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SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH—
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TUBERCULOSIS IN SOUTH AFRICAN NATIVES WITH SPECIAL REFERENCE TO THE DISEASE AMONGST THE MINE LABOURERS ON THE WITWATERSRAND

(Being the Report of the Tuberculosis Research Committee, originally established by the Transvaal Chamber of Mines and later expanded into a Joint Committee by incorporation of representatives of the Union Government).

CORRIGENDA.

p. 78, line 26, for "occasiona" read "occasional."
p. 107, line 39, for "tuccess" read "success."
p. 107, line 41, for "she" read "the."
p. 111, line 43, for "Non-recuited" read "Non-recruited."
p. 161, line 5, for "ate" read "are."
p. 181, last line, for "137 and 138" read "146 and 147."
p. 244, line 8, for "coatal" read "coastal."
p. 402, line 53, for "caseting" read "caseating."
p. 413, line 20, for "(p. 000)" read "(p. 419)."

ADDENDUM.

On page 105 reference is made to the "follow-up" of tuberculin-tested cases, and to the possibility of information being forthcoming at the end of 1931. This additional information is as follows:—The work of the Tuberculin Sub-committee ceased at the end of 1930, but by the courtesy of certain Mine Medical Officers, 100 cases have been notified which arose in the tuberculin-test group during 1931. This supplemental return does not pretend to be a complete return for 1931, but 100 cases are a sufficient number to justify a brief analysis.

Of the hundred cases 32 arose in negative reactors and 68 in positive reactors.

Negative reactors.—All cases arose in subjects tested subsequent to June, 1929. There were twelve cases from the group tested between July and December, 1929, and twenty cases from the group tested between January and September, 1930. There were approximately 16,000 subjects who yielded a negative reaction from the groups tested between January, 1928, and June, 1929; only a small minority of these will have been on the mines during 1931, but not a single case is notified from this minority. Apparently, if a negative reactor does not go down during his present contract he is unlikely to go down later.

Positive reactors.—Of the 68 cases arising among the positive reactors, 11 had been tested during 1928, 19 during 1929, and 38 during 1930. It appears that positive reactors who renew their contracts and stay on the mines retain their susceptibility to tuberculosis.

Strongly positive reactions and susceptibility.—There were 436 cases of strongly positive reactions to dilutions of one in a million and one in ten million. These cases were tested between November, 1929, and June, 1930. By the end of 1931 the number of cases recorded from this group was 14, or a rate of over 3,200 per 100,000. This rate is very high and suggests that strongly positive reaction to an intra-dermal test with high dilutions of old tuberculin is associated with special susceptibility to tuberculosis. It may be mentioned that the one in ten million group has shown no greater susceptibility than the one in a million group in so far as strongly positive reactors are concerned. On the other hand, the susceptibility of those strongly positive to a dilution of one in a million, or over, is getting on for three times as great as that among those strongly positive to a dilution of one in a hundred thousand, or less.

TUBERCULOSIS RESEARCH COMMITTEE.

List of Members.

Chairman :

Sir Spencer Lister,
Director, South African Institute for Medical Research.

Representatives of the Union Government :

Dr. J. Alexander Mitchell, Secretary for Public Health and Chief Health Officer, Department of Public Health.

Dr. L. G. Irvine, Chairman, Miners' Phthisis Medical Bureau.

Dr. J. T. Dunstan, Commissioner for Mental Disorders.

Major H. S. Cooke, O.B.E., Director of Native Labour, Native Affairs Department.

Dr. W. A. Murray, Assistant Health Officer, Department of Public Health.[1]

Representatives of the Transvaal Chamber of Mines :

Dr. W. Watkins-Pitchford,[2]	South African Institute for Medical Research.	
Sir Spencer Lister,[3]	do.	do.
Dr. J. H. Harvey Pirie,	do.	do.
Dr. A. Mavrogordato,	do.	do.
Dr. G. Buchanan,[4]	do.	do.

Dr. A. J. Orenstein, C.M.G., Superintendent of Sanitation, Rand Mines, Ltd.

Dr. H. T. H. Butt, Chief Medical Officer, Randfontein Estates Gold Mining Company, Ltd.[5]

Dr. A. I. Girdwood, Chief Medical Officer, Witwatersrand Native Labour Association.

Dr. A. Frew, Chief Medical Officer, East Rand Proprietary Mines, Ltd.

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[1] Alternate to Dr. Mitchell.
[2] Original Chairman. Resigned through ill-health in May, 1926.
[3] Chairman after Dr. Watkins-Pitchford's resignation.
[4] Alternate to any of the Institute representatives.
[5] Deceased, 1930, after the main work of the Committee was finished.

Dr. A. BLOOM, M.C., Honorary Visiting Physician, Johannesburg General Hospital.

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Mr. H. M. TABERER, Native Labour Adviser, Transvaal Chamber of Mines.

Sub-Committees :

The Chairman of the Committee an *ex-officio* member of all Sub-Committees.

Clinical : Dr. BLOOM (Convener), Drs. BUTT, FREW, GIRDWOOD, IRVINE and PRINGLE.

Pathological : Dr. HARVEY PIRIE (Convener), Drs. IRVINE and MAVROGORDATO.

Tuberculin : Dr. MAVROGORDATO (Convener), Drs. BUTT, DUNSTAN and GIRDWOOD.

Statistical : Dr. ORENSTEIN (Convener), Drs. IRVINE and MITCHELL, Major COOKE.

Hygiene and Preventive Measures : Dr. MAVROGORDATO (Convener), Drs. BUTT and ORENSTEIN, Mr. B. O. ORPEN[6] co-opted as representative of Mine Managers' Association.

Transkeian (dealing with the work in the Native Territories) : Major COOKE (Convener), Mr. TABERER, Dr. HARVEY PIRIE.

Publication : Drs. ORENSTEIN, MAVROGORDATO and HARVEY PIRIE.

Adviser and Consultant :

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Field Research Officer :

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[6] Deceased, 1930, after the main work of the Committee was finished.

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TUBERCULOSIS IN SOUTH AFRICAN NATIVES WITH SPECIAL REFERENCE TO THE DISEASE AMONGST THE MINE LABOURERS ON THE WITWATERSRAND.

REPORT OF TUBERCULOSIS RESEARCH COMMITTEE.

INTRODUCTION.

Circumstances in which the Tuberculosis Research Committee came to be Formed.

During the year 1925 the Transvaal Chamber of Mines, through its Gold Producers' Committee, had under consideration the advisability of instituting an intensive campaign against tuberculosis on the mines within its organization. As a preliminary to the adumbration of a plan to effect this purpose, the Gold Producers' Committee, in April, 1925, addressed a letter to the Director of the South African Institute for Medical Research, Johannesburg, inviting any suggestions or advice that he might care to offer in regard to the whole matter. In the absence of the then Director, Dr. W. Watkins-Pitchford, the letter was replied to by the Editor of this Report, to the effect that the Institute was in full accordance with the proposal and realized the need for investigating the problem of tuberculosis in regard to both the European and Native populations in South Africa. Attention was drawn to two main sections of medical activity into which the problem naturally falls, viz., Public Health and Laboratory Investigation, using both these terms in their widest sense. Upon amplification of the different aspects of the problem that might require investigation, it was suggested that the matter was one for team-work, and it was finally advised that a small Committee be appointed comprising three medical representatives of the Institute and of the Mine Medical Officers' Association respectively, under the Chairmanship of the Director of the Institute. It was foreshadowed that such a Committee would discuss the problem in detail and formulate a programme of research to be taken part in by field workers and clinicians as well as by laboratory workers. As a result of this correspondence and further negotiation, a Committee was appointed on May 4th, 1925, constituted as described above, with the addition of two other medical men who were especially versed in the clinical aspect of tuberculosis, but who were not connected with either of the two organizations previously referred to. This Committee was designated "The Medical Committee on Tuberculosis." In 1926, however, its membership was considerably increased by the addition of both medical and non-medical representatives, and its name was

changed to that of "The Tuberculosis Research Committee." The circumstances that led to these alterations are of considerable importance and merit a brief reference. As the work of the original Committee progressed, it was soon realized that the problem with which it was confronted could not be adequately investigated as a purely local one, confined merely to the Native mine labourers temporarily employed upon the Witwatersrand. This Native labour force is recruited from many regions of Africa and from places geographically separated as widely as the Cape and Mozambique. It was deemed essential to obtain information, by means of a field survey, regarding tuberculosis as it exists in these permanent home areas of the various tribes concerned, and also amongst the large urbanized Native populations resident in what are termed locations, a housing system which is, in effect, a method of domestic segregation of Natives in the larger cities and towns of the Union of South Africa. These, together with the recognition of other unanticipated lines of investigation so extended the scope of the enquiry that wider interests became involved and also heavier commitments in regard to both financial provision and personnel. In due course, the Government of the Union collaborated in the general scheme. This participation was followed by the appointment of Government representatives on the Committee. Further experience disclosed the necessity for appointing a member or members, not necessarily with a medical qualification but possessed of a very particular and intimate knowledge of the native mind, language, history, habits and customs. In conformity with these various circumstances the Committee henceforth termed "The Tuberculosis Research Committee" was constituted as shown on page 3.

The Committee experienced few changes in personnel during its existence, but reference may fittingly be made to the regrettable loss of the valuable services of Dr. W. Watkins-Pitchford, late Director of the Institute and original Chairman of the Committee, who found it necessary to resign in May, 1926, owing to ill-health.

We have to record with regret, also, the deaths of Dr. Butt and Mr. Orpen in 1930. Dr. Butt was a very energetic member and it was extremely fortunate for the Committee that its work was almost finished before his services were lost. Mr. Orpen was not a member of the main Committee but he had been co-opted as a representative of the Mine Managers' Association to serve on the Hygiene and Preventive Measures Sub-Committee.

Financial Arrangements.

The Committee decided upon a plan of investigation to occupy three years, necessitating an annual expenditure of £6,000. This sum was provided in equal proportions of £2,000 per annum each by the Government, the Chamber of Mines and the Natives' Deferred Pay Fund. It was agreed "That the details and control of the survey and investigation, and of the expenditure of the funds for that purpose, be vested in the South African Institute for Medical Research."

THE OBJECTS AND SCOPE OF THE ENQUIRY.

To enable the reader to visualize easily what the Committee had in view, it is desirable to state here, without entering into undue detail, that the main objects of this enquiry were twofold: (1) The extension of knowledge concerning tuberculosis as it occurs in South Africa, and more particularly in its relation to the Native Races; and (2) the diminution of the morbidity and mortality from tuberculosis amongst the European and Native miners in South Africa, most of whom are employed in the gold-mining industry in the Johannesburg area of the Transvaal, known as the Witwatersrand (also frequently referred to as "the Rand"). Although it is possible, then, to summarize in a few words, albeit very broadly, the objects in view, there is greater difficulty in briefly outlining the scope of the enquiry that was considered necessary in attempting their achievement. From the outset it was realized that there was an almost entire lack of precise data regarding all the more important aspects of the problem; it is true that there was available a wealth of data, collected over many years bearing upon all aspects of tuberculosis in Europeans of other lands, and not a little in respect of some other Native races, the Senegalese, for example. This knowledge, however, even where relevant to the particular purpose in hand, could not unquestionably be directly applied to the solution of the problem presented in the case of our Native races, whose circumstances differed so greatly in regard to environment, work, diet and domestic customs. Vital statistics concerning the Native populations of South Africa are non-existent, and at the time of this enquiry the extent of their tuberculization was unknown, the detailed pathology and type or types of the disease had not been closely scrutinized, whilst the relative part played by human and bovine tubercle was merely a matter of speculative opinion. The fate of the large number of Natives who, having developed tuberculosis during their temporary employment on the mines, are constantly being repatriated to their distant homes, was but surmised. The part that these Natives played in spreading the infection amongst their families and others in the kraals was unknown. From a consideration of the circumstances outlined above, it will be gathered that a varied and extensive programme of work became imperative, and not the least urgent necessity appeared to be a field survey of tuberculosis existent in the wide areas of the Native Territories in the Transkei and Ciskei from whence so large a number of Natives are recruited for temporary mine employment. In connexion with this particular investigation the Committee envisaged the carrying out of tuberculin tests, the following-up and subsequent observation of repatriated tuberculous Natives and their families, the collection of historical and statistical information, together with an enquiry into the present customs and economics of the population concerned. In addition to this, there was evidently need of pathological, bacteriological, radiological, statistical and other studies to fill in the lacunae in our knowledge of the local manifestations of this disease.

It was at once obvious that so comprehensive a programme would raise fundamental considerations of an epidemiological nature, and it was considered desirable to obtain the assistance of an overseas specialist in the epidemiology of the disease, to act as adviser and consultant for a period of three years. The Committee was fortunate in securing the services of Professor Lyle Cummins, of the Welsh National School of Medicine, Cardiff, who visited South Africa on three occasions in connexion with these investigations and at other times throughout the whole term of his appointment rendered most valuable advice and assistance by correspondence. It was also realized that the proposed tuberculosis survey of the Native Territories would be a lengthy proceeding and would necessitate the whole-time appointment of a medical man especially qualified to undertake such work. Here again the Committee, through the kind offices of Dr. J. A. Mitchell, Secretary for Public Health of the Union, had the good fortune to be able to arrange for the seconding for three years of Dr. Peter Allan, Superintendent of the Government Tuberculosis Sanatorium at Nelspoort, who had already carried out a similar but less ambitious investigation on behalf of the Public Health Department. The field work carried out by Dr. Allan during these three years forms the basis of Chapter V, Part II, of this Report. Apart from this special field of investigation, almost the whole of the rest of the work was carried out at Johannesburg, and the nature of these studies may be summarized under the following headings: Clinical, pathological, bacteriological, tuberculin tests, statistical, hygiene and preventive measures, and X-ray investigations. Special sub-committees were appointed to deal with these various subjects and to report to the main Committee from time to time.

The constitution of these sub-committees is shown on page 4.

The results of the labours of the various workers concerned are recorded in the Report and in the Appendices thereto and require no further detailed elaboration here. Reflection upon the work and results of this three years' task serves to emphasize the wide boundary to which the domain of tuberculosis research extends. Whilst the Committee has of necessity been obliged to concentrate its resources upon the study of but a mere corner of this terrain, it at all times had particularly in view the necessity for utilizing the opportunities here presented for investigating at first hand the special problems associated with tuberculosis occurring amongst a relatively primitive race. This race, moreover, by force of circumstances, has been impelled, somewhat precipitately, to change its manner of living from that of a pastoral and warlike people to one of industrialism, associated with increasingly close contact with Europeans and, to some extent, with urbanization. Without knowledge bearing upon the fundamental aspects peculiar to our local problem, it would be unwise to attempt its solution by applying unreservedly a number of the accepted tenets regarding tuberculosis derived from the accumulated experience of this disease as observed in European civilized communities. Thus, an enquiry such as this, dealing with a type of population so unusual, has led to the

collection of extensive data relating to the incidence and infectivity of tuberculosis under these conditions, and to a study of the degree of tuberculization and also of the pathological processes concerned in its production and development in these South African Natives.

The literature contains rather scanty records of observations concerning the tuberculosis of primitive races. For this reason, and also to allow those especially interested in this problem the opportunity of examining in detail the data upon which the arguments and conclusions in the body of the Report are based, it has been thought desirable to include as appendices a number of reports by the Committee's individual workers. Attention may here be drawn to the personal commentary by Professor Lyle Cummins in Chapters VI and VII, written at the request of the Committee. It was considered that such a commentary would have a particular value as coming from one not only pre-eminent in this subject but whose thoughts and judgment might possibly be presented from a point of view not easily seen in its entirety by those whose views, owing to long residence in South Africa, might be stamped with a certain conservatism where any measures tending to the advancement of the Natives races are under discussion.

In conclusion, there is another aspect of this research which very deservedly merits recognition :—Reference is made to the enthusiastic and generous collaboration and assistance from many outside sources. It is quite impossible to express appreciation to everyone concerned individually, but the Committee desires to record its indebtedness to Mr. W. Gemmill, General Manager of the Transvaal Chamber of Mines, for his energetic and wise helpfulness on innumerable occasions, and to a number of members of the staffs of the Native Recruiting Corporation and the Witwatersrand Native Labour Association, for assistance in connexion with the investigations in the Native Territories and in Portuguese East Africa ; to the Public Health Department for services rendered through the Secretary for Public Health, Dr. J. A. Mitchell ; to Dr. Park Ross of that Department for arranging the tour through Zululand undertaken by a member of the Committee ; The Mine Medical Officers' Association, whose members were at all times most helpful in fulfilling the numerous requests made of them in furtherance of clinical and statistical enquiries ; the Medical Officers and Staff of the Witwatersrand Native Labour Association Hospital for assistance in connexion with radiological examinations and tuberculin tests carried out at that Institution ; the staffs of the various mental institutions throughout the Union under the direction of Dr. Dunstan for the collection of much useful data and who, in addition, carried out tuberculin tests and in some instances prophylactic inoculations of B.C.G. vaccine ; the Public Health Department at Lourenço Marques, whose Chief Officer, Dr. Ferreira dos Santos, arranged a personally-conducted tour through Portuguese East Africa for Professor Lyle Cummins, Dr. Mavrogordato and Mr. Taberer, enabling them to see, under the most pleasant auspices, a great deal relating to the public health service amongst the East Coast Natives ; to Drs. L. Bostock and Pinto Coehlo, who, with the concurrence of the Portuguese Authorities, arranged for

the tuberculin testing of some seventy thousand Natives at Ressano Garcia, prior to their departure for Johannesburg on mining employment; to the Medical Research Council of Great Britain, which was instrumental in providing information of a most useful character; to Sir Walter Fletcher for his sympathetic readiness to help whenever called upon in connexion with enquiries overseas; to Professor A. V. Hill, of University College, London, and his assistants, for the construction of an electrical thermometer designed to record rapidly the temperatures of large groups of people, according to a plan suggested by a member of the Committee; to Dr. Stanley Griffith for kindly studying, for the purpose of confirmation, a number of strains of acid-fast bacilli in connexion with Dr. Harvey Piric's investigations of the relative prevalence of human and bovine tuberculosis in South African Natives; to Dr. Roodhouse Gloyne for recording on special forms the results of a long series of post-mortems performed on tuberculotics at the Victoria Park Hospital, London, and which were used for comparison with the local post-mortem findings in Native mine workers; to Dr. W. Steuart for valued assistance and advice in connexion with the radioscopic examination of Natives' chests; to Drs. N. Macvicar and F. S. Drewe, Medical Officers of the Victoria Hospital, Lovedale, and of the Holy Cross Mission, Pondoland, respectively, for valuable information resulting from their wide experience in medical work carried on amongst the Native population at these two mission stations over many years; to Dr. F. Allen for carrying out and recording the results of a number of tuberculin tests on Natives employed at the Witbank Colliery; to Mr. F. Brownlow, Magistrate at Butterworth (Transkei), for his kindly hospitality to members of the Committee during their visit to his district, and for placing at their disposal his wide knowledge of the past and present circumstances of the Native races; to Mr. C. C. Frye, Manager of the South African Explosives and Industries, Ltd., for making available all necessary facilities for a visit of inspection by members of the Committee to the two factories under his control at Somerset West (Cape Province) and at Umbogintwini (Natal).

PART I.

A PRELIMINARY SURVEY OF FACTS BEARING ON TUBERCULOSIS IN SOUTH AFRICAN NATIVES.

CHAPTER I.—GENERAL CONSIDERATIONS.

CHAPTER II.—ANTHROPOLOGICAL AND HISTORICAL NOTES ON THE BANTU TRIBES OF SOUTH AFRICA.

CHAPTER III.—REPORTS ON TUBERCULOSIS OF SOUTH AFRICAN NATIVES PRIOR TO THE PRESENT ENQUIRY.

CHAPTER I.—GENERAL CONSIDERATIONS.

1. Isolated Communities.

A community may be regarded as "isolated" in so far as concerns its epidemiology when it is completely cut off from commercial, military or other relations with the outside world. Certain islands in the Pacific were at one time "isolated" in this sense; some of the more northerly Eskimo tribes are, perhaps, so "isolated" to-day; and until recently, a few African tribes have remained isolated through the operation of geographical and other factors; such, for instance, as the Bahr-el-Ghazal Dinkas, so placed in the marshes and steppes to the south-west of Lake No on the White Nile that they were able to maintain an isolation undisturbed up to 1902 by any more permanent "penetration" than an occasional slave-hunting "razzia" by wandering Arabs.

In the case of such isolated communities the tribe or clan usually spreads its population widely over the area occupied. The exigencies of a life depending on the grazing of herds, the capture of game and the raising of crops in bush-clearings, demand wide spaces; and huts are arranged in family "kraals" instead of in villages or towns; these "kraals" being frequently changed from place to place according to the needs of a semi-nomadic people.

In these circumstances, the passing on of bacterial infection from one person to another is limited to a far greater extent than in more sophisticated communities; and, more especially, in diseases of slow development like tuberculosis, sporadic cases, if they occur, tend to die out with the individual or family. While reliable statistics are, of course, in the nature of things, unobtainable, it has been the almost universal experience of those qualified to judge who have had opportunities of studying such communities before tribal conditions were unduly disturbed, that tuberculosis has been conspicuous by its absence both in the humans and also in their cattle.

The manner of life, in these isolated tribes, presents a sharp contrast to that in the big cities of Asia on the one hand and, even more so, to the life of the civilized and industrialized communities of Europe, with their never-ending contacts between individuals and their free communications as between cities and countries.

2. The Tuberculosis of Virgin Soil.

Although the native races of South Africa can no longer be considered as "isolated," their contact with civilization is of relatively recent date and, save for intermittent touch between the coastal fringes of immigrant tribes and European trading, missionary and marine

stations during some four centuries, and Arab coastal settlements for a much longer period of time, may be regarded as falling within the limits of the last hundred years.

In these circumstances, it is obviously desirable to start the consideration of the disease in South African Natives by a brief survey of the tuberculosis of virgin soil. In the words of G. Bushnell[1] "We cannot comprehend how a general tuberculization influences the dissemination and progress of tuberculous disease until we know how communities and individuals fare who have had no previous acquaintance with the tubercle bacillus."

It will be noted that Bushnell uses the expression "communities and individuals"; but a moment's reflection suffices to show that our information can only be exact in so far as it concerns individuals; seldom or never as it concerns communities, since individuals may be studied when they abandon their isolation and enter civilization, but communities cannot be moved about in this way and the penetration of civilization into the midst of "isolated" populations is usually so gradual that no sharp contrasts present themselves for examination.

As to uninfected individuals, while many instances might be cited from older records, there has never been a more favourable opportunity for the study of their behaviour on their sudden introduction into a "tuberculized" environment than that presented by the French "Colonial Troops" called to Europe for military service in the late war.

A. Borrel,[2] to whose lot it fell to study this problem in Senegalese troops arriving in France, has made a contribution to the subject which is likely in the future to become classical and which demands the closest attention from all those who desire to approach the study of tuberculosis in the African races. He showed conclusively that these practically uninfected persons—only four to five per cent. were found to give a positive tuberculin cuti-reaction on arrival—were exceedingly susceptible to tuberculosis and tended to develop the disease in a severe and generalized form. He found that the disease presented two stages; an initial glandular phase with no fever and no definite change in the general state, tending to last, under Army conditions, for one, two, or three months; and a subsequent phase characterized by fever, emaciation and generalized lesions such as caseous lobar or lobular pneumonia, affections of the serous membranes, pleurisy and miliary tuberculosis, either primary or secondary. This latter phase was usually short and death often ensued within a fortnight to two months after its inception.

It is to be noted, however, that although cases which reached the second stage were almost invariably fatal, those detected early and while still in the "glandular" phase, if placed at rest and given suitable food, tended to do well. Borrel reports that 50 per cent. of such cases regained their health and were fit to be repatriated.

To Borrel's records of his post-mortem findings in the fatal cases, reference will be made later in this Report.

For reasons already given, it is difficult or impossible to obtain satisfactory information on how previously uninfected communities behave when infection is introduced. It may be stated with some confidence, however, that the return of individual cases infected elsewhere to such communities does not invariably or even usually light up epidemic tuberculosis. Provided that the community in question still retains its isolated character and continues to follow its primitive mode of life, the spread of the disease, when thus introduced, may, it seems, be arrested or only proceed very slowly; eventuating, perhaps, if the introduction of further cases continues from time to time, in a curious type of endemic and relatively benign tuberculosis in which the fulminating cases described in France by Borrel and others are not frequently observed.

What appears to be an instance of this type of endemic tuberculosis has recently been described by Paneth[3] in the Karo Districts of the Dutch East Indies; but opportunities for observing tuberculosis in these circumstances are naturally rare.

This rarity or absence of epidemic spread of acute tuberculous disease in "isolated" communities exposed to occasional infection is, perhaps, to be explained in terms of the tendency to spontaneous arrest of cases in the "glandular" stage, as noted by Borrel, when placed at rest and suitably dieted.

A type of contact more frequently observed is that in which, under conditions of "segregation," a previously "isolated" community is placed under new and unfamiliar surroundings and provided with "civilized" substitutes for its primitive manners, customs, foods and habitations. In these circumstances, each member of the community, if infected with tuberculosis, tends to behave just as has been above described for the Senegalese troops described by Borrel, and the result is an approximation to epidemic rather than to endemic tuberculosis.

A recent paper giving an extremely interesting and tragic account of tuberculosis in such circumstances is that by *R. G. Ferguson*,[4] in which he describes the behaviour from 1870 onwards of the disease in the Indians of the Great Canadian Plains.

Reference has already been made to the case in which civilization gradually penetrates into the heart of a previously isolated community. Here the issues tend to be somewhat obscured by the gradual nature of the change and results, as might be expected, vary according to circumstances. When the penetration leads to or is accompanied by a marked change in the diet and mode of life of the community, the results may be very similar to those described by Ferguson.

For an example, the reader is referred to a recent article by V. Suk,[5] "On the Occurrence of Syphilis and Tuberculosis amongst Eskimos and Mixed Broods on the North Coast of Labrador," a paper described by its author as a "Study in the Extermination of Aboriginal Races."

Instances might be multiplied, but the above will suffice to establish the point that members of isolated communities exhibit a marked susceptibility to tuberculosis when brought into contact with infection;

and that although the infection may be fairly well tolerated under natural or tribal conditions, this susceptibility is fraught with extreme danger when exposure to infection is accompanied by a sudden change in occupation, food, housing and mode of life.

3. INTERMEDIATE STAGES FROM ISOLATION TOWARDS AGGLOMERATION.

It was, again, the importing of French and other Colonial troops into Europe which afforded unique opportunities for contrasting the tuberculosis, not merely of Colonial Natives with that of Europeans, but of the various types of Colonial Natives with each other.

Ch. Roubier,[6] after a close study of French Colonial troops exposed to tuberculous infection in France and Germany, found that they fell into three main groups, as follows :—

(*a*) Those races which had already experienced considerable "contact" with Europeans in their original surroundings. The Algier-Moroccan units afforded examples of this group and presented clinical types of tuberculosis which, while often severe, tended more towards the types of phthisis met with in Europe.

(*b*) Those from remote and sparsely populated places where there was very little contact with "civilization." The Senegalese troops, with their marked susceptibility to tuberculosis, belonged to this group.

(*c*) Those races which, although remote from European civilization, include relatively large agglomerations in their native townships. Such were the units from Indo-China; and their resistance to tuberculosis was fairly high.

Borrel had likened the tuberculosis of the Senegalese to that of European infants. Roubier went further and noted that the tuberculosis of the Algier-Moroccan and Indo-Chinese was of the more benign type met with in European children and adolescents.

4. ANALOGY WITH THE TUBERCULOSIS OF INFANCY AND CHILDHOOD.

This similarity between the clinical manifestations of tuberculosis in individuals arriving from isolated or relatively isolated surroundings into a society in which tuberculous infection is general, and the clinical types met with in infants and young children of European races, is very interesting and well calculated to guide us in attempts to formulate conceptions as to the pathogenesis of the disease.

It will be recalled that Borrel noted in his Senegalese patients a "glandular" phase during which there was still a good chance that the case, if detected and placed at rest on a suitable diet, might do well and regain health. It was in the cases undetected at this early stage that the second or "generalized" phase supervened under the stress of continued military duty and passed on so rapidly to a fatal issue.

These glandular affections are characteristic of tuberculosis in infants and children, and in them, to a much greater extent, rest and good food suffice to lead on to toleration of the disease, gradual diminution in the adenitis, and a maintenance of health.

The existence of this "larval" or glandular stage, during which normal health is usual but in which undue exertion or inter-current disease may have serious effects in leading on to a generalization of the infection from the glands through the blood stream into other organs, is a fact which must be taken into account by those engaged in the medical inspection of Native recruits for industry, as well as by those charged with the care of the children of infected parents.

The subject has been discussed by Cummins[7] in a recent paper with special reference to the analogy between European children and African Natives; and a series of masterly articles on the tuberculosis of childhood by Opie and his co-workers[8] will repay study by those interested in the question.

5. Theories suggested to explain Differences in Susceptibility to Tuberculosis.

It will be seen then that "communities and individuals who have had no previous acquaintance with the tubercle bacillus" fare badly when brought into contact with infection; especially when such contact is accompanied by an abrupt change from a free and natural life and an accustomed diet, to living, working and nutritional conditions to which the individual or the community is not yet adapted. Just as wild animals in nature entirely escape tuberculosis yet show, in captivity, a marked susceptibility to the disease, so does man, in his primitive surroundings, escape this affection; and yet, in spite of his often splendid physique, he is found to possess little or no resistance when exposed to infection. Some of the theories which have been propounded to explain this susceptibility will now be discussed.

Hippocrates held that certain physical types were especially subject to tuberculosis. These he defined as follows:—"The form of the body peculiarly subject to phthisical complaints is the smooth, the whitish, that resembling the lentil, the reddish, the blue-eyed, the leucophlegmatic, and with the scapulae having the appearance of wings." This notion of a phthisical habitus, naturally acceptable to medical men up to the time when more delicate methods of diagnosis revealed the existence of actual but latent disease as a frequent precursor of the developed malady, is a tribute to the clinical acumen of Hippocrates but need not detain us in relation to phthisis in the African Native; since the latter, as we know too well, may be a picture of physical perfection on arrival into an industrial community and yet die of acute phthisis a few months later.

Nor need we long consider the view of tuberculosis as an inherited disease expressed by Pierre Desault in the following words: "Those who have the misfortune to be born of phthisical parents are very liable to the disease, *because phthisis is transmitted by inheritance.*"

In spite of recent claims to the discovery of filtrable forms of the germ capable of passing through the placenta, the theory of inherited tuberculosis cannot explain the susceptibility of members of isolated communities since the ancestral stock has been free from tuberculosis for generations.

This idea of inherited tuberculosis was abandoned when Villemin proved the infective nature of the disease and Robert Koch isolated the causative bacillus.

The modern view was expressed by Koch as follows : " Tuberculosis is explained most naturally by supposing that the infective germ is not inherited but rather certain peculiarities favourable to the development of germs which may later on come into contact with the body ; in fact, it is the predisposition to tuberculosis which is inherited." Thus, it will be seen that Koch favoured the idea of an " inherited predisposition" to infection ; a theory which received support from the statistical investigations of Karl Pearson[9] on the liability of the children of phthisical parents to tuberculosis. Maynard,[33] of Johannesburg, in 1912, warmly upheld the views of Pearson on this point. Sanarelli, on the other hand, propounded a theory of " inherited resistance " to infection, this quality being less marked in persons showing a liability to the disease than in those capable of escaping it. Either theory will serve to explain the susceptibility of members of isolated communities when exposed to infection.

It is clear, for instance, that in the absence of tuberculosis, an absence usual in primitive tribes, those born with an inherited predisposition would escape the disease and live to propagate their kind. It is equally clear that, in the absence of an inherited resistance, the unprotected would survive and multiply. On either theory, an isolated community, once brought into contact with infection, might be expected to come off badly as compared with an old-standing industrial population from which the " predisposed " or the " non-resistant " families had been eliminated.

Neither theory, however, appears to fit well with the facts of variation in resistance to tuberculosis characteristic of the different age-periods in civilized man. The age of infancy, even in the most resistant communities and races, is characterized by the occurrence of those types of tuberculosis associated with " virgin soil " ; the tuberculosis of young and growing children suggests less power of resistance than that of adolescents ; while young adults are more liable to acute phthisis than persons of middle age who tend to manifest the chronic forms of the disease.

These facts strongly suggest that each individual in " tuberculized communities " must acquire—in varying degree—his own resistance through intermittent contact with small doses of tuberculous infection. That increased resistance may be acquired through graded infection with tubercle bacilli has been proved up to the hilt by animal experiment;

a concrete argument which is better established than much of the evidence adduced in support of "inherited predisposition" and "inherited resistance." In the words of Opie,[10] "There is indeed very little convincing evidence for or against the opinion that inherited susceptibility on the one hand or inherited resistance on the other modifies the progress of tuberculosis in human beings."

While, however, the evidence for and against both these theories *falls short of being conclusive, the marked difference in susceptibility* to tuberculosis still noted between the white and negro populations of the United States after seven or eight generations of co-existence in the same country does suggest very strongly that some inherited factor may play a part; and it is natural that the subject should have received attention from laboratory research workers in recent years. It is recognized that "passive immunity" to certain toxins can be transmitted to the offspring by the female, though this immunity is transitory. But apart from this transmission of "passive" anti-bodies, there is also the possibility that the *power of actively producing anti-bodies* may be transmitted to the offspring in varying degree. In the transmitting of this power, the male parent might participate as much as the female, as was pointed out in 1907 by Theobald Smith[11] as follows: "Though the male parent does not transmit directly any passive immunity, yet there is no evidence to show that he does not, equally with the mother, transmit the capacity for producing anti-bodies, which capacity . . . varies much from family to family."

Aptitude to create immunity has been shown more recently by Grasset[69] to be hereditarily transmissible as a fixed character; the reactive faculty, notwithstanding that there may be no occasion for its application, being transmissible as a latent character from generation to generation, although it is subject to considerable variation in the same species.

Working on this idea, Lewis and Loomis[12] have been able, by the in-breeding of guinea-pigs over several generations, to produce more or less "pure" families, each differing from the others in the power of developing resistance to tuberculosis. It is, of course, very difficult to be sure how heredity works under the conditions of such experiments or to establish exactly what are the factors at play; but the findings show conclusively that certain of these inbred families resist tuberculous infection better than others: thus, family "35" is demonstrated to be more resistant than family "13"; these differences not being confined to tuberculo-resistance but being demonstrable also in relation to the capacity for producing anti-sheep cell amboceptor and in the liability to anaphylactic shock.

These experiments cannot be overlooked in their relation to such fundamental questions as racial susceptibility to tuberculosis. But over and above all these complex problems of heredity stands the established fact that, under the influence of infection, an increasing power of resistance can be acquired by the individual; and that, as it can be acquired, so, under certain circumstances, can it be lost.

For the practical hygienist, these latter facts are of outstanding importance, because the variations in acquired resistance are known to depend to a considerable extent on environmental factors capable of modification. Amongst these factors, inadequate or unsuitable food, industrial fatigue, physiological stress and a low standard of living play an important part, as also faulty habits, such as alcoholic excess, to which, in its deleterious effect on the health of South African Natives, Mitchell[13] has called attention. It is obvious that these latter factors can only operate in a " tuberculized " population, since they do not cause tuberculosis but merely activate or aggravate existing lesions. As will be shown, however, later in the Report, the Native population of South Africa is already extensively infected and may be regarded as " tuberculized " in the sense of the term as above employed.

Much might be written in amplification of these general considerations as to tuberculosis, but an exhaustive examination of the subject would be out of place in what is merely an introduction to an intensive study of tuberculosis in the South African Native industrial worker.

For fuller details and bibliographies, the reader is referred to the standard works of Calmette,[14] Bushnell,[1] Ziemann,[15] Metchnikoff, Burnet and Tarassevitch,[16] Hamburger,[17] Cobbett,[87] and others ; and, in regard to the history of the theories of " inherited predisposition," tuberculous diathesis and dyscrasia to the excellent paper of Bullock and Greenwood[40] in which this side of the question is fully treated.

CHAPTER II.—ANTHROPOLOGICAL AND HISTORICAL NOTES ON THE BANTU TRIBES OF SOUTH AFRICA.

1. Anthropological Notes.

For anthropological data referring to the Bantu tribes of South Africa, the reader is referred to Appendix No. 1, by the late Dr. G. A. Turner. Here it will suffice to reiterate Dr. Turner's warning that the first impression of splendid physique gained on glancing at the dark-skinned and well-conditioned Kafir in the nude is apt to be misleading and that both in height, chest measurement and chest expansion, as well as in cranial capacity and weight of brain, the Bantus fall behind the Europeans.

They are described by Theal as follows: "Frame robust; hair crisp; colour, brown to deep black; weapons, assegai, knobkerrie, shield; in the northern tribes, battle-axe and bow-and-arrow; well-constituted system of tribal government; habitations, huts of thatch on a strong wooden framework; domestic animals, the ox, goat, sheep, dog, poultry; language, harmonious and musical."

While it may readily be conceded that the Kafirs are smaller in build than Europeans, it would be a mistake to suppose that they are inferior to the European races in physical endurance or, apart from their liability to certain bacterial and parasitic infection, in health. Under their natural conditions, the males are capable of tireless exertion in the pursuit of game and in military expeditions; and the women carry heavy weights and work long hours at the "stamping" of mealies and the preparation of food, without serious fatigue. In industry, too, the Bantu work long hours without intervals for rest or food and yet gain rather than lose weight.

Their mode of life under tribal conditions is, on the whole, calculated to provide health and happiness, and merits a short description at this point, although certain aspects of it will be dealt with in greater detail in the body of the Report.

Theal gives the following description of their housing arrangements: "The huts of the tribes along the coast were shaped like domes or beehives and were formed of strong frames thatched with reeds or grass.

Note.—"Bantu" includes all the Native tribes of South Africa except the Bushmen and the Hottentots of the western portion of the Cape Province.

"Kafir" (or Kaffir) is a term not so much used now as formerly. It applied to certain of the Bantu inhabitants of the eastern portion of the Cape Province, including the Xosa and Galeka, but had not an exact tribal limitation. Sometimes the term is employed even more loosely as meaning any Native.

"Coloured" person.—This term, as commonly used in South Africa, means a person of *mixed* descent, usually Eurafrican.

They were proof against rain or wind. The largest were about seven or eight metres in diameter and from two metres and a fifth to two metres and a half in height at the centre. They were entered by a low, narrow aperture, which was the only opening in the structure. A hard and smooth floor was made of ant-heaps mixed with oxen's blood and then kneaded with a round stone. When this had set, it was painted with a mixture of cow-dung and water, which was the material used afterwards for keeping it in good order. In the centre of the floor a fireplace was made by raising a band three or four centimetres in height and a metre or so in diameter and slightly hollowing the enclosed space. Against the wall of the hut were ranged various utensils in common use, the space around the fireplace being reserved for sleeping on. Here in the evening mats were spread upon which the inmates lay down to rest, each one's feet being towards the centre. Above their heads the roof was glossy with soot and vermin swarmed on every side. It was only in cold or stormy weather that huts were occupied during the day, for the people spent the greater portion of their waking hours in the open air." That things have not changed much may be inferred from the following note on some Tembu huts visited and described by Professor Cummins[25] during a tour in the Transkei in 1927 :—

" The kraal was a collection of tidy clay-and-wattle huts, each about 20 to 23 feet across in one of the kraals, but as small as 16 feet across in another. One type was fitted with a pointed roof, another with a convex roof ; both agreed in having no opening except a door, though considerable ventilation must take place through the thatched roof. There was a well " cow-dunged " floor and a central raised circle for a fire. There was no way of escape for the smoke except through the door and the roof, but it was stated that the fuel was lit in a bucket outside and then carried in red-hot, so that but few smoke fumes could arise inside. In the 16-foot hut only two persons were living, but the owner pronounced it suitable for ten. The under-surface of the roof was full of " stalactites " of smoke-soot but there was no heavy smell and the straw mats, neatly folded, took up little space. On the whole, taking into consideration that the inhabitants spend their day out of doors, and that the roof and, in certain types of hut, walls are permeable, I do not think these huts insanitary. While there may be some overcrowding at night, this does not seem common, and, though the fire-smoke may be irritant and the atmosphere stuffy for want of windows, every Native sleeps with his head covered and there is a fairly rapid exchange of air through roof and sometimes the walls without a draught."

Illustrations of huts, both completed and in process of construction, are given later in the Report (Plates XX—XXIV after p. 208).

An interesting account of a Bantu kraal is given by Junod[26] for the Thonga tribe in Portuguese East Africa and may be taken as applicable to tribal life amongst the Kafirs of South Africa. It is quoted here as a vivid pen picture of the kind of life which might, perhaps, be aimed at for the Natives by those responsible for their welfare.

"The Thonga village is not a haphazard agglomeration of people. It is a social organism with a well-defined constitution and is regulated by strict laws. After all, it is merely an enlarged family; the headman and the old people who have fallen to his charge, his wives, his younger brothers and their wives, his married sons, his unmarried sons and daughters. All these people form a community whose life is most interesting to study.

". . . From the oxen kraal to the huts, from the square to the little wood, through the doors and in the reed yards, black forms are moving to and fro. Everybody seems busy. There is talking, laughing, playing and working. The expression 'working like a nigger' is hardly applicable, for they do not kill themselves with work. It would, however, be quite as great a mistake to believe that the Natives spend all their time in loafing about. Far from it."

Domestic Life.

Polygamy prevails amongst the Bantu tribes, the number of wives depending largely upon the wealth of the male, since each wife has to be obtained through the payment of "lobola"* to the bride's parents. Amongst men of rank or outstanding wealth, a considerable number of wives may be kept, partly on account of the prestige which a large establishment commands. In the course of a recent visit to Portuguese East Africa by members of the Research Committee, a M'Chopi chief was found to be the happy owner of thirty wives, all housed in a large enclosure with a separate hut for each. But the poorer men have to be content with one or more wives, according to what they can afford.

The women do the domestic work, cooking the food, preparing beer and other fermented drinks, and keeping the floors of the huts clean by renewed smearing with cow-dung at short intervals, while the boys act as herds for the cattle and the men build and repair the huts, hunt in those districts where game still exists, and go for "contract periods" to work in the mines and other industries of the Union. It appears that the idea now prevails amongst the women that unless a man has "seen the world" or, in other words, done a period of work on the mines or in some other industry and returned with a supply of money, he is not a properly travelled and educated man; a salutary idea which helps the work of recruiting for the mines and tends to make the native territories richer and more prosperous.

Meals are usually served twice daily, the men and women eating separately. A light morning meal appears to be the rule, the substantial repast of the day being taken at sunset. Details of native diets will be given later in the Report (Part II, Chap. V); but it may be said that mealies (maize) form the basis of the day's "menu," being served "stamped" in the form of a crude flour, cooked in a stew with meat, oil, fat, vegetables or other constituents, or they may be eaten "on the cob"; served as "porridge," or as cakes; and, fermented into an acid and

* Lobola = bride-price. Traditionally paid in cattle.

slightly alcoholic drink, as "marewu." "Kafir corn" or millet (*Sorghum vulgare*) is also used for making flour and, after "sprouting," is used as the basis of the beer which is such a popular drink amongst the Bantu. This "Kafir beer" is regarded by them as both a food and a drink and appears to have valuable qualities as a source of certain of the vitamins. Monkey nuts (*Arachis hypogea*) are a favourite article of diet and are used also as a source of oil. The women are very clever at finding edible roots, fungi and other sources of vegetable food growing naturally around the kraals. Potatoes, sweet potatoes, manioc, rice and other vegetables are cultivated; and many leaves are used as spinach.

There are many varieties of wild fruit, employed both as food and as sources of fermented alcoholic beverages. In Portuguese East Africa the coco-nut palm, the pineapple and other imported plants bear fruit which is much used and greatly appreciated.

Cattle are seldom slaughtered for food, being too valuable as "capital," but are kept for use as "lobola" or for supplying milk. Any animal, however, that dies of disease or through accident is eaten; and goats and sheep are occasionally killed on ceremonial occasions. Game makes a welcome addition, if available, but is now so rare as to be almost unobtainable in the Transkei and Ciskei. Locusts are often eaten. Fish is popular in Portuguese East Africa but less so, it seems, in the Transkei. There are certain taboos which in some places forbid the eating of eggs except to the very young.

Milk is an important article of diet and is used as an acid drink called "amaas" or "amasi," a goatskin or calabash being kept outside the hut to which fresh milk is added daily. A little milk is always left in the skin or calabash to bring about acidification in the new milk which is added daily.

Unhappily, with the growth of population which has proceeded without any corresponding increase in the extent of the grazing grounds, the supply of this acidified milk, one of the most valuable constituents of the Native diet, is no longer adequate. In fact, it appears to be true that the Native diet is changing for the worse, partly through poverty and the restriction of grazing land in proportion to the excessive numbers of cattle, partly through the attempt to follow Western ideas in clothing and amusements, and partly through the facilities now available for the purchase of less nutritious but tasty and easily-prepared tinned and preserved foods. This deterioration is much less noticeable amongst the tribes residing in Portuguese East Africa, which is still a land of plenty, both from the ease of cultivation and the abundance of natural foods in the form of fruit, vegetables and game; but there seems reason to fear that, with the gradual approach towards European standards, the food is less nourishing than formerly in the Transkei and to a still greater extent in the crowded Ciskei.

Health Factors in Native Life.

Natives living under their primitive tribal conditions have no clue to the causes of disease and death, but they are not without theories to explain them.

Underlying these theories is the general belief in magic. When an acute disease supervenes in the course of a healthy life, it is usual to attribute this to the magical machinations of an enemy. The natural remedy is to seek out the causative agent, the "witch," and punish or destroy him. Death, too, is looked upon as an evil influence bringing danger to others along with it. Junod, speaking of the Thonga tribes, says: "Death is not only a sad event . . . but a dreadful contaminating power which puts all objects and people in the neighbourhood of the deceased, all his relations, even those dwelling far away . . . into a state of uncleanness." While the belief in magic as a cause of disease does not help in its prevention or cure, the idea as to the "contaminating power" of death appears to lead to customs of a very hygienic kind. Thus, the rugs and mats of the deceased are usually buried with him—an excellent way of getting rid of articles which are perhaps contaminated and capable of infecting others.

Again, the death of the headman of a village usually leads to the destruction of his hut; thus getting rid of a possible source of infection. Further, if the deaths go on occurring, the "divinatory bones" may be consulted and, as a result, the whole village deserted as if it were defiled and dangerous. The facility for cheap and easy construction of houses from simple materials makes these elementary measures of sanitation easy to carry out; and the destruction of the huts of persons dying of disease must help to cope with infectious maladies and must be especially valuable in the case of death from tuberculosis.

Even the huts built by the deceased for his wives are looked upon as contaminated after his death, at least for a time, and Junod describes how "all the widows sleep in the open, their huts, which belonged to the deceased, being taboo. If it rains they sleep in the other huts of the village." This prodigality in the construction or, when desired, the destruction of huts is, or should be, a factor of safety in the prevention of overcrowding. It is the custom for each wife of the headman of a kraal to be given a hut to herself; a sanitary as well as a prudent arrangement.

It appears likely that, in those districts where a hut tax is now claimed from the Natives, the latter appreciate the fact that each hut adds to the expense and therefore cut down the number of huts, making more of the unmarried members of the family sleep in each. This is an instance in which a valuable Native custom calculated to mitigate the spread of disease by the prevention of overcrowding may be lost under the regulations arising from contact with "civilization."

Again, the periodical renewing of the floor surface by cleaning out with cow-dung and ashes is a valuable measure, not only against vermin, but against bacteria.

It is also the custom amongst Natives, while in their huts, to spit into a little heap of sand or earth which is removed daily and disposed of outside the dwelling. This custom must help to limit the spread of tuberculosis.

Another valuable custom, to which the attention of members of the Committee was called, especially in Portuguese East Africa, is the custom of building a separate hut of a "temporary" kind for the accommodation of persons suffering from chronic wasting diseases like tuberculosis. It seems to be true that the patient, thus isolated, is liable to be neglected and may not get much food, the prevailing idea being that it is kinder to let him die; but while hard on the individual, the measure is doubtless a valuable one in the protection of the community from infection. This custom, however, is rapidly dying out in the face of European standards of conduct.

Another habit which, while it appears "stuffy" to Europeans, may be of some value in limiting the spread of respiratory infections is that of covering up the face and head with a fold of the blanket while sleeping. This habit is certainly to be encouraged where several individuals are sleeping round the fire in a native hut. It may, however, be risky instead of salutary if individuals exchange their blankets; an occurrence which is said to be unusual.

Much might be written about the witch doctors and their methods; but although many persons well acquainted with native customs hold that these magicians possess some interesting secrets and have a great knowledge of the properties of herbs in the treatment of disease, their methods have more interest for the therapeutist than for the sanitarian and need not be considered in this summary.

2. HISTORICAL NOTES.

The facts brought forward in Chapter I. will serve to show that their past history may have a bearing upon the present health conditions of the South African Natives.

Theal[18] gives the following account of the distribution of Native tribes towards the close of the fifteenth century, when Europeans first had communications with the Natives of South Africa :— see Map facing p. 184.

"The belt of land comprising the lowest and the second terrace along the western coast, from about Cape Cross southward to the Cape of Good Hope and thence eastward to the Bashee River, was occupied, though thinly, by Hottentot tribes. The same people were to be found along the lower courses of the Vaal and Modder Rivers and along the banks of the Orange from the junction of the Vaal to the sea.

"The Bantu, at that time, occupied the choicest part of the country north of a straight line from Cape Cross to Port Natal* and extended south of that line into the territory now known as Basutoland and also along the eastern coast as far as the Bashee River. They were not to be found in the remaining portions of South Africa.

"Bushmen roamed over the entire country south of the Zambesi from sea to sea and were the only inhabitants of the rugged mountains and arid plains between the Hottentot and Bantu borders. As they could hold their own fairly well against the Hottentots they were more numerous along the western and southern coasts than along the eastern, where the Bantu had better means of exterminating them."

*i.e. from about half-way up the coast of S.W. Africa to Durban.

Of these three races, only the Bantu need consideration to-day. The Bushmen and Hottentots lacked the ability to retain their tribal entities under the stress of contact with European settlers in the south and east and Bantu aggressors from the north. Apart from a few remote clans still surviving in the less accessible parts of the Kalahari Desert and South-West Africa, their blood persists only in the Coloured population of the Cape, the descendants of mixed mating between their females and European, Bantu, Malay, Indian and other immigrants. The cranial capacity of the three Native races of South Africa, as calculated by Professor Flower, was found to be as follows :—Bushmen, 1,288c.c. ; Hottentot, 1,407c.c., and Bantu, 1,485c.c., the average capacity for Europeans being 1,497c.c. It is interesting to note that only the Bantu, with their close approximation to the cranial capacity of the European, have succeeded in surviving, and even increasing considerably in number, through the critical years of early contact with Europeans and entry into industrial pursuits.

Although the Bantu tribes do not constitute a definite ethnological group, the very name, Bantu, signifying merely " people," they possess many characters in common and represent a far higher type than their predecessors on South African soil; a type well calculated to prevail, as indeed it did prevail, when pitted against opponents of an earlier culture.

In the words of MacMillan,[19] " by the eighteenth century the Bantu were firmly established as the only effective occupants of territory stretching from far away in the north down at least to the Kei. In the course of their expansion they displaced, and doubtless slew, the Bushmen and either expelled or absorbed the Hottentots."

As the whole of the Native industrial population to-day, except for the " Coloured " industrials of the Cape, consists of Bantu, the history of these tribes, so far as it is known, is worthy of attention in connexion with the tuberculosis problem in South Africa ; and more especially their history of " contact " with the outside world. But, while accurate information on this point is needed, it must be admitted that very little exists. In tribes without a script, tradition takes the place of written record ; and tradition, especially in the case of peoples of a semi-nomadic type, tends to be vague and unreliable. Extensive relics of ancient gold mining and interesting ruins of buildings constructed of dressed stone, such as the great Zimbabwe, suggest that a much higher standard of technical skill and a demand for gold and other metals far in excess of the simple needs of the Bantu of to-day, must have existed in South Africa in former times. With these relics as a basis for speculation, many theories have been formulated as to contact with ancient civilization from overseas. Thus, Dr. Carl Peters[20] did not hesitate to identify the old gold mining area inland from the east coast, between the Sabi and Zambesi Rivers, with the land of Punt from which the Egyptians of 1500 B.C., and earlier, obtained supplies of gold. The tri-literal root A F R occurring in such names as " Africa," Mount " Fura " and others was, for Dr. Peters, a survival of the word Ophir ; the land of gold from which Solomon obtained his supplies. The

evidence adduced by Dr. Peters is interesting but hardly conclusive; and it must be admitted that, while Egyptian, Greek, Roman and Jewish stories and traditions hint at a vague knowledge of the east coast of Africa, some of these tales may just as well have referred to the much more accessible countries of Abyssinia and the mountainous districts along its northern and western borders where alluvial gold is still to be found in considerable quantities.

Theal,[21] without attempting to draw such definite conclusions as Dr. Carl Peters, still finds the evidence sufficient to justify the following statement, with which many will agree :—

"At some unknown period in the past, people more civilized than the Bantu, but still far from reaching the level of modern Europeans, made their appearance on the central table-land of Africa south of the Zambesi. They were almost certainly Asiatics, and they must have come down in vessels to some part of the coast and then gone inland, for no traces of them have been found to the north. They constructed buildings of dressed stone without cement or mortar . . . and they were gold miners on a very extensive scale. Their abandoned mines—often of considerable size—are found throughout a vast extent of territory, so they must not only have been numerous but must have occupied the country a very long time."

Recent investigations by Miss Caton Thompson lead her to bring the date of the great Zimbabwe down to mediaeval times, and she finds evidence, in the absence of all but Bantu implements, suggestive that the buildings were the work of these tribes themselves.

Whatever may be the truth about Zimbabwe, one thing is certain—that "over a vast extent of territory," as Theal says, there must have been contact between the Bantu tribes and more civilized immigrants from overseas.

Passing on from the period of archæological speculation to historical records, it is known, from the voyage of Vasco da Gama in 1497 that Natives, almost certainly Hottentots, were encountered at St. Helena Bay on the west coast; that a different type of Natives, evidently Bantu, were met with on the Limpopo; that Arabic speech and traces of Indian culture existed at Quilemane, called by da Gama the "Rio dos Bons Sinaes" on that account; and that Arabs with trading vessels and in some places stone buildings, were found as masters of coastal settlements at Mozambique, Sofala, Mombasa, Malindi and Kilwa.

From these records it is clear that, up to 1497, sea-going Arabs, already mixed in blood with the Bantu, yet dominating them and employing them as slaves and as soldiers, had long been the masters of the east coast and its islands and that they traded to India, Persia and perhaps to Eastern Europe and North Africa the slaves and the gold so readily obtainable inland. This brings into the realm of certainty a prolonged and fairly intimate contact of the coastal Bantu tribes with the civilizations of North Africa and Asia prior to the end of the fifteenth century; a contact that must almost certainly have brought with it some degree of exposure to tuberculous infection. Nor was

the risk of exposure confined to the coast, since there must have been slave-trading centres and posts in the interior.

From that time onwards, Portuguese settlements began to appear and the Arab power to wane; so that now it was a question of coastal contact with Europeans and the steady and increasing penetration of soldiers, traders and missionaries from the coast between Delagoa Bay and Mozambique into the interior. With the arrival of Dutch colonists at the Cape in 1652, a new growing point of European penetration was formed, but this at first affected only the Hottentots and Bushmen. It was not for another hundred years that the colonists came into serious touch with the "Kafirs," as the Bantu came to be called; the name being adopted from the Arabs and signifying "Unbelievers."

The earliest recorded conflict between white colonists and Kafirs, according to MacMillan, was in 1702, when a cattle-bartering expedition in the time of the younger Van der Stel had a serious skirmish with Kafirs three or four days west of the Gamtoos River, but it was not until 70 years later that this new racial factor was taken into official cognizance by the Government when, at the time of the first Kafir War, the Fish River was selected as a dividing line between the advancing colonists and the Bantu tribes. From the earliest years of the nineteenth century and onwards, the Ciskei and, later, the Transkei, was the scene of a steadily increasing penetration amongst the Bantu by British, Dutch, French and other missionaries and soldiers, farmers and magistrates, so that the partial isolation of the Bantu tribes in that area gave place to an increasing degree of "contact," a gradual modification of tribal habits and customs, the discarding of old beliefs and old disciplines for the new wine of Christianity, loss of land, subjection to taxation, and the resultant creation of a need for money and an obligation to work.

It is clear, then, that along the coast, at least, and probably also in the ancient gold-mining area of the interior and the routes connecting it with the coast, there must have been opportunities for "contact" between some of the Bantu peoples and aliens from overseas. It is certain, too, that these aliens, whether Egyptians, Phoenicians, Indians or merely Arabs, were derived from races in which large urban communities had reached a stage of civilization in which the gold, ivory, slaves and other products of the East African coast found a ready market; in other words, a stage at which luxury must have prevailed amongst the rich and overcrowding amongst the poor.

These are the conditions in which tuberculosis inevitably prevails and, in fact, we know from the pathological investigations on mummies carried out by Professor Elliot Smith and the late Dr. Armand Ruffer, that tuberculosis did exist in Egypt in dynastic times.

It is safe to assume, then, that certain elements of the Bantu peoples must have been in occasional contact with the germ of this disease brought by cases and "carriers" from the great towns of Asia, North Africa and, perhaps, Eastern Europe, during historic times and probably for long centuries of the unknown past.

Once the Portuguese arrived, the efforts of Christian missionaries to instruct and convert the Natives must have led to a still more formidable kind of contact. Slave-raiders and gold-traders are said to have been in the habit of killing all those members of a kraal too old to be carried off as slaves, and we may assume that the raiders had, themselves, been subjected to a very rigid selection during their long voyages and hardships, calculated to eliminate all except the healthy and robust. In these circumstances, the possibilities of transmission of tubercle bacilli to the Natives, though real, must have been very slight. But missionaries aim at settling among the Natives and getting into the closest possible touch with them by means of schools, churches, visits and so forth ; and the missionary sticks to his post whether his health is good or bad—a form of devotion which may possibly have effects upon the temporal welfare of his flock. It will be conceded that the aggregation of Natives around mission stations and the resultant "contact" established with devoted persons from infected countries is more likely to break down the bacteriological isolation of primitive tribes than the devastating arrival and withdrawal of slave-raiding expeditions. All this "contact" along the coast of Africa was supplemented by the arrival in Cape Colony of Dutch, Huguenot and British settlers with their missionaries, soldiers and traders. And a formidable kind of exposure to tuberculosis was still to come when the improvement in ocean travel and the growing reputation of the South African climate led physicians in Europe to advise their consumptive patients to try a sea voyage and a period of residence in the sunny air of the Cape.

It would be rash, therefore, to assume that, even in remote times, the coastal tribes of Bantu were free from tuberculosis ; and it may be taken as certain that the disease was frequently introduced among them from the sixteenth century onwards, and probably long before.

But there is another side to the question. To what extent do the present-day Bantu of South Africa represent the Bantu tribes with whom the Arabs came in contact ? It must not be assumed that the Bantu tribes in ancient contact with the Arabs had any considerable dealings with the Bantu that later on made their way into the territories now constituting the Union of South Africa. According to Theal, "the territory of Sofala was occupied by Bantu in the ninth century of our era, but how far south that territory extended cannot be ascertained with precision. It is certain, however, that it did not pass the Sabi River and beyond it the only inhabitants were Bushmen. Westward its limit was short of the Mashonaland of our day, for down to much more recent times Bushmen alone occupied the border. Whether the tribe mentioned by Masoudi was the modern Karanga is uncertain, though in all probability it was. . . . There is no other tribe in South Africa which has so many individuals bearing traces of Arab, Persian and Indian blood as the Makaranga, which is due to the long continuance of Asiatic intercourse with them in past times."

Further on, Theal speaks of the "first billow* of Bantu invaders that rolled over the continent from the north-west to the south-east and that subsided on the shore of the Indian Sea between the Sabi River and Delagoa Bay. What set that billow in motion, what havoc it wrought on its way, what time it took on its course, are all among the unknown particulars of the past. Nothing more can be said with certainty than that the Batonga of the Zambesi Valley and of the eastern coast arrived there some time during the fifteenth century. When the ancestors of the Xosa, Tembus and Pondos reached the sea, the coast to the north was already occupied by the Batonga, so they turned to the south and entered the territory now known as Natal." Even as late as 1852, Döhne found a small section of the Amaxosa still living in Natal.

The movements of tribes consequent upon the Zulu military exploits of Chaka and Mzilikazi in the early years of the nineteenth century carried the "billows" of Bantu penetration further still, until they broke against the advancing wall of Cape Colony settlers on the south-east and encountered the Dutch voortrekkers north of the Vaal.

The picture, then, is not one of static contact with coastal Arabs and Portuguese, but of a long series of tribal movements accompanied by all the stress and hardship of war and travel and stern selection by survival of the fittest. Woe to the old, the infirm and the infected under the conditions of such a journey. The merciful custom of the tribes was to desert the old and the fatally ill and leave them in the bush to die; and, as Theal says, "all the weaklings were destroyed in infancy." In these circumstances, a debilitating disease like tuberculosis was unlikely to flourish or to spread. Even the rapidly contagious smallpox, which decimated the already stationary Hottentots and some of the Tembu tribe between the Kei and the Bashee Rivers, failed to infect the fighting tribes. "The state of constant warfare in which these people lived" preserved them from the fate which had overtaken their neighbours.

It is difficult to imagine that cases of tuberculosis, even if such occurred sporadically from time to time, could have spread any more easily than does avian tuberculosis amongst wild birds or bovine tuberculosis amongst wild game. Occasional instances might occur, just as in game a recent example has been noted amongst kudu in the Cape Province; but the forced marches and the desertion of the infirm were calculated to kill off the weaklings and clear the tribe of infected persons.

There is, in fact, little or no evidence that tuberculosis was prevalent amongst the Bantu when they were first encountered by the white races. Lichtenstein[22] encountered none in 1803-1806 and reports the absence of "cough, chronic disease and syphilis" amongst the Kafirs. *Livingstone,[23] in 1857, stated that "tuberculosis did not exist"*

*Professor MacMillan thinks it possible that the "billows" of tribal movement may perhaps have been exaggerated and that the slow movement southwards may have been connected with intensive slave raiding to the north.

amongst the tribes of the interior with whom he was working. Theal speaks as follows : " Consumption, another fell disease that has worked havoc among many barbarous nations, was almost unknown in South Africa until recent years."

The carefully-weighed and cautious opinions of Macvicar,[27] of Lovedale, in describing his experiences in British Central Africa from 1894 to 1900, are worth quoting in relation to the apparent absence of tuberculosis in parts of Africa remote from coastal contact with the Whites. " During the four years I was in charge of the medical work at the Blantyre Mission in the Shire Highlands," he writes, " I saw not a single case of any form of tuberculosis among the people living in the hill country. . . . I confess that during these years I often wondered whether I could possibly be overlooking evidence of the disease, and I feel still that one should be very diffident in asserting a negative proposition of so sweeping a kind as that tuberculosis was absent from any locality. Yet the facts are that for four years I was in close touch with the people, seeing them daily in the dispensary and often visiting them in their villages, and though I was on the outlook for tuberculosis I did not see a single case."

He quotes letters from medical men showing that it was very rare or unknown in Southern Rhodesia, Bechuanaland, Basutoland and the Transvaal as recently as the early years of the nineteenth century and also, prior to the arrival of Europeans, among the Bantu tribes of Cape Colony. All this, however, had changed long before he started work at Lovedale, and he produces evidence of the increase of the disease in the Ciskei and Transkei in recent years.

On the other hand, it appears to have helped in the elimination of the Hottentots, amongst whom it was reported by J. W. D. Moodie,[24] in 1820, to be very prevalent. None of the evidence is conclusive. In tribes cut off from the observation of trained physicians and living a life in which medical science has played no part, the presence or absence of tuberculosis can neither be asserted nor denied.

All that can be stated with certainty is that good observers, such as Livingstone and, later, Macvicar, with a special bent towards detecting the troubles of the Natives in order to relieve them, failed to notice cases amongst the tribes with which they were associated ; that the conditions of life of these warrior communities were not such as to facilitate the survival of cases and the spread of infection ; and that the behaviour of the present-day Bantu when infected with tuberculosis and exposed to physiological stress is not that which has come to be regarded as characteristic of the adult descendants of long generations of a tuberculized stock.

It looks as if the disease had only become prevalent in the Bantu tribes after they had settled down in fixed territories in contact with the " tuberculized " White races and had started on their present mode of life. As to the increase of tuberculosis among them during the last century, this subject will be discussed in the next Chapter.

CHAPTER III.—REPORTS ON THE TUBERCULOSIS OF SOUTH AFRICAN NATIVES PRIOR TO THE PRESENT ENQUIRY.

1. Individual and Non-official Reports on Tuberculosis.

While, as shown in the last Chapter, little or nothing is known as to the existence of tuberculosis amongst the Bantu tribes prior to their contact with the White races, and while there is considerable reason to think that the disease was either very rare or entirely unknown amongst them under their primitive conditions, the infection had already taken a firm hold amongst them in the first half of the nineteenth century, at least in those places where the existence of military, trading, missionary and other centres ensured close touch of Europeans with the Natives on the one hand and efficient means of recognizing tuberculosis on the other. Writing in 1908, Dr. Macvicar[27] quotes his predecessor, Dr. Stewart, of Lovedale, as follows: "Consumption was common in this district (Victoria East) 40 years ago," and he cites a letter from Dr. Girdwood, of Butterworth (1907), to the effect that when he came among the Kafirs in 1868, he saw "a good few cases of tuberculosis." In January, 1881, Dr. Nankevill, District Surgeon at Butterworth, mentions that out of 285 patients attended by him there were "eight cases of phthisis, three of scrofula and one of acute miliary tuberculosis." Sir William Bissett Berry is also quoted by Macvicar as saying, "When I came out in 1864 to Queen's Town, amongst my earliest patients were phthisical natives from the Mission Station of Lesseyton near Queen's Town."

Tuberculosis, including all forms of the disease, was made notifiable throughout Cape Colony in 1904, and "pulmonary tuberculosis" was scheduled as a notifiable disease in Natal in the same year.

To Dr. Gregory, the Medical Officer of Health of Cape Colony, belongs, perhaps, the credit for first calling public attention to the ravages of this disease. From 1895 onwards, basing his observations on the figures which became available after the registration of deaths had been made compulsory, he continued to refer to the spread of tuberculosis in his annual reports. "Of all the diseases attacking the Native and Coloured," he writes,[28] "tuberculosis is by far the most important and it is once more my duty to call attention to the ravages of the population it is causing, and to the extreme importance of taking public measures to restrain its further spread in South Africa."

In November, 1906, a conference of the Principal Medical Officers of Health of all the British South African Colonies and Territories, meeting at Cape Town, reported:—

"All the representatives at the Conference are unanimous in the opinion as to the gravity of the matter and, especially, as to the danger threatening the Native and Coloured races from the extension of tuberculosis . . . and there would appear to be no reason to doubt that the disease is steadily and, in many places, rapidly increasing."

Against this formidable spread of tuberculosis amongst the Natives was to be set, in sharp contrast, the relatively low incidence and mortality from the disease amongst Europeans in South Africa. The average tuberculosis mortality for the 35 chief cities and towns of the Colony for the three years 1903, 1904 and 1905 was estimated by Macvicar to be only 1·48 per 1,000, as compared to an average for the same years amongst Natives and Coloured of 7·20 per 1,000.

Further, the tuberculosis mortality for Europeans above given, low as compared to that in the Natives, was probably an over-estimate so far as the Colony itself was concerned.

Writing on this subject in 1896, Gregory[29] says: "Moreover, the death-rate among Europeans does not legitimately belong to our own population, much of it being due to deaths of phthisical persons coming to the country for relief from the disease. This fact becomes still more evident if the death-rates for the several towns of the Colony are examined separately; for it is chiefly among those that we know to be usually selected for residence by the phthisical immigrant that the bulk of the mortality among Europeans occurs. Thus, the European death-rate from tuberculosis is in Cradock 6·24, in Beaufort West 7·86, and in Aliwal North 6·21 per 1,000." Mention has already been made of the bearing of this immigration of phthisical persons into South Africa upon the infection of the Natives (p. 35), but it must not be regarded as the chief or the earliest source of the disease.

Macvicar, referring to this point, says: "The stream of phthisical immigrants during recent years may, and very likely has, contributed to the spread of the disease, but it has not been its main source. . . . The Coloured people in many parts, at least of the Cape Colony, were suffering from tuberculosis previous to this time—about 1880, as far as I can learn—when consumptive patients began to arrive in numbers from Europe. I think, therefore, that if the White race is responsible for the introduction of tuberculosis among the Coloured people, the disease must have been largely introduced before the time when South Africa became widely recognized as a health resort."

This sounds to be good reasoning. There had been European settlers on the south and south-east coastal areas of Africa for over two hundred years before 1880, and these settlers must have had their consumptives, their chronic cases and their "carriers" from whom infection might spread through contact with servants, through the giving-out of laundry, through presents of discarded clothes, through sputum, and in the contact established in schools, churches and educational and trading establishments of all kinds.

But, although common amongst the Natives and the Coloured persons residing close to the areas with the largest European populations, the disease showed two characters suggestive of recent introduction. On the one hand, it was observed to be *increasing* near these populous centres and it was still rare in districts more remote from the Whites and with a more scattered population. Macvicar, whose classical thesis on "Tuberculosis among the South African Natives" was written

in 1907 at an appropriate moment for gathering together the views of experienced physicians still living and who had worked in the Colony during the latter half of the nineteenth century, testifies to the "increase of tuberculosis during recent years"; *e.g.*, Dr. Darley-Hartley *began practice in East London, 1879, and had a considerable* practice among both Europeans and Natives. For a number of years he does not remember to have seen any case of tuberculosis except imported cases (European). Dr. H. T. Bachelor, of Queenstown, after an experience of 25 years, has no hesitation in saying that the disease is getting increasingly common. Dr. H. Becker, of Grahamstown, writes: "When I arrived in the Eastern Province as District Surgeon of Bathurst and Alexandria combined, in 1870, there were very few cases of tuberculosis among the Natives. The Kafirs and Fingoes were then a race proof against the disease. During my district surgency of four years I do not remember a single case of tuberculosis among these people. It was different with the mixed races . . . tuberculosis was frequent among them."

Macvicar, discussing the Bantu tribes, reports in 1907 that "the Bechuana, including the Basuto, are still in most places comparatively free from the disease. Fifty years ago Livingstone found that the Bechuana among whom he lived and travelled were free from tuberculosis. . . . It seems almost certain that less than a century ago the Bechuana race was entirely free from tuberculosis. It is quite certain that during recent years the disease has been spreading among them and is now found where formerly it was absent."

Speaking of the Kafir-Zulu tribes, he writes:—

"Among certain of the tribes tuberculosis has been known for at least two generations. These include the Kafir tribes known as the Xosa and Galekas, the Fingoes and certain of the Zulus. On the other hand, certain other sections, as the Swazis and Zulus of the Wakkerstroom district of the Transvaal and the Zulus of the Vryheid district of Natal, are reported to be still free from the disease, except for occasional imported cases. . . . The most probable explanation . . . of this unequal distribution, a distribution so unlike what is met with in countries where tuberculosis has been known for centuries, is that the whole race was originally free from tuberculosis."

He believes, supporting his opinion by quotations from such authorities on the Bantu languages as Dr. Soga, that the Kafir tongue possesses no word for tuberculosis; strong evidence that the disease itself was unrecognized in ancient times.

For a précis of the opinions of district surgeons and other doctors as to the prevalence of tuberculosis among the Bantu, Macvicar's article, p. 12, should be consulted.

Dr. Grant Millar, District Surgeon and Justice of the Peace at Flagstaff, Pondoland, a district annexed to Cape Colony in 1894, writes[30] in 1908 as to the rapid extension of the disease amongst the Pondos as the result of infected mine boys returning from Johannesburg. "No one," he says, "who has lived in this country and seen nearly a

whole hut of Natives contract the disease one after the other could possibly have any doubt as to the infectiousness of tuberculosis. . . . Time and again, one Native returned from the mines infects almost the entire occupants of a hut previously quite healthy. . . . Nor is the spread of the disease confined to one hut or even one kraal, because it is the custom among the Natives to crowd together in the different stores, where they frequently spend half a day chatting and idling—and invariably spitting."

Macvicar, who gives a carefully traced series of 27 instances known to him suggesting the spread of tuberculosis in families, is not by any means so dogmatic about the rapid extension of the disease in the huts and kraals as is Dr. Grant Millar. He draws a clear contrast between the "slow spread by ordinary intercourse" and the "more rapid spread where there is extraordinary intercourse." With regard to the slow spread by ordinary intercourse, he writes :—

"Some of these (family) histories are bad enough and yet it seems to me that they contain an element of hope for the Bantu people. In spite of conditions that seem to be favourable to its spread, the tubercular infection, when introduced into a family, does not as a rule spread rapidly from person to person. In some families, while some members suffer, others escape, regardless, it would almost seem, of age. And in those who are attacked the period of incubation is often long—two years or even longer."

G. A. Turner,[31] writing of Portuguese East Africa, after a visit to investigate tuberculosis amongst the Natives, says, in 1906, that "it is a disease which is *certainly not* being spread throughout the country by labourers returning to the East Coast from the mines." Nor is he impressed, like Dr. Grant Millar, with the urgency of the hut infection by sputum. "As regards pulmonary tuberculosis," he writes, "certain cases are isolated in the bush by the Native doctors and are not permitted to enter the kraals proper." Again, "the attendants on a patient who, for some reason, has not been isolated in the bush, are careful in many cases to remove the sand of the floor on which the patient has been spitting, within a few minutes of it being contaminated, not only outside the hut but outside the kraal."

Probably these marked differences of opinion are due to the higher standards of cleanliness which appear to obtain among the M'Chopi and M'Shangaan tribes of Portuguese East Africa as compared to the Pondos. Great weight must be attached to the moderate and cautious yet convincing statement of Macvicar as to the relatively slow spread of the disease amongst the Natives "by ordinary intercourse."

Turning to the consideration of "the more rapid spread where there is extraordinary intercourse," he writes : "The presence of the White race in South Africa has brought the Native races into contact with one another in a greater degree than could have followed even the most violent of tribal disturbances in the old time. Missions, schools, railways, prisons, seaports and, above all, the mines, have brought Natives together in a way that has undoubtedly facilitated greatly the spread of tuberculosis."

The words of Macvicar " and, above all, the mines," should be noted. In spite of the views expressed by Dr. Turner, it is evidence that many experienced medical men were impressed, about this time, with the danger to the Native kraals from this source.

Dr. Macaulay,[32] waiting upon the Commissioner of Mines as a member of a deputation in 1906, says : " It is quite apparent to us from statistics which we have been able to gather, that tuberculosis has enormously increased on these fields, not only amongst the Whites, but largely amongst the Natives, and we feel that it is necessary that some provision should be made in the law to prevent the spread of the disease."

To the question of tuberculosis on the mines, however, attention will be given later, and this part of the summary is intended to deal rather with the disease amongst South African Natives as such than with occupational conditions and risks.

A suggestive paper by Maynard[33] in 1912, while treating chiefly of the general question of heredity in tuberculosis, to the " inherited disposition " theory of which the author gives his support, makes some interesting references to tuberculosis in Bantu races. " It does not follow," he writes, " of necessity that because tuberculosis runs a more rapid course in an adult Native than in a European of similar age that the Native constitution is therefore more susceptible to the disease. The European may and probably has been infected in childhood and has therefore acquired a partial immunity ; while the Native may not have had any previous chance of acquiring immunity."

Maynard went further and attempted to compare the degree of " tuberculization " as between " new " boys* arriving at the Rand from Nyassa and Mozambique, and " old " boys, that is to say boys with previous mine service from the same territories. To this end he employed Calmette's ophthalmo-reaction, a form of tuberculin test attracting attention at that time. The result was extremely interesting. Whereas in healthy European adults Calmette had recorded 18 per cent. of positive reactions, as compared with 92 per cent. in tuberculous patients, Maynard found only 2·4 per cent. of " positives " in 544 " new " boys, but 18 per cent. " positives," exactly Calmette's figure for healthy European adults, in the 115 " old " boys tested. Moreover, in 131 " tropical " boys returning home after one contract period of work in Johannesburg, he found that 19·8 per cent. reacted positively to the ophthalmic test. These observations suggested strongly that a large proportion of these highly susceptible " tropical " Natives arrived at the Rand free from any considerable contact with tuberculosis prior to their engagement.

At this point it is necessary to return to Macvicar's thesis, already freely quoted, since it constitutes by far the most important of the earlier contributions to this subject. Macvicar illustrates in his Tables III and IV, which should be consulted in the original, the inequality

* " Boy " as used here and as occurring frequently throughout this Report, has no implication of youthfulness. The word is used as it is employed colloquially, meaning merely a male Native of any age.

of the distribution of tuberculosis at that time, between the still largely "tribalized" Bantu communities and the urbanized Coloured population. He analyzed the mortality statistics of 35 towns in two groups, those lying east of a vertical line drawn on the map passing immediately to the east of Cradock, on the one hand, and those lying west of that line on the other. This line "coincides closely with the western limit of the great Bantu population of the Colony." And it is interesting to note that the average tuberculosis mortality to the west of the line is 6·69 per 1,000, that to the east of it 3·50 per 1,000.

He finds, too, that tuberculosis had led to a much higher mortality in towns having a Coloured population greatly exceeding the Bantu population than in towns where the Bantu population greatly outnumbered the Coloured.

In order to give a clear idea of the much greater death-rates amongst the Native and Coloured populations as compared with the European populations of the Cape at that time, Tables I and II of Macvicar's thesis are reproduced on the following page.

As to measures for dealing with the tuberculosis problem, Macvicar indicates two main lines along which action might be directed: "first, to do everything possible to prevent the further spread of the disease and, second, to improve the social condition of the people concerned." He is against compulsory segregation of tuberculosis patients, seeing clearly that there would be "great difficulty in carrying out such a system"; but he favours legislation which might "lead to a reduction of overcrowding and to the inspection and disinfection, where necessary, of premises used by employers of labour for their workmen." His experience having shown him that cases generally improve "in the open air on the verandah day and night, and with a liberal diet," he is in favour of sanatoria but realizes the difficulty of making such institutions popular amongst the Natives. "It would be quite possible, for example, to spend large sums of money upon consumptive sanatoria for Natives only to find in the end that for some unexpected reason the whole system was a failure. . . . The wisest course would be to begin the sanatorium treatment of Native phthisical cases in a tentative and experimental way in connection with hospitals which have already secured the confidence of the Natives and then, when a good working system has been found, to extend it as rapidly as possible." He realizes and calls attention to the difficulty and expense of suitably staffing such institutions. "It is truly said that Native sanatoria need not be provided with expensive buildings; tents, even, would do well." But "without skilled attendance, good results could not be hoped for." He has no use for the system of providing unskilled Natives to assist White nurses. Expense must be faced; a resident European medical superintendent is necessary; with the added cost of European nursing unless and until the real remedy be found, *i.e.*, "the employment of *thoroughly trained* Native nurses and orderlies." The treatment, too, should, he suggests, be given free to advanced cases, since the accommodation is not only in the interest of the sick Native but "chiefly for the sake of protecting others."

COMPARISON OF EUROPEAN WITH COLOURED AND BANTU DEATH-RATES FROM TUBERCULOSIS IN CAPE COLONY TOWNS (MACVICAR, 1908).

Town.	TABLE I.					TABLE II.				
	Estimated European Population Middle of 1904, Census, April, 1904.	European Death-rate from Tuberculosis per 1,000 of Population.				Estimated Coloured and Bantu Population, Middle of 1904, Census April, 1904.	Coloured and Bantu Death-rate from Tuberculosis per 1,000 of Population.			
		1903.	1904.	1904.	Average of the 3 years.		1903.	1904.	1905.	Average of the 3 years.
Cape Town	44,677	1·56	1·81	1·32	1·56	33,631	8·52	6·33	6·73	7·19
Six Suburban Municipalities	53,602	1·80	1·47	1·14	1·47	31,523	8·91	5·90	5 46	6·75
Green Point and Sea Point ...	7,654	·57	·91	·77	·75	1,380	3 03	4 35	2·17	3·18
Simonstown, etc.	7,076	1·06	1·70	·85	1 20	3,318	5·63	4·82	5·97	5·47
Kimberley	13,574	2·30	2·50	1·81	2·20	20,878	7 52	6·85	8·03	7·46
Beaconsfield	2,770	·70	1·44	·34	·82	10,990	15 04	5 19	6·82	9·05
Port Elizabeth	22,201	1·55	1·17	1·02	1·24	6,594	8·70	9·71	9·84	9·41
East London	14,995	·87	·80	1·14	93	10,872	3·42	4·05	3·69	3·72
Grahamstown	7,336	1·26	1·23	·94	1·14	6,662	8·39	7·51	7·88	7·92
Uitenhage	6,777	·47	1·48	1·32	1 09	5,612	12·63	9·09	9·93	10·55
Paarl	5,090	·82	·59	·58	·66	6,289	5·86	6·84	4·25	5·65
Graaff-Reinet	4,083	·76	1·22	2·17	1·38	6,105	6·55	7·86	6·99	7 13
Kingwilliamstown	5,919	1·89	1·18	·83	1·30	3,639	2·56	5·77	6·47	4·93
Queenstown	4,209	3·75	3·09	2·59	3·14	5,570	3·31	3·41	4 26	3·66
Oudtshoorn	4,196	3·50	2·14	1·41	2 35	4,773	9 55	10 47	8·85	9·62
Worcester	3,626	·86	1·10	1·09	1·01	4,318	9·21	8·80	7·18	8·39
Cradock	3,087	3·38	3·24	2·58	3 06	4,760	5·27	6·93	6·71	6·30
Beaufort West	2,231	8 88	6·28	3·96	6 37	3,319	18·55	14·16	10·25	14·32
Aliwal North	1,779	2·95	2·25	2 23	2·47	3,900	3·10	2·05	4·22	3·12
Somerset East	1,866	1·12	1·07	1·05	1·08	3,410	4 92	8 80	12·22	8·64
Stellenbosch	2,530	·00	·39	1·09	·52	2,478	4 98	10 09	8·40	7·79
Wellington	2,437	·43	1·64	·82	·96	2,499	7·09	3·60	4·76	5·15
Mossel Bay	1,676	3·13	·60	2·36	2·03	2,588	6 98	9·27	7·29	7·84
Malmesbury	1,988	1·58	1·01	2·49	1 69	1,856	7·17	11·31	9·43	9·30
George	1,840	1·67	1·65	1·61	1 64	1,692	12·85	10·64	12·51	12·00
Robertson	2,054	2·01	·97	1 92	1 63	1,216	8·51	10·69	6·63	8·61
Burghersdorp	*1,295*	*·80*	*3 09*	*·00*	*1·29*	*1,627*	*9 58*	*10·45*	*7·59*	*9·20*
Swellendam	1,148	·00	·00	·85	·28	1,273	2·40	3 93	4·72	3·68
Prince Albert	1,037	1·99	·00	·95	·98	749	9·35	6·68	6·67	7·56
Averages	—	1·64	1·55	1·27	1·48	—	8·09	6·73	6·78	7·20

Other suggestions, which have since been met to a great extent, are the appointment of whole-time Medical Officers of Health for all the larger towns, and legislation to diminish the risk from immigration of European consumptives. He strongly advocates the education of the people in health matters. "After all, unless the people themselves become imbued with the spirit of progress, all efforts for their advancement will prove futile. . . . Here, in the schools, I believe, lies our great hope and our great opportunity."

In almost the same words, Grant Millar advocates health propaganda and education as the most important means towards the limiting of the spread of tuberculosis. "The only effective measures in the long run depend on the Natives themselves. To prevent the spread of tuberculosis the Native must be taught the evils of overcrowding and he must come to learn the dangers that arise from indiscriminate expectoration." He sees that, to overcome the overcrowding, at least, in Pondoland, a great many additional huts would have to be built. "This is a serious matter," he says, "because it means an increased payment by the Native in the shape of hut tax."

Doubtless some additional individual papers and reports bearing on the subject might be found and summarized if a complete review were here necessary; but as the intention is merely to lead up to the general Report by indicating the main features of the problem as envisaged in past years, a fuller treatment of the subject would occupy too much space.

2. OFFICIAL REPORTS.

Report of the Tuberculosis Commission, Union of South Africa,[34] *Cape Town*, 1914.

A Commission was appointed on February 25th, 1912—

(*a*) To enquire into and to take evidence for the purpose of ascertaining the extent and causes of the prevalence and spread of tuberculosis, in its various forms, among Europeans, Coloured persons, Natives and Asiatics in the different areas of the Union, etc., and

(*b*) To enquire into and take evidence for the purpose of ascertaining the extent and causes of the mortality of Natives employed on the Witwatersrand Mines, and their susceptibility to pneumonia, with special reference to those coming from tropical areas, and to make recommendations thereon.

The Commissioners were Drs. A. John Gregory, A. Jameson, T. te Water, Charles Porter and G. A. Turner.

It may be said at once that, although unfortunate differences of opinion amongst the Commissioners made it impossible to formulate unanimous conclusions or recommendations, the Report is of the highest value and provides a mine of information for all future students of tuberculosis in South Africa. It would be quite impossible to summarize a Report covering 352 closely printed pages, nor is this necessary,

as the original document is available for study. Here, however, it is desirable to quote verbatim a few paragraphs of the " Summary of the Facts concerning the Prevalence of Tuberculosis, as regards Natives," given on page 123 of the Report.

" 1. Tuberculosis is of comparatively recent introduction among he Bantu tribes.

" 2. We are satisfied that it has now become a most serious menace to the future of the Native races throughout the Union ; that it is increasing, and that unless effective measures are taken it is likely to materially increase.

" 3. The disease, however, prevails to a variable extent among the different Native tribes and communities, from a comparatively small degree in the raw Native who remains in his kraal and who has come into but little contact with civilization, up to a very large amount occurring among those brought under the influence of European industrialism and living under conditions, to the Native, of exceptional stress. There are many gradations between these extremes. No single term, therefore, will define the extent of its prevalence among the Natives.

" 4. The prevalence is in proportion to the degree and duration in which the following factors have operated :—

" (*a*) The adoption of civilized habits and modes of life as practised by the Natives, including clothing, housing and diet.

" (*b*) The change from the freedom and openness of kraal life to town locations, compounds, barracks, Kafir lodging-houses and other close aggregation.

" (*c*) The change from a leisurely life to one of continual labour under more or less arduous conditions.

" (*d*) The coming into contact with massive infection by association with the European and Coloured races.

" (*e*) The indulgence in deleterious kinds of alcoholic liquor.

" 7. Pulmonary and acute general tuberculosis predominate, more especially among adult males. Among females and children there is a large proportion of glandular cases, mostly cervical, especially among the less civilized and raw Natives.

" 8. Speaking generally, it is found to be least prevalent in Zululand and the Northern Transvaal, more so in Basutoland, still more in the Cape Native Territories, and most widespread among Natives in the settled districts of the Cape Province.

" 9. Tuberculosis is excessively prevalent among Natives working in the large industrial centres and especially on the mines—gold, diamond and mineral.

" 10. *Owing to the extent to which the disease occurs on the mines* and the large number of Natives employed thereon, together with their frequently changing personnel, the mining industry is one of the most important of all the factors in the cause and diffusion of the disease among the Native population.

"15. There are special factors in operation on the mines which predispose to tuberculosis among mine workers." . . .

(Paras. 5, 6, 11, 12, 13 and 14 are here omitted but should be read in the original.)

The "special factors" referred to in para. 15 would appear to be those set out on page 208 of the Report, as follows :—

(*a*) The admission of tuberculous workers into the compounds and mines.

(*b*) Conditions of the compounds favouring the retention and diffusion of infection when introduced, *i.e.*, bad lighting, inefficient ventilation, uncleanliness.

(*c*) Overcrowding and other conditions bringing the healthy into contact with infection either already existing free or being given off by infective individuals.

The relatively slow spread of tuberculosis in the kraals, referred to in the Summaries of Reports by Macvicar and others (p. 41) is also noted by the Commissioners. "It has frequently been asked why—if such a large number of boys are being continuously returned from the mining and other industrial centres to their kraals suffering from . . . tuberculosis—we do not find many more cases in the kraals and see it spreading more than appears to be happening. But obviously, if cases rapidly succumb, there would never be at any one time many cases to be seen or to spread infection." They add: "It must not be forgotten that for every case which has become established and has developed to the extent of producing marked lesions and symptoms of tuberculosis, there must be many others who, having become infected, are still maintaining a successful resistance to the invasion, and for these the return to the open life of the kraal is their salvation . . . they are . . . the cases which would, if they were known, furnish a powerful argument for the system of short contracts and frequent returns to kraal life for all Native labourers on the mines and at labour centres. . . . The influence of the open life of the kraal suggests an explanation of the circumstance, so frequently referred to in this Report, that in the kraals of those suffering from tuberculosis so few women and children appear to be affected with the pulmonary and generalized forms of the disease, but that tuberculous glands seem to be the common manifestation. It is possible that the early limitation to the glands is because of the power of resistance not having been depressed by overstrain and unhealthy environment to which the men are exposed at labour centres."

The bearing of Borrel's observations on the Senegalese troops (p. 19) in France and his division of their tuberculosis into a preliminary "glandular" phase and, under the stress of military duty, a subsequent "generalized" stage, will be apparent in connexion with these remarks of the Commissioners.

Speaking of the disease, in relation to its type and course in the developed cases in Natives, they report as follows: "In its clinical and pathological characters, the disease in the Natives differs markedly

from that in the European. Post-mortem the infection is found usually to be more diffuse and to partake more of the nature of an acute general systemic infection. The tendency to limitation of the lesion . . . by the supervention of fibrotic and caseous and calcareous changes is not seen to any extent."

The conclusions of the Commissioners, while not unanimous, contain a long series of sound recommendations which do not lend themselves to summary and must be studied in their Report. They lay special emphasis on "the fact that measures for combating tuberculosis must begin with the prevention of cases, and that the way to effect this is by improving the conditions under which so large a proportion of the Coloured and Native population live in urban areas and by improving the conditions under which they work in the industrial centres, especially on the mines."

The Gorgas Report, 1914.

In 1914 was published in pamphlet form a "Recommendation as to Sanitation concerning Employees of the Mines on the Rand," by Surgeon-General W. C. Gorgas,[35] United States Army and Chief Sanitary Officer, Isthmian Canal Commission.

This brief but exceedingly valuable Report deals not only with tuberculosis but with health in general.

Gorgas, very rightly, approached the question of bacterial disease as, to some extent, a single problem.

"On analyzing the reports for 1912," he says, "we find that the total death-rate was 22·6 for diseases. The four highest diseases were pneumonia, phthisis, meningitis and enteric fever, giving us rates of 9·8, 5·4, 1·3 and 1·1. These four diseases are all more or less infectious and contractable. If they could be got rid of entirely, the death-rate for 1912 would be reduced to 5·0 for all causes. While entire eradication of these diseases cannot at present be accomplished in this or any other community, probably, by proper hygienic measures, a very appreciable reduction could be accomplished."

Turning to the specific form of tuberculosis, Gorgas thinks the incidence and mortality far too high amongst mine Natives. Allowing for error in diagnosis, he estimates the wastage from this disease as 10·87 per 1,000 in 1912; and records his opinion "that, for the future, present conditions continuing, tuberculosis will cause more trouble among Natives than pneumonia does at present." He points out that overcrowding "plays just as important a part in the spread of tuberculosis of types other than pulmonary tuberculosis as it does in the pulmonary types."

Careful routine medical examination should be made of the sick and, when one is found to have tuberculosis, he should be excluded from the mine. As far as the Native is concerned, the most important single measure is that recommended for pneumonia, that is, "scattering."

"No argument is necessary to prove that by reason of close personal contact, if we have 100 men in a room, with 25 feet of floor space, infection would spread more rapidly and generally than if we had 50 men in the same room having 50 feet of floor space."

"In general, the care of the compound yards showed everywhere neatness, cleanliness and commendable care and discipline. But when we came to examine the interior of the Native living quarters, the very opposite was the case. . .

"I have never seen so large a proportion of the ration supplied by one article as is here supplied by mealie meal. A Native labour force living with their families near the mine would be more stable and contented than the present force."

In conclusion, he reports as follows: "Of the sanitary recommendations, I consider that of increasing the floor space to about 50 feet the most important and pressing, and by far the best way of doing this to be the village hut system and the introduction of families. If this particular method cannot be carried out, to come as near as feasible. The second in importance I consider to be the improvement in the hospital system and the care of the sick. . . . The third in importance is the establishment of a central sanitary bureau or department under the Chamber of Mines—the head of this department to represent the mines on all sanitary questions."

Evidently Surgeon-General Gorgas laid great stress on the passing of tuberculous, as well as other bacterial infection, from man to man in the compounds. He suggested the division of the barracks, as he called the large rooms in the compounds, into smaller rooms to contain not more than 12 to 15 men, and he advised separate sheds for messing to avoid the collection of food and utensils in the sleeping rooms. It is evident that he had heard the argument, still frequently used, as to the fact that many of the old compounds compare favourably with the more modern and spacious ones in regard to disease production, for he adds:—

"There are a considerable number of compounds in which the death-rate has been low for a considerable number of years. They are frequently the old compounds which the Native prefers, and therefore they contain a larger number of old 'boys.'"

This question of the risk of personal contact of Native with Native in a crowded room is a serious one and raises problems as to the number of "tubercle bacillus carriers" at large in the compounds. On this point some valuable information was obtained by Watkins-Pitchford, A. J. Orenstein and W. Steuart[36] in 1916. These observers, in the course of an intensive examination of 400 Native mine workers, selected at random, and investigated by X-ray, clinical and laboratory methods, found "that the disease (tuberculosis) in its open or communicable stage is far less prevalent amongst Natives actually working on the mines than has been hitherto supposed; only 1 case, out of 400 examined, has been detected."

Watkins-Pitchford, however, in a later paper,[37] reports that, in 1913, he examined "250 specimens of sputum which had been collected in various underground workings and found that 38 (15·2 per cent.) contained the infection of tuberculosis." To this observation further reference will be made later (see p. 151), but it is of much importance as it stands.

There are various important discussions on tuberculosis in the Proceedings of the Transvaal Mine Medical Officers' Association from 1921 onwards, but it is not proposed to attempt to summarize these, as discussions do not lend themselves to profitable condensation. The attention of readers is directed especially to Volume 11, No. 1, of May, 1922; No. 4, of August, 1922; No. 6, of October, 1922, and Nos. 9 and 10, of January-February, 1923.

Report of Tuberculosis Survey of the Union of South Africa, 1924, by Peter Allan,[38] M.D., D.P.H., Medical Inspector, Department of Health.

This valuable Report immediately preceded the formation of the Tuberculosis Research Committee and may almost be regarded as a part of the present enquiry, since Dr. Allan has continued his studies of tuberculosis in the Transkei and Ciskei for the Committee, and his completed observations form part of this Report. It is convenient, however, to quote a few of his conclusions, bearing on the picture of tuberculosis in the South African Native as it had taken shape previous to the initiation of the present enquiry.

