° F.), which quinine given intramuscularly and phenacetin did not relieve, and she died from exhaustion.

All members of the family suffered frequently from malaria while in the Islands.

When confronted with the possibly syphilitic nature of his son's eye condition the only suspicious incident that his father could recall was an abscess on his cheek, which he had associated with shaving immediately after opening an abscess on a native, antiseptic facilities not being available. This occurred before he was married, and the doctor who incised the abscess, associated it with the condition he had treated in the native. He has had no rash, and apart from frequent attacks of fever has had

good health. He and his sons have been engaged in mixed farming for the last six years.

There is nothing suggestive in the medical history of the other children, who, on casual observation, appear healthy, well nourished and developed. By a second marriage there have been two children (no miscarriages), who are also in excellent health.

The patient's father associated the deformity of his legs with an abscess which the patient developed on the back of his right thigh, just above the middle third. This was observed seven years ago (1928) while they were staying for a week on the island of Paama. An abscess of moderate size situated deeply in the muscles was observed one day; next day it had become soft and resolved shortly after without incision.

When he came to Australia the next year (1929) his shins were already deformed. This deformity increased during the next few months and was associated with rheumatic pains in the shins and forearms (no joint pains). The patient cannot recollect the onset of the leg condition and does not think he had any pain earlier. He still has occasional pains, especially in the lower third of the forearms. During the last year he has developed a lump the size of a small pea on the back of his left hand, just above his wrist; it is not tender.

In November, 1933, his left eye became inflamed and he was admitted to the Adelaide Hospital in December, complaining of progressive loss of vision in his right eye and intolerance to light. The left eye had given no trouble.

He was a well-nourished lad of average height for his age, but a little pale.

No pathological condition was found in his head and neck, except for the condition of his eyes. There was considerable blepharospasm of the lids of the right eye—some swelling of the lids and a lot of ciliary injection. The tension was full and the cornea hazy, with a more pronounced interstitial milkiness in the centre. The pupil was semi-dilated and fixed, with intense swelling and vascularization of the iris. There was a small hypopyon present. No break in the corneal epithelium could be detected.

No abnormality was detected in his thoracic or abdominal organs or central nervous system. His urine was normal.

His lower forearms appeared rather thick, but were not suggestive of any diseased condition. On the back of the right wrist was found the mass referred to in the

anamnesis. It was three to four millimetres in diameter and appeared to lie in the deep subcutaneous tissue and to be but loosely attached to the fibrous tissues over the tendons.

Both tibiae showed swelling anteriorly (with the maximum point just above the middle of each bone), which gave the impression of forward bowing. There was slight lateral swelling. The anterior tibial crest was rounded. There was no involvement of the soft tissues and no evidence that this had occurred in the past. The whole change appeared of a diffuse character and no tenderness was detected. The tibiae appeared to be of increased antero-posterior diameter in their middle third.

The radiographs of his tibia showed some forward bowing with increase in antero-posterior diameter. There was evidence of some trabeculation in the medullary cavity along the anterior cortex. No lines of arrested growth were present. The radiologist's report was: "suggestive of specific periostitis".

On the skin about both ankles were several oval scars, roughly one to two centimetres in length. The surface was whiter than the surrounding skin and slightly below the level of the normal skin. These, he said, were the result of sores from which he had suffered in the New Hebrides—in fact, all the white children there suffered from them. His brothers had similar scars.

The patient gave a positive reaction to the Wassermann test on December 15, 1933; the father and two brothers, who were tested on December 22, 1933, gave no reaction.

The scars on the legs cannot be regarded as a guide in differential diagnosis, as none of the boys has had any specific therapy, and they were present on his brothers' legs, although his brothers' serum did not react to the Wassermann test.

The patient's father was told by a doctor who was practising on the islands mentioned above, that there was no syphilis among the natives, but that yaws was very common. This is in agreement with the reports from other Pacific islands, where yaws is common among the inhabitants and syphilis practically unknown. His father said bent shins were common amongst the natives.

Within a month from the patient's admission to hospital the left eye commenced to lachrymate and became reddened. The right eye improved, but the left showed signs of acute iritis and corneal haziness. Later both eyes improved and at the end of the second month he could tolerate daylight with dark glasses, but a divergent strabismus of the right eye was present. The cornea cleared and many keratitic precipitates were seen in the right eye. During this time he was given twelve weekly injections of "Novarsenobenzol", 0.45 gramme, followed by mercurial inunctions and a potassium iodide mixture for two weeks. The Wassermann reaction was positive on January 19, 1934. He was discharged from hospital in March, but was readmitted in April and May with episcleritis of the left and right eyes respectively. In May the vision of his right eye was  $\frac{20}{30}$  and of his left  $\frac{4}{12}$ , and both eyes were practically white.

He was readmitted to hospital in March, 1935, for investigation. He was well and his eyes were satisfactory. He had developed a nodule on his left wrist. The serum was weakly Wassermann positive on March 22. On the same date the cerebro-spinal fluid failed to give a Wassermann reaction and on examination was found to contain only an occasional lymphocyte in films. He was given seven more injections of "Novarsenobenzol", 0.45 gramme, and serum collected on May 9 was found not to react to the Wassermann test. During his stay in hospital the strabismus in his right eye was corrected. At this time the nodules on his wrists were subsiding and he was feeling very well. The vision of his right eye was  $\frac{4}{24}$  and of his left eye  $\frac{4}{12}$ .

#### References to the Literature on Interstitial Keratitis and Sabre-Tibiae and Yaws.

Hunt and Johnson (1923), writing of Samoa, where they say syphilis does not exist among the natives, report that they have studied a condition which is identical with parenchymatous or interstitial keratitis.

Blacklock (1930), who holds the view that yaws and syphilis are one disease, in a report on Sierra Leone, Northern Province, records (page 11) ten cases of interstitial keratitis. He postpones the section on syphilis "for a future report". In the Central and Southern Provinces he makes no mention of interstitial keratitis in the table dealing with eye diseases. Discussing congenital syphilis (page 29), he observed one case of Hutchinson's teeth in 3,858 patients examined, and treats of sabre-tibiae as a manifestation and indication of congenital syphilis. He found 38 cases of sabre-tibia in 3,595 patients examined. On page 37 he gives a table (VIII) in which he shows that of these 38 patients with sabre-tibia, three had yaws and 31 gave a history of yaws. Many observers have reported the association of yaws with sabre-tibiae and bone pains: Bahr (1914), Clapier (1920), Wilson and Mathis (1930), Spittel (1923), Botreau-Roussel (1925), Hermans (1928), Manson-Bahr (1929), Montel and Couput (1923).

The association of interstitial keratitis and yaws is less definite.

Hashiguchi (1929) reports the occurrence of interstitial keratitis in rabbits inoculated with yaws.

Wilson and Mathis (1930), in a study of 1,423 cases of yaws in Haiti, report four cases of interstitial keratitis.

Knott (1931) speaks of interstitial keratitis as a yaws condition in Liberia.

Fast (1931), in a review of the literature, found references to interstitial keratitis in yaws.

Takasaki (1932), writing of Truc and Palau, Caroline Islands, speaks of "parenchymatous conjunctivitis, keratitis and iritis" in yaws.

Harley (1933), in a study of 6,291 cases seen in North Liberia, reports 38 cases of interstitial keratitis. Although he speaks of most of his cases as being yaws, he says "there may also be an occasional case of syphilis".

A case in some respects similar to the present one was reported by Gardner (1895).

A male, aged sixteen years, from Meiteum, New Hebrides, had suffered ill-health since six years of age. He had had ague and also bone disease, with sores on arms and legs, and had been in hospital in Sydney in 1888, when the sores nearly healed. He was thin and sallow. He had a "remarkable deformity of both tibiae, especially of the left, the bone being thickened, flattened laterally and bent forward, so that it is shaped somewhat like a boomerang. Scars of old sores, one sore still unhealed on the left ankle. Some swelling and deformity of the left radius and ulna, with periosteal nodes. Liver and spleen very much enlarged." There were enlarged and tender parts on humerus and metacarpal bones. The medulla of the long bones was freely drained at operations, when the bone was found to be sclerosed in parts, while in other parts the compact tissue appeared to be very thin. Considerable improvement followed. The pathological report was: "Evidence of osteitis, but no microorganisms were found."

He quotes a letter from Dr. Paton, the missionary, to the effect that the disease existed in all the southern islands of the New Hebrides. White children on Aneiteum, Aniwa and Nguna had been attacked by it. Five patients were children of missionaries and one was of a trader. Parents were all healthy. In all, from 28% to 30% of the inhabitants (presumably referring to natives) suffered from it. After the children began to walk and as they grew heavier, the disease developed, with swelling and deformity of the bones of the legs and forearms, and finally progressed to ulceration of the skin over the most prominent part of the anterior curvature of the leg. Children who had been removed from the islands when young had in some cases developed the disease years later. It always caused much pain similar to that from inflammation.

Gardner writes: "Apparently the patient suffers first from periostitis and later from an osteitis", and he goes on to discuss platycnemism. He arrived at no diagnosis, but it may be safely suggested that this was a case of yaws and the signs of activity of the disease would have responded readily to modern arsenicals.

A thesis is at present being prepared dealing with the association of "boomerang leg" and yaws, where certain points briefly referred to above are dealt with more fully.

#### Conclusion.

With the conditions present in this case, interstitial keratitis and sabre-tibiæ in a youth, the obvious diagnosis would be congenital syphilis. There is then to be disposed of the absence of Wassermann reactions in his father and two elder brothers. The two accidents in his mother's history—the initial miscarriage and the later stillbirth—cannot be considered any definite indication. Miscarriage of the first pregnancy is common in healthy European women in all countries, and accidents in pregnancy are common in malarial countries.

Mr. A. S. Webb, who was for some years in Aoba, New Hebrides, says that one of the means (practised by the natives) of foretelling the progress of the early years in life of a new-born child, was to observe the effect on the placenta of throwing it upon glowing coals. The forecast depended on whether or not the placenta shrivelled up before it charred. No references to the effect of such treatment on placenta, controlled by microscopical examination for the presence of malarial parasites, have been found; but in West Africa malarial surveys have been attempted by using the percentage of infected placenta as an index.

If the two conditions present are considered separately, there is the interstitial keratitis which is generally understood to be a manifestation of congenital syphilis, and the sabre-tibiæ, commencing in early adolescence in an individual from a locality where yaws is endemic and where sabre-tibiæ occur. Taking Gardner's case into account, the leg deformity would be considered more probably yaws than syphilitic in origin. There is considerable evidence to show that some cross-immunity exists between yaws and syphilis (Reasoner, 1929, Schoebl, 1931). It would be improbable that a congenital syphilitic infection which produced interstitial keratitis would allow of a concurrent infection of yaws.

Hence both conditions must be due to the same cause, either syphilis or yaws. Cases of double infection with these two diseases have been reported, but they are not frequent and all are not satisfactory. The evidence for a congenital syphilitic infection is not convincing. The patient is the last child of the mother, previous children are healthy, and his elder brothers and father do not give Wassermann serum reactions, he alone having a positive reaction. It is difficult to ascertain the part played by the abscess in his thigh; perhaps it further lowered his resistance and allowed an earlier infection to become active. With the present difficulty of differentiating syphilis from yaws, it is perhaps permissible to cast considerable doubt on a congenital syphilitic origin for the conditions present in this case and to suggest that more

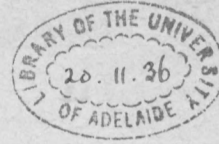
probably yaws was the causal factor, especially in view of the relatively rapid change in the response to the Wassermann test brought about by the administration of "Novarsenobenzol".

#### Acknowledgements.

The patient was under the care of Dr. A. L. Tostevin, and I am indebted to him for giving me access to it and for the clinical notes. I am also indebted to Dr. J. G. Sleeman, Superintendent of the Adelaide Hospital, for permission to publish this report.

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A Critical Survey of Some References to Syphilis and  
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I SHALL not attempt to deal exhaustively with the literature of syphilis and yaws for the whole of Australia; this would necessitate more time than is available. Only the better known and the more accessible statements have been taken; there is little doubt that many more would be found among the journals of explorers and early government reports. Professor J. B. Cleland's (1928) paper is of great assistance in the study of the history of disease among the aborigines, and full use has been made of it.

### References to Syphilis and Venereal Disease.

Bromley (1837) states that he learned from Cooper (a European drunkard) that at Encounter Bay the sailors cohabited with and infected the natives with the venereal disease, and six of them (the original is indefinite) were coming to Adelaide for treatment.

McFarlane (1837), in a letter from Rosetta (whaling) fishery at Encounter Bay, complained of men infecting natives with venereal disease. He states that one European youth, whom after great trouble he had cured, had again consorted with the native women and became reinfected.

Wyatt (1837) made a report to the Governor on his return from Encounter Bay, where he had been to investigate the murder of a European by a native. The European, while drunk, had molested two lubras, the native husband had attacked him, and in the *mélée* which ensued the offender had been killed. He writes: "This native is afflicted with the venereal disease and many other natives are known to be in the same wretched condition."

Leigh (1840), writing of his experiences as a ship's surgeon from 1836 to 1838, during which time he visited South Australia, reports seeing a native

at Adelaide, "nearly eaten away by a virulent species of syphilis, which seems to be indigenous". In an accompanying illustration, purporting to be that of an Australian native, the lower part of the subject's trunk is covered, so perhaps it was the penis that was eaten away. If this surmise is correct, the disease may have been *granuloma pudendi*. This was probably the native referred to by Wyatt (1837).

Nash (1840), Colonial Surgeon in Adelaide, in reply to a request from Captain Sturt for medicines for the treatment of natives at Encounter Bay, writes: "Although the name of the malady they are suffering from is not mentioned" (Sturt, 1840, had used the term "state of disease") "I suppose it to be syphilis and am sending Blue Pills."

It is quite possible that already two fallacies have crept in.

First, the rough seafaring population engaged in the whaling industry at Encounter Bay would most probably have contracted syphilis fairly early in life and would have become non-infective before they arrived in Australia. Many authorities believe that the chances of an untreated syphilitic infecting his partner three years after his primary infection are small, and diminish rapidly as time progresses. It is more probable that the Europeans would have infected the natives with gonorrhœa, which is notorious for its long infective period. This is still further supported by the report of a cure and reinfection.

The second doubt is whether Nash was correct in his supposition. This doubt is supported in the report of Dr. Moorhouse (1840). Moorhouse speaks of a disease of a specific venereal character which for the previous three months had raged extensively amongst the aborigines, of whom nearly one-half had been affected. It had not been introduced by the colonists, but had spread its ravages before they came. The Adelaide natives said it came from the East. He suggests that it may have come from visiting whalers.

I can trace little connection between it and the European disease, it is greatly modified in its appearance by transmission from a white to a black race.

Basedow (1932), in quoting this passage *verbatim*, omits the word "little", which changes the original meaning.

Moorhouse, quoted by Eyre (1845), thought at first that the *glans penis* and groins were never affected, but later thought that this did occur.

Sturt (1833), in the description of his journey down the River Murray, when just east of the present South Australian border, writes (page 96):

The most loathsome disease prevailed among them, several were disabled by leprosy, or some similar disorder, and two or three had entirely lost their sight.

On page 124, Volume II, when above the position of the present township of Waikerie, he records:

The most loathsome of diseases prevailed through the tribes, nor were the youngest infants exempt from them. Indeed, so young were some, whose condition was truly

disgusting, that I cannot but suppose they must have been born in a state of disease; but I am uncertain whether it is fatal or not in its results, though most probably it hurries many to a premature grave. How these diseases originated it is impossible to say. Certainly not from the colony, since the midland tribes alone were infected. Syphilis raged amongst them with fearful violence, many had lost their noses and all the glandular parts were considerably affected.

On page 148, Volume II, after passing the North-West Bend, he makes the following statement:

Leprosy of the most loathsome description, the most violent cutaneous eruptions and glandular affections, absolutely raged through the whole of them.

Basedow (1932) makes no special reference to Sturt's reports.

Cleland (1928), however, raises the question of the accuracy of the use of the terms "syphilis" and "leprosy", and suggests it may have been syphilis which had spread up the River Murray, having originated from visiting whalers from Encounter Bay or Kangaroo Island. He admits there is no record of this having occurred. He thinks Sturt would have recognized it had it been smallpox, and adds: "No trace of yaws has ever been found among the natives of South Australia."

The description might very well be that of a widespread epidemic of yaws among the aborigines. The extensive skin lesions, the incidence among the children, and his statement that it was not associated with the colony support this conclusion. His use of the word "syphilis" could be disregarded. The lost noses might quite well have been "gangosa", which is valuable evidence of the presence of yaws in a native community. That "all the glandular parts were considerably affected" would quite well agree with the secondary yaws eruption, which in drier climates tends to affect the moister parts of the body, that is, round the mouth, the neck, the axillæ, the antecubital areas, the groins and gluteal cleft (Ramsay, 1925). Yaws lesions in aboriginal bones from South Australia have been recently described (Hackett, 1936).

Eyre (1845) reached Murundi (Morrundi or Moorundee, near Blanchetown, and about fifty miles below the north-west bend of the Murray) in 1841 and found the natives well developed and almost free from disease. By October, 1844, however, "from frequent intercourse with the town and neighbouring station they had contracted the most horrible diseases. From that time on many were in a dying condition, some already dead, and but a few of those who had frequent intercourse of every age and both sexes were wholly free from this disease." He describes "round pustules, commonly of the size of an ounce weight" which "rise from the skin".

The centre of these is gradually filled with flowing pus, then as they grow larger and larger and disperse, the surface of the whole body is affected with wasting and scab, which cause horror and disgust to those near them. These ulcers sometimes may persist for six or eight months; but generally when irritants or caustics are applied locally they are cured within three weeks.

After the first or second year the disease disappears, but sometimes causes death. But the unfortunate victims always suffer great torture and continuous pain.

He states that he had seen the *glans penis* and groins affected in natives on the banks of the Murray. In the same part of his book Eyre writes:

Of the diseases from which they [the natives] suffer since the arrival of the Europeans, by far the most frequent and most deadly is the venereal stain. It can now by no means be decided whether this disease was known to the natives before the Europeans mingled with them. They themselves say that it was long before brought from the East, from which it seems very probable that it had its origin in Europe, and from hence tribe to tribe was carried throughout the whole continent.

He states that the disease was less frequent and severe among tribes which do not mingle with Europeans.

Moreover, the habits of the natives are such that, whenever the disease appears in its worst form, it spreads with a swiftness and virulence found nowhere else.

He writes:

These tribes well know that this disease, like other diseases of the same kind, is contracted by contact.

In Eyre's book the above descriptions are in Latin; Cleland (1928) has kindly published a full translation of them. Basedow (1932) considers this a description of *lues venerea*, and adds: "Some of the lesions and conditions observed by Eyre were no doubt of the nature of a soft chancre."

It would appear that the epidemic Sturt reported had subsided by the time Eyre reached the locality ten years later; then after three years, perhaps on account of poor seasons, the general health was lowered and the disease became again evident in quiescent cases and children were infected.

The early records of rainfall for Adelaide kept by Kingston (1861) give the following values:

Average annual rainfall, 1839-45, 19-30 inches on 111 days.

1841,	17-95	93
1842,	20-32	119
1843,	17-19	105
1844,	16-88	135
1845,	18-83	124
1846,	26-88	114
1846-52,	25-27	

Earlier publications of these records include an error in the values for 1844, which was not corrected until 1861.

When Mr. E. Bromley, the Divisional Meteorologist for South Australia, was approached regarding the climate of these years, he said that the winter rains of 1843 and 1844 were good, but there was undoubtedly a dry season from September, 1843, to June, 1844. Although Murundi is seventy miles from Adelaide and lies to the east of the system of ranges which has an influence on the rainfall of Adelaide, he thought it was possible that there may have been a poor season in that district during the summer of 1843-1844. The average annual rainfall at Blanchetown is about ten inches.

That this description might well be considered that of a secondary yaws eruption is supported by the account of the duration of the disease. The "great torture and continuous pain" may refer to the bone pains of yaws.

A small percentage of primary genital lesions is reported in most extensive investigations in yaws-infected communities, and eruptions on the groins often occur in yaws. If one recalls Moorhouse's findings on this point, it may be assumed that it was not of frequent occurrence and might possibly be accounted for by a few cases of *granuloma pudendi*.

The natives say that it came from the East; and this gives Eyre no ground for concluding that it came from the Europeans. I presume he refers to the settlers in Sydney, which would mean an overland spread of nearly five hundred miles. He speaks of the intense infectiousness of the disease. This is well known in yaws, for in many communities where yaws is rife it is found that nearly all over four years of age have been infected with the disease (Lambert, 1929, for Samoa).

Penny (1841), writing from the elbow of the lower Murray, states:

There are few individuals amongst the natives who have the disease severely, but the larger proportion are only slightly affected and are anxious for medical relief.

He asks for further supplies of copper sulphate and potassium nitrate.

A popular remedy in central Australia among the settlers for the disease *irkintja* (yaws) in the natives is copper sulphate (blue-stone) and vaseline, and apparently it hastens healing.

Hutt (1844) writes of two reports of a disease in the native camps "far beyond York" in Western Australia, where "38 cases, male and female, were found suffering from a loathsome venereal disease". A hospital had been established there six months previously (May, 1842), and in one month, of seventeen patients treated, ten were cured. He states that a similar disease was present at King George's Sound. This might well be yaws. It is improbable that it was syphilis.

Wilmot (1842), in his report to Robinson, Chief Protector, gives an account of what he calls syphilis at Nerre Nerre Warrew (Narre Warren, at the foot of the Dandenong Ranges, Victoria):

The natives declared the disease was unknown before they had intercourse with the white people. It generally originates with a small cluster of irritable papules on the inside of the thigh or scrotum and perineum, which rapidly coalesce, and degenerate into foul ulcers, terminating ultimately in a warty excrescence; in a few weeks it spreads very widely, and the skin becomes at length affected with a scaly eruption of a circular form, with a well-defined margin, giving it much the same appearance as lepra vulgares. The action of the virus is singularly modified by the habits and constitution of the native, as it does not appear to pass through the ordinary channel of the lymphatic system into the constitution, but directly through the general circulation or capillary vessels, as only in one instance, and that of a dubious kind, did I meet with any appearance of specific glandular affection. In no case did I find any other than the inguinal glands affected, in no case was there any ulceration of the fauces, nor did I meet with a single instance of a venereal node.

Although it no doubt arises from a specific virus, still the disease is much aggravated by their filthy habits.

I expect in the arsenical solution to find a valuable remedial agent in the treatment of this form of disease.

In the soundness of your expressed opinion before I proceeded to the station, of the inapplicability of mercurial medicine to the circumstances of the natives I entirely accord.

Referring to the last statement, Basedow (1932) wonders "whether possibly some of the cases recorded by the early observers were yaws and not syphilis".

It is difficult to interpret Wilmot's statements; he is not quite satisfied that it is syphilis; his description, together with his remarks about treatment, applies more aptly to yaws than to any other disease, except for the scaly eruption which is a frequent manifestation of syphilis in African negroes, and for the native belief that it was not present before the Europeans came.

Tuckfield (1842) writes that the natives of Geelong (Victoria) "were entirely free from those loathsome diseases under which vast numbers of those who are associated with Europeans groan, and which have in so many instances terminated in death".

Robinson (1844), in a report of a journey to the eastern coast and interior of Victoria, when near Omeo, writes: "A loathsome disease (syphilis) among the natives, imported by the Europeans, is making ravages."

Robinson (1845) on a journey to Wimmera (Victoria) writes, when near Mount Cole: "visited natives suffering from a loathsome disease, the effect of illicit intercourse of white men with native women—one woman was in the last stage of suffering." From Lake Hindmarsh (Victoria) he reports: "Two men afflicted with venereal disease could scarcely walk, an additional proof of the baneful effects of syphilis among the Aborigines of the Interior." Near Glenelg River, South Australia, he reports: "Several natives afflicted with syphilitic disease." He writes: "A plague, the consequence of a dispute with a neighbouring tribe, who had the power, they said, of inflicting it, was apprehended."

In the medical officer's report for the Goulbourne River district (Victoria), which Robinson (1848) includes in his report, is found: "March 3, visited large numbers of natives at Seymour and at Cameron's Well, on the Sydney, as usual a great number were suffering from syphilis." In Appendix B, by John Walton, surgeon, of Robinson's report (1848) it is said that at Mount Rouse "syphilis less frequent than formerly".