After a preliminary survey of the Native territories, Dr. Allan was able to form the opinion that :—

(*a*) Tuberculosis is a common and widespread disease among the Natives of the Transkei and Ciskei.

(*b*) There is evidence that in their natural surroundings the Natives in these territories have a considerable degree of resistance to tuberculosis.

(*c*) As regards the fate of mine boys repatriated with tuberculosis, 112 were traced, of whom 65 were dead and 47 were still alive. Of the 47 still alive, 28 or 59·5 per cent. had recovered sufficiently to be able to work.

(*d*) It is difficult, without extensive examinations and diagnostic tests, to ascertain the extent to which infection from returned mine boys is affecting the general Native population. The small figures at present available indicate that about 25 per cent. of cases seen at the Holy Cross Mission in Pondoland either contracted the infection on the Rand or from relatives who had returned from the Rand.

Dr. Allan was evidently impressed with the part played by insufficient food in adding to the liability of infected persons to develop clinical tuberculosis; and the tendency for tuberculosis incidence and mortality to fall when good and sufficient nourishment is available. He quoted Dr. Wildish, of Eshowe, and the members of the Norwegian Mission

at Entumeni to this effect. In resuming the results of his survey, he is able to point to a satisfactory fall in the tuberculosis death-rate in Whites in the Transvaal, the figures for 1921 reaching the very low levels of 74·4 per 100,000 males, and 21·66 per 100,000 females; an average of 49·16 per 100,000 for the total White population; and this in spite of the miners' phthisis, which helps to explain the higher mortality in males. While accurate figures for the Native population were unobtainable, the death-rate among the mixed Coloured in the Cape Province was found to be about five times greater than among Europeans, following, however, the curve of European tuberculosis in its general tendency to decrease. From these facts, Allan concludes that each race living under constant conditions as regards habits, work and chances of infection, etc., has its own index of tuberculosis mortality.

He considers that at least four factors influence this index, all these factors being inter-dependent. They are as follows :—

(*a*) Susceptibility of the different races and individuals to tuberculosis.
(*b*) Chances of infection and degrees of infection.
(*c*) Resistance of infected persons to disease.
(*d*) Economic conditions.

Dr. Allan's report is illustrated with interesting tables and graphs which must be studied in the original.

In 1926 appeared a valuable pamphlet, on popular lines, from Dr. J. A. Mitchell,[39] of the Department of Public Health of the Union of South Africa. This pamphlet, entitled "Tuberculosis: Summary of Causes and Preventive Measures," lays stress on "overcrowding and bad housing, leading to increased personal contact between and close association of the infected and healthy," as one of the principal factors causing the disease. It is mentioned here as an indication that the importance of educating the public in regard to tuberculosis is receiving official recognition.

There are also many references to tuberculosis in the numerous official reports on silicosis and miners' phthisis, such as the "Report of a Commission on Miners' Phthisis and Pulmonary Tuberculosis," Cape Town, 1912; the "Interim Report of the Miners' Phthisis Commission," 1921, and the successive Annual Reports of the Miners' Phthisis Board and Medical Bureau from 1917 onwards; but as these publications have special reference to the dust factor and, where they refer to tuberculosis, bear on this disease as a complicating element in the development of silicosis, they are not summarized here.

3. BOVINE TUBERCULOSIS.

Macvicar,[27] after a brief account of reports received by him from various sources in reply to his enquiries, sums up the situation, for 1907, as follows: "The evidence, then, of the veterinary surgeons goes to show that throughout the greater part of South Africa, bovine tuberculosis is absent except among imported cattle. The disease seems to

have become established among colonial-grown cattle only in the west of Cape Colony. This distribution is much less wide than that of tuberculosis among the Natives. There is danger of error in pressing a comparison like this, but I think it is a significant fact that a careful observer like Mr. Hutcheon (head of the Veterinary Department of Cape Colony) should not have met with any bovine tuberculosis in a district of the Colony in which, during the ten years of his residence and for long before, human tuberculosis is known to have been very common. On the other hand, it would appear that bovine tuberculosis is relatively more common in Madagascar than human tuberculosis and at Inhambane human tuberculosis is fairly common, although there are hardly any cattle in the locality."

After a careful analysis of the distribution of tabes mesenterica, which he regards as possibly an index of milk infection, Macvicar is forced to the conclusion that "in Cape Colony bovine tuberculosis has at the present time very little to do with the production of human tuberculosis."

The subject of bovine tuberculosis receives much attention in the report of the Tuberculosis Commission[34] of 1914, already referred to. Much evidence was taken and the subject evidently regarded as very important.

As to the early history of bovine tuberculosis in the Cape Province, the Chief Veterinary Surgeon of the Union, Mr. C. E. Gray, is quoted as stating that until 1905 he had held the opinion "that for all practical purposes this disease did not exist in South Africa," and this view was endorsed by Mr. J. D. Borthwick, an official of the Veterinary Department, who considered that it was not until 1904 that in the Cape the prevalence of tuberculosis in dairy herds began to attract serious attention.

"For many years, the Western Province of the Cape has been supplying colonial-bred breeding stock, much of it of the Friesland breed, to the rest of South Africa, and there is evidence that by this means the disease has been distributed in widely different parts of the Union." Speaking of Natal, the Commissioners report that "shortly after the (South African) war, considerable numbers of Madagascar cattle were imported. In 1906, out of a consignment of 64 such cattle landed at Durban, no fewer than 42 reacted to tuberculin, many of them being very severely affected with the disease. Also, 65 per cent. of Madagascar cattle imported through Port Elizabeth were found to be tuberculous."

"The testing of dairy herds in Natal has recently disclosed high percentages of animals to be infected. Thus, of 152 animals tested on account of the discovery of cases of tuberculosis, 43 reactors were discovered, slaughtered and proved tuberculous post-mortem, or 28·2 per cent. Of 56 tested without suspicion of tuberculosis, 14 reacted and were destroyed, or 25 per cent."

The findings at the municipal abattoirs at Johannesburg for 1910 to 1912 and 1912 to 1913 showed an increase of from 0·34 to 0·807 per 1,000 of tuberculosis in oxen; and a rise from 7·19 to 9·99 in pigs. The Commissioners state that, in many cases, "the amount of tuberculosis in swine has increased enormously owing to the practice of feeding on the waste products of creameries."

Several instances are given of the tracing back of the infection discovered in oxen at the abattoirs to the dairy herds concerned; in which subsequent tuberculin tests proved the herd to be seriously infected.

"The general opinion of all the expert witnesses examined by the Commission was to the effect that there was probably very little tuberculosis among the veld cattle of the Union. Also that there is not likely to be much among draught cattle. But among imported stock, among the better class of South African breeding stock and in dairy cattle, especially in the better-bred heavy milch cows, it probably exists to a very considerable extent." The Commissioners were impressed with the desirability of ascertaining "with some degree of certainty the extent of the evil that has to be dealt with." They point to the inadequacy of the Veterinary Staff for such an investigation and to the unsatisfactory state of the legal provisions and statutes relating to animal tuberculosis.

The report goes fully into the question of destruction of "reactors," the compensation for animals destroyed, and the duty of the Government in regard to the carrying out of testing and other measures; and recommends the establishment of a State insurance fund; and makes recommendations as to the control of milk supplies and of meat supplies —all of which deserve study in the original report.

P. Allan,[38] in his report of 1924 already referred to, lays much stress on the importance of prevention of infection from bovine sources as a measure for the combating of human tuberculosis in South Africa. He writes as follows: "A milk supply free from tuberculosis infection must be secured. There is reason to believe that tuberculosis is present to a considerable extent amongst cattle in the Union. Testing with tuberculin has not been carried out systematically, but in several instances . . . a high percentage of reactors has been found—as high as 73·9 per cent. in one dairy herd in the Cape Peninsula."

Sufficient has been said to show that, as appears to be the case with the Native races of man, so with the native cattle tuberculosis was rare or unknown until infected stock was introduced from other countries. And the danger to the indigenous stock appears to be in direct proportion to the degree of contact with foreign cattle to which they are exposed.

The latest information available as to the prevalence of bovine tuberculosis in South Africa is given in Appendix 10, which is a summary of information collected from various municipalities by the Committee.

The subject also receives some consideration in the bacteriological section of this Report (see p. 149).

PART II.

TUBERCULOSIS AS A DISEASE OF THE NATIVE INDUSTRIAL POPULATION IN SOUTH AFRICA OF TO-DAY.

CHAPTER I.—THE PRINCIPAL INDUSTRIES AND OCCUPATIONS IN WHICH NATIVES ARE ENGAGED IN SOUTH AFRICA.

CHAPTER II.—THE GOLD-MINING INDUSTRY AND HEALTH.

CHAPTER III.—HEALTH SERVICES IN THE GOLD-MINING INDUSTRY.

CHAPTER IV.—THE TUBERCULOSIS OF NATIVE MINE-WORKERS ON THE WITWATERSRAND.

CHAPTER V.—TUBERCULOSIS SURVEY OF THE NATIVE TERRITORIES.

CHAPTER VI.—INFERENCES DRAWN FROM THE FOREGOING CHAPTERS IN REGARD TO TUBERCULOSIS IN SOUTH AFRICAN NATIVES.

CHAPTER VII.—DISCUSSION ON PROPHYLACTIC MEASURES NOW IN FORCE OR CAPABLE OF BEING APPLIED IN SOUTH AFRICA.

CHAPTER I.—THE PRINCIPAL INDUSTRIES AND OCCUPATIONS IN WHICH NATIVES ARE ENGAGED IN SOUTH AFRICA.

The Native (Bantu) population of South Africa in 1930 is estimated on a basis of the 1921 census (the last taken), and the percentage increase indicated by the censuses of 1911 and 1921, at 6,000,000, of whom approximately 2,000,000 are males between the ages of 15 and 50, the latter estimate being based on data presented in the last census report.

The population of the three adjacent territories of Basutoland, Bechuanaland and Swaziland is approximately 1,000,000, of which 300,000 are males between the ages of 15 and 50. (Official Year Book, Union of S.A., No. 11, 1928-1929.)

Thus, we have a potential male labour reservoir of approximately 2,300,000 in British South Africa.

From various available sources, such as the Official Year Book of the Union of South Africa (No. 11, 1928-1929) and the "Report of the Inter-departmental Committee on the Labour Resources of the Union," March, 1930, the following table (Table 1) of the principal industries employing adult male Natives was compiled :—

TABLE 1.

Industry.	Number of Adult Male Natives Employed.
Gold Mining	208,000
Diamond Mining	61,000
Coal Mining	33,000
Other Minerals	15,000
Railways	36,000
Trades and Industries	97,000
Domestic Employment	111,000
Government Departments (Union, Provincial and Local) ...	54,000
Agricultural (exclusive of Native peasant farmers) ...	375,000
Total	990,000

Tables given in the above referred to Report of the Inter-departmental Committee show that the estimated number of adult male Natives engaged in certain occupations in December, 1929, was as follows (Table 2) :—

TABLE 2.

	Number of Adult Male Natives Employed.
Agricultural labour, (exclusive of Native peasant farmers) ...	375,716
Mining	261,094
Alluvial Diamond Diggings	28,694
Commerce, Trade and Industries	97,316
Domestic Service	111,361
Local Government	27,221
Union and Provincial Government	27,564
Railways	33,626
Total	962,592

The same Report draws attention to the fact that of this number approximately 225,000 are non-Union Natives. To this one should add that of this 225,000 some 96,000 are Natives from Portuguese territory employed on the gold and coal mines of the Transvaal. Presumably, therefore, the remainder of approximately 125,000 is made up very largely of Natives from the territories of Basutoland, Bechuanaland and Swaziland.

The same Inter-departmental Committee states that, after making a very careful estimate, it has arrived at the conclusion that the Natives employed in various industries on the average devote only 44 per cent. of their time to such employment, aside from their own agricultural and other activities. This is borne out by the experience of the gold mines, where the annual " turnover " approximates 100 per cent.

The phenomenon to which attention is drawn by this statement is one which should be borne in mind in any comparison which might be made between the morbidity and mortality statistics of the mining industry set forth in this Report and similar statistics from other parts of the world, where this phenomenon plays no important rôle. But, on the other hand, it should be remembered that although the annual " turnover " is high, a considerable number of Natives return again and again after variable periods of absence to industrial occupations such as mining. Thus, the proportion of Natives with a cumulative period of over five years of continuous and discontinuous work on the gold mines of the Witwatersrand is approximately 11 per cent. of the total force, and of those of over one year of service and up to five years is approximately 67 per cent. It appears, therefore, that at any one time there are apparently on the mines some 78 per cent. of Natives who have worked for a complete year, or more than a year, continuously or discontinuously.

It seems clear from the above data that an exact weighing of the morbidity and mortality experience with Natives on the gold mines, or, for that matter, in any industry in the Union employing Natives, to enable comparison with similar experience in more settled industrial populations, is impossible, and even a close approximation can hardly be arrived at on the data at present available.

It would appear advisable at this point to state briefly certain facts which have a bearing on the health of Natives employed in South African industries other than gold mining.

(*a*) *Agricultural Labour.*—The Native workers in agriculture in South Africa are either squatters on farms or casual labourers recruited in one way or another ; in the case of the smaller farms, in the immediate neighbourhood of the farm, and in the case of larger enterprises, such as sugar-farming, from various parts of South Africa. With few exceptions, no special provisions are made for the feeding of these Natives and their housing is, as a rule, primitive, approximating that of the Native kraal hut. On the larger plantations, medical services, including hospitals, are provided, but such provision is available only to a relatively small portion of the total number of agricultural workers, which must in the aggregate be over half a million. Morbidity and mortality statistics for this class of workers, are, of course, not available.

(*b*) *Alluvial Diamond Diggings.*—The conditions on these diggings are much like those prevailing in agriculture. The Natives come and go. Sometimes a ration of mealie meal and an occasional ration of meat are issued, but generally speaking they must provide their own food. There is no medical examination on engagement, and no medical provisions, except such as might be available to the population of tho neighbourhood, are made. For this class of Native also no morbidity or mortality statistics are available.

(*c*) *In Commerce, Trades and Miscellaneous Industries* in the towns, the general conditions described under (*b*) prevail, except that the housing is usually superior to that obtaining on farms and alluvial diggings.

(*d*) *In Domestic Service* the Natives, in addition to their wages, receive food and quarters, the latter being as a rule quite adequate.

(*e*) The Native employees of *Government, Local Authorities and Railways* are on the whole better housed and fed than in the previously described employments, but there are among these a considerable number, which might be estimated at about 50 per cent. of the approximately 90,000 thus employed, who receive a wage only and are neither housed nor fed. For these Natives no separate morbidity and mortality statistics are available.

(*f*) *On the Diamond Mines* the conditions of housing, feeding and medical care approximate those of the gold mines. The labour force is, however, almost entirely of British South African origin. Morbidity and mortality statistics are available and their general trend approximates those for the gold-mining industry. As these mines do not come under the provisions of the Miners' Phthisis Act and Regulations and consequently no initial, periodic and final examinations, with special reference to tuberculosis, are made, the incidence of this disease cannot be stated as definitely as that for the gold-mining industry.

(*g*) *Collieries.*—The principal collieries of the Union are situated in the Transvaal and in Natal. In the Transvaal collieries the tribal composition of the labour force is approximately that of the gold-mining industry, with perhaps a slightly larger proportion of East Coast Natives.

In the Natal collieries there is a difference in the composition of the force because on these collieries a considerable number of Asiatics of Indian origin are employed.

These mines, also, do not fall under the provisions of the Miners' Phthisis Act and Regulations, and consequently the physical standard of the Native employees is on the whole not so good as those of the gold mines, and for the same reason the incidence of tuberculosis cannot perhaps be as exactly stated as that for the gold mines. The general trend of mortality from disease is higher on the collieries than on the gold mines, and that is probably due to the lower physical standard of the Natives, and, to some extent, to the generally inferior hygienic conditions under which they live.

CHAPTER II.—THE GOLD-MINING INDUSTRY AND HEALTH.

SECTION A.—THE NATIVE MINE WORKERS.

1. RACES AND AREAS FROM WHICH NATIVE MINERS ARE OBTAINED.

Approximately 200,000 Natives are employed on the gold mines of the Witwatersrand.

A little more than half of this number is obtained from areas within British South Africa, of which the largest portion consists of members of the Xosa, Fingo and Pondo tribes of the Transkei and Ciskei areas of the Cape Province; the second largest portion consists of Natives from the three British Protectorates, viz., Basutoland, Bechuanaland and Swaziland; while the smallest portion is comprised of the tribes of the Northern Transvaal and Zululand. All these Natives are commonly referred to as British South African or, more briefly, B.S.A. Natives.

The remainder of the Native labour force is obtained from Portuguese East Africa (south of latitude 22° South), and consists of the Mchopi, Nyambaan and Shangaan tribes collectively known as "East Coast" Natives. At one time Natives from areas north of latitude 22° South, classified as "Tropicals," were engaged for mining employment, but owing to their susceptibility to pneumonia their introduction into the Union for mining employment was prohibited in May, 1913, by the Government of the Union of South Africa.

2. METHODS OF RECRUITMENT.

Recruiting of Native labour for the gold mines is conducted entirely by the two Native labour organizations of the industry, viz.:—

(*a*) The Native Recruiting Corporation, which operates in British South Africa, and

(*b*) The Witwatersrand Native Labour Association (W.N.L.A.), which operates in Portuguese East Africa.

(a) British South African Natives.

About one-half of these Natives are not, at the time of leaving their kraals, engaged under contract to the mines, but voluntarily proceed to the Witwatersrand and there seek mining employment. These Natives are classified as "Non-recruited from Territories." The remainder contract themselves for work on the mines through representatives of the Native Recruiting Corporation stationed in the various districts of the Native territories. These representatives advance the rail-fare to Johannesburg and the train ration and, if he wishes it, also money to provide for the needs of his family. These Natives are classified as "Recruited Natives."

(b) Portuguese East African Natives ("East Coast" Natives).

These Natives are obtained by the Witwatersrand Native Labour Association. Natives desiring employment, either on the gold mines or the collieries, voluntarily proceed to one of the many stations established and maintained by the Association in Portuguese East Africa. From these stations the Natives are transported to the Association's central depôt at Ressano Garcia, situated within five miles of the eastern border of the Transvaal. From this depôt the Natives for the gold mines are forwarded, under the care of a European conductor, by special bi-weekly trains to the Association's main distributing depôt at Johannesburg. The cost of transport, together with incidental items—including a clothing outfit—is advanced to these Natives.

(c) Medical Examination in the Native Territories.

The British South African "Non-Recruited" Natives are naturally not, prior to leaving for the Witwatersrand, medically examined as to their fitness for mine work; their first examination in this respect is at the mine which engages their services. On the other hand, the recruited Natives, with the exception of a few from areas where medical services are not available, are medically examined by a local practitioner—usually the Government District Surgeon. These examining officers are furnished for guidance with a schedule drawn up by the Transvaal Mine Medical Officers' Association of disabilities debarring Natives from mine employment, especially diseases of the lungs.

East Coast Natives who are obviously ill, disabled or diseased are eliminated at the various subsidiary stations in Portuguese East Africa. The remaining Natives, comprising gangs of between 300 and 400 twice weekly, are submitted to a stethoscopic and general examination and to re-vaccination, where necessary, by the two medical officers (one whole-time and one part-time) employed by the W.N.L.A. at its depôt hospital at Ressano Garcia.

(d) Medical Examination on the Witwatersrand.

Every Native for employment underground on the gold mines, whether non-recruited or recruited, and from whatever area, is submitted to a strict medical examination at the W.N.L.A. distributing depôt, prior to entering upon his contract. As already stated, the non-recruited Native will have been first examined by the mine medical officer. If accepted by him for mine work, the Native is subjected to a further examination at the W.N.L.A. depôt.

In the case of the recruited Native, this sequence of examination is reversed, and a Native considered by the mine medical officer as unfit to commence work is returned to the depôt for re-examination—clinical and radiographic—and probable detention in the depôt hospital.

3. Contracts and Terms of Service.

(a) British South African Natives.

On attestation in the Native Territories, the recruited Native names the mine where he wishes to work, and thereupon contracts for 270

worked shifts,* except in the case of the Bechuanas and Swazis, who usually contract for 180 worked shifts.

The non-recruited Native proceeds direct to the mine of his choice and engages for a period mutually agreed between himself and the mine authorities, usually from three to four months, but occasionally on a monthly basis.

(*b*) *Portuguese East African Natives.*

East Coast Natives proceeding from their kraals to the mines are contracted for an initial period of 313 worked shifts, but in terms of the Convention concluded between the Portuguese and Union Governments in September, 1928, Natives may re-engage for a further period or periods not exceeding 156 worked shifts, upon the completion of which the Native is, in terms of the Convention, called upon by the Portuguese authorities to return to Portuguese territory.

(*c*) *Local Natives* (*all Tribes*).

(*i.e.*, Natives who transfer from one mine to another upon the completion of their contracts or who proceed from other employment in a labour district to employment on the mines.)

These Natives are free to engage in the same manner as non-recruited Natives.

In each of the foregoing cases, the contract is ratified by the issue to the employer and to the Native of the " service contract " prescribed by Government Regulations.

Service beyond the registered period can be terminated by the giving of seven days' notice on either side.

4. THE JOURNEY TO JOHANNESBURG.

It will be gathered from the foregoing sections of this Chapter that many of the recruits for the mines have a lengthy journey from their homes to Johannesburg. This applies at present particularly to the East Coast Natives drawn from the northern portion of the Mozambique recruiting area and used to apply to the Tropicals.

The following extract from a paper " The Recruiting Organizations of the Gold Mines," read before the Empire Mining and Metallurgical Congress, 1930, deals with the transportation functions of the Witwatersrand Native Labour Association in Portuguese East Africa.

" When the Association first entered Portuguese East Africa, the initial difficulties were great owing to drought, fever, absence of communications and, in summer, the difficulty of transport through floods, but to-day its organization is such that a Native in almost any portion of the area can present himself at a W.N.L.A. station within a day of his leaving home. The work of the Association's officials in Portuguese

* A " worked shift " is the period in any twenty-four hours which is spent by the worker continually at his work. In other words, the Native contracts for so many working days, not so many calendar days.

territory consists mainly in keeping in close personal touch with the Native population, and in supervising the elaborate and constantly changing arrangements made to facilitate the journey of the Natives to the Rand. No pressure of any description, either from the Association's officials, from the Portuguese authorities, or from the local chiefs, is applied to induce the Natives to proceed to work on the Witwatersrand. The flow of Natives from Portuguese territory to the mines is indeed a voluntary flow in the fullest sense. Current hut-tax and such transport expenses as are not paid by the Association are advanced by it free of interest and are recovered from wages.

"The Association employs 95 Europeans and 771 Natives. Its organization is managed from Johannesburg through two District Managers in Portuguese territory, under whom are four Assistant District Managers in charge of the four areas into which the Association divides the territory, viz., Inhambane, Chai Chai, Lourenço Marques-Xinavane, and Pafuri. As already indicated, the organization is established on the basis that any Native should be able to reach a W.N.L.A. station within twenty-four hours of his leaving home. At these stations, of which experienced Natives are in charge, the recruits are fed, and forwarded either on foot from station to station or direct by motor transport to one of the Association's main camps. There they are medically examined and, if passed as fit, proceed to the Transvaal frontier. On arrival at the frontier the Natives undergo a further medical examination, and are then presented to a Portuguese Government official who rejects any whom he considers to be under eighteen years of age or otherwise physically unfit. They are provided with a clothing outfit consisting of two blankets, a cotton vest and a large loin cloth at a charge of 20s., and sent forward by rail in the care of conductors to the Association's depôts at Johannesburg, Witbank or Breyten, where they are again medically examined, in some cases detained for a short time to recuperate, and distributed to the mines."

In the case of Natives recruited by the Native Recruiting Corporation in British South Africa, the transportation arrangements for the journey to Johannesburg are fairly similar.

Before ever the employee arrives at the mine to which he is allotted he has already, therefore, been in close contact with strangers.

It has long been recognized that Natives, from the point of view of their health, do not react well to being moved about and to being brought into contact with strangers.

Writing in 1905, Irvine and Macaulay[46] stated in connection with the high sickness and mortality rates obtaining for Tropical Natives—

"But further investigation reveals the important qualifying fact that the excessive susceptibility to disease of these Natives is not a permanent feature . . . the significant fact appears that this incidence falls with exceptional severity upon new arrivals . . . among the Natives allotted during the seven months from June to December, 1903, the mortality was at the rate of 63 per 1,000 per annum. Of the Natives

who died, 45·2 per cent. died within one month after allotment to the mines. After one month's service the mortality steadily declines, and after three months' service the fall is striking."

Dr. A. I. Girdwood, Principal Medical Officer to the W.N.L.A., states that it was quite the usual thing to admit 100 cases of Tropicals to the Witwatersrand Native Labour Association's hospital from a batch immediately on arrival, and that there were always cases of pneumonia on the train.

To turn to present conditions, Dr. Girdwood gives the following information :—During 1928, out of 44,297 East Coast recruits received, 2,119 were admitted to hospital, while out of 49,210 B.S.A. recruits received, 1,313 were admitted. The East Coast Native contributed 107 cases of pneumonia as compared with 12 cases contributed by B.S.A. All Natives are medically examined before starting, yet of 93,507 presumably healthy Natives, 3·67 per cent. were, on arrival, sick enough to be admitted to hospital. A further examination shows that the figures were about 4·7 per cent. for the East Coast Natives and about 2·6 per cent. for the B.S.A. Natives, suggesting that the more arduous journey and greater change of climate had affected the East Coast Natives adversely as compared with the B.S.A. Natives, although the latter had not escaped.

The figures for 1929 and 1930 are available for comparison. In 1929 the East Coast admissions on arrival amounted to 4·3 per cent. of the recruits examined, and the B.S.A. admissions to 3·0 per cent. In 1930 the East Coast admissions were 3·7 per cent., while the B.S.A. admissions were 4·9 per cent. It will be seen that with respect to the matter under consideration, while the East Coast Natives have been steadily improving, the B.S.A. Natives have been steadily deteriorating. The travelling facilities for Natives applying for employment on the gold mines are being steadily improved and this is perhaps reflected in the fall in the admissions of East Coast Natives on arrival. In the case of the B.S.A. Natives the recent hard times and discharge of Natives from employment to make room for Europeans has resulted in a great increase in the number applying for work on the mines and a great falling off in the average physical standard of the applicants. This experience may be illustrated.

A certain proportion of the Natives admitted to hospital on arrival at the depôt are admitted because they are physically below par, and they are kept back for rest and feeding-up before being distributed to the mines. In 1928 this quota accounted for 4 per cent. of the B.S.A. admissions ; in 1929 for 5 per cent. ; and in 1930 for 23 per cent. It must be understood that these figures deal with Natives other than those applicants who are definitely rejected as being unfit physically for employment on the mines. The proportion of all recruits admitted on arrival during 1930 was 4·4 per cent. as compared with the 3·67 per cent. in 1928, so the improvement anticipated from better travel facilities has been more than counterbalanced by the poor condition in which the B.S.A. Native starts on his journey.

The questions as to relationship, if any, between season and number of admissions or between size of gangs and number of admissions have been considered. For the two years 1929 and 1930 Dr. A. I. Girdwood gave the number of recruits received per month and the number of admissions per month. There is no relation between the season of the year and proportion of recruits admitted or between number of recruits per month and proportion admitted. Table 3 shows the figures.

TABLE 3.

Month.	No. of Recruits.	No. of Admissions.	Admissions, %
January	8,980	463	5·1
February ...	6,174	323	5·2
March	5,951	252	4·2
April	6,074	263	4·3
May	5,753	186	3·2
June	6,257	305	4·8
July	7,040	366	5·2
August	8,372	285	3·4
September ...	9,159	308	3·3
October	10,558	436	4·1
November ...	7,756	267	3·4
December ...	8,310	269	3·2

The Table just given deals with East Coast Natives only, but an analysis of the figures for the B.S.A. Natives yielded a similar result.

Out of 700 consecutive post-mortem examinations performed on mine Natives of all lengths of service nearly 18 per cent. were on subjects who had died within one month of their arrival on the Reef.

While the gold mines and collieries draw their labour from a distance and assemble parties from different districts before delivering them to their mine, the De Beers Diamond Mines secure their labour locally and employ no agencies either for enlistment or transport. In response to an enquiry the General Manager replied: " . . . Our experience is not comparable with the experience on the gold mines as to an excess of sickness amongst new arrivals."

One must conclude that, for gold mines, the journey and its associated conditions are responsible for sickness on arrival, and the aftermath contributes to the relatively high sickness rate immediately after arrival. It is obvious that no amount of attention on the mines will deal adequately with this factor: mischief is done before the men are received.

Exactly which elements of the journey and its associated conditions can be blamed for this state of affairs it is hard to say, but it seems reasonable to suspect (*a*) the sudden transition from a tropical or subtropical climate to that of the high veld; (*b*) the close contact into which Natives are brought with strangers and the possibilities thus occurring of bacterial infections.

The Committee is unable to arrive at any definite finding on this question. It is aware that considerable improvements have taken place in late years in the attention paid to creature comforts on the journey but, in view of the still existing excessive sickness rate in new arrivals, it recommends that further enquiry should be made.

It suggests that the first avenues to be explored should be (*a*) the value of further protection against climatic changes en route, and (*b*) the value of keeping gangs from different localities as far as possible isolated from each other during the journey and their early days on the mines.

5. REPATRIATION OF NATIVES.

(*a*) *Time-expired Natives.*

Natives leaving a gold mine, either for return home or for further employment, are medically examined by the Mine Medical Officer in terms of the Miners' Phthisis Act (No. 35 of 1925) and, if found as prescribed in the Act to be free from tuberculosis or silicosis, their service contracts are endorsed accordingly.

In the case of those discharged fit, British South African Natives make their own arrangements for the homeward journey. East Coast Natives, however, are, in terms of an Agreement supplementary to the Convention, repatriated under the aegis of the Witwatersrand Native Labour Association.

There is no further medical examination of these East Coast Natives on their arrival at the W.N.L.A. depôt, Johannesburg, except of those who complain of being sick or who are obviously ill; whereupon they are admitted into the depôt hospital.

(*b*) *Natives Medically Unfit for Employment.*

Convalescent Natives discharged by the gold mines as unfit to resume employment are, as a preliminary measure, forwarded to the central hospital maintained by the Witwatersrand Native Labour Association at its Johannesburg compound. Here they are medically examined to determine their fitness to travel and in due course are forwarded in specially equipped rail coaches to the rail-point nearest their home, from whence, if necessary, they are further transported under the care of trained Native orderlies.

6. HOUSING CONDITIONS.

The Native mine labourers of the Witwatersrand are housed in what are locally known as "compounds." Only an insignificant proportion have their wives and families with them, the total number of these being a fraction of 1 per cent.

The compounds, in which male labourers alone are housed are in the nature of barracks, usually arranged in the form of a quadrangle, with kitchens, ablution rooms and latrines placed in the middle of the square, although sometimes the latrines are outside the square and connected thereto by a covered passage.

The individual rooms of the compounds usually house from 10 to 50 Natives, although there are a few exceptionally large rooms housing up to 60 and, in very exceptional circumstances, 100 Natives. The Regulations prescribe the following essential structural requirements for compound rooms :—

(1) That each occupant be allowed 200 cubic feet of air space, and that for this calculation not more than 12 feet of the available vertical space be taken into account.

(2) That the walls be of brick or concrete.

(3) That the glazed window area bear a ratio of 10 per cent. to the floor area.

(4) That no more than two tiers of bunks be provided.

(5) That the rooms be adequately ventilated.

These Regulations came into force in 1911. Compound rooms built prior to the introduction of these Regulations and which did not conform to them were allowed to exist until radical structural alterations became necessary, so that there are still a few rooms of this type in existence. The bulk of the rooms at present occupied conform to these Regulations, and a great many are structurally considerably above these requirements.

The typical room built since 1911 is oblong, built of brick, with a corrugated iron roof supported on wood, wood-frame windows and a wooden door. Ventilation is by means of air bricks or louvres just above the floor level and open space either at the roof ridge, or between the wall and the roof overhang. It is electrically lighted, and has an iron chimney with a cupola, under which a brazier for heating is placed. The floor is of concrete. The bunks are arranged in the form of two shelves, one about two feet from the floor, and the second about six feet from the floor, placed as a rule along two sides of the room only. The bunks are of wooden boards, and are supported on an iron frame.

It was recognized in about 1914 that these sleeping arrangements, bringing, as they do, the occupants into intimate contact during sleep, would facilitate the transmission of infection from individual to individual, not only through contact but also through the projection of virus carried in droplets of sputum at expiration, and since that date new rooms have been constructed in such a way as to separate the sleepers by means of partitions, and also since then the wooden sleeping shelf has gradually been replaced by reinforced concrete with a covering of some non-heat-conducting substance.

The most recent standard type of compound room is arranged on what is locally known as the "cubicle" principle, the figures on the two following pages showing one of these in sufficient detail to enable a very fair idea to be formed of the structural arrangements. One of these drawings shows a standard room for 40 occupants, and the other a standard room for 10 occupants. The latter type is preferable

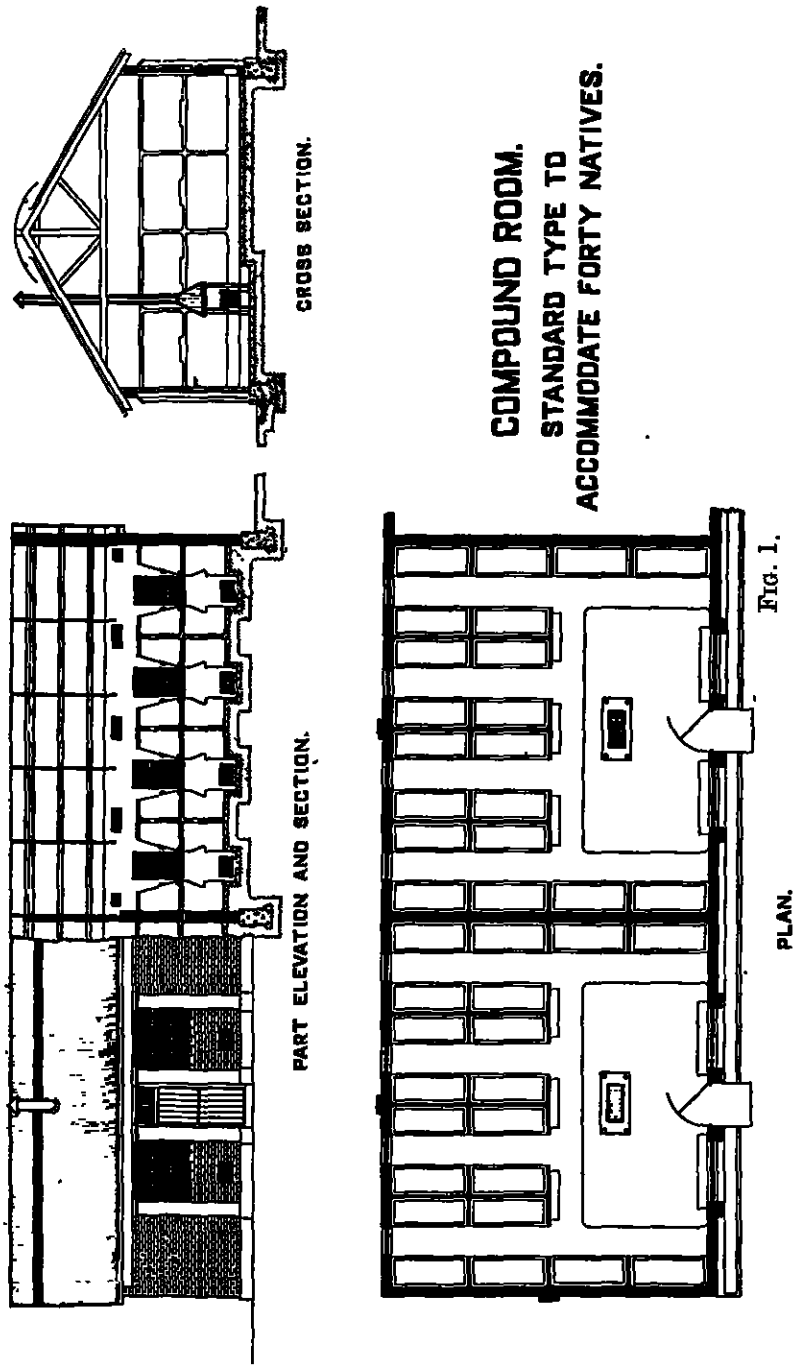
CROSS SECTION.
PART ELEVATION AND SECTION.
COMPOUND ROOM.
STANDARD TYPE TO
ACCOMMODATE FORTY NATIVES.
PLAN.

FIG. 1.

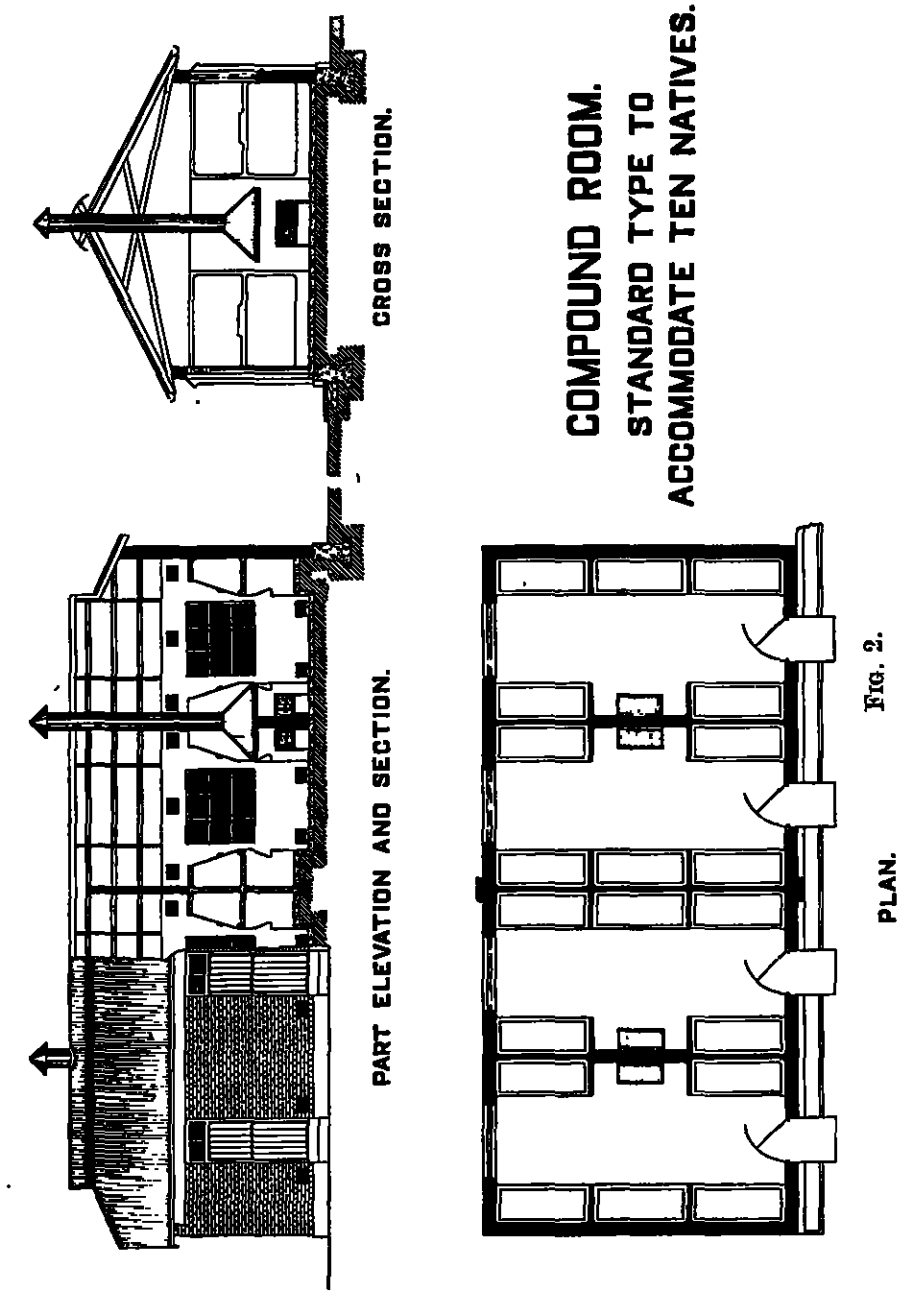
COMPOUND ROOM.
STANDARD TYPE TO
ACCOMMODATE TEN NATIVES.
CROSS SECTION.
PART ELEVATION AND SECTION.
PLAN.

FIG. 2.

where the larger amount of ground required for a compound with this type of room is available. The underlying principles covering the design of this type of room are :—

(1) Without significantly greater cost to provide reasonable separation, either by mechanical means, or by intervening unoccupied space, of each individual sleeper.

(2) To substitute for the movable brazier, with its attendant dangers of fire and CO poisoning, a fixed fireplace.

(3) To provide adequate ventilation which could not be easily interfered with by the occupants.

(4) To minimize the danger of infestation with insect parasites.

(5) To enable the rooms to be easily cleaned and whitewashed.

Two types of latrines are provided in the compounds, depending on whether water-borne sewage is or is not available. Where water-borne sewage is available, the latrines are fitted with the " range " type of closet, the walls are built of brick, and the floors are made of concrete. Where the bucket conservancy system must be used, a similar structure is erected, and seats suitable for this type of conservancy are provided. Usually the arrangements of bucket latrines are of the " squatting " type, whereas in the water-borne latrines they are of the conventional " sitting " variety.

The ablution arrangements are in the form of shower baths which, in the more modern compounds are provided with warm water by means of a calorifier in which the temperature of the water is kept at a constant level. In the older type of compound cold shower baths only are provided, but hot water is made available in a tank from which the bathers draw their requirements in a bucket. One shower is provided for an average of one hundred Natives employed.

Usually there is provision for clothes-washing in the ablution rooms, either in the form of concrete slabs or concrete troughs.

In each compound there is some form of disinfector, in which all the clothing and bedding of the Natives can be at least deverminized. This is important, because of the endemicity of typhus fever in certain areas in the Union. As a rule, the clothing and bedding of all the Natives is deverminized at least once in six weeks, although in some compounds the deverminization is suspended during the cold months of the year. Where boards are used for sleeping accommodation, these are either boiled once in four to six weeks, or treated with some vermin-destroying substance at the same intervals.

7. FEEDING.

The cooking in compounds is done in central kitchens, in steam-jacketed pots, although more recently in a few compounds experiments have been conducted with cooking by means of live steam introduced directly into the pot.

The diet scale, as laid down by the Government Regulations, with its calorific value and approximate vitamin content, is as follows :—

TABLE 4.

RATION SCALE FOR NATIVE LABOURERS.

ARTICLE.	Minimum Daily Allowance.	Energy Value Calories.	VITAMINS.		
			Water Soluble C.	Water Soluble B.	Fat Soluble A.
Mealie Meal	24 ozs.	2,568	0	0	0
Bread	6 „	441	0	0	0
Beans or Peas	1·5 „	145	0	+ +	0
Beans or Peas Germinated ...	1·5 „	145	+ +	+ +	0
Meat	6·85 „	470	+	+	+
Soup Meat	1·7 „	145	+	+	+
Pea Nuts	2 „	241	0	+ +	0
Sugar	1 „	116	0	0	0
Vegetables	5 „	80	+	+	+
Salt	0·5 „	—	0	0	0
Cocoa	0·25 „	34	0	0	0
Kafir Beer	6 „	Total : 4,385	—	—	—

0=Absent. +=Present. ++=Abundant.

The meat provided for in these Regulations is used in the following ways :—

The entrails, heads, hoofs, a certain amount of meat and fat, and certain bones are cooked with vegetables into a stow and issued daily, and generally a total of about 3lb. of the meat is issued to the Natives raw on two or three days of the week. This meat the Natives grill on the fires in their rooms.

The bread is issued at the time of going on shift in the morning, and is supposed to be consumed during the day.

The general custom is to have one large meal immediately after returning from work, and this is supplemented by a lighter meal given before proceeding to work. The practice in regard to this meal varies. In some instances, it consists of coffee or cocoa only. On some mines meat-stow with vegetables is issued before going on shift.

The Natives line up for their food issue and are given a certain amount of each of the foods provided, but any Native may return for an additional portion if he so desires.

In considering the diet of the mine Natives, one may look at it from two points of view :—

(*a*) What the Native usually consumes in his own kraal.

(*b*) The adequacy of the diet from a physiological point of view.

In his own kraal the Native's staple food is maize ("mealie") flour, supplemented by such plants as may be available in his particular locality and collected by himself or his family. Milk is nowadays consumed but relatively infrequently; meat only very occasionally. The maize flour is as a rule not milled, but ground in a mortar and then sifted. It is usually relatively coarse and contains practically the whole of the maize kernel, except the chaff.

There can be no doubt that the mine diet is vastly superior to the average diet of the Native in his home but, on the other hand, his output of energy is very much greater on the mine than at home. At home the Native as a rule takes only one substantial meal a day. The same is at present the general rule on the mines, although when one considers the amount of work performed by the Native on a mine, it can be reasonably questioned whether the one-meal-a-day custom is a sound one.

From the physiological point of view, the diet is reasonably adequate in all but one particular, and that is in its vitamin A content. Up to the time of writing no data are available as to the exact amount of vitamin A in the Native ration as issued on the mines, but even a cursory examination of its constituents indicates that it is deficient in this constituent. The work of the Mellanbys and others has clearly indicated the important rôle played by vitamin A in the prevention of infection. The study of Cobbett[41] indicates that bad diet and deprivation of fats played an important rôle in the post-war increase of tuberculosis in certain countries. It would seem, therefore, that increase of vitamin A in the diet of mine Natives is a desideratum to be aimed at.

Experiments are now being conducted with a view to finding a palatable and at the same time reasonably cheap source of this vitamin for inclusion in the Native diet.

The work of Henderson and Kelly[42] in Kenya seems to indicate that calcium content of the diet also plays an important rôle in the maintenance of health. In order to throw light on this point, the calcium content of a number of typical mine Natives' rations was investigated at the South African Institute for Medical Research, and it was found that it varied between 1·28 gramme to 0·53 gramme. Even the lowest amount found would appear to be reasonably adequate.

8. WORKING CONDITIONS.

Only a small number of Natives are engaged in night-work. The typical working day of a Native starts at about 4.30 a.m., when he is wakened to proceed to the shaft-head preparatory to going underground; and it ends at about 3 to 4 p.m., when he returns to the compound. Sunday is a day of rest.

When off work the Native spends most of his time in the open, strolling about in the compound yard and outside, or sleeping, the latter also usually in the open during the day. The only recreation calling for physical exercise in which Natives indulge to any extent is dancing,

but even in this pastime a relatively small number of them participate. Some of the more civilized Natives, negligible, however, in numbers, play football and cricket. About once a week a cinema show, very largely attended, is given in the compound yard, and some of them take part in educational classes organized by various agencies, in which they are given elementary education. It can be said that for the great body of the Natives there are no organized recreative facilities.

In the neighbourhood of each compound there is usually a Native eating-house, where various foodstuffs which the Natives esteem as delicacies are obtainable. These are fairly well patronized, and serve to some extent as centres of social intercourse, or clubs.

At this point it seems convenient to refer to the consumption of alcohol, which might be conceived as playing a serious rôle in the health of the Natives. The sale or giving away of alcoholic beverages to Natives is prohibited by law under severe penalties. Nevertheless, a considerable amount of alcoholic beverages are obtained through illicit agencies, the lucrativeness of this business apparently outweighing the fear of the severe penalty. But although one can observe a small number of drunken Natives any week-end in the neighbourhood of any compound, these are but exceptional instances, the vast majority of mine Natives not indulging in alcoholic excesses of any sort. From a physiological point of view, therefore, the influence of alcohol on the general health of mine Natives can be dismissed as negligible.

When a Native is engaged for underground work, he undergoes a short period of preparatory training, which varies within wide limits on different mines. On some mines this training comprises instruction in a specially-equipped building, where the Native is shown the various tools which he is to use, and told their names and their methods of use. Models are also demonstrated to him of various types of mine workings, and he is shown how to do drilling with a machine, and how best to perform various other operations which he might be called upon to do. At the same time, he is instructed in the various dangers associated with mining, and given instructions as to safe methods of performing his work.

If the mine is a deep one with high underground temperatures, he is then put to work for a period of about 14 days in a working place with a relatively low temperature and good ventilation, so as to acclimatize him to mining conditions. At the end of this period he may be transferred to a hotter working place.

The majority of Natives underground are employed in one of three main occupations :—Drilling, by means of compressed air actuated drills, principally of the jackhammer type ; pushing trucks loaded with ore ; and/or shovelling ore from one place to another, or loading it into the trucks. A small and decreasing number of Natives still do hand-drilling. Experiments performed to assess the output of energy in the various occupations show that the greatest output is in connection with shovelling rock and pushing trucks, and that the lowest output is in machine drilling.

Broadly speaking, the Natives from the Portuguese territories are principally engaged in drilling, as they show special aptitude for this type of work, which requires a considerable amount of skill and intelligence. B.S.A. Natives are principally employed in shovelling and pushing trucks, although an increasing number of these are being introduced into drilling gangs.

Although the majority of compounds are situated close to the shaft which the Natives have to descend to reach their work, there are a few instances where a considerable distance has to be traversed by the Natives before they reach the shaft-head. In a few instances this distance is as great as two and three miles, but these are exceptional. The transportation of the large number of Natives underground takes a considerable time, and a certain number may have to wait an hour or even two before they can enter the cage which is to carry them underground. On a cold winter's morning this waiting, which is often done in the open, or practically in the open, may make a serious inroad into the Native's vitality, which, if one takes into account a long walk on the surface and a long walk and perhaps a climb underground, may *in toto* represent a serious drain on his energy, so that he may reach his work already in a tired condition. This factor is appreciated by the managements and efforts are constantly being made to minimize this waste of energy as well as the drain on the vitality of the individual.

When the Native's work underground is finished there is again liable to be a considerable period of waiting before he can be transported to the surface.

The mine managements have appreciated the importance of avoiding exposure between the shaft-head and the compound, and there is an adequate provision of changing rooms and baths on most mines.

It appears to the Committee, however, that there has not been an equal appreciation of the risk of chill run by the Natives during the time spent (which may be an hour or more) after knocking off work in a hot, damp place, in waiting to be hauled up out of the mine.

The waiting-places are near the down-casts and comparatively cool and dry. The contrast between one's temperature sensations in the slow-moving air of most working-places and in the gales blowing down the underground main roads must be experienced to be appreciated. At a working place one is glad to be stripped while in the main road one is just as glad to get into clothes, although the thermometer may be registering practically the same temperature in each situation.

A rub-down and a blanket immediately on knocking off work would be better than a Turkish-bath an hour or more later on the surface.

Owing to the Regulations framed with a view to preventing silicosis, a great deal of water is used underground. Not only is all drilling done with axially water-fed drills, but additional water is sprayed on the exposed rock face when drilling is first commenced—"collaring," as this is known—and in addition to it, no rock is handled in any way until it is thoroughly saturated with water by means of a hose. Further-

more, the floor, sides and roof of the working-place are also thoroughly sprayed with a hose. The shafts are also subjected to spraying, and water is atomized by means of compressed air to form a dense curtain during blasting time. The result of this immense and, from the silicosis-prevention point of view, probably greatly excessive use of water, is that the mine atmosphere is in a state of saturation. This saturation, combined in the deeper workings with a temperature between 85° and 90°F., undoubtedly subjects the mine workers to serious physiological stress. Studies conducted by Orenstein and Ireland[43] indicate that under certain unfavourable underground conditions, with a wet Kata cooling-power of 5, as much as 45 per cent. of the efficiency may be lost, as measured in output of work.

In connection with the high humidity of the underground air, the possibility of these conditions facilitating infection leading to respiratory diseases cannot also be lost sight of, when one recalls the difficulty experienced in experimental respiratory infection with dry bacilli, and the ease with which this can be achieved with bacilli suspended in fluids. The fact that work in humid atmospheres is a frequent cause of epidemics of furunculosis may also be an indication of the favourable influence such atmospheres have on the implantation of infection.

Section B.—Industrial Benefits and Risks in Gold-mining.

"... We may still question the expediency and efficiency of those measures introduced by the white man, not in order to satisfy his own commercial requirements, about which he is quite likely to be a competent judge, but in order to satisfy his ideal of what he thinks the dark man under his control ought to require, when he has been taught what his needs should be by him, the superior white. The existence of the so-called 'Native Problem' is sufficient evidence that in this latter respect white men are, and have been, generally speaking, most incompetent."—*Pitt-Rivers* [83].

It would be easy to write this section from the conventional European standpoint, but the quotation given above indicates the advisability of approaching the subject as far as we can from the Native point of view. This entails some general consideration of his needs, hopes, prospects and outlook, and the reader is advised in this connextion to consult such works as those of Junod[26] and Molema[90].

The gold-mining industry, like other industries, is organized primarily in terms of commercial requirements, and the dark man has no private grievance in this respect. This industry entails special risks and has special methods for securing its Native labour force, so the question here to be considered is whether the dark man, as he now finds himself in South Africa, gets any benefit from the gold-mining industry other than that of being employed.

1. Benefits.

One may assume that the Native himself considers that employment on the Witwatersrand gold-field is to be sought after, since, of the 400,000 that go through the mines every year, about 80 per cent. are re-engagements. The labour force is not secured locally, but comes from considerable distances.

Molema writes: ". . . The Muntu (*pl.* Bantu) is essentially a farmer, agriculturist and stock-breeder and, even when at the mines he has, or had, often a little land to cultivate and a few animals to look after . . . his ultimate hope is to return, buy some more cows, and settle down on his little plot."

The land available in the Union whereon the Native can acquire interest is scarce and, for him, expensive. He wants money for another of his needs—a wife. Unless he has paid "lobola" or bride-price he is of no account; moreover, the children will not be legally his but his wife's and go with her in the event of a separation.

The occasion of the desire of this pastoral community to take up mining is, therefore, not far to seek. The industry is the one considerable avenue to skilled labour and the higher wage it commands.

Lovedale and other organizations make praiseworthy attempts to equip the Native as a tradesman, but it is most difficult for the Native thus equipped to secure employment. In this country there is the utmost prejudice against encouraging the Native to become a competitor as opposed to a hewer of wood and a drawer of water. This prejudice is perfectly understandable when one remembers that the Native's desired standard of life can be secured on a much lower wage than will satisfy the European and, other things being anything like equal, cheap labour drives less cheap labour out of the market.

In the respect of earning a decent wage, the Native's position is getting worse rather than better. The prevailing unemployment from which the Union has not escaped has resulted in Native government servants being swept out of the railway departments, post office and telegraph departments and the Civil Service, to be replaced by Europeans.

Since the land available for the Native in South Africa is limited and—for him—costly, the great benefit that he gets from the gold-mining industry and his reason for seeking employment there is that it affords him almost his only means of securing economic ability to become economically free after the only fashion in which economic freedom appeals to him.

It may well be asked: If the gold-mining industry has all this to offer, why recruit labour?

The idea of recruited labour is rather repugnant to the modern European, but it is quite in keeping with the Bantu's own recent tradition.

Before ever the Bantu and the European cultures clashed, the former had an established custom of national service. Every three years or so the adolescents were collected into "mephato" or regiments to undergo the rites of circumcision and initiation into full tribal membership. Each mephato had a distinctive name given to it, and any

mephato was liable to be called upon at any time by the chief to do any work. ". . . Each had, of course, to provide his food and the work was a free service to the tribe, no one getting paid."

The idea was not primarily military at all so far as concerned the Bantu as a whole, although the tribes often did engage in some fighting among themselves, much as did the Highland clans and Border folk in Great Britain.

It is true that about the beginning of last century Dingiswayo, of the Ba-Temba, substituted conscription for national service and militarism for communism, and this idea came to full fruition under Chaka and Mzilikazi, but the manner in which these two fighting captains marched over Africa is good evidence that the rest of the tribes were not organized in a military sense.

The object of this digression has been to show that it comes natural to the Bantu to be sent off in large numbers to work for a central authority. Their own people would never have sent them far away nor have sent them for long; on the other hand, they would not have fed, housed or paid them.

Since the labour for the mines comes from a distance, transport organizations have to be supplied and enlistment for civil purposes is as conventional for the Bantu as is enlistment for military purposes to the European.

Full details of the work of these agencies are to be found in a paper already referred to on p. 61 of this Chapter.

Just as the Native himself does not take any particular exception to the circumstances of his engagement, so, too, he is tolerably well satisfied with his housing.

A visitor from Europe going round a mine compound for the first time is liable to be reminded of the Acts of the Apostles, i., 13, ". . . they went up into an upper room, where abode both Peter, and James, and John, and Andrew, Philip and Thomas, Bartholomew, and Matthew, James the son of Alphæus, and Simon Zelotes, and Judas, the brother of James." There is here some suggestion of overcrowding, but we are unaware of any complaint on the part of the apostles, just as there is none on the part of the Native in his compound room.

Of course, this does not imply that the responsible authorities are always satisfied with the manner in which the Native is housed, but that is another story which is considered elsewhere in this Report. Here we are considering the Native's own attitude towards what he gets and what he gives.

The nearer he can get to his kraal conditions the better he is pleased, and in his kraal he is not now as well housed as he used to be. In older times his hut cost him nothing; there was no lack of ground, materials could be had for the taking and, on application, his headman turned out a party to help with the building.

Nowadays there is not always the necessary ground; material has to be bought and paid for, and his fellows are less ready to do tribal work for nothing. The Native with a growing family can no longer

put up another hut as a matter of course, and his mine wage comes in very useful in this connexion.

The feeding of the labour force is always a very present problem, although the Native is easy to please in this respect, and there are far fewer complaints than among the general run of members of a Johannesburg club.

The diet is certainly adequate from the nutritional point of view. Table 5 summarizes the weights relating to over 20,000 Natives at the beginning and end of a contract. Every Native had at least six months' service; they were selected at random, subject only to the stipulation that all Natives included in the return must have been discharged as apparently fit.

TABLE 5.

Mine.	Total Number of Discharged Natives dealt with.	Natives gaining 1lb. or more between Initial and Final Weighings.			Natives losing 1lb. or more between Initial and Final Weighings.			Natives neither gaining nor losing more than 1lb.	
		No.	%	Average Gain in lbs.	No.	%	Average Loss in lbs.	No.	%
Brakpan Mines ...	827	419	50·7	4·98	334	40·4	3·70	74	8·9
City Deep	1,000	707	70·7	6·25	236	23·6	3·83	57	5·7
Cons. Main Reef ...	500	328	65·6	5·83	148	29·6	4·63	24	4·8
Crown Mines ...	1,000	728	72·8	7·12	210	21·0	3·95	62	6·2
Durban-R. Deep ...	300	227	75·7	8·61	59	19·7	4·34	14	4·6
E.R.P. Mines ...	700	509	72·7	6·74	147	21·0	4·14	44	6·3
Geduld Prop. ...	1,000	594	59·4	6·39	317	31·7	3·94	89	8·9
Geldenhuis Deep ...	340	229	67·4	6·89	85	25·0	3·31	26	7·6
Government Areas	1,000	489	48·9	6·62	432	43·2	4·54	79	7·9
Langlaagte Est. ...	1,000	648	64·8	6·70	262	26·2	3·81	90	9·0
Meyer & Charlton	300	240	80·0	7·60	41	13·7	2·05	19	6·3
Modder B.	771	521	67·6	6·49	195	25·3	4·61	55	7·1
Modder Deep L. ...	379	215	56·7	6·38	138	36·4	4·13	26	6·9
Modder East ...	890	512	57·5	4·25	277	31·1	4·17	101	11·4
New Kleinfontein	250	186	74·4	9·62	46	18·4	3·54	18	7·2
New Modder ...	974	593	60·9	6·44	261	26·8	4·74	120	12·3
New State Areas ...	1,014	484	47·7	5·49	462	45·6	4·92	68	6·7
Nourse Mines ...	300	223	74·3	5·84	64	21·3	4·16	13	4·4
Randfontein Ests.	1,000	762	76·2	3·67	192	19·2	3·33	46	4·6
Robinson Deep ...	500	344	68·8	6·07	124	24·8	3·69	32	6·4
Rose Deep	200	158	79·0	7·57	33	16·5	4·33	9	4·5
Simmer & Jack ...	445	273	61·4	8·92	130	29·2	3·55	42	9·4
Springs Mines ...	1,000	598	59·8	6·43	332	33·2	4·06	70	7·0
Van Ryn Est. ...	172	93	54·1	6·34	57	33·1	3·74	22	12·8
Van Ryn Deep ...	400	236	59·0	5·53	129	32·3	5·06	35	8·7
Village Deep ...	1,000	740	74·0	7·94	98	9·8	4·90	162	16·2
West Rand Cons.	300	239	79·7	7·33	48	16·0	2·21	13	4·3
West Springs ...	550	332	60·4	5·45	185	33·6	4·21	33	6·0
Witwatersrand ...	1,000	751	75·1	6·88	197	19·7	3·56	52	5·2
Wit. Deep	1,000	820	82·0	9·04	128	12·8	4·64	52	5·2
Sub Nigel	500	389	77·8	7·46	80	16·0	4·49	31	6·2
	20,612	13,587	65·9	6 58	5,447	26·4	4·13	1,578	7·7

Although they were, in most cases, coming from the leisure of the kraal to physical labour, the average weight was 132·4lb. on entry and 135·7lb. on discharge.

In so far as there are complaints, they arise, in the main, over tribal taboos. For instance, some tribes will not eat fish, and others consider that fat should be used for external application only. It is more serious when one has to deal with the vegetable taboos. An old hand may not infrequently be seen peevishly picking the vegetables out of his stew and throwing them on the floor. Should he go on doing this long enough and thoroughly enough, he may end by getting scurvy.

The fact is that getting a sufficiency of the accessory food factors into the diet is rather like concealing a powder in the spoonful of jam given to a baby. Should the deception be detected, there is trouble.

On the whole, however, the Native does not find fault with the food provided; he maintains his health and, in the majority of cases, improves in condition during the course of a contract.

2. Risks.

While the Native derives advantages from his employment on the gold mines, he exposes himself to certain risks from which he would be free if he remained in his kraal.

Mining is a dangerous trade, even in an old-established European mining district with a long tradition and spontaneous discipline. Organization and supervision is reducing the Native's accident rate from year to year, but the mine medical officer's accident wards are still far from lacking patients.

Accidents are not the only mining risk. Apart from an occasiona epidemic, the Native in his home is not a great sufferer from bacterial and other diseases. In the mine compounds, however, there is always a certain amount of sickness, mostly respiratory, and the conditions facilitate case-to-case spread.

Nevertheless, the general health of the force, as judged from percentage of "shifts lost" owing to sickness, is good and, if there be more sickness on the mines than in the kraals, there is less than there is in city locations.

There is a rather instructive comparison between the gold mines and collieries on the one hand and the Kimberley diamond mines on the other. The former draw their labour from a distance, and there is consistently a high sickness rate during the early part of a contract. As the new arrivals settle down, all forms of sickness diminish greatly in incidence.

In the case of the diamond mines, labour is drawn from local sources and there is not this excess sickness rate at the start of a contract.

Quite apart from the novelty of mining conditions, the general change is greater for those who come from a distance, and their resistance is affected adversely by the journey and the associated collection of Natives from different localities.

Another matter arises in this context. Natives employed on the diamond mines remain on the mine property throughout their contract,

while the gold-mine and colliery Natives have the run of the neighbourhood.

As soon as Natives are collected in large numbers in accessible places, they are subjected to unaccustomed temptations of drink and venery inseparable from such opportunities for profitable exploitation by a certain unprincipled class of the community. Arising out of this circumstance, which, although unlawful, appears also to be uncontrollable, is one of the risks to which the labour force is exposed, although it is not a risk connected with either gold mining *per se* or with compound management.

There is no doubt that the Natives would benefit in most respects were it practicable—which it is not—to house the labour force in townships and give them an ordinary family life. In one very serious respect, however, this would probably be a disadvantage. It would almost inevitably lead to continuous instead of intermittent employment. The special risk of gold mining would then come more into play and the last state might be worse than the first.

The special risk on the Witwatersrand goldfield is the exposure to silica dust, and in this risk the Native shares. Owing to his intermittent employment and comparatively short total employment, however, this risk is favourably modified. While there is a steady, if comparatively low, incidence of silicosis on the Natives employed, the presence of silica dust must affect the tuberculosis incidence unfavourably.

When considering the benefits and risks of gold mining, we may finish—as we began—with a quotation from Pitt-Rivers :—

" The impotence of the more lowly and barbarian cultures to make an effective resistance against attempts at Europeanization has left the Natives ill-equipped and without the will to survive the destruction of all the values that gave meaning and zest to their lives."

Gold mining does give some meaning and zest to the lives of this landless and homeless proletariat of ours that is loitering on the outskirts of civilization ; it does supply a sort of community of interest.

For many tribes, going to the mines has taken the place of going on a razzia and renders the miner a man of consequence.

He is spoken of as one " acquainted with the deeds of men." A girl who is in a position to choose will choose a miner and this not only because he may make a better home for her : he has accomplished the present-day equivalent of " wetting his spear." The European may not approve of polygamy, but the Native does. The dignity of a man is increased by the number of his wives, and the wife or wives encourage him to take more. It is like showing the neighbours that your husband can keep more than one car. Few Natives other than those who have been employed on the gold mines can run to more than one lobola.

It is probable that the Native dislikes mining less than other manifestations of European culture with which he is brought into contact, and he dislikes it less for the reason expressed in the words of his own grace—" If I have seen the fat I have also partaken of the meat."

CHAPTER III.—HEALTH SERVICES IN THE GOLD-MINING INDUSTRY.

The extensive and efficient health services directed to the welfare of all Natives upon their recruitment to the mining industry stand in direct contrast to the almost entire lack of any such provision for them in their home areas, where the entire medical services available are confined to a few district surgeons and private practitioners, whose numbers are so small that their combined efforts can hardly be said to constitute a medical service in the slightest degree adequate for the necessities of the large and scattered population of the Native Territories.

Here follows a brief description of the system of health services for Native mine labourers in existence on the Witwatersrand, together with a reference to the chief organizations concerned in carrying it out.

SECTION A.—HEALTH SERVICES ON THE MINES.

1. THE MINE MEDICAL OFFICERS.

Government Regulations provide that the Natives employed on the mines shall receive free medical and hospital treatment during their employment. For some considerable time the majority of the mines have provided this treatment through medical officers who devoted their whole time to the Native employees, but there were some of the mines on which this service was rendered by medical officers giving only part of their time to this work. In 1925 Regulations were promulgated, making the employment of full-time medical officers for mine Natives compulsory. The principal duties of a mine medical officer are as follows :—

(1) He is an examiner, under the Miners' Phthisis Act, in so far as Natives are concerned. This imposes upon him the duty of medically examining every Native applicant for work and certifying him as fit for employment, especially in regard to being free from tuberculosis. He must also carry out periodic examinations of all Natives, to satisfy himself that they are fit for work, and especially that they are free from tuberculosis and silicosis. He must examine every Native at the termination of his employment and certify as to his freedom or otherwise from tuberculosis and silicosis. The periodical examination takes the form of weighing at least once every six weeks every Native employed. Any native who is found to have lost 5lb. between two consecutive weighings, or a total of 6lb. or more in three consecutive weighings, is subjected to a special clinical examination,

including, if necessary, detention in hospital. Furthermore, any Native who is admitted to hospital for any cause whatever is specially examined with a view to determining whether he has any signs of tuberculosis and silicosis.

The efficacy of these examinations is indicated by the fact that out of 2,217 consecutive cases of pulmonary tuberculosis (not including tuberculosis with silicosis) which had been certified on the gold mines of the Witwatersrand, 1,006 were diagnosed during illness in hospital, 504 as a result of clinical medical examination outside the hospital, and 707 at periodical weighings. The value of weighing is indicated by the finding that out of 2,054 consecutive cases of pulmonary tuberculosis unconnected with silicosis, 1,714 had lost weight, 404 gained weight, and 136 remained stationary in consecutive weighings. The subject of periodical weighing as an aid in the early diagnosis of tuberculosis receives further consideration in Chapter IV. p. 110, *et seq.*

(2) He is responsible for the hygiene of the Native employees. In this connexion, he periodically inspects compounds, underground workings, food supplies, etc., except that this duty is not imposed upon medical officers on the mines of the Central Mining/Rand Mines Group, where a central organization for the supervision of hygiene exists.

(3) He is responsible for the medical and surgical treatment of all Native employees.

2. MINE HOSPITALS.

In terms of the Regulations, hospital beds in the ratio of 2½ per cent. of the average number employed must be provided. With the exception of seven mines of one mining group, a hospital for Natives is provided at each individual mine. In the group above referred to, there are three central hospitals situated on centrally-located mines, each serving several mines. In these so-called "Central Native Hospitals" the nursing personnel consists of European sisters and Native female nurses, the latter being trained in these hospitals. In the other mine hospitals the nursing personnel consists of European male trained nurses, assisted by trained and untrained Native males. At the mines served by the "Central Native Hospitals," except those at which the central hospitals are situated, there are provided auxiliary "clearing" hospitals, in charge of a European male trained nurse, where minor cases are detained for treatment. Experience has shown that, except in very minor ailments and injuries, restoration to health is delayed in the case of Natives treated as out-patients. For this reason the hospital admission figures of mine Native hospitals are not comparable with general hospitals, even those serving an industrial population, because a very large number of the patients admitted to mine hospitals would not be considered for admission in other hospitals, but would be treated as ambulatory out-patients.

Broadly speaking, 60 per cent. of cases at any one time in mine Native hospitals are surgical, and 40 per cent. medical. The majority of the medical cases are, as a rule, respiratory diseases.

The equipment of these hospitals is up to the standard of ordinary general hospitals. The wards are well ventilated and lighted, provided with suitable beds, and all the ordinary nursing apparatus. In most hospitals there is installed an X-ray plant with sufficient power to make satisfactory radiographs of the lungs. There are well-equipped operating theatres, provided with sterilizing and surgical apparatus. Ablution facilities are ample, and the standard of cleanliness in nursing is in every way satisfactory. Of course, because of the larger size and consequently proportionately lower overhead costs of the "Central Native Hospitals," it is possible to provide a higher grade of equipment in these than is economically possible in all individual mine hospitals.

Mention has been made above of the head office organization of one of the mining groups. This consists of a medical officer, who is in charge of all the medical and sanitary services on the mines comprising this group, who has on his staff a trained sanitarian, and the necessary clerical assistance. The whole administration of the medical and sanitary services is in his hands, and all communications from and to Local and Union Government relating to medical and sanitary matters pass through him. This organization, therefore, potentially permits of unification of policy and interchange of experience and knowledge obtained on the various mines comprising that group. It also permits of the establishment and prosecution of definite lines of investigation, for which purpose a special medical officer is employed, and in which various mine medical officers of the group also lend a hand.

3. Transvaal Mine Medical Officers' Association.

Early in 1921, principally through the instrumentality of the late Dr. H. T. H. Butt, the Senior Medical Officer of the Randfontein Estates G.M. Co., and with the assistance and encouragement of the Chamber of Mines, the mine medical officers for Natives were organized into the Transvaal Mine Medical Officers' Association. This Association holds monthly meetings for the interchange of experience, and conference on the various problems with which its members have to deal. Its *Proceedings* contain a number of valuable contributions, covering investigations into such important matters as pneumonia, tuberculosis, enteric fever, the treatment of various surgical injuries, etc. It also acts as a technical advisory committee to the Chamber of Mines. It is undoubtedly serving a most useful purpose in many directions.

4. Hygiene of Mine Compounds.

The carrying out of the various prophylactic measures in the compounds rests with the compound managers and their staffs, on the advice and under the supervision of the mine medical officer or, in the case of the one group, the headquarters organization. The compound manager is responsible for the cleanliness of the compound, for the

maintenance in a satisfactory condition of the rooms, washing and sanitary installations, kitchens, etc. He supervises the preparation and issue of the food, and the sending for medical treatment of Natives who appear to be unwell or who are injured.

The compound managers are selected from among men who have had long and intimate contact with Natives, and who can speak at least one of the Native dialects. Their duties are very responsible and onerous and, generally speaking, they discharge these in a highly satisfactory manner. Several years ago a course in elementary hygiene was given to compound officials, which was largely attended and which undoubtedly served a very useful purpose. Quite recently, one of the mine groups prepared a special manual on elementary hygiene and the duties of the compound staff in relation to hygiene, which was issued to every member of the staff, and which should also serve a useful purpose. It would appear desirable that all members of the compound staffs should receive a course of elementary instruction in hygiene and sanitation before they are promoted to senior positions.

5. UNDERGROUND SANITATION.

The underground sanitation is in charge of the underground manager, and under him of the mine captains and subordinate officials in charge of the various sections of the mine.

Bacteriologically and chemically satisfactory drinking water is provided underground at conveniently situated centres.

Permanent latrines are provided in reasonably close proximity to the working-places, and are supplemented by portable installations, carried as close as possible to advanced workings. The permanent latrines are constructed with concrete floors, so curbed as to prevent pollution of the mine, and are fitted with pails provided with hermetically closing covers for transport to the surface, where the contents are disposed of, either by dumping into sewers, trenching, or incineration. Separate latrines are provided for Europeans and Natives.

Owing to the presence of a considerable number of hookworm carriers in the mines, the latrine floors and buckets are treated with rock salt, and the perches, walls, etc., are swabbed with a 20 per cent. salt solution daily. Salt treatment is also carried out on the cages which carry the buckets to the surface, and the areas on which the buckets are placed prior to being loaded into the cage are also strewn with salt. The same salt treatment is also applied to any underground and surface transport, where such is employed in carrying the pails.

Where the water used in connexion with drilling, hosing-down of the working-place and rock is found to be infected, it is usually chlorinated.

Supervision directed towards the prevention of fæcal and urinary pollution of the mine is a very difficult matter, owing to the great extent of the workings and the visual difficulties, but the underground officials

and European miners have been made very much alive to this danger, and recent investigations seem to indicate that such pollution is at present exceptional.

Several years ago an investigation was made on a number of sputum specimens collected underground, and in a considerable percentage of these acid-fast bacilli, which on ordinary microscopic investigation were stated to be *B. tuberculosis*, were found. A more recent investigation at the South African Institute for Medical Research (see Appendix 6, p. 367) by means of biological tests, indicates, however, that the acid-fast bacilli found were probably not *B. tuberculosis*, as similarly obtained specimens of sputum showing acid-fast bacilli did not produce tuberculous lesions when inoculated into susceptible animals.

Section B.—General Health Services.

1. Witwatersrand Native Labour Association's Hospital.

(a) Examination of Recruits.

As stated in Chapter II, Section A, all Natives for employment on the gold mines are examined at the Witwatersrand Native Labour Association's central depôt hospital in Johannesburg.

From 170,000 to 180,000 recruits are examined annually, and the numbers presented for examination daily vary from 300 to 1,200. A staff of six whole-time medical officers performs these examinations.

On arrival at the depôt every Native takes a bath, being given soft paraffin soap with which to cleanse himself. The clothes of the British South African Natives are deverminized in a steam disinfector—a necessary precaution in view of the prevalence of typhus fever in the Native Territories of the Union. Thereupon the Natives are drafted in batches to the examination rooms, where they are first taught by trained Native orderlies to breathe in a manner suitable for auscultation. This preliminary may appear unnecessary, but in practice it is found to be essential and saves a great deal of time, as some Natives are very nervous and apprehensive.

These recruits are then lined up, naked, in rows of about 25 before each medical officer, who carefully auscultates the chest—front and back—and makes a mark on the chest on the detection of any abnormality, however slight. He is thereupon removed to a special room for re-examination by a medical officer whose whole time is thus occupied.

If considered advisable, the suspect is detained in hospital, X-rayed, his medical and labour history enquired into, and a bacteriological examination made of his sputum.

On the completion of the auscultation of each row, an inspection is made of the limbs, eyes and glands, while signs of venereal disease are looked for, and those passed fit are sent to the depôt pass office for registration.

In spite of the schooling, there are always some who will not, or cannot, breathe suitably. It has been found necessary to X-ray the chests of such Natives, as a large proportion of them are found to have tuberculosis or silicosis. In many cases the poor breathing is wilfully done, the Native thus hoping to escape the detection of disease.

Cases of early silicosis and early hilus tuberculosis are almost certainly missed at this initial examination, for it is impossible to detect these conditions by auscultation alone.

Disposal of Natives found Unfit at Initial Examination.—Natives found to be unfit at the distributing depôt, including those returned after examination by the mine medical officers on the mines, are dealt with as follows :—

(i) Natives who are ill are admitted to hospital and treated, and if the disease from which they have suffered has been of a serious character, they are repatriated in due course.

(ii) Recruits who are out of condition, or merely "train-weary," are weighed and detained in the depôt under medical supervision for a fortnight or longer. During this time they are periodically examined and only passed out when sufficiently improved for underground mine work. Those who do not improve to any extent are usually put on light surface work at a mine ; they are not allowed to work underground until passed as fit therefor.

(iii) Natives with chest abnormalities are detained in hospital for investigation (radiographic and bacteriological) to exclude cases of silicosis or tuberculosis.

Natives found to be non-tuberculous and otherwise fit for light work are discharged from hospital and offered mine surface work. Tuberculosis cases—incipient or otherwise—are repatriated to their homes. Silicotic or tuberculo-silicotic cases are transferred to the miners' phthisis wards for examination by the medical officers of the Miners' Phthisis Medical Bureau to determine, in terms of the Miners' Phthisis Act, the degree of incapacitation. Such Natives are repatriated when fully dealt with in terms of the Act.

The Service Contracts of all Natives found to be unfit for underground work but fit for surface work are endorsed accordingly, and in each case a certificate of unfitness to work underground, stating the cause, is made out and sent to the Native Affairs Department. Should the mine at a later date wish to transfer these Natives to underground work, it is under the obligation to send them to the W.N.L.A. depôt for re-examination. If fitness for underground work be then confirmed, the Service Contract is duly amended.

Table 6 gives the number of Natives dealt with and the causes and percentages of rejections, at the Central Depôt during the twelve months January to December, 1929 :—

TABLE 6.

Class.	Total Examined.	Total Rejected.	Causes of Rejection.			Percentage of Rejection.
			Tuberculosis.	Defective Lungs.	Other Causes.	
East Coast Recruits	43,392	2,908	160	667	2,081	6·70
East Coast Natives for Re-engagement	11,573	119	18	65	36	1·03
British South African Recruits	54,031	2,287	178	674	1,435	4·23
British South African Non-recruits	43,795	986	57	319	610	2·25
British South African Re-engagements	16,058	198	8	104	86	1·23
Contractors' Natives	2,736	5	2	3	—	·18
	171,585	6,503	423	1,832	4,248	3·79

N.B.—Silicotic and tuberculo-silicotic cases are included with tuberculosis. The term "Defective Lungs" refers to such conditions as crepitations, pleurisy, etc.—anything pulmonary not definitely tuberculous.

(*b*) *Treatment of Invalid "Transfers" from Mine Hospitals.*

The W.N.L.A. acts as a receiving depôt for the following classes of sick Natives from the Mines :—

(i) *Natives for Specialized Treatment.*—Special eye, ear, nose and throat cases, requiring the attention of a specialist, are frequently sent to the W.N.L.A. hospital, when arrangements are made to have them specially examined and treated.

(ii) *Convalescent Accident Cases.*—All compensatable accident cases —usually about 40 to 50 per week—are dealt with at the W.N.L.A. hospital by a Central Medical Board, which estimates the degree of disability in each case. The compensation is assessed by the Department of Native Affairs, and the amount is paid out, on behalf of the Rand Mutual Assurance Company, by the W.N.L.A. prior to repatriation.

(iii) *Cases under the Miners' Phthisis Act.*—All cases of pulmonary tuberculosis and silicosis diagnosed on the mines are sent into the W.N.L.A. hospital, for examination there by the Miners' Phthisis Medical Bureau, with a view to assessing the degree of incapacitation and the payment of compensation (if any) in terms of the Phthisis Act.

(*c*) *Repatriation.*

Convalescent Sick Natives for Repatriation.—About 120 convalescent Natives whom the mine medical officers regard as unfit or think inadvisable to continue working on the mines, are sent in weekly to the W.N.L.A. hospital for repatriation. During the two or three days the convalescents are in hospital awaiting repatriation, their temperatures are taken night and morning, and they are examined mainly

with regard to their fitness to undertake the homeward journey; any who are found to be unfit to travel, or who require further treatment, are either detained or sent back to the mine hospital.

East Coast Natives are forwarded, under the care of a trained European orderly, to the W.N.L.A. hospital at Ressano Garcia twice weekly by train, being accommodated in coaches specially equipped with cooking and other facilities. At Ressano Garcia the Natives are re-examined and provision is made for the conveyance of all serious cases to their homes. Telegrams are despatched to the various stations en route, and at every point of arrival, whether by train or steamer, one of the W.N.L.A. European staff is in readiness to provide all necessary attention.

The acutely-sick Natives proceed to the W.N.L.A. camps, where they are fed and cared for and, in necessitous cases, whatever transport is available is placed at their disposal. The majority of the repatriates consist of the less serious cases of illness, and these usually proceed direct to their homes accompanied by their healthy relatives and friends among the time-expired Natives.

British South African Natives are repatriated by train once a week to the station nearest their homes, where they are met by relatives with a wagon or other means of conveyance.

A specially equipped coach, with lying-down accommodation and cooking arrangements, is provided, and the Natives travel under the care of a European orderly.

In all lying-down cases, arrangements are made at railhead to have the Natives conveyed by available transport to their homes, and if hospital attention is required their admission to the hospital nearest their homes is arranged.

The train is met en route by a medical man who orders to hospital any Natives who have become seriously ill.

2. THE MINERS' PHTHISIS MEDICAL BUREAU AND THE COMPENSATION SERVICE FOR SILICOSIS AND TUBERCULOSIS.

(a) The Miners' Phthisis Medical Bureau is a Government institution in the Department of Mines and Industries, and its work comes under the direct control of the Minister of Mines and Industries, who is responsible for all appointments to the Bureau. The Bureau consists of nine whole-time medical officers, namely, a chairman and eight members. There is also a part-time radiologist, whilst the pathological services are carried out by the Department of Pathology of the South African Institute for Medical Research. The Bureau has in addition a technical and clerical staff of 19. All salaries and administrative expenses of the Bureau are paid by the Government.

The very large amount of pathological and laboratory investigations (examination of lungs, sputum, blood, etc.) necessitated by the work of the Bureau is carried out by the S.A. Institute for Medical Research, but the Bureau is responsible for all decisions which may be based on such investigations.

(b) " *European Miners.*"—The great bulk of the work of the Medical Bureau is concerned with the application of the medical provisions of the Miners' Phthisis Act (Act No. 35 of 1925, Union of South Africa) to " European miners."

The more important classes of examination and investigation conducted by it are :—

(i) *The* " *Initial Examination* " of all persons desirous of entering the mining industry, with a view to determining their fitness or unfitness for underground work.

(ii) *The* " *Periodical Examination* " of all working miners, with the object of securing the early detection and notification of cases of the three compensatable conditions, " silicosis," " tuberculosis with silicosis," and " tuberculosis " (without silicosis). Each individual miner is examined clinically and radiographically once in six months. Any person so detected and notified becomes *ipso facto* eligible for an original award under the Act.

(iii) *The* " *Benefits Examination,*" by which is meant the examination of claimants for further awards in respect of a possible advance in his condition. A few original awards also follow from claims made by retired miners who have not previously been found to have silicosis or tuberculosis at a periodical examination.

(iv) The investigation of *Claims made by Dependants in respect of Deceased Miners.*

During 1929-30 over 44,000 examinations and investigations were made in respect of 29,000 European recruits, working miners or beneficiary miners. The actual number of working miners examined was 16,130.

(c) " *Non-European Miners.*"

The " initial," " periodical " and " benefits " examinations of non-European (Eurafrican and Asiatic) miners are also conducted directly by the Bureau ; 1,127 such examinations were carried out in 1929-30.

(d) " *Native Labourers.*"

The " initial " examinations of Native mine labourers are carried out by the medical officers of the W.N.L.A. Central Depôt, with a supplementary examination by the medical officers of the respective mines to which such Natives are thereafter drafted.

The " periodical " examinations are conducted by the mine medical officers. The system of examination and the methods employed upon the mines for the detection of cases of silicosis or tuberculosis are described in another section of this Report (see Chapter IV, p. 110). An additional examination, termed a " final " examination, is made of all Natives leaving underground employment.

These duties are carried out by the medical officers of the W.N.L.A. and of the mining companies in the capacity of "medical examiners" under the Miners' Phthisis Act, and are subject to the general supervision and control of the Medical Bureau.

All mine Natives who, as a result of these examinations, are found by the medical examiners to be suspected cases of silicosis or pulmonary tuberculosis, or of both conditions, are sent forward to the central hospital of the W.N.L.A. for examination and disposal by the Bureau. Each such case is examined both clinically and radiographically and a sputum examination is also made. Tubercle bacilli are present in the sputum of 75 per cent. of all cases certified by the Bureau to have pulmonary tuberculosis. All decisions as to compensation of Native labourers in respect of silicosis or tuberculosis are thus made after examination by members of the Bureau. These examinations rank as "benefits" examinations. In 1929-30 1,689 Natives were so examined by the Bureau out of a total of 195,151 employed.

(e) *The System of Compensation* in respect of "silicosis," "tuberculosis with silicosis" and pulmonary "tuberculosis" prescribed by South African law is briefly as follows :—

(i) *Silicosis* (uncomplicated by tuberculosis) is graded in three stages—an early stage ("ante-primary"), including cases in which disability due to the disease is absent or is, at most, slight; an intermediate stage ("primary"), in which such disability is definite, but moderate; and an advanced stage ("secondary"), in which disability arising from the disease is serious and permanent.

For the two former stages lump-sum awards are made; for the final stage a life pension is paid in the case of European and non-European miners, with allowances to the miner's wife and his children up to 16 years of age, such allowances continuing after the miner's death, provided that silicosis has caused or contributed to death.

A miner who is notified by the Bureau that he has silicosis is not compelled to leave underground work, but unless he does so within three months after the receipt of such notification, he forfeits within his life time any awards further than that to which the original notification entitled him.

(ii) "*Tuberculosis with Silicosis*" is held, for the purpose of compensation, to be equivalent to silicosis in the "secondary" stage, no matter what the actual stage of silicosis may be.

(iii) A miner who is found by the Bureau to be suffering from "*tuberculosis*" (without silicosis) or "tuberculosis with silicosis," is immediately and permanently debarred from further work underground in scheduled mines. He receives, however, a lump-sum award in lieu of loss of occupation, provided that he has been employed underground in scheduled mines within the twelve months prior to the date of his being found by the Bureau to have pulmonary "tuberculosis."

This system applies also to Native mine labourers, except that in their case lump-sum awards only are granted, the reason for this differentiation being that a very large proportion of mine Natives comes

from territories outside the Union, and that the payment of a pension is accordingly impracticable. In respect of payment of compensation for tuberculosis to mine Natives, it is a necessary pre-requisite that the claimant should have been in continuous underground employment for at least one month, and that his condition of tuberculosis must be detected by the Bureau within six months after he has ceased to be employed underground. The latter restriction is due to the fact that pulmonary tuberculosis in many cases runs a very rapid course (often of only a few weeks) amongst South African Natives.

3. The South African Institute for Medical Research.

The Institute was founded in 1912. The cost of the original buildings and equipment was borne by the W.N.L.A. acting on behalf of the Mining Industry, whilst the Government set aside a piece of ground for the site. In addition, both bodies contribute equally to the maintenance of the Research Division. The building was completed and occupied in August, 1914.

The Institute is controlled by a Board consisting of six members, three of whom are nominated by the Union Government and three by the Witwatersrand Native Labour Association, the technical administration being in the hands of the Director.

Although administered as a single body, the Institute is organized in two distinct technical divisions, known respectively as the "Research Division" and the "Routine Division." The Research Division, as its name implies, is concerned entirely with original research work, *i.e.*, the advancement of medical knowledge in matters yet unsolved.

The Routine Division, on the other hand, is mainly concerned with the application of already known and accepted principles and procedures in the diagnosis and treatment of disease, with university teaching in the medical faculty, with the carrying out of public health, medico-legal and such-like investigations, and with the preparation of bacterial vaccines, antitoxins and other sera.

Research investigations have covered a wide field, including, amongst others, silicosis, pneumonia, meningitis, tuberculosis, plague, rabies, influenza, dysentery, malaria, ancylostomiasis, cell-growth *in vitro*, cancer and biochemical problems.

The Institute is constantly in close touch with health problems relating to the mining population, both European and Native, not only through its association in pathological work with the Miners' Phthisis Medical Bureau and the Witwatersrand Native Labour Association, but also through its frequent collaboration regarding matters of health with the medical officers of the individual mines.

From the circumstances connected with its establishment; its constitution in relation to both the Government and the Mining Industry; together with its activities previously referred to, the Institute furnishes a centre possessing complete research facilities in regard to staff, equipment and available material for the investigation of medical problems in general and, perhaps, in particular those which form the subject of this Report.

CHAPTER IV.—THE TUBERCULOSIS OF NATIVE MINE-WORKERS ON THE WITWATERSRAND.

SECTION A.—TUBERCULIN TESTS.

1. PRELIMINARY STATEMENT OF OBJECTS OF ENQUIRY.

In this section of the enquiry undertaken by the Tuberculosis Research Committee the use and behaviour of tuberculin has been considered in the main from a rather novel standpoint. In most of the work in this field, tuberculin, apart from its use as a criterion of invasion by the virus of tuberculosis, has been studied either from the point of view of its value as an aid to diagnosis in cases of suspected tuberculosis or from the point of view of its value in the treatment and prognosis of recognized tuberculosis.

All the Natives dealt with in this section had, before being accepted for work underground, undergone a fairly stringent medical examination and been passed as in good physical condition and free from recognizable tuberculosis. In so far as we have used the tuberculin test as a means of learning whether the Natives brought their tuberculosis with them or found it on the mines, we have used the test as it has been used elsewhere, while we were breaking fresh ground in so far as we used the test in an attempt to learn what relation, if any, the result of this test had to resistance to infection and to resistance against virulence* in the event of a subject, free from clinical evidence of tuberculosis, succumbing to infection.

We sought for information bearing on the following questions :—

(1) What proportion of the Natives engaged for work on the Witwatersrand gold mines arrive already invaded by the virus of tuberculosis as evidenced by a tuberculin test ? Are the Natives acquiring tuberculosis *de novo* on the mines or are they either lighting up unrecognized but pre-existing foci or being super-infected ?

(2) Under our conditions, is the Native mine-boy who yields a positive reaction to the tuberculin test *more* or *less* likely to develop tuberculosis than is the Native mine boy yielding a negative tuberculin reaction ?

(3) Under our conditions, will a Native mine boy yielding a *positive* tuberculin reaction—should he develop tuberculosis—usually present the " modified "† as opposed to the " natural "† type ?

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* The term "virulence" as used in this section of the Report implies the capacity of the micro-organism to produce extensive, rapid and grave development of the tuberculous infection.

† The terms "natural" and "modified" were adopted from Professor Lyle Cummins. By "natural tuberculosis" is to be understood a generalized disease running a more or less acute course, while by "modified tuberculosis" is to be understood a local disease running a more or less chronic course.

(4) Under our conditions, will a Native mine boy yielding a *negative* reaction to tuberculin—should he develop tuberculosis—usually present the " natural " as opposed to the " modified " type ?

(5) In the case of positive reactors, is there any *quantitative* relation between the degree of the reaction and liability to tuberculosis or to type of an after-coming tuberculosis ?

It was assumed that a positive reaction signified that invasion by the virus of tuberculosis had taken place, while a negative reaction signified that the subject was virgin from the tuberculosis point of view.

It was recognized that, under experimental conditions, animals that have been inoculated with the virus of tuberculosis react to tuberculous infection after a manner different from animals that are virgin from the tuberculosis point of view.

It was supposed, on the strength of data acquired from the study of tuberculosis in the European, that tuberculosis in the virgin subject tends to take the natural, general and acute form, while the tuberculosis of the subject already invaded tends to take the modified, local and chronic form.

From the standpoint of infectivity, it was further supposed, also on the strength of data acquired from the study of tuberculosis in the European, that given conditions favourable to invasion, the subject that was virgin from the tuberculosis point of view was more likely to develop tuberculosis than was the subject already invaded by the virus of tuberculosis.

2. Summary Statement of Outcome of Enquiry.

The results of these investigations show that over 72 per cent. of the Native labour force apply for engagement already invaded by the virus of tuberculosis as judged from their response to a single intradermal test with one-tenth of 1 c.c. of 1/5,000 old tuberculin. Repeated tests with stronger solutions of tuberculin would probably show that 90 per cent. of the boys applying for engagement are bringing their tuberculosis with them to the extent of giving a positive response to the tuberculin test.

Boys yielding a positive reaction to this test are more likely to develop a recognizable tuberculosis than are boys yielding no response to the test. The possession of tuberculo-allergy is associated with lowered resistance against infection and the greater the tuberculo-allergy the less the resistance against infection.

The common form of tuberculosis is a generalized or " natural " tuberculosis, whether the response to the test was originally positive or negative. The septicæmic type of tuberculosis arises most frequently in the negative reactors, so the possession of tuberculo-allergy is associated with some resistance to virulence but not, as a rule, with sufficient resistance to localize tuberculosis. Such localized tuberculosis as does occur is most common in subjects showing tuberculo-allergy.

The possession of tuberculo-allergy while associated with lowered resistance against infection is not associated to any useful extent with the ability to modify an after-coming tuberculosis. While there is definite evidence of a quantitative relation between degree of reaction and liability to infection, there is no very definite relation between degree of reaction and type of an after-coming tuberculosis. Chronic localized tuberculosis occurs in a minority of cases and is met with in two forms. The one is chronic pulmonary tuberculosis; this state is, in mine-boys, practically always associated with silicosis and presents no relation to degree of tuberculo-allergy as far as our evidence goes. The other is local glandular tuberculosis, *e.g.*, glands of neck; this type is slightly more common in subjects presenting a strongly positive reaction. The common type of tuberculosis is the generalized or "cancer-type"* and its occurrence seems to be independent of the degree of tuberculo-allergy presented.

3. PREPARATORY WORK.

The satisfactory conduct of this enquiry entailed decisions on the following points :—

(*a*) The tuberculin to be used.

(*b*) The method of performing the inoculation.

(*c*) The strength of tuberculin to be used.

(*d*) Arrangements for the making of the test and for the recording of the results secured.

(*e*) Arrangements for the "follow-up" of subjects in the tuberculin-test group and recording date of recognition of tuberculosis in the event of its occurrence, with, as far as possible, the type of tuberculosis that had arisen.