Tuckfield's and Robinson's statements are all probably influenced by the opinion of Wilmot (1842), so the literal diagnosis cannot necessarily be accepted. The statement that two men with the "venereal disease could scarcely walk" may perhaps be correlated with the grossly pathological bones which have been found in Victoria. All indications point to these bony changes being the result of yaws. That one tribe should have had the power of inflicting a "plague" on offenders is similar to the Aranda people's "power" of disseminating *irkintja*, which is their name for yaws (see below).

Hull (1858) says that syphilis existed among the aborigines before the Europeans came to Australia.

Earlier he had said the disease the natives suffered from was like syphilis, but indigenous. He refers to Wilmot's statements.

If Hull is correct that the disease was present when the Europeans arrived, it is almost certain, from the findings in the Northern Territory, that it was not syphilis.

Beveridge (1889), writing of the aborigines of Victoria and the Riverina between 1845 and 1868, states that venereal disease "long before the advent of the white man, was one of the greatest scourges this primitive people had to bear". He suggests that the Malay and Chinese trepang hunters brought it to "the northern coast centuries ago, from whence it spread from one tribe to another, until the disease became a national calamity". Later he states that there was an absence of "contagious" disease, except "occasional visits from influenza, which often has a fatal termination".

During winter they, 'tis true, are very much subject to a kind of scurvy, which, from its prevalence, might be deemed contagious, but we are inclined to imagine that it partakes more of a venereal character, and each break-out is due to lack of nutritious food, combined with cold, wet lodgings. As the mild spring advances, and food becomes plentiful, this distemper gradually leaves them, and by summer their skins have returned to their normal sleekness, with a glossiness truly wonderful, considering the blotches with which they were marred during winter.

What has been said of Hull's statements applies also to those of Beveridge. As yaws is prevalent in Malaya, it is more probable that they would have carried that disease to Australia rather than syphilis. It is not certain whether syphilis existed in China prior to European contact. His description of a "contagious venereal scurvy" is rather indefinite, but there are sufficient grounds for considering that the diagnosis of yaws would more probably be correct. Despite what he says of the effects of climate, the winter would be the best season for food; the chief influence of the cold season would be the wearing of body covering and closer contacts to maintain warmth.

Barrington (1802), in his "History of New South Wales", writes:

The venereal disease, there is every reason to imagine they were not ignorant of before they knew us, but if they were, our arrival will account for its appearance shortly after, though every care on the part of the Governor was taken to prevent it.

Here is another opinion that the disease was present before European settlement. The diagnosis cannot be taken as definite.

Handt (1842), reporting on the conditions of the natives in the Province of Moreton Bay (Queensland), writes:

The sicknesses they are subject to are chiefly consumption and rheumatism; and many of them, children not excepted, are infected with the venereal disease.

As the climate of this area is definitely tropical, and children were also affected, this condition is also probably yaws.

As an indication of the accuracy of medical diagnoses in the early days by laymen and others,

reference might be made to the reports of smallpox in South Australia in the early forties. A report was found in the archives at Adelaide which has been missed by reviewers.

Moorhouse (1845) refers to the itch (*scabies papuliformis*) as universally affecting the natives. It had made its appearance nine months previously and had spread over a range of four hundred miles. On account of the great tendency to pustule formation, it "was formerly mistaken for smallpox but yields readily to treatment with sulphur ointment". Moorhouse (1848), referring to native school children in Adelaide, states that when a child lived with its parents for a few days the itch was sure to show itself. Yet at this time smallpox was reported from a large area east and west of Adelaide.

Tate (1881) records that Dr. Gething, who was at Streaky Bay in 1866, told him that "he treated the disease as smallpox, to which it had a close similitude, presenting similar symptoms". The natives at Streaky Bay declared that it came from the north.

Confusion of nomenclature of disease continued through the literature, as is shown in Foelsche's (1881) paper, dealing with the native tribes east of Darwin.

Syphilis is occasionally met with, but it is by no means common among the natives. I have seen only a few cases during the eleven years I have been there.

Again:

Venereal disease is rather prevalent and they have some means of curing it. Later he confuses arteries with veins when speaking of blood-letting for ceremonial purposes.

Woods (1879) quotes the following as a footnote from Eyre (1845) (ii, 239):

To this must be added, from time to time when the Europeans mingled with them, venereal stain. Mothers communicate the disease to the infants, and a great number perish every year from that cause.

He continues (translation from Cleland, 1928):

In this it is probable that Eyre has been to some extent mistaken. The effect of the ailment to which he refers, according to statements gathered from a variety of quarters, was never so widely disseminated as his note would indicate. It is of course impossible to assert that it has not had some influence over the Aborigines, but proof is wanting that it has been sufficiently wide-spread to justify its being regarded as one of the primary causes of the dying out of the tribes. It is not known whence it was derived, or whether it existed among the tribes before the advent of the Europeans. He states, however, as a fact that in 1841, when they assembled at Moorundi, there was but little sickness amongst them, but after visiting the town and adjacent stations, they appeared to have contracted some horrible disorders. He describes certain appearances which are known to be produced from other causes. It is remarkable that if the case was as represented by Eyre, the Narrinyeri tribe must have been particularly exposed to its influence, and it must have left its traces amongst them. Mr. Taplin, however, makes no mention of it, and he would scarcely be likely to pass over such a circumstance if it existed. The natives of some tribes suffer from a sort of leprosy or scrofulous disease, which exhibits many of the characteristics mentioned by Eyre, but this disorder seems to afflict individuals and not families.

He refers to Gason's description given below. "One complaint may thus have been, and not improbably was, mistaken for the other. A friend of mine" (F. Marchant, of Arkaba, in the Flinders Ranges, South Australia) "first called the attention of the writer to the existence of this malady. At the same time he mentioned what would seem a certain cure for it." He describes how a native at Canowie, "in a deplorable condition of suffering from this disease", was "dipped like a sheep". "The dipping mixture (for scab) was composed of water, soft soap, tobacco and arsenic—the last in the proportion of one ounce to the gallon of water." After becoming much worse, "he lost his hair and his finger- and toe-nails", and then "his skin came off", but "eventually he got quite well". He says that "other blacks who had heard of the circumstance came to Canowie and begged to be dipped", but no one had the courage to repeat the experiment lest "a trial for murder or manslaughter" ensue.

That Woods should question the accuracy of some of Eyre's statements is interesting. I have been told that many of the early shepherds on Flinders Range, sheep stations were there for the benefit of the more settled areas, so it is more than likely that the native was as thoroughly immersed in the dip as were the sheep. The general shedding of the epidermal structures was probably the result of direct action, but it is possible that some of the mixture was swallowed. Probably his recovery was hastened by the arsenic. One is inclined to regard this disease as yaws.

Gason (1879) writes, page 283:

Mirra.—A disease which every native has once in his life, sometimes at three years of life, but more frequently at fourteen, or thereabouts. The symptoms are large blind boils, under the arms, in the groins, on the breasts or thighs, varying in size from a hen's egg to that of an emu's egg. It endures for months, and in some instances for years, before finally eradicated. During its presence the patient is generally so enfeebled as to be unable to procure food, and in fact is totally helpless. It is not contagious, and is, I surmise, peculiar to the natives, whose only remedy is the application of hot ashes to the parts affected.

Gason was a police trooper, and it is difficult to reconcile the large size of the lesions, if they were swellings, with any disease of such widespread distribution and apparent chronicity. He must have intended that it was not contracted by Europeans.

It is also difficult to picture the condition of a native population among whom at some time in life every individual was incapacitated for months or years. If, instead of "blind boils", one assumes granulomata, and tempers other parts of the description, it is possible that the disease was yaws.

Taplin (1886), referring to the Murray Lakes area, writes:

I have seen cases, even bad ones, of syphilis amongst the natives. I am sure the disease was imported among them; they knew nothing of it before the advent of the whites—this is the testimony of the natives. I have known fatal cases, also cases where the tibia was affected, and bony excrescences on the skin, with atrocious neuralgic pain; I have also seen buboes in the groin.

Venereal disease is not very prevalent; I am persuaded that sometimes cases of impetigo have been mistaken for it.

This article was published after Woods's (1879) and cannot be regarded as an authentic statement that syphilis occurred among these natives.

Mackillop (1892-1893), referring to the Daly River tribes, stated that cases of cancer were frequent and syphilitic diseases seemed to have gained upon them. There was no word in their language for it, so he believed syphilis was of recent origin.

Cancer is very rare among the aborigines; it is quite possible that cases of gangosa or other tertiary yaws lesions were misdiagnosed cancer or syphilis.

Schultze (1890-1891), referring to the Finke River natives, states:

The worst disease among them is syphilis, with which everyone is more or less tainted. From the first we have had to treat this disease and several natives have died of it. It appears to be coming more common, due probably to general prostitution.<sup>1</sup>

Stirling (1896), page 127, writes:

Venereal diseases are extremely rife amongst the natives, undoubtedly largely owing to infection by the whites. In a few instances I observed the characteristically disagreeable facial aspects due to destruction of the nasal septum and falling in of the bridge of the nose resulting from syphilis. In other cases there were the usual ulcerative affection of the soft palate or loss of voice from laryngeal invasion.

It is still a moot point whether these diseases existed before the advent of Europeans. I can see no reason why the causes, whatever their precise nature, which first gave origin to them elsewhere may not have also operated here endemically.

He refers to Plate XII, Figure 13: "a naturally unprepossessing countenance—the effects of this disease are probably apparent".

Harley (1933), page 252, writes: "Chronic laryngitis is . . . a prominent symptom in hidden gangosa", and he includes ulcerated soft palate in the same category.

Stirling's statements are sufficiently loose to allow of a safer diagnosis of yaws.

Prinsep (1899), Western Australia, in his annual report writes of the "growing prevalence of venereal diseases amongst the aborigines in some places". He quotes the police report for Wyndham, Western Australia: "Syphilis is becoming very prevalent." From Hall's Creek, Western Australia (1898), natives were reported to be disabled by blindness, locomotor ataxia and syphilis.

Roth (1901) writes:

By the term venereal, as commonly employed, must be understood at least three distinct diseases, gonorrhœa, venereal sore and syphilis.

Syphilis may answer to ordinary drugs, mercurials and iodides, but unfortunately this disease takes on very often a malignant or galloping form, running a rapid destructive course. Phagedena appears to be a comparatively common complication of venereal disease.

He noticed comparatively few cases of hereditary syphilis.

I have met with two cases in private practice where European children have been accidentally infected with syphilis.

Natives as a rule do not seek European advice until they have exhausted their own remedial measures, and the disease has already got a firm hold on them.

Roth does not attempt to differentiate yaws from the "venereal" group, nor does he take into consideration *granuloma pudendi*, which might possibly account for the phagedena cases. That mercurials are not wholly satisfactory is a frequent statement concerning yaws (Goodpasture and de Leon, 1923), although United States naval workers at Guam and Haiti state that mercury will cure yaws (Butler, 1928). Of potassium iodide Fitzgerald *et alii* (1934) say that at one time it was used fairly extensively in the treatment of yaws, as in Castellani's mixture, but, as far as they could ascertain, it was entirely inactive. Roth may have confused mild gangosa with hereditary syphilis.

Smith (1906), in discussing errors of diagnosis, is careful to differentiate certain conditions from leprosy. He refers to several instances of mottling of the skin of the hands and feet which, he states, are "of a specific nature".

This is probably the result of yaws—*melung*.

He refers to "specific disease of the mouth and nose in the black fellow".

In one woman I saw that the cartilages of the nose were gone, and the skin was cicatrised in the neighbourhood, including the upper lip.

This might safely be considered as gangosa.

I saw one man with an extensive wound in the sole of the foot and part of the toe was lost, two of his fingers also were contracted. There was indistinct history of specific disease.

This also might have been due to yaws.

Eylmann (1908), page 438, writes:

Syphilis is spread all over the Colony.<sup>1</sup> According to my observations there are only few among the natives whom it has spared. Quite frequently it appears in very serious forms. Thus for example one can meet more frequently than among ourselves, people who are extremely disfigured by the loss of their noses, or in whom it had led to the destruction of the hard palate and a connection between the mouth and nasal cavity. Affections of the bones are not rare. Cutaneous tumour does not often occur. However I do not wish to leave unmentioned that I met a native at Tennant Creek who suffered from freely suppurating syphilitic ulcers and who asserted that he had become infected with the disease in an Eastern tribe, the majority of whose members suffered from it.

We may perhaps assume that syphilis would, in most cases, run as serious a course among the natives as it does among the Germans. This however is not the case because it has not been in the country for long. At any rate the number of serious cases would be much smaller were medical treatment so readily procurable and were it as frequently taken recourse to as among ourselves. We must likewise not forget that the native who lives in a chronic state of hunger in all probability has less power of resistance against disease than the well fed white man.

I need not stress that the number of children who suffer from hereditary syphilis is not small. As among ourselves, syphilitic women after a few years often give birth to quite healthy children. Thus for example I treated at Barrow Creek Station a lubra, twenty to thirty

<sup>1</sup> Vide Basedow (1932), *infra*.

<sup>1</sup> South Australia before 1911 included the Northern Territory.

years of age, whose palate and throat were covered with syphilitic ulcers which had already destroyed the uvula and pierced the hard palate. Her two small daughters (the father of the younger one was an Englishman) however were among the strongest and most healthy native children I saw.

I should not like to leave unmentioned that bushmen who had contracted syphilis from lubras seldom developed severe lesions in spite of the fact that they received no medical treatment. This contradicts the supposition that the disease usually appears in more serious forms when Europeans become infected from people belonging to an alien race. Whether the climate and the mode of living have a good influence on the course of the disease I am uncertain. Usually the bushmen of the inland do not often become infected, which may be explained by the fact that as a rule they only find opportunity for sexual intercourse with the older lubras, the greater majority of whom have contracted syphilis years before and are no longer infectious.

Where and when syphilis for the first time appeared in Australia no one, of course, can tell us. However, we seem to be compelled to assume that it was imported by Malays and Papuans a long time ago. The greatest number of syphilitic cases were at Hermannsburg Mission, in the environment of townships and on the gold-fields. Here, where almost all lubras are prostitutes, syphilis naturally occurs more often than among the tribes who still severely punish an unpermitted breach of marriage (if I may say so). The number of syphilitic persons would however be somewhat smaller near the settlements if the boys and lubras in the service of Europeans did not have many sick relations or friends. (Translation.)

The widespread distribution and the occurrence of facial destruction is more suspicious of yaws than of syphilis. This also applies to the native whom he saw at Tennant Creek, and most probably to the lubra at Barrow Creek.

In reference to the absence of severe infection among the "bushmen" (that is, Europeans), his explanation gives one the impression that infection was extremely uncommon. That the Europeans have intercourse chiefly with the older lubras is quite contrary to what one sees and hears in the interior.

That the Malays and Papuans imported syphilis into Australia is not probable, as among both these peoples yaws is prevalent. There is no proof either that syphilis occurred prior to European contact or that syphilis is or was at any time prevalent among the aborigines.

Syphilis does not exist at Hermannsburg (1934); this is more than thirty years later. Pathological conditions occur there which probably Eylmann would have considered syphilitic, but which clinically and from their rapid response to "Novarsenobenzol" are now diagnosed as yaws. Herbert (1910) states that of one hundred aboriginal females examined by the Government Medical Officer, only one was free from traces of venereal trouble. This probably refers to gonorrhœa, which at present is disturbingly frequent among the natives and half-castes in contact with settlements. Gonorrhœa was not found among the bush natives of the Central Reserve (South Australia) in 1933. Breinl (1912) gives a table (4) of statistics of the Darwin Hospital from 1897 to 1910, which deals mainly with non-aboriginal patients. Among 1,284 patients, only 24 cases of syphilis were treated, and in eight years of this period there were no cases of syphilis.

Gonorrhœa was not included, and only one case of yaws is mentioned. In Table 3, of 2,335 certified deaths among the non-aboriginal population from 1871 to 1910, eleven were due to syphilis, one to gonorrhœa and three to granuloma. If syphilis were frequent among the natives, one would expect to find more evidence of it in these statistics.

Breinl refers to the case illustrated in Figure 19 as the result of syphilis, which is probably due to yaws, being a minimal case of gangosa. He reports yaws as being prevalent among the native children in some localities.

Breinl and Holmes (1915) report that yaws is "fairly prevalent amongst the children" of the Daly River tribes, so that it "may be safely assumed that practically every child suffers from the disease in a mild form at one time or another during its youth". "In later life, as a rule, only a few scarcely perceptible scars, sometimes round the mouth, or in the genital region, bear testimony to the previous illness." They saw several cases suspicious of tertiary yaws. They refer to a case similar to one seen in New Guinea, "which has been described as a 'peculiar disease characterised by arthritis, osteitis and periostitis,'" in which the "upper part of the right tibia was considerably swollen and curved forwards, with fistulous openings discharging a light amber-coloured clear fluid". The left tibia and both ulnæ were affected. "The genitals appeared normal, and no history of previous attack of yaws or syphilis could be obtained."

They state that several authors consider this to be a tertiary manifestation of yaws, but they consider it a "disease *sui generis*".

The evidence of Bahr (1914), Spittel (1923) and Knott (1931) would indicate that these were cases of yaws. I saw a similar case on the south side of the Mann Range in 1933. In other cases I have known great improvement in similar, but less numerous, lesions to follow the exhibition of modern arsenicals.

"One case of advanced syphilis was seen" (Anson Bay) in a boy, aged about nineteen years, in a comatose condition. His disease was supposed to have begun from the time he was employed by white men. "He showed the typical lesions of tertiary syphilis. His outer nose had disappeared, his soft palate was perforated as the result of a large gumma and pus was exuding from his mouth." It is highly probable that this was a case of tertiary yaws with gangosa, especially as it occurred in an area where they record "yaws is fairly prevalent amongst the children" (as previously quoted).

Before reference is made to the more recent papers by Cleland (1928) and Basedow (1932), it might be emphasized that I am not interested in the occurrence of syphilis among the relics of native tribes at present existing as islands in the sea of European settlement.

Cleland (page 141), after referring to the early records which have been dealt with above, reports statements received from medical men in various localities.



Atkinson (Perth, Western Australia) states that syphilis and gonorrhœa are particularly prevalent where Asiatics mix with aboriginals, as in pearling areas.

Atkinson, in 1935, believed that yaws did not occur in Western Australia.

Junk (Wondai, Queensland) states that syphilis was at one time very prevalent at the settlement. The lesions were mostly extensive and chiefly involved the genital region in both sexes. They yielded readily to mercurial treatment, but most patients died from other contributing factors before the tertiary stage was reached.

Leighton Jones (Darwin, Northern Territory) states that he has met with congenital lesions, such as keratitis, in several cases. He has seen perforating ulcers of the palate similar to those in Europeans.

Leahy (Innisfail, North Queensland) considers that the syphilis among natives is similar to that in Europeans, but more chronic.

Illingworth (Taroom, Queensland) states that 20% of natives of the settlement were probably affected with venereal disease and that syphilis spread very rapidly. The chancre was of the same type as in Europeans. He had seen only one case of a secondary syphilitic rash, and that resembled scabies. He considered the disease less grave than in Europeans. He had never seen any case of syphilis of the nervous system. He mentioned one gumma of a cervical gland, two cases of severe heart disease, none of aneurysm, one case of rupture of the aorta from syphilitic atheroma, and six cases of gummatous vulvitis, of which two had been cured. Congenital syphilis was commonly causing the deaths of a "fair number of children up to the age of six or seven years". "These cases showed a trophic rhinitis with sunken bridge to the nose, mental backwardness and stunted growth, and were rather puny."

Vernon (Thursday Island) states that syphilis is undoubtedly common.

Basedow's cases will be dealt with under his own paper.

Cilento (Townsville) considers that syphilis is uncommon and he has never seen a primary chancre. He states that it has been suggested that this is due to the presence of yaws among the natives.

In the section of Cleland's paper dealing with insanity (page 262) there are six cases of general paralysis of the insane and two doubtful cases out of a total of 110.

Cases of general paralysis would be more numerous, both relatively and absolutely, if syphilis were common among the natives and ran a course similar to that in Europeans.

In some of the above reports the condition is probably syphilis, but in others this conclusion is open to grave suspicion.

Basedow (1932), page 194, deals first with the early literature and then adds his own experiences.

I have found syphilis most common among those tribal groups which are resident along the beaten tracks of European and Afghan travellers [the latter are camel teamsters].

According to the natives:

Neither syphilis nor gonorrhœa was known prior to the occupation of their country by Europeans. There still exist a few communities, such as the Western Aluridja and Wongapitcha, inhabiting the Mann, Tomlinson and Petermann Ranges in the Lake Amadeus region, who so far have not come into such contact with civilisation; and these, when last I visited them in 1928, were happily free from venereal diseases.

I saw cases of boomerang leg, yaws and *granuloma pudendi*, in the Mann and Musgrave Ranges in 1933.

Referring to the Lutheran Mission Station at Hermannsburg, Basedow states that in 1920, when he visited it, "venereal troubles were practically unknown locally; only two or three cases of tertiary syphilis were registered". He refers to the natives camping at Alice Springs as "positively reeking with disease at the time", leaving one to infer that the disease was syphilis; but in 1934 I saw no evidence of syphilis among them, though the same cannot be said of gonorrhœa. There is no syphilis at Hermannsburg.

Basedow continues:

Great contrasts are observed in any such districts as have been victimised by the vices of civilisation for any appreciable time. Hereditary syphilis then manifests itself in many forms in the children, most conspicuously perhaps in the form of the almost ubiquitous "snuffles" and objectionable nasal catarrh with a sero-purulent discharge.

Muco-purulent nasal discharge is common in native children and adults in central areas and in the Mann Ranges (observed in 1933). It was markedly influenced by the climatic conditions and in every way resembled a "cold in the nose". It is of interest to note that despite its frequency among the natives with whom we were in close contact, neither Mr. Tindale nor myself contracted any respiratory infection. This may be due to the lower virulence of the local causal organisms. We both contracted "colds" when, after two months' isolation, a party arrived from Adelaide. I have seen no case of sero-purulent nasal discharge among natives.

Hunt and Johnson (1923) record:

It is interesting to note the number of children having an excessive secretion from the nose ("snuffles") during the secondary stage of yaws.

They are speaking of Samoans, among whom, they say, syphilis does not exist.

Later Basedow (1932) writes:

Such a hold, indeed, has the disease in certain tribal localities that it would be a difficult task for anybody to attempt to draw a hard and fast line of discrimination between the congenital and acquired form. Syphilis in the acquired form presents certain peculiarities in the aboriginal. Its primary and secondary manifestations are, generally speaking, less conspicuous than in the European. The affections of the third period are, however, both typical and severe, but it might be mentioned that in spite

of the disease being so rampant, none of the so-called para- or meta-syphilitic conditions have come under my personal observation.

By far the most common manifestations of the disease in its tertiary stage are gummatous ulcers on the lower extremities, gummatous periostitis of the tibiae, and the destructive processes in the nasal organ which eventually give rise to the characteristic "saddle nose".

He refers to two figures which could be quite reasonably considered cases of yaws.

years' experience in northern Australia he had seen no evidence of syphilis among the natives. Only five or six cases of primary chancre had occurred in Europeans, and most of these patients had arrived from outside the Territory during the previous few weeks.

From the Chief Medical Officer's reports of health, 1929-1933 (Cook, 1929-1933), the following table can be drawn up from data of the Kahlin Beach Aboriginal Hospital:

Disease.	1929.	1930.	1931.	1932.	1933.
Gonorrhœa .. .. .	93	59	38	66	33
Granuloma .. .. .	37	16	29	34	25
Yaws .. .. .	22	12	6	11	5
Syphilis .. .. .	Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.
Total cases .. .. .	369	289	213	207	155

The frequency of corneal opacities is no doubt in large measure a sequel to an interstitial keratitis of syphilitic origin.

Leucomata, except of obviously traumatic origin, were non-existent in the tribes of the Mann and Musgrave Ranges in 1933. Those opacities which are so commonly seen in the corneæ of natives in more settled areas of the centre and far north, and occasionally associated with staphyloma or rupture, are undoubtedly gonorrhœal in origin. I saw over a hundred cases of gonococcal ophthalmia (confirmed by microscopical examination) in 1934 at Alice Springs and at Victoria River Depôt.