(*a*) *The Tuberculin to be Used.*—There are various tuberculins on the market and, since it was desirable that the same preparation should be used throughout, a test was made of the various "makes" available. The trial took the form of carrying out the ordinary Von Pirquet test by scarification on various subjects. Both Europeans and Natives were submitted to this procedure. Many of the preparations were unsatisfactory, and it was learnt as the result of enquiry overseas that this was a familiar experience. At length, on the advice of Dr. Peter Allan, trial was made of the tuberculin of Messrs. Lucius and Brüning, and it was found to be satisfactory. Later on, Professor Lyle Cummins supplied the Sub-Committee with tuberculin prepared by Dr. R. A. O'Brien, of Messrs. Burroughs and Wellcome's laboratories. This tuberculin was perfectly satisfactory in use and behaved as did the preparation already adopted. As work had already been started with the Lucius and Brüning tuberculin, it was decided to continue to use it.

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*By "cancer-type" is implied the type of generalized tuberculosis with implication of lymphatic glands and caseating granulomata in the abdominal organs in addition to the pulmonary lesions. It is the same as Aschoff's "Metastasizing tuberculosis."

(*b*) *The Method of Performing the Inoculation.*—After consultation with Professor Lyle Cummins and witnessing his demonstrations, it was decided to adopt the intra-dermal method as practised by Mendel, Mantoux, and others. In our opinion, this method gave the most clear-cut response and lent itself best to uniformity of procedure when tests had to be performed by various different workers. Moreover, the mine-boys would be going straight to underground work, and even trivial open wounds had to be avoided.

(*c*) *The Strength of Tuberculin to be Used.*—Several matters had to be considered in arriving at a decision on this point. Many different men were to be employed in the performance of these inoculations, the majority of them hospital assistants, medically unqualified. In the case of the staff of the depôt at Ressano Garcia, they were asked, on occasions, to carry out as many as a thousand inoculations in a day over and above their regular work. The risk of general reactions had to be reduced to a minimum and, when intra-dermal inoculations are being carried out against time, there is a risk of an occasional subcutaneous dose. While we were, of course, anxious to use such a strength of tuberculin as would yield a fair distribution into "positives" and "negatives" considering that our figures had to be based on single inoculations, other considerations compelled us to keep down the strength. In the end it was decided to make the dose one-tenth of 1c.c. of 1/5,000 old tuberculin to be injected into the skin of the forearm, the diluent being 0·5 per cent. phenol in normal saline. This is the initial procedure of Engel,[44] though this authority, in the event of a negative reaction, repeats inoculations of one-tenth of 1c.c with strengths increasing to a dilution of one in ten before he is prepared to assert that a subject is definitely negative. The above decision as to dosage was arrived at after more than 300 separate tests, the Sub-Committee having formed the opinion—an opinion which turned out to be erroneous by the light of subsequent experience—that if a positive reaction were not yielded to 1/5,000, it would not be yielded to 1/1,000. On the other hand, it was thought that positive reactions to 1/5,000 might be associated with negative reactions to 1/10,000, and this to a misleading extent. There is no doubt that, had a stronger solution been used, there would have been a higher proportion of "positives" than was actually secured. Other observers using full-strength tuberculin and the Von Pirquet scarification method have obtained up to 90 per cent. of positive reactors in a series. Furthermore, as will be seen from Dr. F. J. Allen's work at Witbank (see Appendix 4), a certain proportion of negative reactors, even with our procedure, will yield a positive response to a second test. This is, of course, quite in keeping with familiar experience of these tests. We do not think that our conclusions regarding the relationship of the tuberculo-allergy to infection by and resistance against the tubercle bacillus are vitiated to any serious extent by this admitted fallacy in distribution as between negatives and positives. While the group of negative reactors is too large and therefore gives too low a prevalence rate for tuberculosis arising therein, this is compensated to a considerable extent by the consequent crediting

of cases of tuberculosis to the negative group that would have gone to the positive group had we been able to carry out the test in a more rigorous manner. In this context note the increasing proportion of cases credited to the negative group with reduction in the strength of tuberculin used for the test.

As it was convenient to send out the tuberculin diluted ready for use, tests were made with a view to learning how long tuberculin diluted to 1/5,000 maintained full reactivity. A tuberculin diluted on a known date was tested from day to day against freshly-made dilutions. As a result of this investigation the Sub-Committee recommended that all preparations should be dated and that no preparation should be used that had been diluted for more than fourteen days. When a higher degree of dilution was decided upon these tests were repeated on each occasion. The very dilute solutions used at the end of the enquiry (1/100,000, 1/1,000,000 and 1/10,000,000) were issued once a week and, at Ressano Garcia, used within four days. Attention was called to the need for keeping diluted tuberculin in a cool, dark place.

It has been suggested that the diluting medium, 0·5 per cent. phenol in normal saline, might give pseudo-reactions on its own account. We did numerous controls to test this possibility, with negative result, and would add that in the course of this enquiry we secured nearly 33,000 definite negative reactions. In our opinion, as far as Native mine-boys are concerned, the diluting medium does not give misleading pseudo-reactions.

(*d*) *Arrangements for the Performance of the Test and for the Recording of the Results Secured.*—After consultation with Dr. Bostock, manager for the Witwatersrand Native Labour Association at Lourenço Marques, and with Dr. Pinto Coelho, their senior medical officer, it was decided that all East Coast boys passing through Ressano Garcia should have the intra-dermal test performed on them by the staff of the hospital there. The procedure was under the control of Dr. Gama Rodrigues, resident medical officer. All boys who received the test-inoculation had their passes marked with a rubber stamp. These boys reached the Witwatersrand Native Labour Association depôt at Johannesburg within, at most, 60 hours of receiving their intra-dermal inoculation. All boys inoculated were seen there and the nature of the response recorded in the space provided on the mark stamped on the pass at Ressano Garcia (over 90 per cent. of this group were recorded by one observer). The staff at Ressano Garcia performed 74,987 separate inoculations and it is a great testimonial to their skill and care that not a single case arrived at Johannesburg presenting a definite general reaction. Over 38,000 of these boys received 0·1c.c. of the 1/5,000 dilution or 0·02c.mm. of old tuberculin, a dose sufficient to set up a general reaction in a susceptible subject if given subcutaneously. Some boys were found to be feverish on arrival at the Witwatersrand Native Labour Association depôt 24 hours to 48 hours after their inoculation, but these febrile attacks were no more common in positive reactors than in negative reactors, and no more common in the tuberculin-test group than in boys who had not been subjected to the tuberculin test at all.

In addition to this group of East Coast boys, the mine medical officers were good enough to perform the test on B.S.A. boys admitted to the mine hospitals for minor surgical injuries. A further 18,652 subjects were secured from this source.

As an attempt was being made to learn whether there might be any quantitative relation between degree of response and after-history, it was recommended that reactions should be recorded as " PP," " P," " P— " and " N " (positive plus, positive, weakly positive and negative). It was recognized that, with a variety of observers, uniformity of assay could not be secured, but the Sub-Committee could not arrive at an objective standard. A positive as opposed to a negative reaction takes the form of a definite plaque, but it may present variations in certain directions. There may be vesiculation, there may be efflorescence though a definite reddening of the skin over the plaque does not, in the case of the Native, occur in the majority of cases. The area involved varies. The thickness of the plaque varies and a thick plaque is not necessarily of excess area nor is a plaque of excess area necessarily thick. When all inoculations and records are being made by the same observer, it is possible that an area-standard might serve, but the Sub-Committee could not recommend such a standard in our circumstances. After some experience, the conviction grew that the determination of a " weakly positive " group was an unnecessary refinement, and in the subsequent Tables these weakly positive reactions (" P— ") are included amongst the positives (" P "). Later on it was hoped that it would be possible to pick out " PP " reactions by using such weak solutions that only strongly positive subjects would yield a definite response at all. This expectation was not realized; the matter will be discussed later in this Report.

(*e*) *Arrangements for the Follow-up of Subjects in the Tuberculin-test Group and for Recording the Date of Recognition of Tuberculosis in the event of its Occurrence, with, as far as possible, the Type of Tuberculosis that had arisen.*—This part of the work was undertaken by the mine medical officers. Each mine was supplied with forms, of which a specimen is given in Appendix 2, and a form was filled in and returned once a quarter. On the form the medical officer noted further the date of inoculation and the resulting reaction, also the date on which he recognized tuberculosis and his diagnosis of the type presented. It must be remembered that these diagnoses are in many cases no more than preliminary diagnoses. A Native mine-boy recognized as suffering from tuberculosis is repatriated at once if well enough to travel, and the diagnosis is only final when the boy has died at a mine hospital or at the Witwatersrand Native Labour Association's hospital. In these cases an autopsy is performed and the return may be accepted as complete. The case-mortality *on the mines* is from 17 to 18 per cent., but the disease usually generalizes fairly promptly and the additional deaths occurring subsequent to repatriation bring the actual case-mortality to probably over 70 per cent. within eighteen months.

4. DISTRIBUTION OF TUBERCULOUS INFECTION IN MINE NATIVES.

The inoculations started on January 1st, 1928, with single intradermal injections of 0·1c.c. of 1/5,000 old tuberculin; in the course of the test the dose was reduced on several occasions and details will be discussed directly, but the crude return for the whole enquiry is given in Table 7, and will serve as a basis for a preliminary examination.

TABLE 7.

TOTAL RETURN, showing Reactions to Tuberculin and the Cases of Tuberculosis, all Forms, arising in the Whole Group from April 1st, 1928, to September 30th, 1930.

Total Number of Boys Tested	93,079	
Total Number of "Positive Reactions"	61,115	
Total Number of "Negative Reactions"	32,864	
"Positives"	65 per cent.	
"Negatives"	35 per cent.	
Total Number of Cases of Tuberculosis, all Forms, arising in this Group		566

In Boys yielding a Positive Reaction, 452, or 738 per 100,000

In Boys yielding a Negative Reaction, 114, or 347 per 100,000.

3,879 Boys were returned as "PP." 60 Cases of tuberculosis arose in this Group, or 1,547 per 100,000.

57,236 Boys were returned as "P." 391 Cases of tuberculosis arose in this Group, or 683 per 100,000.

The salient facts appear to be these :—

(1) With the strengths of tuberculin used only 65 per cent. of the subjects yielded a positive reaction.

(2) Despite a probable under-estimate of the true numerical strength of the positive group, the incidence rate per 100,000 of tuberculosis was more than twice as high in the positive group as it was in the negative group.

(3) The more positive the reaction the greater the liability to tuberculosis.

It will be seen that two of the questions we asked ourselves are here answered: A Native mine-boy yielding a positive reaction has, under our conditions, a greater liability to tuberculosis than has a Native mine-boy yielding a negative reaction; there is a quantitative relation between degree of reaction and liability to tuberculosis. The query as to the proportion of boys already invaded by the virus of tuberculosis as evidence by a tuberculin test is answered in part; 65 per cent. of the boys passed as clinically free from tuberculosis show evidence of invasion by the virus. The answer is only partial because the figure of 65 per cent. is certainly too low; even in this test, when the stronger solutions were used, the proportion of positives was 72 per cent. (see Table 8 below).

The first year's work having shown that negative reactors, so far from being in any special danger had the highest resistance to infection, it was decided to attempt a concentration of the positive group by diminishing the strength of tuberculin used. To begin with, a reduction

was made of from 1/5,000 to 1/10,000. This degree of reduction produced no difference either in the character of the reactions or in the proportion as between positive and negative reactors; actually the proportion of positive reactors was fractionally higher with 1/10,000 than with 1/5,000. It was decided to treat these two groups as one and the information secured is summarized in Table 8.

TABLE 8.

REACTIONS TO DILUTIONS 1/5,000 and 1/10,000, January 1st, 1928, to June 11th, 1929, with Cases of Tuberculosis, all Forms, arising in this Group.

Total Number of Boys Tested		57,659
Total Number of "Positive Reactions"		41,844
Total Number of "Negative Reactions"		15,815
"Positives"	72·5 per cent.	
"Negatives"	27·5 per cent.	
Total Number of Cases of Tuberculosis, all Forms, arising in this Group		422

In Boys yielding a Positive Reaction, 358, or 855 per 100,000.

In Boys yielding a Negative Reaction, 64, or 405 per 100,000.

3,105 Boys were returned as "PP." 49 cases of tuberculosis arose in this Group, or 1,578 per 100,000.

38,739 Boys were returned as "P." 309 cases of tuberculosis arose in this Group, or 798 per 100,000.

Although this particular series of inoculations ceased on June 11th, 1929, the cases of tuberculosis are drawn from a more or less complete "follow-up" carried to September 30th, 1930. This latter date is the latest to which cases have been followed so far and it is clear that the later in the series a boy has been inoculated the less time he has had to develop tuberculosis; hence the fall in the tuberculosis rate with the later series.

The cases dealt with in Table 8 represent nearly 62 per cent. of all the cases dealt with, and Table 8 brings out the same points as Table 7.

The strength of tuberculin used for inoculation was then reduced to 1/100,000, and the figures are given in Table 9.

TABLE 9.

REACTIONS TO DILUTION 1/100,000, June 12th, 1929, to November 22nd, 1929, with Cases of Tuberculosis, all Forms, arising in this Group.

Total Number of Boys Tested		20,810
Total Number of "Positive Reactions"		11,472
Total Number of "Negative Reactions"		9,338
"Positives"	*55 per cent.*	
"Negatives"	45 per cent.	
Total Number of Cases of Tuberculosis, all Forms, arising in this Group		94

In Boys yielding a Positive Reaction, 63, or 540 per 100,000.

In Boys yielding a Negative Reaction, 31, or 332 per 100,000.

338 Boys were returned as "PP." 4 cases of tuberculosis arose in this Group, or 1,183 per 100,000.

11,134 Boys were returned as "P." 59 cases of tuberculosis arose in this Group, or 530 per 100,000.

This section of the enquiry yielded interesting if rather sterile conclusions. To begin with, there was a considerable shift from the positive to the negative group ; some such shift was, of course, expected, and we should have been not at all surprised had the shift been greater. It will be seen that of nearly 21,000 boys tested well over half gave a positive reaction to this dilution of 1/100,000. We were impressed by the fact that, even with this dilution, very definite positive reactions continued to be secured. The tuberculosis-rate of the group is lower than the rate in the previous series owing to the shortened period of "follow-up." This dilution was used from June 12th to November 22nd, 1929, so less than a year had elapsed between the close of the test and the close of the "follow-up." The positive reactors still show a higher rate than do the negative reactors though the difference is less marked than in the "bulk test." The positive plus cases, as far as the figures go, stand out even more distinctly, but the numbers are too small to be significant.

As with the 1/100,000 dilution there were no signs of a small but highly susceptible group being isolated, the strength of tuberculin was next reduced to 1/1,000,000. This dilution was used from November 23rd, 1929, to March 23rd, 1930, and the figures are given in Table 10.

TABLE 10.

REACTIONS TO DILUTION 1/1,000,000, November 23rd, 1929, to March 23rd, 1930, with Cases of Tuberculosis, all Forms, arising in this Group.

Total Number of Boys Tested	9,007
Total Number of "Positive Reactions"	4,640
Total Number of "Negative Reactions"	4,367
"Positives"	51·5 per cent.
"Negatives"	48·5 per cent.
Total Number of Cases of Tuberculosis, all Forms, arising in this Group	39

In Boys yielding a Positive Reaction, 24, or 517 per 100,000.

In Boys yielding a Negative Reaction, 15, or 343 per 100,000.

217 Boys were returned as "PP." 5 cases of tuberculosis arose in this Group, or 2,304 per 100,000.

4,423 Boys were returned as "P." 19 cases of tuberculosis arose in this Group, or 430 per 100,000.

Once more the conclusions were rather of interest than importance. To begin with, more than half the boys still gave a positive reaction, though there had been a trifling further shift from the positives to the negatives. As will be seen, the differential tuberculosis rates are very similar to those secured with the 1/100,000 dilution with the positive plus cases standing out more definitely than ever though, of course, the figures are too small for serious conclusions to be drawn. This time there was a change in the character of the reactions ; while the grading into strong, ordinary, weak and nil could still be made, the whole scale had shrunk and there was not seen a single vesicular reaction. Considering how brief is the "follow-up" the rates are rather high.

For the concluding stage of the test the dilution used was 1/10,000,000 and the figures secured are given in Table 11.

TABLE 11.

REACTIONS TO DILUTION. 1/10,000,000, March 24th, 1930, to June 30th, 1930, with Cases of Tuberculosis, all Forms, arising in this Group.

Total Number of Boys Tested	6,503
Total Number of "Positive" Reactions	3,159
Total Number of "Negative" Reactions	3,344
"Positives"	48·6 per cent.
"Negatives"	51·4 per cent.
Total Number of Cases of Tuberculosis, all Forms, arising in this Group	11

In Boys yielding a Positive Reaction, 7, or 221 per 100,000.

In Boys yielding a Negative Reaction, 4, or 120 per 100,000.

219 Boys were returned as "PP." 2 cases of tuberculosis arose in this Group, or 913 per 100,000.

2,940 Boys were returned as "P." 5 cases of tuberculosis arose in this Group, or 170 per 100,000.

At last the negative group exceeds the positive group, but, as Pharaoh said ". . . apart from that I observe no change." The "follow-up" is altogether too brief for anything to be expected and it is a little surprising to find the differential tuberculosis-rates coming *out in the same order as with the 1/5,000 strength and long "follow-up."* It is perhaps worth repeating that the inoculations, as far as concerned the seventy thousand odd East Coast boys, were performed at Ressano Garcia, while the recording of the reaction secured was done over two hundred miles away by an entirely different staff at the Witwatersrand Native Labour Association depôt, Johannesburg (about 90 per cent. were recorded by one observer). The boys were then scattered to over 30 different mines along 70 miles of the Witwatersrand, where the tuberculosis, when it arose, was recognized and recorded by over 30 different medical officers not one of whom had either performed the inoculation or recorded the result. Whatever may be said of this enquiry, it is evident that the "personal equation" factor was reduced to a minimum.

The positive reactors were for a time (see p. 96) recorded in three groups: Positive plus or "PP"; ordinary positive or "P"; weakly positive or "P—." The tuberculosis rate in the P— group was intermediate between the rate in the "ordinary positives" and the rate in the "negatives." The figures were as follows:—Tuberculosis incidence on the positive plus, 10·3 per 1,000; tuberculosis incidence on the ordinary positive, 6·5 per 1,000; tuberculosis incidence on the weakly positive, 4·5 per 1,000; tuberculosis incidence on the negative, 2·9 per 1,000. This is in keeping with the statement—the more positive his reaction the greater is the likelihood of the Native mine-boy to develop tuberculosis in the course of his engagement on the gold mines of the Witwatersrand.

5. TYPE OF REACTION AND TYPE OF AFTER-COMING TUBERCULOSIS.

Any attempt to answer the further question as to relation, if any, between type of reaction and type of after-coming tuberculosis demands a more detailed examination of the series of cases of tuberculosis arising in the tuberculin-test group. The data on which the following discussion is based are given in Table 12 and in Appendix 2. It may also again be mentioned that, except in fatal cases, the diagnoses are preliminary and provisional.

To begin with, let it be granted that different types of tuberculosis are dominant at different ages and that, for convenience, four such dominant types can be isolated :—

(1) Generalized septicæmic, or infantile.
"In infants tuberculosis is an acute, general infection, like typhoid or septicæmia . . ." (Fishberg[45]).

(2) Generalized lymphatic, or tuberculosis of school-age ("cancer-type").
"In children infection with tubercle bacilli, if it causes active disease at all, is usually followed by a generalized morbid process with implication of the lymphatic glands" (Fishberg [*l.c.*])

(3) During the latter half of the second decade, tuberculosis changes from being typically a general disease to being typically a local disease: Usually pulmonary tuberculosis of the caseating or exudative type and acute rather than chronic.

(4) In middle-life tuberculosis continues to be typically a local disease, usually pulmonary tuberculosis of the fibroid or productive type and chronic rather than acute.

It will be seen from data given elsewhere in this Report that the typical tuberculosis of the Native mine-boy is the tuberculosis of school-age (Group (2) above). That is to say, the generalized form of the disease, and, to this extent, "natural" rather than "modified."

In this series of cases from the tuberculin-test group a generalized tuberculosis was almost as much the rule in the positive reactors as it was in the negative reactors. Any cases that were diagnosed as chronic pulmonary tuberculosis did arise in the group of positive reactors, but, in nearly every case diagnosed as chronic pulmonary tuberculosis, this condition was associated with a silicosis and arose in boys of long underground service. The ability to raise barriers of fibrous tissue appears to be related in the mine-boy to invasion by silica dust rather than to invasion by the virus of tuberculosis or to age. However, a certain measure of distinction can be made. Out of the 471 cases of which details are available at date, the diagnosis of general tuberculosis was made in 41 subjects and confirmed by autopsy. In our classification general tuberculosis implies miliary and meningitis. Of these 41 cases of the infantile or septicæmic type 23 arose in the 95 negative reactors while 18 arose in the 376 positive reactors. To this extent, then,

invasion of the Native mine-boy by the virus of tuberculosis may confer on him a measure of resistance to virulence, even if it does lower his resistance to infection. The gain does not amount to much; if compelled to choose between dying of tuberculosis in four weeks or in forty, most people would choose forty, but they would not be particularly grateful for this much of choice. One can take this question of resistance to virulence a little further. As one would expect with tuberculosis of school-age, local glandular tuberculosis is fairly common in the mine-boy. In the series of 471 cases the diagnosis "glandular," usually glands of the neck, was returned on 100 occasions. Of this 100, 85 arose in the 376 positive reactors, or over 22 per cent., while 15 arose in the 95 negative reactors, or just under 16 per cent. There were 15 in 49 "PP" reactors, or over 30 per cent. Here, again, is a suggestion of resistance to virulence in association with tuberculo-allergy, but boys exhibiting tuberculous glands are promptly repatriated, and we have but little direct evidence as to their after-history.

While we have no direct evidence such as that afforded by a rigid "follow-up" of a group, we have a good deal of indirect evidence as to the behaviour of local glandular tuberculosis in the South African Native. Dr. Neil Macvicar, superintendent of the Victoria Hospital, Lovedale, Transkei, has had a very wide experience with diseases of Natives. In response to enquiry he has been so good as to consult with his daughter, Mrs. Ross and her husband, Dr. R. C. Ross, both qualified physicians with wide experience of Natives. Their combined opinion is as follows: "... In some cases the infection seems to spread to other organs, but in the majority of cases tuberculous disease remains limited to the glands and most make a good ultimate recovery. We see many people in good health with the scars of old tuberculous gland abscesses."

Dr. Peter Allan, superintendent of the Tuberculosis Sanatorium at Nelspoort, has carried out several "tuberculosis-surveys" of Native territories, and he writes:—"In the Transkei I saw many Natives with tuberculous glands of neck. They did not appear to be generalizing, in fact, I saw several old gentlemen of 70 years of age with well-marked typical cicatrices who told me that they had had swollen glands which had broken down 40 years previously. After discharging for some time, the glands healed up. One might reasonably compare these cases with the European child, except that the Native seems to develop the condition in early adult life."

Dr. A. I. Girdwood, Chief Medical Officer of the Witwatersrand Native Labour Association Native Hospital, has had an unrivalled experience of the diseases of the South African Native, having been born in the Territories and having practised there before joining the Witwatersrand Native Labour Association organization. In Dr. Girdwood's experience Natives with primary tuberculous glands of the neck do not do well on the gold mines. The glands invariably get bigger and eventually break down and suppurate in spite of treatment. These cases do not, as a rule, develop pulmonary or generalized tuberculosis. On the other hand, Natives with old healed tuberculous scars

of the neck do remarkably well. It is exceptional for the disease to recur or for tuberculosis of the lungs to develop during their period of contract underground.

In the light of experience of great numbers spread over a generation, Natives with old healed tuberculous scars of the neck are being accepted for work on the goldfields. Despite the absence of statistical proof, one feels justified in saying that the mine Native reacts to local glandular tuberculosis as does the European child.

6. TYPE OF REACTION AND SPECIAL SUSCEPTIBILITY TO INFECTION.

Inspection of Tables 8 to 11 suggests that the tuberculosis incidence is less influenced by the progressive shortening of the "follow-up" in the positive plus group and in the negative group than in the ordinary positive group. It seemed worth going a little further into the matter with a view to learning whether there might be evidence associating the strongly positive and negative groups with a section that, under our conditions, were particularly readily infected and included the majority of those who went down early in a contract. Table 12 gives the necessary data.

TABLE 12.

INTERVAL BETWEEN PASSING PHYSICAL EXAMINATION AND RECOGNITION OF TUBERCULOSIS IN 471 BOYS WHO HAD EXPERIENCED THE TUBERCULIN-TEST.

Under Three Months.	Over Three Months and under Six Months.	Over Six Months and under Nine Months.	Over Nine Months and under Twelve Months.	Over Twelve Months.
"PP" 16 or 34% of this Group.	"PP" 6 or 13% of this Group.	"PP" 11 or 23% of this Group	"PP" 8 or 17% of this Group.	"PP" 6 or 13% of this Group.
"P" 71 or 21·25% of this Group.	"P" 61 or 18% of this Group.	"P" 71 or 21 25% of this Group.	"P" 55 or 16·5% of this Group.	"P" 76 or 23% of this Group.
"N" 32 or 34% of this Group. 110 or 25%	"N" 15 or 16% of this Group. 82 or 17·3%	"N" 16 or 17% of this Group. 98 or 20·6%	"N" 15 or 16% of this Group. 78 or 16·4%	"N" 16 or 17% of this Group. 98 or 20·6%

Further details of these 471 cases are given in Appendix 2.

It will be seen that an examination in some detail bears out the conclusion drawn from inspection, but only up to a point. Of the comparatively small number of cases arising in the positive plus and negative groups, over one-third develop tuberculosis within three months of having been passed as free from recognizable tuberculosis. There is not, however, very much in it, as over one-fifth of the cases arising amongst the ordinary positives also go down within three months of having been passed.

The positive plus group is fairly straightforward ; one can say that in the Native mine-boy high tuberculo-allergy goes with poor resistance to infection. The negative group is not so easy ; while the group as a whole has the best resistance to infection, it includes a section with as poor a resistance as has the positive plus group (see Table 12, col. 1).

Apparently there is some factor—not always present, however—in the subject virgin from the tuberculosis point of view that confers a measure of resistance against effective infection. This factor, even when present, becomes attenuated following invasion by the virus of tuberculosis. One is none the wiser for conjuring with such terms as " natural resistance."

It is generally held that a community, virgin from the tuberculosis point of view, has poor resistance to infection ; this is certainly not the case taking as a whole our group of mine-boys who give no reaction to tuberculin, and they are over 30,000 strong. In so far as invasion by the virus confers any benefit it is in the direction of resistance to virulence and not in the direction of resistance to infection. The fact that in tuberculosis, as in other diseases, resistance to infection and resistance to virulence do not go together is a commonplace ; we have only illustrated a form of the expression of this fact. After all, we are dealing with the European's tuberculosis of childhood-age and this type of tuberculosis, if virulent in the sense that it is typically general, is typically associated with low infectivity. The above considerations lead to two conclusions of importance to us. The first is that inoculation with some form of the virus of tuberculosis is unlikely to raise the mine-boy's resistance against infection and the second is that the mine-boy is not likely to spread in his kraal a type of tuberculosis that European children do not spread among their contemporaries. In both Europe and the United States of America mortality credited to childhood-tuberculosis is unimportant from the national point of view. It is by protection from and exposure to physiological stress that this type of tuberculosis is dominated. When the Factory Acts and the Education Acts became effective in England the incidence of this type of tuberculosis fell to a notable extent. Throughout most of the first half of the nineteenth century the mortality from childhood tuberculosis was a very serious matter, but it has ceased to be of national importance for nearly two generations. The Native in his kraal is as much "protected" as is the average European child in the home, while the Native on the mines is much in the position of the European child in the days of child-labour.

Table 12 raises a point that has no direct connexion with a tuberculin test. Several enquiries[46 47 48] have taught us that of the Natives who go down to tuberculosis a considerable proportion go down in the first three months of a contract. The data collected in Table 12 come into line with other experience in this respect, and in the respect that incidence falls for the rest of the first year. We also know that the prevalence of tuberculosis is high again in Natives known to be of five years' continuous service and upwards. There appear to be two antagonistic factors at play—acclimatization to conditions on the mines,

which acts beneficially and reduces the incidence of tuberculosis, and increasing duration of exposure to conditions on the mines, which acts harmfully and is associated with high tuberculosis incidence. It is clear that the harmful factor is dominating the situation by the close of the fifth year, and we are always asking ourselves at what period does the harm of duration of exposure begin to beat the good of acclimatization. In this Report we are dealing with a group of over 90,000 boys and the tuberculosis returns are to be kept up until the end of December, 1931. By this time we shall have a minimum "follow-up" of 18 months, *i.e.*, in the case of boys inoculated during June, 1930, and a maximum "follow-up" of nearly four years, *i.e.*, in the case of boys inoculated during January, 1928. The maintenance of incidence in boys of over 12 months' service as shown in Table 12 suggests that useful information may be forthcoming by the end of 1931.

NOTE.—The significance of some of the matters dealt with in the previous Section may be rendered clearer by a brief reference to conditions of service on the Witwatersrand gold mines.

Mr. W. Gemmill, General Manager of the Chamber of Mines, has been so good as to supply the following information :—

"The original contracts of the East Coast Natives have provided in every case for the Natives working for 313 shifts, *i.e.*, one year. The conditions of renewal of service have, however, varied in the last few years. East Coast Natives recruited prior to the 3rd May, 1927, were allowed to remain as long as they chose. Those recruited between 3rd May, 1927, and 10th October, 1928, were allowed to remain for two years, plus a further maximum period of 18 months. Those recruited after 10th October, 1928, were allowed to remain for 18 months only. The average actual period served is no longer, in the case of East Coast boys, a matter of statistical importance, as the number who are allowed to remain is getting steadily less, whilst all Natives recruited under the conditions of the new Convention serve for at least 313 shifts in ordinary circumstances and not more than 18 calendar months.

"In regard to British South African Natives, the average period of service when last the figure was calculated proved to be about 11 months, but this figure is at the moment in process of re-calculation."

It should also be added that the Portuguese Natives recruited under the new Convention are not renewing their contracts in large numbers, so that the total average period of service must be considerably nearer one year than 18 months.

7. INVASION BY THE VIRUS AND TYPES OF TUBERCULOSIS.

Of the four types of tuberculosis given in the arbitrary classification adopted on p. 101 by far the rarest to be met with in the South African Native is Class (3), or acute pulmonary tuberculosis: the "young adult phthisis" of Brownlee.[49] As this type of tuberculosis is so common and so important in the European the matter seems worth a reference. Of course, typical acute pulmonary tuberculosis—caseating, broncho-pneumonic and pneumonic—is almost the rule in the fatal cases,

but the disease is hardly ever confined to the chest. Almost invariably the abdomen is involved, and grossly involved, into the bargain. If the Native has sufficient resistance to localize his tuberculosis, he usually has enough to send it along a chronic course and present Brownlee's "phthisis of middle age." This condition is uncommon, particularly apart from silicosis, but typical cases of the European type are to be met with. While the old Native generalizes his tuberculosis far more commonly than does the old European, if one meets chronic phthisis at all it is in the old people. Dr. Brownlee writes[50] of "young adult phthisis":—

"It is less common in those districts in which there is a large number of deaths from tuberculosis in children.

"It is also less common in those districts in which there is much phthisis in middle age."

For the Native of South Africa "tuberculosis of school-age" takes the place of "young adult phthisis" and covers much the same age-incidence though prolonged into later life with subjects exposed to physiological stress, such as the old mine-boys who have avoided silicosis. One would rather have expected that, in the Native, "young adult phthisis" would take the place of "phthisis of middle age," as childhood tuberculosis takes the place of "young adult phthisis." The Native appears to skip this step and one wonders why. Dr. Brownlee's note to the effect that childhood tuberculosis and young adult phthisis do not go together is of interest in this context, also a further observation asserting that phthisis of middle age is more common in those districts in which there is a large number of deaths from tuberculosis in children.[51] It appears that Natives who have resistance to virulence at all have a fair amount; on the one hand, there is the considerable proportion of cases of local glandular tuberculosis in subjects with tuberculo-allergy, and, on the other hand, there is this tendency to dodge the betwixt and between stage of acute pulmonary tuberculosis. As said before, useful resistance to virulence is the exception.

After giving due weight to the above considerations one remains impressed by the comparative lack of ability to localize his tuberculosis shown by the positively-reacting adult Native mine-boy. Is it going too far to say that in these Natives a tuberculin-test is no more than a measure of the presence or absence of tuberculo-allergy, and that a positive reaction implies no gain in resistance to infection and but little gain in resistance to epidemiological virulence? Useful secondary immunity in so far as it is conferred by sub-inoculations of the virus of tuberculosis may only be arrived at *via* tuberculo-allergy, but the presence of this allergy is not evidence of the presence of useful resistance. Wingfield writes,[52] "High tissue allergy or hyper-sensitiveness is a dangerous condition (in moderation it may be protective)." In our experience with mine Natives, resistance to infection and resistance to virulence present a certain degree of independence. From the point of view of resistance to infection, any allergy at all puts the Native

in a worse position than does no allergy, and the higher his allergy the worse his position. On the other hand, there is some evidence that the presence of allergy may be associated with *commencing* resistance to virulence. Septicæmic tuberculosis was met with in 4 per cent. of the cases that arose in the " strongly positive " group, in 5 per cent. of the cases that arose in the " ordinary positive " group, and in 24 per cent. of the cases that arose in the " negative " group, while the comparatively benevolent local glandular tuberculosis was met with most often relatively in the cases that arose in the " strongly positive " group. Despite this evidence of there being some resistance to virulence associated with allergy, the fact remains that, nevertheless, most of the cases of tuberculosis in allergic subjects generalized freely and early with the disease running an acute course to a fatal termination.

The results of these investigations indicate that in the Native of South Africa the part played by invasion with the virus of tuberculosis appears to be equivocal, inasmuch as tuberculo-allergy and poor resistance to infection go together, whereas tuberculo-allergy is associated with some increase of resistance to virulence. In subjects virgin from the tuberculosis point of view it is a minority only that has poor resistance and a majority good resistance to infection. In subjects invaded by the virus a minority has good resistance to virulence and a majority poor resistance to virulence. As far as can be judged from tuberculin tests, the adult Native appears to be about as much tuberculized as is the adult European, yet, under conditions favourable for the dissemination of tuberculosis, the Native contracts more tuberculosis and develops a different type of tuberculosis. As between the two the difference of behaviour in the face of tuberculosis appears to be related rather to differences of the soil in which the seed is sown than to any deficiency in the sowing.

Quite apart from association with tuberculosis as a definite disease, tuberculo-allergy waxes and wanes. Dr. Allen's work at Witbank (see Appendix 4) illustrates this phenomenon, and the fact is well established by experience elsewhere. Rigid testing has shown that a positive reactor may become definitely negative. This is important because it leads direct to the conclusion that there are two types of negative reactors: those who are and always have been " virgin " from the tuberculosis standpoint, and the " barren," who have, at one time, been pregnant with tuberculosis but have aborted with complete success. One cannot affirm that a negative reaction to tuberculin signifies that a subject not only is but always has been " virgin " from she tuberculosis standpoint. Our experience shows that the less tuberculo-allergy the less the likelihood of effective infection by tuberculosis. At the end of the allergy road come the negative reactors, and hereabouts the road forks into the virgin negative reactor and the " barren " negative reactor. The virgin has never been on the allergy road at all, the barren has travelled the whole length of it to the end and back again. Tuberculo-immunity is reached *via* tuberculo-allergy, but our experience suggests that as far as the South African Native is concerned, this immunity has to be considered under two heads. On

the one hand, there are factors that confer ability to resist effective infection. Tuberculo-allergy is a measure of this ability; the less the allergy the greater the ability. On the other hand, there are factors that confer ability to modify the course of the disease; in our experience allergy is a negligible measure of this ability. The typical age-curve of tuberculosis incidence the world over suggests that ability to modify the course of the disease is purchased at the price of a greater liability to get the disease. It is possible that while the virgin have least resistance of all subjects to an effective infection, the barren, at the terminus of the allergy road, have most resistance to effective infection. The above hypothesis goes some way in accounting for our rather unexpected experience with the negative reactors of our Native labour force.

The suggestion is that tuberculo-allergy may go but leave behind it tuberculo-immunity factors that have been called into being in association with the allergic state.

Section B.—Tuberculosis in the Witwatersrand Native Labour Association's Hospital.

1. "Observation" Cases.

At the initial examination of recruits at the W.N.L.A. depôt, Johannesburg, a considerable number of Natives with chest conditions suggestive of tuberculosis are detained in hospital for observation and investigation to determine the presence of tuberculosis; these comprise cases of pleurisy, pleurisy with effusion, thickened pleura, unresolved pneumonia, localized crepitations, incipient tuberculosis, silicosis and tuberculo-silicosis. These individuals are all carefully examined and X-rayed and a bacteriological examination of the sputum made. Many are cases such as are included under the heading "Defective Lungs" in Table 6, p. 86.

The cases that present the most difficulty are those with localized persistent crepitations of the lungs, which are extremely common and which, in the majority of instances, give a negative result upon X-ray and bacteriological examination. Various attempts have been made to determine the significance of these crepitations, but without convincing results. That some of these cases are tuberculous—or become so after the Native has been working—is undoubtedly true, but it is impossible to say which are likely to develop tuberculosis. The condition is far too common in otherwise apparently healthy Natives of good physique to warrant the exclusion of all such Natives from mine work.

Enlarged tuberculous glands of the neck are fairly common among recruits who have had no previous medical examination, and a considerable number have healed tuberculous scars. Recruits showing the latter condition, if of good physique, usually complete their contracts for underground work and put on weight; rarely is there any recurrence of the disease or extension to other organs.

2. REPATRIATION OF TUBERCULOTICS.

All cases of tuberculosis and tuberculosis-with-silicosis detected on the gold mines, either while in hospital or at the periodical weighings, or on examination of the time-expired Natives, are sent into the W.N.L.A. hospital for examination by the Miners' Phthisis Medical Bureau in terms of the Miners' Phthisis Act. On completion of this examination and after the payment of compensation (if any)—which formality usually takes about a fortnight—the Natives are sent to their homes in charge of a European conductor. A number of the Natives are in an advanced state of the disease on admission to hospital and are unable to undertake the journey home; these are detained and cared for until death supervenes.

The early cases seem to improve slightly and to put on weight during their stay in hospital. No special treatment is given beyond a course of tonics, good feeding, fresh air and cod-liver oil. The more modern methods of treatment, such as sanocrysin, sodium morrhuate and artificial pneumothorax have been tried, but the Natives clamour to be sent home as soon as they have been dealt with by the Bureau, and refuse to stay in hospital long enough for adequate treatment. The Native firmly believes that when once he gets back to his kraal the witch-doctor will cure him.

All tuberculous cases, incipient or otherwise, detected at the initial examination are also repatriated and advised not to return for mining employment. This advice is not always followed, especially in incipient cases, and many of them return in three or four months' time and, if the abnormal physical signs have disappeared (and there is no method of immediate identification beyond accidental recognition) they may possibly be passed as fit for mine work.

In addition to the conditions above referred to, there are many cases of tuberculous glands in the neck and of abdominal tuberculosis in Natives received from the mines. Such Natives are repatriated every week with the ordinary convalescent Natives.

Tuberculosis of the spinal vertebrae and of the genito-urinary tract are fairly common, but tuberculosis of the wrist, knee and ankle joints is only occasionally met with. Many cases with these conditions, especially those with glands in the neck, improve considerably after repatriation. Many cases that have left the mines with enormous enlargement of the cervical glands have returned for work a year or so later with a few healed scars, the Native being in excellent condition; while such cases, if allowed to remain on the mines, gradually get worse, run a temperature, become more emaciated and eventually develop generalized tuberculosis.

3. LENGTH OF SURVIVAL OF CASES DYING IN W.N.L.A. HOSPITAL.

The duration of survival of tuberculous cases sent from the mines to the W.N.L.A. hospital depends on the condition of the patient and the extent of the disease on arrival at the hospital. Some die on the

day of admission, others within the first week, while a number linger on for a month or six weeks. The average duration of survival is 16 days.

Among recruits there have been cases, especially among East Coast Natives, admitted into hospital a few days after arrival with apparently commencing broncho-pneumonia, who have died of acute miliary tuberculosis in three weeks.

4. Post-mortem Examinations.

A post-mortem examination is held at the South African Institute for Medical Research upon every Native who dies at the W.N.L.A. hospital, and the lungs, if found to be tuberculous or silicotic, are sent to the Miners' Phthisis Medical Bureau for scrutiny. For the last three years all these post-mortem examinations have been conducted by Dr. Mavrogordato and Dr. Pirie, of the South African Institute for Medical Research, and their findings are considered in the Pathological Section of this Report (see p. 153 and Appendix 7).

Section C.—Tuberculosis in Mine Hospitals.

The main interest of the mine medical officer and the mine hospital from the point of view of the prevention of tuberculosis centres round the problem of early detection and the disposal of cases when diagnosed. Various measures are employed as aids in helping towards an early diagnosis, one of the most important being that of periodical weighing.

1. Periodical Weighing as a Means towards Early Diagnosis.

The practice of periodical weighing was first introduced on the mines as a compulsory measure in 1916. It was originally intended that the weighing should be done regularly once a month, but it was found to be much more convenient from the mines' point of view to have the weighing done when the Natives were assembled to receive their monthly pay. As pay is really *per* so many shifts worked, and as the majority of Natives do not work on Sundays, this works out in actual practice at about once in every five weeks.

Many difficulties were encountered when the practice was first instituted, *e.g.*, a Native would send a friend to impersonate him when drawing his pay, or he would not draw his pay for several months on end. These and other loopholes were taken advantage of by Natives who feared that the weighing might result in their being sent home. Gradually, however, the system has been tightened up and to-day it is exceptional to find a boy who has escaped the scales.

On the majority of the mines now, the periodical weighing and the keeping of the records is carried out by a skilled White, usually a hospital attendant, or by Natives under such a supervisor who also picks out all weedy-looking Natives for special examination irrespective of their weight.

At first it was left to the discretion of individual mine medical officers to fix their own standards of what should constitute a drop in weight sufficient to necessitate a further examination, but the Regu-

lations under the Miners' Phthisis Act of 1925 laid down that any Native showing a drop of 5lb. or more in weight between two consecutive weighings, or of 6lb. or more between three such weighings, must be set aside for individual stethoscopic examination by the mine medical officer.

A definite standard was not fixed under the earlier Act, partly because there was not sufficient information available to go upon and partly because in those days there was probably a more marked difference between the working conditions on the various mines.

Even at the present time, undue variations in weight sometimes occur in numbers quite apart from tuberculosis. For instance, Dr. Frew has reported to this Committee that on the East Rand Proprietary Mines he has found sometimes that "lost weights" come along "by hundreds instead of by the more usual tens." The explanation of these variations is not obvious, but he is inclined to attribute them to spells of either very hot or very cold weather. Such occurrences lead to a great increase in stethoscopy and rather tend to defeat the primary purpose of the weighings. Nevertheless, they draw attention to the existence of some factor which may be remediable.

Periodical weighing is accepted as a valuable agency in the detection of tuberculosis. Every Native picked out is stethoscoped and as a result of this examination either sent into hospital or marked for further examination. If sent to hospital they are kept either until their weight has picked up and their general condition improved or until further examination makes clear that the condition is actually tuberculosis.

It cannot be stated definitely what proportion of the tuberculosis cases are picked out solely through the periodical weighings, but it is reported in the Report upon the work of the Miners' Phthisis Medical Bureau for the two years ended July 31st, 1926, that "special investigation has shown that approximately 66 per cent. of bacteriologically-verified cases of simple tuberculosis in mine Natives show a loss of weight of the prescribed amount at their periodical examinations, and should therefore automatically be made available for special stethoscopic examination."

2. OTHER METHODS EMPLOYED FOR THE EARLY DETECTION OF TUBERCULOSIS.

(*a*) All recruits received from the W.N.L.A. are stethoscoped on arrival at the mine by the mine medical officer, although they have already run the gauntlet of the W.N.L.A. examination. Any case the mine medical officer regards as doubtful is either X-rayed at the mine, if apparatus be available, or referred back to the W.N.L.A. for further examination.

Non-recuited Natives applying directly to the mine for underground work are first examined on the mine and then sent to the W.N.L.A. for confirmatory examination.

(*b*) All Natives admitted to hospital, no matter for what complaint, surgical or medical, are stethoscoped either on their arrival, during their stay, or on their discharge from hospital.

(*c*) All Natives with a record of five years' continuous service on any one mine are stethoscoped quarterly and X-rayed yearly. The quarterly stethoscopic examination is statutory and has been in force since 1925. The yearly X-ray examination is voluntary on the part of the Chamber of Mines and has been in force since 1926. These examinations have been found valuable in detecting cases among long-service Natives.

It was realized, however, that many long-service Natives escaped these examinations because their service had not all been on one mine. It is a difficult matter to link up records of service on different mines, but at the request of this Committee it has been attempted, and, during 1930, as a special experiment, all Natives with a cumulative service of five years or more on the Reef, as far as it has been possible to identify them, are being submitted to X-ray examination.

(*d*) Every Native is stethoscopically examined before his discharge from a mine, whether he has lost weight or not.

The results of all these examinations are recorded on the weight-cards and are immediately available at any subsequent examination undergone by the individual.

3. Treatment of Tuberculosis in Mine Hospitals.

No attempt is made to undertake prolonged systematic treatment of cases of tuberculosis in the mine hospitals for the simple reason that every Native put off work on account of tuberculosis merely clamours to get home as quickly as possible.

Even if sanatorium treatment were made available, such an institution would probably be intensely unpopular on account of the number of deaths that would of necessity take place there.

On diagnosing a case of tuberculosis, the mine medical officer has, therefore, only to make up his mind whether or no the Native is fit to be repatriated. The journey back to his home should not take more than a week or ten days, unless in exceptional cases.

The cases retained in hospital are those which, in his opinion, are too weak to travel or would be likely to die within that period.

Naturally, very little can be done for either type of case. Any treatment on the lines of artificial pneumothorax is usually precluded on account of the Native's objection to all operative procedures. The only treatment possible is fresh air, good feeding and palliative medicinal measures, such as the administration of cod-liver oil, vitamines and general tonics.

4. Transfer of Patients from Mine Hospitals to the W.N.L.A.

All patients suffering from tuberculosis who, in the opinion of the mine medical officers, are fit to be repatriated, are transferred by them to the W.N.L.A. for examination by the medical officers of the Miners' Phthisis Medical Board.

The journey may be made by road if the mine is close at hand, by train or trolley if the mine is further out or, if necessary, by ambulance.

Each patient or batch of patients is accompanied by a mine police boy or other attendant, who is responsible for seeing them to their destination.

With each patient is sent a history sheet giving a complete record of his mine service, hospital history, monthly weighings, temperature chart and any other details of the case that the mine medical officer may consider important.

These particulars are available for the benefit of the medical officers of the W.N.L.A. and of the Miners' Phthisis Medical Bureau.

5. LENGTH OF SURVIVAL OF CASES DYING IN MINE HOSPITALS.

In view of the fact that practically only hopeless cases of tuberculosis are detained in the mine hospitals, no full returns of the survival periods have been called for, but some figures submitted by four mine hospitals show that for 145 consecutive cases of deaths from tuberculosis in these hospitals, the average survival period was 28 days.

Dividing the cases into (*a*) purely pulmonary cases (including, however, tuberculosis with silicosis, as well as simple tuberculosis), and (*b*) miliary and other forms, we find that 95 pulmonary cases had an average survival period in hospital of 19 days and 50 miliary and others an average of 37 days.

1 miliary case in this series was returned as dying 2 days after admission, and another 9 days after admission.

Of the pulmonary cases, 19 died within 10 days of admission, and the majority within 3 weeks. 1 very exceptional case (for a mine hospital) lived for 288 days.

6. POST-MORTEM EXAMINATIONS IN MINE HOSPITALS.

In many mine hospitals the carrying out of post-mortem examinations on all medical cases that die is part of their routine procedure.

Where post-mortem examinations are not done as a matter of routine, the Miners' Phthisis Medical Bureau has the right to ask for one in any case where there is still doubt as to the diagnosis.

In practice, this works out that in all cases of suspected possible tuberculosis, where a positive sputum has not already been obtained, a post-mortem examination is asked for and carried out.

During the years 1927, 1928 and 1929 special records were kept at the request of this Committee. The records were sent in to the Committee and are considered in the Pathological Section of this Report (see p. 153 and Appendix 7).

Two series of reports on post-mortem examinations made in mine hospitals may be referred to at this point for comparison with the pathological records of this Committee.

One, by Oronstein[53] deals with 95 autopsies made in 8 different mine hospitals during 1922 and 1923. Tuberculosis was the actual cause of death in 62 of the cases, but all showed some tuberculous lesion.

The series is regarded as showing three noteworthy characteristics : (*a*) The relatively large proportion of involvement of abdominal organs, especially of the spleen—32 cases out of the 95. This is very similar to our findings. (*b*) The relatively large number of cases in which the mediastinal glands were involved—39 cases. The term " mediastinal " is apparently used to cover any thoracic glands other than the peribronchial, which are tabulated separately. These are probably largely cases comparable with those described by Bushnell[1] as " great packets " of caseous glands, a form very characteristic of " primary " tuberculosis. (*c*) The relatively large number of cases of miliary tuberculosis of the lungs—15 out of a total of 42 cases showing pulmonary lesions. The Committee found a similar high proportion among the reports of cases sent in to them by mine medical officers ; they are mostly young Natives with very short mining service.

The analysis is stated to appear to indicate (*a*) that infection by ingestion of tuberculous material may play a not inconsiderable rôle in the incidence of tuberculosis among Native mine-workers, and (*b*) that tuberculous infections still run a markedly acute course in them.

With regard to the first inference, presumably drawn from the frequency of involvement of abdominal organs, it may be pointed out that the investigations of this Committee show that although involvement of abdominal organs is certainly common, it can, in most cases, be traced to a thoracic source and only very seldom implies infection by ingestion.

The other report by Fischer[54] deals with 1,402 autopsies made at the City Deep Central Native Hospital during the years 1922-28. Tuberculosis is given as the main cause of death in 302 of these cases. Of these 302 cases acute miliary tuberculosis constituted 45 per cent. ; general tuberculosis (caseating pulmonary tuberculosis with miliary lesions in other organs), 13·9 per cent. ; pulmonary tuberculosis, 15·9 per cent. ; pulmonary tuberculosis with silicosis, 9·9 per cent. ; and abdominal tuberculosis (tuberculous peritonitis with tuberculous foci in some of the abdominal organs), 7·3 per cent.

A remarkable feature of the miliary cases was the great enlargement of the spleen.

The diseased lungs revealed in 104 cases (40·8 per cent.) the lesions of chronic phthisis, and in 152 cases (59·2 per cent.) those of the acute form. The chronic form was in 30 cases associated with more or less pronounced silicosis.

The only finding in this series showing any essential variance from those of the Committee is that of the larger proportion of cases of chronic phthisis uncomplicated by silicosis. This is probably explicable partly

by a real larger occurrence, owing to these cases being drawn entirely from a mine hospital and not mainly from the W.N.L.A. hospital, but partly by a difference of standard in the definition of the earlier stages of silicosis.

SECTION D.—INCIDENCE AND MORTALITY FROM TUBERCULOSIS ON THE RAND.

1. DIFFICULTIES IN COMPILING ACCURATE STATISTICS.

The compilation and comparison of statistics concerning tuberculosis in Natives in South Africa bristles with difficulties. Several of these are referred to, in passing, in other parts of this Report, but they may be recapitulated here.

There are, in the first place, the lacunæ in the basic statistics regarding the population. These, in a European country, would be readily obtainable from the census or Registrar-General's Department. Here, owing to the lack of any complete system of birth and death registration, it is impossible to obtain readily any definite information about age-distribution, causes of death, etc.

On the mines it is usually a fairly easy matter to get at a close approximation of a Native's age, because, although he may not think in calendar years, he can tell you that he was born in the year of such-and-such a chief's death, or that he started to herd goats when the South African War began, or in some such way it can be arrived at. This helps considerably in dealing with purely mine statistics, but it does not help in making comparison with the general Native population.

But even within the statistics accumulated by the mining industry there are difficulties.

It is highly desirable, for instance, in addition to age-distribution to have some idea of the distribution of the complement in terms of total duration of employment. This information should be obtainable from the "cards," one of which each mine-boy is given and on which his record of service is entered up. This card, however, he regards with much suspicion and loses it so regularly that it has to be re-written on the strength of such information as he chooses to give each time that he signs a contract.

It is very often impossible to be certain from his card, therefore, whether any particular boy is in the first year of his employment on the Witwatersrand or merely in the first year of his *present engagement*. The former would be a raw recruit to the industry who had never worked on a mine before; the latter might be a raw recruit or on his *n*th engagement.

Then there is the difficulty that some returns in connexion with tuberculosis on the mines include all forms of tuberculosis, while others are statutory and only include "tuberculosis under the Act." The

Miners' Phthisis Act, No. 35, Section 76, Sub-section 3, p. 74, lays down for purposes of compensation that a Native is deemed to be suffering from tuberculosis if he is (*a*) expectorating tubercle bacilli, or (*b*) has closed tuberculosis of the lungs or respiratory organs to such a degree as seriously to impair his working capacity and render prohibition of his working underground advisable in the interests of his health.

It is very important to realize, therefore, in considering any returns, whether one is dealing with " tuberculosis, all forms," or " tuberculosis under the Act."

A general difficulty applying to all statistics of the Native mining force is that one is considering a migratory population living in semi-enclosed communities. This particular issue is further complicated by the fact that the "closed population" to be studied circulates within the group of semi-enclosed communities, in addition to the general circulation between the group of communities and the widely-scattered homes.

In many semi-enclosed communities—schools, for instance—the change of population occurs at certain regular periods, but in our case the change is continuous and the rate varies between from about 80 per cent. and about 115 per cent. per annum.

This is brought out in Table 13.

In compiling this section of the Report the Committee has had the advantage of calling in an expert statistician in the person of Professor Dalton, of the University of the Witwatersrand, to help the Statistical Sub-Committee in sorting out the mass of material submitted to them.

It will be fairly obvious, on perusal, which data have been considered sufficiently exact to lend themselves to expert statistical analysis, but the Committee has not confined its report entirely to the consideration of figures of this degree of exactitude, but has also included certain others. It was felt that, even though they might not be of equal value, they were worthy of consideration as being the best obtainable and as being sufficiently nearly accurate to be illuminating on certain questions.

2 Age and Duration of Employment Distributions.

It is estimated by experienced men that, at any one time, about 25 per cent. of the Native complement are boys under 25 years of age, about 70 per cent. between 25 and 40, and not more than 10 per cent. over 40 years of age.

A census of the Native labour force of the Rand Mines Group was arranged for by Dr. Orenstein, and he has put on record the duration of service claimed by about 80,000 mine-boys.

Graph 1 is an attempt at a " standard curve " of age-distribution (showing in addition rates of tuberculosis mortality), and Graph 2 at a " standard curve " of duration of service.

TABLE 13.

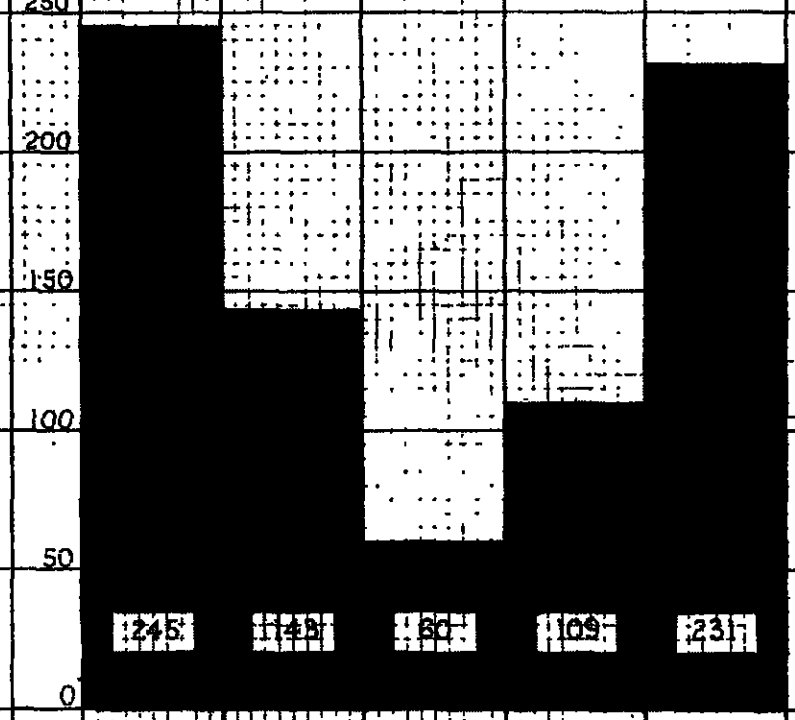
RATE OF CHANGE OF NATIVE COMPLEMENTS ON THE MINES OF THE WITWATERSRAND GOLDFIELD FOR THE YEAR 1929.

Company.	Average Native-Labour Strength.	Each Mine Percentage of Totals.	New Engagements.	Each Mine Percentage of Total.	New Engagements as Percentage of Native-Labour Strength.	Average Labour Strength as Percentage of New Engagements
Brakpan Mines, Ltd.	6,485	3 42	6,773	3·9	104 44	95·75
Daggafontein Mines, Ltd.	—	—	—	—	—	—
Springs Mines, Ltd.	6,045	3·19	6,714	3·86	111 07	90·04
West Springs, Ltd.	3,678	1 94	3,851	2·21	104·7	95·5
New Kleinfontein Co., Ltd.	3,934	2 08	3,915	2·25	99·52	100·49
City Deep, Ltd.	8,971	4·73	7,026	4 04	78·32	127·68
Consolidated Main Reef Mines & Estate, Ltd. ...	5,128	2·71	3,916	2·25	76·37	130 95
Crown Mines, Ltd.	16,166	8 53	12,738	7·33	78 8	126 91
Durban-Roodepoort Deep, Ltd.	3,816	2 01	2,973	1·71	77·91	128 36
East Rand Proprietary Mines, Ltd.	11,565	6 10	10,877	6·26	94·05	106 33
Ferreira Deep, Ltd.	—	—	—	—	—	—
Geldenhuis Deep, Ltd.	4,977	2 63	4,184	2 41	84·07	118 95
Modderfontein B. Gold Mines, Ltd.	4,258	2·25	3,248	1·87	76·28	131·1
Modderfontein East, Ltd.	4,349	2 30	4,104	2·36	94 37	105·97
New Modderfontein G.M. Co., Ltd.	7,838	6·14	8,065	4 64	102·9	97·19
Nourse Mines, Ltd.	4,841	2 55	5,032	2·89	103·95	96 2
Robinson G.M. Co., Ltd.	—	—	—	—	—	—
Rose Deep, Ltd.	3,522	1·86	3,175	1·83	90·15	110·93
Village Deep, Ltd.	4,336	2·29	3,463	1 99	79 87	125·21
Wolhuter Gold Mines, Ltd.	—	—	—	—	—	—
Aurora West United G.M. Co., Ltd.	—	—	—	—	—	—
Meyer & Charlton G.M. Co., Ltd.	1,321	0·70	1,000	0 58	75·7	132 1
Van Ryn Gold Mines Estate, Ltd.	3,025	1 60	3,412	1·96	112·79	88·66
West Rand Consolidated Mines, Ltd.	6,034	3 18	5,098	2·93	84 49	118·36
Government G.M. Areas (M.) Cons., Ltd.	12,291	6·49	13,285	7·64	108 09	92·52
Langlaagte Estate & G.M. Co., Ltd.	7,686	4·06	6,835	3 93	88 93	112·45
New Primrose G.M. Co., Ltd.	—	—	—	—	—	—
New State Areas, Ltd.	5,744	3 03	5,242	3·01	91·26	109·58
Randfontein Estates G.M. Co. (W.), Ltd.	17,051	9·00	14,659	8·43	85·97	116·32
Van Ryn Deep, Ltd.	4,527	2 39	4,780	2 75	105·59	94·71
Witwatersrand G.M. Co., Ltd.	3,398	1·79	3,075	1·77	90·49	110·5
Robinson Deep, Ltd.	5,692	3 00	4,369	2·51	76·76	130·28
Simmer & Jack Mines, Ltd.	5,499	2·9	4,787	2 75	87·05	114 87
Sub Nigel, Ltd.	4,252	2 24	4,073	2·86	116 96	85·5
Geduld Proprietary Mines, Ltd.	4,730	2·5	5,212	3·00	110·00	90·9
Modderfontein Deep Levels, Ltd.	2,293	1·21	2,134	1·23	93·07	107·45
Luipaards Vlei Est. & G.M. Co., Ltd.	2,148	1 13	1,716	0·99	79·89	125·17
Witwatersrand Deep, Ltd.	3,881	2·05	3,244	1·86	83 59	119·64
	189,481	—	173,875	—	91.76	108·98

Graph I.

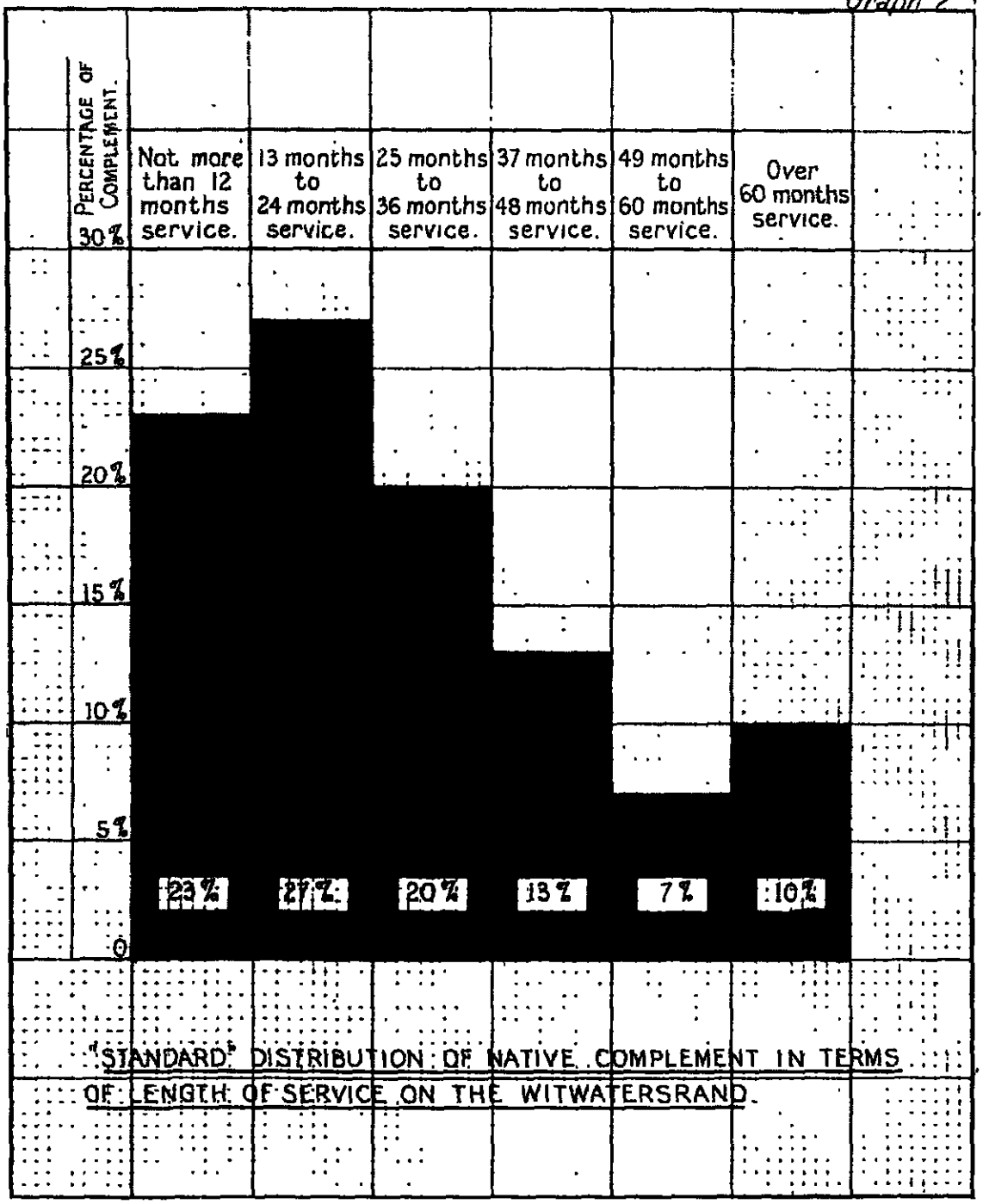
APPROXIMATE AGE DISTRIBUTION OF 788 CONSECUTIVE AUTOPSIES ON MINE-NATIVES WHO HAD DIED OF TUBERCULOSIS.

(The complement is about 190,000 changing at the rate of about 100% per annum. It is estimated that some 20% are 25 years of age or less, 70% between 26 yrs. and 40 yrs., and not more than 10% over 40 yrs.).



Up to 25 years	26 yrs. to 30 yrs.	31 yrs. to 35 yrs.	35 yrs to 40 yrs.	Over 40 yrs.
31·1% of the deaths in 20% of the complement	39·6% of the deaths in 70% of the complement			29·3% of the deaths in 10% of the complement
Death Rates: 0·64%		0·23%		1·2%

Graph 2



"STANDARD" DISTRIBUTION OF NATIVE COMPLEMENT IN TERMS OF LENGTH OF SERVICE ON THE WITWATERSRAND.

Although the data analyzed in these two graphs were secured at different times and by different people, these check better than might have been expected.

The duration of employment curve gives 67 per cent. as of over 1 year and under 5 years' total service, with 10 per cent. of over 5 years' total service. The age-distribution curve gives 70 per cent. as over 25 and under 40 years of age, with 10 per cent. over 40 years of age. The "young" group comes close enough to the proportion of mine-boys claiming to have worked not more than 1 year.

3. General Trend.—All Forms of Tuberculosis.

(a) General Statistics.

Table 14 covers the period from 1915 to 1930 inclusive and gives without analysis the average Native labour force employed on the Witwatersrand goldfield each year, with the number of cases of tuberculosis detected. Under the heading "Tuberculosis" is included all forms of tuberculosis and simple silicosis.

TABLE 14.

Native Tuberculosis.

*Incidence per 1,000 per annum of Tuberculosis, all Forms, and Silicosis, for 1915-1930.**

Average Complement.	Total Number of Cases.	Rate per 1,000 per annum.	Year.
—	—	13·1	1915
—	—	13·9	1916
—	—	12·8	1917
—	—	11·5	1918
—	—	9·6	1919
—	—	10 9	1920
—	—	8 6	1921
154,814	1,587	10·2	1922
170,259	1,396	8·2	1923
171,508	1,595	9 3	1924
168,694	1,550	9 1	1925
176,035	1,778	10·1	1926
180,533	1,596	8·8	1927
193,086	1,617	8·4	1928
193,493	1,445	7·5	1929
194,084	1,401	7·2	1930

It will be seen from Table 14 that, while the prevalence rate has varied from year to year, taking the 16 years as a whole there has been a marked fall, and the latest figures are the lowest figures.

* Figures from 1915 to 1921 are for the Rand Mines Group only. Throughout this period the Rand Mines Group accounted for more than half the Native Reef-complement, and their returns from 1922 to 1930 vary but slightly from the total returns.

(*b*) *Case Mortality.*

For the years 1916 to 1920 the case mortality, worked out on the figures returned by the mines, was 18·7 per cent.,[48] while for the year 1929-30* it was 17·5 per cent. Given our system of repatriation, whereby all cases fit to travel are sent to their homes, whereupon they drop out of statistical knowledge, and knowing from other sources that some 60 per cent. of these cases die within two years, these case-mortality figures have no bearing on the type or severity of disease.

(c) *Comparisons with Tuberculosis Incidence Elsewhere and in Other Phthisis-producing Industries.*

Our figures cannot be directly compared with others owing to our peculiar circumstances ; the gold-mining industry is a phthisis-producing industry worked by a migratory population living in semi-enclosed communities with a system of repatriation. As long as one bears this in mind, one can consider other vital statistics bearing on tuberculosis. As there is no general system of tuberculosis notification, one has to make comparison with mortality figures in most cases and to use the approximation commonly accepted by tuberculosis officers of total prevalence being three times the death-rate.

The following table (Table 15) of deaths from tuberculosis per annum in different countries has been collected from data given in the Statistical Survey of the International Union against Tuberculosis, published in 1925 :—

TABLE 15.

Country.	Deaths per 100,000 per annum.
England and Wales	106
Ireland	146
France	206
Italy	146
Belgium	111
Netherlands	104
Switzerland	164
Austria	227
Czechoslovakia	195
Norway	208
Sweden	163
Denmark	95
U.S.A.	98
Canada	84
New Zealand	62
Argentine	145
Japan	213
" Our Mine Natives "	125

* Figures compiled from returns made to this Committee.

While our figure deals only with men between the latest "teens" and the earliest "fifties," the other figures in the Table cover both sexes and all ages.

An interesting comparison lies with the United Fruit Company, operating in various countries round the Caribbean Sea. This concern, like ourselves, employs a large Native labour force and provides a complete medical service with hospitals for its different districts; moreover, it practises repatriation. For the four years 1926-29 inclusive, its average tuberculosis incidence was 292 per annum for an average complement of 54,819, or a rate of 5·3 per 1,000 per annum. In this case, one is dealing with a Native labour force employed on an open-air occupation and drawn from the neighbourhood. The United Fruit Company sets us an example in the admirable Annual Reports issued by its Medical Department, and it is from these reports that the above data have been taken.

If we consider phthisis-producing industries elsewhere, we learn that in England the tuberculosis mortality is about eightfold that of the general population, while the following brief table (Table 16) dealing with "Dusty Trades" in the U.S.A. is taken from a report of the National Tuberculosis Association published in 1919:—

TABLE 16.

State.	"Granite Cutters." Deaths per 100,000 per annum.
Upper Mississippi and Great Lakes States ...	676
North-western and Rocky Mountain States ...	763
Pacific Coast and South-western States ...	318
Massachusetts	841
New England States	962
Central Atlantic States	728
Lower Mississippi Valley and South Atlantic States	441
Mines of Butte, Montana	1,207

The above figures deal with a "fixed population" and cannot be directly compared with our migratory population. The fairest comparison is with our "old miners" (meaning Natives known to have over five years' continuous service on the gold mines), who may be regarded as a "fixed population." Our old miners have a *prevalence*-rate of about 3,200 per 100,000, or about four to five fold the general rate for our mines. Even they do not compare too unfavourably with the miners of Butte, Montana, with a death-rate of 1,207 per 1,000 per annum, equivalent to a production rate of 3,621 per 100,000 per annum.

If we attempt to compare the figures for our Natives with other figures for African Natives there is a certain poverty of data.

The Premier Diamond Mine presents circumstances in many ways comparable to our own, with the important proviso that theirs is not a phthisis-producing industry. The following figures are due to the

courtesy of Dr. A. Gow. For the ten years 1916-26 the average morbidity per 100,000 was 256, with an average mortality of 176, giving a case-mortality of about 68 per cent. They have not got a repatriation system comparable to that of the gold mines of the Witwatersrand and, from the point of view of case-mortality, are rather comparable with the Union Mental Hospitals and the South African Labour Corps in France.

Professor Lyle Cummins gives the following figures for the South African Labour Corps in France during the War: Prevalence rate, 2,907 per 100,000; deaths per 100,000 were 2,219; case-mortality, about 76 per cent.

By the courtesy of Dr. J. T. Dunstan, we get the following figures for the Union Mental Hospitals: Prevalence, 1,600 per 100,000. Dr. Dunstan stated that nearly all the cases were acute tuberculosis, and that the case-mortality was over 90 per cent.

In his Tuberculosis Survey of the Union, Dr. Peter Allan found no Native location with a morbidity below 600 per 100,000.

The colliery tuberculosis figures for 1926-7 show a prevalence rate of 383 per 100,000 with a case-mortality of 26 per cent.

The mean annual incidence of tuberculosis on Natives admitted to the prisons of the Union, 1919-21, was at the rate of 148 per 100,000. (Incidence on European males for same period, 386 per 100,000.)

The Medical Officer of Health for Cape Town returns non-European mortality from tuberculosis at 430 per 100,000 per annum (1926).

The Medical Officer of Health for Kimberley returns Native mortality from tuberculosis at 213 per 100,000 per annum (1926).

The Tuberculosis Officer for Durban returns the Native death-rate from tuberculosis at 160 per 100,000 for 1925. The actual number of deaths was 45. For the same year 111 cases were notified, or a prevalence rate of 358 per 100,000. (Compare collieries.)

In this context Native Labour Corps and mental hospitals may be regarded as being comparable with phthisis-producing industries. The gold-mining industry does not compare unfavourably with them. If the other figures quoted be considered, one notes that all the populations considered are more or less migratory. If we consider the ratio of phthisis-producing industry tuberculosis to the tuberculosis of the general population among Europeans, the comparison between tuberculosis rates on the Witwatersrand goldfields and among the general Native population is not unfavourable.

4. INCIDENCE RATES ON WITWATERSRAND MINES, 1926-1929.

Data and Primary Statistics.—During the period covered by the investigations of the Tuberculosis Research Committee, monthly returns (hereafter referred to as the standardized monthly returns) have been made by the medical officers of 34 gold mines on the

Witwatersrand, recording the mean Native labour complement employed during each month, and the numbers of discovered cases of (1) pulmonary tuberculosis, (2) pulmonary tuberculosis with silicosis, (3) simple silicosis and (4) other forms of tuberculosis. In this Section these categories will be designated by the corresponding abbreviations—(*1*) P.T.B., (2) T.B.S., (3) S.S., (4) O.T.B.

The monthly returns have been grouped in years for each of the mines under discussion, and the data here used cover the three completed years July, 1926, to June, 1929.

TABLE 17.

LABOUR COMPLEMENT. 34 GOLD MINES.

	1926-7.	1927-8.	1928-9.
Total Complement	180,461	191,486	193,493
Mean Complement per Mine	5,308	5,632	5,691
Standard Deviation	3,485	3,655	3,652
Coefficient of Variation %	65·7	64·9	64·2
Probable Error	± 7·33	7·21	7·09

The mine complements varied from 1,400 to 17,000, which accounts for the large standard deviation ; but it must be borne in mind that the distinction between a large and a small mine is more administrative than statistical, for the large mine has different shafts and different compounds, and its statistical significance differs from that of a similar aggregate of smaller contiguous mines only in so far as it is subject to a unified control.

It is evident from Table 17 that the period under investigation was one of expanding labour force, and the steadiness of the coefficient of variation shows that there was no appreciable bias in the distribution of the increase amongst the mines.

In Table 18 *are given, for each year and in each category,* the recorded number of cases and the mean incidence rate per 1,000.

In considering the numerical values here computed for the rates of incidence, it must be borne in mind that they are relative rather than absolute ; for, owing to the very large turnover of the Native labour force—about 100 per cent. per annum—the actual number of individuals at risk during any year is considerably greater than the average complement. Of course, the mean duration of risk per individual is lessened by the rapid turnover, but this need not necessarily compensate for the increased numbers at risk, and a comparison of the rates here given with those deduced from the experience of a more stable population would be of doubtful validity.

TABLE 18.

34 GOLD MINES.

Category.	P.T.B.			T.B.S.			S.S.			O.T.B.		
Year	1926-7.	1927-8.	1928-9.	1926-7.	1927-8.	1928-9.	1926-7.	1927-8.	1928-9.	1926-7.	1927-8.	1928-9.
Total No. of Cases:	761	746	607	381	345	345	198	162	166	235	355	327
Incidence Rate (per 1,000)	4·217	3 896	3·137	2 111	1 802	1·783	1·097	0·846	0·858	1·302	1·854	1·690
Standard Deviation ...	1·270	1·406	1·487	0 891	0·828	0·784	0·972	0·598	0·604	0·785	1·529	1·190
Coefficient of Variation %	30·1	36·1	47·4	42·2	46·0	44·0	88·6	70·6	70·4	60·2	82·4	70 4
Probable Error ± ...	2·65	3·28	4·61	3·97	4·44	4·19	11 48	8·07	8·03	6·39	10·23	8 03
Charlier Coefficient ...	21·5	29·1	41·1	29·8	33·6	30·8	78·4	53·8	54·0	46·7	76·4	62·6
Probable Error ± ...	3·71	4 07	5 32	5 62	6 08	5·99	12·97	10·59	10 47	8·24	11 04	9·03

It is satisfactory to note that in three of the four categories the general rate-trend has been downwards during the period under investigation. A least-square determination of the linear trend during the 40 months July, 1926, to November, 1929, gave for the mean monthly rate of change in the incidence rates per 100,000—(1) P.T.B., —0·315; (2) T.B.S., —0·145; (3) S.S., —0·086; (4) O.T.B., +0·144.

The large probable error of the coefficient of variation diminishes the significance of changes in this statistic. In only two of the categories, viz., P.T.B. and O.T.B., is the difference between the maximum and minimum values of this coefficient greater than the standard error of the difference. In the case of pulmonary tuberculosis the increase of variability is undoubtedly significant. While the mean incidence rate has diminished, its dispersion has increased. This is accounted for by the fact that the large mines have lagged behind the average in respect of improvement in this category. In the case of Other Tuberculosis, the increased incidence experienced by the large mines has been in advance of the average. In fact, of the excess of cases recorded in this category in the two later years, practically two-thirds are accounted for by two large mines whose joint complement is nearly 30,000.

Despite the warning already given that a mine is an administrative and not a statistical unit, these facts might tempt one to conclude that the size of a mine is one factor which influences the distribution of incidence rates of P.T.B. and O.T.B. Were such the case, the supposition should receive support from a significant positive correlation between incidence-rate and mine complement. The correlation coefficients are as follows :—

TABLE 19.

34 Gold Mines.

Correlation Coefficients between Incidence Rate and Mine Complement.

	1926-7.	1927-8.	1928-9.
P.T.B.	−0·0195±0·116	+0 167±0·112	+0·163±0·113
T.B.S.	−0·092 ±0·115	+0·115±0·114	+0·221±0·110
S.S.	−0·192 ±0·111	−0·137±0·114	−0·133±0 114
O.T.B.	+0 123 ±0·114	+0·198±0·111	+0·213±0·110

Not only are these coefficients intrinsically small, but, in view of their probable errors, even the largest of them does not reach the threshold of possible significance. The nominal size of a mine, therefore, is not a significant factor in the production of tuberculosis or of silicosis.

5. SEASONAL OSCILLATIONS IN THE TUBERCULOSIS INCIDENCE RATES.

(a) *Data.*—The standardized monthly returns yield the following monthly incidence rates for all gold mines :—

TABLE 20.

MONTHLY INCIDENCE PER 100,000 COMPLEMENT.

Year.	Month.	P.T.B.	T.B.S.	S.S.	O.T.B.
1926	July	26·9	9·9	6·6	4·9
	August	25·2	20·2	6·6	6·0
	September ...	28·7	23·3	6·0	6·5
	October	35·5	27·3	15·8	9·3
	November ...	53·5	32·9	12·8	16·7
	December ...	52·7	32·9	25·9	15·9
1927	January	49·1	14·1	7·9	11·9
	February ...	35·1	11·0	6·6	13·2
	March	29·6	11·9	9·2	12·4
	April	32·0	11·2	7·5	8·5
	May	26·1	8·5	6·4	8·5
	June	26·3	11·8	4·8	9·1
	July	30·9	6·0	2·2	11·4
	August	46·1	13·6	5·4	15·7
	September ...	44·2	14·0	3·8	8·6
	October	41·2	13·4	5·9	14·4
	November ...	45·6	18·0	9·0	14·9
	December ...	42·8	14·8	7·9	18·5
1928	January	30·5	17·9	6·8	27·9
	February ...	27·6	16·9	8·2	20·4
	March	27·7	13·6	11·6	15·1
	April	26·0	14·0	5·0	17·5
	May	20·5	14·5	6·5	11·0
	June	19·2	10·1	7·1	10·1
	July	23·0	18·4	6·7	10·7
	August	25·2	9·8	5·1	10·3
	September ...	27·2	14·4	5·7	12·3
	October	33·0	25·3	16·5	20·1
	November ...	34·3	19·8	9·4	16·7
	December ...	25·9	13·8	4·8	20·7
1929	January ...	35·4	10·6	5·3	16·4
	February ...	29·4	12·9	7·7	16·5
	March	24·9	17·8	6·6	11·7
	April	25·8	12·7	5·6	13·2
	May	17·3	11·2	7·6	13·2
	June	16·6	0·3	6·2	7·8
	July	18·9	12·1	5·2	10·5
	August	31·7	12·7	5·3	17·4
	September ...	37·8	11·0	6·3	17·3
	October	36·3	15·8	7·9	17·3

There were also available similar returns made by Dr. Orenstein for the Rand Mines group, but these differed to some extent inasmuch as they did not separate the tuberculo-silicosis cases from the tuberculosis cases.

(*b*) *Secular Trend.*—Assuming a linear law, which is all that is justified in view of the shortness of the period under investigation, we find for the mean secular trend of each of the four categories :—

P.T.B. ... ... $r_1 = 38{\cdot}1 - 0{\cdot}315t$
T.B.S. ... ... $r_2 = 18{\cdot}4 - 0{\cdot}145t$
S.S. ... ... $r_3 = 9{\cdot}42 - 0{\cdot}086t$
O.T.B. ... ... $r_4 = 10{\cdot}6 + 0{\cdot}144t$

r is the monthly incidence rate per 100,000 and t is the number of months elapsed from June, 1926.

Except in the case of " Other Tuberculosis," there has been a mean decrease per month of approximately 1 per cent. of the mean monthly rate. In the exceptional case the secular trend has been upwards to the same extent.

Dr. Orenstein's data for T.B. give for the secular trend :—

T.B. (Rand Mines) ... $r = 64{\cdot}0 - 0{\cdot}305\ t.$

The mean monthly decrease has here practically the same absolute value as that deduced for P.T.B. from the standard returns, but the mean value is much higher. This higher mean value is due probably to the inclusion of T.B.S. cases in the T.B. classification.

In the collieries experience the monthly P.T.B. rate has shown a slight upward tendency, the line of best fit being—

P.T.B. (collieries) ... $r = 23{\cdot}51 + 0{\cdot}074t.$

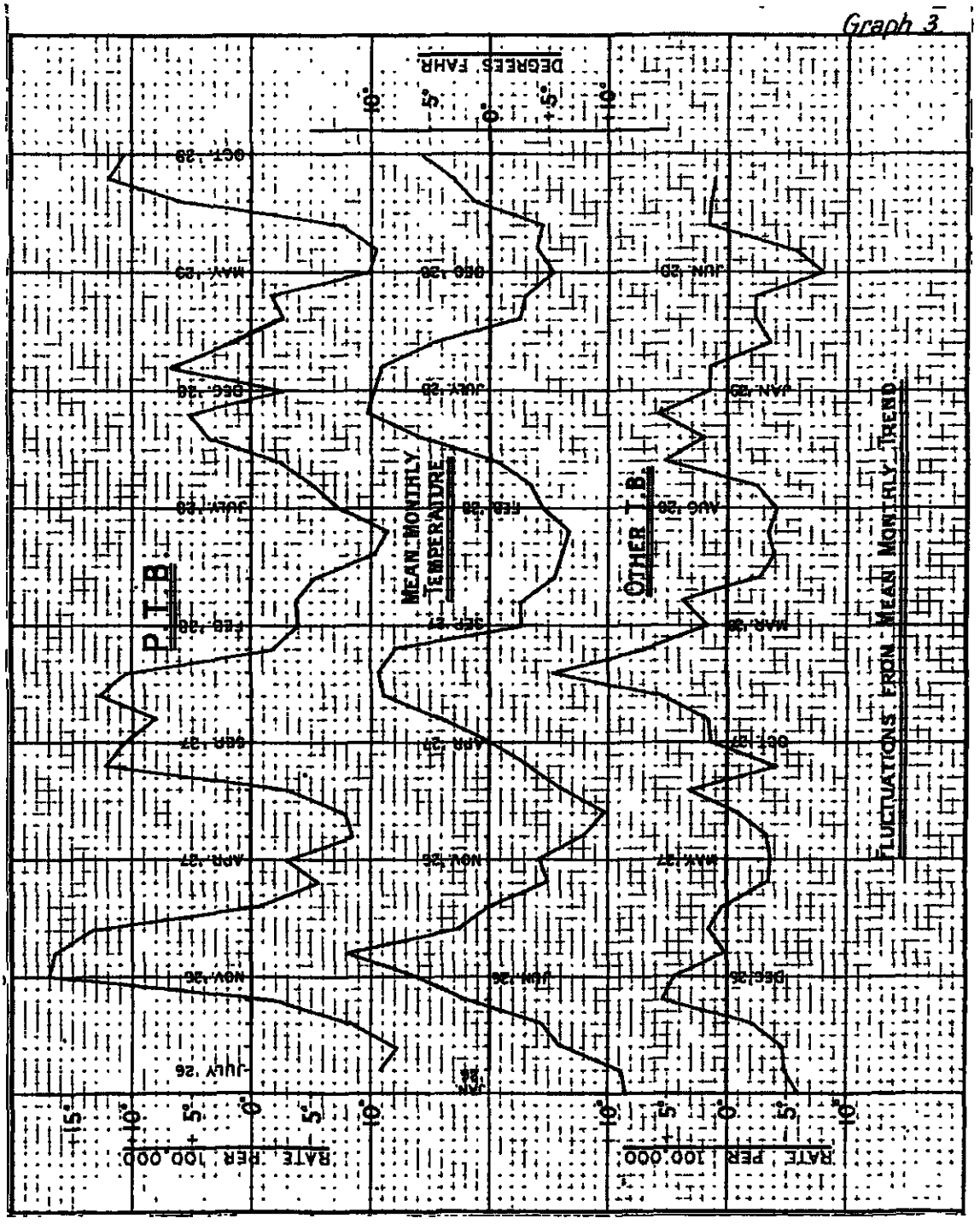
(*c*) *Fluctuations.*—The mean deviations from the secular trend of the monthly rates are given in the following Table :—

TABLE 21.

Category.	Mean Rate.	Mean Deviation.	M.D./M.R.
P.T.B.	31 6	7·4	0·23
T.B.S.	15 4	4·3	0·28
S.S.	7 65	2 5	0·33
O.T.B.	13·5	3·5	0·26
T.B. (Rand Mines)	52 5	14·3	0·27
P.T.B. (Collieries)	25 0	13·6	0·54

The large value of the ratio in the case of the collieries may be due to the smallness of the field of observation ; it may also be due in part to a less systematic medical supervision.

(*d*) *Periodicity.*—There is a marked difference between the character of the deviations from the mean trend in the case of P.T.B. and O.T.B. on the one hand and T.B.S. and S.S. on the other. In the silicosis groups the deviations are irregular and more or less random, while in the categories P.T.B. and O.T.B. there is a very definite seasonal oscillation which is strongly marked in the case of P.T.B.


Graph 3
DEGREES FAHR.
P.T.B.
MEAN MONTHLY TEMPERATURE
OTHER T.B.
FLUCTUATIONS FROM MEAN MONTHLY TREND
RATE PER 100,000
RATE PER 100,000

The accompanying diagram (Graph 3) exhibits the relation between these oscillations and those of the mean monthly temperature as recorded by the Union Observatory. For P.T.B. the maximum of the oscillation occurs in November, and for O.T.B. in December, so that there is a lag of five months and six months respectively behind the minimum temperature. For comparative purposes, these lags are allowed for in the diagram, and the temperature fluctuations are plotted with sign reversed.

As a measure of the significance of these concomitant variations, we find—

P.T.B. and Temperature (5 months' lag) Correlation = −76 per cent.

O.T.B. and Temperature (6 months' lag) Correlation = −67 per cent.

We cannot say if any significance attaches to the fact that the incidence rate for P.T.B. as experienced by the collieries shows no sign of oscillation. Naturally, the smallness of the statistical field here increases the mean deviation, and accounts for a certain amount of irregularity, but one would not expect a periodic factor to be obscured completely thereby. If this oscillation is definitely absent in the experience of the collieries, then it would appear that its occurrence in the experience of the gold mines should be correlated not so much with the oscillations in the Mean Monthly Temperature *per se*, as with the periodic variations in the difference between mean surface and mean underground temperatures.

(*e*) *Rand Mines Experience.*—Dr. Orenstein's T.B. records for the years 1926-7-8 exhibit the same periodical oscillations, but somewhat masked by the inclusion of the non-oscillatory T.B.S. category. Maximum incidence occurs in November, and the correlation coefficient between the oscillations of the T.B. rate and those of the mean monthly temperature of five months previous is −60 per cent.

His pneumonia records likewise exhibit a seasonal oscillation about the mean trend, but in this case there is no lag between incidence rate and temperature. The coefficient of correlation between the oscillations is here −70 per cent.

Dr. Orenstein's graph (not published) also exhibits the monthly records of percentage of new recruits. Here again the fluctuations from the mean trend are definitely seasonal, the maximum being attained in the initial months of the calendar year. This influx of new recruits seems to have the effect of raising the incidence rate of T.B. during the ensuing winter months*; but this effect, if existing, is certainly less noticeable than the influence of the temperature, and the data are so irregular that it cannot be accepted as definitely established.

The returns on which the foregoing analysis is based contain a possible fallacy inasmuch as they include the returns of the " special examinations " of long-service mine Natives and most of these examinations were returned in the summer months, when the " peaks " occur.

*Seasons here refer, of course, to those of the Southern hemisphere.

(*f*) *Death Rates.*—Deaths, however, are not affected by the special examinations and Graph 4 gives the monthly returns for deaths due to tuberculosis. It will be seen that deaths show a clumping in the summer months October to February.

The most comprehensive returns available are the Monthly Sickness Returns of the Native Affairs Department. These deal with a population of about 250,000, of whom about 80 per cent. are mine-workers of some kind. Graph 5 gives the monthly returns of deaths due to tuberculosis from January, 1914, to December, 1930, inclusive. In this graph, covering a period of 17 years and including nearly 9,000 deaths, there is the same clumping in the months October to January.

In conclusion, the Chamber of Mines has been good enough to supply figures giving the monthly tuberculosis prevalence on the gold mines from 1st July, 1919, to 30th June, 1926, thus avoiding any fallacy introduced by the special examination of 1926-1930. Table 22 and Graph 6 deal with these figures. The figures for 1921-1922 are not included in Graph 6, being slightly incomplete. It will be seen that the spring-summer clumping remains.

TABLE 22.

GOLD MINES.

MONTHLY RETURNS FOR TUBERCULOSIS (ALL FORMS) AND MINERS' PHTHISIS.

July 1st, 1919, to June 30th, 1926.

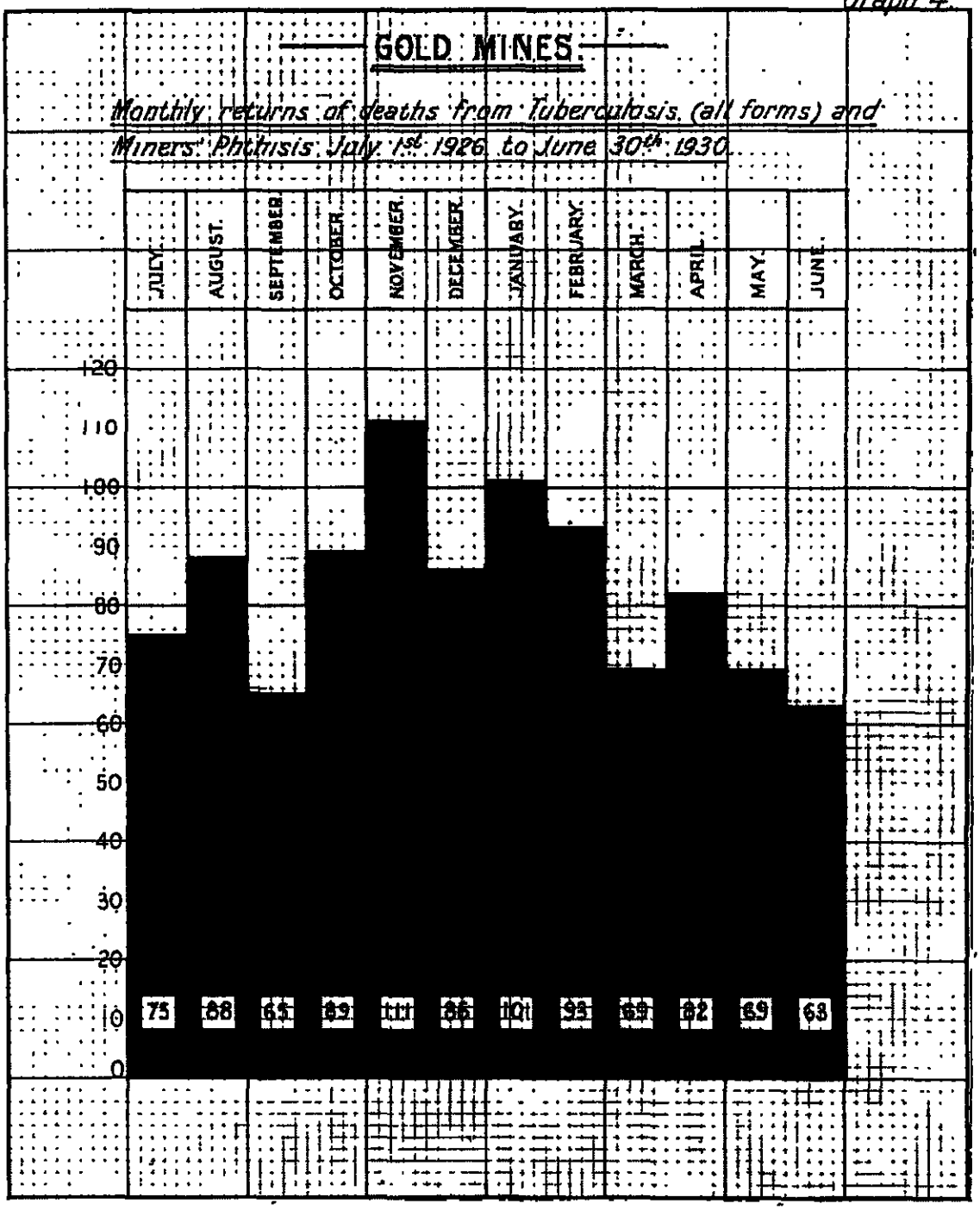
Includes both Deaths and Repatriations.