A well-marked icterus is often recognised by the yellow coloration of the conjunctiva (Basedow, 1932).

I saw no indication of this in the eyes of over 300 natives, and Professor J. B. Cleland and Dr. J. H. Gray (personal communications) say they have never observed this at the various localities in which they have worked in central Australia.

The tongues of adult sufferers are not infrequently covered with pinkish, warty papules; this being particularly noticed in persons whose teeth are decayed.

This condition was seen in a child and a youth in the Musgrave Ranges (1933), both of whom appeared quite healthy.

Condylomata generally appear about the anus, especially in children; in the case of children small ulcerations and fissures also occur around the mouth.

These are probably metastatic (secondary) skin lesions of yaws.

The periostitis and osteitis following the gummatous lesions on the tibiae often produce a thickening and curving of the bone, known as the "sabre-blade" deformity, which is at times wrongly referred to locally as the "boomerang leg".

This is a very subtle differentiation which, unfortunately, Basedow does not complete.

When I discussed the problem of the existence of syphilis in the Northern Territory with Dr. C. E. Cook, the Chief Medical Officer and Chief Protector of Aborigines, he was quite definite that in eight

Dr. Cook's opinion is supported by that of the other officers in the Northern Australian Medical Service.

Many cases of gonorrhœa in Europeans, contracted from native women, occur each year; if syphilis existed to any great extent among the aborigines, primary chancres and later lesions would have been seen among Europeans.

Professor J. B. Cleland assures me that (taking into consideration the existence of yaws among the natives of central Australia) he has seen no condition among them which he would consider as definitely syphilitic in origin. The case reported by Cleland (1934) as possibly syphilitic is more likely to be one of yaws.

In concluding this section one may quote Koch (1900), who, in his report to the German Government, states:

In the Bismark Archipelago I have seen places in which almost all the children were affected with yaws . . . even the children of Europeans occasionally suffer from it. Very often frambœsia is mistaken by laymen, and even by medical practitioners, for syphilis, and I feel warranted in assuming that the statements as to the great diffusion of syphilis in the South Sea, and particularly in the German colonial region, are based on the confusion of syphilis with frambœsia.

I am in complete agreement with this statement if it be applied to the Northern Territory of Australia. There is no proof that syphilis occurred in Australia prior to European contact, or that syphilis is, or was at any time, prevalent among the aborigines.

References to Yaws.

On coming to the direct references to yaws there is less difficulty. From the reports of Breinl (1912), Holmes (1912), and Breinl and Holmes (1915) one learns that yaws was prevalent in the coastal country of the Northern Territory. The presence of yaws among the natives in this area is now well recognized, and its treatment is one of the duties of police officers.

Basedow (1932) writes:

Yaws is widely distributed over Northern and Central (i.e., tropical and sub-tropical regions of Australia) Australia. I regret to record that during the years of personal observation I have been able to record a perceptible increase in the number of cases met with in the camps. I found the disease particularly rampant in the Northern Kimberleys of Western Australia and in the western rivers district of the Northern Territory. In Central Australia it is less common and sporadic in its appearance. It was surprising to me to find a case in the extremely arid country immediately south of Lake Armadeus. Yaws particularly affects aboriginal children of tender years.

Speaking of the secondary lesions, he writes:

The face, neck, chest, legs and anal cleft are particularly favoured by the disease.

The patients, especially the children, are very uneasy, complain of the irrepressible itch and pains in their bones when attempting to sleep at night.

He writes of chronic ulcers:

Where the limbs have been affected, the scar which is formed after the sores have healed becomes very tense and glossy.

He disagrees with Breinl and Holmes (1915) when they say that the disease is of little practical importance among the natives, although they recognize its prevalence.

He reports having seen cases of gangosa in the northern tropical belts and also over a considerable part of the arid central area. He speaks of the popular misdiagnosis of cancer for gangosa and "cannot recall a single case of face cancer from any tribal district". He describes and illustrates the case of a boy, aged fifteen years, from Port George IV, with active gangosa, and writes:

Other manifestations of disease were several prominent gummatous ulcers upon the anterior crest of each tibia which were characteristic of those seen in cases of yaws.<sup>1</sup>

Mr. N. B. Tindale (personal communication) says that he saw natives with fissured and sore feet at Groote Eylandt and Roper River (Northern Territory).

Cleland (1933), writing of natives seen at Mount Liebig, states:

The skin and subcutaneous tissues of a number of individuals were thickened and coarse, and tended to crack, giving a kind of crocodile-skin appearance. Probably the extremes of temperature (the days being often in early spring 32.2° C., or 90° F., or more, and the nights perhaps being below freezing point) account for this.

These cases resemble those that I observed in the Musgrave Ranges. It is probable that these lesions resulted from yaws.

Attention may be called to a paper by Hale and Tindale (1934), in which they write:

Many of the Kokolamalama people talk rather indistinctly, with markedly aberrant aspirated "d" and "w", strongly voiced "th" and "s" and "f" sounds which are absent in their neighbour's speech. It was noticeable that several individuals of this tribe suffered from palatal abnormalities, and the above-mentioned modification may be due to this factor, the manner of speech of the abnormal individuals having become the norm for the others of the group.

They say (personal communication) that yaws was seen at Princess Charlotte Bay (north Queensland), where this tribe lives, and also that some natives had facial disfigurement which they would now recognize as gangosa.

#### References to "Irkintja".

In 1934, at Alice Springs, it was found that many natives (Aranda tribe) attributed the scars which were associated with "boomerang legs" to a previous attack of *irkintja*, and by further inquiry I was satisfied that this was a specific term and not used for sores in general.

Basedow (1932) refers briefly to the description of the tradition of *irkintja* given by Spencer and Gillen (1899), which is as follows:

In the Alcheringa (mythologically distant times) one of wandering parties of the Achilpa, or wild cat men, coming from the south, were under the guidance of a famous old man renowned for the size of his penis. He was always gorgeously decorated with down, especially about his penis. This party camped near the Ooraminna rockhole and performed certain initiation rites. They discovered a group of wild cat men suffering from the disease called *Erkintja*, who smelt most offensively. The southern Achilpa men had intended to settle there, but the presence of these men frightened them and they hurried northwards. Shortly after the wild cat men had gone a party of men belonging to the Arwarlinga (a species of Hakea) totem, who dwelt close by in the sandhills, came in and went to the top of the Ooraminna rockhole and made a drink by steeping Hakea flowers in water. Then, opening veins in their arms, they allowed the blood to flow into the vessels containing the drink and mix with it until the vessels overflowed to such an extent that the Ooraminna Creek became flooded and all the *Erkintja* men were drowned. A stone arose at the spot. Since the days of the Alcheringa this stone has been known as the *Alperta atnumbira* (the stone of the diseased growth issuing from the anus). Ever since that time the *Erkintja* has been prevalent amongst the natives. It is believed that old men visiting the stone can, by means of rubbing it and muttering a request to the contained evil influence to go out, cause the disease to be communicated to any individual or even group of men whom they desire to injure.

In a footnote, page 444, they write:

The disease is common amongst the young people, only attacking each individual once. It affects only the glands of the part of the body in the neighbourhood of the sore. At first sight it has much the appearance of being syphilitic in nature, but Dr. Eylmann, who had studied it, is of the opinion that it is distinct from syphilis. It usually appears in the anal region, under the arms or legs, or close to the mouth.

Mr. T. G. H. Strehlow, who has recently been working among the Aranda tribe, confirms the above tradition, and I obtained confirmation of that part dealing with the spread of the disease.

From the footnote it appears that the disease is not syphilis, and all the evidence is overwhelmingly in favour of its being yaws.

Eylmann (1908), on page 441, writes:

One kind of ulcer is the most interesting of all cutaneous diseases among the natives. The Arunta call it "irrakintja" or simply "mamma" (wound). The bushmen of the interior use the first name for it. The natives say that they could contract it only once, usually during childhood. At times the cases in one place increase in a conspicuous manner. Thus at Daly River Mission three out of four

<sup>1</sup> Compare Basedow's description of tertiary syphilis above.

children between the ages of 1½ to 3 years suffered from these ulcers. Usually the parts of the skin affected are those exposed to the macerating effect of sweat or other fluids; in the majority of cases, therefore, the perineum together with the genitalia and parts round the anus have become diseased. Other regions frequently affected are the axillæ and the lips. Often the disease is confined to one place; it rarely occurs in more than three or four separate regions; originating on the outer skin of the genitalia, at times it spreads to the mucous membrane of the penis or the labia pudendi. In the early stages a few various-sized ulcers on an area of skin which can be covered with one's hand are often found. Later they coalesce to form a single ulcer, which in the course of years may become 15-20 cm. in diameter. I have unfortunately not been able to discover how the infection commences. The smallest ulcers I saw were approximately the size of a lentil. The base of the ulcer is bluish red and from some there is a scanty, purulent secretion, from others, however, there is considerable discharge. In the course of time conspicuous, extremely red granulations frequently develop. In an elderly Waramunga native who had come to see me on account of a disease of the bladder the granulations had completely filled the artificial fissure of the penis. The largest lesions of this kind which I saw were 1 cm. in height and 10-12 cm. in circumference. The margin of the ulcer is slightly raised and in most places is well defined. At first it is circular but later it becomes scolloped. The ulcer feels hard and the base does not lie deeper than its surroundings, which are slightly or not at all altered. The neighbouring lymphatic glands, however, are swollen. If the ulcers are small and not numerous, they have, in adults, an insignificant influence on the general health. Pain is present but it does not appear to be very severe. If the ulcer surrounds the anus, the pain often becomes very acute at defecation. Cure takes months or years, and in some cases is never effected. At Kilalpanina Mission I saw an elderly man who had an extraordinarily large ulcer of this kind round the anus. As Missionary O. Siebert told me, it shortly after led to the man's death. The cicatrices lie on a level with the skin and show no tendency to retraction. In exceptional cases they are so insignificant that they escape the eye, but a deeply pigmented stain remains.

With which kind of ulcer do we have to class "irrakintja"? In the interior a kind of ulcer called "barcoo rot" is found occasionally among the whites, which is said to become rapidly larger, and is not very distinct from simple cutaneous ulcers. We find in many hot parts of the earth similar ulcers which have probably been caused by infection of quite insignificant skin injuries; under the influence of the climate and of manifold irritations they assume an obstinate nature. A marked inflammatory infiltration which occasionally persists till the death of the person concerned, accompanies many skin diseases of this kind, as for example the "ulcer of Aden" and the "Malabar ulcer". They do not spare those who have suffered from them previously. The two cases of "barcoo rot" which I saw (they were pointed out to me as such by bushmen) also had caused a swelling of the affected part of the body; however, I believe that they were not at all typical. I am unable to say if this skin disease of the whites is identical with that of the natives. "Irrakintja" differs perceptively in some points from the ordinary cutaneous ulcer. The main difference consists in that one can be taken with the latter more than once. "Irrakintja" also unmistakably resembles lupous ulcers, but it only spreads on the surface and does not penetrate into the deeper tissues. It resembles an ulcerous syphilitic when its base lies deeper than usually and has a definitely purulent investing layer. The "tumours of Aleppo", "of Biscara", and "of Delhi" which endemically occur in Syria, North Africa and India seem to be closely related to it. Natives contract these "tumours" (bolls) only once, usually during the first years of life. Foreigners likewise have a great predisposition to them. "Irrakintja" however usually spares white people, provided that it is not identical with "barcoo rot". Two Irishmen of my acquaintance maintain

that they have suffered from it. It is, however, not unlikely that they had eczema. As domestic animals are also taken with the "tumours" I shall not leave unmentioned that I saw a dog at a Delari camp on whose genitalia was an ulcer the size of a crown, which could in no way be distinguished from an "irrakintja" ulcer.

As the reader can see, I have not succeeded in identifying "irrakintja" with any known disease. I have to leave undecided whether it is an hitherto unknown cutaneous disease. Naturally one could consider it a simple eczema which has acquired unusual characteristics owing to climatic influence and so on. According to my own convictions the statements of the keenly observant native that anyone who had got over "irrakintja" does not have it a second time deserves fully to be taken into account.