Month.	1919-1920.	1920-1921.	1921-1922.	1922-1923.	1923-1924.	1924-1925.	1925-1926.	Totals.
July	123	161	64	139	154	165	114	920
August	160	199	94	205	165	123	118	1,064
September	145	205	83	212	166	175	159	1,145
October	146	171	88	228	191	153	152	1,129
November	226	184	136	192	224	186	167	1,315
December	176	198	118	148	160	180	142	1,122
January	163	106	128	157	216	160	141	1,071
February	140	106	77	143	184	77	124	841
March	177	114	97	122	138	120	127	805
April	133	98	105	134	120	131	111	832
May	148	90	112	127	177	94	115	853
June	162	69	122	134	166	125	130	908

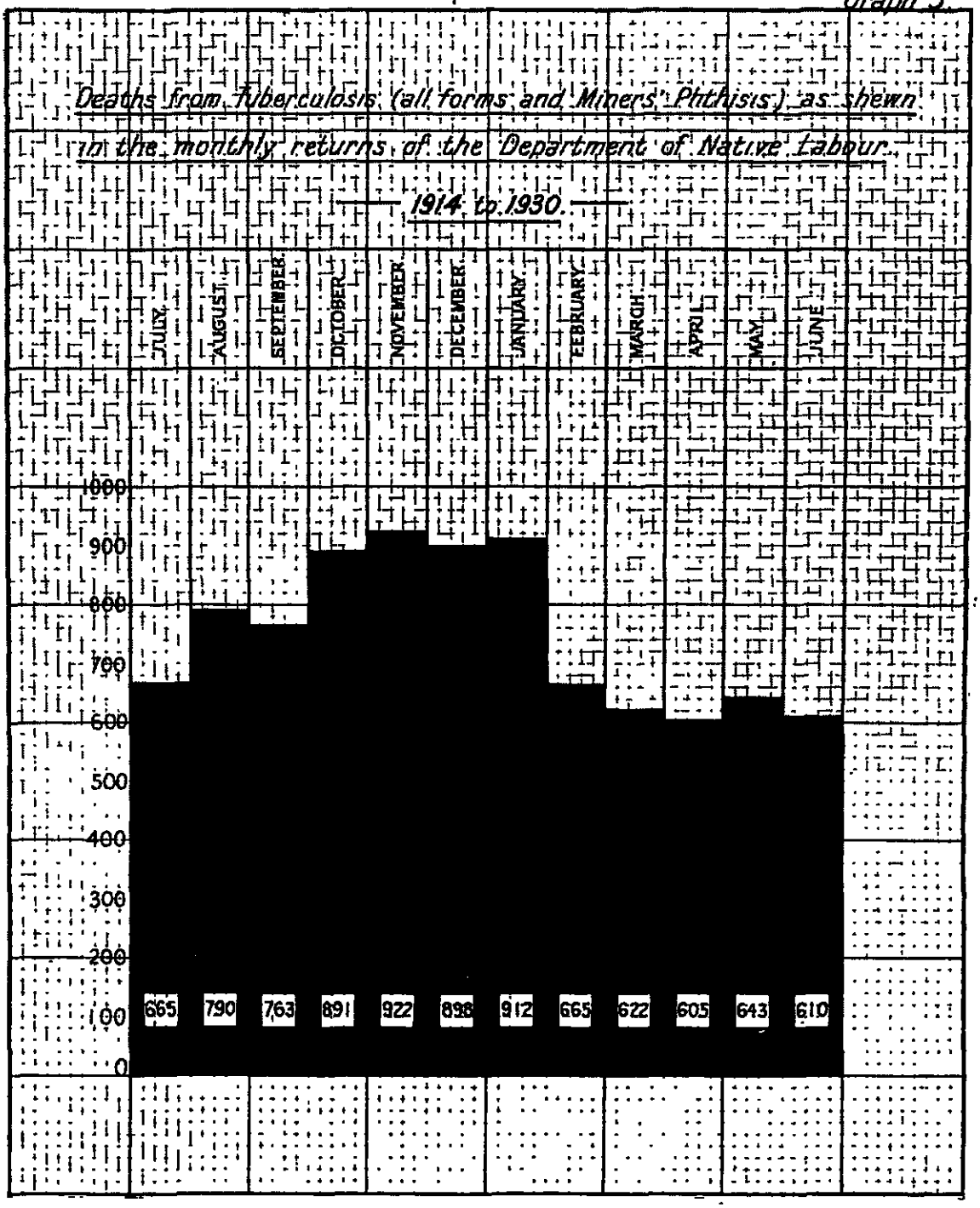
There does seem, therefore, to be a definite seasonal distribution, but why ?

One might say that the Natives start their tuberculosis in the winter and that it goes on to recognition and death during the summer. This hypothesis would be more interesting if we were dealing with Natives in their kraals. One would then refer to food shortage and exposure, but fully 80 per cent. of the Natives considered are working mine Natives, and there is no question of special winter food shortage and exposure in their case.

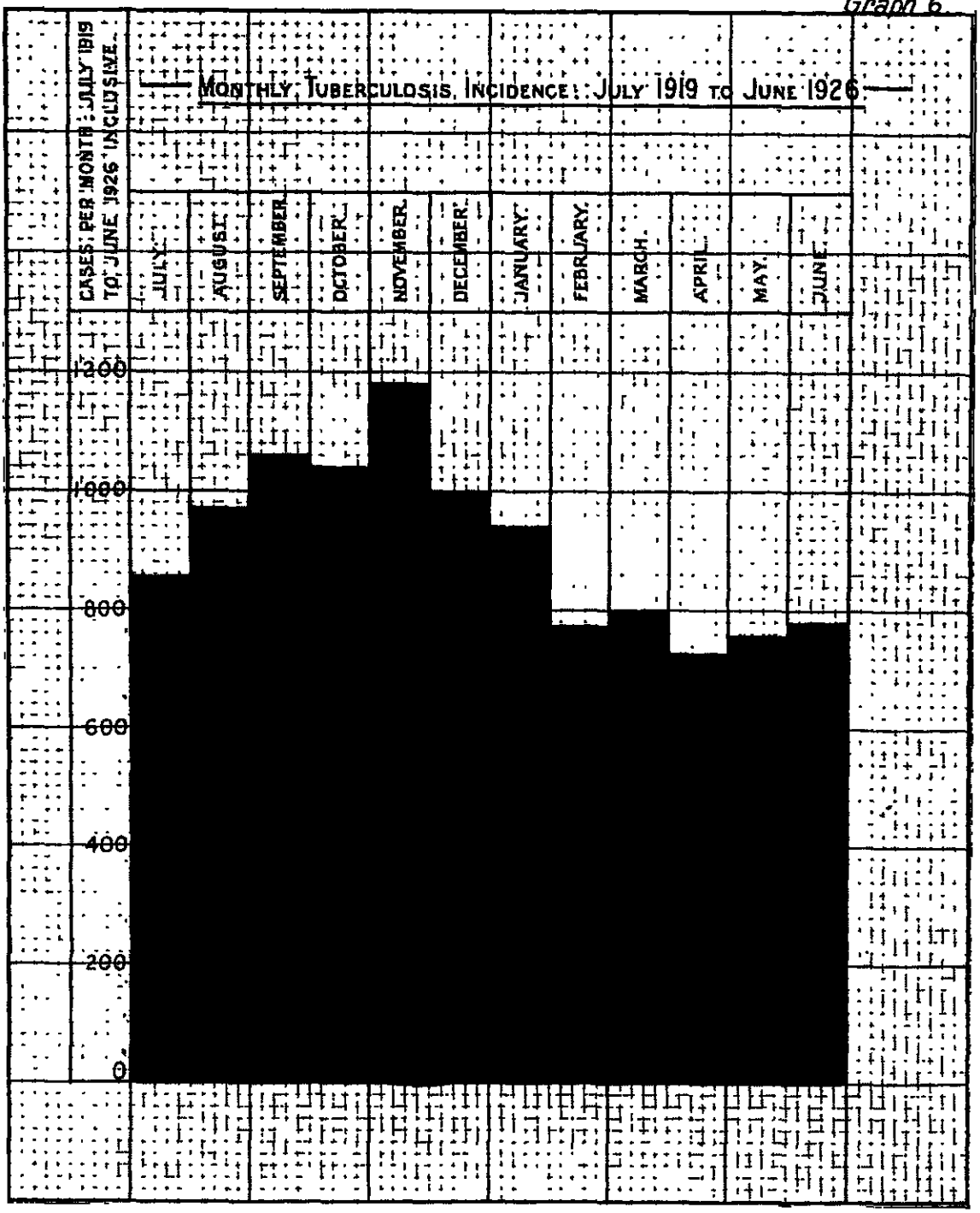
Graph 4.


GOLD MINES.
Monthly returns of deaths from Tuberculosis (all forms) and Miners' Phthisis July 1st 1926 to June 30th 1930.
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
120
110
100
90
80
70
60
50
40
30
20
10
0
75
88
65
89
111
86
101
93
69
82
69
63

Graph 5.


Deaths from Tuberculosis (all forms and Miners' Phthisis) as shewn in the monthly returns of the Department of Native Labour.
1914 to 1930.
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
1000
900
800
700
600
500
400
300
200
100
0
665
790
763
891
922
898
912
665
622
605
643
610

Graph 6.


MONTHLY TUBERCULOSIS INCIDENCE: JULY 1919 TO JUNE 1926.
CASES PER MONTH JULY 1919 TO JUNE 1926 INCLUSIVE.
JULY.
AUGUST.
SEPTEMBER.
OCTOBER.
NOVEMBER.
DECEMBER.
JANUARY.
FEBRUARY.
MARCH.
APRIL.
MAY.
JUNE.
1200
1000
800
600
400
200
0

Another hypothesis which seems worth considering, not as an explanation covering all the facts but as playing a part, is the relationship between tuberculosis and influenza.

Various mine medical officers are of opinion that tuberculosis is frequently "lit up" by influenza; cases regarded as influenza passing on to definite tuberculosis, or cases that had been in hospital for influenza and discharged developed a definite tuberculosis comparatively soon afterwards.[48]

With the object of tracing, if possible, any connexion between tuberculosis and any preceding disease such as influenza, a special entry was provided for in the post-mortem record form used by the Pathological Sub-Committee in collecting pathological data (see Appendix 7, p. 411). It must be admitted that this line of enquiry did not elicit any definite connexion between tuberculosis and an antecedent influenza attack but some more recently-acquired information may not be without bearing on this point.

Dr. Ordman[55] has shown that the seasonal distribution of pneumonia on the mines shows a winter peak and a spring peak in its incidence. The winter peak is predominantly due to pure pneumococcal infections, whereas the spring peak is due to a variety of organisms, being, in fact, what is commonly termed influenzal pneumonia.

It is tempting to suggest that this spring influenza sets light to the tuberculosis, which burns on to death or recognition in the ensuing summer months.

6. FACTORS INFLUENCING INCIDENCE ON INDIVIDUAL MINES.

(*a*) *Working Conditions.*—From the values of the Charlier "coefficient of disturbancy"[56] given in Table 18, it is evident that the distribution of incidence rates forms, in all four categories, a hypernormal series, and that the variations in the rates for the different mines are not of the nature of random fluctuations. The problem then is to endeavour to disentangle some of the more important factors operative in causing these discrepant experiences. Such possible influences might be classified as (*a*) *permanent*, and (*b*) *transient*. Permanent factors are those which change but little from year to year; they are inherent in the mine itself and may be summarized under housing and working conditions. Transient factors, on the other hand, are in a state of flux, and depend upon the constitution of the mine complement at any given time. The rapid turnover of the labour force may cause considerable variations from year to year in any individual mine, in the age and tribal constitution of its complement, as well as in the ratio of new recruits to experienced Natives.

A complete discussion of these factors is not possible, as the requisite data are not available. No general system of identification is in force whereby the previous mining history of a Native may be established, nor is the age or tribal constitution of the general population accurately known. In fact, few Natives know their own ages. In

recording a case medical officers, by personal enquiry, ascertain the tribe and an approximate previous history; and they estimate the age. But in the absence of corresponding data for the total complement no reliable inferences may be drawn.

If what have been called permanent factors were the more important influences which determine an incidence rate, then one would expect significant correlation between the experience of individual mines in successive years. Correlation coefficients have therefore been computed for the returns for successive years in all four categories.

TABLE 23.

34 GOLD MINES.

CORRELATION BETWEEN EXPERIENCE IN SUCCESSIVE YEARS.

	1926-7 and 1927-8.	1927-8 and 1928-9.
P.T.B.	+0·288±·106	+0·380±·099
T.B.S.	+0·461±·091	+0·736±·053
S.S.	+0·686±·061	+0·636±·069
O.T.B.	+0·427+·095	+0·522+·084

When, as in the present instance, different causative agencies are operative, simple correlation coefficients must be treated with reserve. Nevertheless, it is suggestive that simple silicosis should show the steadiest influence of working conditions, and that the production of the two silicosis categories should, on the whole, be most influenced by mine-to-mine variation of these conditions. On the other hand, the low value and the bare significance of the correlation coefficients for pulmonary tuberculosis lead one to the conclusion that in this case working conditions are of general effect only, and do not constitute a paramount factor in the variation of incidence experienced by the different mines.

NOTE.—Since the completion of the foregoing statistical analysis a fourth year of observation has terminated, viz., July, 1929, to June, 1930. 2 of the 34 gold mines dealt with in the preceding paragraphs closed down and therefore disappear from the records. The total mean annual complement of the remaining 32 was 193,843.

The mean incidence rate for pulmonary tuberculosis was 3·307 per 1,000, showing a slight increase on the 1928-9 rate.

The improvement in the two silicosis categories was maintained, for the additional year's experience yielded incidence rates of 1·357 per 1,000 for T.B.S. and 0·614 per 1,000 for S.S.

In these three categories correlation of the experience of 1929-30 with that of the previous year reveals the same general features as those of Table 23. The correlation coefficients are (1) P.T.B., 0.468±·090; (2) T.B.S., 0·704±·058; (3) S.S., 0.609±·073.

(*b*) *Housing Conditions.*—As general diet and hygienic conditions are fairly stable throughout the compounds, an obvious factor left to consider is the influence of the number of occupants per room upon the distribution of incidence of P.T.B. This number varies from 2 to over 100. If tuberculosis were appreciably infective, then a contact should experience greater liability to contract the disease than a non-contact, and larger rooms should exhibit a significantly higher rate of incidence than smaller rooms. To throw some light upon this problem, the Research Committee asked mine medical officers to keep compound spot maps of their recorded cases. On some mines this was not possible; while many maps were unusable for statistical purposes. One medical officer had, on his own initiative, been keeping excellent spot-maps since the inauguration of the Research Committee, and his data, embracing 404 rooms with a capacity of over 20,000 Natives, and covering an experience of 33 months, are here dealt with separately. Of the others only 10 were ultimately found satisfactory; they cover an experience of 17 months and deal with 1,194 rooms with a population of over 38,000.

TABLE 24 (*a*).

DATA REGARDING NUMBER OF OCCUPANTS PER ROOM.

5 Compounds—33 Months' Experience.

Room Capacity	No. of Rooms.	No. of Occupants.	Number of Cases per Room.									Total Cases.	Incidence Rate per 1,000
			0	1	2	3	4	5	6	7	8		
1– 20	17	226	12	5	—	—	—	—	—	—	—	5	22·1
21– 40	89	3,141	45	21	19	3	1	—	—	—	—	72	22·9
41– 60	232	12,023	95	75	38	14	7	2	1	—	—	237	19·7
61– 80	52	3,527	14	17	15	5	1	—	—	—	—	66	18·7
81–100	8	730	1	2	2	2	1	—	—	—	—	16	21·9
101–120	6	635	—	—	1	1	—	2	—	1	1	30	47·2
Totals	404	20,282	167	120	75	25	10	4	1	1	1	426	21·0

TABLE 24 (*b*).

DATA REGARDING NUMBER OF OCCUPANTS PER ROOM.

10 Compounds—17 Months' Experience.

Room Capacity.	No. of Rooms.	No. of Occupants.	Number of Cases per Room.							Total Cases.	Incidence Rate per 1,000
			0	1	2	3	4	5	6		
1– 20	495	6,726	422	65	7	1	—	—	—	82	12·2
21– 40	272	8,513	205	55	10	2	—	—	—	81	9·5
41– 60	302	20,370	243	108	33	5	3	—	—	201	9·9
61– 80	22	1,513	6	13	2	—	1	—	—	21	13·9
81–100	6	550	2	3	1	—	—	—	—	5	9·1
101–120	7	730	1	1	3	—	1	—	1	17	23·0
Totals ...	1,104	38,411	870	245	56	8	5	—	1	407	10·6

The incidence rates here computed are for the whole experience. A proportional reduction to one year does not render them comparable with the mean annual rates used in Table 18, on account of the turnover of the occupants. An assumed annual turnover of 90 per cent. brings them fairly close to the mean of the recorded rates for each group.

With the exception of rooms of capacity over 100, these incidence rates offer no grounds for suspecting any definite influence of the size of a room upon the number of cases occurring in it. The matter may be definitely tested by means of Pearson's well-known " Goodness of Fit " criterion.[57] If we assume that there is no bias in the risk either for individuals or for rooms, and that the probability of the occurrence of a tuberculosis case in any room is in no way affected by the previous occurrence of a case in the same room, then the distribution of cases amongst the rooms should follow the well-known Poisson Law.

Taking, therefore, the mean probability of the occurrence, of a case in the two experiences as $\frac{426}{20282}$ and $\frac{407}{38411}$ respectively, we find, on the assumptions just made, the following expected distributions :—

TABLE 25 (*a*).

POISSON DISTRIBUTION—33 MONTHS' EXPERIENCE.

Room Capacity.	No. of Rooms.	Number of Cases per Room.						Expected No. of Cases.
		0	1	2	3	4	5+	
1– 20	17	12·86	4·14					4·75
21– 40	89	42 41	31·44	11·65	3·50			65·97
41– 60	232	78·12	85·03	46·28	16·79	4·57	1·21	252·53
61– 80	52	12 51	17·82	12·70	6·03	2·94		74·08
81–100	8	1 18	2·26	2·16	1·38	1·02		15·33
101–120	6		2·09	1·61	1·19	1·11		13·34

TABLE 25 (*b*).

POISSON DISTRIBUTION—17 MONTHS' EXPERIENCE.

Room Capacity.	No. of Rooms.	Number of Cases per Room.				Expected No. of Cases.
		0	1	2	3+	
1– 20	495	428·62	61·71	4·67		71·27
21– 40	272	195·23	64·74	10·73	1;30	90·20
41– 60	392	226·03	124·45	34·26	7·26	215·84
61– 80	22	10·62	7·29	2·82	1·27	16 03
81–100	6	2·27	2·21	1·52		5·83
101–120	7	2·29	2·56	2·15		7·83

In these theoretical distributions the end classes have been grouped so that no frequency-cell contains less than a unit. The number of frequency-cells filled is 26 in 25 (*a*) and 21 in 25 (*b*). If E is the expected

frequency from Table 25 and O the corresponding observed frequency from Table 24, then the total variance is given by $\Sigma\ (E-O)^2/E$ where the summation is over all the cells. In the first case, the variance is found to be 31·58, and in the second 21·33. Now, in each case, the marginal totals of rooms are fixed, and furthermore the total number of cases in the theoretical distribution is also fixed by the experience. These restrictions necessitate the removal of seven degrees of freedom, and therefore the number of cells which may be filled arbitrarily is 19 in (*a*) and 14 in (*b*). For these values of χ^2 we find P = ·04 and ·09 respectively. That is to say, random sampling would lead to a worse fit with hypothesis in 4 per cent. and 9 per cent. trials respectively, and we therefore conclude that the evidence of the compound spot-maps discloses no grounds for belief that the number of inhabitants per room is a factor affecting the variations in the incidence rate of pulmonary tuberculosis.

The quest for an explanation of the differences in tuberculosis incidence between mine and mine is taken up also by Dr. Mavrogordato in a communication published as an Appendix to this Report (Appendix No. 5, p. 332).

In this communication he has set up like a row of ninepins the various tentative explanations which have been put forward from time to time and has then proceeded systematically to bowl them over one by one.

The only logical conclusions would appear to be either (*a*) that we have still not found the one factor accounting for the differences or (*b*) that there is no such one adverse factor in operation, but that the same influences operate all along the Reef, only varying in degree and in their combinations from mine to mine

7. RELATION OF INCIDENCE TO AGE.

No large series of figures is available showing the relationship between tuberculosis incidence and age-distribution, because the age of the employees is not a matter *per se* that the mining companies concern themselves with, nor is it anybody else's business to keep record of them. We are dependent upon the series of post-mortem reports collected by this Committee for some definite information on this point. These are probably fairly representative, but it must be borne in mind that, for reasons given earlier in this section, ages are often only approximations and not exactitudes. Graph 1 deals with these figures.

The figures obtained from the series of 788 consecutive autopsies on mine Natives who had died of tuberculosis show that 245 cases were under 25 years of age. This represents 31·1 per cent. of the deaths occurring in 20 per cent. of the complement, and a death-rate of 6·4 per 1,000. In Natives aged between 25 years and 40 years there were 312 deaths; this represents 39·6 per cent. of the deaths occurring in

70 per cent. of the complement and a death-rate of 2·3 per 1,000. There were 231 deaths in boys of over 40 years of age, *i.e.*, 29·3 per cent. of the deaths occurring in 10 per cent. of the complement, a death-rate of 12 per 1,000.

The incidence of tuberculosis in relation to age shows a striking similarity to the incidence in relation to length of service, viz., a " clumping " at the extremes, with comparatively few cases in the intermediate years ; or, in other words, tuberculosis abundant in the first year of service or in ages under 25, infrequent in the second to fifth year of service or in ages between 25 and 40, and again abundant in Natives with total service of over five years or in ages over 40.

Is age or length of service the important factor in determining this incidence ? There can be little doubt that it is length of service and not age.

The numbers of Natives starting mining work for the first time when they are already " olderly " are too few to test on a statistical basis whether they show a similarly high incidence in the first year of their service, but the fact brought out in the Pathological Section of this Report (see p. 169) that in Natives over 40 years of age, apart from the influence of silicosis, tuberculosis tends to become generalized practically just as much as in the younger Natives, would indicate that age *per se* has little influence on the power of resistance and therefore on the incidence.

8. Relation of Incidence to Length of Mining Service.

The first of what have been called transient factors which calls for investigation is the influence upon the incidence rates of the constitution of the mine complements with respect to previous contact with mining conditions. Unfortunately, data are not available for the previous history of all working Natives ; but two specially undertaken enquiries throw some light upon the problem.

The first of these was a census in respect of past service of the Native employees of eight mines. The total mean annual complement of these mines is about 75,000, and the samples covered by the census embraced 64,000 Natives.

This should be representative of the whole mine complement in each case. The years of service enumerated were years spent on any Witwatersrand gold mine, and not merely the years of employment on the mine on which the census was taken. The two terminal groups are here designated N.R (*i. e.*, now recruits of under one year of service) and L.S. (*i.e.*, long-service Natives of over five years' experience) respectively. How far the census figures obtained may be considered to reflect the average constitution of the complement of each mine during the year in which it was taken is not by any means certain, but in all probability they are substantially representative. The data are given in Table 26

TABLE 26.

EIGHT WITWATERSRAND GOLD MINES.

CONSTITUTION OF COMPLEMENT AND INCIDENCE RATES.

1928-29.

Mine Index No.	Total Complement in thousands	% of New Recruits.	% of Long Service.	Incidence Rates per 1,000.			
				P.T.B.	T.B.S.	S.S.	O.T.B.
2	9	16·84	15·47	3·49	3·04	0·563	1·58
4	16	21·14	16·65	2·73	2·02	1·366	2·17
6	11	31·53	8·41	6·52	2 06	0·687	1·12
14	4	17 58	8·87	1·39	1·86	1 625	0·46
16	4	16·23	11·67	2·12	1·18	1·884	0·94
18	8	22·19	6·07	1·02	1·15	0 638	0·13
21	17	25·76	6 23	2·63	1·70	0 527	4·04
28	6	27·23	0 33	5·45	3·86	0 454	0·68

From these the following correlations were obtained :—

TABLE 27.

EIGHT WITWATERSRAND GOLD MINES.

CORRELATIONS BETWEEN EXPERIENCE AND INCIDENCE.

	P.T.B.	T.B.S.	S.S.	O.T.B.
% N.R.	$+0·72\pm0·12$	$-0·46\pm0·20$	$-9\ 52\pm0·19$	$+0\ 17\pm0·25$
% L.S.	$-0·02\pm0·25$	$+0·69\pm0·13$	$+0\ 52\pm0·19$	$-0·12\pm0·25$

On account of the meagreness of the data upon which they are based, the probable errors of these coefficients are high. Nevertheless, the conclusion is legitimate that pulmonary tuberculosis and the two silicosis categories tend to be selective in their incidence ; the former attacks the new recruit more readily than the experienced Native, while the latter, depending, as they do, upon a continued inhalation of quartz-dust, can only appear, as a rule, in the Natives who have had at least a few years' service. Granting, therefore, that the various mines differ amongst themselves in respect of the experience of their Native complements, part, at least, of the hypernormality disclosed in Table 18 is accounted for in these three categories.

In so far as the present data are concerned, there is no evidence that experience of mining conditions influences in any way the incidence of tuberculosis other than pulmonary.

The second special enquiry directed towards the elucidation of the influence of previous experience upon the incidence of pulmonary tuberculosis involved Mines Nos. 2 and 4, with mean complements of

about 9,000 and 16,000 respectively. Over the period January, 1927, to June, 1928, the total number of shifts worked on any Witwatersrand gold mine was recorded for each case. (Mine No. 2 returned the information for P.T.B., T.B.S. and S.S. cases together; No. 4 for P.T.B. and T.B.S. together.) From these returns, in conjunction with the special census of service respecting these mines, relative incidence-rates for various durations of service have been obtained. As the previous histories are in terms of "shifts worked," while the census of service is in terms of years, the former have been converted into years on the approximate basis of one year service=300 shifts worked. This gives the following distribution :—

TABLE 28.

SERVICE DISTRIBUTION OF CASES, January, 1927, to June, 1928.

Mine Index No.	Category.	Years of Total Service.						Total No. of Cases.
		0–1	1–2	2–3	3–4	4–5	over 5	
2	P.T.B., T.B.S., S.S.	33	12	9	10	3	18	85
4	P.T.B., T.B.S. ...	77	19	14	8	6	17	141

To obtain annual incidence rates, a hypothetical complement (100,000) is assigned to each mine, and the hypothetical cases are obtained from the appropriate rates of the 1927-8 standard returns. These cases are now distributed amongst the years of service in the proportions disclosed by Table 28, while the hypothetical complement is likewise distributed in accordance with the proportions disclosed by the "census of service."

TABLE 29.

VARIATION OF INCIDENCE RATE WITH YEARS OF SERVICE.

Mine No. 2.—Hypothetical Complement, 100,000.

Recorded Rate: P.T.B.+T.B.S.+S.S. 7·60 per 1,000 per annum. Equivalent Cases: 760.

Years of Service.	0–1	1–2	2–3	3–4	4–5	Over 5	Totals.
Percentage of Cases (Table 28) ...	38·8	14·1	10·6	11·8	3·5	21·2	100
Percentage of Complement (Census)	16·8	24·2	19·7	14·7	0·1	15·5	100
Distributed Cases ...	295	107	80	90	27	161	760
Rate per 1,000 P.T.B. T.B.S., S.S. ...	17·6	4·42	4·06	6·12	2·97	10·39	7·60

Mine No. 4.—Hypothetical Complement, 100,000.

Recorded Rate: P.T.B.+T.B.S. 6·84 per cent. per annum. Equivalent Cases: 684.

Years of Service.	0–1	1–2	2–3	3–4	4–5	Over 5	Totals.
Percentage of Cases (Table 28.) ...	54 6	13·5	9·9	5·7	4·3	12·0	100
Percentage of Complement (Census)	21·1	24·1	16·6	13·2	8·3	16·7	100
Distributed Cases ...	374	92	68	39	29	82	684
Rate per 1,000 P.T.B. T.B.S.	17 7	3 82	4·10	2·95	3·49	4·91	6·84

These rates are exhibited on the next page in Graph 7, in which, for graphical purposes, the terminal group "over five years" is arbitrarily centred around the year 8-9. The results strengthen the conclusions based upon the correlations of Table 27. The incidence-rate in the first year of service is much greater than in any subsequent year. After that critical year is passed, the incidence rate drops abruptly, and remains moderately steady for a few years. In the later years the inclusion of silicosis cases causes the rate to rise again, the sharper rise in Mine No. 2 being a good deal due to the inclusion in its returns of simple silicosis cases, which are omitted in the returns from Mine No. 4.

The influence of length of service on tuberculosis prevalence is further discussed by Dr. Mavrogordato in Appendix No. 5, p. 348.

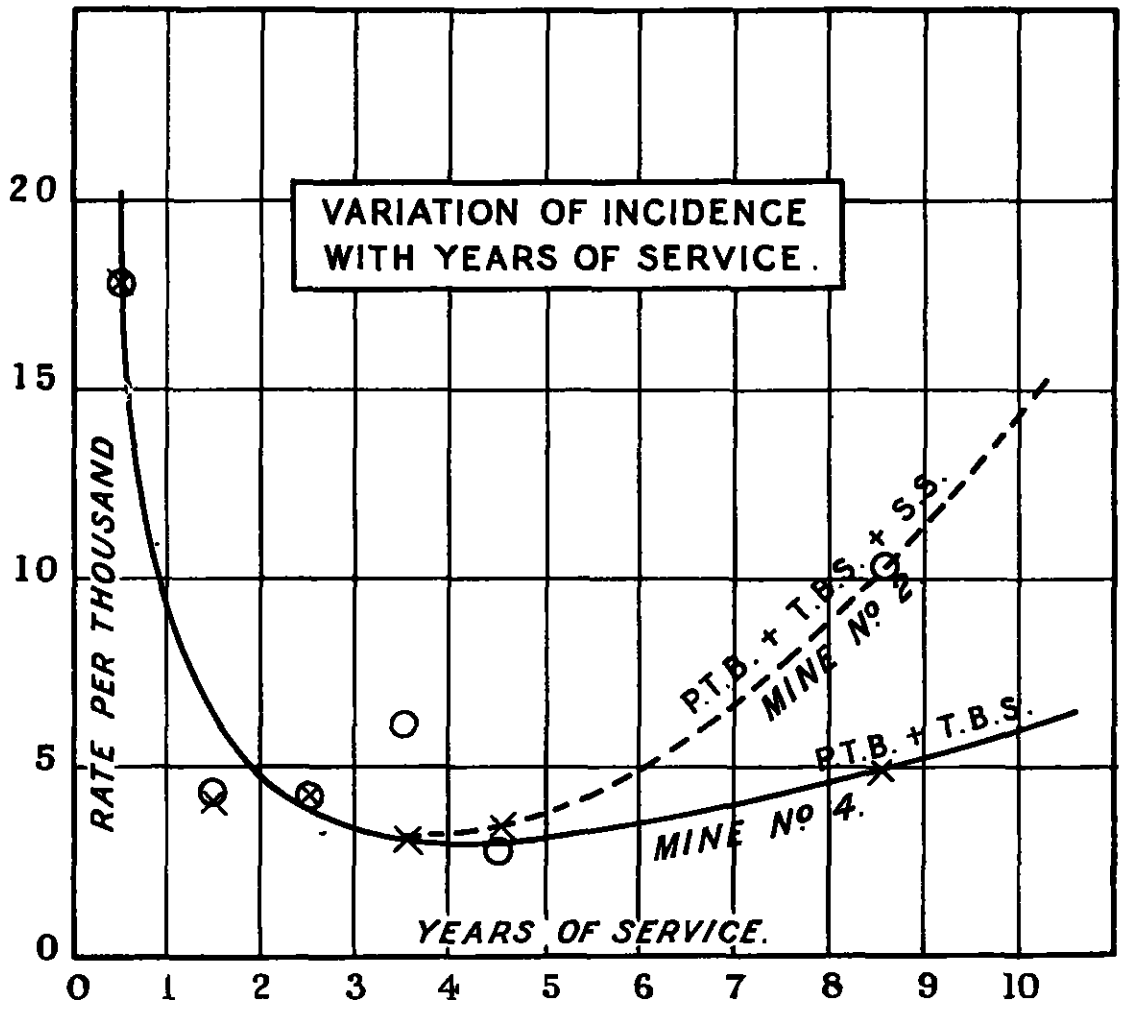
In this communication it is brought out :—

(1) That the first year on the mines, whether on first engagement or on re-engagement, is the great danger zone, and that the liability to contract tuberculosis is far greater on first engagement than on re-engagement.

(2) That boys who run the gauntlet of the first year are in a good position for some time. The incidence of "tuberculosis under the Act" from the end of the first year to the end of the fifth year is under 3 per 1,000 per annum. This compares very favourably with, say, the English figures for pulmonary tuberculosis amongst males between 20 and 40 years of age for the decennial period 1901-1910 (this being fairly comparable with our "tuberculosis under the Act"), which show a death-rate of over 1·5 per 1,000 per annum. This figure would imply a prevalence rate of probably between 4 and 5 per 1,000 per annum.

(3) After the close of the fifth year, the tuberculosis rate starts to rise as the baneful effects of duration of exposure to mining conditions overcome the beneficial effects of acclimatization to these conditions. The silicotic element plays a large part in the rise of the tuberculosis rate after the close of the fifth year.

Graph 7.



○=Incidence rates on Mine No. 2.
×=Incidence rates on Mine No. 4.

9. RELATION OF INCIDENCE TO TRIBAL IDIOSYNCRASY.

Owing to lack of data, it has not been possible to analyze tribe by tribe the influence, if any, of the tribal factor on the incidence rate.

A customary dichotomy, however, divides the Native labour force into East Coast and British South African Natives, and the opinion has been generally held that the former are more susceptible to tuberculosis than the latter.

An attempt has been made to investigate this supposed differential susceptibility on the basis of data supplied by the W.N.L.A. These data were obtained from their records of cases repatriated and cases compensated during the four years 1927-30.

An analysis of these records is shown in Table 30.

TABLE 30.

EAST COAST AND B.S.A. CASES REPATRIATED OR COMPENSATED.

Year.	P.T.B.			T.B.S.			S.S.		
	E.C.	B.S.A.	Total.	E.C.	B.S.A.	Total.	E. C.	B.S.A.	Total.
1927	369	330	699	217	75	292	127	38	165
1928	272	214	486	293	89	382	167	44	211
1929	260	307	567	259	105	364	136	52	188
1930	241	285	526	173	85	258	186	91	277
Total	1,142	1,136	2,278	942	354	1,296	616	225	841

The Chamber of Mines figures for the total Native complement for the four years under consideration were as shown in Table 31.

TABLE 31.

TOTAL NATIVE COMPLEMENT.

Year.	E.C.	B.S.A.	Total.
1927	82,163	103,258	185,421
1928	90,811	104,350	195,161
1929	85,771	106,358	192,129
1930	78,056	122,578	200,634
Average ...	84,200	109,136	193,336

For the four years under review, therefore, these figures yield the following mean incidence rates (Table 32) :—

TABLE 32.

MEAN INCIDENCE RATES PER 1,000 (1927-1930).

	P.T.B.	T.B.S.	S.S.
E.C.	3·39	2·80	1·83
B.S.A.	2·61	0·81	0·52
Total ...	2·95	1·68	1·09

It will be seen that these total rates differ to some extent from those deduced from the standardized returns of the mine medical officers (see Table 18). The difference cannot be accounted for by the fact that the returns cover slightly different periods of time. A re-grouping of the standardized monthly returns into calendar years shows that the numerical content of their P.T.B. category is invariably higher than that of the W.N.L.A. figures, while their silicosis categories are almost always lower.

The explanation lies in the fact that the two sets of figures deal to some extent with different cases, although many cases are common to both sets. The standardized returns contain a considerable number of cases of Natives dying in the mine hospitals who do not figure in the W.N.L.A. returns. Many of these, as the pathological records show, are cases of acute pulmonary tuberculosis; they therefore go to swell the P.T.B. column in the standardized returns. The W.N.L.A. figures, on the other hand, contain a fair number of cases which do not appear in the standardized returns; these being Natives with previous mining service who turn up at the W.N.L.A. either through having been detected when applying for re-engagement or through definite application for compensation. Such cases tend to swell the silicosis categories of the W.N.L.A. returns.

It was necessary to take the W.N.L.A. figures for the purpose in hand instead of using the standardized returns because the latter were not sufficiently complete in detailing the tribes of the cases.

Table 32 shows that in each of the three categories here considered there is a higher incidence rate for East Coast than for British South African Natives. The important question, then, is—how far may these differential susceptibilities be regarded as statistically significant?

There can be no doubt regarding the significance of the difference in the two silicosis categories, for the observed difference is from eight to nine times its standard error in each case. But although the difference is significant, one is not justified in deducing therefrom a higher degree of susceptibility in East Coast Natives. Silicosis is a cumulative disease and its presence is not normally apparent until after the passage of some years of mining service. It is well known that a large proportion of the long-service Natives are East Coast boys, and the observed differences between the incidence rates in the two silicosis categories are in all probability secular phenomena, and not due to tribal idiosyncrasy.

In the pulmonary tuberculosis category, the difference between the rates of incidence for East Coast and for B.S.A. Natives is just over three times the standard error of that difference, so that the level of significance is here considerably lower than in the two silicosis categories. The relative distribution table for the four years' experience of P.T.B. is shown in Table 33.

TABLE 33.

	Not Attacked.	Attacked.	Total.
B.S.A.	0·563019	0·001469	0·564488
E.C.	0·434035	0·001477	0·435512
Total ...	0·997054	0·002946	1·000000

The mean annual complement is 193,000 and the tetrachoric correlation coefficient with its approximate probable error is therefore 0·055±·012. Hence the observed association is slight, but possibly significant.

Tribal idiosyncrasy receives some consideration in the Pathological Section of this chapter, the indication given there being that within the B.S.A. group the Basuto are more susceptible than the other tribes among which recruitment takes place.

In Appendix 5, Dr. Mavrogordato attempted to correlate the differences of tuberculosis incidence on various mines with the varying proportions of East Coast and B.S.A. Natives in their complements, but was unable to find that the proportion had any bearing on the mine's tuberculosis rate. He arrives at the interesting conclusion that within the East Coast group there is probably a section (not definitely identified) of " more susceptibles " than the group as a whole. This would be comparable with the Basutos among the B.S.A. group.

The greater susceptibility of the Basutos and the unidentified section of the East Coasters is probably to be linked up with a greater degree of isolation from outside civilization.

10. SUMMARY OF STATISTICAL SECTION.

(1) The statistics available are of unequal value; the difficulties concerning them have been stated plainly and it is made clear where interpretations must be treated with some reserve.

(2) The general incidence rate of " tuberculosis, all forms," in the Natives employed upon the Witwatersrand gold mines has been falling during the past 16 years, and is now in the neighbourhood of 7 per 1,000 per annum. This rate is calculated in terms of average complement engaged, and when it is remembered that this complement changes at a rate of over 90 per cent. per annum it will be realized that this is making the most of the rate of incidence.

(3) Many European countries and countries inhabited by European stocks have a prevalence rate of tuberculosis no lower than that obtaining among our mine Natives for the same age-group.

(4) On the other hand, taken over the last ten years, our Native incidence-rate for simple tuberculosis is fully twice that of the White miners employed on the Witwatersrand, but the incidence of "tuberculosis under the Act," which includes silicotic cases in addition to simple tuberculosis is only about one-quarter of that in the European.

(5) Mine Natives running the gauntlet of their first contract have a lower tuberculosis prevalence for the next four years than obtains for the general male population in Europe of the same age. The employment risk is shown by the marked rise in the rate after five years of completed service.

(6) The two unhappy features of our mine Natives' tuberculosis are (*a*) the really high prevalence rate that obtains for the first contract worked on these mines and (*b*) the fact that, taken over two years' duration, the mortality is 70 per cent. of the morbidity owing to the severe form which tuberculosis takes in the Natives.

(7) There is evidence of a definite seasonal oscillation in the tuberculosis incidence on the gold mines, the peak coming in the summer months, and it is suggested that this may be due, in part, at least, to the inciting influence of the prevalent influenza in the spring months.

(8) There are marked differences in the incidence rate between mine and mine. No one factor has been found to account for these differences. It is suggested that the same factors operate on all the mines along the Reef but that they vary from mine to mine in their degree and in their combinations.

(9) There is evidence suggesting that certain groups of Natives coming from parts most isolated from outside contacts with civilization are more susceptible than the others.

Section E.—Pathology of Tuberculosis on the Witwatersrand.

1. Bacteriology.

Bacteriological investigations on the subject of tuberculosis on the Witwatersrand gold mines have been conducted on two main lines :— (1) The type of tubercle bacilli associated with tuberculosis among the Native mine labourers, and (2) a search for tubercle bacilli in samples of mine air, dust and mud, and in specimens of sputum collected underground.

(1) *Type of Bacilli associated with Tuberculosis in South African Natives.*—It has generally been taken for granted that the tuberculosis of Natives in South Africa is due mainly, if not entirely, to bacilli of human type. The following statement taken from the "Report upon the Work of the Miners' Phthisis Medical Bureau for the 12 months ended July 31st, 1925," by Dr. Watkins-Pitchford, indicates the grounds for this belief in so far as the Native mine labourers are concerned : "The form in which the disease is encountered on the mines

indicates that it is due to infection with the human type of the bacillus, since tuberculous disease of the skin, joints and bones—which characterize infections with the bovine bacillus—are practically never seen. In a recent publication (Bigger, *Handbook of Bacteriology*, 1925, p. 299) it is stated that the human adult is almost completely resistant against infection with the bovine type of *B. tuberculosis* and, moreover, tuberculosis is very rarely encountered amongst cows in the Transvaal, nor is cows' milk supplied to the Native labourers. These considerations point to the conclusion, not only that the disease is due to the bacillus of human type, but also that it is communicated directly by infection from one individual to another."

Tuberculosis among Animals in South Africa.—The situation at the present time as regards the prevalence of tuberculosis among cattle and other animals in South Africa may be gathered from the following extracts :—

Viljoen[58] states that until about ten years ago tuberculosis in cattle was almost confined to dairy herds in the western districts of the Cape Province, but more recently it has become increasingly prevalent in dairy herds in other parts of the Union. Exact statistics are not available for the northern provinces, but it is believed that not more than 10 per cent. of the dairy cows are affected. More definite statistics are obtainable for slaughter cattle. In the Durban export abattoir 0·05 per cent. were found to be tuberculous, out of 62,000 head. Pigs showed a heavier incidence—9 per cent. out of 6,500—but it was not determined whether their infections were of bovine, human or avian type. It is known, however, that many of the pigs came from dairy farms, and it is also known that avian tuberculosis is fairly common in some parts of Natal, so that there is a likelihood of bovine and avian types predominating.

In the report of the Johannesburg Municipal Abattoir for the period 1st July, 1926, to 30th June, 1927, A. C. Kirkpatrick, M.R.C.V.S., Acting Director for that period, reports that out of 112,495 head of cattle slaughtered there were 29 cases of tuberculosis (0·025 per cent.), 1 bull, 7 oxen and 21 cows. Among 72,059 pigs there were 267 cases (0·37 per cent.).

No information is obtainable as to the incidence of tuberculosis among the cattle belonging to Natives living in their own reserves. That it might exist is suggested by a recent observation recorded by Paine and Martinaglia.[59] They have found cases of tuberculosis occurring in wild buck living under natural conditions in the Albany district of the Cape. Two species (Kudu, *Strepsiceros strepsiceros*, and Cape Duiker, *Sylviacapra grimmi*) have been found so infected, the organisms isolated in every case being of characteristic bovine type. The infection must presumably have been derived from cattle, although the incidence among cattle in that district appears to be very low. Statistics from the Grahamstown abattoir show only 2 cases for the last 5½ years out of 17,263 cattle slaughtered, and 1 of these cases was a cow recently introduced from the Western Cape area.

On the whole, therefore, the evidence goes to show that tuberculosis is rare among cattle kept in the open, although it appears to be becoming more rife among stall-fed dairy cows. The risk of bovine infection occurring in humans is probably, therefore, greater among children in towns than it is among the Natives in their own kraals.

Some further information about the prevalence of tuberculosis in domestic animals is given in Appendix 10, p. 422.

The Present Investigation.—Although there was no real reason to doubt the generally accepted belief that the tuberculosis of the Native was due mainly, indeed, almost entirely, to the human type of bacillus, it appeared advisable to put this belief upon the surer basis of direct observation, hence the undertaking of the present investigation.

The details of the work—source of material from which the cultures were obtained, technique, etc.—are given in Appendix 6, p. 357.

The main finding of the investigation can be stated very briefly, *viz., that the generally accepted belief was justified by the facts, for* of the 100 cultures of tubercle bacilli isolated from various sources in Natives not a single one turned out to be other than human type.

Tuberculosis on the Rand gold mines and, seeing that it has been established that a big proportion of the Natives come to the mines already infected, tuberculosis of the South African Natives generally, must, therefore, be accepted as practically entirely a disease due to the human type of bacillus and spread from individual to individual.

The infection, as will be seen from the following report on the pathological anatomy of the disease, is largely air-borne, entering by the respiratory tract, although a small proportion of cases are infected through the alimentary tract.

As many cases as possible where the route of infection appeared to be *via* the alimentary tract were included in this investigation, so as to increase the chances of finding bovine types, but despite this loading of the dice in their favour no bovine types were found.

It may be noted that in four cases a growth was obtained from tissues of acid-fast organisms other than tubercle bacilli. These growths were always scanty, single colonies usually, and there was nothing to suggest that the organisms were in any way pathogenic. Three of the cases had characteristically tuberculous lesions, although tubercle bacilli were not obtained in culture; the fourth case had no tuberculosis. The presence of these living acid-fast bacilli in organs is of some interest, especially when taken in conjunction with the fact of their common occurrence in the water and soil of the mines. Whatever their significance may be, their recovery in culture serves as a reminder that not every acid-fast bacillus found in tissues, even in tuberculous tissues, is necessarily a tubercle bacillus.

(2) *Tubercle Bacilli in Mine Soil and Air and in Samples of Sputum Collected Underground.*—The examination of mine soil, air, etc., was undertaken at the suggestion of Prof. Lyle Cummins as an endeavour to find out, if possible, to what extent the mines themselves were infective.

It is obvious that if cases of open tuberculosis cough or expectorate underground, there are considerable possibilities of mine air, dust and soil becoming infected, and it is likely that in the absence of sunshine and the presence of abundant warmth and moisture, tubercle bacilli might have a long life in the conditions prevailing underground. If this could be definitely established for any particular place or type of place in the mines, direct disinfecting methods of treating such places would be indicated, always provided that such methods could be devised.

That infection with tuberculosis can occur underground had already been shown by Mavrogordato.[60] He found tuberculosis in 8 out of 46 rats kept underground for varying periods, but in no instance for more than 18 months.

These considerations suggested to Professor Lyle Cummins that it might be of value to undertake a series of systematic examinations of mine soil, dust and air to see whether direct evidence could be obtained of their being infective.

It was realized that too much was not to be expected from such examinations, as the size of the samples that it was practicable to examine could at most only be but an infinitesimal fraction of a mine area. Negative results were therefore expected to predominate, but in accordance with the general rule applicable to such cases, it will be realized that failure to find tubercle bacilli in samples of mud or dust from a mine does not prove that that mine is necessarily free from tubercle bacilli.

The known frequency of acid-fast bacilli in mine soil and water made it essential that the identification of tubercle bacilli should be by biological methods and not merely by bacterioscopic examination. As a matter of fact, a quite cursory (by no means prolonged or exhaustive) examination of smears of the various samples obtained showed the presence of acid-fast bacilli in 48 out of the 100 samples of soil, etc., examined and in 3 out of the 14 samples of air examined.

The examination of specimens of sputum collected underground was considered advisable on account of the findings reported by Dr. Watkins-Pitchford.[37] He found 15·2 per cent. of sputa from underground workings to be tuberculous, but the diagnosis was based merely on bacterioscopic findings. In view of our later acquired knowledge that non-pathogenic acid-fast bacilli are common in mine soil, it seemed possible that his inference that the sputa were tuberculous might be in part, at least, incorrect, and that it would be advisable to have fresh observations made in which the diagnoses were based on a biological test. Unfortunately, for reasons given in detail in Appendix No. 6, it was only practicable to examine 33 such specimens of sputum. Amongst these 33 direct bacterioscopic examination showed the presence of acid-fast bacilli in 7 (20 per cent.), so that if dependence had been

put on the microscope alone a diagnosis of tuberculous sputum would have been given in even a higher percentage of cases than by Dr. Watkins-Pitchford.

The details of the examination of these various underground materials are given in Appendix 6. The results and conclusions drawn from them are as follows :—

(*a*) *Mine Dust and Soil.*—Although 48 samples out of the 100 examined showed the presence of acid-fast bacilli the biological tests were in every instance negative for tubercle bacilli.

Seeing that the samples with which it was possible to deal represent but such very minute portions of the whole mines, it cannot be inferred from this that mine dust is entirely non-infective, but keeping in view the fact that most of the samples came from picked spots where tubercle bacilli might reasonably have been expected to have lodged, it seems not unreasonable to infer that the dust and soil of the mines cannot be regarded as highly infective.

Tubercle bacilli must, of course, frequently be expectorated underground, and the question arises what becomes of them.

It is possible that those which lodge in dry dust become non-infective, as they have been shown by various writers (see, for example, Calmette[14]) to do in other similar situations. Probably, also, the frequent lime-washing of the walls which is carried out on the mines in the vicinity of all waiting-places is an important factor in the immobilization or destruction of tubercle bacilli. In moister situations the bacilli may either be diluted in numbers to such an extent as to be harmless, or they may be swept away altogether.

Inferentially, if the mine dust is regarded as not of much importance as the infective agent, only "droplet infection" remains as an important factor in the spread of tuberculosis.

(*b*) *Mine Air.*—Tubercle bacilli were not isolated from any of the 14 samples of air examined, but this is scarcely to be wondered at, as it would only have been by the merest chance if they had been.

Acid-fast bacilli were found present along with the dust filtered out of the air in 3 of the 14 samples. This is not without significance, as it indicates that, in addition to the possibility of tubercle bacilli being sprayed directly into the air by coughing, bacilli deposited on the soil or dust in sputum might again find their way into the atmosphere and so be inhaled. If their return to the air took place soon after their original deposition they might quite well be infective.

Although the direct examination of dust and soil indicates that these factors cannot be regarded as of much importance in the spread of tuberculosis, this finding suggests that they cannot be entirely ignored in this respect.

(c) *Specimens of Sputum from Underground Workings.*—Although 7 of the 33 specimens examined showed the presence of acid-fast bacilli the biological test for tuberculosis was positive in only 1.

In view of this finding, the figures reported by Dr. Watkins-Pitchford in 1916 can only be accepted with reservation as his purely bacterioscopic diagnosis cannot be regarded as definite proof that the acid-fast bacilli in the sputa were tubercle bacilli.

2. PATHOLOGICAL ANATOMY.

The data upon which the following section is based are given in Appendix 7, p. 374.

It should be borne in mind that the Report only deals with Native mine labourers, an exclusively male population mostly aged between 20 and 40, with extremes at, say, 17 and 60. Further, it only deals with approximately one-sixth of the total number of cases of tuberculosis and/or silicosis diagnosed in this population, viz., those cases which die on the Rand. The other five-sixths are repatriated and practically no pathological information is available regarding them. From Dr. Allan's work in the Transkei, however, it is known that although many of the repatriates die within comparatively short periods of their return home, others live for long periods and some even return to the mines and are passed for work there. It would seem to be a fairly safe assumption, therefore, that amongst the repatriates there are cases of a more chronic type than the majority of those which figure in this Report, although what proportion of those would fall amongst the group with pure tuberculosis, and what proportion are associated with silicosis, is unknown.

In considering tuberculosis among the Native mine labourers, two other features have to be kept in mind.

(1) The industry is a dust-producing one and an association of tuberculosis with a pneumonoconiosis (silicosis) is therefore common.

(2) The service of the Native mine labourer is as a rule not continuous but broken. It does sometimes happen that a Native "signs on" again whenever his contract is finished, so that cases with 10, 20 or even 30 years' continuous service are met with, but in a big proportion of cases, after 9 months or so of service, he has a spell at his kraal, but he may return to mining work again and again.

The 600 Cases.—The 600 cases reported in Appendix 7 include 338 "acute" cases—Groups C and D—in which the cause of death was uncomplicated tuberculosis; 200 "chronic" cases—Group B—in which the cause of death was also tuberculosis, but in which that disease was associated with silicosis; and 62 cases—Group A—in which tuberculous lesions were present but death was not actually due to tuberculosis. Of these 62 cases, 29 showed silicotic lesions in addition to tuberculosis, 26 had tuberculosis without silicosis, and in a more or less active form, 7 had only what seemed to be completely-healed lesions.

If we consider the question of susceptibility to tuberculosis of the different tribes of Natives employed, we find that, broadly speaking, there is very little difference between the two sections "East Coast" and "B.S.A." Natives. We started this investigation with the general impression that the East Coasters would probably be found to furnish the bigger proportion of cases of the "natural tuberculosis" of virgin soil, but this has not proved to be the case. Indeed, if any one tribe can be said to show a bigger proportion of this type of tuberculosis than any other, it is unquestionably the Basuto. This is brought out by the figures in Table III of Appendix 7, and this feature may be correlated with the fact that Basutoland is not open to European settlement. The Basuto have probably, therefore, less previous tuberculization than any of the other tribes and are more nearly virgin soil when they come first to the Rand. Unfortunately, there is no extensive record of tuberculin tests among newly-recruited Basutoland labourers for comparison with the records in the East Coast recruits, but the small series of tests made by Dr. Allan, showing a lower percentage of positives than other tribes, is in harmony with this finding.

(*a*) *Acute Tuberculosis.*—Let us consider, firstly, the 338 cases put under the heading of "Acute Tuberculosis," although sub-divided into Group C of 241 cases in which the lesions were mainly thoracic, and Group D of 97 cases in which the lesions were mainly extra-thoracic.

It will be seen from Tables VIII-XI of Appendix 7 that considerably more than half of the deaths in these groups occur in boys under the age of 30 and that almost exactly half occur within the first year of mining service.

Table 34 shows the *percentage* of these cases in which the various organs and structures tabulated were the seat of tuberculous lesions.

It should be pointed out that these are minimal figures, based very largely on naked-eye examination only. Microscopic examination of some doubtful lesions and of some tissues in which tuberculosis was not even suspected established the presence of that disease, so that if microscopic examination of every organ had been systematically made there can be little doubt but that some of these figures would have been somewhat higher. Also, it should be stated that the head was only opened when there was a history of cerebral symptoms, so that the figure for the brain and meninges might well have been higher had head examinations been made in every case.

Comparisons may be drawn between tuberculosis as seen in this series of 338 cases and tuberculosis as it appears in other populations.

Through the co-operation of Professor Lyle Cummins and the kindness of the (British) Medical Research Council and of Dr. Roodhouse Gloyne, we obtained 200 post-mortem records completed at the City of London Hospital for Diseases of the Heart and Lungs, Victoria Park, London. These records were made on forms similar to those employed by this Committee.

TABLE 34.

Percentage involvement of various organs in 338 cases of Acute Tuberculosis.

Glands—		
Cervical	16	
Clavicular	21	
Tracheo-bronchial	88	
Diaphragmatic	31	
Pancreatic	48	
Lower Retro-peritoneal	30	
Portal	46	
Mesenteric	34	
Axillary	1	
Inguinal	0·3	
Lungs—		
Caseation	25	81
Caseation with Excavation	30	
Milia only	26	
Pleuræ—		
Definite Tuberculous Pleurisy	32	
Heart and Pericardium—		
Definite Tuberculous Pericarditis or Myocarditis	17	
Adhesions, possibly Tuberculous	4	
Spleen	70	
Liver	61	
Kidneys	31	
Suprarenals	10	
Peritoneum	31	
Intestine	21	
Brain or *Meninges*	2·5	
Bone or *Joint*	4	
Genitalia	1·5	

For comparison we have made in tabular form (Table 35) an analysis of the records of these 200 London cases and of 200 Witwatersrand mine Native labourers, taking 100 W.N.L.A. cases and 100 mine medical officers' cases. All cases with silicosis were excluded, but otherwise there was no selection, the cases being taken consecutively as they occurred. The comparison is therefore between uncomplicated tuberculosis in the two series of cases.

Comment may be made on the following points brought out in Table 35 :—

Glands.—Cervical glands are rarely involved in the Native, as compared with the European, but there is a strikingly more common involvement in the Natives of the "other thoracic" (retrosternal and diaphragmatic) glands, also of the "other abdominal" (portal and various groups of retro-peritoneal) glands.

Lungs and Pleuræ.—Lung lesions are more extensive as well as more constantly present in the European as compared with the Native. Scarring, fibrosis, pleural adhesions, caseation and cavitation are all obviously more striking features in the European. Definite caseous deposits in the pleural sacs, however, are more common in the Native.

TABLE 35.

COMPARISON OF 200 BRITISH WITH 200 NATIVE POST-MORTEM RECORDS.

		GLANDS.			LUNGS.						PLEURÆ.				HEART AND PERICARDIUM.	GLANDS.		ABDOMINAL ORGANS.					
	Degree of Involvement.	Cervical.	Tracheo-Bronchial.	Other Thoracic.	Affected.	Caseous.	Cavities.	Scars.	Fibroid.	Miliary.	Effusion.	Adhesions.	Caseous.	Miliary.	Effusion Adhesions Cascation.	Mesenteric.	Other Abdominal.	Spleen.	Liver.	Kidneys.	Intestines.	Peritoneum.	Other Abdominal (including Genito-urinary Organs)
London Patients.	+++	11	46	—	168	60	69	2	10	23	6	42	1	5	—	17	2	7	1	3	18	8	—
	++	19	66	—	20	44	56	10	17	15	16	90	4	5	—	58	2	4	2	15	23	6	1
	+	40	56	1	9	43	30	20	27	7	14	54	7	6	1	27	1	11	3	20	18	6	4
	+−	27	23	—	1	—	2	—	—	—	2	3	—	—	34	14	1	5	—	10	—	—	—
	Total 200	106	191	1	198	147	157	32	54	45	38	189	12	16	35	116	6	27	6	48	59	20	4
Witwatersrand Native Mine Workers.	+++	1	20	1	24	13	9	—	—	6	—	3	3	—	11	12	14	27	6	2	7	17	—
	++	7	79	12	77	45	36	1	1	25	11	13	13	1	7	29	42	65	38	6	13	13	5
	+	19	91	81	74	47	18	10	2	48	18	51	30	1	13	40	71	59	73	49	31	31	23
	+−	—	2	—	—	—	—	—	—	—	—	—	—	—	6	1	—	1	7	2	1	—	4
	Total 200	27	192	94	175	105	63	11	3	79	29	67	46	2	37	82	127	152	124	59	52	61	32

Heart and Pericardium.—Although the two figures given for the two series are almost identical, there is actually a very marked difference in character. Of the 35 European cases, only 1 was a case of actual tuberculous pericarditis, the other 34 being merely cases of some excess of fluid or of slight adhesions. In the Native series, 31 were definitely cases of tuberculous pericarditis or myocarditis, and 6 cases with adhesions of doubtful origin.

Abdominal Organs.—These show perhaps the most striking difference between the incidence in the two series. Involvement of the spleen and liver is very much more common in the Native, and in the spleen especially the degree of involvement is much greater. Tuberculous peritonitis and involvement of "other abdominal organs" such as suprarenals and genitalia is also more common in the Native.

Certain other items not brought out in the Table might also be referred to :—

Laryngeal Involvement is mentioned in 43 of the 200 Europeans. It was only observed in 2 Native cases, but it was not systematically examined for in all of them, so that it might possibly have been actually more common, although it is improbable with the short life of so many of the Natives that the figure would have been as high as for the Europeans.

Tuberculous Meningitis or Cerebral Tuberculomata were present in 16 European cases, only in 2 Native cases. Here it must be noted, however, that head examinations were only made in those Natives who had shown definite cerebral symptoms during life.

Amyloid Disease was met with in 13 of the European cases ; it was not present in any of the Native cases.

Comparison with Tuberculosis amongst Cape Coloured (Eurafrican) People.—Through the courtesy of Professor Ryrie, Department of Pathology, University of Cape Town, we have received post-mortem records made at the City Hospital, Cape Town, of 25 cases of tuberculosis in Coloured persons (Eurafricans). The series is small, but it is of interest as giving some idea of the character of tuberculosis in a section of the South African population in which the disease is rather rife.

An analysis of these records on the same lines as that shown in Table 35 shows that the type *en masse* is much nearer that of the Witwatersrand Native cases than that of the London European cases. The figures for scarring and fibrosis of the lungs are, however, of the London type rather than of the Witwatersrand type.

This discrepancy is readily explicable by a consideration of the age grouping of the Cape Town series. Of the 25 cases, 15 were under the age of 15, and only 10 over that age. All the cases with "chronic" lesions in the lungs occurred in the group over 15 years of age.

Amongst the Cape Coloured adults, therefore, the suggestion is that their tuberculosis is more of the European adult type than of the African Native type. The numbers are insufficient to warrant any more definite conclusion.

Tuberculosis approximating to the "Natural" Type.—Consideration of the above comparison with European cases and of the figures in Table 34 brings out the fact that the "acute" tuberculosis of the Witwatersrand Native mine labourers approximates to the "primary," "unmodified" or "natural" tuberculosis which, amongst Europeans, is seen almost only in young children. It is not, however, entirely the natural tuberculosis of completely virgin soil, but is modified to a certain extent.

This is brought out by comparison of our tuberculosis with that of other localities or populations where natural tuberculosis prevails. For this purpose, we have made comparisons with the general record of Bushnell[1] and the particular one of Borrel[2].

Numerous illustrations have been met with of the forms cited by Bushnell as characteristic of "primary" tuberculosis. He states that the most characteristic feature is general infiltration of the lymph glands, not in a chronic form as in the imperfectly immunized, but manifesting itself often as great packets of enormously enlarged caseating and suppurating glands. Our figures show the frequency of involvement of many groups of glands and very often indeed they were in "great packets" (see Pl. I, Fig. 3). Caseation was very common, but actual suppuration, although not exactly rare, could not be said to be very frequent. More common than suppuration was some hardening of the glands, microscopic examination showing a mixture of caseation, some fibrosis and considerable proliferation of endothelial cells—an approach to the "large-celled hyperplasia" of older writers. Associated with this there was occasionally a remarkable degree of hyaline degeneration of the fibrous tissue in the glands, but apparently not the condition described by Aschoff[81] as characteristic of healing primary infections. This degree of fibrosis and endothelial proliferation probably points to the tuberculosis occurring, not in a perfectly natural condition, but in a subject slightly although very imperfectly immunized. A terminal miliary spread was commonly seen when there was extensive caseation in one or more of the gland groups.

Tuberculous lobar pneumonia, or gelatinous pneumonia, is another feature mentioned by Bushnell as characteristic of natural tuberculosis. It was rather rare in our series, only two really characteristic cases being seen, although we might have added another six or seven cases with a confluent broncho-pneumonia involving the whole or nearly the whole of one lobe (see Pl. I, Fig. 4). We have the impression from previous experience that the massive tuberculous pneumonias are usually proportionately more numerous, and that it just happened by chance that we have not encountered more of them in this series, but we have not definite figures to prove this.

"Another characteristic," Bushnell says, "is the primary involvement of serous membranes—the disease is a tuberculous serositis." The figures given for the pleural, pericardial and peritoneal involvements illustrate the occurrence of this type frequently in our series. Further, "very characteristic of primary tuberculosis are caseous tubercle of the myocardium and the pericardium." He quotes Zone Clark's figures from a series of 452 autopsies amongst West Indian negroes at Panama, with 15 cases (3·3 per cent.) of large caseous nodules in the myocardium, and 62 cases (14 per cent.) of tuberculous pericarditis. Our figures for the whole 538 cases dying from tuberculosis are 5 cases of tuberculous nodular myocarditis (1 per cent.) and 80 cases of tuberculous pericarditis (15 per cent.), *i.e.*, a slightly higher figure for pericarditis, but a lower figure for cardiac tuberculomata.

In the same series of cases, he gives the involvements of the spleen, liver and kidneys (expressed as percentages) as 58, 52 and 42 respectively. Our corresponding figures are 61, 52 and 28, *i.e.*, almost identical for the spleen and liver, but distinctly lower for the kidneys. For illustrations of spleen and liver involvements, see Plates II–IV.

Borrel[2] states that tuberculosis as he saw it amongst Senegalese troops in France during the war had an evolution which might be divided into two stages—(1), an initial latent period with no symptoms and which might last one, two or three months, in which there was glandular involvement only, the general condition of the patient being unaffected. Gradually, however, there is the supervention of Stage (2), in which general symptoms appear—fever, loss of weight and signs of the spread of the disease beyond the limits of the original glandular focus. Caseous pneumonia (lobar or lobular), serositis and miliary tuberculosis (either primary or following on involvement of the lungs or serosa) are the features of the second stage. This stage is usually short and death takes place in from two weeks to two months. Only rarely does one see chronic local pulmonary tuberculosis with cavity formation.

We are unable to say what proportion of our cases had an evolution similar to this, not having been in touch with the cases during life, but probably a considerable number of the cases figuring in Tables IX and XI of Appendix 7, as dying after less than one year's service, would have shown at all events a similar rapidity of development when Stage (2) supervened. The majority of these cases occurred in the mine medical officers' series of cases, and we do not know the actual duration of illness, but we have records of some cases which have died within a month of their arrival on the Rand, and of others who have been working up to within a few days of their death. In some instances, therefore, the course of the final stage is very rapid.

The figures given on p. 113 for the period of survival of cases dying in the mine hospitals are in keeping with the view that Stage (2) is here also often a very short one.

Borrel states further that the initial lesions are almost always in some of the glands draining the upper air passages (90 per cent. of cases); relatively rarely in the cervical glands; in 70 per cent. of cases in the "clavicular" glands (see p. 399), and in 80 per cent. in the tracheo-bronchial glands. These glands form the starting-point of the disease; they break down and further spread takes place either by the lymph or blood-stream. The glands follow on an erosive lesion or tuberculous chancre in the tonsils, pharynx, larynx or at the level of the primary bronchi. Direct initial lesions in the lungs are rare, tuberculosis starting near the apex not being found in more than 5 per cent. of cases. Pulmonary involvement in most cases is secondary to caseation in the tracheo-bronchial glands. A hilus gland may break down and discharge directly into a bronchus with the development of a massive caseous pneumonia in the middle or lower lobe. This is the commonest occurrence and was found in 30 per cent. of cases. At other times, the caseation may be lobular and more widely distributed over one lung or both lungs. Death may occur rapidly with no cavity formation, or without any further spread of the disease, but often there is a parallel blood-stream spread and in 20 per cent. of cases there was found miliary tubercle along with caseous lesions. In 25 per cent. of the cases death occurred from a purely miliary spread from the original caseous glandular focus.

In two respects our series of cases shows a very striking difference from the tuberculosis of the Senegalese as outlined above by Borrel.

In the first place, there is the comparative rarity of primary lesions in the "clavicular" glands in our cases. This is commented upon in greater detail in Appendix 7. The position in this respect of the South African Natives obviously more nearly approaches that found by Borrel among the Malagasy, and he states that the tuberculosis of the Malagasy is more like that of Europeans than is that of the Senegalese.

The second difference is that of the seat of the primary lesion. Borrel found it in the Senegalese to be in the lungs in not more than 5 per cent. of cases. In our series we put the figure much higher, probably in over 30 per cent. of cases. Whilst we have many cases similar to the majority of those of Borrel, with massive initial caseous lesions in the glands, more especially in the tracheo-bronchials, with secondary spread to the lungs or with a generalized miliary spread, we have also many where there were extensive lung lesions, especially in the upper lobes, with well-developed cavity formation and only comparatively slight and recent infection of the tracheo-bronchial glands. Also, we had quite a considerable number in which there were caseous lesions in both the lungs and the glands of about equal severity and apparently equal age. In this last group we did not feel that one could say with any certainty which was the primary focus, hence our inability to state more definitely the percentage of cases with a primary lung lesion. We believe we are justified in saying it is not less than 30 per cent., but it may be well over that figure. Some further light is thrown on the question of the primary site of infection by radiographic examination of lungs (see pp. 174–179).

The number of cases showing pulmonary cavities must be taken as indicating that many of our cases ran a somewhat longer course than did the majority of Borrel's. This may be regarded as another indication that they were occurring in slightly-immunized individuals.

Cavities in themselves are not, however, evidence of very long survival. That is indicated by the formation of fibrous tissue round them. Only 6 of our cases (314, 322, 407 and 446 in Group B, and 189 and 439 in Group C) showed this to an extent comparable with ordinary European phthisis. It is, of course, highly probable that had we had access to repatriated cases, a higher percentage of this type would have been encountered.

That healing or arrest of primary pulmonary lesions does occur is evidenced by the finding amongst the 62 cases of death from conditions other than tuberculosis of 5 cases showing such features (Cases 229, 234, 369, 447 and M128 in Group A).

Borrel also distinguishes a group of cases where the lesions, secondary to an initial glandular focus, are predominatingly in the serous sacs. This, of course, we can parallel abundantly.

Then he records a few cases showing an initial infection by the abdominal route with no lesions in the tracheo-bronchial glands, lungs or thorax, but abundant evidence in the abdomen—ascites, mesenteric glands, omental cake, matting of the intestines, etc. He excludes from this group certain cases of " type abdominale d'origine thoracique " developing mainly by blood-stream spread from a tracheo-bronchial focus.

We have also separated a series of 97 cases (Group D) in which the lesions were mainly extra-thoracic. Only in 6 of these, however, did we feel quite satisfied that the original invasion was by the abdominal route ; a few were doubtful as regards the source of spread. In 75 we were of opinion that although the main brunt of the disease fell outside the thorax, the spread was definitely from tracheo-bronchial glands.

A few cases were very suggestive of the converse condition, *i.e.*, of invasion by the abdominal route but with extension of infection to, and main development in, the thorax. Cases of this type are Nos. 7 and 59 in Group B and Nos. 55, 117, 196 and 272 in Group C.

Borrel states that he found bone tubercle relatively rare as a primary lesion, bone involvement being almost always merely a complication of a primarily glandular leson. In our 12 cases showing bone or joint lesions (15 if we include the 3 cases in Group B) only 2 (Nos. 9 and 388 in Group D) appeared not to be obviously primarily glandular.

To sum up, it may be said that the acute, progressive tuberculosis as seen mainly in the younger Natives early in their mining career, although partly " natural " tuberculosis, is largely somewhat modified and has reached a stage intermediate between the completely " natural " tuberculosis of virgin soil and the " modified " tuberculosis of the European adult.

Before passing on to a consideration of tuberculosis associated with silicosis, we have a few remarks to make about tuberculosis of the pancreas and of the spleen.

Pancreas.—According to MacCallum[62] the pancreas is especially resistant to tuberculous infection, and references to tuberculous lesions other than miliary tubercle are hardly to be found. Some cases described are probably really affections of embedded lymph glands.

We have observed 5 cases (Nos. 277, 354, 360 and 361 in Group C, and 427 in Group D) with definite caseation in pancreatic tissue. Nos. 360 and 361 were merely slight involvements by direct extension from neighbouring caseous glands. No. 377 showed a rather more diffuse caseation, but was probably also a direct spread from an adjacent gland. In No. 354 the whole tail of the pancreas for a distance of 5–6cm. from the tip was caseating, with some haemorrhages. Adjacent pancreatic-lienal glands were caseous. The condition may have originated by direct spread from these but, even if so, it had extended well beyond their immediate neighbourhood. No. 427 was the most interesting. In this instance, there was very little involvement of adjacent lymph glands, but almost the whole pancreas was caseating. There were numerous ulcers high up in the jejeunum and recent involvement of the corresponding mesenteric glands suggesting that there had been an abundant outpouring of tubercle bacilli from the pancreatic duct. Elsewhere there were a few caseous nodules in the spleen and numerous small caseous areas in the liver.

Primary Tuberculosis of the Spleen.—According to MacCallum (*l.c.* p. 240), tuberculosis of the spleen, notwithstanding that there have been descriptions in the literature of a primary affection, may be regarded as always secondary to tuberculous lesions of other organs. With this *dictum* we are, of course, in general agreement, but would nevertheless like to record in the next paragraph two possible exceptions to it.

Amongst the mine medical officers' cases three were recorded with lesions limited to the spleen, but as we do not know in these cases how meticulous a search was made for other lesions we will leave them aside. Amongst our own cases we have recorded two (Nos. 256 and 401 in Group A) in which there was apparently a tuberculosis limited to splenic tissue. In neither case had the disease gone on to gross caseation, but the diagnosis was confirmed by microscopic examination. Careful examination failed to reveal any glandular or other lesion in either case, but we now realize from our own experience with X-ray examination of lungs, that we might have overlooked some minute pulmonary focus. We can only claim definitely for these two cases therefore that the first gross lesions were in the spleen.

(*b*) *Chronic Tuberculosis (associated with Silicosis.)*—We have brought together in Group B 200 cases in which the tuberculosis which was the cause of death was associated with more or less silicosis.

The age and mining service distribution of these is strikingly different from that of the cases uncomplicated by silicosis. More than half of the cases fall into the age-group 40–49 and fully two-thirds into the age-period 30–49. As regards the period of mining service, the average works out at over 6 years.

Table 36 shows the *percentage* of cases in which the various organs and structures tabulated were the seat of tuberculous lesions.

TABLE 36.

Percentage involvement of various organs in 200 cases of Chronic Tuberculosis.

Glands—	
Cervical	12
Clavicular	38
Tracheo-bronchial	95
Diaphragmatic	52
Pancreatic	54
Lower Retroperitoneal	31
Portal	47
Mesenteric	36
Axillary	0
Inguinal	0·6
Pleurae—	
Definite Tuberculous Pleurisy	18·5
Marked Adhesions, probably Tuberculous	32
Heart and Pericardium—	
Definite Tuberculous Peritonitis	10·5
Adhesions, possibly Tuberculous	10·5
Myocardial Tuberculomata	1
Spleen	40·5
Liver	37
Kidneys	21·5
Suprarenals	11·5
Peritoneum	9
Intestine	20
Brain or Meninges	3
Bone or *Joint*	1·5
Genitalia	1·5

Comparison of this table with Table 34, which shows the corresponding involvements in the cases of tuberculosis uncomplicated by silicosis brings out the fact that the greatest difference lies in the much less abundant affection of the spleen, liver and peritoneum in the tuberculo-silicotic cases, although the figures are still well ahead of those for the London cases.

In this Report we are not specially concerned with the pathology of silicosis *per se*, merely with the modifications which it imposes upon tuberculosis when the two conditions are associated. In Appendix 7 are described the naked-eye character of silicotic and of tuberculo-silicotic lesions as they are met with in the Witwatersrand Native mine labourers. For illustrations of pulmonary tuberculo-silicotic lesions, see Plates V–VIII.

NOTE.—"Tuberculo-silicosis" is a pathological term originally introduced by Watt, Irvine, Pratt-Johnson and Steuart ("Silicosis on the Witwatersrand," Appendix No. 6 to the General Report of the Miners' Phthisis Prevention Committee, Pretoria, 1916, p. 96), as descriptive of the areas of fibroid consolidation arising as the end result of a chronic tuberculous invasion of the silicotic lung.

In this Report and in Appendix 7 the term is used in a somewhat wider sense, including under it any association of tuberculosis and silicosis, whether as separate lesions or as a combined condition, although it is also used as descriptive of a definitely combined condition when it is employed in antithesis to simple silicosis. No implication is made, however, as regards priority of one or other of the two factors, silicosis and tuberculosis.

Influence of Intermittency of Employment on Silicosis.—The development of silicosis is dependent upon the permanent arrest of silica in the lung; it is not the amount inhaled that matters so much as the amount arrested. One factor leading to the arrest of silica-dust is that, in contrast with coal-dust, it does not provoke expectoration, but the extent of arrest varies from subject to subject, and the following observation appears to have some bearing on factors influencing dust-retention.

In re-engaged mine Natives dying shortly after their return from their kraals, we have been impressed by the comparatively moderate degree of pigmentation often presented, although they may previously have worked several contracts.

If contracts be short, say, twelve months or less, and be followed by an interval of three months or more before underground work is resumed, then it would appear as if the lungs possessed considerable power of ridding themselves of the silica which has been inhaled.

In the absence of a clinical silicosis, much of the lung pigmentation is due to soot deposited on silica particles and aggregates of particles. Such soot on or with silica may be retained for years after exposure to it has ceased, but if the silica has not had time to do much damage and become permanently arrested, then both soot and silica may largely come away during a period of non-exposure to underground conditions.

In a death from pneumonia of a newly re-engaged mine Native large numbers of silica-laden cells are to be found in the alveoli, so it appears as if inhaled silica retains for some time, so to speak, considerable ability to move about in the lung and, consequently, to get out of the lung.

This ability is limited, however, and it is because it is limited that silica is a phthisis-producing dust. Many silica-laden cells appear to be retained in fluid but stagnant lymph; once this lymph becomes organized the dust-laden cells are finally trapped, but till then they have a chance of escape.

Intermittent employment favours escape and this observation may well be related to the fact that the incidence of silicosis is lower in the Native than in the European with equal total length of service, although the Native is, in most cases, more exposed to dust. In the case of Natives continuously employed, they appear to have about the same silicosis-rate as do European miners and to develop clinically recognizable silicosis in less time.

Incidentally, it may be noted here that the tubercle bacillus is about the same size as a phthisis-producing dust, and shares the ability of such a dust to become arrested in the lung without being destroyed. If the tubercle bacillus shares the ability of silica-dust to move about within the lung in response to an exudative inflammation, we may have some light thrown on the tendency of tuberculosis to flare up following on an attack of influenza—the bacilli passing from a region of less allergy to a region of more allergy.

Actually, we have very little evidence of such flare-ups occurring in the population we have dealt with in the Report. A special entry was provided for, on their own request, in the Report Form issued to the mine medical officers (see Appendix 7), in the belief that some useful information might be accumulated with regard to the lighting-up of tuberculosis after attacks of other infections. Evidence reported suggesting that this has occurred is of the most meagre, and in some of the cases where it has been supposed to have occurred it is much more probable that the so-called influenza or pneumonia preceding the tuberculosis was really the early stages of the tuberculous process itself.

Silicotic Lesions not limited to the Lungs.—In the 200 cases in which tuberculosis and silicosis were associated, there were 7 in which the lungs showed no tuberculosis. In 2 of these there was no silicosis either (the lungs showing merely an excess of pigment but without macroscopic fibrosis, the silicosis being in the tracheo-bronchial glands); in the other 5 there were silicotic nodules in the lungs.

Stress is laid in Appendix 7 on the fact that the lesions of silicosis and tuberculo-silicosis are not limited to the lungs but may be found also in various groups of lymphatic glands.

That they should be found commonly in the tracheo-bronchial glands is not surprising and, actually, they are more consistently to be found there than in the lungs, and the earliest development is usually to be seen in these glands. Out of 178 cases, 167 showed tuberculo-silicotic lesions, 8 silicotic lesions without obvious tuberculosis, 2 tuberculosis without silicosis, and only 1 neither silicosis nor tuberculosis.

What has come as rather a surprise to us, however, is the frequency with which tuberculo-silicotic lesions extend to other groups of glands, both upwards into the neck and downwards in the thorax and into the abdomen. So frequent, indeed, is the extension to the portal glands and to the glands which we have grouped together under the headings "Diaphragmatic" and "Pancreatic" that we have come to look upon the lungs, tracheo-bronchial, diaphragmatic, pancreatic and portal glands as "the tuberculo-silicotic zone," Tuberculo-silicosis in these various groups of glands has probably been observed before, but we have not seen any published account of it. For an illustration, see Fig 12, Plate IX.

To explain this curious distribution on anatomical grounds is not quite so simple.

A study of lymphatic connexions as described by Bartels[63] makes it quite clear that there can be no *direct* carriage of pigment, etc., from the lungs to abdominal glands. Bartels states precisely: "There are no direct connexions known between the pleural, lung or bronchial glands with the abdominal lymph system. The outlet paths of the latter go into the thoracic duct or into the posterior mediastinal glands. Only the lymph vessels of the diaphragm provide a direct connexion

between the lymphatics of the chest and those of the abdomen through their anastomoses with the lymphatics of the pleural and peritoneal coverings thereof."

The lymphatics of the diaphragm itself, it may be said, drain into the lowest group of the retro-sternal glands and into the anterior and posterior mediastinal glands, three groups which Sappey classes together as the " diaphragmatic " glands.

Bartels says further, however: "It is questionable how far the results obtained by the injection of healthy cadavers can be applied to the living body and especially how far altered conditions such as stream reversal from pressure variations, or retrograde transport, may play a part. These are not subjects for anatomical decision."

In addition to the description of the lymphatic system of all the area concerned given by Bartels and in other anatomical text-books, an excellent account has been given by Scott and Beattie[64].

Three possible explanations of the distribution of lesions over what we have termed the " tuberculo-silicotic zone " occur to us.

(1) That the anatomical arrangement of lymphatics is different in the Bantu and the European, and that in the former there is some direct connexion between the lung drainage and the upper abdomen. This explanation is, on the face of it, improbable, and moreover it appears to be quite ruled out of court by the fact that the same lesions are to be found in the White miners here. We can state this from our own limited observations, but we have had these observations confirmed by Dr. A. Sutherland Strachan, of the Pathological Department, South African Institute for Medical Research, who has had a much larger experience of post-mortem examinations on European miners here than we have had.

(2) By two somewhat roundabout routes :

" Dust-cells " carrying all or any of the three factors—carbon, silica and tubercle bacilli—which go to the development of tuberculo-silicosis ordinarily travel from the lungs to the tracheo-bronchial glands either by the deep plexus of lymphatics running along with the bronchi or by the superficial plexus running in the subpleural tissue. Having reached the tracheo-bronchial or paratracheal glands they might then travel—

(*a*) To clavicular or upper retro-sternal glands, thence to lower retro-sternal glands, and from there through the lymphatics of the diaphragm and its peritoneal covering *via* the falciform ligament to the glands in the portal fissure ;

(*b*) *Via* the lymphatics of the œsophagus. The lymphatics of the middle third of the œsophagus drain into the tracheo-bronchial and posterior mediastinal glands, those of the lower third into the superior gastric glands. Doubtless there is an anastomosis between those of the middle and lower thirds, so that a route is open between the tracheo-bronchial and the superior gastric glands whence extension to the neighbouring upper retro-peritoneal or " pancreatic " glands is easy.

These are certainly possible routes and travel by them would satisfactorily explain the development of tuberculo-silicotic lesions in the sites where they are commonly found. The occasional occurrences in even more distant groups, such as the cervical and the lower retro-peritoneal, are readily understandable through their connexions with the upper retro-sternal and upper retro peritoneal groups respectively.

The only objection which we see to acceptance of these routes as the path taken is that it is not easy to see why obstruction in the tracheo-bronchial glands should set pigment, etc. (which must perforce pass through these obstructed glands), travelling by either or both of these roundabout routes, more especially as the carriage over parts of them would needs be either by stream reversal or by carriage against the stream.

(3) By direct trans-pleural carriage :

Given some degree of fibrosis of the tracheo-bronchial glands and of the various small lymph nodes and around the lymphatics between the visceral pleura and these glands, with consequent partial blockage of the normal flow from the visceral pleura towards the roots of the lungs, it is conceivable that the " dust-cells " might migrate through the visceral pleura into the pleural cavity, then through the parietal pleura and their further course would be determined by the drainage of the parietal pleura.

Passage across the pleural space would be made easier if pleural adhesions were present. Scott and Beattie (*l.c.*) state that " lymphatic vessels are formed in pathological adhesions in serous cavities. These lymphatic spaces are derived probably from a pre-existing lymphatic plexus by an invasion of endothelial-lined vessels. Injections carried out on adhesions show that the vessels are formed soon after the invasion of fibroblasts into the primary inflammatory adhesion." A greater or lesser degree of formation of pleural adhesions is very common in tuberculo-silicosis of any standing ; indeed, it might be said to be exceptional not to have some pleural adhesions present.

When we come to consider the drainage of the parietal pleura, we find that it will satisfactorily account for the more distant developments of tuberculo-silicosis.

The anterior upper areas of the thoracic wall drain *via* the internal mammary (or sternal) and infraclavicular glands, a route which would account for the common finding of tuberculo-silicosis in these glands. The rarer further extension of the process upwards into the lower deep cervical glands can be accounted for by passage through or past the " clavicular " glands.

Inferiorly, the sternal trunk vessels connect with the vessels of the falciform ligament and the convex surface of the liver. This would explain the spread to the glands in the portal fissure, with involvement of the gland behind the xiphisternum which we have so commonly found affected. The small glands lying on the central tendon of the diaphragm and usually surrounding the inferior vena cava receive some

of the drainage from the lower parts of the thoracic wall and diaphragm, and correspond with the gland or glands which we have commonly found in this situation affected with tuberculo-silicosis. There is also drainage from the lower portions of the thoracic wall to glands lying in the region of the origin of the cœliac axis on the lateral aspects of the aorta. These correspond with the glands which we have termed the "pancreatic" or "upper retro-peritoneal. "Further extensions to glands adjacent to these are readily understood.

Two objections may be raised to acceptance of this theory of a transpleural route :—

(*a*) That some trace of it should be visible in the shape of pigmented spots on the parietal pleura similar to those seen so commonly on the visceral pleura. We have never observed any such. We have sometimes observed the development of flat tuberculo-silicotic plaques on the diaphragm subpleurally (see Fig. 12). These are always associated with well-developed tuberculo-silicotic lesions in the "diaphragmatic" glands above the diaphragm and in the "pancreatic" and portal glands below it. They are indicative of a blockage in the lymphatic passages through the diaphragm rather than necessarily of a transpleural carriage.

(*b*) Seeing that some of the drainage of the more posterior portions of the parietal pleura goes through the small vertebral glands lying near the heads of the ribs, tuberculo-silicotic lesions in these might sometimes be expected, but actually we have never found any.

On the other hand, it may be that transpleural carriage does not occur readily except when adhesions are present, and in that case these objections would largely fall away. Scott and Beattie (*l.c.*) in discussing the stages of dissemination of tuberculous lesions of pulmonary origin figure as Stages III and IV a transpleural spread *via* lymphatics in adhesions with involvement of sternal glands and glands just above and below the diaphragm. They evidently regard this as the normal method of spread prior to generalization by blood-stream invasion through the paratracheal glands and thoracic duct. They also state, in reference to tuberculosis in monkeys, that the central lobe of the liver differs from the other lobes in that it has wide connexions with the lymphatics outside the liver, and it is significant that it is only in the region of the central lobe that tuberculous deposits secondary to tuberculosis within the thoracic cavity are to be found.

Which of these routes from the lungs to the abdomen is actually followed, or whether both do not come into action, we have not decided, but it appears to us that the distinctive features of tuberculo-silicosis as seen on the Rand have made apparent to the naked eye a mode of spread of tuberculosis from the lungs to the abdomen by lymphatic channels which has not hitherto been fully appreciated.

Tuberculo-silicosis a "Chronic" Form of Tuberculosis.—Attention is drawn in Appendix 7 to the resemblance between tuberculo-silicosis as seen here and the ordinary fibro-caseous tubercle of European adults

in two respects. Firstly, in the fact that there is much fibrous tissue formation, and, secondly, in the comparative frequency with which the tuberculosis is limited to the lungs or, at all events, to the tuberculo-silicotic zone. In 70 out of the 200 cases, the tuberculosis was completely limited to this zone, and in another 49 cases the tuberculous developments outside this zone were very slight. Finally, we might point out that with the exception of a very few cases of fibro-caseous tubercle referred to in the " acute " section, tuberculo-silicosis furnishes the only cases of " chronic " tuberculosis which we have seen amongst these mine-labourers. Although silicosis may be regarded usually as a factor predisposing to tuberculosis, its possible beneficent action should not be overlooked. In a race with little resistance to tubercle, it would seem to play a considerable part in converting an acute, progressive and often rapidly fatal disease into a chronic, long-lasting one.

Age and Limitation of the Disease in the Mine Native.—In European adults there is commonly acquired the ability to prevent tuberculosis from becoming a generalized condition. This ability is strikingly lacking in the Native except when the tuberculosis is associated with silicosis.

To illustrate this point we have gone over the records of 681 post-mortems (the present series of 600 cases *plus* some others) where death was due to tuberculosis. In this series of 681 cases there were 264 in which the age was given as 40 or over. Of these 264 cases, silicosis was associated with the tuberculosis in 176, whilst in 88 there was no silicosis.

In the 88 cases without silicosis the disease was a more or less generalized condition in 80 ; only in 8 was it limited to the lungs or to the lungs and tracheo-bronchial glands.

In the 176 cases associated with silicosis, generalization had only occurred in 76 ; in 100 it was limited to the bounds of the tuberculo-silicotic zone.

Localization or limitation of the disease in the Native may be said, therefore, to be a factor, not of age, but of silicosis.

In the elderly Native, apart from the influence of silicosis, tuberculosis tends to become generalized practically as much as in the younger Native.

Oesophageal Fistulae.—A point of some interest is the frequency with which oesophageal fistulae had formed in relation to breaking down tuberculo-silicotic tracheo-bronchial glands (see Fig. 13). No fewer than 9 actual cases of fistulae were found (Nos. 61, 80, 86, 302, 346, 371 and 392 in Group B and Nos. 406 and 444 in Group A), whilst in 3 other cases (Nos. 383 and 430 in Group B and No. 349 in Group A) stages leading up to the formation of a fistula were found.

Oesophageal diverticula are not uncommon in relation to adjacent fibro-caseous glands and have been described as a stage in the formation of fistulae. In this series of cases we did not encounter any traction diverticula, but we have since seen one whose tip was attached to a tuberculo-silicotic tracheo-bronchial gland.

(c) *Evidence bearing on Etiology.*—Having made a general survey of the pathological anatomy of tuberculosis amongst Native miners, we now come to two specific questions upon which it was hoped that this investigation would throw some light.

(i) *Point of Entry of the Tubercle Bacillus.*—The first of these is the point of entry of the tubercle bacillus, and we think the answer to this is that in the great majority of cases infection takes place by the respiratory route.

The infrequency of involvement of the cervical glands would appear to indicate that the point of passage past the primary defences was but rarely in the tonsils, pharynx or larynx.

The commonest route is probably by passage of the bacilli from the lungs to the tracheo-bronchial glands with the development of initial lesions there. Running this fairly close, however, is the development of initial lesions in the lung substance, especially near the apices, with secondary spread to the tracheo-bronchial glands. Later studies of X-ray examinations of lungs (see pp. 174–179) show that this opinion may have to be modified, however.

Infection by the abdominal route is much less common. Among the 62 cases dying from causes other than tuberculosis (Group A) there were 3 (Nos. 66, 88 and 306) showing initial lesions in mesenteric glands, and 1 (No. 148) showing what was probably a completely healed initial lesion in that situation.

6 cases in Group D, 2 in Group B, and 4 in Group C have already been referred to on p. 161.

We have, therefore, a total of 16 cases out of the 600 in which invasion appeared to have been definitely by the abdominal route, but, as noted under Group D in Appendix 6, there were 8 others which might possibly be added. This gives a total, at the outside, of 24 cases (4 per cent.) of primary abdominal tuberculosis.

In 3 of the undoubtedly abdominal cases the initial lesions were in glands of the mesentery of the uppermost loop of the jejeunum, and in several other cases we have observed that these particular glands, although sharing in the process of caseation with other mesenteric glands, were the most severely affected. We are not aware of attention having been drawn before to this particular group.

From a clinical standpoint abdominal tuberculosis is commonly looked upon here as being of frequent occurrence in the Native. This may be correct if one merely takes into consideration where the main lesions are situated, but it cannot be regarded as correct if one takes into consideration the source of the spread. The tuberculosis of the Rand Native mine labourer must be regarded as essentially a respiratory disease, only rarely an abdominal one.

(ii) *Is Tuberculosis Acquired on the Mines or merely Lit Up?*—If a canvass of opinion had been taken a few years ago on this question there can be little doubt but that the answers would have been overwhelmingly

in favour of the view that the tuberculosis of the Native mine labourers was acquired on the mines *ab initio*. The recent demonstration of the fact that 70 per cent. or more of the Natives arrive with a positive tuberculin reaction, however, has made it possible to hold the view that many of them arrive already infected, and that the disease develops either through super-infection or through the lighting-up of old foci through stress of work or other circumstances.

What has pathological anatomy to say on this point ?

Well, the fact that amongst " new arrivals " with no evidence of any previous mining service dying from conditions other than tuberculosis within a few days of their arrival, there were found a certain number of cases with definite tuberculous lesions, is clear proof that some Natives do arrive already infected.

A consideration of the proportion of these cases is of some interest, and for this purpose we will limit ourselves to the figures for one year (1927) as it is easier by so doing to make a comparison with the average total complement. In that year among 73 new arrivals there were 6 cases of deaths with tuberculous lesions which unquestionably antedated their arrival. 6 is not a large number, but it constituted one-twelfth of all the deaths among new arrivals, and we are never likely to get any larger figure to base any argument on, as such findings are dependent upon deaths from fortuitous causes.

The actual turnover of boys on the mines in the course of a year is generally taken as being about twice the mean complement, so we will not be far out if we put the turnover for the year at 360,000. If the proportion of cases showing tuberculous lesions among those dying from other causes within a few days of their arrival holds good throughout the whole force, this would give us a figure of 30,000 cases *per annum* arriving with latent tuberculous lesions.

At first sight such a figure may seem absurd, but if a positive tuberculin reaction be accepted as evidence of some previous tuberculization, then a 70–80 per cent. rate of positives gives us a figure, not of 30,000 but of 270,000. Also, we ought to have found lesions not in 6 cases out of the 73, but in 55 ! As it is, we may regard the 6 as representing that proportion with tuberculization ante-dating their mining service and severe enough to be recognized readily at post-mortem examination, although not readily detectable during life. Also, it may be added, that we have little doubt from our later experience with X-ray examination of lungs (see p. 174) that if such examinations had been made of all these 73 new arrivals we would have found numerous small pulmonary lesions that escaped ordinary pathological investigation.

There is another line of consideration which leads us to believe that latent tuberculosis in new arrivals is by no means a negligible factor in the production of active tuberculosis. That is the number of cases in which death occurs after a period of service of only one month or less. In all, 28 such cases are recorded, 24 in Group C, and 4 in Group D.

If we accept Borrel's minimum figure of one month for the duration of the first—latent or glandular—stage as applying here (we have no evidence available on this point, but we may state that Professor Lyle Cummins has told us that he has information that the latent period in monkeys is also about one month) and also his minimum of a fortnight for the second stage, which we are prepared to do from local experience, *then we have either to admit that if these cases acquired their infection* after arrival they all died within the minimal period (this is allowing for a fortnight in hospital in addition to a month's service, and some of the cases we know did not even have that time), or else they are cases arriving already infected and passed with latent lesions. It is not credible that they all fall into the former category; some, at least, must be in the latter.

The same argument would apply to some of the cases of tuberculosis dying after two or three months of service as minimal periods cannot apply to all cases, but it cannot be pushed to the same extent in these.

It must be taken as established, therefore, that some of the tuberculosis occurring early in mining service is due to the lighting-up of infections already present on arrival but undetected at examination, or, in other words, it is of endogenous origin.

In the case of tuberculosis developing later, infection acquired on the mines, *i.e.*, exogenously, may reasonably be suspected of playing a more important rôle, either as a primary infection or as a super-infection.

Just how important a rôle exogenous infection plays is difficult to estimate. Herewith follows a consideration of this point on purely pathological grounds. Other arguments bearing on the question are considered in Chapter VI., p. 277.