In the northern coastal districts, which have good rain-falls, a skin disease frequently occurs associated with itching, and often covering great portion of the body. The formation of scales may be so extensive that the affected portions of the skin appear a dirty grey colour. In old people the wrinkles of the skin become strongly marked, and slight fissures may develop so that the disease resembles ichthyosis. Occasionally I have also observed in the North a papular exanthema which causes irritation and moderate desquamation. I think it is infectious. In Rum Jungle an old Wulwanga native who suffered from it, often visited me. While we sat talking he used to place one of his hands on one of mine. A few weeks after his first visit I noticed on the back of my left hand some irritating scaly papules which with a vitriol ointment, however, disappeared in a few days. I think it is probable that here we have not two different diseases, but two stages of the same disease.

The occurrence of *irakintja* (*irrakintja*) only once in each individual, and then in childhood, the distribution of the lesions and Eylmann's identification of this condition (the name is used only by the Aranda tribe) with a similar one at the Daly River Mission [in the coastal belt, where yaws is common (Breinl and Holmes, 1915)] gives the impression that *irakintja* is yaws. His description of the character of the scars also supports this conclusion. Later in his description he becomes confused with *granuloma pudendi* and dermal leishmaniasis.

Barcoo rot occurs in Europeans only and is probably dietetic in origin. Professor J. B. Cleland tells me that at one time it was thought that dogs suffered from *granuloma pudendi*. The skin disease which he saw in the coastal areas is still common and is an epidermophyton infection (tinea).

The "ulcer of Aden" and "the Malabar ulcer" are conditions more commonly known as *ulcus tropicum*, the ætiology of which is not definitely known, but is in no way associated with yaws. That Eylmann makes no mention of syphilis bears out the note by Spencer and Gillen (1899) that he differentiated *irakintja* from it.

Basedow (1932), in his introduction, writes:

The dreaded yaws . . . throughout those parts of the great interior where the Arundta tongue prevails is known as larrekincha or errekincha.

In the sections on yaws he writes:

The lesions [of yaws] in obstinate cases become deep ulcers which eat their way deeply into the subjacent and surrounding tissues and discharge a putrid serum. The natives do not discriminate between this and that of typical gangosa.

He deals with gangosa under a separate heading and writes:

Gangosa is well known to and dreaded by the Arundta, and other tribes of the interior, who have given it the name *errkincha* (often wrongly pronounced *larrekincha*), the derivation of the word being from the Arundta *errekama*, meaning "to itch".

He makes no definite reference to the yaws aetiology of gangosa. He brings forward no evidence to demonstrate the identity of *irkincha* and yaws.

The spelling "irkincha" is used on the advice of Mr. T. G. H. Strehlow, who has studied the Aranda language. This is in agreement with the system of phonetics he uses. It is pronounced "air-kincha", where the "r" is trilled.

In the course of investigations at Alice Springs (Northern Territory) in 1934 it was found that *irkincha* is yaws (Hackett, 1936).

#### Conclusion.

In this paper there is a critical survey of some references to venereal disease and syphilis in Australian aborigines. It is suggested that, if *granuloma pudendi* is excluded, in most cases the disease referred to is yaws. In a future paper (Hackett, 1936) it will be pointed out that among the aborigines of the Northern Territory of Australia today syphilis is unknown, while yaws is frequent. It will also be shown that in museums in Australia there are aboriginal bones from the southern and eastern areas which show yaws lesions.

It is probably correct to conclude that when Australia was discovered by Europeans yaws was present in all native communities and that as long as they were leading lives not completely divorced from their bush fashion, they still suffered from yaws and not from syphilis. This confirms the suggestion that the descriptions of venereal disease and syphilis were of yaws. It has been taken for the purpose of this paper that syphilis and yaws are two separate diseases.

That the disease known to the Aranda tribe as *irkincha* is yaws indicates that that disease has been endemic in central Australia for a long time.

#### Acknowledgement.

These studies were undertaken in the course of an investigation into the aetiology of "boomerang legs" in 1934, which was made with the assistance of a grant from the Sheridan Research Fund of the University of Adelaide.

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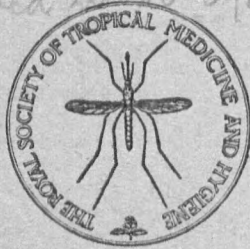
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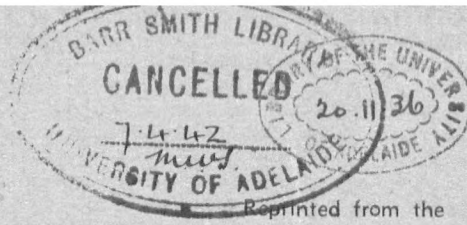
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BOOMERANG LEGS AND YAWS IN AUSTRALIAN ABORIGINES.

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## BOOMERANG LEGS AND YAWS IN AUSTRALIAN ABORIGINES.\*

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The deformity of boomerang legs consists of a forward bowing of the lower limb below the knee (Fig. 1). This may be associated with some increase in the antero-posterior diameter of the tibiae. Clinical signs which are also present are the flattening of the calf and of the hollows each side of the tendo Achilles. The condition is of frequent occurrence in Central and Northern Australia, and its existence was first recorded by STIRLING (1894 and 1896). Several papers on boomerang legs have appeared since that date, but most of them have done little to elucidate its aetiology. SPENCER and GILLEN (1899) were uncertain if it were pathological or a racial characteristic. SMITH (1907) and EYLMANN (1908) suggest that perhaps it is caused by rickets. BREINL and PRIESTLEY (1915) report a case and postmortem findings. They exclude syphilis and tuberculosis

\*The full report on this subject will be published as Monograph No. 1, to be issued as a supplement to the TRANSACTIONS.

The greater part of the work recorded in this paper was carried out in the Northern Territory of Australia in 1934, with the assistance of a grant from the Sheridan Research Fund of the Adelaide University. Other localities which were visited were Oodnadatta and Alice Springs in 1927, the Musgrave Ranges in 1933, Ooldea in 1934 and the Warburton Ranges in 1935. This was done under the aegis of the Board for Anthropological Studies of the Adelaide University.



as causal factors, but wrongly describe the specimen, which is in the museum of the School of Tropical Medicine at Sydney, as consisting almost entirely of compact bone. This error has been quoted by CASTELLANI and CHALMERS (1919), who also refer to the paper by CHRISTOPHERSON (1918) describing a case from the Sudan which was probably not one of boomerang legs. They say that a condition clinically similar to boomerang legs is undoubtedly a late manifestation of yaws; and they consider that neither rickets nor osteomalacia plays any part in the production of the deformity. BASEDOW (1925) thinks that the tibialis posticus may be a factor but mentions no associated conditions. HERMANS (1928 and 1931) suggests that boomerang legs may be identical with the "sabre tibiae" which result from yaws. Various authors have emphasized that the deformity is found in individuals who appear to be quite healthy.

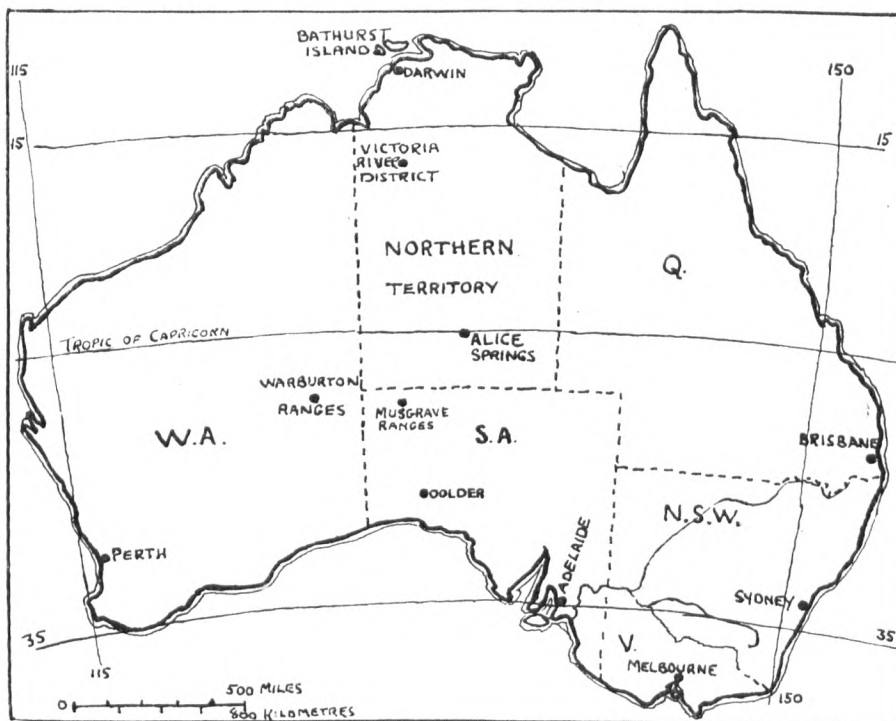
In 1933 a native child was seen who had several diseased bones and joints, extensive skin ulceration and boomerang legs. It was suggested that perhaps the leg deformity was associated with the other conditions and that they were all due to yaws. The work in 1934, in the first instance, was planned to test the validity of this association. The papers by HERMANS (1928 and 1931) and CASTELLANI and CHALMERS (1919) were not seen until work in the field had been commenced.

#### THE AETIOLOGY OF BOOMERANG LEGS.

In 1934 clinical, radiographical and serological studies were begun at Alice Springs. Here observations were made on fifty aborigines of a population of about 400. It was found that certain scars were often present about the mouth and in the joint skin flexures. (Fig. 2.) These scars were characterized more by a loss of elasticity of the skin than by previous extensive destruction. There was usually no alteration in the pigmentation of the scars in full-blood natives, who attributed them to an earlier attack of a disease that they called *irkintja*. SPENCER and GILLEN (1899) record a legend of the existence of this disease in the mythologically distant times and the belief that certain magical processes can cause the disease to break out among any whom one wishes to harm, EYLMANN (1908) also writes of this condition. It is said that it only attacks an individual once, and appears in the moist areas of the body. EYLMANN thought that it was not syphilis but confuses it with a number of tropical skin lesions. BASEDOW (1932) rather indefinitely indicates that this disease and yaws are the same but offers no evidence in support, except that the natives knew both the secondary eruption of yaws and gangosa by the same name, *irkintja*. Many subjects at Alice Springs also gave a history of having suffered from pains in the shins before the onset of boomerang legs. The clinical course of the development of the deformity may be epitomized as follows: During infancy or early childhood the subject contracts the disease, *irkintja*, after this clears up there is a quiescent period of a few years; then pains in the shins are experienced and the legs become bent.

This rarely occurs after puberty and it is probable that no increase in the

deformity takes place after the epiphyses are fused. The kinship of some of the cases is probably accounted for by the presence of *irkintja* as an endemic disease, rather than that the deformity is hereditary. In many instances the Wassermann reaction was positive. On analysing the data the only significant association was found in the presence of scars and the history of a previous attack of *irkintja*. There were, however, indications that other associations were also



MAP OF AUSTRALIA SHOWING AREAS IN WHICH INVESTIGATIONS WERE UNDERTAKEN.

present. The association of scars and boomerang legs was upheld by observations in the Victoria River District and at Bathurst Island, where of 322 subjects, 49 per cent. had boomerang legs and scars, 9 per cent. had boomerang legs only, 5 per cent. had scars only and 37 per cent. had neither condition. The association of positive Wassermann reactions in the sera and boomerang legs was supported by observations at Darwin and in the Warburton Ranges, Western Australia. Among the inmates of the Darwin Half-Caste Institution, five with neither boomerang legs nor scars were found to give negative Wassermann reactions in their sera, while five with boomerang legs and scars gave positive results. Of thirty-six males in the Warburton Ranges, over the age of 15 years, seventeen

(44 per cent.) gave positive Wassermann reactions. Of seventeen cases of boomerang legs fifteen (88 per cent.) had positive reactions and one of the remaining two cases had a chronic arthritis of the knee.\*

The scars, which have been referred to, were recognised by medical men in the Northern Territory as resulting from yaws. As syphilis is unknown among the aborigines in this area, it may be concluded that the positive Wassermann reactions in the sera of these cases are due to infection with yaws ; and that yaws is the cause of boomerang legs.