The ordinary chronic phthisis of Europe is commonly held to be the result of exogenous re-infection or re-infections. One of the main arguments in favour of this view, as set out in standard text-books on tuberculosis or, more recently, as by Aschoff[61] and here summarized, is as follows :—

The *primary affect*, if not healing completely, goes on to a stage of generalization from which the individual may die or the metastasizing process may come to an end, but the local infections, the so-called organ phthisis, goes on. Thus develop such forms as chronic bone, joint or urogenital tuberculosis. *Chronic pulmonary phthisis* is rarely seen in such cases, the mutual exclusion of the simultaneous occurrence of chronic pulmonary phthisis and chronic phthisis of other organs being well recognized. It must be inferred, therefore, that the lungs are not liable to be affected by endogenous spread, and that subjects with organ phthisis are too well immunized for exogenous infections to take root. In persons in whom the primary affect has healed without any generalization, on the other hand, such high immunization is not present and in such individuals subsequent exogenous infections may be able to set up a chronic pulmonary phthisis which will then be present without the presence of organ phthisis.

How does the phthisis of our long-service Natives fit in with this conception ?

The pathological records show that in approximately 50 per cent. of the chronic cases the pulmonary phthisis is unassociated with any organ phthisis. Therefore, if the same argument holds good here, it is to be inferred that these cases have resulted from exogenous infection or infections.

Furthermore, in many of the other 50 per cent. of cases—those in which organ phthisis was present—the involvement of the other organs was obviously much more recent than that of the lungs, so that these also might be regarded as starting exogenously, although there had been a later endogenous spread.

There is, however, a possible fallacy in the whole argument as applied to these cases, associated with the presence of silicotic lesions in the lungs, a factor which does not complicate the ordinary European case.

In those cases where the tuberculo-silicotic lesion is a single one it has been observed that the situation is commonly sub-apical, *i.e.*, in the locality regarded by Aschoff (*loc. cit.*) as characteristic of secondary exogenous infections. The character of these solitary foci is, moreover, usually suggestive of being initially tuberculous and merely secondarily taking on a tuberculo-silicotic facies through the accumulation of silica and pigment in the tuberculous tissue.

The more common class of case, however, with multiple tuberculo-silicotic lesions, while also explicable on the theory either of the simultaneous inhalation of silica and tubercle bacilli or of the earlier development of silicotic lesions and the subsequent trapping of inhaled tubercle bacilli in them, is capable of another explanation.

It might well be argued that although tubercle bacilli of endogenous origin are rarely responsible for the initiation of chronic phthisis in the otherwise healthy lungs, in the case of lungs with silicotic foci such bacilli might well be trapped and be able to gain a footing in these areas of already damaged tissue.

This argument would imply two things :—(*a*) The presence of an endogenous source, and (*b*) that bacilli from this source get loose and travel around either in the blood-vessels or lymphatics.

The first implication will readily be granted. The high rate of tuberculization of the Natives has been proven, and it has been shown by Puhl (*cit.* by Aschoff) amongst others that tubercle bacilli may remain alive and virulent for many years in lesions which are calcified or even ossified and apparently quite dormant.

On the second point we have, unfortunately, no definite evidence to offer, but it may be pointed out that numerous recent workers have shown that a tubercle bacillaemia without any necessary spread of actual disease is no uncommon thing, and the possibility of lymphatic spread is mentioned because our pathological investigations have shown that lymphatic dissemination in tuberculo-silicosis may be a widespread affair.

On purely pathological grounds, therefore, it seems probable with regard to these cases of chronic pulmonary phthisis that—

(*a*) A few of the more acute cases are almost certainly of endogenous origin from the erosion of blood-vessels by slowly progressive foci with a resultant miliary spread.

(*b*) A few cases—those with solitary lesions—are almost certainly of exogenous origin.

(*c*) The majority of cases may be explained either on an endogenous or an exogenous basis.

(*d*) *Radiographic Pathology of the Lungs.*—At the conclusion of the examination of the 600 cases which form the basis of the foregoing Pathological Report, a special examination of a further series of 87 cases was undertaken in which an X-ray photograph of the lungs was taken after removal from the body. The lungs and tracheo-bronchial glands were then carefully examined from the point of view of any information given by the radiograph.

The technique employed was to remove the thoracic contents intact along with the trachea and larynx. The lungs were then inflated through the trachea with a bicycle-pump and Kaiserling's No. 1 fixing fluid run through them by means of a canula introduced into the pulmonary artery. The trachea and pulmonary artery were tied off, the main mass of the heart cut away and the photograph was then taken. We are indebted to Dr. Irvine, chairman of the Miners' Phthisis Medical Bureau for permission to have the photographs done at the Bureau.

The object in making this series of examinations was to see how the findings would fit in with the views of the pathology and pathogenesis of tuberculosis as championed by such writers as Aschoff[61] and Opie.[65]

Their view, is briefly, that ordinary pulmonary tuberculosis is an exogenous or endogenous recidive of an infection experienced in childhood and that in adults not so immunized in childhood a tuberculous infection first encountered in adult life will be of the infantile type.

According to Aschoff, the primary infection may be in any part of the lung, but the upper lobes, especially the right, are the site of predilection. It is almost always immediately under the pleura and is usually single. It is sharply delimited, rapidly caseates and is always accompanied by a somewhat larger caseous focus in the related lymph node near the root of the lung.

In the great majority of cases this primary affect heals completely. The healing takes place about both foci by the development of a specific granulation tissue which becomes transformed into a hyalinized fibrous tissue scar surrounded by ordinary non-specific fibrous tissue. In the encapsuled caseous masses calcification occurs, and they are gradually absorbed by invading connective tissue which builds typical bone. The marrow of this bone is often richly pigmented by carbon-laden cells.

The reinfection, in contrast to the primary infection, may be multiple. It occurs most often at the apex of the lung, but is more often within the substance of the lung than subpleural, so that when it heals it brings about contraction of the surface of the lung in the process of cicatrization. The productive phthisical focus resulting from reinfection also tends to caseate and calcify but only very rarely is bone formed. Especially characteristic of reinfection is the freedom from involvement of the related lymph node.

In a certain proportion of cases the primary affect does not heal but carries over to the stage of generalization or metastasizing phthisis. In such cases the process manifests itself not so much in the lungs as in the lymph nodes. Rapid caseation may take place in the whole of of the tracheo-bronchial glands, not merely in those corresponding to the primary lung focus. These may invade bronchi and bring about a rapidly-caseating aspiration pneumonia, or there may be a break into the blood-stream and metastases in various organs of the body.

Opie (*loc. cit.*) from his work in children, gives a very similar description of the occurrence and characters of primary infections and reinfections, except that (so far as we can judge from those writings of his which we have been able to consult) he does not appear to lay stress upon the development of bone in primary affects.

Ordinary chronic pulmonary phthisis as seen in most civilized communities of the present day, presupposes a previous immunization through a primary infection in childhood or youth. Phthisis in adults not so immunized in youth tends to run a virulent course like that seen in childhood in the stage of generalization. Such absence of primary immunization is the explanation of the virulent character of the tuberculosis of primitive races, not any racial feature *per se*.

Let us see how our findings fit in with these views.

The 87 Cases.—The cases were quite unselected, being 87 consecutive deaths at the W.N.L.A. Hospital, irrespective of the cause of death.

Group A. Showing no Tuberculosis (18 cases).—These 18 cases showed no evidence of any tuberculous infection either by ordinary examination or radiographically.

12 were "new recruits" with ages in the early twenties, with no record of any mining service and, judging by the amount of pigment in the lungs, they were all actually newcomers to the Rand. In only 1 of the 12 was there a record of a tuberculin test and that was negative.

3 cases whose ages were 30, 30 and 35 respectively were also apparently truly newcomers.

1 case *aet.* 20 had 2 months' service.

1 case *aet.* 24 was marked "time-expired," *i.e.*, he had probably served one contract of 9 months' duration.

1 case *aet.* 40 had a record of 4 years and 8 months' service.

Group B. Tuberculosis, but not as the Cause of Death (12 cases).—This is an interesting group in view of the dictum of Opie, "I am inclined to believe that more knowledge of the pathology of tuberculosis can be obtained by careful examination of the tuberculous lesions of those who die from causes other than tuberculosis than from fatal instances of the disease."

Of the 12 cases, 6 had silicotic lesions associated with the tuberculosis, 6 had no accompanying silicosis.

Sub-group. Uncomplicated by Silicosis (6 cases).—Of these 6 cases, 4 were young new recruits (1 with a tuberculin reaction recorded as positive).

1 was a Pondo *aet.* 32 with 1 year of service, and 1 was a Msutu *aet.* 40 with 15 years' service.

5 of the 6 cases showed single subpleural calcified foci and 3 of the 5 also had calcified corresponding lymph nodes; in the other 2 no corresponding glandular lesion was found.

1 of the 6 had several subpleural calcified, pigmented, scarred areas, but no corresponding glandular foci.

None of the 6 showed any tuberculous lesions other than those mentioned.

3 of the 6 might be described, therefore, as showing typical full primary affects (except for the absence of bone); 2 had primary affects subpleurally only, and 1 had multiple subpleural primary affects but nothing in the lymph nodes.

It may be noted here that although Aschoff states that the primary subpleural affect is always accompanied by a corresponding glandular focus, he quotes statistics of Puhl which show that in about one-third of cases a primary affect was found in lung alone or in lymph node alone but not in both situations.

Sub-group. Complicated by Silicosis (6 cases).—The 6 cases with associated silicosis all occurred in older subjects, with records of service varying between $2\frac{1}{2}$ and 13 years.

2 cases showed tuberculo-silicotic lesions in the tracheo-bronchial glands only. 1 of these showed marked calcification in numerous glands on both sides but no apparent lung-lesion of any kind. The other showed caseation but no calcification in several glands and near one apex was a subpleural calcified area with the character of a primary affect.

1 case showed calcified tuberculo-silicotic tracheo-bronchial glands and scanty simple silicotic nodules in the lungs but nothing suggestive of any tuberculous lesion in the lungs.

PLATE I

FIG. 3.—Left lung with numerous broncho-pneumonic caseous areas showing through the pleural surface, and a moderate-sized " packet " of enlarged caseous tracheo-bronchial glands in section. Even larger groups than these are not uncommon whilst still larger " packets " of retroperitoneal glands are of frequent occurrence.

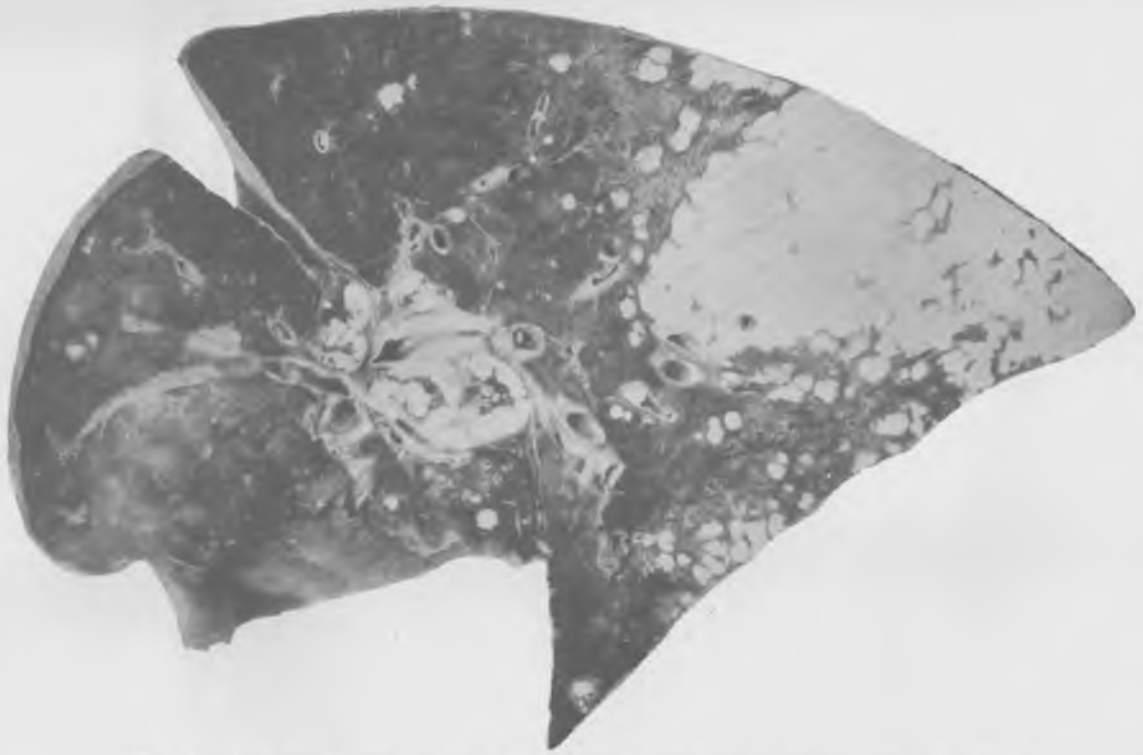


FIG. 4.—Section of lung showing a caseous confluent broncho-pneumonia in the lower lobe, resulting from a caseous broncho-pulmonary gland bursting its bounds and opening into a bronchus.

PLATE II

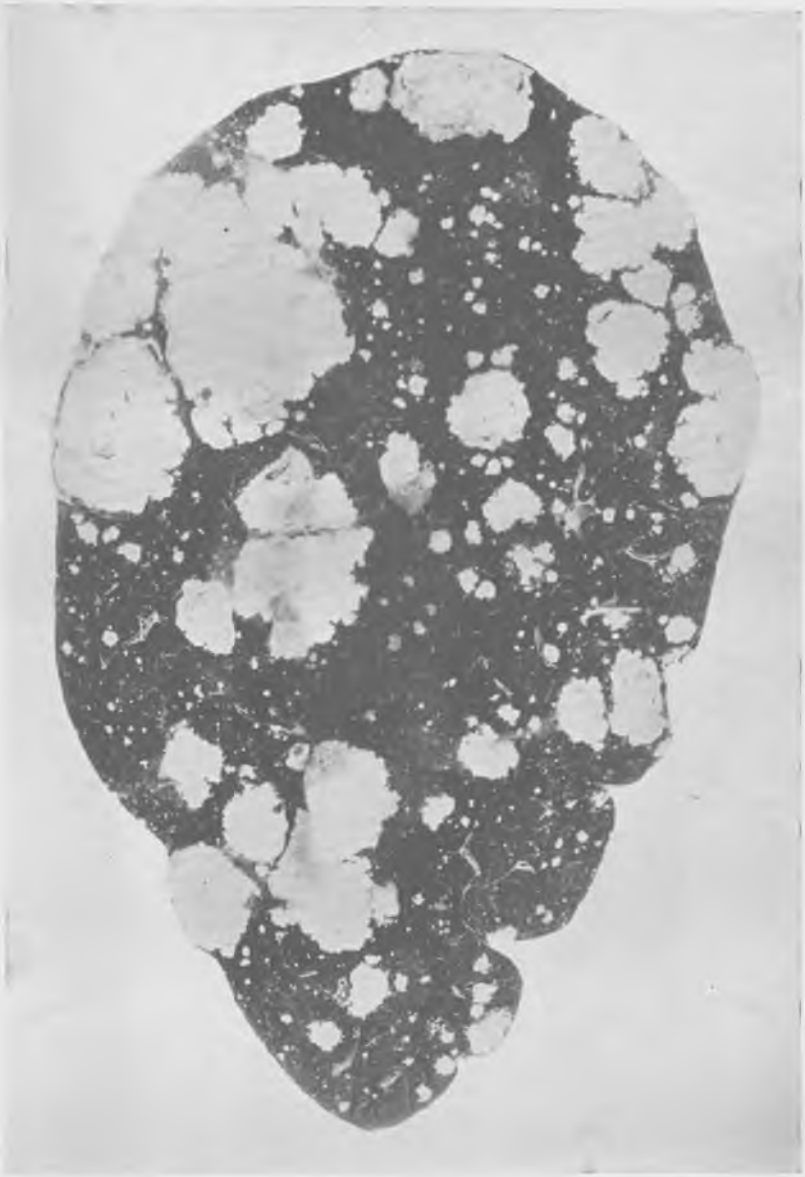


FIG. 5.—Section of a moderately-enlarged spleen with caseous nodules of various sizes. The typical acute " monkey spleen " is usually smaller than this, and the areas of caseation not larger than the medium-sized nodules of this specimen. On the other hand, more chronic and still larger specimens are fairly common, the caseous areas being then mostly of large size also.

PLATE III

FIG. 6.—Section of liver (reproduction of photograph, hand coloured) showing the type of tuberculous lesions usually encountered—numerous miliary, small, and medium-sized areas of caseation.

PLATE IV

FIG. 7.—Section of liver (reproduction of photograph, hand coloured) showing extreme type of tuberculous involvement—numerous medium and large-sized caseous areas. Many of these have opened into bile passages, and the caseous material has, to a greater or lesser extent, escaped, leaving cavities with bile-stained contents—the so-called " bile abscesses."

PLATE V

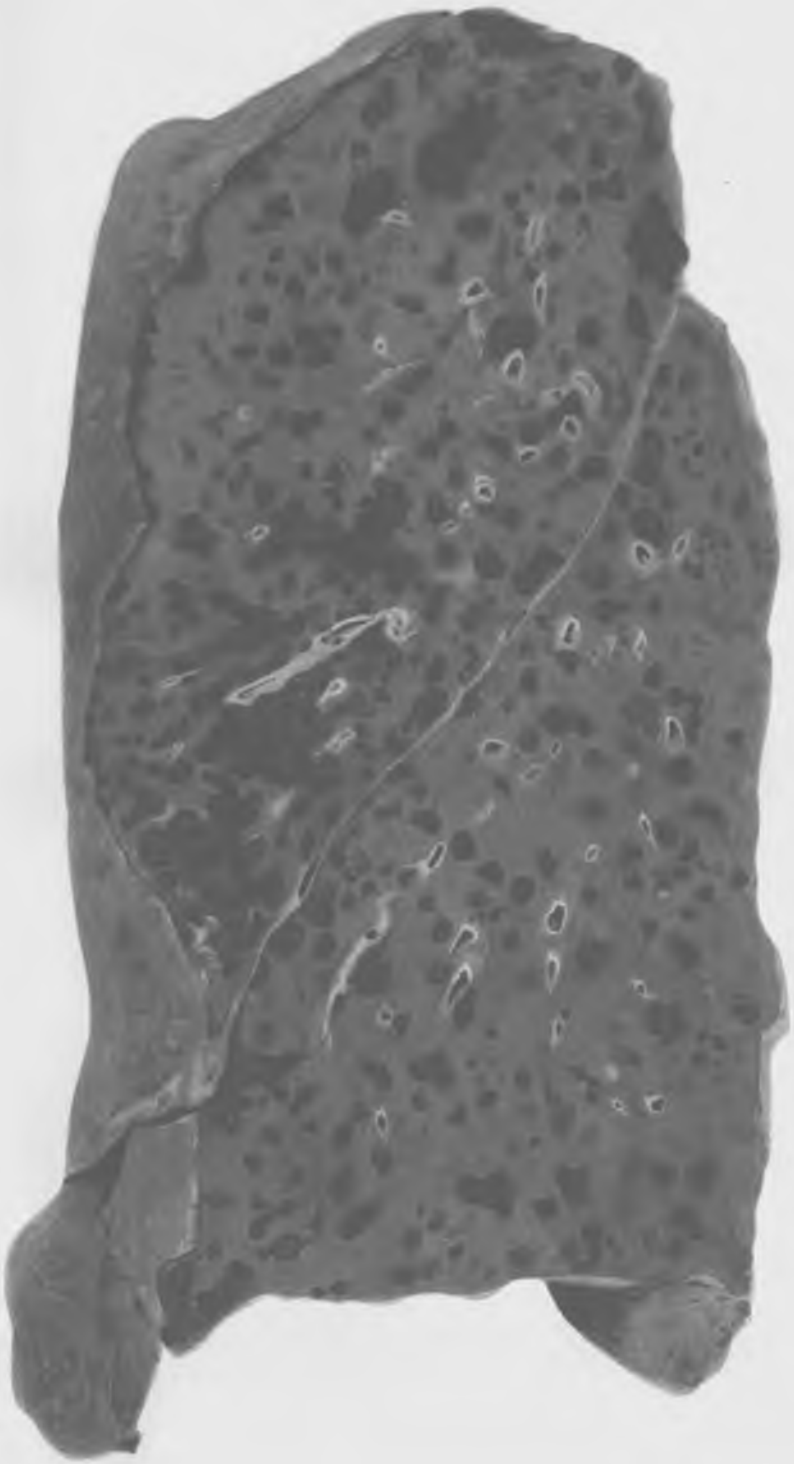


FIG. 8. — Section of lung (reproduction of photograph, hand coloured) showing numerous discrete tuberculo-silicotic nodules of dark steel-grey colour distributed fairly uniformly throughout the lung. There are also larger areas composed of nodules which have met and have, to some extent, coalesced, although the outlines of the originally discrete nodules are still discernible.

PLATE VI

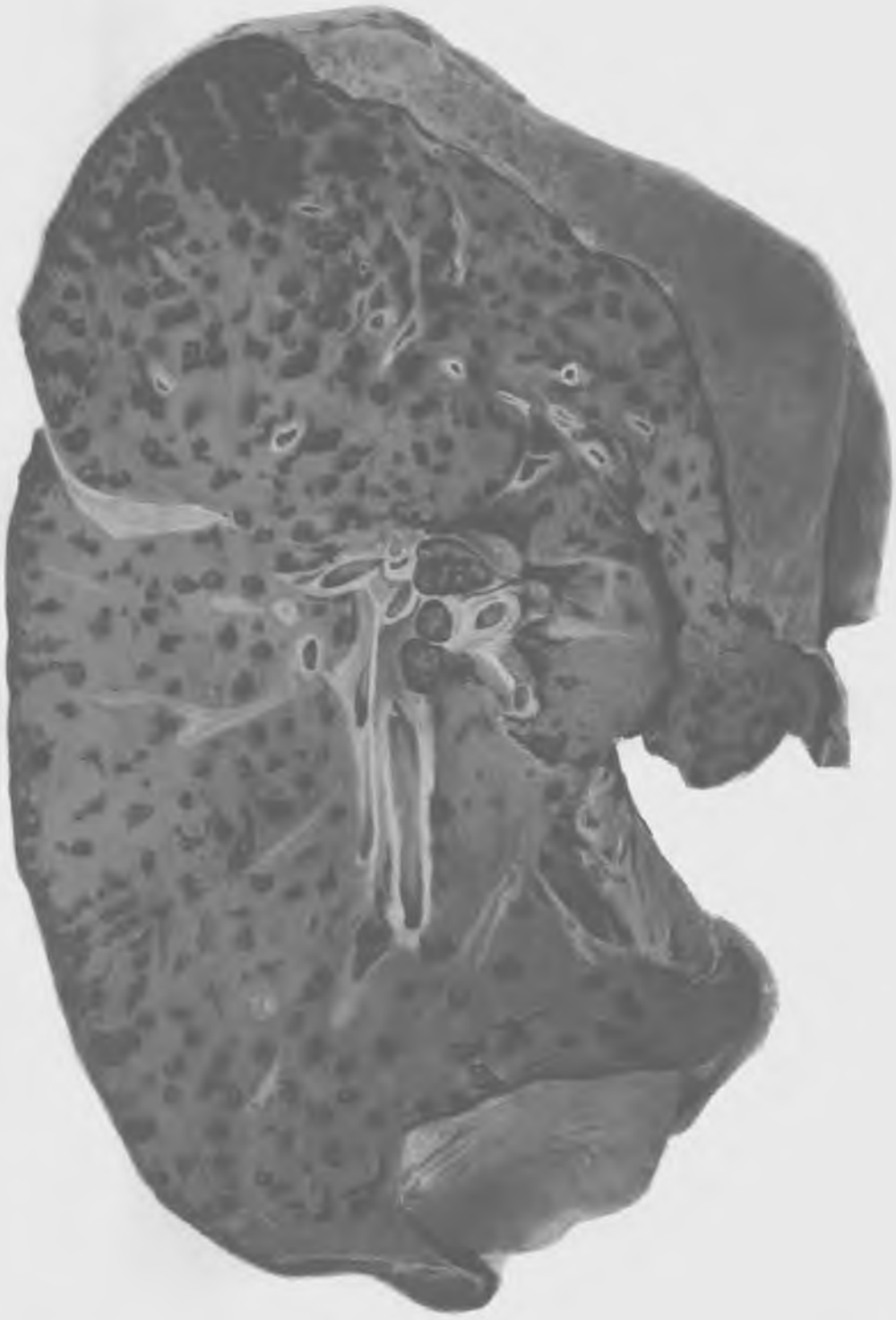


FIG. 9.— Section of lung (reproduction of photograph, hand coloured) showing numerous islands of simple pigmentation, and, near the apex, a cluster of tuberculo-silicotic nodules, the majority of which are coalescing. The glands at the root show a well-marked tuberculo-silicotic condition.

PLATE VII

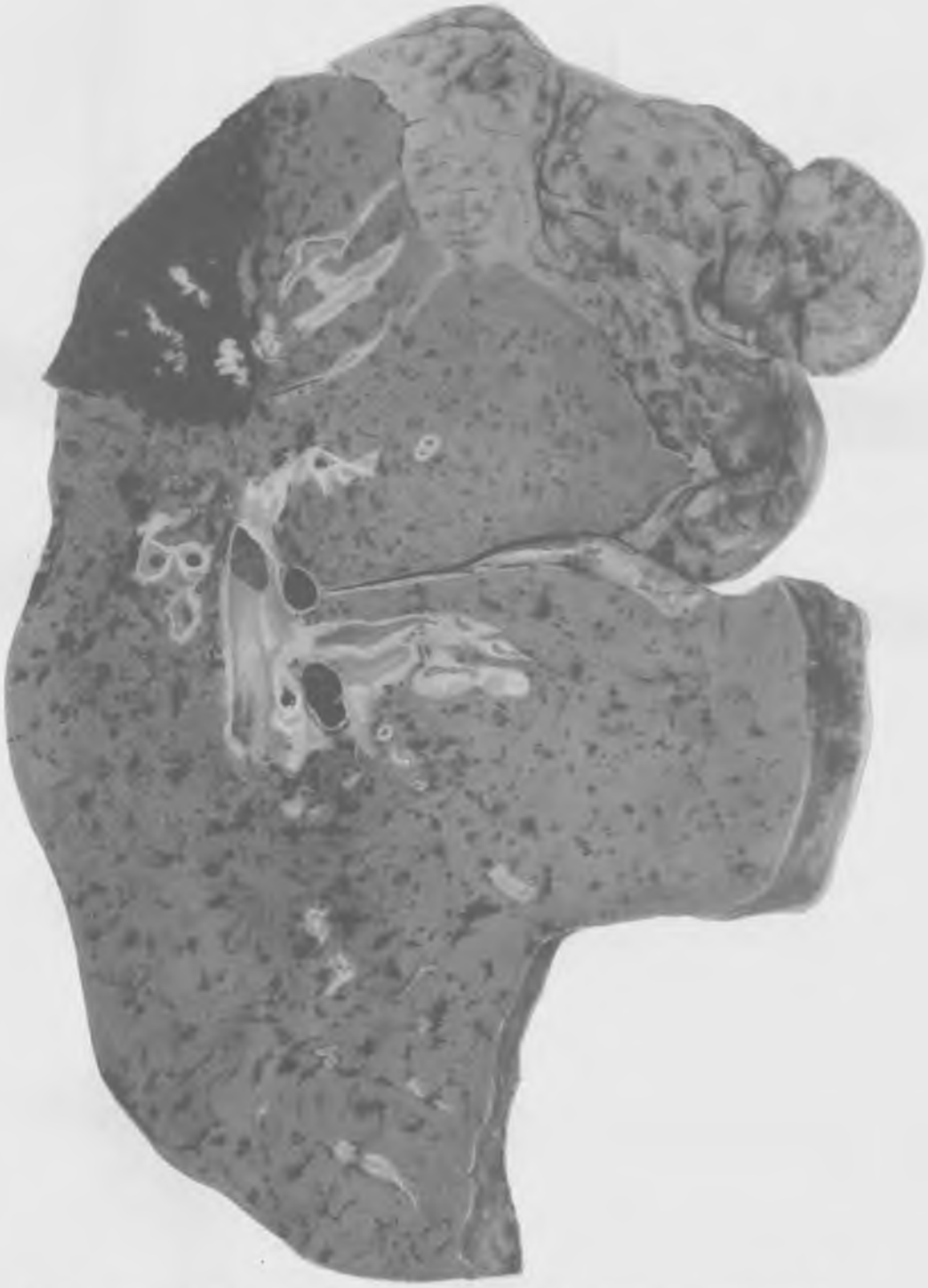


FIG. 10. — Section of lung (reproduction of photograph, hand coloured) showing a single wedge-shaped area of tuberculo-silicotic fibrotic consolidation, the remainder of the lung being remarkably free even of pigment. Several small tuberculo-silicotic glands are seen in section near the root of the lung. (NOTE : The colour of the tuberculo-silicotic area as reproduced is too purple in tint, it should be more of a blue-grey colour.)

PLATE VIII

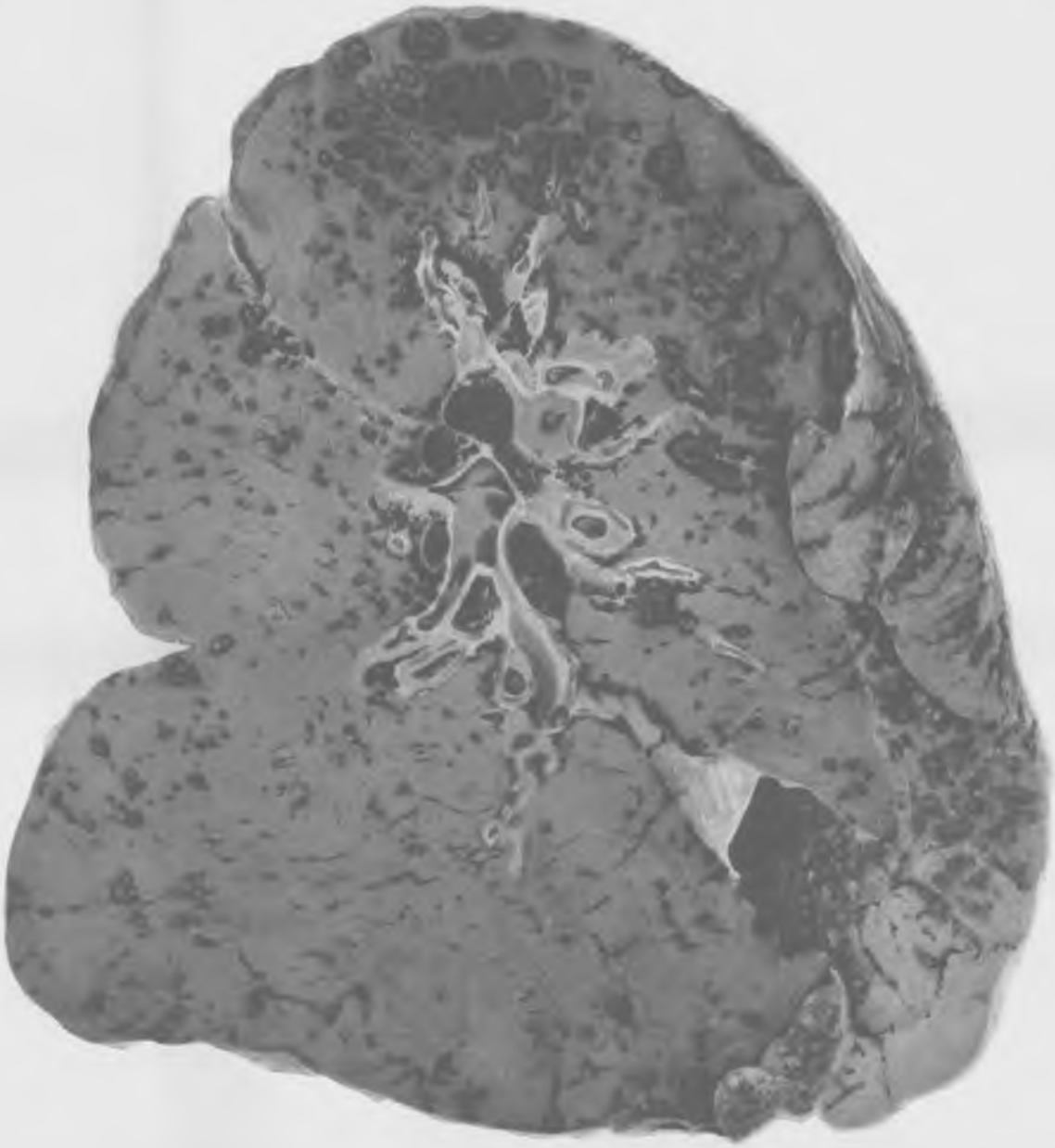


FIG. 11. — Section of lung (reproduction of photograph, hand coloured) showing numerous small and medium-sized tuberculo-silicotic nodules scattered irregularly throughout the lung. Near the apex discrete nodules are seen coalescing ; at the right margin a number of discrete sub-pleural nodules are visible ; and, near the base, there is a gross tuberculo-silicotic area. Numerous tuberculo-silicotic glands are seen in section near the root.

PLATE IX

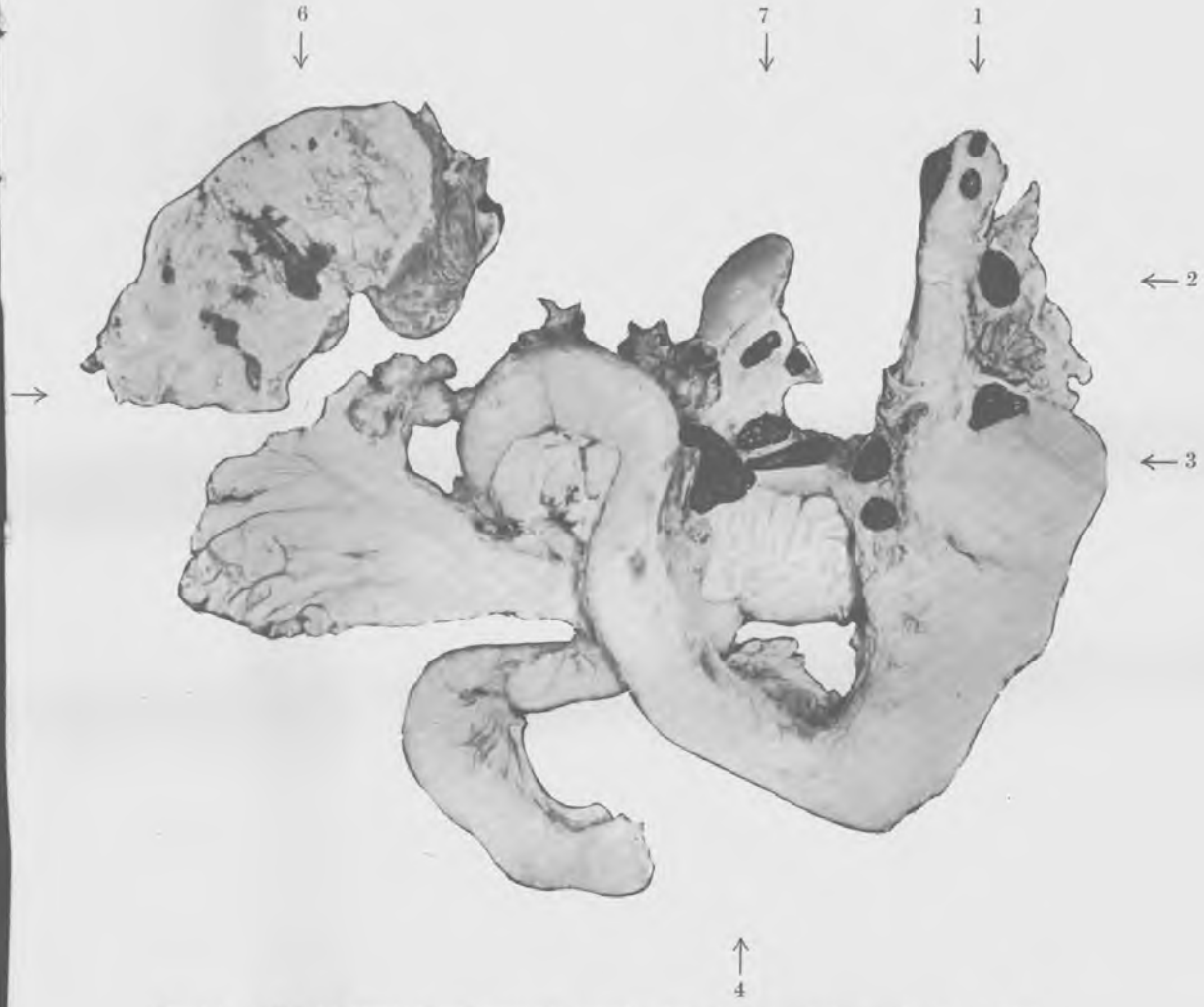


FIG. 12.—"The tuberculo-silicotic zone" outside of the lungs and the tracheo-bronchial glands. This specimen, for which we are indebted to Dr. A. Sutherland Strachan, of the Pathlogical Department, South African Institute for Medical Research, is from a European. The degree of pigmentation of the glands has been somewhat exaggerated in the reproduction, but all the glands shown were either silicotic or tuberculo-silicotic, and they have not been exaggerated in size.

(1) Three small glands lying on the oesophagus above the diaphragm.

(2) A posterior mediastinal or "diaphragmatic" gland lying just above the diaphragm, part of the muscle of which is seen just below the gland.

(3) Three of the superior gastric glands which form a collar round the cardiac end of the stomach.

(4) Three large pancreatico-lienal or "pancreatic" glands lying along the upper border of the pancreas.

(5) A group of six old, completely calcified (not pigmented) glands in the mesentery. Not part of the tuberculo-silicotic zone.

(6) A portion of the diaphragm, showing its pleural surface with a number of specks and plaques of tuberculo-silicosis sub-pleurally. The surface of the diaphragm was free from adhesions. This condition is not infrequently associated with a spread of tuberculo-silicosis beyond the lungs and tracheo-bronchial glands.

(7) Two small portal glands in the portal fissure. The piece of tissue above them is a small portion of the liver which has been left to show their position.

PLATE X

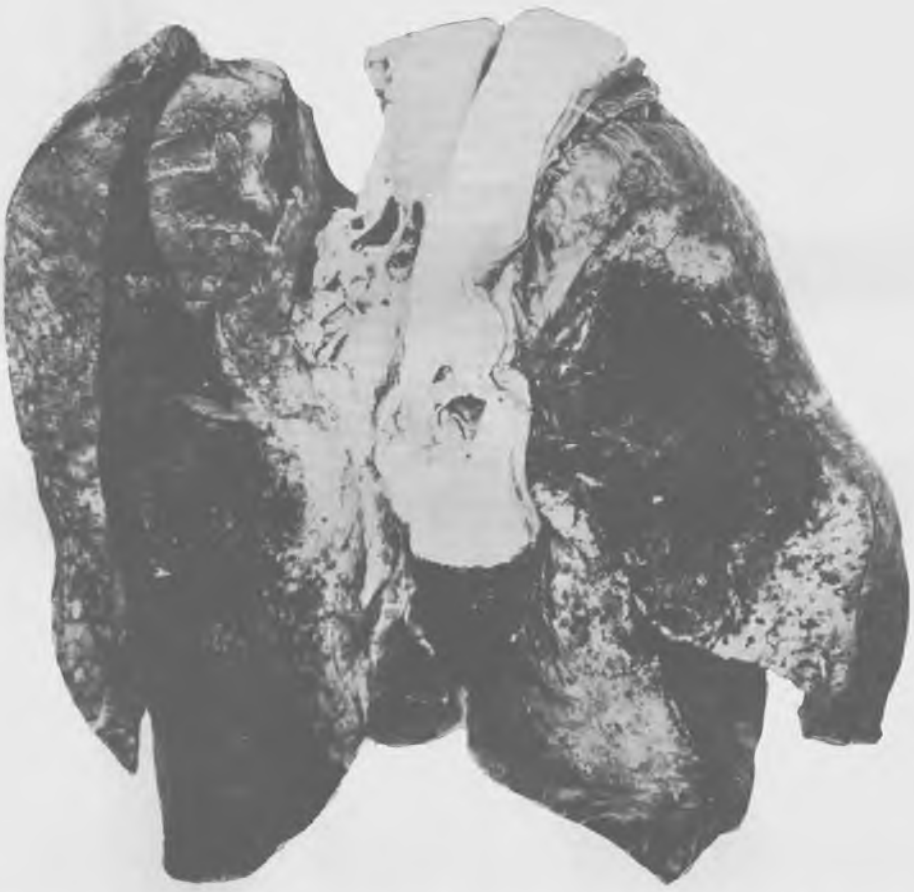


FIG. 13.—Thoracic contents as seen from the posterior aspect, with the oesophagus laid open. There is a double fistulous opening into the oesophagus. The subject, a Mchopi, *aet.* fifty, with seven years and ten months' mining service, had only scanty discrete tuberculo-silicotic nodules in the lungs, but the tracheo-bronchial glands were markedly tuberculo-silicotic and calcified. Breaking down of these glands resulted in the fistulous connexion with the oesophagus, and when the thoracic contents were removed from the chest, a mass of necrotic glands about the size of a pigeon's egg dropped out. Death was due to gangrene of the lungs. Fig. 15 is a radiograph of the same specimen.

PLATE XI

FIG. 14.—Radiograph. Case 475, Shangaan, new recruit. Left lung shows three small subpleural calcified foci; the right a ring of calcified foci, which were found to lie in a scarred area within the lung substance. There was nothing in any of the hilus glands.

PLATE XII

FIG. 15.—Radiograph. Case 577 (same as Fig. 13). Plate shows two small subpleural calcified foci in the right upper lobe and marked calcification of the hilus glands on both sides.

PLATE XIII

FIG. 16.—Radiograph. Case 522, Zulu, *aet.* sixty, with seventeen years' mining service. Recent acute tuberculous peritonitis, but no other active tuberculosis. Lungs heavily pigmented, but not definitely silicotic, and no tuberculosis. Plate shows nothing in lungs but one large and one smaller broncho-pulmonary gland on the right side (reversed in picture) caseous and calcified. These glands were tuberculo-silicotic.

PLATE XIV

FIG. 17.—Radiograph. Case 542, Shangaan, *aet.* fifty with six and a half years' service. Lungs showed gross areas of tuberculo-silicosis with excavation. Tuberculosis of spleen, liver, peritoneum and intestine. Plate shows intense calcification of the tracheo-bronchial glands and numerous specks scattered over the lungs. These specks appeared to be mainly, if not entirely, in tuberculo-silicotic areas and nodules.

PLATE XV

FIG. 18.—Radiograph. Case 564, Msutu, *aet.* forty-five with four years' service. Slight tuberculo-silicotic lesions in lungs and glands. A subpleural calcified scar in the left lower lobe, probably a primary affect, certainly not a tuberculo-silicotic patch. Calcification in several of the tuberculo-silicotic glands.

PLATE XVI

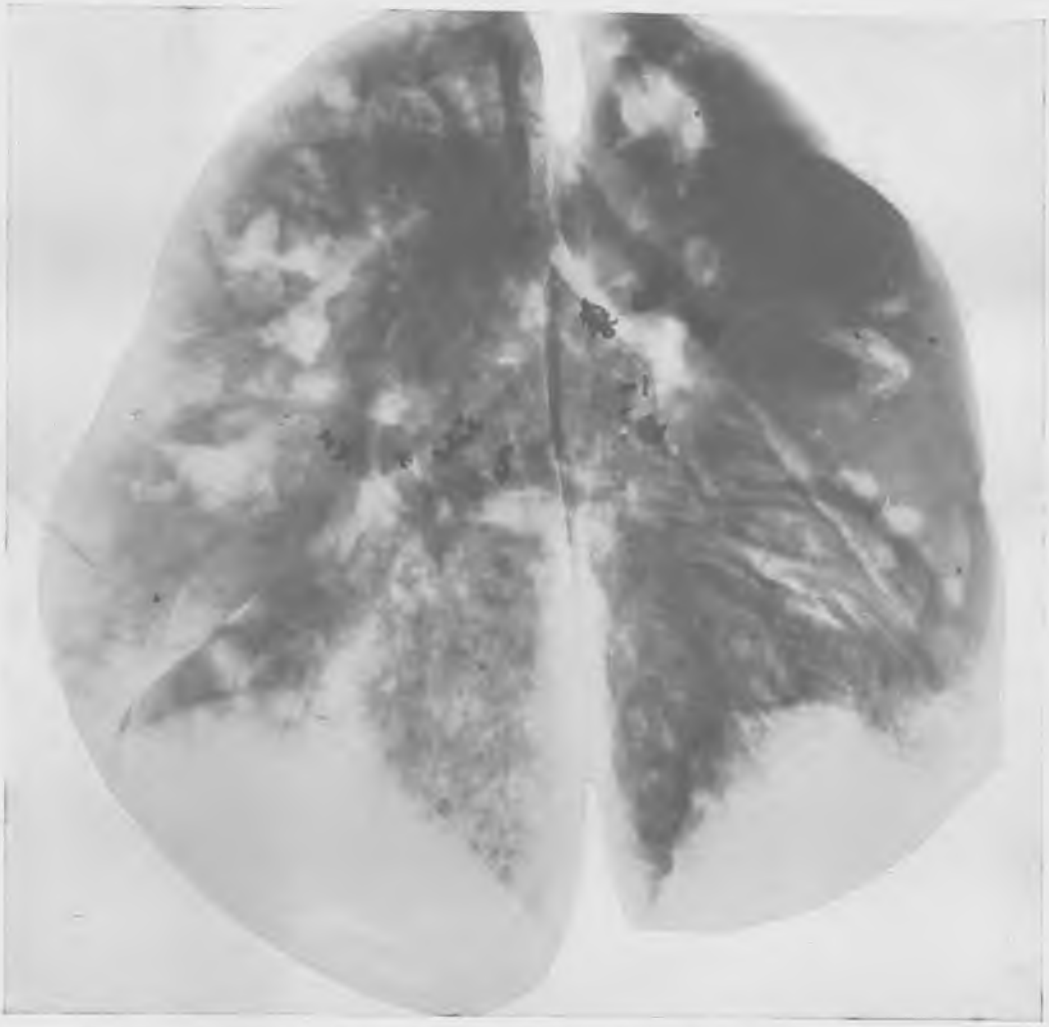


FIG. 19.—Radiograph. Case 501, Msutu, *aet.* thirty-two with only one month's record of service. Caseating phthisis with excavation in both lungs. Numerous slightly calcified areas in broncho-pulmonary glands. The three specks near the outermost part of the right upper lobe corresponded with three subpleural pigmented scars.

1 case had tuberculo-silicotic areas in the lungs and all groups of glands falling within the tuberculo-silicotic zone but no apparent pure tuberculous lesion.

1 case had tuberculo-silicotic nodules in the lungs and in the tracheo-bronchial glands, the latter being calcified. There were no pure tuberculous lesions.

1 case was similar to the foregoing but with the additional presence of a subpleural calcified scar.

Of the 6 cases associated with silicosis, therefore, it may be noted that calcification in hilus glands was a prominent feature in 4. Only 2 cases showed lesions in the lungs that could be interpreted as primary affects.

This absence of subpleural primary affects in silicotic cases is commented upon further in connexion with the next group of cases.

Group C. Tuberculosis the Cause of Death. The Tuberculosis associated with Silicosis (22 cases).—Of these 22 cases, 6 showed no calcified lesions in either lungs or tracheo-bronchial glands.

In the other 16 calcification was present in all in one or more (usually in several) of the tracheo-bronchial glands, and in 8 there were also subpleural calcified foci. In 4 of these 8, however, the calcification was in areas which had the characters of ordinary tuberculo-silicotic foci, only 4 being in apparently simple primary tuberculous affects.

The only inference that it seems possible to draw from this group of cases and from the preceding sub-group of 6 is that in the presence of silicosis the development of tuberculosis is modified and that the formation of typical primary affects does not take place. Or, alternatively, that they only form in the tracheo-bronchial glands and are not recognizable in the general tuberculo-silicotic process.

This inference is not affected by the presence of a few subpleural affects because it is only to be expected that silicosis and tuberculo-silicosis should develop in some cases with already-present primary affects. We have not been able to detect any difference in type between such cases and the others.

Group D. Tuberculosis the Cause of Death. The Tuberculosis uncomplicated by Silicosis (35 cases):—

No Calcified Foci in either Lungs or Glands	16	cases
Calcified Foci in both	7	,,
Calcified Foci Subpleurally but not in Glands	9	,,
Calcified Foci in Glands but not Subpleurally	3	,,
	35	

Bone was found in 2 cases; once in a subpleural area (there was also another calcified subpleural scar), the corresponding lymph node showing no calcification or bone formation; and once in a tracheo-bronchial gland. In the latter case there was no corresponding subpleural lesion, but as there was a large cavity in the upper lobe it is possible that it may have disappeared in the formation of the cavity.

Leaving aside the question of bone formation, it may be said, therefore, that one-fifth of the cases showed full primary affects, *i.e.*, both subpleural and glandular lesions; one-third primary affects in either lung or gland, but not in both; and almost one-half no primary affects at all.

That half of the cases should show no evidence of primary affects is rather remarkable. Two possible explanations occur to us—

(1) That the cases ran such a rapid course—primary infection not healing but passing directly on to the stage of generalization—that the calcification stage was never reached.

That this is probably a true explanation for the majority of the cases is suggested by the fact that in 13 of the 16 cases showing no calcified foci in either lungs or glands the picture presented was largely one of a widespread involvement of lymphatic glands, more or less of the whole chain from the cervical to the lower retro-peritoneal being implicated. Commonly, also, there was much involvement of the spleen, liver and peritoneum, but usually comparatively little in the lungs, although in several cases there was direct spread outwards from a caseous hilus gland which had burst its bounds. These features are in keeping with the description given by Aschoff of the cases of primary infection which do not heal but pass directly on to the generalization stage.

Whether or not the fully developed primary affects are to be found in such cases, he does not say, but on the face of it, it would appear to be reasonable to expect that they might not.

(2) Another possible explanation, which is not exclusive of the former, but might come into play along with it, at any rate in so far as the glands are concerned, would come under the heading of a racial differentiation. Whilst we quite agree that an important reason for the difference between the tuberculosis of African Natives and of ordinary European communities may be the presence or absence of immunization in youth, we are not entirely satisfied that a partial explanation may not be found in a difference in structure of their lymphatic system.

Our attempt to correlate the inability of the Native of South Africa to localize tuberculosis with a specific anatomical factor is based partly on direct observation and partly on several other converging lines of evidence.

In the course of studying our series of cases, we have made numerous microscopical examinations of their lymphatic glands and have formed the opinion that the typical lymph node of the European is the exception in the Bantu. In these subjects the lymph node as usually met with is neither a "lymph gland" nor a "haemo-lymph gland" but a "mixed gland." The detail we wish to emphasize is that these nodes, without being typical haemo-lymph glands, are far more highly vascularized than are the nodes of the European. This more intimate association with the blood-vascular system may be related to the apparently deficient filtering power of the lymph-nodes of the Bantu. The

realization of the different character of the lymph nodes in the Bantu has only been gradually forced upon us during the course of this investigation.

The other lines of evidence pointing to a difference between the lymphatic system of the Bantu and that of the European are as follows :—

(1) In Appendix 7 there is described what has been termed the tuberculo-silicotic zone. While this condition is met with also in the European miner, it is developed far more rapidly in the Native and is of more constant and comprehensive occurrence. This suggests greater freedom of lymphatic circulation.

(2) In this Section (p. 169) we discuss a group of 264 cases aged 40 years and over. Tuberculo-silicosis was found in 176 and simple tuberculosis in 88. Of the 176 cases of tuberculo-silicosis, in 100 (57 per cent.) the disease was localized, and in 76 (43 per cent.) it was generalized. Of the 88 cases of simple tuberculosis, in 8 (9 per cent.) the disease was localized, and in 80 (91 per cent.) it was generalized. The limiting factor seems to be related to silicosis rather than to age, and we are disposed to associate it with the lymphatic obstruction characteristic of silicosis.

(3) The frequency and grossness of involvement of the spleen is a characteristic of the tuberculosis of the Native. Owing to their similarity with the lesions associated with experimental tuberculosis in the monkey, Dr. Watkins-Pitchford used to call these spleens "monkey-spleens," a term which we have adopted, although we cannot say whether our former chief is its authentic parent, as used in this context. Accessory spleens are very common in our subjects and when there is abdominal tuberculosis these accessory spleens are always involved. This suggests that the spleen-haemolymph circulation in the Bantu is more intimately associated with the lymphatic circulation than is the case in the adult European.

(4) In the section of the Report dealing with tuberculin reactions (p. 92) it is stated that tuberculosis in the series studied ran the same course whether a tuberculin reaction determined previous to the recognition of clinical tuberculosis had been positive or negative. In the Bantu a previous invasion with the virus of tuberculosis does not appear to be associated with any appreciable gain in ability to localize an after-coming clinical tuberculosis.

Fishberg[45] writes: "In children infection with tubercle bacilli, if it causes active disease at all, is usually followed by a generalized morbid process with implication of the lymphatic glands." The above passage (and similar passages could be quoted from almost any standard work on tuberculosis), applies to our series of Bantu subjects throughout their lives. Whereas in the early adult period of the western European tuberculosis usually turns over from being a general disease to being a local disease, we have found no evidence of a turn over on a corre-

sponding scale in the Bantu. This seems to us very strong evidence of a racial difference, and it is possible that the free vascularization of their lymph-nodes plays some part in their lack of ability to control a " lymphatic spread."

For illustrations of radiographic examination of lungs, see Figs. 14–19, Plates XI–XVI.

SECTION F.—CLASSIFICATION OF CLINICAL TYPES OF TUBERCULOSIS MET WITH IN NATIVE MINERS ON THE RAND.

(1) *An investigation was made by Professor Lyle Cummins and* Dr. L. G. Irvine of the clinical and radiographic records filed at the Medical Bureau in respect of 512 cases of " simple tuberculosis " and 250 cases of " tuberculosis with silicosis," with the object of obtaining information as to the clinical types of tuberculosis present amongst mine Natives (see Appendix 8).

(2) The data were entered on special cards showing (i) the number of years worked underground by the Natives concerned ; (ii) whether the cases were sputum-positive or sputum-negative ; (iii) the extent of the lesions as shown by the radiograph, classified as " minimal," " moderate " or " maximal " ; (iv) the amount of systemic disturbance, classified as S1, S2 or S3, and (v) the temperature, whether normal or a mild (T+), moderate (T++), or severe (T+++) pyrexia.

(3) In the cases of simple tuberculosis the general results were as follows :—

(i) The sputum-positive cases numbered 392, or 76·6 per cent., and sputum-negative cases 120, or 23 per cent.

It was noted that the number of cases in the sputum-negative group fell with each year of service, suggesting that the lung lesions tend to be more " open " in the mine Natives who have worked longest on the Rand.

(ii) As regards *extent of disease*, there was a higher percentage (42) of cases of " maximal " extent amongst the sputum-positive group than amongst the sputum-negative group (27), the difference being greatest in the " first-year " cases. In the sputum-positive group the average percentages of cases of "minimal," "moderate" and " maximal" extent were respectively 17, 41 and 42, and the percentages showed no significant differences at different durations of service.

(iii) As regards *systemic disturbance and pyrexia*, the Natives in the first year of service showed a higher percentage of cases with severe systemic disturbance and a higher proportion of markedly pyrexial cases than the Natives with longer periods of service. This result appears both in the sputum-positive and in the sputum-negative groups. In the same way, the proportion of cases with normal temperature increases in both groups with increase in years of service. This increased power of holding in check the more severe types of pyrexia and of limiting the tendency to loss of flesh and general health suggests that the older mine Natives have acquired, in the course of

some years' exposure to contact with tuberculosis on the Rand, some degree of resistance, sufficient, if not to bring the disease to a standstill, at least to ameliorate its worst manifestations.

(4) It was considered desirable to treat cases of *tuberculosis with silicosis* as statistically distinct. The following points were noted regarding the 250 cases investigated :—

(i) These cases fall almost exclusively into the "five years" and "over five years" service groups.

(ii) Practically 85 per cent. were sputum-positive.

(iii) In this group the same tendency to keep the temperature within normal limits was evident in the long-service Natives, especially in the sputum-negative cases, amongst whom the chance of secondary infection is less than in the open cases.

(5) In attempting to draw conclusions from these records, it must be remembered that they include only cases in which a radiograph had been taken ; the more severe cases of simple tuberculosis who had died in the mine hospitals or at the W.N.L.A. hospital, and in respect of whom no radiograph could be taken, were necessarily excluded. Had these cases been added, it might have been expected that they would have still further accentuated the evidence of lack of resistance manifested by the "first-year" Natives as compared with cases contracting tuberculosis after a longer acclimatization to mining conditions.

The investigation, so far as it goes, serves to show that the "new" mine Natives tend towards a very acute and severe type of disease, whereas the "long-service" Natives learn to tolerate tuberculosis to a greater extent. In this respect, these clinical observations fall into line with the pathological findings as well as with the statistical studies.

The same point is brought out by an enquiry made into the length of service in cases found fit for repatriation, as compared with the length of service of those dying on the mines, the findings being summarized in Table 37.

In this series of 500 cases of each of the two categories, all being cases of tuberculosis uncomplicated by silicosis, the average length of service in the cases fit for repatriation was found to be 3 years and 10 months as compared with 2 years and 6 months in those dying on the mines.

This indicates an enhanced power in the longer-service cases to control their symptoms and to retain a certain measure of good health in spite of clinically evident tuberculosis.

It is also clear from this Table that the East Coast Native comes out better than the B.S.A. Native ; the average length of service amongst the former being about one and a half times that of the latter in the case of the repatriates, and about two and a half times in the fatal cases. That this apparent superiority of the East Coast Native is, however, mainly due to greater duration of service, has already been shown on pp. 137 and 138.

TABLE 37.

INVESTIGATIONS INTO SERVICE AND ORIGIN OF MINE NATIVE LABOURERS CERTIFIED TO BE SUFFERING FROM PULMONARY TUBERCULOSIS.

DECEASED.							REPATRIATED.						
Year.	District of Origin.	No. of Cases.	Total Service.		Average Service.		Year.	District of Origin.	No. of Cases.	Total Service		Average Service	
			Yrs.	Ms.	Yrs.	Ms.				Yrs.	Ms.	Yrs.	Ms.
1926	B.S.A. ...	81	154	2	1	10							
	East Coast ...	69	286	8	4	1							
	Total ...	150	440	10	2	11							
1927	B.S.A. ...	100	173	1	1	8	1927 (last month of) year)	B.S.A. ...	32	90	10	2	10
	East Coast ...	51	198	8	3	10		East Coast ...	33	126	3	3	9
	Total ...	151	371	9	2	5		Total ...	65	217	1	3	4
1928	B.S.A. ...	86	119	3	1	4	1928	B.S.A. ...	172	519	7	3	—
	East Coast ...	72	250	3	3	5		East Coast ...	233	1,084	8	4	7
	Total ...	158	369	6	2	4		Total ...	405	1,604	3	3	11
1929 (first 4 months of year)	B.S.A. ...	24	34	10	1	5	1929 (first month of year)	B.S.A. ...	15	39	10	2	7
	East Coast ...	17	53	3	3	1		East Coast ...	15	60	2	4	—
	Total ...	41	88	1	2	1		Total ...	30	100	—	3	4
Grand Total	B.S.A. ...	291	481	4	1	7	Grand Total	B.S.A. ...	219	650	3	2	11
	East Coast ...	209	788	10	3	9		East Coast ...	281	1,271	1	4	6
		500	1,270	2	2	6			500	1,921	4	3	10

CHAPTER V.—TUBERCULOSIS SURVEY OF THE NATIVE TERRITORIES.

1. INTRODUCTION.

The previous Chapter has dealt mainly with the manifestations of tuberculosis occurring amongst Native mine-workers on the Witwatersrand. Reference has been made in the introduction to the necessity of expanding the scope of the enquiry beyond a consideration of the problem of tuberculosis amongst this group of labourers, merely during their temporary sojourn on the gold mines of the Rand. The Committee deemed this to be essential, owing to the fact that there are no official statistical data concerning deaths and diseases in the Native Territories, consequently knowledge as to the position existing in regard to tuberculosis amongst the inhabitants has always been unsatisfactory. Such information as does exist is derived mainly from the experience of medical missionaries and practitioners long resident in these areas. The absence of ordinary vital statistics, however, represents but one aspect of our lack of data relating to tuberculosis. The degree of tuberculization of the population as expressed by their reaction to tuberculin was unknown and the type or types of the disease prevalent amongst them a matter of uncertainty.

It was thought that the problem of tuberculosis amongst the Native labourers on the gold mines could not be viewed in proper perspective unless some of the lacunae in our knowledge of the disease in their home areas were filled in.

It was realized, however, that in existing circumstances any effort in this direction would result in only partial success, particularly in view of the primitive state of social evolution of the Natives, and the absence of any adequate health organization or medical service amongst them. Despite these difficulties, it was decided to make an attempt, and a programme of enquiry was carried out by Dr. Peter Allan, Medical Superintendent of Nelspoort Tuberculosis Sanatorium. His seconding for this purpose by the Union Government to the Tuberculosis Research Committee for a period of three years has already been referred to.

The investigations comprised a general enquiry into the prevalence of tuberculosis amongst the Natives of these territories with particular reference to the ultimate fate of Native mine labourers who had been repatriated from the mines as a result of tuberculosis either contracted or discovered during their temporary employment on the Witwatersrand.

It was also sought to obtain information concerning the spread of tuberculosis by these repatriated Natives and their relation to familial infection. These investigations included a great number of clinical

examinations and the performance of numerous tuberculin tests. In addition to work of this nature, extensive enquiries were made concerning the dwellings, diet, habits and customs of these Natives, information being obtained by personal observation and also through the knowledge possessed by medical practitioners, missionaries and magistrates long resident in the territories.

The work involved in this survey was difficult and time-consuming out of all proportion to what might appear possible to any one unacquainted with the special circumstances surrounding this undertaking, such as the great distances to be traversed by motor car, often along primitive roads, many of which become almost impassable for this kind of transport in the rainy season, and the necessity for overcoming the perhaps natural suspicions of the Natives in order to secure their collaboration in the matter of clinical examinations and tuberculin testing. The situation was rendered the more embarrassing through the necessity of often having to conduct such negotiations through an interpreter. The tracing of Native repatriates was frequently troublesome, because they often change their names when going to work and in other cases a Native will assume another's name; moreover, they are sometimes careless and lose the discs and papers by which they are identified, so that in many instances it was found necessary to seek the assistance of a local trader or official in order to identify the individual. Not infrequently a long journey to some district undertaken to interview a repatriate was fruitless owing to his absence on a round of visits to other kraals, a custom very common amongst them. Despite these inherent difficulties, the continuous work carried out over a period of two and a half years has provided a great deal of useful and interesting information regarding tuberculosis in the Native Territories, a name which suffices in a general way to include both the Transkei and Ciskei.

The Transkei is, however, a territory with defined boundaries stretching N.E. from the Kei River to the Basutoland and Natal borders, whereas the Ciskei, with a population of less than one-third of the Transkeian, has no well-defined boundaries (see p. 198 and sketch map, Fig. 20, Pl. XVII).

This work was done for the most part in the Native Territories, but a certain amount of time was spent in studying the tuberculosis incidence in Natal, Zululand and Basutoland. The survey, though directed chiefly to the Natives living in rural locations, included also an investigation of the tuberculosis situation existing in a number of urban locations. To prevent any misconception, it should be realized that the term rural location signfies a large tract of country often relatively sparsely inhabited, whereas urban location denotes a limited site in a town, built over with houses and hutments in close contiguity.

The following short account of the Natives inhabiting these Territories will enable the reader to gather a general impression of the kind of community amongst whom these investigations were undertaken.

2. ORIGIN OF THE BANTU PEOPLE OF THE TERRITORIES.

The present Bantu inhabitants of the Transkeian Territories were not the original people of these parts. Very little is known of their origin. Theal[18] theorizes on their coming into North-eastern Africa at some period "not exceedingly remote" after Hamitic people had occupied the land from the valley of the Nile to the Atlantic, and from the Mediterranean to the Sahara Desert, and Negroes had spread along the southern border of the Desert. It seems likely that at some later period the forbears of the Bantu commenced migration from the western part of Africa near the Guinea coast.

As the tribes increased in numbers, divisions took place, and these sub-clans moved off. Inter-tribal fights occurred, and wars were waged against peoples of other origin, who were met with. The girls, and often the young boys, of the conquered were absorbed into the tribe, while the older members of the vanquished people were destroyed. Thus, differences in the constitution of the sub-tribes arose, as some had incorporated Asiatic, others Negro, and others Bushman elements.

The easiest line of advance was towards the south, where there were only the Bushmen to oppose them. At that time various lighter-coloured peoples of Asiatic origin had settled south-west of the Red Sea; Hottentots occupied land somewhere between the Gulf of Aden and Lake Tanganyika, while the remainder of Southern Africa was occupied by Bushmen, the aborigines of the Continent. The Bantu were very prolific and constantly encroached on fresh ground.

Due to their different lines of advance, and their absorption of conquered people of different types, the Bantu of to-day, although derived from one parent stem, can be divided into three groups, which vary considerably one from another.

The first group, apparently, came from West Africa, near the coast of Guinea, and moved south-eastward to the Congo basin, and later south-eastward to the eastern coast. In this group are the Bantu of the south-eastern coast, now living south of the Sabi River, although some of them have moved into the high lands of the interior. In this group are included the Xosa, the Tembu, the Pondo, the Baca, the Fingoes, the whole of the tribes of Natal, the Shangaans, and the Matabele. It is in this group principally that the present investigations into the incidence of tuberculosis in their own territories has been carried out.

The second group includes the tribes who at the beginning of the nineteenth century occupied the greater part of the interior plain north of latitude 29° S. and reached the ocean between the Zambesi and Sabi Rivers. This group includes the Batlapin, Barolong, Baroswi, Basuto, etc., and can be called the interior tribes. Investigations were carried out in Basutoland.

The third group is that living between the Kalahari Desert and the Atlantic, who may be termed the Western Coast tribes. They are a much more primitive people than those of the other groups and have much more of the Negro element.

The Natives who now inhabit the Transkeian territories belong to the eastern coastal group of the Bantu people. They are more accurately described as negroid than negro. Many of them are light brown in colour and have oval chins and well-cut features with well-formed noses and thin lips.

The principal tribes are the Xosa, Tembu, Pondo, Baca and Fingo. The Fingo are remains of tribes which were driven southwards in the destructive wars of Tshaka early in the nineteenth century, and who sought refuge with the Xosa. The other tribes all have their own chiefs, but the Fingoes have no chief. In many ways they are the most progressive of the Bantu people in the Transkei.

The Transkeian Territories extend from the Kei River on the south, the Indian Ocean on the east, to the borders of Natal, and the Drakensberg range of mountains. The altitude varies from sea-level to over 5,000 feet. The total area is 16,351 square miles, of which some 13,000 are Native locations. The Transkei is a very pleasant land, with grass-covered, rolling hills, intersected by deep valleys. There are not many indigenous trees now left, except in some of the more inaccessible valleys. Various rivers run through the land. The Umzimvubu at Port St. John is about three-quarters of a mile wide at the mouth.

Some of the scenery in the Transkei is magnificent. At Port St. John the cliffs rise sheer upwards, the other slopes are covered with luxuriant growth of indigenous trees and bushes, and from the heights one sees the Umzimvubu winding along between banks covered with banana plantations and gay with all the luxuriant growth of a sub-tropical climate.

Except along parts of the coast, the climate is temperate. The average annual rainfall is about 26 to 27 inches, except along the coast, where it is nearer 50 inches. About 70 to 80 per cent. of the rain falls during the summer months, so that in most parts the winters are clear and dry, with warm, sunny days and cold nights.

It is in such a pleasant land that the section of the Bantu with whom we are now dealing has come to settle after three centuries of wandering. These Natives are very prolific. They have been polygamists for as long as we know, and still continue the practice to a large extent. In the middle of the nineteenth century they were doubling their number in 25 years, but the rate of increase is now slower.

Plates XVIII and XIX (after p. 208) portray the characteristic facial features of the chief tribes represented on the mines. The clay models were executed by Captain R. H. van Ryneveld and are now in the possession of Mr. H. M. Taberer, to whom we are indebted for permission to reproduce them photographically in the Report.

3. CONDITIONS OF LIFE AT THE PRESENT TIME.

From their history we have seen that the Bantu were migratory for several centuries, but they were by no means nomads. They settled in one place perhaps for years, when their life was both pastoral and agricultural, but now that the Bantu have reached the barrier of European occupation their opportunities for migrating have ceased.

In the olden days, when there were always fresh woods and pasture-land, there was no incentive for the Bantu to make the most of their lands, and probably it is because of this that the Natives of to-day are so improvident. They have excellent lands in the Transkei, but they are not getting the full value out of them.

In 1927-28 two plots side by side in the Zimbane Location, Umtata, were selected. One plot was cultivated by up-to-date methods and the other by Native methods. The first plot yielded 12 bags of mealies (maize) to the acre, as against 3½ bags to the acre yielded by the second plot, showing that the land is capable of producing nearly four times the crop which is got when Native methods are employed.

Cattle have always represented the Bantu wealth. The breed and quality of the animal does not matter, one bovine being in the Natives' eyes as good as another—numbers only count. For this reason, the country is overstocked with many useless cattle. The milk yield of such animals is small in quantity and as they are not slaughtered for food they are not of much use to the Natives.

Fewer cows of reasonably good breed would be much more useful. Every effort is being made to remedy this state of affairs, but when dealing with a primitive people some considerable time must elapse before much improvement can be expected.

Owing again to the Natives' improvident habits, there has been much destruction of trees, and there are now very few indigenous trees left. Efforts are being made to establish plantations on a fairly extensive scale, and to conserve what remains of the natural forests. The game has been killed off, and except in bush in rather inaccessible places, there is very little left. The instinct to kill is very strongly developed in the Natives, and even the small boys, when out herding the cattle, are always on the look out for something to hunt.

Superstition and witchcraft have always played a large part in Native life.

Their religion was one of spirit influence, and the tribal priest* was possessed of very great power, as he was supposed to be in touch with the spirit of their ancestors. Any misfortune was supposed to be due to the anger of these ancestral spirits, or to the machinations of some living wizard. If the priest declared that the former was the cause, the ancestral spirits were appeased by sacrifices, and if the latter, the sorcerer was "smelled out" and killed. No punishment or torture was considered too excessive for those accused of malignant sorcery.

* The term "priest" is used here, not as one equivalent to a "clergyman," but as indicative of an individual, usually a sorcerer or witch-doctor, who professes to be able to communicate with the spirits of the departed.

As an example of the power of the tribal priest, on an occasion which largely affected the history of the Transkei, there is the case of the destruction of all their cattle and grain by the Xosa in 1846 and 1847. The priest prevailed on this tribe to slaughter their cattle and destroy their grain, as he declared that when this was done, the spirits of the ancestors would return in full glory and drive the White man into the sea. Numerous deaths from starvation followed this mad act, and the power and vigour of the tribe was broken.

Missionary work and education have done much to bring enlightenment to the Natives, but even to-day many of them still cling to their old beliefs. At the 1921 census over 60 per cent. of the Natives were stated to be heathen.

Administration.

In the olden days the tribes were centred round the chiefs. The various members of the tribe were merely units or chattels, at the command of the chief, and the well-being of the tribe was given first consideration. There was never any attempt to fuse the various independent tribes into one nation, and each tribe lived its own life and took its own course, without any intercourse with the other tribes.

In some cases there were various sub-clans owning allegiance to one paramount chief, but except when war or some common danger threatened, the sub-clans were separate units.

Under such a system the government of a tribe varied with the character of the chief. In some cases it was pure despotism, such as occurred under Tshaka, paramount chief of the Zulus, in the early years of the nineteenth century.

The annexation of the Transkeian Territories by the old Cape Government commenced in 1877 with Fingoland and ended with Pondoland in 1894, and these territories to-day are virtually a large Native reserve under one single administration. It was soon realized that these primitive people did not understand the laws of the White man, so that only suitable laws were enforced. Since the union of the various provinces in 1910, the laws of the Union apply to the Territories, except when they are specially exempted.

The Governor assumed the legislative function of the various paramount chiefs. The social status of the chiefs was recognized, and they were consulted on all matters of importance, while the Government paid them substantial salaries. The petty chiefs were made headmen, and were also paid salaries. They were vested with a certain amount of authority and were responsible to the various magistrates.

There is a system of administration in the Transkei in which the Natives are represented on General and District Councils, which were instituted by Mr. Cecil Rhodes. A district council consists of the Resident Magistrate and six Native members, four of whom are elected by the Natives, and two are nominated by the Governor-General. From each of these district councils three members are elected to the

General Council or "Bunga." The General Council is presided over by the Chief Magistrate, and consists of the various resident magistrates from each district and the elected Native members. Neither the General nor District Council is executive, but acts as adviser to the Administration.

Generally speaking, it may be said that the administration of the Transkeian Territories has been carried out in such a way that there has been no sudden or drastic change from Native custom, and has been much more evolutionary than revolutionary.

Native Taxation.

Under Act 41 of 1925, the following is the scheme of Native Taxation :—

Each adult male over the age of 18 years is subject to a tax of £1 per annum. Exemptions are made in the cases of men who are physically unfit to work, Natives attending educational institutions who are not yet at a wage-earning stage, and Natives who pay income tax of £1 or over.

The money from this tax goes to the Union Government. One-fifth of the total is returned to what is known as the "Native Development Fund," and is expended mostly on education.

Taxes which are dealt with through the General Council.

(1) *Surveyed Lands.*—(*a*) Quit-rent of 3s. per morgen (approximately two acres) per annum. This averages out at about 15s. per landowner. (*b*) 2s. 6d. per annum for a building site of half a morgen in extent.

(2) *Unsurveyed Lands.*—A hut tax of 10s. for every hut, according to the number of wives, not exceeding four, for whom the taxpayer is responsible.

Land Tenure.

In the olden days the chief of the tribe allocated the land. Experiments on a large scale were carried out in the Ciskei, by way of making individual grants of land to Natives in locations. This proved a failure and in 1894 the "Glen Grey Act" of Cecil Rhodes first reduced the grant of small arable lots to Natives on a quit-rent tenure to a manageable system.

In 1898 this system was extended to the Transkeian Territories.

The titles provide for forfeiture on certain conditions, one of which is failure to pay quit-rent for two years. Succession is based on the Native laws of succession, and transfer other than to an heir is subject to the approval of the Chief Magistrate. The titles are kept in a registry at the office of the Chief Magistrate, and records are kept of transfers, re-allotments, forfeitures, etc. Thus there has been evolved a system where the original tribal communal tenure of land has been reduced to one of individual ownership.

Native Housing.

In the olden days, the huts of the Natives are described as of beehive shape, made of strong poles and thatched with grass. This type of hut is still largely used by the Zulus, but very few are to be seen in the Transkei.

The Native builds his huts on the ridges, where there is always plenty of air, good drainage and consequently little underground dampness. This is important, as the Natives sleep on mats on the floor. The huts are scattered along the ridges and are not in villages.

The slopes of the hills and the valleys are used as the lands for growing mealies, kafir-corn (millet or sorghum), pumpkins, beans, etc. There is usually a little patch near the huts where tobacco is grown.

The cattle-kraal is in close proximity to the huts. The well-to-do Native has usually three circular huts. The living hut is about 18 feet in diameter, a smaller hut is used as a kitchen and storeroom, and the third hut is used as a store for implements.

Hut Construction.

There are two main types of hut-construction :—

(1) *Wattle and Daub.*—In this type a basket framework is made of woven boughs, and this is plastered inside and outside with a mixture of mud and cowdung. The average thickness of the wall is about six inches. The door is about two feet three inches wide and about five feet five inches high, and in many huts the door is made of basket-work. In most of these huts there are no windows, but in some an opening in the basket framework about nine inches by six inches may be left.

Some of these huts approximate to the beehive type, and the upper part is thatched with straw, but in the majority the walls are perpendicular.

(2) *Sods.*—In the other type of hut the walls are perpendicular and are built of sods. The walls are usually about 15 inches thick, but may be over two feet in thickness.

In this type of hut windows usually about one foot square are provided. In some of the more advanced, windows with glass frames of the casement type are fitted. In others, a pivoted wooden shutter is fitted on the window whilst in many huts the opening is left open, but is usually stuffed up with old sacking.

Many huts, however, have no opening, except the door, which in the sod hut may be about five feet ten inches in height. The door faces in a north-easterly direction. The huts are circular, as the Native is most adept in constructing a circular dwelling. When there are openings or windows, they are never opposite the door, but a quarter-way round from the door on each side.

Roof Construction.

There are two main types of roof construction :—

(1) A squat dome of woven basket-work, thatched with grass about six inches thick, and projecting about six or eight inches over the eaves. The roof is supported by poles in the interior of the hut.

(2) The rondavel type of hut, *i.e.*, a circular hut with vertical walls and a conical roof, which may have one supporting pole, but often none at all. The basis of this roof is more substantial, and is made of poles radiating from the centre with interlaced cross-pieces. The roof has a pitch of one in three, and is thatched with grass.

The height of the wall is about seven feet from the ground. In the squat-dome type, the roof in the centre is about nine or ten feet from the ground.

The floors are made of beaten earth, later smeared with cowdung. This cowdung becomes hard and gives a fairly good surface, and the smearing is carried out periodically, usually about once a week.

A fireplace or hearth is built in the centre of the hut by making a raised rim on the floor about two or three inches high. The hearth is usually about two feet to two feet six inches in diameter. No outlet for the smoke is provided, so that the inner surface of the roof soon becomes all blackened with soot.

The Natives usually occupy their huts only at night, or during the day in inclement weather, and except for those who are occupied with cooking, they spend all the daylight hours in the open air.

The huts, in many cases, are heavily infested with bed-bugs.

The number of persons occupying a hut is usually about five or six, so that the average air space is probably about 300 to 400 cubic feet per person.

The Natives sleep on grass mats, which are woven by the women. A fire is kept burning all night—cowdung or wood being used for fuel—and the resulting smoke is most irritating, so that it is often impossible to stand up in a hut with any degree of comfort. The Natives, therefore, squat or lie on the floor. In rainy weather when wet wood is used the smoke is particularly irritant.

For illustration of huts see Plates XX to XXIV (after p. 208).

Dress of the Natives.

Many of the young boys, up to the age of nine or ten years, wear no clothing whatever. Small girls usually have only a short apron of beadwork.

Now that it is difficult to procure skins of animals, the typical dress of the Native is a blanket. The men wear a blanket looped picturesquely over one shoulder. The women make a long skirt of one blanket, and cover their shoulders with another. In the case of married women a little band of cloth covers the breasts.

The blankets are smeared with fat and red-ochre, and the women have patterns in either small white buttons or black braid, on their skirts. The blankets used in the Transkei are mostly of cotton and cost about 20s. to 30s. each.

Many Natives wear odd pieces of European clothing. The small boys may be clothed in a shirt, and many of the men wear a pair of trousers in addition to the blanket. It is very difficult to give the

actual ratio of those who have absolutely discarded Native dress and taken to European clothing, but the general consensus of opinion of officials, who see all types of Natives, is that about 25 per cent. of the Natives of the Transkei now wear European dress.

Dietary of the Natives.

Millet or kafir-corn is indigenous to the country and was one of the main foodstuffs in olden days. It is still used to a certain extent, mainly, however, in the making of Kafir beer, but maize (mealies) now forms the staple food of the Natives of the Transkei. There seems considerable doubt as to the date when maize was introduced. The first mention of its use as a Native food as recorded by Theal[66] is attributed to the survivors of the " Nossa Senhora de Belem " in 1633.

A man will eat about 4lb. of mealies a day, with the addition of beans, pumpkins or sour milk (*amasi*).

The mealies are prepared in various ways :—(*a*) Ground on a hollow stone with a smaller stone, into a coarse meal ; (*b*) stamped or roughly ground in a mortar hollowed out of a log of wood ; (*c*) roasted on the cob.

Two meals a day is the general rule, a breakfast of mealie-meal porridge in the morning, with perhaps coffee and sugar when available. (In some cases the meal is allowed to ferment before being made into porridge.)

The second meal is in the evening and consists of boiled stamped mealies, with the addition of beans or pumpkins and fat, if available. Sometimes sour milk is added to the boiled mealies. Sour milk is drunk. A calabash is kept for this milk, and as its contents are used fresh milk is added, a little of the original sour milk being left to start fermentation. Milk of the cow, goat and ewe is used.

Boiled ground maize is called *umpotulo*, and when this is mixed with sour milk it is called *umvubo*, a dish which is much enjoyed by the Natives.

Two kinds of drink are made by the Natives :—(1) *Marewu*, which is made from fermented mealie-meal, and is a light, sour drink ; (2) *Kafir-beer*, made from millet, or Kafir-corn, which can be made a highly intoxicating liquor.

Meat does not form a staple part of the average Native's daily diet, and at the present day most Natives do not eat meat oftener than once in two weeks. When meat is available the Native will eat several pounds of it at one sitting.

In most of the ceremonials meat is provided, such as at weddings, circumcision rites, etc., or on the occasion of visits of persons of importance. The type of animal to be killed varies ; for instance, at the circumcision ceremony a sheep must not be killed, but an ox or a goat must be slaughtered.

The Natives until recent years did not eat pork, but many of them do so now.

Kafir-beer is usually brewed at several huts in the location, and when a beer-drink is in progress the Natives go from place to place as the supply finishes. This may last for a week, during which time very little food is eaten, and at the end of the orgy the Natives have a great craving for meat.

In addition to beans and ripe pumpkins, the young shoots of the pumpkin are eaten. The bitter melon and various wild herbs called *imifino* are also used. The term "imifino" includes most of the weeds which grow in cultivated gardens, and certain wild plants are also eaten. To some of these are ascribed certain medicinal properties; one, for instance, is eaten by women during pregnancy to ensure easy labour.

The Natives are very fond of sugar and eat a wild sugar-cane, *imfe*, when available. The fruit and leaves of the *msobosobo* plant, which has little black berries, and prickly pears, also serve to satisfy the craving for sugar.

Sour milk and beer are very important articles of diet and are universally used. The raw Native grows practically all his own foodstuffs, but the more educated Native is using in addition boer meal (a whole meal) and white flour for bread-making.

White flour is freely used by both classes of Natives for assisting the fermentation of marewu.

The educated Native eats much the same as the raw Native, but instead of two meals a day he often has three. His breakfast consists of mealie-meal porridge with fresh milk and sugar, bread, tea or coffee with milk and sweetened with plenty of sugar. He buys meat when he can afford it. As he does not attend the heathen ceremonies, he probably gets less meat than the raw Native.

Beer and marewu are taken all the year round and are regarded as foodstuffs. Milk is usually consumed in a sour state, except that the breast-feeding of young babies may be supplemented with fresh milk. As soon, however, as the child can crawl, it is given sour milk. Butter and cheese-making are unknown arts to the Native.

The Natives are acquiring a taste for curries, and use curry powder freely with meat. Most of them do not eat eggs.

The water supply is got from various streams and springs. The women carry the water in pots or cans on their heads. The Natives do not take any precautions to safeguard the water supply, and allow the cattle to trample the ground all round the water-sources.

Except in times of very severe drought, or other calamity affecting the whole community, the Natives never reach a state of actual starvation, and the poorer members are helped by their more fortunate neighbours. Some Natives do undoubtedly have a limited food supply, and their supply of milk is, at times, very small.

In times of drought, such as occurred in the Ciskei in 1927 and 1928, many Natives were in dire straits, and were saved by the issue of rations by the Government and from private sources.

The seasonal diet for a year is as follows :—

About the beginning of March green mealies are available and from early March till about the end of May the diet consists of freshly-picked mealies, together with pitted mealies and dry beans, also young pumpkin shoots and wild herbs. Milk at this season is plentiful and is freely partaken of in a sour state by all ; the calabash is available to all members of the family, as they wish.

Umvubo is much eaten at this time, and the mealies are also eaten on the cob, either roasted or boiled. When the pumpkins are ripe they are cooked with the ground or whole mealies. Some pumpkins are cut into slices, and dried on the roofs of the huts and used as a winter vegetable.

The harvest is usually about the end of May, when Kafir-corn is ready for reaping and umvubo and Kafir beer are made. As the winter approaches the milk supply diminishes. Mealies are reaped usually from early June till some time in July and are stored in the huts until thoroughly dried.

In August milk is very scarce and marewu is used as a beverage to a great extent. Beans are mixed with the mealies in cooking.

When the mealies on the cob have become sufficiently dry, the grains are beaten off the cobs with sticks, but some mealies are kept on the cob and hung up in the hut to serve as seed for the next year's sowing.

About November weavils are apt to appear in the mealies, so after keeping back sufficient for the needs of the near future, the mealies are pitted. The pit is usually situated in the cattle kraal. The mouth of the pit is about two feet in diameter, and is covered by a flat stone. Pits are made to hold anything up to 20 bags, *i.e.*, about 4,000lb. weight of mealies, so that such pits are of a good size but with a narrow opening. Any mealies left over from the previous season are cleared out before the new season's crop is put into the pit. Pitted mealies lose the power of fermentation and have a rather acrid odour, but from December to March this is the staple food of the Native, and they are also used to supplement green mealies when the young crop is ripening.

After the summer rains, grazing improves, so milk again becomes more plentiful.

Education of Natives in the Transkei.

Mission stations have been established in various parts of the Transkei for just over 100 years, and much has been done by the missionaries to educate and enlighten the Native, although the average Transkeian Native is still very primitive. He has very little inventive power and many of his methods and implements are still those of his forefathers.

Native education is now financed out of the Native Development Account which was created under Act 41 of 1925. Previous to that, the Provincial Council was responsible for financing Native education, and was assisted by grants from the Transkeian Territories General Council.

The following data are extracts from the Report of the Superintendent-General of Education for 1927 and 1928 :—

In 1928 there were 1,108 schools in the Transkei for the education of Natives, and 550 in the remainder of the Cape Province, grouped as follows :—

	Transkei.	Cape Province, excluding Transkei.
Training Schools	9	6
Secondary Schools	2	4
Industrial Schools	8	5
Mission Schools	1,089	535
	1,108	550

It is claimed that there is a demand for further schools, but finances do not permit of an increase at the present time.

The total number of pupils attending these schools in 1928 was 78,131, as against 76,770 in 1926.

Mode of Life of the Natives.

The men usually do the ploughing, but the weeding and cultivation is left to the women and children. The young boys act as cattle-herds and shepherds.

Large numbers of Natives are constantly absent from the Territories working for various periods elsewhere in the Union of South Africa.

In the Umtata area, which includes Butterworth, Idutywa, Nqamakwe, Willowvale, Umtata, Libode, Mqanduli, Ngqeleni, St. John's, Tsolo, Qumbu, Maclear and Elliotdale, in 1927, there were 141,903 general tax-payers, of whom 39,572 got travelling passes to go out to work on the gold mines.

Thus, in 1927, from the Umtata area as a whole, some 27 per cent. of the males over 18 years of age went away to work, and of these 27 per cent., 72·8 per cent. went to the gold mines. The latter proportion varied in different districts; for instance, in the Ngqeleni district 95·57 per cent. went to the gold mines, and in the Butterworth district only 57·58 per cent.

In 1928, from the Umtata area, 38,961, of whom 75·22 per cent. went to the gold mines, went out to work out of a total number of 144,220 general tax-payers.

Thus, in each year there are roughly some 27 per cent. of the adult male population away at work. There is not very much for the remaining 73 per cent. to do at home. A considerable number have work as teachers, store boys, clerks, etc., but the vast proportion are not employed, and lead a very easy life. They spend their time in gossiping, and often attend beer-drinks, although the educated Natives do not usually participate in these.

It must not be implied that the Natives are in a continual state of drunkenness. Although one comes across a beer-drink almost daily in travelling through the Native Territories, probably only small sections are attending a drink at any one time. And although some people do get drunk, the beer-drinks are more or less social functions, corresponding to tea-parties in more civilized communities.

Then there are various ceremonies which help to while away the time, for instance, the circumcision rites.

The actual ceremony at which the operation is performed is preceded by a period—sometimes as long as six months—during which the young Natives of 17 to 18 years of age are housed in beehive-shaped grass huts and are fed upon the best food available. Instruction is given by the men, as this is the initiation into manhood.

During the time that the boys are in the instruction state, they appear at various dances. At these dances the boys wear a short skirt, or kilt, of grass about three or four inches thick. Their faces are covered by a mask made of grass with two long pieces like antennae sticking up. Their bodies are painted white and picked out with spots of colour about the size of a shilling. Some have blue spots, others red or purple, and the general effect is very picturesque. These dances are attended by many Natives.

The music is supplied by a number of women who hold an outstretched ox-hide and beat time on it with sticks. Other women, as at the circumcision ceremony itself, thread their way through the crowd all the time uttering shrill cries like yodelling. Beer and meat are supplied.

The usual Native dance consists of the men forming a circle and stamping on the ground while they intone a monotonous sort of chant. The women do a similar dance, but men and women do not mix in their dancing.

The Natives lead a very happy, rather happy-go-lucky, sort of existence. They can grow most of their own foodstuffs and most of them have not yet learned the value of money. With a mass of people such as the Transkeian Natives, manners and customs alter slowly.

Urban Areas in the Transkei.

In each district there is a village bearing the same name as the district. The village is the seat of the magistracy. The doctors, lawyers and some traders live in these villages, none of which are large. Umtata is the largest town in the Transkei and is the seat of the Chief Magistrate.

Economics of the Transkeian Natives.

From old records we learn that several centuries ago the Bantu were both a pastoral and an agricultural people. They are still so to-day, but, owing to changing conditions, agriculture, although still in a large part very primitive, has come more to the fore.

Their cattle are economically of little use to them but represent to them wealth. The milk supply is much smaller than it should be. The Natives do not attempt to winter-feed the cattle, so that to a large degree the milk supply is seasonal. They do not slaughter the cattle for meat and rather than sell cattle to a trader they will borrow money and leave the cattle as security.

There are some 600 trading stations in the Transkeian Territories. Before the annexation of these territories, European traders used to get land and permission to trade from the Native chiefs. Now licences are issued by the Chief Magistrate. Trading sites, five morgen in extent, are granted by the Government, and no new site or licence to trade in a location is granted for a station within five miles of an existing station. This may seem like giving one man a monopoly, but the Natives readily go to the next station if dissatisfied.

The Natives do not buy or sell in bulk, but sell or buy a sixpence or a shillingsworth of Kafir-corn or maize. They will often sell just sufficient to purchase some little thing they want at the trader's store.

The return of pastoral products shown as purchased by the traders does not tally with the return of wool and mohair shorn as shown in the Native agricultural census, as the Native does not usually sell his wool immediately. Tobacco is grown by most Natives. They are inveterate smokers, both men and women, and use long wooden pipes made by themselves.

Without a thorough economic survey, it is impossible to give accurate figures regarding Native economics. Their production of foodstuffs is not consistent, and depends largely on seasonal variations.

From a consideration of the 1926-27 Native agricultural census figures for certain districts of the Transkei wherein resided more than 100,000 tax-payers it would appear that their agricultural produce, after deducting the foodstuffs used by the Natives, yields only between £2 and £3 per tax-payer per annum. From this he has to pay taxes, to buy blankets, imported foodstuffs, ornaments, implements, etc., so that it is evident that the Native cannot come out on his profits from farming operations.

Then there is the system of "lobola," the giving of cattle to the father of the girl the Native marries. From five to ten cattle are usually given. Thus, the average Native young man has to find the means of getting these cattle. The opportunities of acquiring them by raids do not now exist, so that work is the only means of getting the necessary cattle to secure a bride.

The bulk of this necessary work is spent in employment in the mining industry. In a report of the ".Bunga" Meeting, 1930, it is stated that "without these earnings at the gold mines and other labour centres, it would not be possible for the people of the Territories to discharge their obligations either to the State or private enterprise."

In 1921 the average number of non-Europeans employed on mines and in allied concerns was 258,175 and their total money wages for that year was £7,554,670, that is, approximately £28 per head for the year.

Say the average mine Native earns £25 a year over and above his feeding and housing. Then, in 1927, for the districts under review, 39,572 men earned £989,300, which, if equally divided amongst the tax-payers, would be approximately £7 per head. To this must be added £2 10s. 0d. per head average from agricultural and pastoral products. Then a certain number of Natives are employed in their own Territories, some getting as much as £10 10s. 0d. a month.

Thus, the adult male Native has probably an average of £10 a year to pay his taxes, buy clothing and other necessaries, and spend or save the rest. There are approximately 295,000 tax-payers in the Transkei.

In addition to the Transkei, there is the large Native area of the Ciskei. The Ciskei proper is the country immediately south of the Kei River and includes Peddie, Alice, Kingwilliamstown, Keiskamahoek, Cathcart, Queenstown, Sterkstroom and Stutterheim. From the point of view of Native administration, the Ciskei is all the territory bordering the Transkei. Crossing the Kei gorge and going northwards are Molteno, Barkly East, Aliwal North and Herschel, forming the western boundary of the Transkei. The Native population of the Ciskei in 1921 was 399,677.

The conditions of life in the Ciskei are much the same as in the Transkei. During the past few years large areas of the Ciskei have experienced very severe droughts, so that the Natives have been worse off than the Transkeian Natives.

Medical Services for Natives.

Most of the Natives when ill never see a qualified medical man. They cannot afford to call one for a case of prolonged illness, and even in cases of acute illness, as many of them live in inaccessible places, the cost of a visit from a European doctor would be too high for their resources. There is a great need for some form of medical service in the Transkei.

4. Distribution of Tuberculosis as Indicated by Tuberculin Tests.

Dr. Allan carried out his survey by the tuberculin test in three stages :—

(1) The southerly part or Butterworth area.
(2) The central part—Pondoland, or the Lusikisiki area.
(3) The northern part—Basutoland and the Matatiele area.

In so far as possible, Dr. Allan conducted separate investigations in each area on—

(1) Natives in kraals.
(2) Natives in institutions.
(3) Natives in locations.

All Dr. Allan's tuberculin tests were performed by the intra-dermal method, using one-tenth of 1c.c. of 1/5,000 of Koch's "old tuberculin." The same tuberculin was used by Dr. Allan as was used for the tests on mine boys applying for work on the Witwatersrand goldfield. A considerable proportion of the tests on the Rand were performed with much higher dilutions than 1/5,000, hence the lower percentage of positive reactions on the Rand as compared with the male adults from the southern and central sections of Dr. Allan's survey.

Tuberculin tests in the Southern Area.

The first series to be considered are the tests performed on Natives living in the southern portion of the Transkei, an inland area between the Kei and Bashee Rivers with Butterworth as its administrative centre. The results secured are given in Table 38.

TABLE 38.

TUBERCULIN TESTS IN THE SOUTHERN AREA (KRAALS).

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female Positive.	Total Positive.
Under 5 years	165	73	92	27 or 36·9%	34 or 36·9%	36·9%
5 to 10 years	486	180	306	97 or 53·9%	194 or 63·4%	59·8%
10 to 15 years	610	164	446	113 or 68·9%	324 or 72·6%	71·6%
15 to 20 years	278	90	188	71 or 78·8%	156 or 82·9%	81%
20 to 25 years	85	17	68	17 or 100%	62 or 91%	93%
Over 25 years	657	268	389	241 or 90%	352 or 90%	90%
All Ages	2,281	792	1,489	566 or 71%	1,122 or 75%	74%

Over the age of 20 years, both sexes yield 90·5 per cent. of positive reactions.

The institutions in the southern area are, with one exception, in the Ciskei and not in the Transkei. Opportunity for making tests was afforded by the kind permission of the Rev. Dr. Henderson and Dr. Macvicar at Lovedale, near Alice; of the Rev. A. A. Wellington at Healdtown, near Fort Beaufort, and of Principal Kerr at the Native University College at Fort Hare. The Rev. D. P. Davies arranged for tests on girls attending the domestic science course at Butterworth.

The results secured are given in Table 39, where the series of four tests on Natives attending educational institutions is summarized.

TABLE 39.

TUBERCULIN TESTS IN THE SOUTHERN AREA (INSTITUTIONS).

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female Positive.	Total Positive.
Under 10 years ...	174	77	97	37 or 48%	56 or 58%	53%
10 to 15 years ...	256	112	144	73 or 60%	107 or 74%	70%
15 to 20 years ...	766	384	382	306 or 80%	316 or 83%	81%
Over 20 years ...	322	265	57	222 or 84%	50 or 88%	84·5%
All Ages ...	1,518	838	680	638 or 76%	529 or 78%	77%

There are locations round the mission stations at Lovedale and at Healdtown. The small number of tests performed at these locations are given in Table 40.

TABLE 40.

TUBERCULIN TESTS IN THE SOUTHERN AREA (LOCATIONS).

Age in Years.	Total No. Tested.	Male.	Female.	*Male* Positive.	*Female* Positive.	*Total* Positive.
Under 5 years ...	21	6	15	1 or 16 %	4 or 26%	24%
5 to 10 years ...	17	7	10	3 or 43 %	6 or 60%	53%
10 to 15 years ...	9	7	2	4 or 57 %	2 or 100%	66%
15 to 20 years ...	4	—	4	—	3 or 75%	75%
20 to 25 years ...	7	1	6	1 or 100 %	5 or 83%	86%
Over 25 years ...	76	34	42	31 or 91 %	41 or 98%	95%
All Ages ...	134	55	79	40 or 73 %	61 or 77%	75%

Dealing with the cases recorded in those three Tables, Dr. Allan points out that while the proportion of positive reactors in the two sexes is fairly equal below the age of 5 years and above the age of 15 years, *there is considerable divergence between the ages of 5 and 15.* Summarizing location and institution figures for this period, we get 547 boys with 59·5 per cent. positive reactions, and 1,005 girls with 68·5 per cent. positive reactions. Dr. Allan points out that it is at this period that girls are much more confined to the huts than are the boys, and suggests that tuberculization takes place to a certain extent in the huts.

Dr. Macvicar, of Lovedale, has been so good as to supply the following information to Dr. Allan: "In 1913 tuberculosis gave rise to grave anxiety at Lovedale and, at this period, 92 pupils yielded 62 per cent.

of positive reactors to the Von Pirquet test by scarification. Since then the buildings have been reconditioned and the cubic feet of air-space allowed in the dormitories raised from 300 cubic feet per individual to 500 cubic feet per individual. It is rare now to find a case of tuberculosis among the pupils at Lovedale. In 1928 a tuberculin test on 788 pupils showed 77 per cent. of positive reactors. This experience of Dr. Macvicar's at Lovedale may be compared with Dr. Dunstan's experience with the older mental hospitals quoted in Appendix 3.

Tuberculin Tests in the Lusikisiki Area.

Crossing the Bashee River and going north, one comes first to the Tembuland and then to the Pondoland section of the Transkei with its long sea-coast. Dr. Allan worked round Flagstaff and Holy Cross Mission. Tests were carried out at Holy Cross Mission School, locations near the mission station and in the kraals.

TABLE 41.

TUBERCULIN TESTS IN THE FLAGSTAFF AREA (KRAALS).

Age in Years.	Total No. Tested.	Number Positive.
Under 10 years	71	42 or 59%
10 to 15 years	36	28 or 78%
15 to 20 years	7	7 or 100%
Over 20 years	69	67 or 97%
All Ages	183	144 or 78·5%

TABLE 42.

TUBERCULIN TESTS IN THE FLAGSTAFF AREA (INSTITUTIONS).

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female Positive.	Total Positive.
Under 10 years ...	18	12	6	8 or 66·5%	5 or 83%	72%
10 to 15 years ...	57	26	31	21 or 81%	25 or 81%	81%
15 to 20 years ...	47	18	29	15 or 84%	28 or 96%	91·5%
Over 20 years ...	8	6	2	6 or 100%	2 or 100·5%	100%
All Ages ...	130	62	68	50 or 80%	60 or 88%	84·5%

TABLE 43.

TUBERCULIN TESTS IN FLAGSTAFF AREA (LOCATIONS).

Age in Years.	Total No. Tested.	Number Positive.
Under 10 years	48	25 or 52%
10 to 15 years	21	20 or 95%
15 to 20 years	12	12 or 100%
Over 20 years	64	59 or 92%
All Ages	145	136 or 94%

In addition to the three series just tabulated, amounting to 458 tests in all, an additional 55 tests were performed on children attending school, hospital attendants and the general population, bringing the total number of tests carried out on Natives in Pondoland up to 513. The results are summarized in Table 44.

TABLE 44.

TUBERCULIN TESTS IN THE FLAGSTAFF AREA (TOTAL FOR PONDOLAND).

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female Positive.	Total Positive.
Under 10 years ...	146	72	74	50 or 69%	35 or 47%	59%
10 to 15 years ...	134	60	74	50 or 83%	61 or 82%	83%
15 to 20 years ...	*62	22	40	21 or 95·5%	39 or 97·5%	97%
Over 20 years ...	171	61	110	58 or 95%	104 or 94·5%	94·5%
All Ages ...	513	215	298	179 or 83%	239 or 80%	81·5%

* As given in original script.

Dr. Allan took the opportunity of making tuberculin tests in "Coloured" families, among whom tuberculosis had occurred and in Coloured families among whom no cases of tuberculosis were known. The tuberculous families yielded 81 per cent. of positive reactions in 69 persons tested, while the non-tuberculous families yielded 57 per cent. of positive reactions in 82 persons tested.

Tuberculin Tests in the Matatiele Area.

The next survey deals with the most northerly part of the Transkei proper, with Matatiele as administrative centre. This district borders on Basutoland to the north and is inhabited by Basuto and Xosa. Three Native villages or kraals were studied. The results secured are given in Table 45.

TABLE 45.

TUBERCULIN TESTS IN THE MATATIELE AREA (KRAALS.)

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female. Positive.	Total Positive.
Under 5 years ...	120	48	72	5 or 10·5%	6 or 8·5%	9%
5 to 10 years ...	261	115	146	25 or 21·5%	40 or 27·5%	25%
10 to 15 years ...	279	98	181	30 or 30·5%	67 or 37%	34·5%
15 to 20 years ...	149	50	99	14 or 28%	47 or 47·5%	38·5%
Over 20 years ...	402	108	294	75 or 69 5%	174 or 59%	62%
All Ages ...	1,211	419	792	149 or 31%	334 or 42%	40%

Tuberculin Tests in Basutoland.

The last survey to be considered is that of Basutoland. Dr. Allan carried out two series of tests—one in kraals and one in institutions. The result of the institution tests are given in Table 46.

TABLE 46.

TUBERCULIN TESTS IN BASUTOLAND (INSTITUTIONS).

Age in Years.	Total No. Tested.	Male.	Female.	Male Positive.	Female Positive.	Total Positive.
Under 10 years ...	12	7	5	1 or 14·5%	3 or 60%	33%
10 to 15 years ...	96	48	48	18 or 37·5%	18 or 37·5%	37·5%
15 to 20 years ...	226	162	64	80 or 49 5%	41 or 68·3%	53·5%
Over 20 years ...	103	100	3	58 or 58%	1 or 33%	57%
All Ages ...	437	317	120	157 or 50%	63 or 52·5%	50%

The tests in the kraals are given in Table 47.

TABLE 47.

TUBERCULIN TESTS IN BASUTOLAND (KRAALS).

Age in Years.	Total No. Tested.	Male.	Female.	Male. Positive.	Female. Positive.	Total Positive.
Under 10 years ...	87	40	47	4 or 10%	4 or 8·5%	9%
10 to 15 years ...	66	22	44	5 or 22·5%	15 or 34%	30%
15 to 20 years ...	46	11	35	5 or 45·5%	18 or 51·5%	50%
Over 20 years ...	215	79	136	64 or 81%	93 or 68·5%	73%
All Ages ...	414	152	262	78 or 51%	130 or 50%	50%

Dr. Allan notes that between the ages 10 years to 20 years there are a higher proportion of positive reactors among the females than among the males but that after the age of 20 the positive is reversed, presumably owing to the adult males leaving their kraals for work. This last suggestion is borne out by the much higher proportion of positive reactors in kraal male adults who leave Basutoland for work than is found in institution male adults who stay at home.

Basutoland being a mountainous district with a different group of the Bantu people living above 5,000 feet to that living at lower altitudes, a grouping of the results of the tuberculin tests has been made in terms of different altitudes of residence. The results secured are given in Table 48. The coastal districts' positive reaction-rates run high, while in the mountainous districts they run low. The low rate found for the latter group is, presumably, related to isolation.

For comparative purposes surveys were made of locations on two of the mine properties on the Witwatersrand. Married Native mine boys live in these locations and tuberculin tests were performed on such of their women and children as volunteered. In the one location 109 women yielded 88 per cent. of positive reactors and 133 children under the age of 15 years yielded 55 per cent. of positive reactors. In the other location 139 women yielded 57 per cent. positive reactors and 206 children under the age of 15 years yielded 27 per cent. of positive reactors.

Dr. Allan notes that the location with low tuberculization drew over 57 per cent. of its inhabitants from Sutu (Basuto) tribes, while the location with high tuberculization drew only 18 per cent. of its inhabitants from Sutu tribes. There may be some relation between these findings on the Reef and the comparatively low tuberculization of the Sutu in their own territories. Dr. Allan notes, too, that the location with low tuberculization was much to be preferred as a residence to the location with high tuberculization.

If the total number of tests performed in the Territories be taken together, the following return is yielded for all ages and both sexes :—

Total Number Tested	6,508
Male	2,788
Female	3,720
Males, Positive	1,849 or 66 per cent.
Females, Positive	2,478 or 66 per cent.
Total, Positive	4,327 or 66 per cent.

If the above summary be given in a little more detail, an interesting feature is brought out (Table 49).

TABLE 48.

RESULTS OF INTRA-DERMAL TUBERCULIN TESTS ON SOUTH AFRICAN NATIVES LIVING AT DIFFERENT ALTITUDES.

Age Groups in Years.	Coastal Belt.			Altitude 1,700–2,000 feet.			Over 5,000 feet, Matatiele.			Over 5,000 feet, Basutoland.		
	Male. % +	Female. % +	Both Sexes. % +	Male. % +	Female. % +	Both Sexes. % +	Male. % +	Female. % +	Both Sexes. % +	Male. % +	Female. % +	Both Sexes. % +
Under 5	69·4	47·3	58·9	35·2	35·5	35 4	10·4	8·3	9·1	10·6	13·4	12·1
5 under 10				51 8	61·9	58·0	21·7	27·4	24·9			
10 under 15	83·3	82·4	82·8	67·1	73·1	71 2	30·6	37·0	34 7	32·8	35·9	34·5
15 under 20	95 5	97·5	96 8	79·5	82·7	81·3	28 0	47·4	38·3	49·1	59 5	58·1
Over 20	95	94·5	94 7	87·5	90·7	89·1	69·4	59·1	61 9	68 1	67·7	67·9
All Ages ...			80·7	58·6	76·1	75·1	35·5	42·2	40·0	50·1	50·5	50·3

TABLE 49.

Butterworth Area with neighbouring Ciskei.		Lusikisiki Area with neighbouring Ciskei (Pondoland).	
Total No. Tested ...	3,933	Total No. Tested	513
Male	1,685	Male	215
Female	2,248	Female	298
Males, Positive ...	1,286 or 76%	Males, Positive ...	179 or 83%
Females, Positive ...	1,712 or 76%	Females, Positive	239 or 80%
Total, Positive ...	2,998 or 76%	Total, Positive ...	418 or 81%
Matatiele Area with neighbouring Ciskei.		**Basutoland.**	
Total No. Tested	1,211	Total No. Tested	851
Male	419	Male	469
Female	792	Female	382
Males, Positive ...	149 or 31%	Males, Positive ...	235 or 50%
Females, Positive	334 or 42%	Females, Positive	193 or 50%
Total, Positive ...	483 or 40%	Total, Positive ...	428 or 50%

Table 49 shows that the Southern District (Butterworth and Pondoland) yields 77 per cent. of positive reactors while the Northern District (Matatiele and Basutoland), yields 44 per cent. of positive reactors.

Following up this observation, Dr. Allan found that the incidence of tuberculosis in mine boys from the Matatiele area is about 12 per 1,000. The incidence of tuberculosis is higher in mine boys coming from the *area* that is least tuberculized as judged by the tuberculin test. This is in marked contrast with the tuberculin test on the mines, which showed that the incidence of tuberculosis was lowest on the *individuals* least tuberculized as judged by the tuberculin test.

Tuberculin Tests—Summary.

The southern group shows quite a high degree of tuberculization as judged by the tuberculin test and, going with this, a fair amount of endemic tuberculosis, some of it "chronic." Boys from this area going to work on the Witwatersrand goldfield have comparatively low tuberculosis prevalence.

The northern group shows a much lower degree of tuberculization as judged by the tuberculin test and, going with this, tuberculosis is uncommon, and the cases seen were of a mild type. Boys from this area going to work on the Witwatersrand goldfield have a high tuberculosis-prevalence.

As between the two sexes tuberculization is even, taking all ages, but the girls run ahead of the boys between the ages of 5 years and 15 years, while the men catch up when they leave their homes for work in early adult life.

As judged by the intra-dermal tuberculin test with 1/5,000 strength the men of over 20 years of the southern district are tuberculized to the extent of about 88 per cent., while those of the northern district are tuberculized to the extent of about 69 per cent.

5. EXAMINATION OF CASES OF TUBERCULOSIS IN NATIVES AMONGST THE GENERAL POPULATION.

Through the kind collaboration of medical missionaries, it was possible to examine patients in the mission hospitals and to scrutinize past hospital records. Apart from these facilities, however, there was no ready-made organization for getting into touch with tuberculotics throughout the Territories; this had to be accomplished by enquiries amongst officials, traders, headmen and other Natives, followed by a personal visit to those individuals who were, through these sources, reported to be ill. Clearly the results of such a procedure cannot be regarded as possessing an accurate statistical value as to the true tuberculosis morbidity and mortality amongst the Native population. It may, however, be conceded that this investigation conducted by a medical worker especially qualified for such a purpose has been the means of adding largely to our knowledge and has enabled us to visualize far more clearly than hitherto the extent, distribution and type of tuberculosis in the Native Territories. It is not only the number of cases of tuberculosis detected and the various and extensive areas visited, but also the continuous daily intimate association of the observer with Native life in its own home—for a period of two and a half years—that adds additional weight and validity to the data obtained and to their interpretation.

Areas in which Clinical Investigations were Carried Out.

Native tuberculotics were examined and reported upon in the following areas:—

Transkei.—Magisterial District of Butterworth, Pondoland and adjoining Territory, Matatiele District of the Transkei (E. Griqualand).

Ciskei.—Kingwilliamstown and District.

Basutoland.

Natal and Zululand.

Although Basutoland, Natal and Zululand appear in this list, they are not geographically situated within the terrain properly known as the Native Territories; nevertheless, this is the most appropriate section of the Report for their inclusion.

A brief description of the various areas investigated, together with a summary of the tuberculosis findings therein, is set out below:—

Magisterial District of Butterworth.

This district has an area of 263 square miles.

The township lies at an elevation of 1,753 feet above sea-level. The country consists of rolling, grassy hills with deep gorges towards the Great Kei River. There are few trees, except a few scattered patches of mimosa bushes and shrubs of the euphorbia type in the gorges.

The district comprises :—

(*a*) A number of farms, some owned by Europeans and others by Natives.

(*b*) 13 locations, divided into 25 wards, for each of which there is a headman who receives a small salary from the Government.

The estimated population at 30th June, 1928, was :—

Europeans	870
Coloured	70
Natives	23,050
	23,990

The census of Europeans in 1926 gave the following figures :—

	Urban.	Rural. Farming Community.	Rural. Traders, Missionaries, etc.
Males	319	48	73
Females	318	45	47

The last census of the Native population was made in 1921 :—

Males.		Females.	
Adults.	Children.	Adults.	Children.
4,695	4,029	5,550	5,757

A total Native population of 20,031, disposed as follows :—

Urban	415
Rural	19,616

In the rural areas there are some 188 Natives to 1 European. The railway line reached Butterworth in 1906. The average rainfall for the past 10 years has been 25 inches per annum. The rains fall mostly during the summer months.

Tuberculosis in the Butterworth Area.

Tuberculosis is very rarely met with among the European inhabitants. Among the Natives, however, it is fairly common, and the local medical practitioners state that about 10 per cent. of all Natives who consult them are suffering from tuberculosis in some form or other.

The two European doctors in Butterworth see some 5,000 Native patients per annum. The proportion of tuberculous patients is about 9 per cent., so that in the Butterworth area there must be at least some 450 Natives affected by tuberculosis out of a population of some 23,000.

PLATE XVIII.

FIG. 21.

FIG. 22.

FIG. 23.

FIG. 24.

TYPES OF THE PRINCIPAL TRIBES REPRESENTED ON THE MINES.

PLATE XIX.

FIG. 25.

FIG. 26

FIG. 27.

FIG. 28.

TYPES OF THE PRINCIPAL TRIBES REPRESENTED ON THE MINES.

PLATE XX.

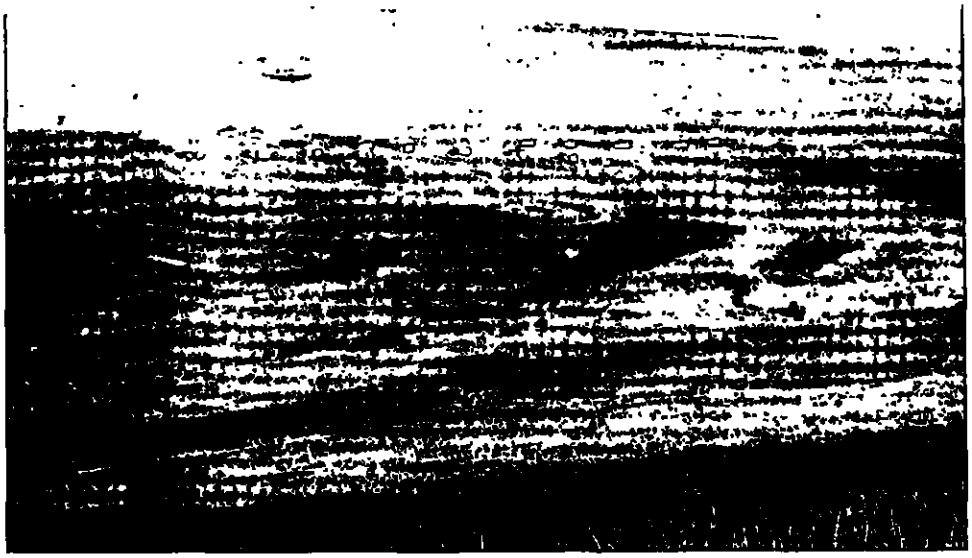


FIG. 29.—Native huts scattered along a hillside ridge. In front of the huts and on the farther ridge are circular brushwood cattle kraals. The darker areas are patches of cultivated ground.

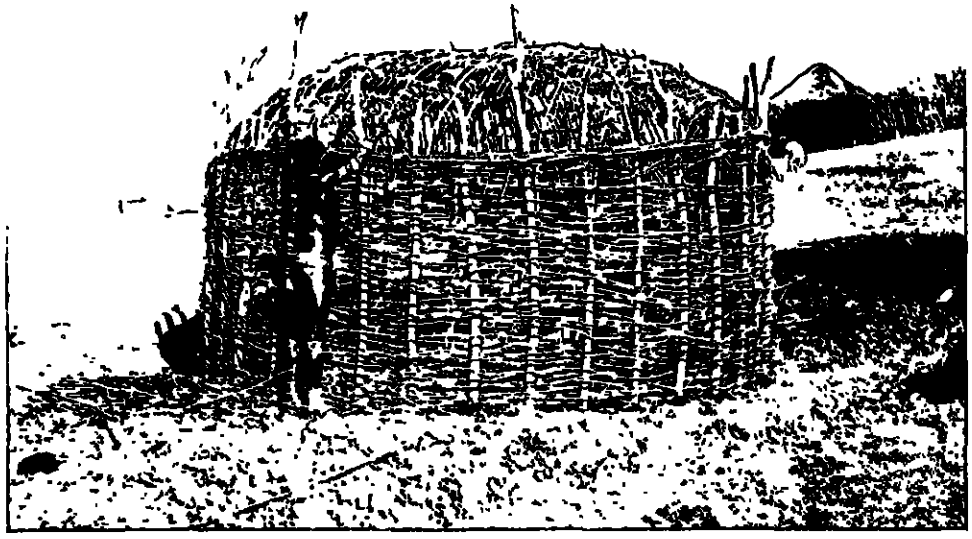


FIG. 30.—A wattle and daub hut in course of construction. This type of hut is nowadays mostly to be found amongst the rawer Natives—the "red" or "blanket" Kafirs.

PLATE XXI.

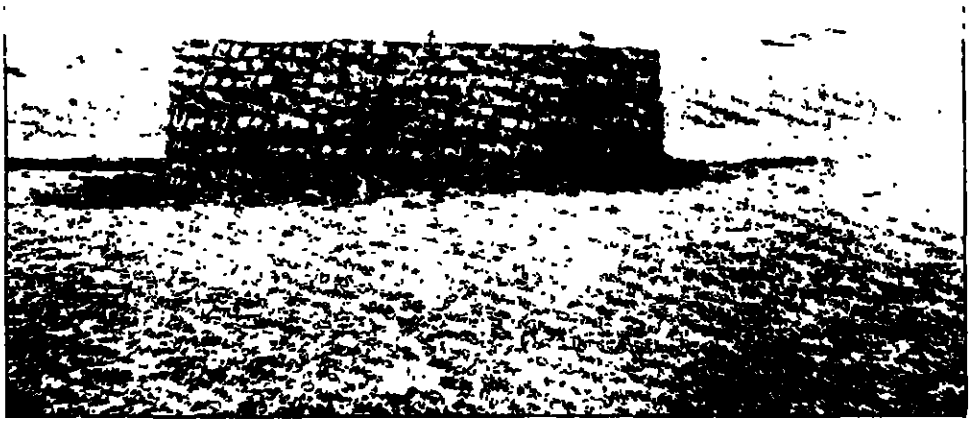


FIG. 31.—A sod hut in course of construction.

FIG. 32.—A sod hut after the inside and outside of the wall has been lined with clay. Note the thickness of the wall.

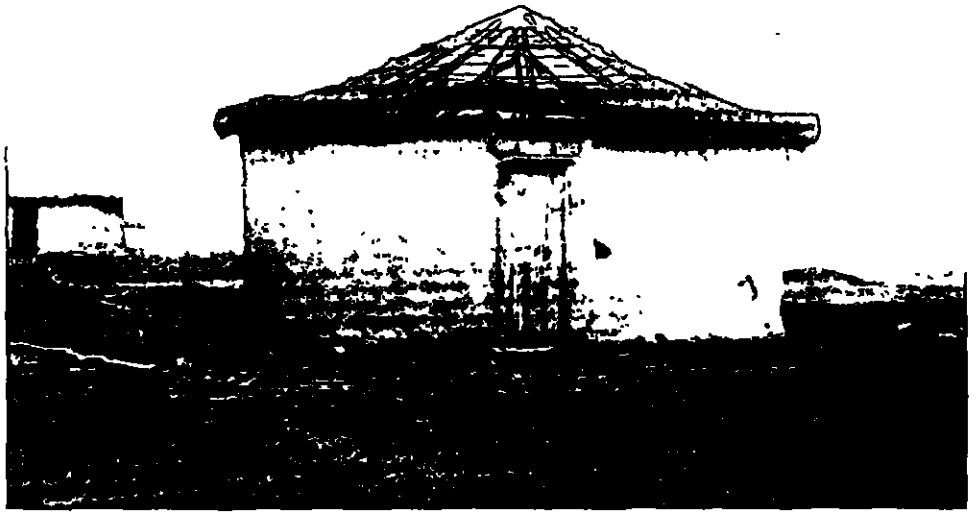


FIG. 33.—Sod hut with conical roof supported by one centre pole.

FIG. 34.—Wattle and daub hut with low dome roof supported by several poles inside.
The home of a poor Native with only one hut.

PLATE XXIII.

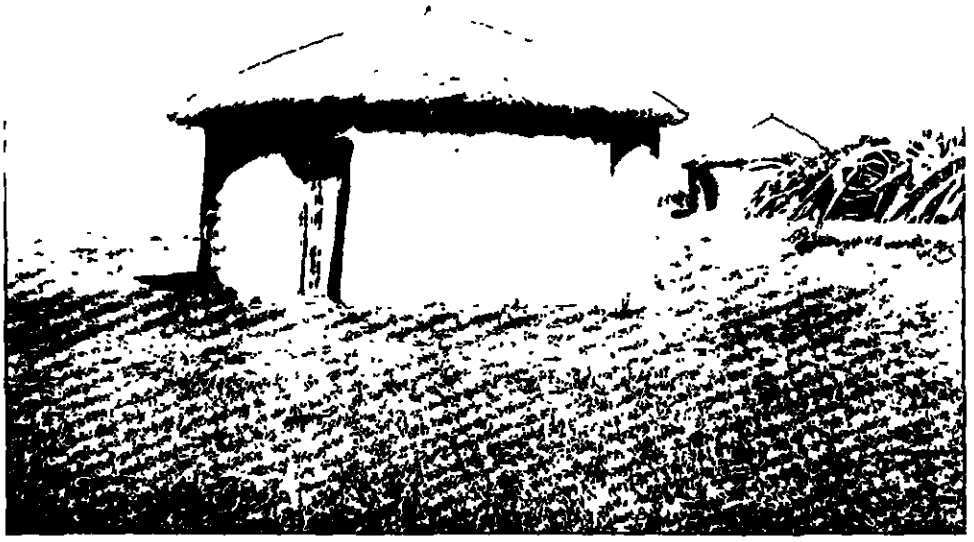


FIG. 35.—Finished sod hut with ventilation opening to right of door. Note tidiness of surroundings. The Native in his kraal is quite clean and tidy, in marked contrast to his behaviour in an urban location.

FIG. 36.—Kraal of well-to-do Native, consisting of five huts. Note the glazed windows and the fact that two of the huts are square. The wicker basket at the foot of the tree is used for keeping mealies in, prior to pitting.

PLATE XXIV.

FIG. 37.—Stamping mealies in a primitive wooden mortar.

FIG. 38.—A primitive mill. Grinding mealies on a hollowed stone with a rounded stone.

Dr. Fennell, the District Surgeon, produced his figures for one year. Out of 3,360 Natives who consulted him, 298 were suffering from some tuberculous affection, *i.e.*, 8·8 per cent. Type of tuberculosis : Lungs, 272 ; glands, 14 ; spine, 12.

It will be seen that tuberculosis of the lungs is the most common form. Some of the cases seen were acute, but many were fairly chronic, lasting at least three years and over, showing that the Natives, under their own conditions, have a considerable power of resistance.

In the course of the present investigation in the Butterworth area, some 100 cases of tuberculosis were seen, and it is certain that there were many others which were not seen.

It was stated that many cases did not come forward, as they were afraid they might be treated like lepers and taken away to an institution.

As post-mortem examinations could not be obtained, it is impossible to state to what extent repair is found in the lungs, nor could the prevalence of miliary tuberculosis be estimated. That it does occur, however, is indicated by the cases in the Ciskei of two children who strayed away from home, were found dead, and in whom miliary tuberculosis was found post mortem. One case occurred at King-williamstown and the other at Stutterheim.

Although the majority of cases seen were pulmonary, cases of bone, (mostly spine) and glands were seen. There are numbers of children with healed Pott's disease. Spinal caries is not limited to children ; several cases of Pott's disease in adults were seen.

It will also be noticed from the histories of the cases described below that many of them have had no connexion with industrial employment. Familial infection was noticed in several cases, but in the majority of instances no source of infection from other members of the family could be traced. The cases of tuberculosis were found scattered throughout the district, and the incidence among "dressed" and "red" Natives* was about equal.

The types of cases met with are illustrated by the following examples :—

(1) ABRAM MABINZA, Kentani's Location, aged 40 years ; I.D.†+.—This man stated that he had been ill for two years with cough, shortness of breath, weakness and expectoration of sputum. The sputum contained tubercle bacilli ++.

Physical Signs.—Emaciated man, marked deficiency of movement over right side of chest. Impaired resonance over upper half of right lung where crepitant râles are audible. The breath sounds are feeble.

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* A dressed Native is one who has adopted (more or less) a European mode of dress, usually through having been engaged in industry or from living in fairly close contact with Europeans.

A "red Native," "red Kafir" or "blanket Kafir" is a more unsophisticated type whose clothing consists mainly of a blanket. The favourite colour of blanket is red, in keeping with the older custom of smearing the body with a mixture of red ochre and fat.

† I.D. signifies "Intra-dermal Tuberculin Test."

One sister is stated to have died of tuberculosis six years previously, and one of the man's children died of what may have been tuberculosis.

(2) GABISO NYLLA, aged 55; I.D.++vesication.—This man was a headman, and had never been away to work. He was a thin man, but looked well, and the vesication which arose from his intra-dermal test led to a further clinical examination.

Physical Signs.—Very marked flattening and deficient movement of right side of chest. Dullness to percussion over upper third and lower third of right lung. Bronchial breath sounds at apex and coarse crepitations over lower third of right lung.

The family history as given by the Rev. D. B. Davies, who has known the family for many years, is that this man has lost two wives and four children from tuberculosis. Gabiso died within a year.

(3) JOHN INKWA, aged 34.—This man had been employed on surface work at the mines. He developed pleurisy with effusion, and was tapped at Roodepoort in 1924.

Physical Signs in March, 1928.—Marked flattening of the left side of chest. Impaired resonance all over the left side, breath sounds bronchial at left apex, where crepitant râles were audible, crepitations at right base, and impaired resonance at right apex.

(4) ROSE LINDA, aged 14, Bulubi's Location.—It was stated that this girl had always been delicate, but previous to this examination, she had been ill for four months: she was now too ill to stand up. There was cavitation in both lobes of the left lung, and the right upper lobe was also involved. This girl died within a month, so that her illness had lasted somewhere about six months.

(5) WALTER TSHINGELA, aged 55, of Feldman's Location; I.D.+.—This man stated that he had suffered from chest trouble as a boy. Both his parents had died at an advanced age. One brother died of tuberculosis in 1921, at the age of 46 years, and his brother's wife died of tuberculosis in 1915.

Physical Signs.—Dullness to percussion over the upper half of the right lung, with bronchial breath sounds at the apex.

(6) DRUMMOND TSHINGELA, aged 25, son of Walter.—This man stated that he had recently had an attack of pleurisy. There was marked shrinkage of the right apex, which suggested a healed tubercular lesion. The intra-dermal tuberculin test was positive.

(7) ESTHER MAKAZELE, aged 38; I.D.+.—Complained of cough and pains in the chest for the past nine months. It was stated that a cousin suffered from chest trouble.

Physical Signs.—Chest flat, movement deficient on right side. Dullness to percussion over upper third of right lung, where the breath sounds were bronchial, and crepitations were heard. Crepitations were also present in both nipple areas, and at both bases.

(8) JOHNSON FELDMAN, aged 45: I.D.+.—This man saw service in France with the Native Labour Corps, and was also in South-West Africa with the troops. After demobilization, he joined the police force, and felt quite well until 1924, when he became ill and after a period in hospital was invalided out of the force.

Physical Signs.—Well-formed chest, but movement deficient over left side. Percussion note impaired over upper half of the left lung, where breath sounds are feeble. There is marked hoarseness which has persisted since the beginning of the illness.

(9) ENOCH MOGOMA, aged 50, school teacher; I.D.++.—This man has old tubercular cicatrices in his neck. These have been healed for 20 years.

(10) JESSIE YAMBA, aged 36; I.D.++.—This woman stated that she had had a pain in her right side for six months.

Physical Signs.—A thin woman. Chest flattened on right side and movement is deficient. Impaired resonance over upper half of right lung, and slightly also at left apex. Crepitant râles are audible over the areas where resonance is impaired. Breath sounds amphoric under right clavicle. Tubercle bacilli were present in the sputum.

She was a Stage 3 case in which the constitutional disturbance was about equal to the local. This woman's husband was stated to have worked on the mines, his last trip being in 1925. He is stated to have developed tuberculosis, thus there is a possibility that this woman contracted the disease from her husband. This woman died about six months later, so that the duration of her illness was about one year.

(11) NLANGENI MKUKWANA, male, aged 18 years.—This boy did not present himself for examination, but it was observed that he was coughing, and he was asked how long the cough had been present. He had had a troublesome cough and spit for four months, and had also been very hoarse during that time. He had also a pain in the left side, and had had occasional small haemoptysis. Sputum contained tubercle bacilli.

Physical Signs.—Flattening of left side of chest and movement deficient. Impaired resonance over upper half of both lungs where numerous crepitant râles were audible. Breath sounds were bronchial at the left apex.

This boy was sent to Nelspoort Sanatorium, and returned much improved in health. Gained 23lb. in weight.

(12) JOSEPH MAFUYA, aged 36; I.D.+.—This man has worked on the mines. In 1917 he did eight months' drilling, and in 1919 he worked on machines underground for six months. He stated that he had also worked on the surface at the mines for a considerable time. He had last worked on the mines six years previously, and had been sick for the past three years. He complained of a troublesome cough, sputum and recurrent haemoptysis. His wife and five children are healthy.

Physical Signs.—Very thin man with marked flattening of right side of chest, marked dullness over whole of the right lung. There was a large cavity in the right lower lobe. Crepitations were present all over the right side, and at the left base.

A Stage 3 case with general and local signs about equal.

(13) VEYENA QUTU, male, aged 28 years, of Bushula's Location.—This man gave the following history:—He was employed at Roodepoort for six months' drilling, and for a further three months' drilling at Randfontein. He became ill and returned home in 1923. He was not repatriated. After a time at home he felt better and returned to the Rand, where he was employed loading at Geduld Mine for 13 months. He again became sick and came home. He was not repatriated, but came home on his own account in 1925. This time he did not improve, and when seen in 1928, three years after his return home, he was very ill. He complained of cough, shortness of breath and pains in the chest.

Physical Signs.—The man was emaciated. Every lobe showed evidence of gross damage, and it was evident that he had not long to live.

He died about two months later. If this man's history is correct, his illness had lasted some three years. Judging by the extent of the lung involvement, the process was probably gradual.

(14) NANJANA MBENYA, female, aged 21. This woman stated that she had been ill for ten weeks. Her illness commenced with weakness, palpitation of the heart, and swelling of the glands of the neck. Later a cough developed. She stated that her husband was employed on the mines.

Physical Signs.—The woman looked very ill and was too weak to walk. Enlarged glands were present, as large as hen's eggs on both sides of the neck. Dullness over upper half of right lung and crepitations present. The breath sounds were bronchial over the upper third of the lung.

The woman died about a month later, but no post-mortem examination was obtained. This case was one of acute tuberculosis.

(15) MROMZELE BATALA, male, aged 36.—This man stated that he had worked underground at the Geduld Mine for 13 months, and at Roodepoort on surface work for one year and eight months. He stated that he became ill in January, 1927, when he had sharp pains in the chest, and headache, later a cough developed and he lost flesh.

Physical Signs.—When seen in March, 1928, he was emaciated. The apices on both sides were much shrunken. A large cavity present in the left upper lobe, and the right upper lobe was also involved.

His general condition was fairly good compared with the amount of disease in the lung. The history of the illness was of 15 months' duration.

(16) LOLIWE SIGADE, aged 50, male.—This man complained of cough, pains in the chest, and in the legs. He had worked for nine months drilling at the New Primrose Mine ten years before. He had since worked in Cape Town and became sick three years ago.

Physical Signs.—Impaired resonance over the upper half of the right lung. Bronchial breath sounds and crepitations present at the right apex.

(17) SILUMBELE NTLOMBENI, aged 2.—A "red" child. Wasted, abdomen prominent, and an area of impaired resonance present at the left base where crepitations are audible.

(18) NOVEYILE BAVUMA, aged 54, a "red" woman of Foswa's Location.—She complained of cough, dyspnoea, and pains in the chest. The illness commenced six months before with persistent diarrhoea. After a time the diarrhoea stopped, but the woman continued to lose flesh and she suffered from increasing dyspnoea. She stated that her husband, who had never been to the mines, died of tuberculosis some ten years before her illness commenced. Five of her seven children had died from causes which she did not know.

Physical Signs.—Impaired resonance over upper third of both lungs; breath sounds bronchial at both apices, crepitant râles present at left apex, and bubbling râles throughout the left lower lobe.

(19) NOMZEMANGELO TSHONDONDWE, aged 7 years; "red" child of Bushman's Location; I.D.++.—Glands were present on the left side of neck about the size of walnuts. She was a thin child with a dry skin. The abdomen was tense but no fluid was detected.

(20) MDASHI MBAWN, male, aged 68 years.—This man stated that he had never been to the mines, nor had any of his people. He said he had been ill for three years with a troublesome cough, spit and occasional haemoptysis. Sputum for examination could not be obtained.

Physical Signs.—There was a large cavity in the left upper lobe, and numerous crepitations were present. The right upper lobe was also involved, percussion note impaired, and numerous crepitations, with bronchial breath sounds at the apex. His general condition was good. A Stage 3 case with little systemic trouble.

(21) NTOMBIZODIVA CIMA, of Zazini's Location; a female, aged 16 years; I.D.+, but less intense than the average.—This girl stated that she had been ill for one year with cough, spit, occasional haemoptysis and pain in the left side.

Physical Signs.—Dullness over upper half of the left lung where the breath sounds were low-pitched bronchial. Bubbling râles were present over the left upper lobe. Tubercle bacilli present in the sputum++. The girl's general condition was good.

Family History.—Father died suddenly six years ago, cause unknown. Mother died of chest trouble shortly afterwards. Two elder sisters, both of whom gave positive intradermal tests, were apparently healthy.

(22) STOLOM TENGO, male, aged 60, stated that he had suffered severely with chest trouble several years ago.

Physical Signs.—Definite dullness to percussion at the right apex, where the breath sounds are bronchial.

This appears to be a case of healed tuberculosis.

(23) WILLIAM NGUDLELE, aged 40 years.—This man stated that he had been ill for 20 years. He had a troublesome cough, but not much sputum, and had occasional haemoptysis.

Physical Signs.—Dullness over upper half of right lung, and to a lesser degree over upper half of left lung. Resonance impaired in right axilla. The breath sounds were bronchial over upper third of right lung, air entry entirely deficient at left base. There were numerous crepitations present over the areas where percussion note was impaired.

The man was very ill—a Stage 3 case where the systemic intoxication was marked.

(24) The following case is of interest:—

A Native nurse who had just completed three years' training at the Victoria Hospital, Lovedale, was seen in November, 1927. In October, 1927, she had suddenly broken down. Her temperature was hectic, and there was apparently an acute tuberculous process in her lungs and larynx. Tubercle bacilli were present in her sputum. After a period of treatment at the Victoria Hospital, Lovedale, she was sent to her home in *Nguza's Location, Butterworth district.*

In June, 1928, Dr. Joynt, of Butterworth, kindly arranged for her to come to hospital for a fortnight's observation. Her weight was then 133lb., and her general condition good. Her physical signs had localized, and were limited to a small cavity at the right apex. The laryngeal condition had cleared up to a remarkable extent, and although some swelling of the arytenoids and cords persisted, the congestion was not very intense. Her temperature had settled down, and only on two occasions during the fortnight did it reach 100°F. in the evening.

This girl then went to Nelspoort Sanatorium, and was still alive at home in January, 1930.

(25) ELEANOR GOBINDUKE, female, aged 27 years, stated that she had been ill for four years. Her illness commenced with pains in the right lumbar region, then both sides were affected, and then the legs. She now walks with difficulty, with the aid of two sticks. There is marked deformity of all the lumbar vertebrae, but her Pott's disease now seems quiescent.

The other cases of Pott's disease seen in adults did not recover, but progressed to acute generalized tuberculosis.

Pondoland and Adjoining Territory.

Pondoland was not annexed to the Cape Colony till 1894. Its area is 3,926 square miles.

At the 1911 census there were resident in Pondoland

Europeans	1,383
Native and Coloured ...	233,254
	234,637

That is, 1 European to 168 of Native and Coloured.

Persons to the square mile, 59.

At the 1921 census the figures were as follows :—

Europeans	1,500
Native and Coloured ...	263,455
	264,955

That is, 1 European to 176 Native and Coloured.

Tuberculosis in Pondoland and Adjoining Territory.

Tuberculosis is very prevalent among Natives in the Flagstaff and Lusikisiki districts of Pondoland. These districts are contiguous to the sea.

Tuberculosis was noted as being common in these areas at the beginning of the twentieth century. In 1901 the magistrate of Lusikisiki stated that many Native deaths were due to tuberculosis, and in 1907 the district surgeon of Flagstaff reported that phthisis and tuberculous glands were commonly met with in Natives.

Holy Cross Mission has been founded within the past 30 years, and a mission hospital was opened by Dr. Drewe in 1920. There are 24 beds and the majority of patients are tuberculous.

Adhesions are very frequent in Natives and the lung is often bound down to the chest-wall.

Dr. Allan is of opinion that these adhesions are frequently *not* due to tuberculosis. A post-mortem examination made on the body of a Native who died from an assegai stab is instructive in this respect. The left lower lobe was bound by adhesions to the chest wall. One band of adhesions in the axillary area was an inch in diameter. No sign of tuberculosis was found in the body.

He is of opinion that these adhesions are caused by limited pleurisy, often in the lower lobes towards the lung margin, and that this pleurisy is caused by the inhalation of acrid fumes, due to burning damp wood, dried cowdung, etc., in huts without any outlet for the smoke.

In Pondoland the weather was very wet when he was there, and the Natives spent most of their time in their huts. He noticed a great increase in the number of persons, men, women and children, with "marginal râles" after this spell of wet weather.

Two cases of lupus of the face were seen at Holy Cross Mission. One of these, a boy of about 18 years, died later of acute generalized tuberculosis. Several cases of gland tubercle were also seen.

Generally speaking, the cases seen in the Flagstaff area were similar in type to those seen in the Ciskei and in the Butterworth area.

In other parts of the Transkei similar cases were seen, except in the high-lying areas at the foot of the Drakensberg range—the Matatiele district. The observations made in this district are given on p. 220.

Herewith follow illustrative cases seen in various parts of the Transkei other than the Butterworth district and the Matatiele district.

PONDOLAND.

(1) WILLIE MBANE, male, aged 50 years.—Admitted to Holy Cross Hospital, 4th November, 1928. He gave a history of one year's duration of cough and blood-stained sputum. Tubercle bacilli in sputum.

Physical Signs.—Marked dullness right upper lobe, where numerous crepitations were present. Weight, 160½lb. Temperature, 97°–99°F. He left hospital three weeks later, having gained 2lb. in weight. He was readmitted to hospital on the 9th January, 1929, with a temperature of 102°F. He improved a little, but later relapsed and died on the 2nd February, 1929. He had never worked in the mines. His illness lasted about 15 months.

(2) DANIEL MALODE, aged 40, male.—Admitted to Holy Cross Hospital, 29th October, 1928. History of five months' duration of cough, spit, pain in chest, loss of flesh and night sweats. The sputum contained tubercle bacilli.

Physical Signs.—Extensive dullness and crepitations over both lungs, with signs of cavitation in the right middle lobe. Temperature, 98°–104·6°F. Pulse, 106–148.

He died on 17th November, 1928, after an illness of six months' duration.

(3) VICTORIA LANGA, aged 15 years, Christian.—Admitted 28th October, 1928, discharged 26th November, 1928. On admission she stated that she had only been ill for five weeks.

Physical Signs.—Cavity at right apex, dullness and bronchial breath sounds in the right axilla, and dullness at the right base. Her temperature was 97°–103°F. Pulse rate, 80–114.

She died before the end of 1928, her illness only having lasted about three months.

(4) In contrast to the last case, with a short duration, the following case had a history of nearly six years, and was still alive at the end of 1929.

GRACE MTENTSO, at the age of 17 years had in 1924 a haemoptysis of 2oz. of blood, and was then diagnosed as suffering from pulmonary tuberculosis.

Five years later, on the 24th January, 1929, she came to Holy Cross Hospital with signs of active tuberculous disease at the left apex.

In view of her long history, and the degree of resistance she had shown, an artificial pneumothorax was induced on the 29th January, 1929. The initial pressure was −1, −4; after 325c.c. of air +2, −4.

Complete collapse, however, could not be attained, and on the 18th February, after the usual routine of induction and refills had been done, it was found that only 50c.c. of air could be introduced. The initial pressure was +1, −4; after 50c.c., +14, +10. Examined on 8th September, 1929, this girl showed signs of cavitation at the left apex.

(5) NTUKY SOBANBAVANE, aged 5 years, female, "red."—Was admitted to Holy Cross Hospital on 30th July, 1929, complaining of cough, sputum, night sweats. The duration of illness was not ascertained. Her temperature ran from 96°–100·4°F.

Physical Signs.—Extensive, practically the whole of the left lung being involved.

On 31st August, 1929, the temperature ran up to 105°F. and it was discovered that the child had developed a spontaneous pneumothorax on the left side. The pressure was relieved by withdrawing some of the air, and the patient left hospital about the middle of September.

(6) GRACE MYAMAKAZI, aged 10 years.—Stated to have been ill for about one year. When seen in October, 1929, she looked very ill. She was emaciated and very short of breath. She had a troublesome cough and it was stated that she sometimes coughed up blood. Her temperature at 4 p.m. was 100°·6F.

Physical Signs.—Marked dullness upper two-thirds of left lung, with numerous crepitant râles. Signs of cavitation were present in both lobes of the left lung.

(7) NOMAHINAY BHECE, aged 15, female, "red."—Was admitted to Holy Cross Hospital on 2nd January, 1929. History of six months' duration—cough, sputum, loss of weight—tubercle bacilli present in sputum. Temperature, 96°–99·2°F.

Physical Signs.—Dullness upper third of both lungs, and at left base. She improved under treatment and was discharged on 20th February, 1929.

She gained 2lb. in weight in seven weeks.

(8) ALFRED TSHAWS, aged 40, male.—Admitted 30th December, 1928, with a history of cough, spit and loss of weight of three months' duration. Sputum contains tubercle bacilli.

Physical Signs.—Dullness and numerous crepitations upper third of both lungs; cavity in left upper lobe.

This man did not improve and left hospital 8th February, 1929.

(9) ESTHER MDA, aged 28, female, Christian.—Came in January, 1929, with pleurisy with effusion. Two pints of fluid were withdrawn with air replacement.

(10) SARAH NYAXABA, aged 47.—Had Pott's disease for 18 months when seen in October, 1929. She said that as a girl she had had a very severe cough which kept her awake at night. Her husband was diagnosed by Dr. Drewe in 1920 as being tuberculous. He was still alive in 1929.

Physical Signs.—Pott's curvature over 1st and 2nd lumbar spines. Chest, signs of cavitation at right base. Temperature, 97°–100°.6F.

(11) GAGA RASMEME, aged 28, male, Christian.—Stated that he had worked on the mines prior to 1918. He said he had had a cough for ten years. He had a haemoptysis of about one pint in June, 1928.

Examination, October, 1929.—There was a cavity in his left upper lobe. He had also evidence of bone and joint involvement. The left elbow was ankylosed, and there were several scars of healed sinuses in this area. There were three discharging sinuses on the outer aspect of his right foot, in which he had developed talipes equinus.

(12) AMOS JOHN, aged 14, male, Christian.—Had a tuberculous hip which he said had commenced two years previously.

(13) Case of arrested disease.

A Native man called SPELMAN was in France with the Native Labour Corps. In 1920 he had a brisk haemoptysis, and was found to have active tuberculous disease in his right upper lobe.

At the end of 1929 he was quite fit with no signs of any active disease.

(14) DAVID WASA, aged 19 years.—Complained of pain in the back at the beginning of October, 1928. He was seen in September, 1929. He was then emaciated, and had a well-marked psoas abscess. His temperature was 100·4°F., and his pulse rate 128.

(15) One family of Coloured people had had several cases of tuberculosis. One girl died of pulmonary tuberculosis at the age of 20 years in 1925. Another sister, Annie, has had tuberculosis of the lungs since 1920. Tubercle bacilli have at various times been found in her sputum.

This girl was seen in 1927. The left lung was extensively involved. She had a haemoptysis on the 7th March, 1929, at the age of 27 years. An artificial pneumothorax was induced soon afterwards, and was being continued at the end of 1929.

When seen in October, 1929, this girl's general condition was very good. The artificial pneumothorax was not entirely successful as the apex of the lung had not collapsed properly.

QUMBU.

(1) WILLIAM KALI, aged 50, of Lodidi's Location, Qumbu.—This man had never been on the mines. He said he had suffered from chest trouble for 20 years.

Physical Signs.—Dullness, bronchial breath sounds and crepitations in the right axillary area, and crepitations at both bases.

(2) ZACHARIUS BATWENI, aged about 60.—This man stated that he had worked on the mines.

Physical Signs.—Dullness over the hilus of each lung. Impaired resonance right apex, where crepitations were present. Crepitations both axillary areas.

(3) JULIA MASIZA, aged 20.—Ill for two years. Complained of pain in chest and shortness of breath.

Physical Signs.—Dullness, bronchial breath sounds and crepitations at the right apex. Crepitations scattered throughout both lungs.

(4) MAZULA TIWANI, aged 30.—Stated that she had been ill for four years with cough, spit and several attacks of haemoptysis. She was thin and miserable looking, and there was marked clubbing of the fingers.

Physical Signs.—Large cavity in left upper lobe and scattered crepitations throughout both lungs.

(5) A NATIVE FEMALE, aged 27.—A school teacher, who said she had been ill for four years. *She was found to have definite Stage 2 tuberculosis of the lungs.*

A cousin and an uncle of this girl were stated to have died from tuberculosis in the previous 18 months.

(6) MABEL JARA, aged 32.—Had numerous enlarged glands, about the size of small hen eggs, in the neck, and there were numerous cicatrices.

It was stated that the father of this woman had tuberculosis but had left the district.

MOUNT FRERE.

(1) SAMUEL KOYANI, aged 46.—Had worked for many years as a clerk in the local N.R.C. office. He stated that he had had a pain in his back for some years as a boy. He attributed this to a fall from a horse. In 1924 he noticed a swelling over the lower part of his back, and this caused him much pain. He was able to carry on his work until the end of 1927.

When seen in 1927 there was marked protuberance of the vertebrae in the lumbar region, with some bogginess. His lungs were apparently unaffected.

Six months later he died of acute generalized tuberculosis.

(2) ZIMEWA MDABUKA, a man aged about 50.—Stated that he had worked on the mines several times. He came home from the mines about three years previously and said he was not then ill. He was now emaciated and there was marked clubbing of the fingers. He complained of a troublesome cough which often caused vomiting. Dyspnoea was very marked.

Physical Signs were extensive, and there were signs of cavitation in the right upper lobe.

Two of his children had died within the previous year of illnesses lasting about one month. This man's illness had been of less than three years' duration.

(3) EMILY DLADLA, aged 40.—Stated that she had been ill for one year. She complained of cough and spit, pain in the chest, and very troublesome dyspnoea, and said she had got much thinner.

Crepitations throughout both lungs and signs of cavitation at the right apex.

MOUNT AYLIFF.

EMILY ROBASHE, aged 45 years.—This woman stated that she had been ill for two years. She had a troublesome cough, dyspnoea on exertion, and loss of flesh. She stated that her husband had died of chest trouble 14 years ago.

Physical Signs.—Dullness at both apices, more marked at the left apex, where the breath sounds were bronchial and crepitations were present.

KOKSTAD.

Several members of the Muyawaza family (Pondos) who resided in Kokstad were examined. The father had died of tuberculosis in 1926 after an illness of one year and four months. He was a police constable. One son, Philemon, aged 26, employed as a clerk, stated that he had had a cough, pain in the side, and several attacks of haemoptysis during the past year.

Physical Signs.—Thin, narrow chest, dullness over left upper lobe, where the breath sounds were bronchial and numerous crepitant râles were audible. The general condition was very poor, and the prognosis appeared to be grave.

A sister, aged 22 years, had died of haemoptysis in 1928, after an illness of two years' duration.

A brother, Joseph, aged 17, said he had been ill for two months with cough and haemoptysis. He had also old hip-joint disease which dated from the age of four years. There was three inches of shortening on the affected side. He also showed several tuberculous cicatrices in his neck.

Physical Signs.—Very flat chest, with very deficient movement of the left side. Dullness over upper two-thirds of left lung, where the breath sounds were bronchial, and numerous crepitant râles present. Impaired resonance at the right apex where the breath sounds were bronchial. Crepitations were general throughout the right lung. The general condition was very poor.

The mother was examined. She was a stout, healthy-looking woman, and no signs of tuberculous infection were found.

ENGCOBO.

A similar family history was found in a family living in the Engcobo district, that of SAMUEL GAZA.

One son, a teacher, came home from Cape Town with tuberculosis in December, 1924, and died in April, 1925. Two sisters were then put to sleep in the hut which this man had occupied; one sister, aged, 16 died in July, 1927, and the other, aged 13, died in October, 1927, both from tuberculosis.

A young brother was examined in January, 1929. His age was then 13 years. Except for some slight impairment of resonance, and deficient air entry in the left axillary area, he seemed quite well.

The father, aged 71, had typical tuberculous cicatrices in his neck. He said that he had swollen glands which broke down when he was 28 years of age.

ELLIOTDALE.

In the Elliotdale district, near the sea-coast, many Natives suffering from tuberculosis were seen.

One man, DABILIZWE MANOWELE, who stated that he had worked on the mines 15 years ago, was found to have pleurisy with effusion. He had been working on a road gang before he became sick. When seen in November, 1927, he was unable to walk. Nothing was being done for him, and the other Natives regarded his case as hopeless. A quart and a half of fluid was aspirated from his chest.

A year later he was alive and apparently quite well, but he disappeared mysteriously about six months later.

A brother, KEKELI MANGWELE, stated that he had worked on the mines seven years ago and had become ill with chest trouble, and had been compensated. In 1927 he was apparently quite well, and the only physical signs suggestive of old tuberculosis was that of the air entry in the right lung being diminished.

DABILZIWE'S WIFE had died from haemoptysis about the beginning of 1927.

At the next kraal a woman, MARASHA, aged about 32, was found in an advanced stage of pulmonary tuberculosis. It was stated that this woman had married a native from a neighbouring district, but two years previously she had returned ill to her home. Her husband had worked on the mines, but she stated that he was quite well. The woman had a small child with her, who looked ill, and had well-marked crepitant râles in both axillary areas.

Another small girl, aged about six years, was seen at Dabilizwe's kraal. She had Stage 2 tuberculosis of the lungs. She was a recent arrival at the kraal.

It was stated by Mrs. Lawlor, who owns the trading-station near this kraal, that several members of the family of Dabilizwe had died of tuberculosis. Mrs. Lawlor also pointed out several other kraals where cases of tuberculosis had occurred, and mentioned a case where a complete family had died of the disease.

UMTATA.

Similarly, in the Umtata district, tuberculosis is common among the Natives. Something like 18 per cent. of the patients who consult European doctors have tuberculosis in some form or other.

A post-mortem examination was made of an old Native woman, who had died in Umtata hospital. She had been admitted owing to a discharging sinus in the left flank.

The left kidney was totally disorganized and caseous. The spleen and liver showed miliary tuberculosis. No obvious tubercle was seen in the lungs, but the left base was pneumonic.

The wife of a Native constable was examined. She was a native of the Libode district, and said she had only been ill for one month. She had had a small haemoptysis then. Her age was about 30 years.

Physical Signs.—Both apices were involved and also the left base.

A sister-in-law of this woman, DORA DOTWANA, aged 25, said she had no cough, but that she was losing flesh. This woman had dullness at both apices where numerous crepitations were audible and the breath sounds were bronchial at the right apex.

Her child, aged eight months, had a patch of broncho-pneumonia in the right interscapular area. This family had had no connection with the mines.

A student at Clarkeburg College was seen at his home. His father was a police constable. This man said he had had a cough for three months. There was definite involvement of the right upper lobe, and also a large area of crepitation in the right axilla.

TSOLO.

NDLOBONGELA MUGELE, a Xosa, aged about 30 years, single, stated that he had been ill for ten years. He had completed seven months underground on the mines when he became ill. He complained of a very troublesome cough, and occasionally spat up blood. He said he was getting thinner.

Family History.—Father and mother died during the influenza epidemic. Two brothers and three sisters are alive and well. None of his brothers or sisters have died.

Physical Signs.—A thin man with considerable flattening of the right side of his chest, and marked clubbing of the fingers. Dullness to percussion upper half of right lung, and at right base. Breath sounds amphoric at the right apex, where numerous crepitant râles were audible. A few crepitations at the right base, where the breath sounds were feeble. This is a chronic case, whose general condition was fairly good, after having had tuberculosis for ten years.

A student from the Agricultural College at Tsolo was examined. He had had no connection with the mines, and came of well-to-do parents in the Tabankulu area. He was a well-nourished youth of about 20 years of age. He stated that he had had a cough for nine months, and had occasionally coughed up blood.

Physical Signs.—Flattening at the right apex, where there was some impairment of resonance and some post-tussic crepitations. There was also fairly acute pleural crepitus over the 3rd and 4th intercostal spaces on the right side.

A case was seen at the St. Cuthbert's Mission Hospital, Tsolo. This was a boy, a Pondomese, aged about 15 years, who had been ill for several months. His sister and brother had both died of tuberculosis. He had been in hospital for two months, and had gained 14lb. in weight. His temperature during that time was from 96·8° to 100°F., and his pulse rate 60–90. His general condition was good, and he was responding well to treatment.

Physical Signs.—Dullness upper third of left lung, where the breath sounds were bronchial and numerous crepitant râles were audible. Whispering pectoriloquy was heard at the right apex. The percussion note was impaired at the left base where the breath sounds were feeble.

The Matatiele District.

This district, situated along the foothills of the Drakensberg range, lies at an altitude of about 5,000 feet above sea-level. Although politically a part of the Transkei, this district is physically more comparable with Basutoland, and the findings as regards tuberculosis are similar to those of Basutoland (see p. 227) rather than to those in other parts of the Transkei.

The Natives in the Matatiele district are mainly Basutos who were given land in that area by Queen Victoria for loyalty in the Basuto wars of 1880-81.

Three locations were visited, those of Moshesh, Nkau and Sibe.

Moshesh's location is called Queen's Mercy and the inhabitants are practically all Basutos. It is more or less a village, the huts not being scattered along the ridges as in the case of most Native locations.

In the other two locations there are a number of Xosas.

The Basutos wear more or less European clothing, while the Xosas retain the red blanket.

The lands in this district are fertile and the Natives own many cattle.

Tuberculosis in Matatiele Area.

Tuberculosis does not occur very frequently in the Natives of this area, and the cases seen were of a mild type. There are three Europeans living in the district who have tuberculosis of the lung, all three cases running a chronic course.

Dr. Graham, the district surgeon, gave information about the case of his predecessor's Native interpreter. This Native developed tuberculosis and died, and later six members of his family all developed the disease and died.

The following are notes of cases seen in this district :—

(A) Cases of Tuberculosis Acquired Locally.

(1) Isaiah Marwe, aged 60, Basuto.—Has never been to the mines. He stated that he had been ill for one year with a troublesome cough and spit, and had coughed up blood on several occasions. There was marked clubbing of the fingers. His general condition was good.

Physical Signs.—Impaired resonance at both apices where the breath sounds are harsher, numerous crepitant râles over the upper two-thirds of both lungs.

(2) Susan Gwaza, aged 18, a school teacher.—Had slight cough but no sputum and no haemoptysis.

Physical Signs.—Impaired resonance and harsh breath sounds over left upper lobe.

(3) Emily Mafhalane, aged 22.—Had enlarged cervical glands, as large as hen's eggs.

I.D.+1·3cm. in diameter.

(4) John King Mokoatle, aged 48, Sibe's Location.—Had never been to the mines. He stated that he had been ill since the influenza epidemic. He had a troublesome cough and at one time copious sputum, but now has no sputum.

Physical Signs.—Impaired resonance at left apex with post-tussic crepitations. Crepitations present in left axillary area.

(5) Sepinare Agurea, aged 50, a school teacher.—Was on sick leave. He had a troublesome cough and had had several attacks of haemoptysis, and had lost considerable weight.

Physical Signs.—Narrow chest, movement deficient over right side. Dullness over upper half of right lung, where the breath sounds are bronchial. Crepitations were present in the left axillary area.

(6) Alfred Pharoe, aged 23, a pupil teacher.—Father worked on the mines many years ago, and is still alive and well.

This young man has well-marked Pott's curvature in the mid-dorsal area. He developed spinal caries at the age of three years.

(7) Motsalisa Motumi, aged 30.—Had enlarged cervical glands, those in the right side of his neck being especially enlarged and much fixed down.

(B) Tuberculosis Acquired in Other Parts of South Africa.

(8) Makbulalo Moshesh, aged 25.—This man had worked on the gold mines, but left in 1926 and went to Durban. He later worked in coal mines and on sugar estates. He continued work up till the end of 1928, when he was admitted to the Addington Hospital, Durban, where he remained for three weeks, and came home to Queen's Mercy early in 1929. Seen on the 6th May, 1929. He was then bedridden and had advanced tuberculous disease of his lungs. He died about a week later.

(9) Brinton Moshesh, aged 30, a brother of the former patient.—Stated that he had been a police boy on the Modder East Mine, and came home three years ago. He complained of cough and night sweats.

Physical Signs.—Dullness upper half of left lung. Bronchial breath sounds at apex, and crepitations throughout the whole of the left lung. His general condition was below normal.

(10) A case of tuberculosis of 33 years' duration.

This patient is the wife of a native minister. Both she and her husband are Hlubis (Fingoes) from the Cala district of the Transkei.

In 1896, the late Dr. Stewart, of Lovedale, diagnosed that this woman had tuberculosis of the lungs. Her husband was then stationed at Lovedale, and they moved up into the Matatiele district, where they have lived since. She has had seven children, two of them died in infancy of bronchitis, but the other five are all alive and well. At various times she has had copious haemoptysis, large haemoptyses occurred in 1911, 1916 and in July, 1928.

Examined in November, 1928. She was a thin woman, aged 56 years. She had a very troublesome hacking cough, and was very breathless. Her general condition was fairly good. The sputum contained tubercle bacilli.

Physical Signs.—Dullness over upper half of the left lung where the breath sounds were bronchial, crepitant râles very numerous all over left lung. Slight impairment of resonance at right apex.

In this case there has been a very considerable degree of resistance. She was reported to be still alive at the end of 1929.

(C) CASES IN PERSONS OTHER THAN BASUTOS IN THE MATATIELE DISTRICT.

(11) A GRIQUA (Coloured), male, aged 64.—This man had been ill for 3½ years. Two months before he was seen he developed pleurisy with effusion, and 1½ pints of fluid had been withdrawn. He had always lived an open-air life, and had been healthy up till 3½ years ago, when he developed a cough, and has had several attacks of haemoptysis.

Physical Signs.—Dullness over upper third of left lung, where the breath sounds are harsh, and numerous crepitations are audible. Marked dullness at left base where breath sounds are inaudible.

(12) WILIFA RONA, a Fingo, aged 5 years.—Has lived in Matatiele all his life. At the age of 4 years the glands of his neck became enlarged.

At the time of examination the glands on both sides of his neck were enlarged, one on the left side being about the size of a hen's egg, while numerous glands about the size of marbles were present on both sides of his neck. The mother stated that she, as a child, had suffered from a similar condition. The glands became enlarged and suppurated about 1900, and on both sides of her neck typical tuberculous cicatrices were present.

The Ciskei.

The Ciskei is not an exactly-defined area, but the name is a convenient one for the territory south of the Kei River, bordering on the Transkei. Under this heading may be included, at any rate, the districts of Peddie, Alice, Kingwilliamstown, Keiskamahoek, Cathcart, Queenstown, Sterkstroom and Stutterheim.

The Natives in this region are very similar in type to those living across the Kei River in the Butterworth area of the Transkei, and the tuberculosis seen in the Ciskei is also very similar to that of the Butterworth area.

Tuberculosis in the Ciskei.

Details regarding the type of tuberculosis in this area are available for a number of years back, thanks to the publications of Dr. Macvicar of the Victoria Hospital, Lovedale.[27]

At that period he found in his own practice that pulmonary tuberculosis was by far the most common form of the disease and that next in frequency came infection of the cervical glands. Abdominal tuberculosis he found rarely.

During the course of the present investigation, Dr. Allan was given opportunity to see cases at Lovedale and to examine the hospital registers.

He found that of 300 consecutive admissions to hospital in 1927, 55 cases had tuberculosis of the lungs; 5, tuberculosis of the spine; 5, other forms of tuberculosis, not specified; 5, tuberculous glands; 3, tuberculosis of the abdomen, and 1, genito-urinary tuberculosis.

Of the 74 tuberculous cases, 55 had pulmonary tuberculosis, which gives a percentage just about the same as that recorded by Dr. Macvicar in 1908.

As an indication of the proportions of acute and chronic cases, the following analysis of 37 fatal cases of pulmonary tuberculosis alone or of pulmonary tuberculosis plus infection of the larynx or pleura is of interest. These cases were all in the Victoria Hospital.

TABLE 50.

Survival Period of 37 cases of Tuberculosis in the Victoria Hospital, Lovedale.

Duration of Illness.	Male.	Female.
Under 6 months	7	11
6 to 12 months	5	5
1 to 2 years	2	3
2 to 3 years	3	0
3 to 4 years	1	0
	18	19

An analysis of the foregoing 37 cases, together with 52 others for whom information regarding the duration of illness was not available, shows the following :—

TABLE 51.

Age at death of 89 cases of Tuberculosis in the Victoria Hospital, Lovedale.

Ages.	Pulmonary Tuberculosis.		Other Forms of Tuberculosis.	
	Male.	Female.	Male.	Female.
Under 12 months	3	2	0	1
1–5 years	1	4	0	1
5–15 years	2	1	3	6
15–30 years	10	14	3	1
Over 30 years	17	11	6	3
	33	32	12	12

These figures, although small, are in keeping with the indication given by the tuberculin tests, viz., that between the ages of 5 and 15 the incidence of infection is greater in females than in males.

The types of cases met with in the Ciskei are illustrated by the following examples :—

(1) Wife of a native parson near Alice, seen first in December, 1927. This woman, now aged 39, was a nurse at the Victoria Hospital, Lovedale, and left in 1911. She was well up to October, 1926, when she had what she described as an attack of influenza. She has never been well since this attack, and now has a troublesome cough which occasionally causes vomiting, and she has been hoarse for six months. Tubercle bacilli present in sputum. Husband and four children healthy.

Physical Signs.—Extensive involvement of left lung, with signs of cavitation at apex and base. Also early involvement of the right lung.

Seen again, April, 1928. Fluid now present at the left base, but on the whole her condition is better. The temperature has not exceeded 98°F. for the past four months.

This woman had been carrying out instructions given when first seen, and was following sanatorium treatment as far as she could in her own home.

(2) FLORENCE MIBERE, aged 27.—This girl stated that she has had Pott's curvature for as long as she could remember. An abscess was found near the site of the curvature. This was aspirated. No physical signs of lung tubercle were discovered.

Her sister, Linda, aged 19, had been a patient in the Victoria Hospital, Lovedale, about a year previously, suffering from broncho-pneumonia, which at the time was considered as probably tuberculous. No signs suggestive of lung involvement were found on examination.

Dr. Macvicar stated that an uncle of these girls had died about 18 months previously from tuberculosis.

(3) REUBEN RUNE, aged 31, seen at the Victoria Hospital on 24th November, 1927. He stated that he had returned from the mines in September, 1927. He said he had been before the Miners' Phthisis Board, but had not been compensated.

In November, 1927, he was seriously ill with abdominal tuberculosis, and also slight lung involvement. He died two months later. Thus, his whole illness was not six months in duration.

The family history is as follows :—

While this man was working on the mines, a brother aged 13 years, a sister aged 27 years, and his father all died of tuberculosis within the space of one year. These persons were all attended by Dr. Macvicar, who stated that another sister had developed tuberculosis and was then in an advanced stage, and another had developed tuberculous glands.

The mother had died when Reuben was a child. There is some doubt as to the cause of her death, but it was probably tuberculosis.

Of the whole family only one member was healthy—a sister who is married and does not live at the kraal.

(4) JOSEPH MTSHAKAZE, *alias* Mbindla, of Mabandla's Location, Alice.—This case presents a marked contrast to the preceding. He came back from the mines in 1921 and died on November 27th, 1927. A post-mortem examination was made by Dr. Allan, with the following findings :—

An elderly man. Body not wasted. Lungs much pigmented and very adherent. In getting the right lung out a cavity was ruptured in the upper lobe. Tracheal glands much enlarged, hard and pigmented, and on section showed some caseation. As the

lungs were being sent to the Miners' Phthisis Bureau, sections were not made, but numerous nodules could be felt in the lungs. The abdomen was not apparently much involved, but some peritoneal fluid and some thickened peritoneum were sent to the South African Institute for Medical Research, and a culture resulted in the growth of a few colonies of tubercle bacilli of the human type.

The relatives of this man received £81 compensation from the Miners' Phthisis Bureau.

(5) MOUNTAIN CAKUCAKU, male, aged 6 years.—Had Pott's disease in the 11th and 12th dorsal vertebrae. He also had enlarged glands—about the size of marbles—in the right cervical region. He had an illness about a year previous to his being seen and after that illness the swelling on the back was noticed. The glands in the neck had been present for six months before his Pott's disease developed.

The abdomen was prominent, but no areas of resistance or tenderness were detected. There were a few scattered crepitations in the right lung, and a few dry sounds in the left lung. The boy's father works in Cape Town. No other cases of tuberculosis are known in the family.

(6) ANNE MABERE, an old woman.—Had a scar suggestive of old tuberculous trouble in the left axilla. Three years ago, she stated, a swelling appeared on her right side, and this swelling lasted about two years and then burst, and had been discharging for a year. The seventh rib was evidently involved, but the woman would not have it excised. The condition, in all probability, was tuberculous.

(7) SOLOMON RALASHE, aged 40.—This man stated that he had worked for a long time on the mines. He had been at home for five years, and had been ill for three years.

In 1928 he had acute Pott's disease of the 12th dorsal vertebra. There was a swelling present about the size of an orange, which was very tender, and the man was only able to walk with difficulty with the aid of two sticks. No abnormal physical signs were detected in the chest. He gave a positive intra-dermal tuberculin test, but his two children were negative.

(8) ELEANOR MAHLUBI, aged 25; I.D.++ with vesication.—She complained of cough, spit and pain in the right side. She stated that she had been getting thinner during the past four years.

Physical Signs.—Thin chest with deficient movement over the left side; impaired resonance over upper third of left lung, where the breath sounds were bronchial and crepitations were present. Numerous crepitations were present throughout the lower half of the left lung and in the right axillary area.

(9) JOHNSON ZIDAMBA.—Seen on his admission to the Victoria Hospital. He came from the Peddie district. He had worked several times on the mines. He came home in June, 1926, and felt quite fit. Early in 1927 he developed a cough and dyspnoea. He has had several small haemoptyses, and had got much thinner. His father died long ago, of what the man thinks was tuberculosis. His mother died after having had a cough for some time, and his only brother died while this man was in Johannesburg. His wife and three surviving children are healthy. Three children died in infancy.

The whole of the left lung is involved. The man looked very ill. Tubercle bacilli present in sputum. The man himself said that his illness was not due to working on the mines.

What Dr. Allan considered probably the most heavily infected area he encountered in the course of his investigations was Burnshill, about six miles from Middledrift in the Ciskei.

Burnshill is one of the oldest mission stations and there are some 600 Natives living in a village there. Dr. Milne Murray, of Keiskamahoek, informed him that he had found numerous cases of tuberculosis among these Natives, and in October, 1928, Dr. Allan, thanks to information given by the local school-teacher, was able to examine 12 cases of definite tuberculosis in this one locality. The following are brief notes of these cases :—

(10) HAMILTON BAKELA, aged 5 years.—An uncle, Henry Bakela, is reported to have returned home from work in Port Elizabeth, in November, 1927, with pulmonary tuberculosis. This small boy occupied the same hut as his uncle, who died after a few months at home. The child has now advanced tuberculosis of the lungs, with cavitation in the right upper lobe.

(11) RITA BATYI, aged 6 years.—Had consolidation at the right apex, where the breath sounds were bronchial and numerous crepitant râles present. Duration of illness stated to be about six months.

(12) NOTANYI LUFUME, aged 60, female.—Stated to have been ill for one year. She stated that her son had worked on the mines, and had died of chest trouble in 1918. This woman looked ill. The physical signs were extensive, with cavitation at the right apex.

(13) CAROLINE NTSHENLA, aged 30.—Ill for one year. Moderate though definite involvement of the right lung.

(14) HELENA SINAKA, aged 30, female.—Said she had been ill for several years. None of her relatives had been to the mines.

Physical Signs.—Extensive cavity formation at the right apex.

(15) JIKCEWA MGATWELWA, aged 65, female.—Ill for two years with cough and occasional haemoptysis. She has had no relatives on the mines. She had definite physical signs at the right apex.

(16) NOWISILE KESI, aged 26, female.—Said she had been ill for about 15 months. Her husband had worked on the mines, but was apparently quite well when he returned. He later developed a cough and died a year ago. This woman had definite signs at the left apex, dullness, bronchial breath sounds and crepitations.

(17) NDYWESHELA MLUNG'SI, aged 6 years, a blanket Kafir.—Had numerous enlarged glands in the neck with discharging sinuses. Glands were enlarged in the left axilla, and she had arthritis in the left ankle. There is a possibility in this case of infection from the father, who had worked on the mines.

(18) NOYUNTYI MGAZA, aged 40, female.—Ill for six months. No relatives had been to the mines. This woman had extensive involvement of the right lung and left apex.

(19) SIZUVE TUSWA, female, aged 4 years.—Had Pott's disease for two years. There was marked deformity in the mid-dorsal region.

(20) MINA MGCOTSHE, aged 13, female.—Had crepitations over the lower two-thirds of the right lung. Her father, it is stated, died of chest trouble.

(21) JOSEPH GAIKA, Disc No. 6768.—Repatriated from the mines, suffering from tuberculosis, 10th May, 1928. He was examined on 30th October, 1928.

He had a wood and iron house, plastered inside with a thin layer of mud. There was a wooden ceiling. Furniture of European type was used. He had spent all his compensation money on this house, and was poverty-stricken. Food was very scarce and no milk was available.

He stated that he got a little better after coming home, but the improvement did not last long, and when seen he was seriously ill and very thin. There was extensive involvement of the right lung. This man died in April, 1929.

For comparison with the purely Native situation in the Ciskei, the following statistics and note regarding tuberculosis in Kingwilliamstown are appended :—

Tuberculosis in Kingwilliamstown and District.

POPULATION.

European.		Native.	
Urban.	Rural.	Urban.	Rural.
6,000	3,612	4,000	55,000

DEATHS FROM TUBERCULOSIS IN 1926 AND 1927.

European.		Native.	
Urban.	Rural.	Urban.	Rural.
14	1	61	76

Country certificates are not always complete, and many native deaths are not reported.

DEATHS FROM ALL CAUSES DURING 1926 AND 1927, TUBERCULOSIS INCLUDED.

European.		Native.	
Urban.	Rural.	Urban.	Rural.
204	123	574	1,913

The cases of tuberculosis in Natives seen by the medical men in Kingwilliamstown are described as more or less chronic.

Tuberculosis in Europeans in Kingwilliamstown.

Cases of familial tuberculosis in Europeans, similar to those described in Natives, came to Dr. Allan's notice in Kingwilliamstown, for example, a family was seen in consultation with Dr. Burton. The father has tuberculosis of the lungs, and has had several copious haemoptyses; the mother has advanced pulmonary tuberculosis, and also abdominal tuberculosis. One daughter, aged 19 years, had recently died from tuberculosis, while another daughter had advanced pulmonary tuberculosis. She had undergone sanatorium treatment and had improved, but the prognosis was very grave. In the house next door to this family, a whole family had died from tuberculosis in about five years.

Basutoland.

Basutoland is a Crown Colony and its administration is under the British Colonial Office.

Basutoland is a rugged, mountainous country, with peaks rising to 11,000 or 12,000 feet, and is 11,716 square miles in extent.

The Basutos are remnants of several tribes broken up by the wars waged by Moselikatze, king of the Matabele, in the early years of the nineteenth century. These scattered tribes were united under the powerful chief Moshesh in 1818. Many of the Basutos of to-day are descended from the Bakwena and Bataung tribes. These tribes belong to the second group of Bantu people as described by Theal.

Censuses were taken in Basutoland in 1904, 1911 and 1921.

TABLE 52.

Basutoland Population Statistics.

Year.	Europeans.	Natives and Coloured.			Grand Total.
		Bantu.	Mixed and Other Coloured.	Total.	
1904:					
Male ...	520	163,216	137	163,353	163,873
Female ...	375	184,515	85	184,600	184,975
Total ...	895	347,731	222	347,953	348,848
1911:					
Male ...	799	182,583	720	183,303	184,102
Female ...	597	219,224	584	219,808	220,405
Total ...	1,396	401,807	1,304	403,111	404,507
1921:					
Male ...	866	222,342	627	222,969	223,835
Female ...	737	273,595	614	274,209	274,946
Total ...	1,603	495,937	1,241	497,178	498,781

TABLE 53.

DENSITY, ETC., OF POPULATION (OTHER THAN EUROPEAN) OF BASUTOLAND, 1904, 1911 AND 1921.

	1904.	1911.	1921.
Number of Persons per Square Mile	29·70	34·41	42 44
Number of Acres per Head of Population	21·55	18·60	15·08
Number of Occupied Huts per Square Mile	7·40	9·54	—
Number of Persons per Occupied Hut	4·01	3·61	—

Tuberculosis in Basutoland.

Tuberculosis among Natives in Basutoland is not so prevalent as in the Transkei. The number of cases seen to-day is very small, and the opinion of medical men and others in a position to judge is that it is a comparatively recent introduction.

Dr. Neil Macfarlane, late Principal Medical Officer of Basutoland, states that it was very rare indeed 40 years ago. About that time cases began to appear in boys returning from work in the Union.

In the Basutoland Government Report for the twelve months ended 30th June, 1906, attention is drawn to the spread of tuberculosis. Dr. Macfarlane, who was then at Leribe, states: "Phthisis is becoming more common in the district. Hitherto it has not been indigenous to this part, and the cases seen were boys who had been working on the mines and in Johannesburg; but now it is attacking others who have never left the country."

Dr. Hertig, of Morija, in a letter in 1907, quoted by Dr. Macvicar, stated that in the eight years prior to that date he had examined some 50,000 Basutos, and had found 250 cases of tuberculosis among them, and these mostly in the last four years. All these cases were pulmonary in type, and all except seven were in persons who had been out of the country. Unfortunately, Dr. Hertig was killed in an accident in 1929, and it was not possible to ascertain what his later experience had been.

Dr. Macvicar (*l.c.*) quotes Dr. G. A. Casalis, who was for a time in Basutoland at Thlotse Heights, as stating that tuberculosis did exist among the children in Basutoland, but it was rare.

The disease is to-day not regarded as a menace, and there does not seem any likelihood of its assuming epidemic form, such as occurred among the Plains Indians of Canada in 1882.[67] There was a sudden change in the mode of life of these Plains Indians following the disappearance of the herds of buffalo in 1879.

With the South African Natives no such drastic change has taken place, and their mode of life is the same as it was centuries ago, except that migrations have ceased, the density of the population has gradually increased, and a varying, but increasing, proportion seek employment in industries.

A marked difference is seen in the two groups of South African Natives, when mortality returns of these Natives in industrial employment are compared.[68]

Territorial Analysis of Mortality from Disease (rate per 1,000 *per annum of Natives employed on Gold and Coal Mines.*

	1925.		1926.		1927.	
	Gold.	Coal.	Gold.	Coal.	Gold.	Coal.
Natives from—						
Cape Province ...	5·96	20·51	6 33	18·85	7·0	15·96
Basutoland ...	11·41	24 84	12·14	16·76	14·32	19·21

Very few actual cases of tuberculosis were seen by Dr. Allan on the occasion of his visit to Basutoland in 1929, and most of his time there was taken up with tuberculin tests. The results of these are considered on pp. 203 to 206 and need not be further dealt with here.

Cases of definite tuberculosis examined in detail were only three in number :—

(1) A boy aged about 18, with Pott's curvature.

(2) PETER SELLO, aged 38 years.—This man stated he had worked for 15 months on the mines, and had been home for two years. He said that he had had a troublesome cough, and had coughed up blood. His general condition was good and the only abnormal physical signs found in his chest were flattening at the left apex, with impaired resonance in that area.

(3) LEAON, aged about 55 years.—Stated that he had worked for a long time on the mines and had been home for three years.

Physical Signs.—Impaired resonance at the right apex, where the breath sounds were bronchial. Marked dullness at the right base, crepitant râles in both nipple areas.

Natal.

Investigations were not made on the same scale in Natal and Zululand by Dr. Allan as in the districts already described, but a few representative places were visited in order to make the examination of the various sections of the Native population more nearly complete.

The principal industry of Natal and Zululand is sugar cane growing, the milling of cane and the production of sugar. Over 200,000 acres are devoted to the growing of sugar cane. Cane cultivation commenced in Natal about 1850, but the Zululand estates are of much more recent date. Indians are largely employed on the sugar estates.

A visit was paid to the Mount Edgecombe Sugar Estates, which is representative of such estates.

Mount Edgecombe Sugar Estates.

Natives are recruited in Pondoland on six months' contract. There are 300 Natal Natives employed and approximately 1,000 Pondoland and East Griqualand Natives, and with the constant change the total number of Natives employed annually is about 2,000. They range in age from boys of 12 years of age to men of about 35 years of age.

Housing is on the small-room system, as at Umbogintwini (see below).

The weekly ration per head is as follows :—

	lbs.
Mealie Meal	16½
Maize	1
Samp (Crushed Maize off the Cob, boiled) ...	1
Beans	2
Meat	2
Onions	½
Potatoes	1
Sugar	½
Salt	½

Half a gallon of Kafir beer is issued per week. Meat is issued, 1lb. on Sunday and ½lb. on Tuesday and Thursday.

The mealie-meal is used to make porridge, *puto* (a dry porridge) and marewu.

There is a resident medical officer and a hospital on the estate.

In 1928 there were six deaths of natives in hospital, one of which was due to tuberculosis. This case developed after a seeming attack of influenza and was acute, the course being less than one month.

In 1929, up to the end of August, there were three deaths, two being due to tuberculosis. One case was that of a Native, aged 48 years, and his illness was stated to be of long standing. The other case was that of a boy who had worked for a long time on the estate, and who was admitted to hospital six weeks before his death. When reported sick there was evidence of cavity formation in his lung.

There is no medical examination made of boys leaving the Company's employ, so that cases of tuberculosis may go home without being detected, and it is probable that only those cases which become gravely ill come to the medical officer's notice.

There are some 5,000 Indians resident on the estate—men, women and children. Tuberculosis is stated to be much more common among them than among the Natives, but no definite details were available.

South African Explosives Factory, Umbogintwini.

As representative of industries other than sugar production, a visit was paid to the South African Explosives factory at Umbogintwini, South Coast, Natal. At this factory the main products are fertilizers and sulphuric acid.

The employees in 1929 were as follows :—

Europeans	... ...	150
Indians	... ...	89
Natives :	Cape Province	437
	Natal	372
	Nyasaland	40
	Coloured	25

The Natives are partly recruited and partly voluntary labour. Recruiting is carried out in the Matatiele district, and the recruited boys are Basutos, Hlubis (Fingoes) and Tembus. Non-recruited boys came from Mount Frere (Bacas) and Mount Ayliff (Xosibe). The average contract is six months.

The Natives are housed in small dormitories for 4, 8 or 16 boys. The beds are wooden planks on iron supports, similar to hospital beds in many mine hospitals.

The rations consist of the following amounts per head :—

Daily : 3lb. mealie-meal, 4oz. dried beans and 2 fluid oz. of Tomango (orange juice).

In addition, 2oz. monkey nuts and ½lb. sweet potato are given twice a week. Meat, 2lb. per head, is issued on Saturday. Meat includes bone but is mostly hindquarter joints. This is given uncooked, and the Natives cook it themselves, often by grilling over the coals.

The mealie-meal is used for porridge, puto and marewu, which is issued *ad lib.* The mealie-meal is ground daily. Twice a week boiled mealies are given, with a proportionate reduction of the day's ration of mealie-meal.

Milk (or amasi) is not given, but is readily obtainable for those boys who want it.

Except for the meat, the other rations are cooked before issue. The cooking is done in steam-jacketed cookers.

The Native employees get three meals a day. Breakfast at 6 a.m.—Porridge, puto and marewu.

Midday meal at noon.—Porridge, puto, marewu, Tomango and monkey-nuts.

Supper, 5 p.m.—Porridge, puto and marewu.

There are approximately some 1,000 Natives employed per annum. Many come on a six months' contract, so there is a constant change.

The deaths from tuberculosis in Natives average two or three a year. The number of tuberculous Natives is approximately about 12 per annum. The majority of the cases seem to occur among boys working on the acid plant. Forms other than pulmonary are rare.

There is a resident medical officer at the factory and a hospital of 24 beds. The average daily number of in-patients is four. When a Native is found to be suffering from tuberculosis he is not repatriated but endeavours are made to find him a light job.

The incidence of tuberculosis among the Europeans is very small. One man had tuberculosis and remained at work for many years.

Tuberculosis as seen at the Addington Hospital, Durban.

An analysis was made of the registers of the Addington Hospital, Durban, as affording some sort of a cross-section of the tuberculosis position in general in Natal.

In the first six months of 1929, the following persons suffering from tuberculosis were admitted to the Addington Hospital :—

Race.	Pulmonary.	Non-Pulmonary.	Total.
Europeans	20	3	23
Natives	98	34	132
Indians	20	15	35
Coloured	—	2	2
	138	54	192

In races other than Europeans, the proportion of non-pulmonary cases is high.

Europeans.

Total number admitted suffering from tuberculosis in all forms=23.

Total number of deaths from tuberculosis=5.

Of the 20 pulmonary cases, 2 are described as acute and both died in hospital. 18 are described as chronic, of which 1 died in hospital.

The non-pulmonary cases in Europeans were :—

Tuberculous Glands	2
Tuberculous Hip	1

Both the Coloured cases had tuberculous disease of the hip.

Natives.

Total number admitted suffering from tuberculosis=132.

Of the 132 there were 58 deaths.

There were 98 pulmonary cases, of which 30 are described as acute, and 62 chronic.

All acute cases died in hospital with the exception of 2, whose death occurred after discharge.

The non-pulmonary cases admitted were :—

Tuberculosis of Spine	4
Tuberculosis of Hip	4
Tuberculosis of Other Bones	3
Tuberculosis of Other Joints	3
Tuberculosis of Glands	16
Tuberculosis of Intestine (1 fatal)	2
Tuberculosis of Meninges (fatal)	1
Tuberculosis of Skin	1
	34

Indians.

Total number admitted suffering from tuberculosis=35.

Total number of deaths in hospital=13.

20 cases were admitted with pulmonary tuberculosis, and of these 11 are described as acute and 9 chronic.

9 of the acute cases died in hospital.

NON-PULMONARY TUBERCULOSIS IN INDIANS.

Tuberculosis of Hip	2
Tuberculosis of Other Joints ...	3
Tuberculosis of Bones	3
Tuberculosis of Glands ...	3
Tuberculosis of Intestine ...	3
Tuberculosis of Pericardium ...	1
	15

Zululand.

In Zululand proper the situation as regards the population is more comparable with the Transkei than is Natal as a whole ; there being a large Native population and a very small European one.

The area of Zululand is 10,427 square miles, and the population of Natives at 1921 census was 252,464. The European population was 3,983. Thus, the population per square mile is 26 Natives as against more than double that number in the Transkei.

The land is more fertile and the rainfall is also better than in the Transkei, being between 30 and 40 inches annually in Zululand. The country is not so overstocked so that, economically, the Native of Zululand is much better off than his Transkeian brother.

Thus, in 1921, out of over 1,000,000 Natives in Natal and Zululand, only 24,335 went to the gold mines, as against 73,519 from the Transkei and Ciskei, where the Native population was about one-quarter more.

The Zulu is more pastoral than agricultural. He regards himself as the aristocrat of the Bantu people, probably largely because of the superiority he showed in the wars under Tshaka in the early years of the nineteenth century. As will be seen from the analysis of Natives employed on work in Natal, the Zulu constitutes a small proportion of those employed. Even on road-work in their own territory, the Zulus constitute a very small proportion of the Native labour, and Natives from other parts are imported for the work.

The conditions of life and the economic position of the Natives in Natal and Zululand were not investigated in detail by Dr. Allan as in the Transkei, but the general impression gained on his visit was that the Zulus are much better off than the Natives of the Transkei and Ciskei.

In his report of the Tuberculosis Survey of the Union, he recorded the results of an investigation of these parts made in 1922. At that time he found that medical men who had practised in that area for many years were of opinion that there was a decline in the incidence of tuberculosis among Natives.

After the Anglo-Boer War, and after the East Coast fever which carried off many of their cattle, the economic position was bad. Dr. Wildish, of Eshowe, stated that he often saw at that time as many as five cases of Native tuberculosis a day. As the economic position improved, the number of tuberculotics diminished and in 1921 he only saw 50 cases out of 3,000 Native patients in that year. In 1929 the proportion was even less.

The following cases were seen at Eshowe :—

(1) A Zulu boy, aged about 10 years, was stated to have been ill for two years. He had a troublesome cough, and had occasionally coughed up blood. His general condition was good.

Physical Signs.—Impaired resonance at both apices, more marked at right apex. Impaired resonance and feeble breath sounds at the right base, suggestive of old pleurisy.

(2) Zulu girl, aged 23.—Had enlarged cervical glands of three months' duration.

(3) KWALI FAMILY.—These are dressed natives. A small boy aged about eight years was in hospital with tuberculosis of the knee joint, and tuberculous glands in the neck. There is a history of familial infection. The mother has had pulmonary tuberculosis for ten years, and was acutely ill during the puerperium following the birth of this boy. The husband developed tuberculosis and was ill and unable to work for four years. He has now sufficiently recovered to work as a taxi-driver.

(4) DAVID MARUPER.—Seen in hospital at Eshowe. He is not a Zulu but has lived in Zululand for many years, and has been ill for the past ten years. When seen he was confined to bed with advanced disease of both lungs. His temperature was running from 97·8° to 101·4°F.

(5) PHELMAN, aged 20.—Had tuberculous glands in the neck.

(6) FREDDY NDELE, aged 41.—Stated that he had worked on the gold mines and at Kimberley.

Physical Signs.—Impaired resonance and harsh breath sounds over left upper lobe. Crepitation throughout right lower lobe. The general condition was good.

(7) ALEXIUS NKOMANZI, aged 42.—Said that he had worked for three years on the gold mines at Brakpan and Driefontein. Part of the time he was engaged on drilling, and later was employed as a boss-boy.

In 1917 he went to France with the Native Labour Corps, and was employed at Le Havre and Rouen. He escaped the influenza epidemic, and returned to his home in 1918. After his return he did not feel well, and did not attempt to go off to work till 1923. He was rejected as medically unfit for work on the mines. He had a cough at that time which has got worse, and on several occasions he has coughed up blood. He is now very hoarse and very short of breath.

Physical Signs.—Resonance generally impaired all over the left lung, where the air entry is poor; some crepitations are present at the left base.

He is unable to work, but is still fairly well nourished. He has a wife and four children alive. One child "died of cough" at the age of four months.

(8) MUDOKALWENI SHANDU, aged 50 years, single.—Has been ill for seven years. He had worked in the coal mines but never on the gold mines. He has a troublesome cough, and had coughed up blood. He stated that he was getting thinner.

Physical Signs.—Impaired resonance over both upper lobes, more marked on the left side. Numerous crepitations were audible over both upper lobes, the breath sounds were bronchial at the left apex, and feeble at the right apex. One brother is stated to have died of tuberculosis.

Tuberculosis of bones is stated to be rare in this area, and Dr. Wildish said that he had only one patient, an adult male with spinal caries.

General.

The Zulus are not tubercle-free, but the disease does not appear to be very common amongst them, and from the cases seen by Dr. Allan (as illustrated by those quoted above) he formed the opinion that the disease tended to run a more chronic course than among the Transkei Natives.

This opinion was not corroborated, however, by Dr. MacMurtrie, the medical officer in charge of the Marianhill Mission Station near Pinetown, which was also visited by Dr. Allan. Dr. MacMurtrie had previously been for many years in charge of the mission hospital at St. Cuthbert's, near Tsolo in the Transkei, so that he is in a position to make comparison between the type of tuberculosis in Natives in Natal and in the Transkei. In Dr. MacMurtrie's experience the Native in Natal had the more acute type.

6. SUBSEQUENT HISTORY OF REPATRIATED BOYS.

The third line of investigation was the tracing of Natives repatriated from the Rand with tuberculosis. Those who could be seen were examined and also as many contacts in their families as possible.

This work was very difficult, as Natives often change their names when going to work, and in other cases a boy will assume the name of some other boy. This happens when the latter has paid his taxes and the former has not done so. Natives are often very careless, and lose the discs and papers by which one could identify them, so that in many instances the help of a local trader or official had to be obtained to identify the boy.

For this line of investigation—planned to ascertain the ultimate fate of repatriated Natives and also to discover to what degree, if any, the repatriates were responsible for the spread of tuberculosis in the

Territories—Dr. Allan was kept supplied periodically from the Chamber of Mines with lists of Natives repatriated during the years 1926, 1927, 1928 and 1929.

These lists gave the dates of repatriation, names, residences and other necessary details for tracing the individuals.

The actual tracing of them was done in 1928 and 1929, so that for some of the earliest repatriates their condition was ascertained nearly as long as four years after their leaving the mines, whereas for the latest cases only a six months' subsequent history is available.