#### GEOGRAPHICAL DISTRIBUTION.

It is found that boomerang legs and yaws occur throughout the Territory. BREINL (1912), HOLMES (1912) and BREINL and HOLMES (1915) report that yaws was frequently seen in the northern coastal districts and BASEDOW (1932) reports its presence in Northern and Central Australia. BASEDOW also encountered it in north Western Australia, and it occurs in Northern Queensland. In Australian museums are specimens of boomerang tibiae from localities which cover the eastern half of the continent. In a recent critical survey (HACKETT, 1936) of references to syphilis and "venereal disease" among aborigines from early medical and lay writers, dealing especially with the south-eastern quarter of Australia, it was found that (if occasional cases of gonorrhoea and granuloma pudendi were excluded) these descriptions are probably misdiagnoses of yaws. In most tropical countries, where yaws is endemic, sabre tibiae are also reported. Thus the co-equal distribution of boomerang legs and yaws in the Northern Territory at present, and more extensively in the past, supports the conclusion that this deformity is none other than the sabre tibiae of yaws.

#### PATHOGENESIS.

The fifty cases that were studied at Alice Springs were arranged, according to the degree of the deformity, into three groups. From the radiographs of the group with the most marked bowing, it was possible to follow the course of the development of boomerang legs. This was supported by the findings in the other two groups.†

It was found that the earliest stage was identical with lesions described by MAUL (1918). These consist of multiple small areas of rarefaction in the cortex and medulla. In the case in which these were present, the tibiae were already bent and the zones of condensation round the rarefied areas were taken to

\*Through the kindness of the Director of the Adelaide Hospital Laboratory, the Wassermann reactions were carried out by Mr. F. S. TEE.

†I am indebted to Messrs. W. WATSON & SONS (Melbourne) for the loan of a Caldwell portable X-ray outfit, to KODAK (Australasia) for the provision of a supply of films, to the Post Office authorities for the electrical supply and accommodation at Alice Springs, and to Mr. C. H. MARSHALL, of the Adelaide Hospital, for his excellent services as radiographer.

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FIG. 1.

FIG. 1.  
Marked boomerang legs in  
a male aborigine aged  
about 28 years.



FIG. 2.

FIG. 2.  
Scars about the mouth in  
a half-caste boy.



FIG. 3.—Radiograph of case illustrated in Fig. 1.

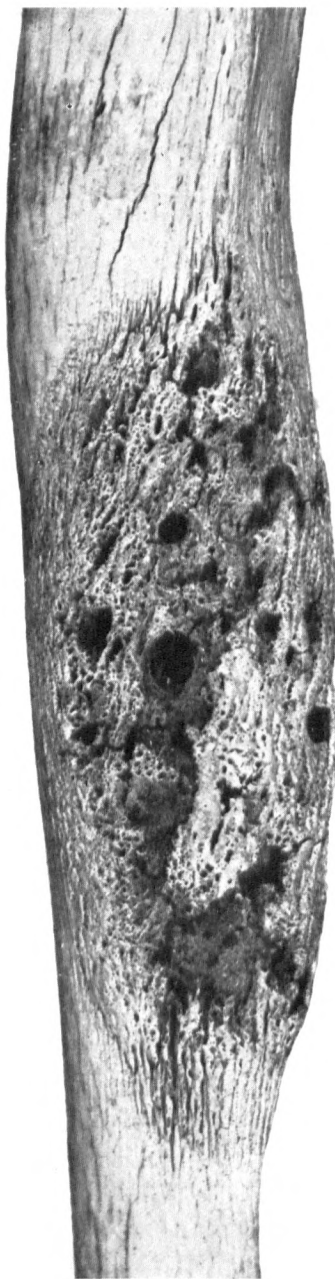


FIG. 4.—Multiple necrotic foci in Specimen 1031. Pathological Museum, Adelaide University.

indicate that the process was resolving. It is suggested that it is during this stage that the weakened bone is deformed by body weight and muscular action. As resolution takes place the cortex becomes thickened and the marrow cavity is encroached upon, so that the cortical shadows may occupy the greater part of the antero-posterior diameter of the bone. With the further passage of time the thickened cortex is converted into cancellous tissue from the medullary surface and in time may be reduced to normal proportions (Fig. 3). This may account for the statements of some of the earlier writers who spoke of a bone which was normal except that it was bowed. In some of the more severe cases the nutrient canals were notably enlarged. In some tibiae there were areas of sclerosis, transverse linear shadows in the medulla of the shaft and lines of arrested growth. The last two changes are non-specific and may be taken as indications of general disorder in the health of the subject as a whole rather than peculiar to any bone disease. In those who had not reached puberty the epiphyseal regions were normal. The above interpretation of the radiographical findings is based on the examination of museum specimens. The appearance presented by any case of boomerang legs would depend on the severity of the initial lesions and the time that had elapsed since the onset. The absence of marked periosteal deposits would differentiate the condition present from syphilis.

#### OTHER BONE LESIONS.

In the radiographs of the Alice Springs series three types of lesion were found which did not fit into the development of boomerang legs. These three types may be described as : (1) multiple necrotic foci, 5 to 10 mm. in diameter in long bones associated with expansion of the bone and some relatively slight periosteal reaction (Fig. 4), but there may be no reaction in flat bones. (2) periosteal nodes with or without necrosis, (3) generalised periosteal deposits. Similar lesions are to be found in aboriginal bones in many museums both in Australia and Great Britain, and at present are usually regarded as syphilitic.\* However, taking into account the absence of syphilis among the autochthones of Australia and the presence of these lesions in the Alice Springs series, it is suggested, until further work has proved otherwise, that they are probably the result of yaws. Sir ROBERT MUIR kindly examined several of these specimens and said that while the changes exhibited by the third type did not differ from those due to syphilis, he had not seen syphilitic lesions resembling those of the first type. In a tibia in the Royal College of Surgeons, London (3974·1) in which there are generalised periosteal deposits, there are also necrotic foci, which indicates that these two types of lesion may have a common causal factor. The periosteal deposits in some cases may result from secondary infection of previously diseased bone, through open lesions. Trauma and superinfection may play a part in determining the situation and type of lesion that is produced.

\*Unless otherwise noted these specimens are in the Wellcome Medical Museum, London.

In the skulls of aborigines in museums several kinds of lesion are met with. In a specimen from Victoria the lesions of gangosa are present. In a skull from Adelaide there are multiple small areas of erosion. A skull from the lower River Murray district has several areas, 1 to 2 cm. in diameter, of necrosis in the calvarium. In some of these areas central sequestra have formed while in others these have separated and cavities have appeared. In two Australian skeletons in the Royal College of Surgeons (20-7342 and 20-6508), the skulls show similar massive necrotic foci while other bones exhibit lesions comparable with those described above. This, together with the considerations already referred to, leads to the suggestion that these changes may also be due to yaws.

It is regretted that no histological material is available, but most of the descriptions of yaws bone lesions in the literature can be fitted into the above types. In conclusion, attention might be drawn to the work of SCHOEBL (1928) where he suggests that the bone lesions of yaws are probably the result of a process analogous to that of keratoderma plantare, which he regards as a late framboeside, the result of only partial immunity. TURNER, SAUNDERS and JOHNSTON (1934) report the failure to find spirochaetes in yaws bone lesions.

#### SUMMARY.

- (1) The yaws origin of boomerang leg in Australia is demonstrated.
- (2) The widely spread distribution of yaws and boomerang legs in Australia is recorded.
- (3) The development of boomerang legs is outlined from radiographical and morbid anatomical findings.
- (4) Certain other bone lesions of Australian aborigines are described which, it is suggested, are the results of yaws.

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## DISCUSSION.

**Prof. H. A. Harris** (of Cambridge) : Dr. HACKETT has presented a series of clinical events which is disturbing. We have heard much of transitory rachitic lesions in bone in childhood, but here we have a condition which is new to all of us inasmuch as the condition is traced both as regards the skin lesion, the bony lesion, the deformity and the radiographic appearance from infancy to adult life. The boomerang tibia is a deformity which does not fit in with any of the deformities seen in orthopaedic clinics in this country. The bending of the tibia is so marked and yet so gradual and regular ; the antero-posterior curve is strictly limited to the sagittal plane. The curve is clean and free from any irregularity or epiphyseal enlargement. The condition in the sabre tibia is distinct from any condition known in this country.

As to the general features of the Australian skeleton, one is struck in the first place by the shape of the skull, which from the posterior aspect, appears as a pentagon—like a haystack seen end-on. Another characteristic is the poor development of buttocks. The small buttocks are associated with a small femoral head, long thin femoral shaft, absence of heavy muscle markings—especially for the gluteus maximus. Any series of European long bones, if examined with care, can be graded so as to yield three main types. In the first group are the bones with a stout shaft and large epiphyses. In the second group are finely made bones with a slender shaft and small epiphyses, whilst the third group presents a shaft which is slender over the whole extent but broadens out suddenly into enlarged epiphyses. This last type presents marked tubulation of the shaft with the maximum of bony absorption at the metaphyses during the



growth period. The long bones of the Australian definitely belong to the second group, with long slender shafts, small epiphyses and extreme tubulation so that the bone as a whole is reduced to the minimum bulk.

If you consider the native in the sitting position with elbow on knee, it is possible that any great degree of muscular wasting, involving the extensor before the flexor muscles, might give rise to an antero-posterior bowing of the femur or tibia as a result of the unopposed action of the hamstrings and the flexors of the calf. Similarly, extreme wasting in the forearm might give rise to the curvature of the radius and ulna on account of the unopposed action of the flexors. The production of such a static deformity by muscle wasting still fails to explain the side to side flattening and bony absorption in the tibia.

What condition might give rise to the extreme economy in the handling of the inorganic elements in the bone, possible disturbances in antagonistic groups of muscles, and consistent uniformity in the type of bony deformity? We may be dealing with a phosphorus deficiency, for muscle contains far more phosphorus than calcium. The phosphorus shortage may be a definite factor in the production of the bony deformity. The presence of an infection such as yaws may aggravate the effect of the phosphorus shortage.

Dr. HACKETT has demonstrated a condition which calls for a detailed study of bone pathology with special reference to yaws and the possible role of phosphorus or other deficiency.

**Dr. Mather Cordiner :** Dr. HACKETT is to be congratulated on his very excellent series of radiograms, a series which I think, must be unique. Such X-ray appearances as we have been shown this evening are not met with in this country, but would, almost certainly, be regarded as syphilitic. There is one point, however, which is strongly against the lesion being syphilitic. In the congenital syphilitic lesion the chief characteristic is a periosteal reaction with very little bone atrophy. As a result deformities do not take place and one does not encounter a bending of the bone with the syphilitic lesion. In the older person the lesion shown is not unlike an osteitis deformans but in this condition there is always a very marked increase in the bone trabeculation, while in none of the radiograms of boomerang leg shown is this trabeculation apparent.

**Professor Warrington Yorke :** It is a mystery to me that these people do not get syphilis seeing that they suffer from gonorrhoea, unless *irkintja* immunizes against syphilis. I am sorry that Professor BLACKLOCK is not here, as he holds very definite views on the relationship of syphilis to yaws. It is curious that the same infection in different parts of the world seems to produce, at times, different lesions. If *irkintja* is yaws, why does it not exhibit the classical manifestations of this disease which one sees in other parts of the world? I have been struck with a similar fact in respect of filariasis, which, in some parts of the world, produces predominantly chyluria, in other places elephantiasis of

the legs, and in still other parts elephantiasis of the arms. If all these conditions are due to filaria, one can only assume that the habits of life of the people, and possibly their diet, has something to do with the kind and position of the lesion produced.

I do not know that it is any real argument to say that boomerang leg is yaws because you have not found in this country similar bone lesions in syphilitics. We might as well argue that *irkintja* cannot be yaws because no one has as yet seen in it the typical cutaneous lesions of yaws. The whole subject is of great interest and urgently requires further investigation.

**Dr. H. S. Stannus :** I am glad Dr. HACKETT has drawn attention to the fact that so much of our knowledge concerning yaws lacks exactitude ; in regard to "boomerang leg," he has made a valuable contribution towards defining the evolution of that affection.