694 repatriates during these four years represents the total of the lists supplied to Dr. Allan, and of this total he was able to ascertain the fate of 475.

The details of this investigation have been filed with the Committee by Dr. Allan, but it is unnecessary to give these in full here.

The following summary, with some illustrative details and comments will sufficiently bring out the information elicited by this laborious piece of work.

Table 54 shows at a glance the fate of all cases traced, whilst Table 55 gives a percentage analysis of the survival periods.

Leaving out of account the 1929 repatriates, for none of whom a full year's subsequent history was available, and for whom even the six months' return is not complete, it will be seen that of the three years, 1926, 1927 and 1928 batches, information was obtained of 348 repatriated Natives, of whom 138, that is, *39·9 per cent.*, had died within *one year* of repatriation.

Of the two years 1926 and 1927 batches, 207 boys were traced, of whom 120, that is, 58 per cent., were dead within *two years*.

Condition of Survivors after Two Years' Repatriation.

Dr. Allan has divided the survivors into the following three groups :—

Group 1.—Cases of cure or arrest, the individuals being fit to return to heavy work.

Group 2.—Cases fit for light work at home.

Group 3.—Cases alive but unfit for any work and with a bad prognosis.

Group 1.—Cases of cure or arrest of the disease, to such an extent that the individual was able to return to industrial pursuits.

The majority of the cases coming under this heading were naturally not seen by Dr. Allan, but the information regarding them may be taken as reliable. The following are illustrative cases :—

(1) DISC 5396, JACOB ZAMANI, aged 40, of Middledrift district.—Repatriated 17th June, 1926. Examined 23rd November, 1927, 18 months after repatriation. Married, three children (healthy). He was compensated £35 10s. 0d.

Condition at 23rd November, 1927.—Well nourished and general condition very good No cough and no sputum.

TABLE 54.

SUMMARY OF FATE OF REPATRIATED BOYS.

Year.	Total on Repatriated Lists.	Total Traced.	Total Examined.	Total Dead.	Died within 6 months of Repatriation.	Died within 6 to 12 months after Repatriation.	Died within 1 year to 1½ years.	Died within 1 to 2 years after Repatriation.	Lived 2 years died within 3 years.
1926 ...	123	85	13	49	23		11	11	4
1927 ...	148	122	38	76	32	19	16	8	1
1928 ...	186	141	25	71	44	20	6	1	—
1929 ...	237	127	11	51	45	6	—	—	—
Totals ...	694	475	87	247	—	—	—	—	—

TABLE 55.

PERCENTAGE ANALYSIS OF THE SURVIVAL PERIODS.

Year.	Total Traced.	Dead in 6 months	Dead 6–12 months.	Dead 1 year to 18 months.	Dead 1½ to 2 years.	Dead 2 to 3 years.	Period.	Total Percentage Dead
1926 ...	85		23 or 27·0%	11 or 13%	11 or 13%	4 or 4·7%	3 years	57·7
1927 ...	122	32 or 26·2%	19 or 15·5%	16 or 13·1%	8 or 6·5%	1 or 0·8%	2 years	61·3
1928 ...	141	44 or 31·2%	20 or 14·0%	6 or 4·4%	1 or 0·7%	—	1 year	45·2
1929 ...	127	45 or 35·4%	6	—	—	—	6 months	35·4

Physical Signs.—Slight flattening over left side. Impaired resonance general over left side. Breath sounds bronchial at apex. Slightly impaired resonance at right apex and right base. Breath sound diminished at base. Some pleural crepitus in left axilla and some indefinite crepitations at both bases.

Dr. Allan considered this boy an arrested case. He went off to work at Port Elizabeth soon afterwards, and was reported alive and well on 31st December, 1929.

(2) DISC 5207, JOSIAH ZINTO, *alias* Colenso Sivundle.—Repatriated 4th March, 1926. Was stated by the relatives to be working on the surface at No. 15 Shaft, Crown Mines, on 13th January, 1930.

(3) DISC 5456, POLWENI REBI.—Repatriated on 15th July, 1926. Reported as having returned to the Rand in December, 1928.

(4) DISC 5619, DYABOSINI QUNGA.—Repatriated on 7th October, 1926. Returned to Rand as a recruit, T.P. No. 182,985, batch 1,396 from Queenstown on 13th September, 1928. Dr. Allan was assured by his relatives that this is the same man who was repatriated.

(5) DISC 5646, QADOLO DAYALE.—Repatriated on 11th November, 1926. Was reported at work at Jagersfontein on 30th October, 1928. The local trader who knew the man well, stated that Qadolo was paying off a debt, and sent instalments periodically.

(6) DISC 6206, SHADRACK BUNGANI.—Repatriated on 30th June, 1927. Working with a road party on 30th March, 1929.

(7) DISC 6357, TAX INDEX NO. 49.29.409, PERCY KANYU.—Repatriated on 3rd November, 1927. This man is exempted from tax payment on account of his illness. His relatives twice informed Dr. Allan that he is working in Johannesburg.

(8) DISC 6434, QAMA KHOTAMA.—Repatriated on 3rd November, 1927. Working on sugar estates in 1929.

Histories were obtained of a number of boys who had returned to work within two years of repatriation, but as their condition at the end of the two-year period was not ascertainable they are not included here.

The following case might be included in the Group, although the boy had not actually returned to industrial work. Dr. Allan's report on him is as follows:—

(9) DISC 5208, MKOKOTWANA MPOTYA, aged 24, a Pondo of Elliotdale district.—Repatriated on 11th March, 1926. Examined on 11th November, 1928. Married, wife and two children healthy.

Condition at 11th November, 1928.—No cough and no sputum, and said he was getting fatter.

Physical Signs.—Impaired resonance at right apex, where breath sounds bronchial. Impaired resonance right axilla, where a few crepitations were audible.

This looked like an arrested case.

Group 2.—Cases fit for light work at home.

The following are typical cases reported by Dr. Allan as falling into this Group :—

(1) DISC 5152, MPRINGOBOLA NOTA, aged 54 years, Kentani district.—Repatriated on 18th February, 1926. Examined on 22nd February, 1929, three years after repatriation. No history of tuberculosis known in family. Wife and three children healthy.

Condition at 22nd February, 1929.—General condition good. Rather short of breath. Has slight cough and some sputum. No haemoptysis.

Physical Signs.—Well-formed chest. Marked flattening over right side. Dullness at right upper lobe and at right base. Percussion note impaired at left apex. Crepitations throughout right lung. Breath sounds bronchial at right apex, and feeble at right base. In addition, there was some rib involvement, two sinuses being present, one below right nipple and one at lower end of sternum.

A Stage 2 case whose general condition was good. Food, including milk, plentiful. Man able to work at home.

(2) Disc 5270, Mcizwa Sibanjo, aged 25 years, married, Ngqeleni district.—Repatriated on 8th April, 1926. Examined on 12th September, 1928, and 20th January, 1930.

This boy said he had only been on the mines once, when he worked for six months underground pushing cocopans.

Condition at 12th September, 1928.—Sparely-built man but quite active. He had a slight cough but no sputum, and is not short of breath.

Physical Signs.—Dullness at right apex and over right lobes. Crepitations lower two-thirds of right lung. A few crepitations in left axilla.

Condition at 20th January, 1930.—Very good.

Physical Signs.—Dullness as before, but crepitations diminished.

A Stage 2 case with very good general condition.

(3) Disc 5472, Malumko Bakabu, aged 23, Elliotdale.—Repatriated on 22nd July, 1926. Examined on 11th October, 1928. This man had walked over 20 miles just prior to being examined. General condition very good.

Physical Signs.—Dullness. Bronchial breath sounds and crepitations at the right apex.

(4) Disc 5499, Tom Ngqukumbana, aged 43, of St. John's district, a Pondo.—Married, three wives and three children, all healthy. Repatriated on 29th July, 1926. Examined on 24th September, 1928.

This man appeared well-to-do, and when seen he was selling his crop of mealies. He is able to walk about and carries on his own farming operations. He had no cough and no sputum, and his general condition was very good.

Physical Signs.—Dullness over left upper lobe, where breath sounds are bronchial, and numerous crepitations present. Resonance slightly impaired at right apex.

(5) Disc 5505, Mkotsi Mpulwana, aged 32, a Pondo, of Umtata district.—Repatriated on 12th August, 1926. Examined on 10th September, 1928.

Condition at 10th September, 1928.—This man appeared very well. He was found at a beer-drink. He stated that he still had a little cough and spit, and occasionally his sputum was blood-stained. He was a thin man.

Physical Signs.—Flattening at both apices. Marked dullness upper third of both lungs, where breath sounds were low, bronchial and numerous crepitations were present, especially in the right lung.

A Stage 3 case with good general condition. Wife healthy. Food, including milk, was plentiful.

(6) Fanasi Mgqakwe, aged 35, a Xosa, living on the sea-coast.—Repatriated on 12th August, 1926. Examined on 21st February, 1929. Married, 5 children alive.

Condition at 21st February, 1929.—Well-nourished, healthy-looking man.

Physical Signs.—Flattening over left side, where movement deficient. Impaired resonance over left upper lobe and at left base. Breath sounds bronchial over left upper lobe, where a few crepitations are audible. Air entry poor in left axillary area.

Food rather scarce. A Stage 2 case whose general condition was good.

(7) Disc 5524, Johnson Gwazela, a Fingo, aged 39 years, married, no children.—Repatriated on 12th August, 1926. Examined on 19th October, 1928.

Condition.—Thin man, but otherwise appeared well. Had a slight cough, and said he was putting on flesh.

Physical Signs.—Dullness over upper two-shirds of right lung, where air entry is poor. Crepitations throughout right lung, and a few in left axilla.

Food is plentiful, including milk. This man was compensated £44. Hut was furnished in European style.

(8) Disc 6115, SANOYI GABAYI.—Repatriated on 5th May, 1927. Seen in Johannesburg prior to his repatriation. He gave a mine history of about five years. He was aged 34 years. Weight, 128lb; temperature, 97°–100°F.; pulse, 108. He was seven days in the Mine Hospital and 22 days in the Witwatersrand Native Labour Association Hospital before coming home. His sputum contained tubercle bacilli. He was compensated £86 19s. 3d.

Physical Signs.—Marked dullness upper two-thirds of right lung. Low-pitched bronchial breath sounds at apex. Numerous crepitations throughout right lung. Percussion note impaired at left apex where the breath sounds were harsh. Crepitations present at left base.

The Bureau diagnosis was tuberculosis of lungs, but no silicosis.

Seen in the Transkei on 16th November, 1927, *i.e.*, six months after repatriation, his weight (clothed) was 147lb., and allowing 10lb. for clothes, he had gained 9lb. in weight. He said he felt quite well, and had no cough and no spit. He had two wives and three children, all of whom were well.

Physical Signs.—Dullness and breath sounds as at 5th May, 1927, but crepitations very much diminished in extent, and limited now to right upper lobe and left axilla.

16th October, 1928.—Again examined. He was looking very well and said he felt quite well. He had no cough and no sputum. Dullness and breath sounds as before, but crepitations only heard after coughing over a limited area in right upper lobe.

About the end of 1928, this man felt so well that he went off to work in Cape Town. He was employed at a pumping station at Maitland. After three months he became ill again and returned home in March, 1929.

22nd January, 1930.—Dr. Allan again examined this man on 22nd January, 1930. He had lost flesh and was rather hoarse. His cough was again troublesome. Temperature and pulse at 11.45 a.m. were: Temperature, 100·2°F.; pulse, 120. Weight, 131lb. (clothed), a loss of 16lb. since 16th November, 1927.

Physical Signs.—Dullness and breath sounds as before. Crepitations now present over right upper lobe.

General Condition.—Poor. This man has had no special treatment, and improved until he went away to work. His case is instructive, as it appears that if he had not undertaken comparatively heavy work in Cape Town, he would have continued to improve.

Group 3.—Cases alive but unfit for any work.

Two illustrative examples of this Group may be given :—

(1) Disc 5132, MAHLUMUWE MABAYI, aged 37 years, Mqanduli district.—Repatriated on 4th February, 1926. Examined on 19th October, 1928, over 2¾ years after repatriation. Married, one wife and one child.

Condition and Physical Signs at 19th October, 1928.—This man was emaciated and was lying outside his hut. Marked dullness throughout left lung, with large areas of bronchial breath sounds over both lobes. Numerous crepitations throughout whole of lung. Dullness over right upper lobe, where breath sounds bronchial, and numerous crepitations throughout lung.

He was an advanced Stage 3 case, and had in addition acute spinal caries. All the lumbar spines were prominent, and there was marked swelling and tenderness over that area.

The prognosis was very bad. This family is stated to be leprous. Food, including milk, plentiful.

(2) KONANA MPIKWA, aged 40, Pondo, living in Ngqeleni district.—Repatriated on 3rd June, 1926. Examined on 12th February, 1929. Married, wife healthy, no children.

Condition at 12th February, 1929.—Thin man, rather breathless, with marked clubbing of fingers. Cough troublesome and occasionally spits blood. Cannot walk far but goes about on horseback.

Physical Signs.—Extensive, practically whole of left lung being involved, and also large areas of left lung. Breath sounds are bronchial at both apices, poor air entry lower two-thirds of right lung. Numerous crepitations throughout left lung, and a few in right lung.

General condition fairly good for a Stage 3 case. Food, including milk, plentiful.

As a summing up of the whole of his work in tracing the fate of Natives repatriated to the Territories with tuberculosis, Dr. Allan gives the following round figures :—

Condition of Repatriated Boys at end of Two Years.

Dead	60	per cent.
Alive, fit to return to heavy work	4	„
Alive, fit for light work at home	26	„
Alive, quite unfit for any work	10	„

6. Tuberculosis in Families and the Spread of Tuberculosis by Repatriated Mine Boys.

Another line of enquiry pursued by Dr. Allan in the Native Territories was an endeavour to find out to what extent tuberculosis prevailed as a familial disease and how far this was attributable to infection spread by repatriated tuberculotics from the mines.

This objective was kept in mind throughout the whole period of his investigations, but in spite of the time spent there and the variety of districts covered, he has found it impossible to give a completely satisfying answer to this question.

It is impossible to take up the attitude that the repatriated tuberculotic plays no part in the spread of the disease, but it seems equally impossible to believe that he is the sole or even almost the sole agent responsible for its wide dissemination. The truth would seem to lie somewhere between these extremes but exactly where is very difficult to ascertain.

The explanation of this difficulty is twofold :—

(1) The fact that there is now so much endemic tuberculosis among the Natives of the Ciskei and Transkei that it is, in many instances, impossible to be certain where the infection has been acquired, the possibilities being so numerous.

(2) The fact that in many cases the incubation period appears to be so long—two years or more. This further complicates the difficulty of tracing the source of infection.

It is perfectly clear to-day that the repatriated tuberculotic is returning to anything but a tubercle-free population.

The earlier introduction and spread, so far as it can be traced, has already been dealt with in Part I. of this Report and need not be further discussed here. Nor need we at this point dwell further on the question of how far the repatriated tuberculotics in the past have been respon-

sible for the spread of the disease. It will have been already noted from the evidence adduced in Chapter III, Part I, that there is divided opinion even on that point.

We have to deal with things as they are now and need only consider here how far the repatriated tuberculotics of to-day are responsible for the dissemination of tuberculosis.

The considered opinion come to by Dr. Allan after 2½ years' study of the question is that the part played by them is small.

In his reports to this Committee, Dr. Allan writes as follows :—

"I have heard of several instances where a family of Natives has all perished of tuberculosis within a short period of the introduction of the first case from the mines. The statements have been made by people whose good faith could not be doubted, but I have never personally seen such an instance, and no such tragedy has come to my notice in the families of the boys with whom we are now dealing. On the contrary, I have been impressed by the few instances where there seemed a definite history of infection in the families of repatriated mine-boys. I do not intend to convey the impression that infection of such families does not occur, but that the Natives in their home surroundings and living their natural lives, have a certain degree of resistance."

As examples of instances where, in all probability, family infections were originally brought from the mines, he cites the following instance of the Mapukata family :—

The Mapukata family living in Idutywa district. Two brothers in this family were repatriated from the Rand suffering from tuberculosis during the period of this investigation.

(1) Disc 6216, JAMES or MPUHLE MAPUKATA.—Repatriated on 7th July, 1927. This boy was seen in Johannesburg prior to his repatriation. He was about 30 years of age and married. He had a labour history in the mines totalling 45 months. He had been 7 days in the mine hospital, and was repatriated after 13 days at the Witwatersrand Native Labour Association Hospital.

Condition at Time of Repatriation.—Weight, 132lb; temperature, normal; pulse-rate, 80. He looked fairly well, but rather thin. Tubercle bacilli were present in his sputum.

Physical Signs.—Flattening at right apex. Percussion note impaired upper third of right lung, where his breath sounds were bronchial and crepitations were present. Crepitations were present at the left base.

Visited his home on 10th November, 1927. The boy was away from home, but his relatives stated that he was quite well. Again visited the kraal on 10th October, 1928, and was informed that James had died during the previous month. His wife returned to her own people.

The next time the kraal was visited was on 28th June, 1929, to see a brother, Bennett, Disc No. 7010, repatriated on 11th October, 1928.

(2) BENNETT MAPUKATA, aged 44, married.—Has had four children, three of whom died in infancy. One child, a boy, aged about 16 years, was still alive and healthy.

Condition at 28th June, 1929.—Man walked with difficulty on account of dyspnoea. He was quite unable to work. His cough was troublesome and he said he had coughed up a lot of blood about a week previously. He was thin and looked ill.

Physical Signs.—Marked dullness over left upper lobe. Breath sounds bronchial at apex; numerous crepitations throughout left lung. Percussion note impaired at right apex, where the breath sounds were bronchial. A Stage 2 case, with considerable constitutional disturbance.

In January, 1930, he was still alive, but bed ridden, and the prognosis was very bad.

The family history as given by an uncle was as follows:—

The father of these two men had worked on the mines, and had died of chest trouble in 1923. A sister, aged 22 years, died from chest trouble soon after the father. A brother, Ntsentse, aged 35, was repatriated from the mines suffering from tuberculosis, and died early in 1927. The mother was alive and well.

Thus, in the Mapukata family, the following deaths occurred from tuberculosis:—

(1) Father (ex-mine worker)	1923
(2) Sister (aged 22)	1923
(3) Ntentse (aged 35, ex-mine worker)	1927
(4) James (aged 30, ex-mine worker)	1928

While (5) Bennett, aged 44, is seriously ill in 1930.

In this family there is the possibility that the father contracted the disease on the mines and infected the family. The three sons were apparently healthy when they went to the mines, but broke down under industrial strain.

Cases 10 and 14 from the Butterworth area (see pp. 210 and 211) and the Kwali family in Zululand (see p. 233) are also instances of probable spread of infection from mine tuberculotics.

On the other hand, similar cases can be quoted in families where there has been no connexion with the mines, such as the Gaza family at Engcobo, and the family of a Native police constable at Kokstad (see p. 217).

The Native interpreter and his family in the Matatiele area (see p. 220) is another example of this class, also the family of Gabiso Nylla in the Butterworth area (see p. 210).

For independent evidence on this question, Dr. Drewe, of Holy Cross Mission, was asked by Dr. Allan to keep a record of the cases of tuberculosis seen by him. Dr. Drewe kindly did so and made notes *of those who had had any connexion with the mines and those who* had not.

In only some 25 per cent. of the cases was there any possibility of mine-infection.

In tracing the repatriates, Dr. Allan came across many instances *in which there was no evidence of the disease having spread from them* to other members of their families but, of course, it must be remembered that if the incubation-period is often as long as two years, then his period of follow-up was not sufficiently long to give a conclusive answer to this question, from his own observations alone.

In arriving at the conclusion that familial spread was not a very common phenomenon, Dr. Allan had to depend to some extent on opinions expressed by medical men and others with a lengthy experience *of individual Natives and families.*

Such an opinion was typically expressed by Dr. Macvicar when he wrote in 1907:—"In spite of conditions which seem so favourable to its spread, the tubercular infection, when introduced into a family, does not as a rule spread rapidly from person to person. In some

families, while some members suffer, others escape, regardless it would seem of age, and in those who are attacked, the period of incubation is long—two years and even longer."

There seems to be no reason to think that conditions in this respect have materially changed since that date.

Similarly with regard to the opinion expressed regarding the frequently long incubation period of the disease. This opinion is also partly dependent upon the observations of others.

Although quite a number of cases were encountered by Dr. Allan in which the evolution of the disease was rapid (see, for instance, Cases (4), (10) and (14) from the Butterworth area (pp. 210 and 211), and Cases (2) and (3) from Pondoland (p. 214), nevertheless his opinion is that much more frequently the evolution is slow, extending over a period of two years or longer.

Possible Reasons for Non-spread of Disease by Returned Mine Boys.

(1) The more acute cases die very soon after their return home.

(2) The majority of mine boys are blanket Kafirs. At home they are seldom in the hut except at night and during inclement weather. As long as they are able to move out of the hut they do so and sit in the sunshine.

During the night they cover their heads with their blankets and this prevents dissemination of spray. There is a fire burning in the hut and the sick boy spits into the fire.

During the daytime the blanket is exposed to the sunlight.

When a tuberculotic becomes too ill to move out of the hut, a little fine ash is used as a spittoon and later thrown out, and the sun soon dries it up, and destroys the tubercle bacilli.

Among the rawer Natives the women are not permitted to cross to the men's side of the hut. On entering the door, the men's side is to the right hand and the women's to the left. This is said to be a survival of an old custom, as anyone coming to attack the people of the hut could not throw an assegai at the men without coming into view.

8. SPREAD OF TUBERCULOSIS AMONG NATIVES.

The spread of tuberculosis in a community depends on several factors; these are:—

(1) The number of "open" cases.
(2) The tuberculization of the members of the community.
(3) The degree of resistance reached.
(4) Economic conditions, including feeding, clothing, housing, work, etc.

(1) *The Number of "Open" Cases.*

Tuberculosis, as we have seen, probably existed amongst the south-eastern coastal Natives before the coming of the Europeans, but under old tribal customs a rude kind of "Public Health Law" prevailed—cruel but efficacious. A migratory people, always more or less in

danger of attack or preparing to attack some other tribe, could not afford to have invalids, so invalids disappeared. "Open" cases of tuberculosis in those days were probably, therefore, very rare.

Further, after a person died in a hut, everthing belonging to him, and the hut, were destroyed. Also, the contacts of a person who died from disease had to undergo a period of isolation.

To-day these customs do not prevail and "open" cases of tuberculosis are common amongst the coatal Natives.

The return from industrial and other employments of Natives suffering from tuberculosis, undoubtedly adds to the number of such "open" cases.

(2) *The Tuberculization of the Community.*

It is generally assumed that when the degree of tuberculization of a community is high, tuberculosis, when it does occur, tends to run a more chronic course. The following discussion is based on this assumption, but from the evidence adduced on pp. 91–108 it should be remembered that this may not apply so completely to the Bantu as to the European.

The tuberculin tests which have been done on the south-eastern coastal Natives resulted in a high proportion of positive reactions, which shows that those Natives have been widely tuberculized and may be expected to have acquired a certain degree of immunity.

(3) *The Degree of Resistance.*

Numerous cases seen by Dr. Allan were running a chronic course, showing that in some of these Natives a very considerable degree of resistance exists.

Resistance might also be described as capacity to respond to improved conditions. An acute infantile type of tuberculosis is unlikely to improve under any conditions, as the afflicted person has no resistance.

As an example of this capacity to respond to improved conditions, there might be cited the instance of the "tuberculosis gaol" at Cradock.

Native prisoners, who contract or are found to be suffering from tuberculosis are sent to a special gaol at Cradock. There is accommodation at this gaol for 33 patients. There are three wards, one for 19 beds, one for 11 and one for 3. The diet is liberal. Work is provided for prisoners, mostly at shoe-making, which is carried on in the open air under the verandahs of a quadrangle.

The total number of tuberculous inmates from 1st January till November, 1929, when it was visited, was 30. Of these, 12 had been discharged, 17 were still inmates and 1 dead. The man who died was admitted in an advanced stage on 12th March, 1929, and died on 23rd October, 1929. One man had been an inmate for over six years and several for three or four years. All looked well, most of them gaining weight, and all were running a fairly chronic course; in other words, all were showing a considerable degree of resistance.

(4) *Economic Conditions.*

The Natives are pastoral and agricultural—the men attend to the pastoral part and the women to most of the agricultural part.

The average income per tax payer, that is, every male of 18 years of age and over, from the results of pastoral and agricultural pursuits is only about £2 to £3 per annum, after allowing for the products used by the Natives themselves.

As wood is now scarce, poles for roofing of huts must now be bought, and with the increase of population thatching grass is now very scarce, so that hut accommodation is now probably more limited than in the olden days. Clothing, blankets or European clothing must now be purchased, as the old dress of skins is not now used.

Then the Native has to find money for taxes. He does not sell his cattle to get this money. In olden days the chief levied his taxes as cattle, and the Native to-day looks upon his cattle as his wealth, but does not use them as currency.

Thus he is by force of circumstances compelled to go out and work for Europeans. He is brought into contact with conditions totally different from those to which he has been accustomed. He gets work in industries such as the gold-mining industry, where his absence from his home conditions need not be for long periods at a time.

With the degree of immunity already acquired at home, he becomes hardened gradually and able to resist infection to a considerable extent. The great majority of Natives are able to complete their contracts ; others are unfortunate and contract tuberculosis. Some of these die before they can be sent home, others are repatriated, and of these repatriates 60 per cent. are dead within two years.

Similarly, the repatriates are returning to an area where infection exists to a considerable extent, where a large proportion of the people have received a dose conferring a certain degree of immunity, so that unless some marked change for the worse in the Natives' condition takes place, the danger from these repatriates should gradually diminish.

The Natives of the south-eastern coastal group have reached a stage where their resistance is sufficiently high to benefit from modern methods of treatment. It might be argued that they would be unwilling to undergo sanatorium treatment, but the increasing number who yearly seek hospital treatment indicates the growing confidence of the Natives in European methods.

The following are the returns of the numbers of Native patients admitted to the hospitals in the Transkei in 1914 and 1928.

	Butterworth.	Umtata.	Kokstad.	St. Lucy's, Tsolo.
1914	178	215	8	96
1928	185	1,155	69	158

Two hospitals started since 1914 :—

	St. Barnabas, Ngqeleni.	Holy Cross, Flagstaff.
1928	205	328

9. Tuberculosis in Natives Living in Urban Conditions.

For comparison with his study of the Native living in his kraal or in a rural location, Dr. Allan also investigated the condition of Natives living under urban conditions. He has reported in greater or lesser detail on four urban Native locations, viz., two small locations on Reef mine properties and the locations in Queenstown and in East London.

The locations on mine properties are for married Native employees of the mines. Cases of tuberculosis arising among the male adults would be dealt with under the Phthisis Act and repatriated, so that he only dealt with the women and children. The average duration of stay on the location for the women is five to six years. Dr. Allan was only able to trace one death from tuberculosis in the last twelve years among the women ; the daughter of this woman, aged thirteen years, had definite tuberculosis. In addition, in the two locations, Dr. Allan found five women and a boy aged seven years to be " suspicious of tuberculosis." Over 100 women and 100 children were clinically examined.

The information elicited by tuberculin tests of these women and children has already been considered (see p. 204).

The location at Queenstown houses approximately 8,000 Natives. During 1927 the mortality from tuberculosis was at the rate of 2·5 per 1,000, suggesting a prevalence for both sexes and all ages quite as high as that on the mines for men between 20 years and 40 years.

The most detailed study was made in the two Native locations of East London. This is the nearest large town to the Native Territories, with a population of about 39,000, of whom approximately half are non-Europeans. Dr. Allan submitted a report dealing very fully with the social, economic and hygienic condition of the Native section of the population and statistical comparison with the European section where necessary. It is unfortunately rather too bulky to give here in full and we must content ourselves with the following brief extract.

The two locations house about 15,000 Natives, who either rent a stand and build their own huts or hire houses built of wood and iron. The municipality provides and rents to Natives concrete rondavels and square one-roomed houses. The density of the Native population is considerable and averages two or three per room. Regulations require 400 cubic feet for each adult person over ten years of age, 200 cubic feet for each person under ten years of age.

Natives in locations cannot produce their own food but live on purchased food. A man's average earning is about 18s. per week and, if he can afford it, he spends from 9d. to 1s. a day on food. When able to do this he is sufficiently fed but hardly lives as well as the mine boy, whose rations cost 3d. per head per diem.

The European death-rate in East London has fallen during the past 20 years from 11·6 per 1,000 in 1908 to 8·9 per 1,000 in 1927-28. The non-European death-rate, on the other hand, has gone up from 22·3 per 1,000 in 1908 to 53·9 per 1,000 in 1927-28. This rise may, however, be due, in part at all events, to an increase in numbers of infants and a change in the age-distribution of the population.

The tuberculosis mortality over the period 1915-28 has not varied very much, the percentage of deaths, from all causes in all races, being between 7 and 8. It is rather higher in the non-European than in the European, the mean figure for the former section over the period mentioned being 9·9.

Tuberculosis is a notifiable disease and the average prevalence amongst Natives only, over 16 years of age, is about 4 per 1,000. It is generally agreed, however, that notification is incomplete, as the Native rarely consults a doctor and there are no post-mortem examinations. Probably between 60 and 70 per cent. of the actual notifications are only made at death or shortly before.

In a personal examination of 14 cases, Dr. Allan found that 9 had not yet been notified. The population must be very migratory, as deaths are to births in the ratio of 50 to 40, while 45 to 50 per cent. of the infants die below the age of twelve months. Males between the ages of 20 years and 39 years account for about half the male population and about half the cases of tuberculosis in all males. Males and females are about equally affected.

Most of the tuberculosis is recognized as pulmonary tuberculosis and the disease usually runs its course to a fatal end in about twelve months. As far as can be judged in the absence of post-mortem examinations, the location Native at East London gets much the same sort of tuberculosis as does the mine Native on the mines.

Of the cases actually examined by Dr. Allan most were "more or less chronic cases." In the locations, as in the kraals, there seems to be about two years' interval between contact and infection, which suggests that, in Dr. Allan's words, "the Native, in his own home, either in the urban area or the kraal, has considerable resistance to infection." The fact that Natives move a great deal between kraal and location, added to this long interval, renders it very difficult to be at all sure about the part played by contact.

Summary of Chapter V.

1. The general "life of the Native" in the Territories is described, discussing the origin of the different tribes, their present-day administration, conditions of living, housing, clothing, dietary and economic situation.

2. The past history of the tuberculization of these tribes is not considered in this Chapter, as it has already been dealt with in Chapters *II* and *III*, Part *I*, of this Report.

3. The investigation of the present degree of tuberculization in various parts of the Native Territories is then described. Part of this work consisted in the carrying out of tuberculin tests in various sections of the communities.

4. Tuberculosis as seen in various districts is described, with illustrative cases.

5. Out of 694 boys repatriated from the mines with tuberculosis during the years 1926-29 the fate of 475 was ascertained. This follow-up showed that at the end of two years after repatriation 60 per cent. had died, 4 per cent. were alive and fit to return to heavy work, 10 per cent. were alive but unfit for any work, and 26 per cent. were alive and fit for light work at their homes.

6. The prevalence of tuberculosis as a familial disease and the extent to which familial spread occurred from repatriated mine tuberculotics was investigated. The opinion arrived at is that although cases of familial spread do occur, the part played by repatriated mine tuberculotics in this spread is not of relatively great importance. The reasons for arriving at this conclusion are given.

7. The factors governing the spread of tuberculosis in any community, viz., general degree of tuberculization, number of "open" cases, degree of resistance and economic conditions, are discussed with regard to their application to the community under review.

8. For comparison with tuberculosis as seen among the Natives in their natural surroundings, an account is given of tuberculosis as occurring among Natives living in urban conditions. The state of affairs is not materially different in the two situations.

CHAPTER VI.—INFERENCES DRAWN FROM THE FOREGOING CHAPTERS IN REGARD TO TUBERCULOSIS IN SOUTH AFRICAN NATIVES.

(WITH COMMENTARY BY PROFESSOR LYLE CUMMINS.)

NOTE.—In writing Chapters VI and VII the Committee has had the advantage of the co-operation and help of Professor Lyle Cummins, and after their final form was decided upon they were again submitted to him for his opinion. This he has expressed in the shape of comments which are printed as a running commentary throughout the text of the two Chapters. They are distinguished by being printed in heavier type.

The views of the Committee are therefore supplemented by the independent views of an outside observer of international repute.

Merely local observers are sometimes not unjustly accused of bias and their views are liable to suffer from the defects of the very advantages they possess—too much detailed knowledge or, as the popular phrase has it, inability to see the wood for the trees.

Professor Lyle Cummins has the advantage of having been sufficiently inside our wood to be aware of the density of its thickets but still remains outside and sufficiently far off to be able to see the wood as a whole unhampered by the details of its undergrowth.

In the absence of reliable vital statistics bearing on the general Native population of South Africa, it is very difficult to draw satisfactory comparisons between the incidence and mortality-rates of tuberculosis among Native mine workers and similar industrial groups in European countries. The Native mine population is not a relatively fixed community such as, for instance, the coal-mining population of England and Wales, in which the losses due to death and superannuation are made good by new entries from the adolescents of the districts concerned, but a kaleidoscopic population in which, apart from a small number of non-recruited Natives engaged locally, nothing approaches constancy except the "total strength" of round about 200,000 Native miners on the Rand. The wastage due to repatriation and death is made good by a constant stream of recruits from the "Native Territories" of the Union and of Portuguese East Africa, the periods of "contract" of these Natives varying from 9 months in the case of B.S.A. Natives to 12 months for the Natives of Portuguese territory, with a large and growing number of "voluntary" short-service Natives.

Thus it comes about that, although accurate records of deaths and repatriations are available, these refer not to a fixed population but to one changing continually at the rate of about 100 per cent. per annum.

But more eloquent than mere statistics are the actual cases of Native tuberculosis seen in the wards of the mine hospitals on the one hand or on the post-mortem table at the South African Institute for Medical Research on the other. To anyone accustomed to the slow and gradual course of tuberculosis in phthisical cases in European countries, and to the fibrotic state of many of the phthisical lungs seen at autopsy, this fulminating tuberculosis would be a new thing.

While slow and chronic cases do occur, it is common to encounter patients, who, having been at full work in the mines a week or so before, are now prostrate with all the signs and symptoms of generalized tuberculosis and, being too ill to allow of repatriation, are destined to die in a few weeks in the mine hospital to which they have been admitted.

About one-sixth of all the cases of tuberculosis in Natives on the mines are of the sort that die on the Rand, being too ill for the journey back to the Territories. But it must not be supposed that all those sent home are very different. About one-tenth of those repatriated die within two months of leaving the Rand, nearly half of them are dead within the year, and 60 per cent. within two years.

As to the type of the disease met with on the post-mortem table, the Pathological Section of this Report tells the same story. The outstanding features are the caseous nature of the lung and gland lesions, and the tendency to generalization of the disease with involvement of the liver and spleen. The type of tuberculosis, then, tends to be terribly severe.

Fortunately, there are other aspects of the question which are much less depressing.

The great majority of the Native miners escape tuberculosis and other bacterial diseases and gain in health and weight during their contracts. Nevertheless, the fact remains that this severe tuberculous disease is one of the outstanding features of the mining industry, as it concerns the Native, and one of the factors which introduce an element of risk into the association of Native and European workers in a "dusty" industry.

What, then, as to incidence? From the Chamber of Mines' Annual Summaries, we find, after deducting the incidence and deaths from simple silicosis, that the total tuberculosis-incidence was, for 1926-7, 6·81 per 1,000; for 1927-8, 7·53 per 1,000; and for 1928-9, 6·62 per 1,000; while for respiratory tuberculosis, the incidence-rates were 5·82, 5·68 and 4·93 per 1,000 respectively. Those rates are, doubtless, under-estimates, since they take no account of cases which might be expected to occur later amongst Natives who had worked on the gold mines during the years in question and only developed the disease after return to their kraals; they are, however, considerably more correct than the estimates of tuberculosis-incidence based on notification in England.

The notifications for 1926 in England and Wales amounted to 1·45 per 1,000 for "respiratory tuberculosis"; in London to 1·62 per 1,000. But "notifications" in England are notoriously incomplete and cannot be regarded as anything approaching the true incidence of tuberculosis. Apart from the fact that numerous cases are wrongly diagnosed and escape recognition, many persons with more or less benign tuberculosis must remain at large and never consult a doctor at all.

It is safe to assume—so the Committee has been informed by Professor Lyle Cummins—that if the male population of England and Wales, in age-groups comparable to those of the mine Natives, were subjected, like the mine Natives, to monthly weighing and a careful clinical examination combined with observation in hospital for those falling short of normal weight, the incidence-rate from tuberculosis would at least approximate to that recorded on the Rand.

It comes to this, that, as regards the tuberculosis of England and Wales, we possess, through the Registrar-General's Annual Reports, a fairly accurate record of mortality-rates; but we have no real knowledge of the incidence-rates from the disease.

In the case of the Native gold-mine labourers, on the other hand, we have in the monthly tuberculosis returns a fairly correct approximation to the incidence of tuberculosis but no accurate figures as to the mortality; since the deaths recorded include only those of the very acute cases too ill to be repatriated and the returns give no information as to the number of cases which die after their return home.

As pointed out above, however, there is reason to believe that, while the incidence-rate in the Native, so far as it can be ascertained, is not much higher than what might be expected, the case mortality-rate in Native mine workers is very high.

For the comparison of the tuberculosis of the mine Natives and of a similarly-occupied community of European origin, an idea is obtained by contrasting the incidence and mortality of the gold-mine Natives with that of the White miners on the Rand; this being especially valuable because, owing to the periodical examination of all White miners, a true incidence-rate is available.

Such data as are available for this comparison are to be found in the Annual Reports of the Miners' Phthisis Medical Bureau, but it must be remembered that these Reports deal only with "tuberculosis under the Act" (for definition, see p. 116) and not with "tuberculosis, all forms." It is very necessary in considering statistics about tuberculosis on the Witwatersrand to be clear as to whether they deal with the "legal" disease or with the "clinical" disease. If the distinction be not made, fallacious inferences are liable to be drawn.

The comparison made in this instance, therefore, is one between the annual incidence of pulmonary tuberculosis on the European and Native labour forces respectively.

From Table 14 of the Report for the year ending 31st July, 1928, we learn that the "production-rate" of pulmonary tuberculosis for European miners for 1927-1928 was 2·19 per 1,000, while from Table 17 of the same Report we learn that of Native labourers coming to the notice of the Bureau the "production-rate" of pulmonary tuberculosis was 3·85 per 1,000. In other words, the annual pulmonary tuberculosis rate for Natives was nearly double that for Europeans.

Here, again, it is impossible to draw an accurate comparison between the tuberculosis *mortality*-rates of the two groups, since the Native cases are invariably repatriated if fit to travel, while the White miners are kept under observation, either at Springkell Sanatorium or elsewhere. We learn from Table 13 of the Report quoted that, of 390 cases in White miners, 117, or 30 per cent. had died within the first year after diagnosis.

Turning to the annual summaries of the monthly tuberculosis returns of Native miners (collected by the Chamber of Mines), we find that, during the three annual periods 1926-7, 1927-8 and 1928-9, a total of 4,120 cases of tuberculosis were recorded. Of these, 722 were so acute as to be unfit for repatriation and died in the mine hospitals, and 3,398 were repatriated. If we apply the findings of Allan during his three years of work in following up cases in the Transkei and assume that half of the cases repatriated died within the year, then we have to add 1,699 deaths to the 722 which occurred on the Reef, making 2,421 deaths in all, or about 59 per cent. of the cases.

It seems, therefore, probable that the case-mortality within the first year is about twice as high amongst Native as amongst White miners.

It is to be regretted that no adequate vital statistics exist as to the incidence and mortality from tuberculosis in the non-mining sections of the Native populations of the Union; but the above approximations suffice to show that, in the gold-mining industry, the Native miner is more liable to develop tuberculosis than the miner of European origin, and that the disease, when contracted, tends to run a much more rapid course with a marked tendency to a fatal termination.

This want of resistance to tuberculosis is, as pointed out in Part I, Chapter I, of the Committee's Report, a biological character of the African Native which can only disappear with the lapse of time and during many successive generations of industrial contact. This biological lack of resistance exists quite apart from any risk incurred in the mining industry or in other industries; but there can be no doubt that the concentration of Native industrial "recruits" under the conditions inseparable from practically all commercial developments in Africa, together with the unaccustomed hard work and the unfamiliar housing and diet conditions of a new environment, leads to a state of things in which this liability to tuberculosis ceases to be latent and becomes actively manifest.

If the Native tuberculosis cases, like the Whites, were to remain under observation at Johannesburg instead of being repatriated and lost sight of, the gross mortality from the disease would, doubtless, appear in the mine statistics at a much higher figure than that recorded under the present system.

It may be surmised, too, that if the Native miners were retained for observation and treatment in hospitals on the Reef, the mortality from tuberculosis would not only be more accurately appreciated statistically but would also be *actually* greater than at present, since

it appears certain that Native cases of a relatively favourable type tend to improve rapidly when they get back to their homes, their friends, the familiar Native diet as prepared under domestic conditions, and the "magnificent leisure" of the Bantu kraal—conditions which can hardly be realized in hospitals run by European staffs on "approved" lines.

The contrast between the tuberculosis of Native mine workers and that of Europeans, while fairly definite, is somewhat obscured by the grouping together of all forms of pulmonary tuberculosis occurring in Native miners. As a matter of fact, the tuberculosis of Native mine workers includes at least two sharply distinct types, one of which tends to approximate to the phthisis of civilized adults, while the other is highly characteristic of African Natives in general and finds its homologous type not in the phthisis of European adults but in that of European children and adolescents.

In the Chamber of Mines' tuberculosis returns, these types are roughly differentiated under the headings "Simple Tuberculosis" and "Tuberculo-Silicosis" respectively, although, of course, intermediate stages exist.

For a fuller discussion of these types, the reader is referred to the Statistical, Pathological and Clinical Sections of Chapter IV, but it may help towards a comprehension of the problem if the points of differentiation are given further consideration here. At the same time, the reservation must be made that no attempt at differentiation can do more than afford a general basis for discussion, nor must the distinctions made be accepted as too rigidly exact. The discussion aims at contrasting extreme types; but intermediate types are common and the most important fact, perhaps, is that the one type shades off by imperceptible stages into the other.

To the reader it may appear curious to introduce an extraneous element, such as silicosis, into a discussion on tuberculosis, but in the absence of any definite clue to the identity of the Native mine worker throughout the successive contract periods of his mine history, it is convenient to find, in the co-existence of silicotic changes in the lungs, a clear proof that such an individual has spent a considerable period of previous work in the gold-mining industry.

These silicotic changes stamp an "old" or "long-service" boy. Whether the silicosis greatly modifies the course of tuberculosis in the African Native is a question for further discussion, but there can be no doubt that the addition of tuberculosis acts as an "amplifier" to silicosis and, in the susceptible African Native, converts what might otherwise have remained a relatively benign peribronchial fibrosis into an active pulmonary phthisis.

THE TUBERCULOSIS OF "NEW RECRUITS."

Under this heading it is convenient to include both the "simple tuberculosis" of the Standardized Monthly Returns, which consist of cases regarded as pulmonary on clinical grounds, and also the "Other

Forms of Tuberculosis" of these Returns, since we know, from the pathological investigations that "simple tuberculosis" is seldom confined to the lungs, and that there are often pulmonary lesions in cases of "other forms of tuberculosis." It is significant that, of 3,046 cases recorded in the Returns for the three years 1926-7, 1927-8 and 1928-9, 610, or 20 per cent., died in the mine hospitals, and cases of this type must have constituted a large proportion of those found by Allan to die within a few months of repatriation.

[To the student of tuberculosis, it is extremely interesting to meet this highly fatal type of combined pulmonary and "generalized" tuberculosis in a community of Natives who are not "virgin soil," but arrive on the mines with a percentage of positive tuberculin reactions approaching 70 per cent.—S.L.C.]

The pathological findings in the fatal cases—that is to say, in the 20 per cent. of cases so severe as to be quite unfit for repatriation and dying within four or five weeks after admission to the mine hospitals—are almost exactly like those hitherto associated only with "virgin soil." There are, it is true, certain points of difference noted between the findings at Johannesburg and those of Borrel in the tuberculin-negative Senegalese soldiers imported into France during the European war, but the resemblances are great and the differences small. About one-fifth of the cases of "simple tuberculosis" arising in these usually tuberculin-positive mine Natives die on the Rand of a type of disease approximating closely to "natural" tuberculosis.

It appears evident that these Natives, infected during their childhood or adolescence in the kraals where, as shown in Part I, Chapter III, tuberculosis is now endemic, have, in many cases, developed only sufficient resistance to keep their initial lesions latent under the easy conditions of tribal life. For the new and strenuous conditions of life and work on the mines the resistance of at least a certain proportion of them is quite insufficient.

The degree of resistance developed under tribal conditions may perhaps serve, as in experimentally-infected guinea-pigs, to impede and retard the establishment of exogenous reinfections, but it does not, under the conditions of stress in the mines, suffice to keep within bounds the tendency to generalization of tubercle bacilli from the still active though clinically latent foci dating back to earlier years.

The result is that considerable numbers of these Natives, more especially the "new recruits," develop acute and fatal tuberculosis of what is, to all intents and purposes, the "natural" type, early in their mine service. A certain proportion of these cases is, in all probability, quite identical with the Borrel type, since it may be assumed that some, at least, of the "tuberculin-negatives," as classified according to tests with a five-thousand fold or still higher dilution, are really "virgin soil." There is reason to think that this was often true of "Tropicals" in past times and it may still be true of some of the Basutos, known to be so specially liable to tuberculosis. But, apart from the "virgin-soil" minority, there is reason to believe that most

of these " early cases " actually arrived on the Rand with definite but unrecognizable tuberculous lesions and that on starting the hard work of mining, they broke down into clinical disease through generalization of bacilli from these pre-existing foci.

[In a recent paper[7] I have attempted to express my views on this phase of tuberculosis and have pointed out the analogies between the African Native in his comfortable village and the European child in its relatively sheltered environment.

Just as some of these infected but healthy European children break down into acute tuberculosis after intercurrent respiratory diseases or on quitting the leisure of childhood for the stress of wage-earning, so does a certain proportion of the young African mine recruits break down with acute disease shortly after starting work in the mines.

It would be a mistake to lay too much stress upon the minor differences between this acute type of tuberculosis of the Native mine worker and the secondary phase of tuberculosis described by Borrel in the Senegalese.

In the Senegalese soldiers, the first exposure to tuberculous contact and the " activating " stress of military service occurred at the same time. In the Native mine worker, the tuberculous contact occurs first, in the home-kraal or village, and under the easy conditions of life which permit all except the very heavy infections to become established as larval rather than progressive lesions. The " activating stress " comes later when the boy quits his kraal for Johannesburg. But, apart from the limited degree of enhanced resistance resulting from the longer duration of these quiescent lesions, the type of tuberculosis resulting from the " activation " is almost the same in the Native mine worker as in the Senegalese soldier.

Even where the " infection " and the " activating stress " were contemporaneous, Borrel noted that the " glandular stage," as he called it, lasted three or four months ; the infected person remaining in fairly good health during this more or less prolonged latent period.

Exactly the same process initiates tuberculous infection in the European child ; but, under the favourable conditions of home life and school life, the lesions usually remain " larval " ; the minimal and successive re-infections of childhood and adolescence leading on, in a majority of individuals, to a stage of " compensated " sub-infection in which the resistance is so high that there is little risk of developing clinical tuberculosis. Thus, it comes about that, especially in the well-to-do and well-fed classes, the danger-period of adolescence is, as a rule, safely negotiated and the vast majority of the population remains healthy but tuberculin-sensitive and relatively tuberculo-resistant.

In the African Native, while the initial process of infection is the same, there is no equivalent opportunity for "acclimatization." The change from tribal life to the strain of work on the mines is abrupt; nor does the African Native yet appear to possess so efficient a mechanism for acquiring tuberculo-resistance as does the European adolescent.—S.L.C.]

In the Transkei it has been found that the more intense reactions to tuberculin occur in those persons found to be in actual contact with open cases. At Johannesburg it has been observed that the highest ratio of tuberculosis cases arises in persons who had given an intense tuberculin reaction on arrival. At post-mortem examinations it has been found that, in Native recruits dying of other than tuberculous diseases *before* starting work on the mines, a proportion of the cadavers contain tuberculous lesions in the tracheo-bronchial and other glands of such a nature as to be liable to "light up" under any severe stress. Finally, the proportion of "other forms of tuberculosis," as shown in the Monthly Tuberculosis Returns, is very high, no less than 30 per cent. of the tuberculosis, excluding tuberculo-silicosis, arising on the mines, and yet most of these "other forms of tuberculosis" must, almost of necessity, have been acquired previous to arrival at Johannesburg, since many of the lesions are of the so-called "secondary" types.

The conclusion seems inevitable that the greater part of the "simple tuberculosis" of the gold mines results from the recruiting of infected persons whose lesions are still so "larval" and so little "compensated" as to break down under the stress of life on the mines.

The Tuberculosis of "Long-service" Boys.

The extreme type of "long-service" tuberculosis in Native miners is met with in the cases classified as "tuberculosis with silicosis" in the Monthly Tuberculosis Returns; and this group has, from the point of view of statistical examination, the added advantage of possessing a definite guarantee of long service as shown by the presence of silicotic changes in the lungs. In this group the proportion of cases dying in the mine hospitals is only half that noted in the "simple tuberculosis" group.

It appears, too, that, apart from the cases in which there is clinical or X-ray evidence of co-existent silicosis, a considerable number of the cases regarded as "simple tuberculosis" arising in Natives with several years of mine service should be differentiated from the "early" cases and included under the heading of "tuberculosis of 'old' or 'long-service' boys." The outstanding character of this group is the possession of an increased tolerance to tuberculosis.

Of 1,074 cases with tuberculosis and silicosis recorded in 1926-7, 1927-8 and 1928-9, 112, or just over 10 per cent., died in the mine hospitals; whereas 20 per cent. of the "simple tuberculosis" group died on the Reef.

Even when the recognized tuberculo-silicotic cases are left out of consideration, this tendency to increased tolerance is clearly seen in the enhanced power of the long-service cases to control their symptoms and retain a certain measure of good health in spite of clinically-evident tuberculosis. This was proved in a statistical report to the Committee, in which the average length of service of those cases found fit for repatriation was shown to be definitely greater than amongst the cases dying in the mine hospitals (see p. 181).

That a certain number of these cases go undetected owing to their being able to carry on at mine work in spite of their disease and without marked loss of weight is proved by the fact that a fair number are discovered annually at the clinical and X-ray examination of "long-service" Natives.

This tendency to *tolerance* of tuberculous lesions is also apparent in the fact brought to light during investigations into clinical types (see p. 180) that the Native phthisics with five years or more of mine service to their credit before the onset of clinically manifest tuberculosis show, in a fairly high proportion of cases, a power of maintaining their weight and keeping their temperature within normal limits in spite of marked pulmonary disease; a tendency which is slight or absent amongst the "short-service" cases with disease of equivalent extent.

In the Pathological Section of this Report (see p. 169) it is stated that tuberculo-silicosis is almost the only form of tuberculosis in this series of Natives which takes anything like a chronic form or, in other words, in which there is any appreciable amount of fibrous tissue, also, that in another respect these tuberculo-silicotic cases have some resemblance to the European-adult type of tuberculosis, viz., the comparative frequency with which the tuberculosis is limited to the lungs or, at all events, to the tuberculo-silicotic zone.

In this connexion, however, it must be borne in mind that tuberculosis itself, in its more chronic forms, leads to the formation of fibrous tissue and that the mere co-existence of carbon pigmentation along with fibrotic changes and chronic tuberculosis does not prove that silicosis is necessarily a dominant factor. While the presence of silicotic nodules affords an excellent basis for placing certain cases in the category of "long-service" boys, this does not take away from the undoubted fact that many long-service boys develop a chronic form of tuberculosis without showing definite evidence of silicosis. This comes out clearly if the "five years" and "over five years" groups of "simple tuberculosis" cases be compared with the "tuberculosis with silicosis" groups in the tables of clinical types already quoted (see p. 180). These tables show that, to all intents and purposes, the cases in these groups are identical in character so far as concerns maintenance of systemic condition and power of temperature control.

While this statement is correct in so far as it deals with clinical findings in the living, one must bear in mind autopsy experience to the effect that, in the absence of a silicotic element it is unusual for

lesions to be confined to the lungs, although these organs may show local attempts at repair. The comparative inability of the Native of any age to localize tuberculosis permanently is a much more important manifestation than his occasional ability to modify the course of the disease.

What matters is the time-factor. In these susceptible Natives, the co-existence of a certain amount of silicosis with their tuberculosis is chiefly important as a measure of the time spent in the industry. With each year passed in mining, the power of "confronting" a tuberculous process becomes greater. Whether this is due mainly to the early elimination of the more heavily infected or to the exaltation of acquired resistance in those longest exposed remains an open question. Probably both factors play a part.

The outstanding differences between these two types are here set forth briefly in tabular form :—

TABLE 56.

The Tuberculosis of "New Recruits."	The Tuberculosis of "Long-service" Boys.
Is associated with a high mortality rate.	*Is associated with a lower mortality-rate.*
Shows little or no tendency to fibrosis.	Shows definite fibrosis, in part due to silicosis.
Tends to generalization of lesions.	Tends to localization of lesions in the lungs.
Is seldom consistent with "working health."	Is often consistent for some time with "working health."
Appears to be due, in the main, to "breakdown" of pre-existing lesions under stress of unfamiliar conditions of work on the mines.	Is probably due, in the main, to the gradual development of cumulative exogenous re-infections in the course of work in the mines.

The statistical differences between the tuberculosis of "new" boys and the tuberculosis, whether uncomplicated or combined with silicosis, of "old" boys are clearly brought out in the tables of the Section dealing with the incidence and mortality from tuberculosis on the Rand (see p. 154 *et seq.*, also Appendix 5).

Since, in this Report, the tuberculosis of the "new boy" has been compared to the tuberculosis of the European child, and the tuberculosis of the "long-service boy" has been compared to that of the European of middle-age, it may be of interest to give the characteristics of these types as presented by the National Tuberculosis Association.

TABLE 57.

Childhood Type.	Adult Type.
Usually occurs in children, but rarely in adults.	Usually occurs in adults, but rarely in children.
Result of primary infection.	Result of a reinfection.
May be localized in any part of the lung.	Localization is apical.
Tracheo-bronchial lymph-nodes always involved.	Tracheo-bronchial lymph-nodes not involved by this reinfection.
Caseous lesions usually become calcified.	Caseation of lesions followed by excavation and fibrosis.
Excavation very rare and but little tendency to fibrosis.	

If we turn to our own autopsy evidence and X-rays of the lungs after removal from the body we cannot say that, in the "new" boy excavation is very rare and calcification usual. If we turn to the "old" boy we find that the tracheo-bronchial lymph-nodes usually presented tuberculo-silicosis. The general comparison holds but much of our detail is *sui generis*.

One has greater confidence in associating the "chronic phthisis" of the "long-service" boy with exogenous re-infection than one has in minimizing the part played by this process in the tuberculosis of the "new" boy. The salient distinctions met with are apparently related to the fact that the "new" boy has been caught in a tuberculo-allergic state and also lacks the fibrous tissue barriers contributed by the silicosis factor. As bearing on the above, Myers [71] writes :—

"I do not mean to leave the impression that every case of tuberculosis among young adults is due to direct spread of tubercle bacilli from old childhood lesions. Perhaps a large number, if not the majority, are due to re-infections from exogenous sources, but the childhood tuberculosis had prepared the way, as evidenced by the fact that it has left its indentity in more than 50 per cent. of the clinical cases of tuberculosis in young adults."

FACTORS UNDERLYING THE PREVALENCE OF ACUTE TUBERCULOSIS IN "SHORT-SERVICE" NATIVES.

(1) *"Natural" and "Acquired" Liability to Generalized Infection.*

On the one hand, the presence amongst new mine recruits of a certain proportion of previously uninfected boys may be expected to favour the occurrence of at least some cases of the "Borrel" type, the acute "natural" tuberculosis of virgin soil.

It is possible that, in the early days of the gold-mining industry, the proportion of cases of this type was fairly high, especially in those racial groups, such as the "Tropicals" and others, in which previous

contact with Europeans had been slight. When the step was taken of stopping all recruiting of Natives from north of latitude 22°S., a marked improvement followed in the health of the younger groups of Native miners.

This measure, and also the gradually increasing endemicity of tuberculosis in the kraals, has probably diminished the proportion of " virgin-soil " recruits ; but, in view of the known liability of Basutos to contract acute tuberculosis on the Reef, together with the relatively low percentage of " positive " reactors to the tuberculin tests applied in the recent survey in Basutoland, it appears probable that a certain proportion of Natives, especially those from the less " Europeanized " districts, still arrive at Johannesburg with their " natural " liability unaltered by contact with infection.

On the other hand, the presence amongst mine recruits of a high percentage of young Natives from districts where tuberculosis is known to be endemic ensures the arrival of a large number of infected persons ; and we know from the results of tuberculin tests that nearly all the mine boys are already infected on reaching Johannesburg.

Nor is it merely the percentage of positive tuberculin reactors which is high. A still more suggestive fact is that, as judged by tests with very dilute tuberculin, the degree of sensitivity is extreme (see p. 99).

[**The tuberculin tests carried out under the Committee's auspices show that fully 50 per cent. of healthy Natives arriving at Johannesburg are capable of reacting to a 1/1,000,000 tuberculin dilution whereas, in tests carried out by me on clinically non-tuberculous adults in Wales, only about 25 per cent. were found to react positively to a dilution of 1/100,000.**—S.L.C.]

Now it is known that a diminution in tuberculin sensitivity in infected persons may be due to gradual healing and inactivation of tuberculous lesions, with a corresponding reduction in specific auto-inoculations ; or to a loss of the power to respond to specific auto-inoculations, such as accompanies failing health, whether due to the extension of the tuberculous process or to some intercurrent illness.* It may be inferred, then, that in persons with unusually intense tuberculin sensitivity, like these Native mine-recruits, the invasion of the virus producing this marked allergy must be recent and " active," and yet the resultant tissue changes must occur in such a position or else be of such a nature as to be consistent with good general health and the absence of signs and symptoms indicative of tuberculosis in the clinical sense.

We are able to exclude any significant amount of *active pulmonary* tuberculosis in these recruits, since this would be easily detected at the medical examination. Further, Professor Lyle Cummins examined at the W.N.L.A. hospital a series of 500 successive X-ray films from recruited boys without finding a single characteristic instance of active pulmonary infiltration, although some 30 per cent. of the films afforded

* Attention is directed to the possibility of there being two types of negative reactors as suggested in the last paragraph on p. 107.

evidence suggestive of the presence of inactive "primary foci" (see Appendix 9). We are thus in a position to infer that the "active" lesions proved, by the high tuberculin sensitivity, to be present somewhere in the body must be located, for the most part, in the tracheo-bronchial glands; one of the few situations in which active tuberculous processes may exist without seriously affecting the general health and without being clinically recognizable. We possess, indeed, in the observation that no less than 30 per cent. of healthy recruits have visible X-ray evidence of having passed through the stage of a primary lung focus, a proof that the lesions on which tracheo-bronchial glandular infection usually depends have actually occurred.

We find, then, in these "tuberculin-sensitive" boys, evidence that their condition represents, so to speak, a long-drawn-out phase of Borrel's "glandular stage," in which, owing to the favourable circumstances of life in the Native Territories, the process has not advanced any further towards generalization. In some of them, the process may, indeed, have gone a long way towards the healed and "compensated" tuberculosis that makes for resistance; in others the "larval" lesions may be close to breaking point. The more intense and the more recent the glandular infections, the greater will be the tuberculin sensitivity and the greater the risk of a breakdown into acute tuberculosis. The follow-up of the tuberculin-tested Natives on the Rand shows that there was, amongst the boys giving a "positive-plus" reaction, a decidedly greater liability to develop tuberculosis than was present in the "positive," "weakly-positive" and "negative" groups (see p. 100).

[Allan, in a private letter written to me from the Transkei, dated 25th November, 1929, reports about the more severe tuberculin reactions that "the cases with vesication came from families where tuberculosis is rampant."

Ukil[70], writing of his tests in Indian village communities, reports that "most of the cases giving +++ reactions were traced to a tubercular focus in the family."—S.L.C.]

This greater liability to develop tuberculosis, noted amongst those Natives whose extreme tuberculin sensitivity implies close and recent contact with infection and the existence of definitely "active" lesions, is what Professor Lyle Cummins terms "acquired liability," as opposed to the "natural liability" associated with virgin soil. This phase may be regarded as a dangerous defile at the very start of the road towards immunity.

The tuberculosis occurring in these new recruits, while approaching the "natural" tuberculosis of virgin soil, has been shown in the Pathological Section of the Report (see p. 160) to possess certain characters which differentiate it and indicate that it implies some degree, though only a very slight degree, of resistance to the tuberculous invasion.

[The Pathological Section of the Committee's Report, based on the pathological findings described by Pirie and Mavrogordato in Appendix 7 compares the descriptions of "primary"

and " natural " tuberculosis as given by Bushnell and Borrel, to illustrate the partial divergence of the local tuberculosis from the entirely " natural " type.

If we speak of the tuberculosis of virgin soil as the " Borrel " type and that of these tuberculin-sensitive Natives as the " Pirie-Mavrogordato type," we are in a position to appreciate this distinction ; and it may be added that, while the Borrel type may still occur in a few uninfected Basutos and " Tropicals," the real problem of the tuberculosis of the " new mine Native " on the Rand at the present time is presented by the Pirie-Mavrogordato type.—S.L.C.]

(2) *Conditions in the Recruiting Areas.*

It has been shown that tuberculosis is now endemic in the Native Territories, both in the Union and in Portuguese East Africa, a fact which helps to explain the tuberculous infection underlying the prevalence of the type of disease found in the new recruits.

But the question arises as to whether any other factors exist in connexion with early life in the Native Territories which may help to explain the liability of young mine Natives to develop acute tuberculosis shortly after arrival on the Rand.

It was pointed out by Miss Delf[72] that scurvy, an endemic disease in certain districts, " although rarely found potent and severe " among the Natives in their home surroundings, tended to become clinically obvious, in spite of the better diets, when work was started on the mines.

This observation on scurvy appears to fall into line with what has just been said about tuberculosis ; and the close parallel between these two diseases in respect to latency under home conditions, and the tendency to activation on starting mining work, suggests that food deficiency in the Native Territories, which plays such a dominant rôle in scurvy, may enter into the tuberculosis picture as well.

[In this connexion, I think it advisable to quote some passages from my South African diary in which the results of enquiries and conversations during my visits to the Transkei were noted down at the time. These summaries of talks with persons possessing intimate knowledge of local conditions must be regarded as important in connexion with the present enquiry.

Dr. Roberts, F.R.S., at that time a Senator and a member of the Commission on Natives under the Union Government, interviewed at Queenstown on 28th August, 1928, expressed the opinion " that the Ciskei and Transkei Natives are deteriorating through diminution of stock and resultant loss of the traditional occupations of a pastoral people and a loss of milk from the dietary." He said that " when, in 1850, Sir Harry Smith exacted a fine of 50,000 head of cattle out of the Ciskei, this loss made little or no difference, so numerous were the

cattle then. Now it would be difficult or impossible to find 50,000 head of cattle in the same district. The custom of making and using "*amasi*" (sour milk) has almost ceased for want of milk."

Dr. Macvicar, of Lovedale, interviewed on the same date, "is struck with the amount of scurvy and xerosis in Native children." . . . On my asking as to breast-feeding, he stated that he had seen scurvy in a breast-fed infant at five months, suggesting insufficient or unsuitable feeding of the mother." Miss Macvicar, the daughter of Dr. Macvicar, herself a doctor on the staff of the hospital at Lovedale, "spoke of the frequency of acute tuberculous broncho-pneumonia in infants and young children, always fatal."

Mr. F. Brownlee, of Butterworth, gave it as his general impression that "there is less milk available and a larger population needing it, and a larger claim on the family purse for luxuries, than 25 years ago; with the result that the people are not so fit and not so well fed as they used to be. . . . There used to be a "milk-sack" in each kraal from which sour milk could always be had. Now this is seldom seen. . . . So poor are local resources that . . . we could not carry on for a twelve-month without the remittances from the miners."

Mr. C. Brownlee, formerly Chief Magistrate of the Transkei, told us, on the subject of fatty foods, "that the Natives do not make butter. Their fat is derived chiefly from sacrificial animals and is preserved in calabashes. They lay much stress on fat and each boy is told at circumcision 'never let your mother's calabash be dry.' . . . Now there is no game and they are averse from killing stock. Only the rich can afford to kill sheep or goats for their food. It is not so much that stock has diminished in number—the country is really over-stocked—but cattle have become concentrated in the hands of a few and in certain areas . . . . so that there is no longer milk for all." —S.L.C.]

While the Natives of the Ciskei and Transkei still present, to the eye of a visitor, the appearance of good health and good humour so characteristic of African Natives in general, and while it would be clearly wrong to take an exaggerated view of their alleged deterioration, it seems that all is not well with them. Their numbers continue to increase without any corresponding increase in territory; and the lands they now occupy are very much less in extent than those over which they roamed with their flocks and herds before they encountered the advance of the White man from the Cape and from Natal.

They are in a difficult intermediate stage between a primitive state of society and a state of conformity to the standards of Western civilization and are not in a position to enjoy the advantages of either.

They have not yet lost the customs and traditions which belong to a pastoral and military community, and for which wide spaces for the grazing of cattle are a basic necessity, nor have they acquired the agricultural efficiency and the commercial sense needed for life in close proximity to European settlers and merchants.

The men have lost the hard discipline of warriors and hunters, and the women, with all the attractions of the trader's store close at hand, dream of short frocks and silk stockings and see the momentary advantages of tinned fruit and tinned milk over wild berries and herbs and the calabash of *amasi*.

As for the children, they are under-nourished; and in seasons of drought, many of the Natives, both adults and children, approach the starvation line.

In these circumstances, it is not to be wondered at that latent tuberculous infection should tend to light-up into activity when a life of monotonous leisure is suddenly exchanged for one of strenuous and unfamiliar exertion.

So much for the Native Territories within the Union.

What, then, of the other great source of mine recruits, the Native Territories of Portuguese East Africa?

The Committee has not had such detailed information laid before it in connexion with the life and economic conditions of the "East Coast" Natives, but a brief visit was paid to these Territories by Professor Lyle Cummins, and his impressions as laid before the Committee in a report dated 30th August, 1929, were much more favourable. The acquisition of land by White settlers appears to have been much less extensive, and the Native tribes seem still to enjoy a considerable amount of "elbow-room." A paragraph in his report runs as follows:—"We were struck, during our visit, by the plenty and variety of the foodstuffs available. . . . Mealie crops and crops of Kafir-corn and millet were reported to be excellent, and there was to be seen, on all sides, flourishing pineapple and mandioca cultivation. Ground-nuts, sweet potatoes and other vegetables were plentiful and many edible fruits grow wild for the plucking. To judge by the meals in preparation in various kraals visited by us, the Native women are excellent cooks and make a full use of the foodstuffs available."

In another part of the report there is mention of "the seemingly good conditions in which the Native population lives, conditions which appear to us much more favourable than those existing in the Transkei."

[To amplify this description of Portuguese East African conditions, I might again quote an entry from my diary, dated 12th August, 1929, at Zandamella. "We were much struck by the evident health and happiness of the Natives in this place; they seem sleek and well fed and the country is rich"; and, next day, "in the afternoon, a very good Native dance, at which we saw the whole population of the Zandamella area assembled; and a fine lot of handsome, healthy people they appear to be."

This impression, as a set-off against which must, however, be placed the fact that 1929 was an unusually favourable year, appears to have been strongly fixed in my mind at the close of my visit to Portuguese East Africa, as the quotations made from my report already show.—S.L.C.]

Is this apparent relative superiority of Native life in Portuguese East Africa associated with any advantage in respect of the acute generalized type of tuberculosis? There appears to be some reason for thinking that it is. Thus, Pirie and Mavrogordato, in their report on the Pathological Anatomy of Tuberculosis in Mine Natives (see Appendix 7, p. 378) grouped the cases coming to autopsy according to the country of origin as follows :—

EAST COAST NATIVES :	
Chronic Tuberculosis associated with Silicosis	117
Acute Lesions, Intra- and Extra-thoracic	146
TOTAL	263
BRITISH SOUTH AFRICAN NATIVES :	
Chronic Tuberculosis associated with Silicosis	83
Acute Lesions, Intra- and Extra-thoracic	191
TOTAL	274

From this it appears that the East Coasters only produced 56 per cent. of "acute lesions," while British South Africans produced 70 per cent. of the acute type. When it is recalled that the Portuguese East Coast Natives come to the high level of Johannesburg from a warmer and more malarial climate than do the Transkei Natives and are, therefore, subjected to a sharper and more trying contrast in temperature than the latter, the fact that they produced 22 per cent. less of the acute types of tuberculosis appears very suggestive. It would appear that faulty conditions of life and diet before coming to the mines predispose to a danger of breaking down of "larval" tuberculous lesions into active ones under the stress of hard work.

(3) *The Journey to Johannesburg.*

There is also a further possible source of risk which, while antecedent to arrival at Johannesburg, might, under unfavourable circumstances, lead on to tuberculosis in those with "acquired liability" to the disease, viz., the long and arduous journey from the Territories to the Rand. In this journey, for the young recruit the first departure from adolescent ease to a new way of life, the Native ascends from the warm levels of the African coast to a point about 6,000 feet above the sea and to a climate which is, at least, in the winter months, very cold, dry and dusty. The journey is a slow one and, at least from the more northerly recruiting areas of Portuguese territory, a long one, including both sea and land transport.

The possibilities for risk in transit are too obvious to require more than mention at this stage, and all that need be said is that the warmth, diet, comfort and night-accommodation of Native mine recruits on the journey from their Territories to Johannesburg are matters of hygiene which deserve the closest consideration.

[I cannot speak with authority on this subject of the journey to Johannesburg, not having personal knowledge of the conditions of travel, but I remember my attention being drawn to it by Dr. Mavrogordato, so I presume the Committee has reason to believe that the conditions are capable of improvement.—S.L.C.]

The medical examination undergone by recruits at the W.N.L.A. compound is believed by the Committee to be such that few, if any, recruits with clinically-defined defects can be passed as fit for work. This fact makes still more suggestive the well-marked tendency of a certain percentage of the recruits to "break down" into generalized tuberculosis within the first few months after arrival. If the contention that the larval lesions underlying the characteristic acute tuberculosis of new recruits are situated, for the most part, in the tracheo-bronchial glands be correct, this failure of the careful medical examination to weed out all those with "acquired liability" to tuberculosis will be readily understood, since these tracheo-bronchial lesions defy accurate diagnosis nor are they often accompanied by general signs of ill-health.

[It has been my privilege to see a great deal of the medical examinations carried out at the Witwatersrand Native Labour Association's Compound to supplement the preliminary medical tests applied before departure from the Territories. These medical examinations are described in the body of the Committee's Report (p. 84), so need no elaboration here. It suffices to say that, in my opinion, the work is well and carefully carried out by an experienced staff of whole-time medical men, and that the physical examination is supplemented by facilities for "observation" in hospital and X-ray examination in the case of "doubtful" recruits. The examinations are thorough and may be said to ensure that no recruit with clinically-defined defects can possibly slip through the net.—S.L.C.]

(4) *Life in the Mine Compounds.*

When the Native mine recruit has passed the medical examination, he is posted to a mine and enters the new life which is to be his during the period of his contract. Here he becomes one of a community of workers, dwelling in large compounds close to the mines, accommodated in rooms, usually in batches of about 40 to each room, with an air-space of about 200 cubic feet per head, fed from the communal kitchen of the compound on rations based upon Native diets and regulated by a minimum scale of issue laid down by the Native Affairs Department. He is provided with communal bathing and sanitary arrangements, summoned to work each day between 4 and 6 a.m., and he gets back to the compound after the day's work at an hour which varies in the different mines, but is usually from about 3 p.m. to 4.30 p.m.

While in the compound his life is regulated by the compound manager, a European official selected for his knowledge of Native languages and customs and possessing, as a rule, long and sound experience of the administration of Natives under compound conditions. Under the compound manager there are usually a group of Native policemen or Native "boss boys," chosen from amongst the "long-service" boys on grounds of character, influence and tribal prestige.

He has few organized amusements in his leisure hours, but then the Native is not devoted to sports and his leisure hours, except at the week-end, are few. But the compound is full of Native musical instruments, there is the "club" life of the rooms, with its story-telling and gossip and the Native games, so well described by H. Junod,[26] which afford opportunities for mild gambling; and at the week-end there are "passes" to visit the towns and all the fun of visiting neighbouring compounds, or receiving visits from outside, for elaborate Native dances, which afford just as much exercise as a game of football.

This life in the compound is, in many ways, preferable to the idle life of the kraals which, now that wars have ceased and tribal wanderings have come to an end, may be described as "monotony interrupted by beer-drinks"; and there is no doubt but that, apart from the minority which contracts or develops bacterial disease, the Natives benefit in health and return home fitter as well as richer after their periods of service on the Rand. This is proved by the gain in weight which is found to occur in the majority of Natives and on most of the mines.

But there remains the minority, fated to contract or to develop bacterial diseases, and it is with these that we are now concerned.

What factors in compound life may be expected to have a bearing upon tuberculosis?

(5) *Compound Accommodation and Management.*

It has been pointed out in Chapter II, Part II (p. 66), that even to-day a few of the compounds do not come up to the standard laid down by the 1911 regulations, but it has also been made abundantly clear during the course of the Committee's investigations that neither the general sickness-rate nor the tuberculosis incidence-rate nor even the average gain or loss in weight of the Natives correspond with variations in the outward efficiency of the compounds or the type of room in use. Nevertheless, compound conditions may have their bearing upon the question at issue.

[I have never been able, during my three yearly visits to South Africa, to become quite reconciled to the outward appearance of the compounds and hutments as seen during occasional inspections; nor am I alone in this, since the Report of Surgeon-General Gorgas, in 1914, voices a similar unfavourable impression. Possibly the attitude of mind engendered by years of military hygiene may have something to say to this adverse reaction, since the life of a community of mine Natives hardly permits of the same standards of barrack-room cleanliness and

smartness exacted in Army life. Certain it is that neither the general sickness-rate nor the tuberculosis incidence-rate nor even the average gain or loss in weight of the Natives correspond with variations in the outward efficiency of the compounds or the type of hutments in use.

The anomaly of the maintenance of a high standard of health under apparently unfavourable compound conditions is well brought out in the following quotation, entered in my diary on the evening after a visit to a certain mine compound :—

" Visited the compound, which is one of the ' rare old sort,' very dirty and untidy, the rooms holding up to 40 (but some have only 10) boys, the windows stuffed or draped over with cloths, food cooked in the rooms, odds and ends of food scattered about, washing-water, urine, soap-suds, etc., constantly flushed away along open gutters. And yet the boys seem healthy and the proportion with tuberculosis is not unduly high. As a matter of fact, this mine shows the highest percentage gain in weight and the highest average gain (9·04 for the average Native during his contract) of any mine on the Reef. The ' production of tuberculosis ' rate is of medium degree only and is falling."

The Natives themselves like this particular mine, which attracts a considerable proportion of " voluntary boys." The greatest care is given to the feeding, a matter in which both the compound manager and the mine medical officer take a keen interest. But, so far as the state of the compound goes, no claim for special efficiency can possibly be made. Nor is this an isolated instance. It is the common experience that the health of the Natives is often as good or better in the " obsolescent " mines, where financial difficulties forbid modernization of the compounds, as in the more up-to-date and richer mines.

This being so, it is perhaps rash to criticize compound conditions, but the fact remains that morbidity and mortality statistics depend on a large number of varying factors and that, whatever the reason, there does remain to be explained the definite liability of the new mine Natives to acute tuberculosis. —S.L.C.]

The entry of a " raw " Native into a mine compound means, for him, close and intimate contact with a new community, and this contact is especially close and intimate in the crowded room in which he rests and sleeps. His companions include, perhaps, a few other recruits, often from remote areas, as well as " old " mine Natives who have learnt to tolerate the bacterial flora of the mines and compounds and some of whom may, indeed, be germ-carriers of one sort or another.

While carefully kept " spot maps " of tuberculosis incidence have failed to show any case-to-case association of this disease in the mine compounds, this, in view of the long latency of infection in tuberculosis,

does not exclude the possibility of re-infection from healthy carriers, nor does it bear upon the question of the lighting-up of old lesions, since cases so produced would be unassociated with previous cases.

The opportunities for the handing round of other respiratory infections must be considerable in rooms accommodating 40 or more persons with an air-space sometimes no more than 200 cubic feet for each.

Smaller rooms, with fewer persons per room, would certainly lessen this risk. The advice of General Gorgas, given in 1914, to "scatter" the Natives and thus diminish the chances of transmitting respiratory disease is undoubtedly sound in regard to tuberculosis also.

[In this connexion, it might be pointed out that influenza, pneumonia and cerebro-spinal meningitis are never entirely absent from the mines and often assume considerable proportions; and it is generally admitted that influenza, at least, is able to play a formidable rôle in lighting-up dormant tuberculous lesions. That this generalization applies in the compounds of the Rand appears probable, to judge by the close correspondence between the variations in incidence-rates of tuberculosis and influenza for the Rand Mines Group, recorded as graphs for the last twelve or more years by Dr. Orenstein, through whose kindness I was able to see the figures.

The conditions in nearly all the compound hutments which I have visited appear calculated to facilitate the spread of influenza and other respiratory infections; and it is believed that, for those with "larval" tuberculous lesions, exposure to these respiratory infections involves a definite risk.—S.L.C.]

(6) *Feeding.*

The "Minimum Ration Scale for Native Labourers," as laid down by the Native Affairs Department, is quoted in Part II, Chapter II, p. 70, together with the calorific values and the presence or absence of vitamins A, B and C. Individual mines differ in their scale of provision; none of them fall below this minimum, but few of them exceed it to any considerable extent. Through Professor Lyle Cummins this minimum scale was submitted to the Medical Research Council, London, and through the kindness of Sir Walter Fletcher was reported on by Miss Harriette Chick, who writes: "The diet appears to be well supplied with vitamins B and C and to be low in vitamins A and D, and in mineral salts."

After a discussion on the values of the different constituents, she concludes, "if the labourers are exposed to sunshine the deficiency in vitamin D in the diet is unimportant, but the effect of sunshine in providing vitamin D is enhanced if the diet is well supplied with salts."

The Native miner, working underground, is not exposed to sunshine except during his week-end rest and during the short interval of daylight between his return from the mine in the late afternoon and the early African sunset.

It may be assumed, then, that the diet is deficient in both A and D vitamins, but there are numerous difficulties in the way of a more generous provision of fats. For one thing, the Native has his own ideas and preferences about food, and the diet, monotonous as it certainly is, meets his wishes and is based on his customs and habits. There is also the hard financial fact that even a very small increase in the daily ration for some 200,000 Natives mounts up into a very large sum and would involve an addition which some of the less prosperous mines might find impossible to face. At the same time, a more ample diet in respect to fats might be expected to yield some monetary return in the shape of a better output per man and in economics in hospital services and compensation claims for tuberculosis.

The Native diet in the kraal is based on the Native mode of life, an open-air life much less exacting from the point of view of metabolic waste than that of gold-mining. The diet on the mines is based to some extent, possibly too closely, on this kraal dietary. It may be added that milk is an important element in the diet of all cattle-owning tribes, whereas milk and butter are absent from the mine rations. While proof cannot be obtained except by trying, it is at least highly probable that an all-round increase in vitamins A and D to the Native mine rations would lead to a decrease in incidence and mortality from tuberculosis, just as attention to the provision and cooking of fresh vegetables has been followed by a fall in scurvy.

It is not, however, only in respect of diet constituents that the present arrangements are open to discussion. In respect of the intervals between meals, too, there is a problem difficult of solution and yet requiring close attention in relation to health.

Here, again, the arrangements in the mines are based on Native custom. The South African Native takes food twice daily; shortly after rising in the morning and again on return to his kraal in the late afternoon. The latter is the principal meal of the day. But the Native day starts with dawn and the amount of hard work included in the hours between dawn and dusk is not great. The Native miner's working day, on the other hand, starts as a rule some hours before sunrise and starts in the haste of getting a large shift of labourers down into the mine. It is usual to provide a small loaf of bread and a drink of " marewu " or, perhaps, coffee, which the Native must either consume in the hurry of his start for the mine or take with him to eat on the way. Apart from this, he gets no food until his return to the compound ten or more hours later, after a strenuous day of muscular work carried out, to all intents and purposes, on an empty stomach.

This arrangement, on the face of it, scarcely seems satisfactory, and should be capable of being improved with advantage to all concerned.

[I am unable to believe that this feeding arrangement is satisfactory.

The arguments usually brought forward in support of it are that Native custom must be followed, that the Native is superstitious and will not eat in the depths of the mine, which he regards as dirty and haunted by evil spirits; and, finally, that the difficulty of bringing food to the Natives during the "shift" is too great to justify a change in the present arrangements.

None of these difficulties are insuperable, as is proved by the fact that, on the recommendation of Dr. Orenstein, meat sandwiches are now being issued, during working hours, to the Natives in the Village Deep, one of the most difficult mines from the point of view of distribution; and that these are readily eaten.

Drinking water is normally supplied to the workers in most of the mines, salt being added to it where the conditions involve a great loss of fluid in sweating; and if salted water can be distributed, there should be no insuperable difficulty in the distribution of a nourishing meat-broth or soup.

A good cup of warm soup, too, would be a very desirable addition to the morning meal issued before descending the mine, and a meal of this sort is given on one of the healthiest and, from the Native point of view, one of the most popular mines on the Rand.

To summarize my feelings about the feeding of the mine Natives, it seems clear that the food provided is good in quality, adequate in caloric value, well cooked and in line with Native preferences and habits. On the other hand, it is monotonous, inadequate in respect of fats, and the intervals between meals are unduly long. The elements in which the diet are admittedly deficient, vitamins A and D, are known to be of especial value to the body in its defence against tuberculous disease and the various septic infections.—S.L.C.]

(7) *Hours Underground and Hours of Work.*

The relation of hours underground to hours of work varies in the different mines according to the relative ease and rapidity with which the Natives can be transported from the surface to their working place and actually started on work.

It is no small feat of organization to get several thousand Natives down to, and up from, depths averaging over 4,000 feet below the ground-level, and delays must necessarily arise. Even when they have reached their working levels, the work cannot be started until the White miner responsible for the safety of working conditions has investigated and reported "all well."

As already stated, conditions vary from mine to mine, but probably 10½ hours underground may be taken as a fair average for the whole Reef, not all of which, however, is spent on actual work.

[A couple of casual entries from my diary bearing on this point record the " hours underground " at a mine visited in September, 1929, as 10 to 11, while the actual working hours were 8. Here all the miners had to be lowered down a single shaft. At another mine, visited in July, 1929, the average time was 11 hours underground for 9 hours' work, and at another 10¼ hours for about 8.

The Tuberculosis Commission of 1914[34], reporting on conditions of work in the coal mines at Witbank, stated (pp. 192 and 193) that shifts were from 6 a.m. to 6 p.m., without intervals for meals, and that overtime was sometimes worked straight on after completion of the shift time, the day's work sometimes lasting from 15 to 17 hours. As the Commissioners put it, " the average owner of a horse would not think of working it like this."

Things have much improved at Witbank where, to-day, the conditions of work are much less severe than in the more difficult gold mines.

But it is still a question whether " the average owner of a horse " would long enjoy the advantages of ownership if he kept his beast out of the stable and without a feed for 11 hours every day and made it pull a cart for 8 or 9 hours of the time.

Native mine-workers appear to be more enduring nor is this rather rhetorical comparison quite a fair one, though it expresses a truth in picturesque language.—S.L.C.]

It still remains true that the Natives are not in the habit of taking a midday meal and that the average Native miner gains in weight and health during his contract, proving that even these long hours of exertion are not beyond average capacity. But again it must be pointed out that we are not here concerned with the average Native. We are considering the factors which may tell against the Native with " larval " tuberculous lesions hidden in his tissues.

Whether any man, healthy or infected, can continue for long to do effective work for eight or nine consecutive hours, without intervals for meals, is an economic question as to which scientific tests must supply the answer; but it can hardly be doubted that, for the man whose health depends upon a delicate balance between larval tuberculous lesions and tissue resistance, a day's work of this length, without food, is calculated to swing the balance the wrong way.

(8) *Conditions of Work.*

Those desiring to gain an idea of the conditions under which these Native miners work should consult papers dealing with this question published by Orenstein and Ireland[48] and Mavrogordato and Pirow,[73] in both of which the physiology of South African gold mining receives consideration. The latter paper deals especially with deep-level mining and high temperature, and is based on an enquiry carried out

by the authors into a series of four deaths from heat-stroke which occurred in Natives working in the Village Deep mine in December, 1925, and January, 1926. In this mine, the deepest on the Reef, the working conditions, involving great heat, were, as is the case on all the mines, complicated by the necessity of reducing the dust-content of the air by means of sprays, thus raising the humidity and approximating the wet-bulb to the dry-bulb temperature, so that evaporation of sweat became difficult or impossible and temperature-regulation was interfered with. Discussing the problem, the authors say: "It will be seen that the deep-level mines on the Witwatersrand, in the absence of mechanical ventilation, realize something like the ideally bad conditions." Steady and successful effort in the direction of better ventilation has now led to a great improvement in this particular mine, but the quotation serves to indicate the natural difficulties always present in deep mining and the trying conditions of physiological stress under which the Native miners carry out their daily task. (At the time of publication this mine had practically ceased operations, for economic reasons.)

(9) *Acclimatization to Work at Deep Levels.*

As time goes on, men adjust themselves to these conditions, but it is the young Natives, the "new recruits," amongst whom tuberculosis is especially prevalent, with whom the Committee is now concerned.

To adapt oneself to the work of deep mining at a high temperature needs a period of "acclimatization"; a period in which not only is the new work learnt but during which the body adjusts itself to unfamiliar and trying conditions.

In this connexion, Mavrogordato and Pirow (*l.c.*) write as follows:— "It is neither kind nor wise to set a raw boy to learn 'lashing' at 86°F. wet-bulb." It may be said at once that efforts are made to get the new mine Natives gradually "entered" before allotting to them the harder tasks at the deep levels. Special gangs for new Natives have been organized on all deep-level mines and for a period of 24 working days they are thus gradually acclimatized.

The introduction of this system is a step in the right direction and every effort should be made to perfect it.

There is also a field for improvement in protecting the Natives during their return from hard work in the great heat of the deep levels from sudden changes in air-temperatures and velocities, either by means of suitable ventilation controls or, where this is impossible, by the provision of extra clothing.

[I am of opinion that there is still room for improvement in the direction of a well-defined system of "entering" new boys through a series of graduated tasks over a period of at least a month. While fully aware of the administrative difficulties involved, I consider that a whole-hearted effort in this direction is urgently desirable throughout the industry in the interests of the health of the Native miners.—S.L.C.]

(10) *Exposure to Silica-dust.*

Until quite recently there appeared to be good ground for the opinion that the influence of silica upon tuberculosis was manifest chiefly as an adjuvant to the development of a slow bacterial invasion contemporaneous with or subsequent to the appearance of silicotic fibrosis. All the epidemiological evidence pointed to this late effect; the silicotic fibrosis appearing first and the tuberculous element making itself manifest as a late or perhaps a terminal phenomenon. The salient fact brought forward as proof that silicosis predisposed to tuberculosis was the existence of a higher tuberculosis death-rate amongst silicotics of late middle-age and onwards than in the rest of the community.

Collis[76] lays down "latency of onset of the disease" as one of the characteristics of exposure to a dust predisposing to phthisis, and the Royal Commission on Metalliferous Mines and Quarries[78] puts the facts very clearly as follows:—"If in any given class a high death-rate from pulmonary tuberculosis is found occurring at a later period of life than is usual for pulmonary tuberculosis, and if this high death-rate is associated with a high death-rate from other respiratory diseases, then this class is exposed to the inhalation of injurious dust."

It is known from the important experiments of Gye and Purdy,[76 77] Gye and Kettle[78] and Kettle[79] that silica, either in colloidal solution or in its crystalline state, is capable of assisting the invasive activity of tubercle bacilli introduced into the tissues of experimental animals, but the acute tuberculous processes thus produced appear to be so different from the chronic tuberculous disease associated with advanced pulmonary silicosis that it is difficult to see the precise bearing of these laboratory experiments upon the question of miners' phthisis.

New light has recently been thrown on this question by the publication of a highly important series of experiments by Leroy U. Gardner,[80] in which he shows that the exposure to silica-dust of guinea-pigs already infected with a low-grade tuberculosis caused by an attenuated strain (R.1) leads to a reactivation and often to a generalization of the disease. To quote his own words: "A series of guinea-pigs has been primarily infected by the inhalation of tubercle bacilli of low virulence. In normal animals such infection produces isolated sub-pleural pulmonary tubercles which attain a state of caseation, then retrogress, and finally heal by resolution. As a part of the picture of primary infection, the tracheo-bronchial lymph-nodes are also involved and the lesions in this situation undergo a similar series of changes. At serial intervals, ranging from 54 to 206 days and, in a few cases, 400 days, after such infection, groups of four animals were removed to each of three dusting chambers where they were exposed to the inhalation of quartz, carborundum and granite-dust until they died or were killed. The experiment has demonstrated that the inhalation of these three dusts will stimulate a renewed multiplication of bacilli in the healing tubercles. . . . With quartz, 73·6 per cent. of the animals exhibited evidence of progressive tuberculosis, with carborundum there were 31·8 per cent., and with granite only 26·3 per cent."

Here we have what can only be described as a remarkably close parallel to what appears to occur in new mine Natives. Gardner's guinea-pigs, infected in such a way as to produce what Professor Lyle Cummins has called, in man, "larval" tuberculosis, prove to possess what has been described above as "an acquired liability" to progressive tuberculosis when exposed to silica-dust; a liability which would never have come to light had it not been for some "factor of aggravation," possibly that introduced by the dust-exposure.

Applying the findings of Gardner in guinea-pigs to the problem of tuberculosis in raw South African mine Natives, it will be seen at once that there is a close parallel between the conditions obtaining on the Rand and the conditions artificially produced by Gardner in his animal experiments. On the one hand, there is the new mine Native arriving, infected but healthy, from his kraal. We know him to be healthy, since he has just passed a rigorous medical examination. We know him to be infected from tuberculin tests and post-mortem observations. He starts work in an atmosphere charged with a certain amount of silica-dust. We know that this is still true, in spite of the precautions taken, because of the continued occurrence of tuberculo-silicosis in the older miners. The necessary conditions for Gardner's experiment are, therefore, present: "larval" tuberculosis and exposure to silica-dust.

We may, therefore, have in silica-dust an important element in the production of the acute generalized tuberculosis of new boys. That other factors also contribute we infer from the fact that the acute generalized tuberculosis of Natives is not confined to the gold mines but occurs also in a certain number of Native coal-miners and diamond-miners not exposed to silica-dust. Indeed, it is common in the mental hospitals of South Africa, where neither dust nor industrial fatigue can be invoked to explain it. But it appears to be more common and to occur, on the average, after a shorter period of time, in the case of gold-mine Natives, and this special tendency may well depend on the adjuvant action of silica.

These experiments of Gardner's suggest to their author "that the evidence submitted may be applied to human pneumonoconiosis and that it affords reason for thinking that all tuberculosis complicating this condition is not necessarily an exogenous industrial infection. In a certain proportion of the cases it seems probable that inhaled dusts of the proper type may light-up pre-existing quiescent foci of infection or disease."

This conclusion is admirably expressed and its possible bearing on the tuberculosis of the mine Natives at Johannesburg will not escape those familiar with the problem.

Previous experiments of Mavrogordato[60] have demonstrated the influence of inhaled silica in facilitating the effective infection of rats and guinea-pigs by the tubercle bacillus.

It seems that we may have to postulate a dual rôle for silica-dust in the determination of tuberculous disease in man; an early action while the lymphatic drainage of the lungs is still efficient, permitting

of the transport of phagocyted silica-dust by the same channels as those along which tubercle bacilli had already been carried and to the same situations, glandular and other, in which the bacilli had already been arrested and had set up larval foci of infection; and a late action in which, owing to the previous establishment of silicotic fibrosis and lymph-blockage, inhaled tubercle bacilli and inhaled silica-dust must accumulate together in the lung parenchyma and set up the chronic tuberculosis so characteristically associated with the pneumonoconiosis of White miners in Africa and elsewhere.

[The "saddle-back" curves of age-mortality once so evident in the lead-mining districts of Cardiganshire, the quarry districts of Pembrokeshire and of Anglesey, and other parts of North and West Wales may, perhaps, be taken to suggest that not only in Africa but in European districts also in which a silica risk occurs in industrial centres situated amongst relatively recently "tuberculized" populations, this dual mode of action of silica may afford part of the explanation.

To sum up my views as to the "simple tuberculosis" of the newer and younger Native miners, this form of the disease, apart from rare instances of the early infection of virgin soil, is due to the reactivation of larval tuberculous lesions under the stress of work in the gold-mining industry. The factors which are calculated to lead to this reactivation are discussed in the Committee's Report and are briefly as follows: Lack of adequate "acclimatization" to a trying industry; exposure to "secondary" respiratory infections in crowded compound hutments; the mixing-up of the relatively immune with non-immune persons; the poverty of the otherwise adequate dietary in vitamins A and D; the strain of deep mining and all that it implies in long hours underground; severe physiological stress and climatic contrasts between conditions underground and on the surface; and, lastly, exposure to silica-dust.

It is the cumulative effect of these several factors which proves too much for those whose previously acquired tuberculous lesions are in a state to be readily brought into fresh activity. —S.L.C.]

FACTORS LEADING TO TUBERCULOSIS IN "LONG-SERVICE" NATIVES.

Amongst older mine Natives, who have passed safely through the early years of work in the mines without loss of health, and who remain in the gold-mining industry either intermittently or in continuous employment, there tends to appear a relatively chronic type of tuberculosis not unlike that met with in Europeans of middle-age.

With this type, as has been already explained, is usually associated more or less silicotic fibrosis, affording proof of a considerable period of mine service and giving evidence of the cumulative effect of prolonged exposure to silica-dust.

There are, of course, intermediate types between this more or less chronic and localized pulmonary tuberculosis of the older men and the acute generalized disease met with in "new" boys; and it is true, also, that cases of generalized tuberculosis sometimes occur amongst the long-service Natives; but, on the whole, there is a rather sharp contrast between tuberculosis in the "old" and the "new" boys.

The question arises whether this relatively chronic type of phthisis can be explained as due to the persistence of early lesions and their late re-activation or whether it is due to super-infection from without; in other words, whether it is of endogenous or exogenous origin.