Among other points to which he has drawn attention is the question of the geographical distribution of yaws in Australia. Basing his conclusions upon the fact that "boomerang" tibiae have been recovered from all parts of Australia, Dr. HACKETT says that yaws occurs and has occurred in native groups living in non-tropical climates and in areas far removed from the defined geographical tropics ; and he suggests that conditions other than atmospheric temperature and humidity play a part in the etiology of the disease, the special factor being scantiness of clothing. It is worthy of note however that the area of Australia demarcated in his map, that in which yaws is found, will be seen to correspond very closely with the area enclosed by the isotherms which delimit the tropical belts of other countries, and I suggest that this is a fairer way of defining "the tropics" than by making use of the tropics of Cancer and Capricorn. Alice Springs is almost on the tropic of Capricorn, Musgrave Ranges are well within the geographical tropics and Warburton Ranges only 26° S. That absence of clothing is perhaps the most important etiological factor there can be little doubt ; it is a view I expressed elsewhere last year when I suggested that it was the conditions associated with a tropical climate rather than the climate *per se* which governed the distribution of yaws : primitive peoples, living under primitive conditions in regard to clothing, housing, feeding, cleanliness and protection from traumata. Thus are explained the wide diffusion of yaws among bush natives, its absence among those who dwell in towns, the comparative freedom of the white man, childhood infections, etc. Where similar conditions are met with outside the tropics there I think yaws might spread if introduced, as is well exemplified by the outbreak of yaws in a Johannesburg mine (C. J. SCOTT, 1933) where, though the altitude of Johannesburg is 6,000 ft., work was carried on 1,000 to 2,000 ft. below sea level at a temperature of 88° to 92° F. dry bulb thermometer and 87° to 91° F. wet bulb. The miners worked, stripped to the waist, but wearing boots, and it is of interest to observe that primary

lesions occurred on every part of the body and limbs except the foot and ankle, also that white miners were infected as well as native.

In regard to "boomerang leg" itself the point which strikes one most forcibly is the extremely high incidence. At Alice Springs alone, Dr. HACKETT collected fifty cases where, let it be remembered, the population all told only numbered a few hundred, this sparsity of population being a point which perhaps Dr. HACKETT has not emphasized. In the Northern Territory, of 322 persons no less than 58 per cent. exhibited the condition. In no other country, as far as I know, in which yaws is endemic, is there such a high incidence of this or of the similar bone deformity known as sabre tibia. One is I think forced to the conclusion that some other factor must be involved, as Professor HARRIS has suggested. This high incidence of a particular lesion reminds one of the high incidence of goundou among the yaws-infected primitive natives of the forest zone of the Ivory Coast as reported by BOTREAU-ROUSSEL. There surely must be a special factor at work. That concurrent infections, deficiency states and endocrine disturbances play a part in determining the course of syphilis is well known, and I think the same may be true of yaws. The subjects of Dr. HACKETT's observations are, I gather from him, a people with a very precarious food supply and unbalanced dietary. It would seem quite possible that some deficiency is the factor determining the local incidence of boomerang legs.

Just how common bony lesions are in yaws we do not know; serial X-ray examinations of a large number of cases of yaws throughout the course of the disease are required: they were not uncommon in association with goundou in BOTREAU-ROUSSEL's cases.

I gather that Dr. HACKETT regards the pathological changes in boomerang tibia as differing from the picture presented in syphilis; but I am not quite clear whether he thinks the presence or absence of periostitis a point of differentiation. Osteo-periostitis is common in yaws—if periostitis is rare or absent in boomerang leg it would perhaps be another point in favour of there being a special factor involved in that condition. Bone lesions due to yaws, in an otherwise normal individual, might differ from those occurring in one suffering from a condition of sub-scurvy. Trauma may certainly play some part but the evidence for believing that superinfection may have an effect in producing bone lesions is I think unconvincing. I am not quite clear on what grounds it is suggested that bone lesions may be a manifestation of partial immunity. I could understand their being, like gummatous lesions, possibly an expression of the allergic state—a very different thing.

Many of the bony exhibits show evidence of marked necrotic lesions. It would be interesting to know whether they were associated with ulcerative lesions of the skin and secondary infections.

It would be interesting also if Dr. HACKETT would add some observations concerning the lesions on the skulls shown. As far as I can remember only once have I seen it suggested that yaws causes lesions of the vault of the skull.

**Dr. G. Carmichael Low** said that from what Dr. HACKETT had told them, it was clear that boomerang legs had some connection with yaws. The only point of criticism that might be put forward was that Dr. HACKETT had not seen ordinary yaws amongst the children and young adults of the aboriginal natives. That might be explained of course by the difficulty of seeing sufficient cases in such a sparsely distributed population.

He (Dr. Low) agreed with Dr. STANNUS that there must be some other factor present to make the bones so soft as to allow of this special bending seen in boomerang leg. In countries where yaws was very prevalent, one did see from time to time examples of sabre tibia, but not in great numbers, and the same held good for some other conditions now generally attributed to yaws. For example, if goundou was a sequel of yaws, why was it limited almost entirely to natives in some areas of the West Coast of Africa, and practically not seen elsewhere, and why was gangosa specially found in Guam? Again juxta articular nodes were more common on the West Coast of Africa than elsewhere. All these examples pointed to some other factors, in addition to the treponema of yaws, influencing the development of these special pathological conditions.

The question of syphilis and yaws was a very interesting one; they had a close similarity, but in his (Dr. Low's) opinion, they could be differentiated clinically with ease.

Other anomalies which required clearing up, as regards these two diseases, were the absence of syphilis and the great prevalence of yaws amongst the Fijians; and now, according to Dr. HACKETT, the absence of syphilis amongst the aboriginal natives of Australia and yet the presence of yaws.

As regards the bone shown with the fenestrated holes in it, he again agreed with Dr. STANNUS that there must have been open ulceration of the skin present over the lesion, and that cocci had played a part in its production.

He hoped that Dr. HACKETT would be able to continue his work on yaws, and that he might have the opportunity later of seeing the disease in other parts of the tropics where it was specially prevalent.

**Dr. Clement C. Chesterman**: I, too, have been very much interested in this discussion on yaws, because in the Belgian Congo the disease is very widespread, and during the last three years we have treated 22,000 cases of yaws at the Baptist Mission Hospital of Yakusu and its village dispensaries.

Dr. HACKETT has staked out a good claim for the presence of yaws in the Australian continent. There is no doubt that these bony lesions are very similar to those we have in the Congo. There the natives call them "machete legs"; the machete being the equivalent of the sabre. But I have not seen such marked bowing and thinning as Dr. HACKETT has shown us. There seems to be more sclerosis, due probably to the better food supply in the rain forest than in the Central Australian districts. Also I am sceptical about the specimen from the Royal College of Surgeons Museum. I have spent many hours hacking away

the involucra from old cases of osteomyelitis, and I am sure that condition occurs frequently among natives. The natives of the Congo have good resistance to septic infections, but they are not so immune to it as the Australian natives seem to be. I have not observed scars on the skin, except after the superficial tertiary ulcers. The primary lesion, unless infected with the organisms of sloughing phagedena, does not leave much scarring of the skin, neither does the secondary lesion. Most of the osteo-sclerosis in this condition is on the anterior or convex surface, and is frequently seen in the forearm bones, the clavicle and tibia, and so I wondered whether a mechanical explanation would not serve, the convexity of a slightly curved bone being under tension both when bearing weight or through muscular action, while the concavity would be under compression.

I ask whether Dr. HACKETT, or any other Fellow of the Society, has any idea why some people do not get this bony lesion; why should tertiary yaws develop in some cases and not in others? I have never found this or any manifestation of tertiary yaws in patients who have had some chronic secondary lesion, such as crab yaws or other persistent secondaries which refuse to heal. This suggests, and native opinion strongly confirms it, that a good cutaneous reaction is the best safeguard against tertiary lesions.

I can support Dr. HACKETT's experience that syphilis is not always prevalent where other venereal diseases may be found, and we have also had cases in the Congo in which typical syphilis has been contracted after typical yaws.

**The President, Sir Arthur Bagshawe :** One thing which occurred to me, as it probably has occurred to others, is that with such an amount of bowing there may be a liability to fracture. If there is a dietetic factor, one would think it would leave some brittleness of bone.

**Dr. Hackett (in reply) :** The yaws origin of the lesions in the skulls in the demonstration is only a suggestion based upon the absence of syphilis and pyogenic infections and the frequency of yaws among the aborigines. Further evidence is needed for confirmation of this probability.

Some of the periosteal deposits round open lesions may be due to secondary infection in de-vitalised tissue. And the same remark applies to the lesions in the skulls, which are probably associated with sinuses though I have not any living cases. Of the massive necrotic condition there are six specimens in the Royal College of Surgeons Museum.

I do not think fracture often occurs in these bent bones. If one leg is more bowed than its fellow, a history is frequently given of some trauma in early life, such as a fall or some knock; I think such traumata must play an important part in the determination of the localisation of the lesion.

As to cross-immunity between syphilis and yaws: from the few cases I have seen reported of yaws, which later developed syphilis, the first disease was

of mild character. One such case was recently reported from Kenya. In that, the attack of yaws was so mild that the patient had taken but little notice of it, when however, he developed a syphilitic chancre he sought medical advice. In SCHOEBL'S work on cross-infection between these two diseases in animals, it was found that to get immunity to syphilis it was necessary to keep the yaws lesion going for at least 4 months: after that period the chances of infection with syphilis were greatly diminished. Earlier, however, there was a fair chance of such infection.

With regard to the persistence of secondary lesions hindering the production of tertiary ones, SCHOEBL found with his monkeys that if in the early inoculations a good metastatic eruption developed the animals would not develop late lesions.

The change which occurs on the convex surfaces of the boomerang tibiae opens up the question of mechanics and the operation of bone trajectories.

The scars, which Dr. CHESTERMAN has not seen frequently in the Belgian Congo, are found, in the regions of Central Australia where the climate is drier, in the skin creases in infancy round the neck, the gluteal cleft, and the axillae and the ante-cubital fossae. At Bathurst Island, where there is a good deal of hookworm disease, the incidence of these scars round the mouth was increased. There the habit of earth-eating was frequent. I do not know whether the trauma of the earth passing over the lips would be responsible for the localisation of the lesions, or whether it is due to fingers carrying infection from elsewhere on the body.

With regard to the influence of secondary infections in the production of these lesions, septic infections of the soft tissues are not frequent and they heal very readily. Deep depressions are often found over the left scapula, the results of fighting, but they are probably due to thorough undercutting and sloughing, rather than to infection. I have seen only one serious infective process in a native, a facial carbuncle which developed in 2 days; in another 2 or 3 days it had resolved.

On the question of the distribution of yaws being due to some factor other than a climatic one, I have wondered whether the common factor is not skin exposure. In the tropics there is the factor of warmth; among the Australians there is ethnological backwardness. The winter nights in Central Australia are cold, the temperature often falling below freezing point.

The distribution and character of the lesions of yaws seen in Central Australian natives fall into line fairly well with those reported by RAMSAY (1925) in Assam. In the dry hill country the lesion is a dry scab localised to the moist areas in the flexure regions of the body; but in the lower-lying moist climate, there is a more general distribution. When the hill people come down to the moist country, they are found to develop the typical yaws.

I agree with Professor WARRINGTON YORKE concerning the inability of comparison of these lesions in Australian aborigines with syphilis in Europeans. There is little opportunity of studying Australian aborigines, under full European

conditions. But much can be done by a comparison of negro syphilis in the northern part of the United States, and the bone lesions of yaws in Africa.

Professor HARRIS and Dr. STANNUS's suggestions of an extra factor and deficiency are sound and it would be interesting to get early active cases, selected by radiography, and to study their calcium and phosphorus balances and their blood phosphatase values. If these lesions are not due to syphilis but are due to framboesia, that is some indication that these diseases are not identical.

It is reported by TOPINARD (1890), that 16 per cent. of the tibiae taken from graves in Paris, of the 4th to the 10th century, are both flattened and bent in an antero-posterior direction. It would be interesting, if rickets could be excluded, to see how these deformities compare with those in boomerang legs. EATON (1916) speaks of syphilitic lesions in Peruvian bones from burials before the European discovery of the country. The differential diagnosis was not very thorough; osteitis deformans was excluded in one instance on account of the youth of the subject and it was concluded that the lesions present were the result of syphilis. Yaws was not considered. The changes present in this case are not unlike those present in some of the Australian bones, and do not resemble the usual syphilitic lesions.

I have had little opportunity this evening to acknowledge my indebtedness to the many, both in the field and in the cities of Australia and in Great Britain and elsewhere, who have so freely and willingly given me any assistance needed, and I take this opportunity of expressing my deep gratitude to them.

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