Apart from surgical tuberculosis, the only "local" tuberculosis met with in the Native labour force is this chronic pulmonary tuberculosis or the tuberculo-silicosis of the long-service boy. It is in this "tuberculosis of middle age" and in this type only that our Natives resemble Europeans in the manner of their response to effective infection by the tubercle bacillus. Arguments leading to the association of the chronic pulmonary tuberculosis of the European with exogenous inhalation re-infections apply equally to the Native. The main argument in this connexion has already been elaborated fully in the Pathological Section of this Report (p. 172) and need not be repeated again here.

The experiment of Mavrogordato[60] in which rats left underground in cages were later found to be infected with tuberculosis proves conclusively that mine-air may contain sufficient tubercle bacilli to produce infection and disease even in a highly-resistant animal like the rat.

In many cases, both in Europeans and Natives, tuberculosis of the lungs, when first recognized, is widely distributed through those organs and resembles an experimental inhalation infection.

Strachan and Simson[81] have shown by inoculation experiments that in many cases of tuberculo-silicosis the dust and the living tubercle bacilli are associated in the same nodule. Dust is certainly an inhalation invasion and it has occurred that an X-ray plate has shown up the stigmata of dust in the lungs of a patient for the first time simultaneously with the recognition of pulmonary tuberculosis; thus, a miner whose chest has shown no evidence of either silicosis or tuberculosis may, three months later, present a typical X-ray plate of silicosis with associated tuberculosis. This abrupt appearance of the stigmata of silicosis is not met with apart from an associated tuberculous infection. These findings suggest that the dust and the tubercle bacilli have travelled by the same road at more or less the same time.

There are certain facts which may be quoted against the exogenous theory:—

Contact spot-maps of tuberculosis incidence in the compounds and in the mines have yielded no satisfactory evidence connecting case with case and the examination of mine-dust and air for tubercle bacilli has been inconclusive. Case-to-case infection, however, is never easy to

establish in tuberculosis even under family conditions owing to the slow rate of development of infection into disease. The detection of tubercle bacilli in dust and air is at any time rather a difficult procedure technically, and in the case of the mines was rather a forlorn hope from the outset, owing to the very minute samples of the whole which could be dealt with.

Despite failure to adduce complete proof of the presence of all the stages involved in exogenous infection, the Committee is of opinion that conditions favouring it are present in the case of the long-service miners.

Cases of tuberculosis continue to be detected at the periodical examination of White miners, at the monthly weighings of Natives, and through the X-ray investigation of long-service boys, proving that there are carriers at large in the mines and compounds; while the spitting habit, so common among Natives, ensures the repeated contamination of working places, waiting places, rooms, etc.

Examination of random samples of sputum collected underground (see Appendix 6) showed one specimen positive for tubercle bacilli out of 33 examined, and the conditions met with underground—warmth, humidity and absence of sunlight—are eminently calculated to favour the survival of tubercle bacilli outside the body.

On the whole, then, the evidence available is definitely in favour of the conclusion that the chronic pulmonary tuberculosis of long-service Natives is due in the main to exogenous re-infection aided by the simultaneous inhalation of silica-dust and the resultant silicotic fibrosis. In fact, it is the silicotic fibrosis that plays a large part in raising the fibrous tissue barriers that localize the disease. At autopsy it is found that the long-service Native who does not present a silicosis usually generalizes his tuberculosis.

Taking first the presence of infected persons, the outstanding characteristic of the tuberculosis of long-service Natives is, as has been pointed out above, the possession of an increased tolerance of the disease, with the result that "open" lesions often co-exist with a considerable measure of good health. This situation could develop into a vicious circle in which the presence of carriers leads on to repeated infection of relatively resistant persons and the tolerance of these persons for tuberculosis infection leads to their becoming carriers in their turn.

That the danger involved through the existence of this pool of infected persons is fully appreciated is shown by the elaborate measures taken to detect cases of this kind by monthly weighings, radiological examination of old mine workers, and constant attention to the elimination of clinically tuberculous persons during the medical examination of recruits.

Everything possible seems to be done on these lines, and the good effects are already evident in a gradual fall in the morbidity and mortality rates from tuberculosis. But the mere fact that cases continue to be

detected at these periodical examinations constitutes, in itself, the best proof that final success has not yet been reached, and that the efforts towards early detection must be sustained.

Even on the assumption that exogenous infection is of little importance in the etiology of the phthisis of long-service Natives, there would, of course, be no justification for relaxing the measures in force for the detection of cases. Their recognition would still remain a matter of importance for their own sakes, for the sake of the White miners and for the sake of the general population with which they come in contact about the mines, the compounds, the Reef and their kraals.

Turning to the question of exposure to silica-dust, precautions against dust have received and are receiving so much attention as to make it unnecessary to do more than stress the importance of not relaxing the attention paid to this question.

[My observations upon the risk of accumulation of coal-dust in the lungs of silicotic miners in Wales lead me to regard with a certain amount of apprehension the recent suggestion of "stone-dusting" as a precaution against silica, especially in an industry in which many of the older and more experienced workers must be in a sub-silicotic state. Even the least harmful dusts may, perhaps, accumulate to a dangerous extent where the lymph-drainage of the lungs is impaired by silicotic fibrosis.

Efforts towards "dry" mining and better ventilation so ably advocated by Professor Haldane during his recent visit to the Rand should be the inspiration of those responsible for further developments in dust precautions at Johannesburg.

It has come as a surprise to me to see such a limited use made of dust-catching apparatus at the point of application of the drill. I am aware that this subject has received and is receiving close attention from experts and that what is possible in European mines may be difficult or impossible with Native miners in South Africa. But the impression remains that more might be accomplished in this direction.—S.L.C.]

CHAPTER VII.—DISCUSSION ON PROPHYLACTIC MEASURES NOW IN FORCE OR CAPABLE OF BEING APPLIED IN SOUTH AFRICA

(With Commentary by Professor Lyle Cummins).

Note :—The Introductory Note to Chapter VI applies to this Chapter also.

Before attempting to consider anti-tuberculosis measures in detail, it is well to be clear as to the following points, which follow upon the foregoing discussion in Chapter VI :—

(*a*) A majority of the Native mine recruits, drawn, as they are, from endemic areas, arrive at the mines already invaded by the virus of tuberculosis.

(*b*) There are certain factors connected with the mining industry which tend, especially in the case of those with latent tuberculosis, to change this into active disease. These "factors of aggravation" constitute a special danger to new boys, and underlie the "simple tuberculosis" of the earlier periods of work on the mines.

(*c*) Prolonged periods of work in the mining industry, involving danger of exposure to further exogenous infections with tubercle bacilli accompanied by a cumulative risk from inhalation of silica-dust, are conditions which predispose to the more chronic forms of pulmonary tuberculosis and tuberculo-silicosis of long-service miners.

(*d*) The repatriation of Natives infected with tuberculosis, while often exaggerated as a cause of infection in the kraals, does undoubtedly make a constantly repeated contribution to the endemicity of tuberculosis in the Native Territories.

Inasmuch as the endemic tuberculosis of the Territories constitutes a danger to the mines and the "tuberculosis production" in the mines involves a danger to the Native Territories, any comprehensive anti-tuberculosis policy must therefore include measures on the Witwatersrand and also measures in the Native Territories.

Anti-tuberculosis Measures on the Witwatersrand.

General Measures of Hygiene.

If it be true that "there are certain factors connected with the mining industry which tend . . . to change latent tuberculosis into active disease," these factors ought to be sought out and, if possible, neutralized or eliminated.

A perusal of the foregoing will show that, in the opinion of the Committee, many of the factors involved are of a general nature and not exclusively connected with tuberculosis. Their amelioration may

raise financial and administrative problems, the consideration of which is not within the province of this Committee, which is solely concerned with the hygienic aspects.

There is unanimity amongst the members of the Tuberculosis Research Committee that many of the compounds are unsatisfactory; that the accommodation of 40 or more men in the same room for sleeping and eating, with about 200 cubic feet of air-space per person, involves risks of overcrowding and the distribution of air-borne infections; and that the newer type of room for a much smaller number of men diminishes these risks. That a period of from 9 to 11 hours underground without a rest interval and without a meal is hygienically unsound; and that there is a probable lack of vitaminized fats in the diet which ought to be made good in the interests of health.

The Committee is of the opinion, however, that the initiation of a comprehensive policy of better housing, shorter working hours and additions to the Native diets would involve expenditure which might prove impossible for some mines at the present time.

When it is recalled that there is normally a Native labour force of about 200,000 men constantly at work in the gold mines, that land is exceedingly expensive in the vicinity of large and growing centres of population, that many of the older mines are barely holding their own or are actually running at a loss and that, in the opinion of many experts, the next 50 years will see the end of profitable gold-mining on the Reef, it is not to be wondered at that the Committee hesitates to recommend measures which appear to be outside the range of practical politics. The situation is well summed up in the reply commonly made to the suggestion that milk, butter or animal fat be added to the Native diet—"Do you realize that the additional expenditure of 1d. per head per day to the diet of 200,000 men means £25,000 per month or £300,000 per year?"

Add to all this the fact that the Native makes no complaint about his diet, which is admittedly more generous than what he can obtain at home; that the average Native miner gains in weight during his contract; and the hesitation to recommend a further financial burden, which may very likely prove unproductive from the point of view of the balance-sheet, is easy to understand.

Yet the industry pays something like a million pounds annually in compensation for silicosis and tuberculosis, to say nothing of the expense involved in the accommodation, treatment and repatriation of sufferers from diseases which, if not entirely preventable, are certainly capable of being diminished.

Without desiring to discuss financial questions which are outside the province of this Committee, and which may be the over-riding factor in the matter, we are of opinion that there is a strong case to be made out for the gradual, if not the immediate, provision of more up-to-date compound accommodation on some of the mines;

for a close investigation into working hours and hours underground, with a view to their shortening; an enquiry into the possibility of improving the mine-rations in respect of animal fats; and into the question of the provision of food at a suitable period during the working-shift.

To bring about these essential improvements a co-ordinated effort guided by expert advice will be necessary. With this end in view the Committee recommends that the Transvaal Chamber of Mines set up a Health Advisory Committee, consisting of consulting engineers, mine managers, medical officers and a representative from the South African Institute for Medical Research and from the Witwatersrand Native Labour Association; the personnel of the Committee to be, if possible, so adjusted as to ensure representation of each mining group by at least one member.

[The medical services of the gold mines are, from the point of view of curative work, excellent. The visitor cannot fail to be struck with admiration for the Native mine hospitals, and it may be stated with confidence that, since the initiation of a whole-time medical personnel following upon a recommendation to this effect in the report of Mr. H. O. Buckle on "Native Grievances" (1913-14), there has been steady progress in the treatment of the injured and the sick.

Not only has there been progress in curative medicine but a body of competent medical men has grown up in the mining industry and now includes many who have gained invaluable experience in the problems of mine hygiene. It would be incorrect to say that these medical men are sanitary specialists in the strict sense of the term. Few of them possess the Diploma of Public Health and all of them regard medicine and surgery as their chief province rather than preventive medicine. But they do possess a special knowledge of mine and compound hygiene gained through every-day familiarity with the medical problems of the mines and, in this respect, they are of great potential value to the industry. But they do not regard themselves, and are not regarded, as sanitary officers.

Apart from the "Corner House Group" (Rand Mines, Ltd.), an organized group of mines with a centralized system of sanitation under the control of a medical superintendent, the compound managers, a body of gentlemen highly trained in the administration of Natives but without any special knowledge of hygiene, constitute the real sanitary officers of the gold mines on the Reef.

The mine medical officers are there to advise and help but, for the most part, are kept fully occupied with the surgical and medical work needed for a large Native population engaged in an industry which involves many risks and provides plenty of patients.

The compound managers do wonderfully well, on individual mines, and some of them are first-rate sanitary officers, but it is their duty to look at things from the economic rather than from the hygienic point of view; nor can they be expected, in the course of a life full of urgent business of a non-medical nature, to familiarize themselves with the complex questions of modern preventive medicine.

The result is that there are inequalities between the efficiency of hygiene in the different compounds, that some mines provide better-cooked and more suitable food than others, and that the policy as to the rooms, with regard to air-space, the use of numerous blankets and hangings, the opening of windows and the general cleanliness, is not constant but subject to much variation.

Apart from the highly developed sanitary organization of the Corner House Group, there is no centralized system of hygiene for the gold-mining industry at Johannesburg. The local authorities of the administrative areas in which the individual mines are situated are vested with an agreed measure of sanitary control and carry out the usual inspections, but these arrangements, while doubtless adequate in the interests of the non-mining inhabitants of the areas concerned, are not calculated to take the place of the sort of sanitary service which is available, for instance, in the Corner House Group.

At first sight, this want of any centralized service of hygiene comes as a surprise; but it is necessary to realize that the mining industry itself is not centralized, but consists of a large number of separate business concerns, the individual mining companies or groups of mining companies, each responsible for its own organization and development, each employing its own medical staff and managing its own affairs after its own fashion. The proximity of one mine to another, the identity of the climatic, geological and other problems along the Reef, and the existence of such bodies as the Chamber of Mines, the Native Recruiting Corporation and the Witwatersrand Native Labour Association, give a spurious impression of centralization, but are, in fact, merely the expression of certain common needs. The individual groups and mines are independent concerns and the industry hardly lends itself to any such centralization of sanitary services as is found convenient, for instance, in military formations.

This absence of unification in the general direction of the industry seems to preclude any centralization of executive sanitary control, except on the initiative of the industry as a whole. Health regulations issued by a central authority and involving, perhaps, the expenditure of considerable sums of money would not meet with any enthusiastic welcome from independent mining companies. And yet the problems of health

are similar throughout the Reef and the monetary loss to every mine and every group through the payment of "compensation" and through "loss of time" due to illness suffices to show how much might be gained by a co-ordinated effort towards improved hygiene.

This need has obviously been felt for some time and efforts have been made to meet it. In the Mine Medical Officers' Association there exists a body to which sanitary problems are often referred and which is capable of rendering considerable help.

While this Association serves a most valuable purpose in making the mine medical officers acquainted with each other, in affording opportunities for discussing common problems of professional work, and in fostering the team spirit, it does not, so far as I can see, provide the industry with an entirely adequate machine for the working out and direction of sanitary policy.

Amongst its members are many highly-trained physicians and surgeons, but their training and their interest lie chiefly in the direction of the daily work of the mine hospitals and the routine of the mine compounds. They have neither the time nor the special training needed for the seeking out of new knowledge by research and the furnishing of expert advice on complicated questions in preventive medicine.

Leaving out of consideration the Corner House Group, which has already faced the problem of sanitation on excellent lines, and as to which no further suggestions are necessary, it seems to me that there is an urgent need for greater organization in hygiene services throughout the industry.

So far as the executive control of hygiene in mines and compounds is concerned, this must be vested in the directors of the companies or groups concerned. No executive authority is worth much unless it is in the hands of a body that can punish or dismiss an official for failure to carry out an order.

Without entering into details, it is my opinion that much could be accomplished on individual mines by the formation of Executive Mine Hygiene Committees consisting of the mine manager as chairman and the mine doctor and compound manager as members. Such a committee, meeting once a month to discuss problems of health, might serve to tighten up sanitary measures very effectually, and such discussions, carried out in the presence of the mine manager, should be of great service to both the doctors and the compound managers, in affording opportunities for expressing their views and in getting action initiated. Much improvement in relation to diets, housing, hours and conditions

of work and the daily life of the Native personnel might thus be attained, especially if the groups to which the mines belonged had established similar Group Committees, to which the larger issues might be referred.

But it is quite clear that, for the elaboration of a general sanitary policy and for the collection of the new knowledge upon which a progressive policy must be based, some more scientifically constituted, more centrally placed and more authoritative organization is required. As to the exact type of organization I am not equipped to make any final recommendation. There are so many factors to take into account in the shape of existing machinery, financial difficulties, personal equations and so on that only those in close touch with the local situation can work out an effective scheme.

But the work of the Tuberculosis Research Committee during the last three years serves to illustrate how a suitably chosen body, including expert research workers, Government and Chamber of Mines representatives, members of the Miners' Phthisis Medical Bureau, the Witwatersrand Native Labour Association, the Transvaal Mine Medical Officers' Association and others, can work out set problems through special sub-committees, piece together individual reports, and sort out information in such a way as to bring it to bear on current problems.

It appears to me that, quite apart from the executive side of sanitation, which hardly admits of centralization outside of the groups of mining companies, there is an urgent need for the creation of some authoritative sanitary organization, dealing not merely with tuberculosis, but with all the problems of the hygiene of the gold-mining industry, and so constituted as to be able to initiate research, co-ordinate knowledge and advise both the Chamber of Mines, the mining groups and companies and the mine hygiene committees as to the lines along which executive action might be directed.—S.L.C.]

So much for general measures of hygiene. As to the more particular question of tuberculosis prophylaxis, it will be evident, from the foregoing remarks, that, in the opinion of the Committee, the main need is for a general raising of the standards of living and working conditions in the compounds and mines. There remain, however, certain specific suggestions which must be further discussed.

Prophylactic Inoculation.

At the commencement of the present onquiry, it was hoped that it might be possible to adopt the direct method of active immunization against tuberculosis which has proved successful against certain acute bacterial diseases, and it was thought possible that B.C.G. vaccine might be used to this end. The discovery, however, that a large majority

of the Native mine recruits arrive at Johannesburg already allergic, as proved by tuberculin tests, suffices to show that the employment of B.C.G. vaccine is not to be recommended. Neither Calmette nor Guerin advise the use of this vaccine in tuberculin-positive adults.

Although its use in mine recruits is contra-indicated, a large field of possible usefulness which should be explored is to be found in the children of urban and rural locations, where tuberculosis is rife. The suggestion has also been made that tuberculin, applied by inunction or otherwise introduced, might help towards raising the immunity.

No significant difference has been observed in tuberculosis incidence and mortality between the large numbers of Native recruits given tuberculin injections intra-dermally during the present enquiry as compared with the Native miners to whom no such injections were given, although special attention was directed to this point in the "follow-up" of the tuberculin-tested groups. There is some argument, therefore, against the efficacy of tuberculin in prophylaxis.

Not much is to be hoped, then, at the present time, from attempts at active immunization against tuberculosis in mine recruits in South Africa, but the question of how to induce tuberculo-immunity is being pursued in many laboratories both in Europe and America, and it may well be that an effective method may yet be discovered. The importance of the problem to South Africa and the special circumstances attending the use of Native labour in industrial developments afford both a stimulus towards research and the opportunity for carrying it out.

[To try out the effects of tuberculin upon the tuberculosis of previously infected animals (since the Native mine recruits have been shown to arrive infected from the kraals), I undertook two series of experiments in guinea-pigs; the attempt being made to raise their immunity to subsequent tuberculosis by injections of tuberculin, B.C.G., and "Bacillary Emulsion" after a previous artificial infection but before the onset of symptoms. No results of a kind to suggest any acquisition of immunity were obtained. In fact, the treated animals died, for the most part, sooner than the non-treated "controls." Subsequent experiments on rabbits, however, have given more encouraging results.

While these experiments suggest, so far as they go, that little is to be expected from tuberculin in the treatment of healthy but infected individuals, it is difficult to say how far these results in guinea-pigs are applicable in the case of man. It is clear that further work is necessary before any attempt at systematic immunization can be initiated.

It is exactly such a problem as this that best illustrates how urgently is needed some competent body of experts associated with the mining industry able and willing to press forward

investigations in this direction. The opportunity for experiments in the effects of preventive inoculation of selected groups of Natives in mines conveniently situated is unique. It is hoped that work on these lines may be pursued by some of the research workers in the South African Institute for Medical Research.—S.L.C.]

Deficiency of Vitamin A in Mine-rations.

While this question has been discussed under "General Measures of Hygiene," it may be regarded, also, as having a specific bearing upon tuberculosis.

Work on this subject has been carried out by Schutz and Zilva,[82] Smith and Hendrick[83] and others; and there is much experimental evidence to show that rats and other animals fed on diets deficient in vitamin A become less resistant to tuberculosis than adequately-nourished "controls."

[This problem is receiving the close attention of Dr. Orenstein, whose enquiries are directed to the finding of some cheap and readily available source of the A vitamin which can be added to the Native diets.

Here again the necessity for research, as a preliminary to sanitary recommendation, is well illustrated; and it would, in my opinion, be well worth the expense to the industry to invite to Johannesburg an expert worker on the problems of food-deficiency, to pursue nutrition experiments on the spot, with special reference to tuberculosis, as was done when Miss Delf worked at the subject in relation to scurvy.—S.L.C.]

Silica-dust as an Adjuvant to Tuberculosis.

The association between exposure to dust of free silica and an excess tuberculosis-prevalence needs no emphasis at this time of day. In our own case, by the systematic use of water, the concentration of air-borne dust has been reduced to such an extent that tuberculosis now constitutes the chief factor of destruction in what might otherwise remain a relatively benign fibrosis. The Committee is troubled by the suspicion that the measure of control of the silicosis factor secured by the free use of water may have been secured at the expense of some facilitation of the tuberculosis factor. Certain considerations may be mentioned here. In connexion with our tuberculosis it has been argued that inhalation infections and re-infections play a considerable part and the viability of the tubercle bacillus outside the body is much favoured by damp conditions. It has been shown that, under experimental conditions, the presence of water droplets in the air favour the passage of micro-organisms and other particles into the lungs by inhalation. As far as we are aware, in phthisis-producing industries that can avoid the use of water, tuberculosis does not play so important a part in miners' phthisis or stone-cutters' rot, as is the case with us. In certain grinding industries the change from "wet-control" of dust

to " dry-control " of dust has been associated with a fall both in silicosis and tuberculosis incidence. While " wet-control " of dust is incomparably preferable to no control of dust the Committee is strongly of the opinion that every effort should be made to reduce the amount of water used underground in so far as this may prove to be practicable without prejudicing in any way the conditions with regard to air-borne dust. Apart from tuberculosis, the association of high temperature with high humidity is undesirable in many respects. The solution of the problem lies with the engineers and not with the medical service.

At the South African meetings of the Empire Mining and Metallurgical Congress, the British Association for the Advancement of Science and the International Silicosis Conference, emphasis was laid on the urgent need for introducing into mining practice some means of controlling dust without the use of water.

[The problems of silicosis and tuberculosis are indissolubly linked together and it seems to me that, whether as a sub-committee of some larger organization or as a special committee for a definite end, there should be brought into existence a small group of physiologists, bacteriologists and physicists to work together at Johannesburg on this combined problem of tuberculosis and silicosis, with the object of discovering more efficient methods of protection against dust and the bacteria that are suspended with it in the air of the mines.—S.L.C.]

" Carriers."

There remains the problem of the undetected " carriers " of tubercle bacilli, chiefly to be found amongst the long-service Natives.

As a means towards the elimination of " carriers," the periodical examinations are of great value. These examinations, including special examinations of "long-service" Natives, have now been brought to a high degree of efficiency, as the result of this Committee's interim recommendation.

[It would seem that, in addition to the clinical and radiological examinations, an attempt ought to be made to obtain specimens of sputum from all " long-service " Natives when brought up for X-Ray examination. A sputum bottle might be handed to each with a request to provide a sample if possible. Doubtless many would fail to produce any phlegm, but some would succeed in doing so. Stress is laid on this point, as it has been observed that a positive sputum not uncommonly goes with an X-ray film which appears otherwise not inconsistent with health. The trouble might be considerable but the risk from undetected " carriers " is a real one and must be diminished by every possible means.—S.L.C.]

Acquisition of Resistance.

There is at least one hopeful aspect to a problem fraught with many difficulties. The South African Native is becoming more resistant under the combined forces of elimination of the highly-susceptible

and the gradual acquisition of an augmented immunity by the more resistant survivors under the spur of exposure to endemic infection. We see in the older mine Natives a definitely increased tolerance of tuberculous infection and the opinion of many medical practitioners in the Transkei and elsewhere is that the type of tuberculosis seen to-day is less acute and the number of cases smaller than formerly. Given time and opportunity, the problem will solve itself; but, judging by the slow progress of the American Negro population in this respect, the day is far distant that will see the African Native and the White equally resistant.

In the interval, the problem of tuberculosis must remain urgent in South Africa, both from the point of view of the value to industry of a healthy Native population, and because of the debt which civilization owes to the less sophisticated peoples whose native culture and amenities it often destroys.

ANTI-TUBERCULOSIS MEASURES IN THE NATIVE TERRITORIES.

It has been shown in the preceding pages that much of the tuberculosis which develops amongst the Native mine workers in the gold-mining industry is due in reality to the breaking down of tuberculous lesions contracted while in the Territories; and this must apply to other industries also. Nor is the danger of tuberculous infection imported from the Territories confined to the Natives. The recruiting of Native workers from the kraals, where tuberculosis is endemic, is, in especial degree, a menace to the White miner, whose simultaneous exposure to silica-dust makes the presence of an infected Native mine population a very serious risk; but it is a risk also to all Whites who employ Native nurses, houseboys and other classes of domestic labour.

In these circumstances, it might be expected that Government would be deeply concerned in supplying an efficient tuberculosis service in the Territories, by means of which "contacts" might be traced, advanced cases isolated, curable cases treated, and the extent of the tuberculosis problem carefully investigated and controlled by means of a sound system of vital statistics.

Instead, one finds that not merely is there no serious attempt at the collection of vital statistics, or the organization of a tuberculosis service, but that, apart from the appointment of a few district surgeons, the provision of a small hospital at Umtata, and the voluntary and highly commendable work of the medical missionaries, there is no medical service of any kind for the large Native population of the Territories.

When one contrasts the generous provision of hospitals and efficient whole-time medical staffs by the mining industry for its Native workers on the Rand with the almost complete absence of a public medical service of any kind for the Natives in the Transkei—and, indeed, throughout South Africa—one appreciates the fact that industrial concerns often set an example to governments in the care of their dependants.

[Governments do not invariably lag behind private corporations in this respect. During my recent visit to Portuguese East Africa, I was able to observe, with great pleasure, the growing point of what is likely to become an excellent medical service for the Native population ; a sanitary organization with numerous hospitals, a good scientific equipment, an adequate medical staff and a growing number of Native out-patient sections, in which trained Native medical orderlies carry out simple measures of medical assistance under the supervision of the European doctors of the Native districts.

In the Anglo-Egyptian Sudan, the Government had already made extensive provision for the medical treatment of the Natives within a few years of the re-conquest of the Sudan.

***In the French African Colonies, as has been so well described* by Sir Edward Thornton,[84] a very comprehensive scheme for a Native medical service, in which Native doctors, trained on a modified syllabus at a medical school at Dakar, work amongst their fellow-countrymen under general supervision by European medical officers, has been brought into being and is being rapidly extended to meet the needs of a large Native population.**

And yet, in none of these colonies or dependencies is the Native population of more dominating importance to industry and agriculture than in the Union of South Africa.—S.L.C.]

It seems almost unnecessary to lay stress on the economic value of a working population which appears content to give honest service in return for the privilege of being allowed to "squat" on land that was once its own ; to labour underground for wages less than one-tenth of those earned by the White man for shorter hours ; and so docile and agreeable under trying conditions, with little hope of attaining anything but the lowest standard of prosperity and comfort, that thoughtless people are inclined to argue that it is unnecessary to "do any more" for Native welfare.

[To one who is merely a visitor to South Africa, the sight of such a dependent population, giving so much and obtaining so little in return, is calculated to arouse feelings much deeper than surprise.—S.L.C.]

Surely the health of these people ought to be one of the most urgent considerations for the Union Government and all the local authorities in South Africa, not merely on grounds of humanity, but as an economic problem of first-rate importance in which not merely the health but the financial interests of the dominant races are concerned.

Yet there is no organized medical service for the Native Territories and, at a moment of the world's history when medical science can do so much to ameliorate human suffering, the majority of the subjects of the Union Government have no hope of medical aid beyond what they may obtain from their own witch-doctors.

The "Report of the Committee to Inquire into the Training of Natives in Medicine and Public Health" (Pretoria, 1928) is eloquent as to the need for a better medical service for the Natives. It quotes the report of a previous committee as follows: "It cannot be denied that at present there are hordes of Natives in many centres who have little chance of medical treatment, and the untreated sick become a menace to the community," and adds "the evidence submitted to your Committee fully confirms this opinion."

"In spite of the activities of the district surgeon, it is no exaggeration to say that in most parts of the country the Natives have had to depend on their own medicine-man and herbalist except where they have been fortunate enough to be within reach of a missionary doctor. The complete inadequacy of the available resources has been demonstrated by the history of recent epidemics."

The urgency of the problem may be gathered from an article by Dr. R. H. Welsh[85] in which he describes the actual conditions with the intimate knowledge only to be gained in the course of a life devoted to medical work in the Transkei. "It is quite certain," he says, "that under present conditions, the great mass of the Native population, who are more and more appreciating the benefits to be derived from European methods of treatment, cannot get them."

Sir Edward Thornton (*l.c.*), writing with the knowledge of a high official in the Health Department of the Union Government, expresses the following opinion: "We must frankly admit that even in urban areas very little is being done for the Native either in preventive or curative medicine and that the need is great appears to admit of no argument."

While there are conflicting views as to the details of organization, all these authorities agree that there is an urgent need for a Government medical service for the Native population and that, in the work of this service, doctors, health visitors, midwives and nurses should play a leading part.

"The Committee on the Training of Natives in Medicine and Public Health" is of opinion that the Government Native medical service should be open to all fully-qualified registered medical practitioners, whether European or Native. It recognizes that Natives would probably be more acceptable to their own people.

[In connexion with tuberculosis work amongst the Natives, it is interesting to note this view, since it is so amply confirmed by the experience of those who are organizing the anti-tuberculosis campaign amongst the negro population of the United States. Dr. H. R. H. Landis[86], discussing this problem, writes as follows:—"In spite of the excellent results obtained by all the public health movements, there was one portion of the population that benefited but very little, namely, the Negroes. While hospitals and dispensaries were open to them, they availed

themselves very slightly, or not at all, of their aids. . . . For the first ten years of its existence the attendance of Negroes at the dispensary averaged about 100 per year, and this in spite of the fact that Negroes lived in the closest proximity to the Institute.

"In 1913 it was realized that something should be done. It was evident that the machinery we had in operation was ineffective. It occurred to us that where the White doctor and nurse had failed, the Negro doctor and nurse might succeed." The experiment of employing Negro nurses was tried and the report adds: "Dating from this time the Negro work gradually increased, at first slowly, but within a few years the increase in the number of Negro patients became one of the outstanding features of the work of the Institute."

"Preventive work among the Negroes," says Dr. Landis, "can best be carried out by Negro physicians. Indeed, we do not believe that it can be done effectively otherwise. . . . For a time the feeling was entertained that it would be possible, eventually, to turn the entire responsibility of the Negro Bureau over to the Negroes themselves. This idea has been abandoned, for the present, at least. The race is too inexperienced to walk entirely alone. They still need guidance."

This article, written by Dr. Landis in relation to a problem so similar to that of South Africa, is one which has lessons for those responsible for the health of the Natives in the Territories of the Union. It is to be hoped that, before long, the importance of a healthy Native population, so clearly realized by the Health Department of the Union Government and by all who have first-hand knowledge of the subject, will become sufficiently realized by the White population and their representatives that action in the matter may follow.—S.L.C.]

At the present time, the White population appears to be indifferent and the Natives themselves, in the absence of any adequate representation in the government of their country, are dumb on a subject of urgent importance to themselves and their White neighbours. "Such a condition of things," says the Report of the Committee on the Training of Natives in Medicine and Public Health, "is a double menace to South Africa. Firstly, there is the immediate danger of the spread of infection and contagious diseases from areas where they may be said to be practically endemic. Secondly, there is the economic danger of the deterioration and eventual failure of the labour supply." Tuberculosis is one—perhaps the chief one—of these endemic diseases, and it is not an infection which may be safely ignored.

[In the absence of any systematic attempt as yet by the Government to deal with the problem of tuberculosis or, indeed, of disease in general, amongst the Native populations from which

the mine boys are drawn, it would be well worth the while of the mining industry itself to initiate, in its own interests, a system of medical "follow-up" of the repatriated Natives and a continuance of the tuberculosis survey of the more important recruiting areas. Dr. Allan has already accomplished so much in the way of preparing the ground that it seems a thousand pities that the opportunity for its extension should be lost.

Much would depend on a wise selection, as experience both of tuberculosis and of the Transkei Natives is essential and success would depend largely upon popularity with the Native chiefs and headmen, the European doctors, missionaries, magistrates and the Natives themselves. Such a man might accomplish much but his work would be chiefly that of preparation.

A tuberculosis service, gradually developed under the direction of a skilled medical man with a first-rate knowledge of tuberculosis and a personality commanding popularity and respect, might, especially if it were made to include Native doctors and nurses, extend in ways most valuable to the mining industry and might ultimately become a part of the Government Medical Service for Natives which is so badly needed and which is certain to be conceded in the future.

It should be the duty of the medical officer selected for this appointment to continue the work initiated by Dr. Allan in the follow-up of repatriated tuberculous mine boys, to develop Native methods of "isolation" of advanced cases in the kraals, to help in starting a system for the treatment of suitable cases; at first through the missionary hospitals and other existing organizations and, later, in any special institutions that may become available; to initiate experiments in the anti-tuberculosis immunization of the infants of tuberculous parents by means of B.C.G. or in other ways; to aid in preventing the recruitment of persons likely to develop tuberculosis in the mines, and to advise the mining industry in all matters relating to tuberculosis in the Native Territories.—S.L.C.]

The Committee, in agreement with Professor Lyle Cummins' comment, recommends that the mining industry give serious consideration to the appointment, through the Native Recruiting Corporation, of a medical officer whose special duty it should be to tour the recruiting territories in the Union of South Africa and adjacent Protectorates for the primary purpose of following up cases of tuberculosis repatriated from the mines, and advise and assist in their care, with a special view to preventing the spread of infection.

The Committee considers that such a medical officer would also be of great value in conferring with the medical examiners of the N.R.C. on methods of preliminary medical examination, thus co-ordinating and standardizing these. He should also advise the N.R.C. on matters connected with the hygiene and transport of recruits and repatriates.

The Committee hopes that such a medical officer would receive the support and co-operation of the Union and local health authorities, and that in his selection special attention would be paid to his knowledge of tuberculosis and personal adaptability in dealing with Government representatives.

So much for the Native Territories, areas in which little or nothing is done for the health of the Natives in general and for tuberculosis in particular. In regard to these areas, the indifference of the White population, is, at least, to be understood because the problem is remote and its bearing upon their own interests somewhat obscure except after deliberate enquiry.

But it is strange, indeed, that the White population of the large cities should show so little interest in the lot of the Native communities in their midst. With the exception of Capetown, where an active and progressive policy in regard to tuberculosis has been initiated by the local authority and pushed forward energetically by the Medical Officer of Health and an influential body of persons interested in prevention and after-care work, the municipal arrangements for the diagnosis, treatment and prevention of tuberculosis in the Natives are primitive or non-existent throughout South Africa. Yet the Natives play a large part in the life of the European populations as domestic servants, messengers, shop-boys and in other similar capacities.

So far the splendid climate, the high standards of prosperity and of life in general and the absence of overcrowding, have combined to render the White population of South Africa in a measure secure from tuberculosis. This fact helps to explain the seeming indifference to the wide diffusion of this disease in the Native and Coloured populations of the city locations and townships, where the conditions of life are so different from those of the Whites and where overcrowding, dirt, the traffic in illicit alcoholic drinks, and the fatalistic despair of persons lost to their own tribal discipline and as yet merely disturbed by the ideals and discipline of Europeans, all contribute to enhance and spread disease.

It is possible that the critical reader, bearing in mind the opening sentences of Chapter VI, where reference is made to " the absence of reliable vital statistics," may question the statement just made as to the wide diffusion of tuberculosis in the Native and Coloured populations of urban areas. It is true that we have no reliable figures as to the tuberculosis of these Natives, but what we do know is positive ; that is to say that, while we know nothing of the cases that escape record, we are on safe grounds about those that do come to notice.

The records as to deaths from tuberculosis amongst the Whites are probably more accurate than those of European cities and may be taken to include nearly all the cases that occur. The records for Natives and Coloured persons are no guide to the actual incidence and mortality, but it is significant that, as far as they go, they show that the known

mortality from tuberculosis is from three to six times as great amongst the Natives as amongst the Whites. Were the figures to include all the cases, the contrast would be still greater.

It must be freely admitted that the problem of how to provide for the medical needs of the Natives in large cities, where the burden of the rates falls almost entirely on the relatively small White population, is far from simple. Perhaps there may be a subconscious admission, amongst those responsible, that "where ignorance is bliss, 'tis folly to be wise." One thing is certain; that an efficient system of out-patient service and an adequate provision of beds for Native and Coloured persons suffering from tuberculosis would, as in the case of Capetown, lead to an apparent rise in the incidence and mortality from the disease; but with this would go the advantage that the extent of the problem was better appreciated and the power of grappling with it increased.

The need for "vital statistics" as a preliminary to a scientifically-organized anti-tuberculosis campaign, or, indeed, any organized effort for health, was stressed by the Tuberculosis Commission in 1914, and the same need is fully realized by the Health Department of the Union to-day. It is remarkable that, 16 years after the publication of a far-reaching report by a committee nominated by the Government and set to work, at considerable expense, for several years, to study tuberculosis and make recommendations as to its prevention, this cardinal necessity for progressive work on prevention of disease should still remain unprovided.

[An entry from my diary, under date 2nd October, 1929, makes interesting reading in this connexion: "To Pretoria and called at Census Office where the Director gave me much information as to the absence of statistics bearing on Native population." Nothing could have been kinder than the reception given me by Dr. Holloway during this visit. No trouble was too great to seek for information of the kind needed; but the information had never been collected nor could it be collected under the circumstances now existing. Dr. Welsh, already quoted by the Committee, estimates that there is one doctor to every 27,000 Natives in the Territories. It is not to be wondered at, then, that vital statistics are still to seek.

I have before me at the moment a document recently received from Canada, a "Survey of Registration of Births, Deaths and Marriages among the Indians of British Columbia, 1917 to 1928." This document, while it bears evidence of the difficulty of attaining to accuracy in relation to Native tribes, represents an honest attempt to get down to facts about increase and decrease of population, and about the main causes of death. Were it possible to have access to any similar collection of figures bearing upon the South African Natives, the work of the Tuberculosis Research

Committee would have been greatly simplified ; and the task of officials in directing a progressive policy of preventive medicine for the Natives would be rendered less difficult.—S.L.C.]

Nor is this ignorance as to essential facts confined to the tuberculosis of man. As to tuberculosis in cattle, for instance, nothing, or next to nothing, is known, nor is there any definite policy for the control of infection in herds. Here, again, the problem is not merely one of economics for the farmer but has a still more important aspect in its bearing upon the health of the community.

The tuberculosis of the Native is not only a "Native" problem. It is a problem which touches the health of the White community very nearly and it will do so to an increasing extent as populations increase and as the movement of Natives towards the towns and of Europeans into areas now dominantly " Native " gathers force and becomes more general.

Those who take the long view will agree that the sooner the length and breadth of the problem is made known through the collection of vital statistics, the better for the Union of South Africa.

SUMMARY OF THE RECOMMENDATIONS OF THE COMMITTEE.

Whilst the Committee recognizes that no sudden or dramatic reduction in the incidence or mortality of tuberculosis can be expected, it is convinced that the putting into force of the recommendations contained in the various chapters of this Report and summarized hereunder will lead to a gradual and steady diminution in both the incidence and mortality of this disease.

The measures recommended aim at increasing the resistance of the individual against infection, diminishing the sources of the infective agent and the opportunities for transmission of infection.

The Committee desires to make it clear that its recommendations are based upon such knowledge as at present exists, and that the acquisition of further knowledge may in the future necessitate the adoption of additional or different means.

The acquisition of the necessary knowledge is, however, exceedingly difficult, and in certain directions almost impossible because of the absence of full and reliable statistics concerning the Native population of the Union. The Committee, indeed, was greatly handicapped in its work by the absence of such data, and desires to record its considered view that an improvement in the collection and recording of vital statistics concerning the Natives is of the utmost importance to the progress of improvement in public health. It would point out that the Tuberculosis Commission of 1914 then stressed the same point, and that the position is nevertheless no better to-day than it was at that time. The absence of the basic information afforded by reliable vital statistics of the Native population seriously impedes the planning of any organized campaign against tuberculosis and other diseases, and, furthermore, makes it difficult, if not impossible, to assess the value of any measure adopted for improving public health.

Although only a truism, the Committee would point out that the health problems of the Native population are intimately bound up with those of the European population, and in dealing with the problem of public health there can be no separation of the various races in South Africa into separate compartments.

I.—ANTI-TUBERCULOSIS MEASURES IN THE NATIVE TERRITORIES.

Recognizing the value of improving the health conditions in general of the Native population, the Committee recommends :—

1. *Improved Medical Services.*—There is the most urgent need for a radical improvement in the medical services in the Native Territories. The Committee is aware that the Union Health Department recognizes this need, but nevertheless the Committee feels it its duty specially to emphasize this point.

2. *Tuberculosis Officer in the Service of the Mining Industry.*—The value to the industry of a healthy Native labour supply need hardly be stressed. It is, therefore, in the interests of the industry to do everything practicable to further hygienic conditions in the Native Territories.

The Committee considers that a very valuable step in that direction would be taken through the appointment by the industry of a medical officer to travel in the Native Territories and to be specially charged with the duty of dealing with tuberculosis among repatriated mine Natives, and in areas in which intensive recruiting takes place.

The Committee has no doubt that such an officer would receive the support of the Union Health Department and, working in co-operation with all health agencies in the Territories, would achieve important results.

II.—Anti-tuberculosis Measures in Cities and Towns.

3. The Committee is impressed with the need of improving the general health conditions of the Native locations of certain urban areas and, without drawing attention to any particular area, recommends that urban authorities have their attention invited to the urgent need of effecting such improvements, and especially to the need of anti-tuberculosis services, which at present are mostly woefully deficient.

4. The Committee is of opinion that there is scope for investigation as to the value of B.C.G. inoculation amongst the Natives and Coloured children of urban locations where tuberculosis is rife.

III.—General Measures of Hygiene on the Mines.

5. *Journey to the Mines.*—In view of the fact that there is still a considerable amount of sickness amongst Natives on arrival at Johannesburg, in spite of improvements in the transport conditions, the Committee recommends that further investigation be made into the travelling conditions, more especially with regard to the possibilities of greater protection against climatic changes and the possibilities of isolation of gangs from different localities on the journey and in their early days on the mines.

6. *Improvement in Sleeping Quarters in the Compounds.*—Although improvements have been made on most mines, there are still to be found mine compounds of the type condemned by General Gorgas in 1914. Where this is the case the Committee recommends that improvements should be introduced in the direction of having fewer occupants per room and of better separation of the individual bunks in each room. In the opinion of the Committee, these measures would diminish the liability of the transmission of infections of the respiratory tract, including, of course, tuberculosis.

7. *Rest and Feeding Underground.*—The Committee recommends that the principle should be recognized of the general need for some period of rest during working hours and a light meal underground in the resting time.

For reasons given (pp. 269–272), the Committee feels that the present system, with an average of 10½ hours underground, 8 hours continuous work and nothing to eat during that time, is unlikely to be conducive to the highest efficiency in work and is liable to be a decisive factor in swinging the balance the wrong way in the case of individuals liable to a flare-up of a latent tuberculous infection.

8. *Addition of Vitamin A to the Dietary.*—The dietary of the Native mine labourer is deficient in vitamin A and this deficiency can almost certainly be correlated with a defective power of resistance to infection by tubercle bacilli and other germs. The Committee therefore recommends the definite addition to the standard diet of food containing an adequate amount of this vitamin. Animal fat or specially vitaminized oils would probably best meet this need.

9. *Risk of Chill Underground.*—The Committee is of opinion that there is room for improvement in the protection of Natives during their return from hard work in the great heat of the deep levels from sudden changes in air temperatures and velocities, either by means of suitable ventilation controls or, where this is impossible, by the provision of extra clothing.

IV.—SPECIAL ANTI-TUBERCULOSIS MEASURES ON MINES.

10. *Initial Examination.*—Whilst of opinion that the initial examinations and the examinations designed for the early detection of tuberculosis are well organized and conducted, the Committee recommends, in view of the number of cases which develop tuberculosis early in their working life on the mines, thus indicating that they arrived with latent tuberculous lesions, that the initial examination, particularly that of the lungs, should be kept as stringent as possible, with a view to excluding from the mines Natives who would be liable to develop active tuberculosis.

11. *Acclimatization to Mine Work.*—Recognizing that the unaccustomed stresses to which the Natives are subjected in the first few months of mine service constitute a great danger-zone to their health, the Committee considers that this zone can probably be most safely traversed if the breaking-in to these unaccustomed stresses be made a gradual one, and recommends that measures now in force on the mines in this direction be continued, improved and strictly adhered to.

12. *Periodical Examination of Long-service Natives.*—The Committee recommends that the system of periodical examination of all Natives with five years and over of total mining service be continued as being a very valuable method for the earlier detection of a class of chronic case liable to be a focus for spreading the disease.

13. *Anti-dust Measures.*—Realizing the influence of silica-dust as a factor in the development of tuberculosis, the Committee recommends that all those concerned with the prevention of dust be made aware of its importance in the development of this disease, as well as its already recognized importance in silicosis, and that every avenue be explored to improve on even the present admittedly high standard of dust suppression.

14. The Committee also recommends that the use of water in the suppression of dust be minimized, and that greater attention be paid to other measures, and particularly to ventilation.

V.—Advisory Health Committee in Chamber of Mines.

15. Finally, in order to ensure continuity of policy of investigations and application of suitable anti-tuberculosis measures on the mines, the Committee recommends to the Chamber of Mines that a Standing Advisory Health Committee be appointed and maintained by it.

An early duty of this Committee should be to advise what health statistical returns should be kept up by the mines.

APPENDICES

1. SOME ANTHROPOLOGICAL NOTES ON SOUTH AFRICAN NATIVE MINE LABOURERS. BY THE LATE DR. G. A. TURNER.

2. SOME DETAILS OF 471 CASES OF TUBERCULOSIS THAT OCCURRED IN TUBERCULIN-TESTED BOYS.

3. *TUBERCULIN TESTS ON INMATES OF MENTAL HOSPITALS IN THE* UNION. FROM DATA SUPPLIED BY DR. J. T. DUNSTAN.

4. TUBERCULIN REACTIONS IN NATIVE COLLIERY WORKERS. FROM DATA SUPPLIED BY DR. F. J. ALLEN.

5. TUBERCULOSIS PREVALENCE ON THE WITWATERSRAND GOLD MINES
   (1) COMPARISON OF MINE WITH MINE.
   (2) INFLUENCE OF LENGTH OF SERVICE ON PREVALENCE.
   BY DR. A. MAVROGORDATO.

6. BACTERIOLOGICAL INVESTIGATIONS IN CONNEXION WITH TUBERCULOSIS AMONG SOUTH AFRICAN NATIVES.
   (1) TYPE OF TUBERCLE BACILLI ASSOCIATED WITH TUBERCULOSIS AMONG SOUTH AFRICAN NATIVES.
   (2) EXAMINATION OF SAMPLES OF MINE AIR, DUST AND SOIL, AND OF SPECIMENS OF SPUTUM COLLECTED UNDERGROUND, FOR TUBERCLE BACILLI.
   BY DR. J. H. HARVEY PIRIE.

7. PATHOLOGICAL ANATOMY OF TUBERCULOSIS AMONG NATIVE MINE LABOURERS ON THE WITWATERSRAND. BY DRS. J. H. HARVEY PIRIE AND A. MAVROGORDATO.

8. CLASSIFICATION OF CLINICAL TYPES OF TUBERCULOSIS, FROM X-RAY AND CASE RECORDS FILED AT THE MINERS' PHTHISIS MEDICAL BUREAU. BY DR. L. G. IRVINE AND PROFESSOR LYLE CUMMINS.

9. REPORT ON THE EXAMINATION OF 500 X-RAY FILMS FROM "NEW" MINE NATIVES. BY PROFESSOR LYLE CUMMINS.

10. SUMMARY OF INFORMATION RECEIVED FROM VARIOUS MUNICIPALITIES REGARDING THE PREVALENCE OF TUBERCULOSIS IN DOMESTIC ANIMALS.

APPENDIX NO. 1.

SOME ANTHROPOLOGICAL NOTES ON SOUTH AFRICAN NATIVE MINE LABOURERS.

By the Late Dr. G. A. Turner.

These notes were compiled by the late Dr. G. A. Turner about the year 1910, at a time when he was Chief Medical Officer to the Witwatersrand Native Labour Association.

The Notes have been in the possession of the South African Institute for Medical Research for a number of years and it was thought by the Committee that that portion of them dealing with the physique of the Natives was of sufficient value to reproduce here as documenting the statements made in Part I of this report.

The larger portion of the Notes, dealing with various organs, their measurements, peculiarities, etc., although recording many data of interest are omitted as not sufficiently germane to our subject.

It is hoped the following account of some of the anatomical and physical differences observable between South African Native races and Europeans will be of interest.

In connexion with the subject under consideration, we must bear in mind the wide area over which these races are spread, the very various climates to which they are subjected, and the differences in the food on which they subsist.

The great majority of Natives employed in the mines belong to the Bantu division of the South African races. Before discussing this type, I would warn the observer not to be deceived by the black colour of the skin, which usually leads people to over-estimate the measurements, and to infer that the subject of observation is a much finer specimen of humanity than he is in reality. I have often been deceived in this way and have been surprised at the mistakes of my friends.

For instance, I have measured a particularly fine-looking specimen of Native and have asked a medical colleague to give me an approximate estimate of the boy's chest measurement. This would be guessed as 44 inches, while the tape showed it was only 36. The following tables give a number of anthropological observations made on Natives of various tribes :—

No. I.—The average height of 5,866 male Natives of various Bantu tribes of all ages from 14 years and upwards.

No. II.—The average height of 3,339 Natives, at an age estimated to be 21 years and over. This is really Table No. I, in which all those boys under 21 years have been withdrawn.

No. III.—The average height of 759 Natives mostly coming from tropical areas.

TABLE I.*

AVERAGE HEIGHT AT VARIOUS AGES OF SOUTH AFRICAN MALE NATIVES.

No. examined	2,390	1,142	1,047	548	321	169	126	100	23
	AVERAGE HEIGHT.								
Ages.	Inhambane, Gaza and Lourenço Marques	Transvaal.	Cape Colony.	Zambezia Co.	Rhodesia.	Nyasaland	Basutoland.	Bechuanaland.	Mozambique District.
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.
Under 14 yrs.	—	4 8½	4 6½	—	—	—	—	4 10⅞	—
14 years ...	5 2½	4 11½	4 10⅜	—	—	—	—	—	—
15 years ...	5 1⅜	5 1	5 0⅜	5 3½	5 0½	—	5 1⅞	—	—
16 years ...	5 3⅜	5 3	5 3	5 3⅜	5 2½	5 4⅞	5 1⅞	4 11½	5 0½
17 years ...	5 5½	5 4½	5 4⅞	5 3½	5 3½	5 4⅞	5 2⅜	5 4⅞	5 2½
18 years ...	5 5½	5 5	5 5⅜	5 4⅜	5 4⅜	5 5⅜	5 5	5 5¼	5 7
19 years ...	5 5⅞	5 5¼	5 5¼	5 4⅜	5 5¼	5 5⅜	5 5⅜	5 4½	—
20 years ...	5 6¼	5 5¼	5 5½	5 5½	5 5¼	5 5⅜	5 5⅜	5 6½	5 7
21/25 years	5 6½	5 5⅞	5 6½	5 5	5 5⅜	5 4½	5 6⅜	5 4⅜	5 3½
26/30 years	5 6⅜	5 6	5 6½	5 5⅜	5 5⅞	5 5⅜	5 6½	5 7	5 4⅜
31/35 years	5 6½	5 5¾	5 6⅞	5 4⅜	5 5½	5 6	5 5⅜	5 4½	5 3½
36/40 years	5 6½	5 6½	5 6⅜	5 5⅜	5 5½	5 4½	5 7¾	5 6½	5 6½
41/45 years	5 6¾	5 7½	5 5¾	5 4⅞	5 5½	5 5⅞	5 8¾	5 4⅜	—
46/50 years	5 6⅜	5 5½	5 6½	5 4⅞	5 7	5 8½	5 3½	5 5½	—
Over 50 yrs.	5 7	5 5¾	5 6⅜	5 5⅜	—	—	—	—	—
General Average from 21 years of age upwards	5 6½	5 6	5 6¼	5 5⅜	5 5½	5 5½	5 6½	5 5½	5 4½

* Compiled by the late Dr. Brodie.

TABLE II.*

GIVING THE AVERAGE HEIGHT OF 3,339 NATIVES OF VARIOUS TRIBES, AT AGES ESTIMATED TO BE 21 YEARS OR OVER.

Tribe.	Number of Observations.	Average Height. in inches.
†East Coast	1,337	66·5
‡Transvaal Basuto	521	66·0
§Cape Colony	680	66·25
Mozambique	17	64·5
Bechuanaland	66	65·5
British Basutoland	79	66·5
British Central Africa	121	65·5
¶Rhodesia	199	65·5
Zambesia	319	64·25
Total	3,339	66·1

* Table compiled by the late Dr. Brodie.

† East Coast=Mixture of Nyambaan, Mchopi and Shangaan Natives.

‡ Transvaal Basuto=Natives from Northern Transvaal. They are distinct from the British Basuto, who come from Basutoland proper.

§ Cape Colony=A mixture of Xosa, Pondo, Pondomese, Baca and other tribes.

¶ Rhodesian Native. These boys were principally composed of Makalanga.

TABLE III.

COMPILED FROM PERSONAL OBSERVATION, SHOWING THE AVERAGE HEIGHT OF 759 MALE NATIVES PRINCIPALLY RECRUITED FROM TROPICAL AREAS.

Tribe.	Number of Observations.	Average Height. in inches.
Nyasa	46	62·6
Mozambique	98	63·9
Makua	15	65·9
Swahili	45	66·6
Quelimane	11	63·6
Angoni	196	63·6
Senna	1	68·5
*British Central African	19	67 0
Beira	8	63·8
Msenga	14	65·2
Yao	24	65·9
†Tonga	11	63·9
‡Mixed East Coast	23	65·2
Nyambaan	10	65·8
Mchopi	4	66·2
Shangaan	20	66·725
Swazi	6	64·3
Zulu	6	64·46
Xosa	26	65·0
British Basuto	19	64·8
Transvaal Basuto	45	64·34
Bechuana	4	71·3
Damara	41	66·6
N.E. Rhodesia	07	64·4
Total	759	64·4

* British Central African=Mixture of Natives from areas around the southern portion of Lake Nyasa.

† Tonga Natives=A tribe living on the N.W. coast of Lake Nyasa.

‡ Mixed East Coast=Mixture of Nyambaan, Mchopi and Shangaan boys.

An examination of these figures shows that the average height of 5,866 male Natives of various Bantu tribes of all ages from 14 years and upwards was 65·16in. (see Table I). By excluding all under 21 years of age, the average rose to 66·1in. (Table II). From 759 observations made myself, I obtained an average height of 64·4in., a difference of 1·7in., which may be accounted for by the larger proportion of Cape Colony and Natives from more southern parts in Tables Nos. I and II. We may take it that the southern tribes are taller than those coming from nearer to the Equator.

The total figures show that 4,098 South African Natives of all races and above the age of 21 years had an average height of 65·8in.

Weight.

The average weight of 3,339 mixed Bantus, above the age of 21 years, was roughly, according to Dr. Brodie, 129·87lb. My 500 observations (see Table VI) gave an average of 128·9lb., only a little over 9 stone. The heaviest I have recorded was the average of four Bechuana boys, 148·76lb.

TABLE IV.*

Average Weight at Various Ages of South African Male Natives.

No. examined	2,390	1,142	1,047	548	321	169	126	100	23
	Average Weight.								
Ages.	Inhambane, Gaza and Lourenço Marques	Transvaal.	Cape Colony.	Zambesia Co.	Rhodesia.	Nyasaland	Basutoland.	Bechuanaland.	Mozambique District.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Under 14 yrs.	—	74·35	67·0	—	—	—	—	60·20	—
14 years ...	101 75	84·71	85·5	—	—	—	—	—	—
15 years ...	96·65	89·57	94·82	108 80	93·25	—	100·63	—	—
16 years ...	109 02	108·0	111·01	108·80	103·50	115·83	100·63	82·0	90·0
17 years ...	118 56	117·14	121·31	114·37	112·89	125·83	119·0	110·72	114·0
18 years ...	125·26	122·90	124·33	119 73	116·75	123·27	127·80	109·0	112·0
19 years ...	126·91	123·26	129·74	119·73	121·90	123·27	134·70	111·77	—
20 years ...	128 76	128 06	131·71	117·38	121·90	123·27	134·70	128·50	123·0
21/25 years	132·68	130·44	135·64	123·18	124·71	121·42	136·57	120 84	117·25
26/30 years	133·61	133 87	135·38	126 38	129·13	128·45	136·54	126·52	131·40
31/35 years	133·13	134·06	139·76	122·57	128·93	127·11	137·5	122·28	121·75
36/40 years	135·61	135·50	138·71	125 66	126·06	126·44	137·60	127·45	135·75
41/45 years	133·26	139·30	135·16	121 87	119·25	121·0	149·5	119·75	—
46/50 years	133·19	132·14	137·76	126·76	150·0	134·0	127·0	114·0	—
Over 50 years	130·39	126·26	137·40	125·46	—	—	—	—	—
General Average from 21 years of age and upwards ...	133·61	132·91	136·47	124 55	127·24	126·90	136·88	123·45	126·82

* Compiled by the late Dr. Brodie.

CHEST MEASUREMENTS.

According to Dr. Brodie, this averaged, for 3,339 adults, 33·97in. which, for all practical purposes, is 34in., as shown in Table V.

TABLE V.*

AVERAGE CHEST MEASUREMENTS OF SOUTH AFRICAN MALE NATIVES.

No. examined	2,390	1,142	1,047	548	321	169	126	100	23
	AVERAGE CHEST MEASUREMENT.								
Ages.	Inhambane, Gaza and Lourenço Marques	Transvaal.	Cape Colony.	Zambesia Co.	Rhodesia.	Nyasaland	Basutoland.	Bechuanaland.	Mozambique District.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Under 14 yrs.	—	26·62	26·50	—	—	—	—	26·0	—
14 years ...	29·12	27·97	27·0	—	—	—	—	—	—
15 years ...	29·58	28·84	29·11	31·95	30·62	—	30·81	—	—
16 years ...	30·65	31·02	31·07	31 95	30·96	32·58	30·81	29·50	31·0
17 years ...	31·96	32·12	32·24	32·47	32·35	32·58	32·04	31·45	32·25
18 years ...	33·27	32·73	32·69	32·33	32·46	33·80	33·0	32·0	30·0
19 years ...	33·05	32·70	33 38	32·93	33·44	33·80	33·03	31·77	—
20 years ...	33·49	33·95	33·65	33·18	33·44	33·80	33·03	33·0	32·50
21/25 years	33·92	33·74	34·08	33·55	33·84	33·97	33·90	32·47	33·0
26/30 years	34·0	33·94	34·17	33·18	34·15	34·50	34·38	34·0	34·40
31/35 years	34·02	33·99	34·74	33·40	34·68	34·72	35·10	35·28	32·75
36/40 years	34·19	34·11	34·55	33·62	34·15	34·71	35 0	33·84	34·12
41/45 years	34·13	34·23	33·89	33·81	33·37	34·37	34·5	33·6	—
46/50 years	34·0	34·0	34·51	33·68	36·16	34·4	34·5	33·0	—
Over 50 years	33·94	33·75	35·0	33·11	—	—	—	—	—
General Average from 21 years of age upwards	34·10	33·94	34·27	33·51	34·10	34·45	34·26	33·33	33 85

* Compiled by the late Dr. Brodie.

My observations, already referred to, on 500 mixed Natives, are recorded below :—

TABLE VI.

SHOWING THE AVERAGE HEIGHT, WEIGHT AND CHEST MEASUREMENTS OF 500 MIXED NATIVES EXAMINED AT THE ASSOCIATION'S COMPOUND.

Tribe	No. Examined	Average Height	Average Weight	Chest Measurements		
				Min.	Max.	Mean.
		Ins.	Lbs.	Ins.	Ins.	Ins.
Mixed East Coast ...	23	65·2	128·5	32·4	34·8	33·6
Swazi	6	64·3	137·1	33·12	35·7	34·4
Zulu	5	65·05	132·4	32·7	34·7	33.46
Xosa	26	65 0	133·8	32·3	35·2	33·7
British Basuto ...	18	64·65	129·2	31·5	34·3	32·9
Transvaal Basuto ...	44	64 2	127·2	31·7	34·3	33 0
Maherero	41	66 6	136·0	32·16	34·8	33·48
Bechuana	4	71·3	149·2	34·2	36·1	35·15
Mozambique	77	64 03	126·5	32·09	34·86	33·47
Nyasa	45	62·6	125·5	31·8	34 4	33·1
British Central Africa	19	67·0	139·3	32·78	35·8	34·29
Angoni	117	62·7	127·7	32 26	34 5	33 38
Beira	8	63·8	127·37	32·28	34·6	33·44
N. E. Rhodesia ...	67	64·4	125·9	31·82	34·6	33·16
	500	64·1	128·9	32·1	34·8	33·24

The column of Chest Measurements in Table VI showed an average at inspiration of 32·1in., and at full expansion of 34·8in., giving a mean of 33·24in., while the results of measurements of 121 absolutely tropical Natives* gave an average chest measurement of only 32·6in. These figures demonstrate that 34in. is a very generous estimate of the chest measurement of the average South African Native. I refer to the movements of the chest wall later on (p. 309).

If we compare the figures given above with those contained in any tables relating to Europeans, it will at once be seen that the Africans are much smaller.

Dr. Hunt has been good enough to furnish me with the chest measurements, taken consecutively, of 69 male Europeans who presented themselves for medical examination for the purpose of life assurance. According to these figures, the average normal chest measurement of the European was 36in., the maximum was 45in., and the minimum 31in., while the average expansion was 3·2in.

* The 121 observations were made from a mixture of Angoni, Msonga, Swahili, Yao, Makua and Tonga boys. The Yao Natives showed the greatest chest measurements of these.

Of 50 males passed by the South African Mutual Assurance Company as first-class cases, the average chest measurement was 35·8in., and the average body weight 151·5lb. The Native is evidently smaller than the European. The question whether, although small, he is or is not well proportioned, is not easily answered, and I can only attempt to do so by applying some rough European standards. Captain Alves, Military Commandant of Zavalla, Portuguese East Africa, tells me that, in the Portuguese Army, it is not considered advisable for a recruit to undergo a full gymnasium course unless his chest measurement is equal to at least half of his height. Thus, a man 6ft. high should have a chest of at least 36in. If we refer to the foregoing tables, we see that the Natives, as a body, just reach this low standard.

Captain Alves also gave me another rough standard, namely, that a man should weigh as many kilogrammes as he has centimetres of height above 100. Thus, a man who is 1·80 metres high should weigh 80 kilogrammes. The average height of a Native is 65in., or 1·65 metres, therefore, according to this rule, he should weigh 65 kilogrammes, whereas the actual average weight was 129lb., or 58·5 kilogrammes, so that the standard is not generally reached by the Native.

Some years ago I required a standard for Natives applying for labour in the mines, and I endeavoured to obtain this by multiplying the chest measurement in inches by the weight in pounds, and divided the product by the height in inches.

The average chest measurement of the Native is 34in., his weight 129lb., and his height 65in.

$$129 \times 34 \div 65 = 67{\cdot}4.$$

Dr. Sargent prepared, from some thousands of measurements of students at Harvard and various girls' colleges, clay figures of a man and a woman.

Of these, the male measured 68in. (172·71cm.) in height, 34 to 37in. round the chest, and weighed 138lb. Taking 35 as the mean chest measurement, these figures would give

$$138 \times 35{\cdot}5 \div 68 = 72{\cdot}0.$$

This 72 compared with the 68 figure for the Coloured races shows that the latter is physically inferior to the European.

Probably the most serious difference between Native and European chests is the limited movements in the Native, especially the tropical Native, as compared with the European.

When every allowance is made for the fact that raw Natives are exceedingly stupid and do not try to expand the chest when observations are being taken, there is no doubt that in many cases, especially amongst tropical Natives who have recently arrived from their kraals, the chest walls are almost immovable, and respiration is mainly abdominal.

The result of this condition is, to my mind, very injurious. It renders the Native more susceptible to pulmonary complaints, and such complaints, when contracted, are more liable to terminate fatally. The Native patient who suffers from pneumonia very frequently succumbs to the disease without any hope of recovery. The lower lobes of his lungs do not expand, and the air enters the pulmonary vesicles almost entirely by a process of diffusion. It is uncommon to see a tropical pneumonia patient struggling for breath; as a rule, his chest is perfectly passive, and the only indication that his lungs are affected is the movement of the alae nasi. In consequence of the comparative immobility of the lungs, exudation accumulates very rapidly in the dependent parts, and hepatization results at an early stage in the attack. In some cases, in which the infection is not very virulent, the lack of chest movement, in my opinion, is responsible for the condition of chronic pneumonia so much more common in Natives than in Europeans. The exudation accumulates, by gravity, in the basal part of the lungs, no effort is made by the patient to remove it, the virulence of the organism dies out, the patient's temperature becomes normal, and the effect of the exudation is then purely mechanical. A quarter or a half of a lobe of a lung is cut off, it is clogged and solid, causing general debility from respiratory deficiency, and very commonly the tubercle bacillus finds in this solid quiescent patch a suitable field in which to propagate itself, and consequently the patient rapidly succumbs to pulmonary tuberculosis.

I must, however, call attention to the fact that, although this relative immovability of the chest walls in Natives is, to my mind, beyond question, it is not certain that it must be regarded as the chief reason or one of the reasons why respiratory diseases are so frequent and so fatal amongst them, because the Chinese employed in the mines exhibited a similar peculiarity, and amongst them pneumonia was quite exceptional. Of the thousands of Chinese coolies who were employed in the mines, very few were admitted to hospital suffering from pneumonia.

My statement that the South African Native is inferior in physique to the European is supported in some respects by Hoffman,[91] who draws the following conclusions from a series of anthropometric statistics on the American Negro which he compiled :—

(1) The average weight of the Coloured male of military age, and of Coloured male and female children, is greater than that of Whites of the same class. This excess in weight prevails irrespective of age, stature or circumference of chest.

(2) The average stature of the Negro is less than that of the White, and the difference, though slight, prevails at all ages.

(3) The greater weight and smaller stature of the Negro as compared with the White are found to prevail practically the same to-day as 30 years ago. The race has, therefore, undergone no decided change in respect to these conditions of bodily structure.

(4) The average girth of chest of the Negro male of 30 years ago was slightly greater than that of the White, but at the present time the chest expansion of the Coloured male is less than that of the White. This decrease in size of the living thorax in part explains the increase in mortality from consumption and respiratory disease.

(5) The capacity of the lungs of the Negroes is considerably below that of the White. This fact, coupled with the smaller weight of the lungs (4 ounces) is without question another powerful factor in the great mortality from diseases of the lungs.

(6) The mean frequency of respiration is greater in the Negro than in the White. An accelerated respiration indicates a tendency towards disease. The fact just stated supports those regarding inferior vital capacity and lesser degree of mobility of the chest.

(7) The mean lifting strength of the White is in excess of that of the Negro. The prevailing opinion that the Negro is on the whole more capable of enduring physical exercise is therefore disproved. This fully agrees with the facts regarding excessive mortality, which in itself is proof of a lesser degree of physical strength.

(8) The power of vision of the Negro is inferior to that of the White, but he is less liable to diseases of the eye, especially colour-blindness.

These deductions are interesting and, as stated, in many respects they tally with conclusions which one must draw from my observations. At the same time, it must always be remembered, when comparing the American Negro of the present day with the African Native, that the former has very often a very large amount of European blood in his veins. Further, we must not forget that the American Negro, from a physical point of view, came of a picked stock. I quote Tillinghast[92] to demonstrate the manner in which slaves were selected and afterwards bred :—

"The method by which Africa was drawn upon to supply the American market led to the most drastic selection that the world has ever seen. Of every thousand Natives captured in the jungle only a handful of the hardiest lived to put foot on the American shore. This fearful elimination of the unfit was due in part to the attitude and method of the slave-traders, and in part to the African's utter indifference to human sufferings and death. . . . When a village was captured all who were judged non-saleable to the White trader, *i.e.*, the aged, the infants, the sick and the defective, were at once slaughtered. This was in accord with former custom, but the selection was harsher. On the march to the seaside little food was given, and the captives were pushed forward with all possible speed. Everyone becoming weak or ill was promptly killed or abandoned. By the time the slave-ships were reached, all who fell below a certain rude standard had been eliminated.

"Next ensued the expert sifting done by the "factors," or middlemen, who bought from the Native sellers either as agents or on their own account, in order to sell again to the ship captains. They were far from accepting all the human material offered. By long experience they had become expert in detecting unsoundness or defects, and they subjected every individual, male or female, to minute examination and shrewdly devised tests; in the end there were several classes to accord with a scale of prices, and all who fell below the minimum standard were rejected. These soon found a grievous end. We are told that an African factor of fair repute is ever careful to select his human cargo with consummate prudence, so as not only to supply his employers with athletic labourers, but to avoid any taint of disease. No ship company wanted to load its vessels with 'perishable freight' if it was avoidable.

"After the thorough sifting before embarkation came the 'middle passage'—a test of such severity that a cargo rarely reached America without losing a heavy percentage. Densely crowded together, fed just enough to keep body and soul linked together, depressed with vague terrors of the unknown future, only the hardiest could endure to the end. All weakness or disease that had eluded the vigilance of the buyers in Africa was sure to be eliminated during the ordeal.

"In view of these facts it is probable that the Negro stock landed in America was physically superior to the average of that left behind. No doubt many were permanently broken in health, but it could not have been so with any large proportion, or the trade

could not have flourished as it did. It is probable that the great majority, being by nature the soundest and strongest, quickly recovered and transmitted to their offspring their congenital qualities. The conclusion seems justified that the American Negro began his American career with an important advantage, secured, however, at frightful cost.

"But it would be easy to exaggerate the advantage. Consideration of this process of selection shows that it led to physical improvement only. At every sifting the criteria of selection were those of physique. Mental and moral qualities could not be taken much into account. If in voluntary emigration there is a selection of bold and able characters, in this enforced American emigration it was the bold and able who were most likely to escape capture. In West Africa those who had initiative and energy were likely to become the hunters rather than the hunted.

"To appreciate the net result of this extraordinary selection, let us imagine the entire West African population divided into four classes, and consider each in turn :—

"*First*, those below normal, both physically and mentally.

"*Secondly*, those below par physically, though above it in mental force, would be effectually eliminated.

"*Thirdly*, those well above the average, both physically and mentally, were apt to elude capture and become themselves the captors.

"*Fourthly*, those above the average in physique, but ordinary or even under average in mental force would, under the peculiar methods of the slave-trade, constitute the major portion of the slaves successfully shipped to this country.

"In America the race came under other, though less drastic, selective forces, both artificial and natural. Inasmuch as the slaves were property, absolutely ruled by the will of their owners, the latter could largely control the relations of the sexes, with a view, more or *less deliberate, to securing improvement of the race.*

"Dr. Paul B. Barringer, of the University of Virginia, says: 'In a virgin land of incomparable fertility strong labourers were of course extremely useful and hence much valued. Being valuable they were allowed to multiply, *but under a careful and selective process of breeding*, which outstripped nature itself. Docility, decency, fealty and vigor were desired, and the slave man having these attributes with his master's pass scorned the rural patroller and roamed at will to replenish the earth. This selection process not only caused the Negroes to increase in numbers but to improve in kind.'

"Another authority, Mr. Frederick Law Olmsted, writing about 1854, states that a slave-owner, writing to him, says: 'In the States of Maryland, Virginia, North Carolina, Kentucky, Tennessee and Missouri, as much attention is paid to the breeding and growth of Negroes as to that of horses and mules.'"

If we take the above statements as regards the selection of the original American Negro stock, and then again refer to Tillinghast for the diet of the American slaves, we need not be surprised that Hoffman is able to state that the American Negro of 30 years ago was heavier, and the girth of his chest greater, than that of the White man.

Writing of the slave diet, Tillinghast says: "The house servants generally enjoyed much the same diet as the Whites, a distinction being made in the place and the manner of serving it."

In other words, the American house-servants occupied the position commonly known as plate-lickers in this country. Everyone with any experience knows how the Kafir thrives at this occupation. Speaking of the diet of field Negroes, he says it was very different. It was based

upon certain fixed rations dealt out once a week or oftener. From a peck to a peck and a half of meal, with from two to five or even six pounds of bacon, according to age and sex and severity of labour required was the most prevailing ration. To this ration as a foundation were added other articles of food varying with the seasons and different localities. Save on very poorly-managed plantations (of which there were, of course, not a few), there were regular allowances of vegetables in season—sweet potatoes, Irish potatoes, roasting ears, cabbages, beans and peas. The addition of molasses was widely prevalent, and the Negroes were especially fond of it. Coffee was allowed in some localities, especially during the season of heavy crop work, and milk was supplied in many places.

It was an almost universal practice to allot to each cabin a small plot of ground, from a quarter to half an acre, usually to the use of which the occupants were exclusively entitled. Thus, the opportunity was given to raise vegetables and fruit according to their own choice. Frequently the privilege was given of keeping pigs and sometimes even a cow. It was the exception for plantation Negroes to be without poultry.

Tillinghast goes on to quote Olmsted, who says: "I think the slaves generally—no one denies there are exceptions—have plenty to eat; probably they are better fed than the proletarian class of any part of the world. Certainly the contrast is striking between this diet and that of the race before its removal from West Africa."

APPENDIX NO. 2.

SOME DETAILS OF 471 CASES OF TUBERCULOSIS THAT OCCURRED IN TUBERCULIN-TESTED BOYS.

NOTE.—(*a*) The contractions used in the last column of the Table are explained in the Form at the end of the Table. The Form is that which was issued by the Committee to mine medical officers for making the returns.

(*b*) In the Table no P— cases are shown. For reasons given on p. 96 of the main Report, it was decided to count these with the ordinary P cases.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
1	4/x/27	30/xii/27	N.	Gen.
2	23/i/28	8/iii/28	P.	A–P.
3	24/i/28	14/iii/28	P.	A–P.
4	1/viii/27	28/iv/28	P.	A–P.
5	19/ii/28	5/iv/28	N.	Gen.
6	5/iii/28	5/iv/28	N.	Gen.
7	5/iii/28	11/iv/28	N.	A–P.
8	22/ii/28	11/iv/28	N.	Gen.
9	5/iii/28	16/iv/28	N.	Gen.
10	10/ii/28	23/iv/28	N.	Gen.
11	30/xii/28	24/iv/28	P.	B.
12	24/ii/28	4/v/28	P.	C–P.
13	5/ii/28	5/v/28	PP.	G.
14	24/iii/28	7/v/28	N.	E.
15	4/iv/28	15/v/28	PP.	G.
16	1/ii/28	17/v/28	PP.	A–P.
17	31/viii/27	19/v/28	P.	C.
18	22/ii/28	24/v/28	N.	E.
19	8/iv/28	28/v/28	P.	A–P.
20	8/iv/28	28/v/28	P.	E.
21	18/iv/28	20/vi/28	P.	A–P.
22	7/iii/28	25/vi/28	P.	B.
23	10/iv/28	2/vii/28	P.	A–P.
24	28/iv/28	16/vii/28	PP.	A–P.
25	28/vi/28	5/viii/28	P.	A–P.
26	3/vii/28	5/viii/28	PP.	A–P.
27	19/iv/28	15/viii/28	P.	G.
28	26/vii/28	18/viii/28	N.	A–P.
29	19/vii/28	27/viii/28	P.	A–P.
30	26/iv/28	31/viii/28	N.	A–P.
31	19/vi/28	5/ix/28	P.	A–P.
32	26/vi/28	10/ix/28	N.	Gen.
33	25/i/28	17/ix/28	P.	Abd.
34	19/vi/28	26/ix/28	N.	Gen.
35	13/ix/28	8/x/28	PP.	A–P.
36	7/ix/28	9/x/28	P.	E.
37	23/iii/28	10/x/28	P.	A–P.
38	29/v/28	15/x/28	P.	Gen.
39	25/i/28	17/x/28	PP.	A–P.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
40	30/i/28	17/x/28	PP.	A–P.
41	29/vi/28	19/x/28	N.	A–P.
42	14/vi/28	22/x/28	P.	G.
43	17/ii/28	24/x/28	P.	G.
44	26/vi/28	24/x/28	PP.	A–P.
45	27/viii/28	25/x/28	P.	G.
46	3/ii/28	30/x/28	P.	A–P.
47	24/vi/28	5/xi/28	N.	Gen.
48	6/ix/28	6/xi/28	P.	C–P.
49	1/vi/28	7/xi/28	PP.	A–P.
50	3/vii/28	8/xi/28	N.	Gen.
51	16/i/28	10/xi/28	N.	G.
52	25/vi/28	12/xi/28	P.	G.
53	21/ix/28	15/xi/28	P.	E.
54	27/i/28	15/xi/28	P.	A–P.
55	24/iii/28	19/xi/28	P.	G.
56	9/viii/28	19/xi/28	P.	G.
57	26/vi/28	20/xi/28	P.	G.
58	27/v/28	21/xi/28	P.	C–P.
59	13/iv/28	23/xi/28	PP.	A–P.
60	5/x/28	26/xi/28	P.	A–P.
61	26/iv/28	26/xi/28	PP.	G.
62	24/iv/28	26/xi/28	P.	A–P.
63	9/iii/28	3/xii/28	P.	C–P.
64	3/v/28	3/xii/28	P.	A–P.
65	9/v/28	5/xii/28	N.	A–P.
66	9/x/28	10/xii/28	N.	A–P.
67	26/iii/28	11/xii/28	P.	G.
68	7/viii/28	26/xii/28	P.	G.
69	4/i/28	27/xii/28	P.	G.
70	10/xi/28	31/xii/28	P.	Gen.
71	30/vii/28	31/xii/28	P.	Gen.
72	21/viii/28	31/xii/28	P.	G.
73	20/i/28	7/i/29	P.	G.
74	27/iii/28	7/i/29	P.	A–P.
75	16/iii/28	8/i/29	P.	G.
76	14/viii/28	9/i/29	P.	A–P.
77	10/ix/28	11/i/29	P.	A–P.
78	18/i/29	12/i/29	P.	G.
79	4/x/28	14/i/29	P.	A–P.
80	3/ix/28	16/i/29	N.	A–P.
81	9/x/28	17/i/29	P.	A–P.
82	15/x/28	17/i/29	P.	G.
83	21/xii/28	18/i/29	P.	A–P.
84	19/iv/28	19/i/29	P.	A–P.
85	18/x/28	22/i/29	P.	G.
86	29/x/28	24/i/29	P.	G.
87	4/v/28	24/i/29	PP.	G.
88	20/ix/28	24/i/29	P.	A–P.
89	2/ii/28	25/i/29	P.	G.
90	13/ii/28	28/i/29	P.	C–P.
91	27/viii/28	28/i/29	P.	A–P.
92	7/vii/28	28/i/29	P.	A–P.
93	31/viii/28	29/i/29	N.	A–P.
94	26/v/28	30/i/29	P.	G.
95	15/ii/28	31/i/29	P.	G.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
96	13/ix/28	1/ii/29	P.	C–P.
97	7/ii/28	2/ii/29	P.	A–P.
98	13/xi/28	5/ii/29	P.	G.
99	3/xii/28	11/ii/29	PP.	A–P.
100	11/xii/28	11/ii/29	P.	A-P
101	22/xi/28	12/ii/29	PP.	G.
102	28/x/28	12/ii/29	P.	A–P.
103	20/v/28	15/ii/29	P.	A–P.
104	27/x/28	18/ii/29	PP.	G.
105	28/x/28	19/ii/29	P.	C–P.
106	3/ix/28	20/ii/29	P.	C–P.
107	30/x/28	23/ii/29	P.	A–P.
108	30/x/28	25/ii/29	P.	A–P.
109	22/vi/28	25/ii/29	P.	A–P.
110	29/vi/28	26/ii/29	P.	A–P.
111	17/viii/28	26/ii/29	P.	A–P.
112	12/x/28	28/ii/29	P.	A–P.
113	9/viii/28	6/iii/29	N.	Gen.
114	3/v/28	8/iii/29	P.	A–P.
115	1/i/29	11/iii/29	P.	C–P.
116	15/ix/28	11/iii/29	P.	A–P.
117	7/ii/28	12/iii/29	P.	A–P.
118	16/iv/28	12/iii/29	N.	B.
119	11/i/29	13/iii/29	N.	Gen.
120	22/v/28	13/iii/29	PP.	A–P.
121	28/ii/28	14/iii/29	P.	A–P.
122	10/iv/28	14/iii/29	P.	A–P.
123	30/vii/28	17/iii/29	P.	A–P.
124	30/i/29	18/iii/29	P.	C–P.
125	7/ix/28	19/iii/29	P.	Gen.
126	16/xii/28	21/iii/29	P.	A–P.
127	3/xi/28	23/iii/29	P.	A–P.
128	1/ii/29	25/iii/29	P.	A–P.
129	26/ii/29	25/iii/29	P.	C–P.
130	20/i/29	26/iii/29	N.	C–P.
131	15/i/28	26/iii/29	P.	A–P.
132	26/ix/28	2/iv/29	P.	G.
133	28/viii/28	3/iv/29	N.	G.
134	20/vii/28	5/iv/29	P.	A–P.
135	3/iii/29	11/iv/29	PP.	Gen.
136	3/x/28	15/iv/29	P.	C–P.
137	1/ii/29	15/iv/29	N.	Gen.
138	21/viii/28	15/iv/29	PP.	G.
139	15/iv/28	16/iv/29	P.	C–P.
140	20/xi/28	16/iv/29	PP.	E.
141	3/iv/28	16/iv/29	P.	A–P.
142	29/i/29	17/iv/29	P.	A–P.
143	10/iv/28	18/iv/29	P.	E.
144	25/vi/28	22/iv/29	P.	A–P.
145	25/ii/29	22/iv/29	P.	B.
146	28/xii/28	22/iv/29	P.	A–P.
147	16/viii/28	22/iv/29	P.	B.
148	10/iv/28	25/iv/29	P.	A–P.
149	22/iii/29	27/iv/29	P.	A–P.
150	24/viii/28	30/iv/29	P.	A–P.
151	21/vii/28	30/iv/29	N.	G.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
152	11/v/28	1/v/29	P.	A–P.
153	17/iv/28	1/v/29	P.	A–P.
154	14/v/28	1/v/29	P.	C–P.
155	9/iv/29	2/v/29	P.	Gen.
156	14/xii/28	4/v/29	P.	Gen.
157	20/iv/28	4/v/29	P.	A–P.
158	11/iv/29	6/v/29	P.	G.
159	28/v/28	6/v/29	P.	C–P.
160	22/i/29	10/v/29	P.	Gen.
161	21/ii/28	10/v/29	P.	A–P.
162	9/x/28	10/v/29	P.	Abd.
163	31/viii/28	17/v/29	P.	E.
164	14/i/29	18/v/29	P.	G.
165	26/x/28	20/v/29	P.	G.
166	7/iv/29	20/v/29	PP.	G.
167	26/vi/28	20/v/29	P.	A–P.
168	22/vi/28	21/v/29	P.	A–P.
169	4/ix/28	21/v/29	P.	A–P.
170	20/ix/28	21/v/29	N.	E.
171	17/ix/28	22/v/29	P.	G.
172	2/xi/28	23/v/29	P.	A–P.
173	15/iv/28	27/v/29	P.	A–P.
174	6/ii/29	27/v/29	PP.	G.
175	15/iv/29	29/v/29	P.	C–P.
176	21/viii/28	1/vi/29	P.	A–P.
177	11/iv/29	2/vi/29	P.	G.
178	28/vi/28	3/vi/29	N.	Gen.
179	28/xii/28	4/vi/29	P.	C–P.
180	21/vi/28	5/vi/29	P.	A–P.
181	19/iii/29	11/vi/29	P.	C–P.
182	8/x/28	11/vi/29	P.	A–P.
183	13/viii/28	13/vi/29	P.	C.P.
184	22/vi/28	17/vi/29	P.	A–P.
185	7/v/29	18/vi/29	P.	Gen.
186	20/xi/28	18/vi/29	PP.	A–P.
187	28/i/29	20/vi/29	P.	B.
188	7/v/29	24/vi/29	P.	E.
189	1/v/28	26/vi/29	N.	A–P.
190	26/vi/28	26/vi/29	N.	G.
191	26/vii/28	28/vi/29	P.	G.
192	15/x/28	4/vii/29	P.	A–P.
193	11/v/28	5/vii/29	P.	A–P.
194	21/v/28	9/vii/29	P.	A–P.
195	29/iv/29	18/vii/29	PP.	A–P.
196	13/vi/29	22/vii/29	N.	E.
197	20/x/28	23/vii/29	N.	A–P.
198	18/vii/28	24/vii/29	P.	Gen.
199	5/i/29	24/vii/29	P.	A–P.
200	24/v/29	25/vii/29	P.	A–P.
201	2/xi/28	26/vii/29	P.	A–P.
202	5/xi/28	29/vii/29	P.	G.
203	9/xi/28	30/vii/29	P.	A–P.
204	8/vii/28	31/vii/29	P.	A–P.
205	8/ii/29	31/vii/29	P.	A–P.
206	17/ix/28	2/viii/29	P.	A–P.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
207	14/viii/28	5/viii/29	P.	A-P.
208	28/i/29	5/viii/29	P.	A-P.
209	14/xii/28	5/viii/29	P.	C-P.
210	2/vii/29	6/viii/29	P.	A-P.
211	25/vi/29	6/viii/29	N.	Gen.
212	8/v/29	7/viii/29	P.	A-P.
213	28/v/29	9/viii/29	P.	C-P.
214	19/vi/29	9/viii/29	P.	A-P.
215	2/iii/28	12/viii/29	P.	A-P.
216	3/viii/28	13/viii/29	P.	Abd.
217	26/vi/29	16/viii/29	P.	A-P.
218	11/vi/28	17/viii/29	N.	A-P.
219	23/iii/29	19/viii/29	P.	A-P.
220	1/i/29	19/viii/29	P.	A-P.
221	12/iii/29	19/viii/29	P.	Gen.
222	17/x/28	19/viii/29	N.	A-P.
223	22/xi/28	20/viii/29	PP.	C-P.
224	23/vii/29	20/viii/29	P.	A-P.
225	20/vii/29	20/viii/29	P.	G.
226	11/xii/28	21/viii/29	P.	G.
227	11/v/29	22/viii/29	P.	A-P.
228	11/xi/28	24/viii/29	P.	G.
229	20/xii/28	26/viii/29	N.	A-P.
230	18/vi/29	27/viii/29	P.	Abd.
231	5/xi/28	28/viii/29	P.	G.
232	5/vi/29	30/viii/29	P.	A-P.
233	16/vii/28	30/viii/29	N.	Gen.
234	10/vi/29	4/ix/29	N.	A-P.
235	24/ix/28	4/ix/29	PP.	A-P.
236	29/vi/29	5/ix/29	N.	Gen.
237	10/vi/29	7/ix/29	P.	A-P.
238	28/iv/29	9/ix/29	P.	G.
239	17/vii/28	10/ix/29	N.	G.
240	4/i/29	10/ix/29	P.	G.
241	26/vi/28	10/ix/29	P.	G.
242	1/x/28	10/ix/29	P.	B.
243	27/xii/28	11/ix/29	P.	A-P.
244	8/i/29	17/ix/29	N.	A-P.
245	15/xii/28	20/ix/29	P.	A-P.
246	31/viii/28	20/ix/29	P.	A-P.
247	30/x/28	21/ix/29	N.	Gen.
248	6/ii/29	23/ix/29	P.	A-P.
249	1/iii/28	23/ix/29	PP.	G.
250	8/iii/29	24/ix/29	PP.	A-P.
251	8/iii/29	24/ix/29	N.	A-P.
252	3/vii/28	24/ix/29	N.	A-P.
253	17/ix/28	24/ix/29	P.	A-P.
254	20/xi/28	27/ix/29	P.	Gen.
255	11/vii/28	7/vii/29	P.	A-P.
256	1/ii/28	16/viii/29	P.	A-P.
257	29/xii/28	13/vii/29	P.	A-P.
258	13/vii/29	24/viii/29	P.	A-P.
259	3/viii/28	28/viii/29	P.	A-P.
260	4/x/27	28/ix/29	P.	A-P.
261	30/iii/28	30/ix/29	P.	A-P.
262	31/vii/29	1/x/29	P.	G.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
263	11/xii/28	2/x/29	PP.	A–P.
264	25/vi/29	3/x/29	P.	A–P.
265	3/x/28	3/x/29	P.	A–P.
266	12/vii/29	4/x/29	N.	A–P.
267	22/x/28	4/x/29	P.	A–P.
268	5/vii/28	5/x/29	P.	G.
269	16/viii/29	8/x/29	PP.	G.
270	13/ii/28	9/x/29	PP.	Abd.
271	15/ii/29	14/x/29	PP.	A–P.
272	12/viii/28	10/x/29	N.	G.
273	18/vi/29	10/x/29	N.	Abd.
274	3/xii/28	14/x/29	P.	E.
275	15/ii/28	14/x/29	P.	G.
276	4/xi/28	15/x/29	P.	Abd.
277	9/xi/28	15/x/29	P.	G.
278	22/iv/29	15/x/29	P.	G.
279	22/iv/29	15/x/29	P.	G.
280	29/vii/29	21/x/29	P.	C–P.
281	18/ix/29	22/x/29	N.	A–P.
282	10/xi/28	22/x/29	PP.	A–P.
283	15/vii/28	25/x/29	P.	G.
284	23/x/28	26/x/29	P.	G.
285	22/x/28	29/x/29	P.	Abd.
286	5/xii/28	29/x/29	P.	G.
287	13/ix/29	30/x/29	P.	A–P.
288	16/x/28	30/x/29	P.	G.
289	23/vii/29	1/xi/29	N.	G.
290	11/vi/27	1/xi/29	P.	A–P.
291	8/viii/29	2/xi/29	P.	A–P.
292	1/iii/29	2/xi/29	P.	G.
293	24/ix/29	4/xi/29	P.	Abd.
294	24/vii/28	4/xi/29	N.	A–P.
295	30/iv/29	4/xi/29	P.	Abd.
296	13/v/29	4/xi/29	P.	E.
297	7/iii/29	5/xi/29	P.	A–P.
298	30/x/28	5/xi/29	P.	A–P.
299	16/iii/29	6/xi/29	P.	Abd.
300	17/ix/28	7/xi/29	P.	G.
301	1/viii/29	7/xi/29	P.	G.
302	4/vii/28	7/xi/29	PP.	G.
303	27/v/29	8/xi/29	P.	G.
304	28/xii/28	11/xi/29	P.	A–P.
305	8/vi/28	11/xi/29	P.	A–P.
306	1/xi/28	11/xi/29	N.	A–P.
307	20/viii/28	12/xi/29	P.	C–P.
308	25/vi/28	12/xi/29	P.	G.
309	20/viii/29	12/xi/29	P.	C–P.
310	25/vi/28	12/xi/29	P.	G.
311	3/xi/28	14/xi/29	P.	Gen.
312	5/x/28	15/xi/29	P.	A–P.
313	6/ix/28	18/xi/29	P.	A–P.
314	26/viii/29	18/xi/29	P.	A–P.
315	1/xi/28	18/xi/29	P.	G.
316	30/x/28	19/xi/29	P.	G.
317	21/ii/29	19/xi/29	P.	G.
318	5/x/29	19/xi/29	P.	A–P.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
319	8/i/29	19/xi/29	N.	A–P.
320	4/i/29	19/xi/29	N.	G.
321	8/i/29	19/xi/29	P.	G.
322	10/x/28	20/xi/29	P.	A–P.
323	29/i/29	20/xi/29	P.	A–P.
324	3/v/29	21/xi/29	P.	A–P.
325	4/iv/29	21/xi/29	P.	A–P.
326	16/i/28	22/xi/29	P.	A–P.
327	5/iii/29	25/xi/29	P.	A–P.
328	26/vii/28	25/xi/29	P.	A–P.
329	6/ix/28	26/xi/29	N.	A–P.
330	27/v/29	26/xi/29	P.	C–P.
331	15/vii/29	27/xi/29	N.	Gen.
332	21/x/29	28/xi/29	P.	A–P.
333	3/viii/28	28/xi/29	P.	A–P.
334	20/vi/29	29/xi/29	P.	G.
335	23/vii/29	29/xi/29	N.	A–P.
336	28/ix/28	30/xi/29	P.	A–P.
337	24/ix/28	30/xi/29	P.	C–P.
338	21/vii/29	30/xi/29	N.	G.
339	6/xi/28	/xi/29	P.	C–P.
340	31/iii/28	/xi/29	P.	C–P.
341	3/xi/28	/xi/29	P.	C–P.
342	1/x/29	2/xii/29	N.	C–P.
343	20/xi/28	3/xii/29	P.	A–P.
344	7/i/29	3/xii/29	PP.	A–P.
345	30/viii/29	3/xii/29	P.	A–P.
346	3/vii/29	3/xii/29	P.	A–P.
347	12/vi/29	3/xii/29	P.	A–P.
348	20/vii/29	6/xii/29	P.	A–P.
349	2/iv/29	10/xii/29	P.	Abd.
350	19/ix/28	10/xii/29	PP.	A–P.
351	13/xi/29	11/xii/29	P.	A–P.
352	15/iv/29	12/xii/29	P.	A–P.
353	11/v/29	12/xii/29	P.	A–P.
354	10/ix/29	9/xii/29	P.	A–P.
355	5/ix/29	12/xii/29	P.	G.
356	14/x/29	13/xii/29	N.	Gen.
357	8/xi/29	13/xii/29	P.	A–P.
358	13/ix/29	13/xii/29	P.	A–P.
359	5/iii/29	17/xii/29	PP.	G.
360	3/viii/28	17/xii/29	P.	C–P.
361	3/vi/29	17/xii/29	P.	C–P.
362	15/ii/29	17/xii/29	P.	Gen.
363	31/vii/29	19/xii/29	N.	A–P.
364	5/vi/28	20/xii/29	P.	A–P.
365	15/iii/29	23/xii/29	N.	A–P.
366	23/x/29	23/xii/29	PP.	A–P.
367	22/v/28	26/xii/29	N.	E.
368	27/v/29	27/xii/29	P.	A–P.
369	20/ix/29	31/xii/29	N.	A–P.
370	20/xi/29	31/xii/29	P.	Gen.
371	14/xi/28	30/xii/29	PP.	C–P.
372	24/x/28	—	P.	C–P.
373	16/i/29	11/xi/29	P.	C–P.
374	7/i/29	—	N.	C–P.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
375	4/xii/29	—	PP.	G.
376	5/vii/28	25/x/29	P.	G.
377	25/ii/29	17/xii/29	P.	Gen.
378	25/x/28	3/i/30	P.	A–P.
379	29/xi/29	3/i/30	N.	Gen.
380	29/i/29	6/i/30	P.	G.
381	21/i/29	7/i/30	P.	A–P.
382	21/xii/28	7/i/30	P.	C–P.
383	18/x/28	8/i/30	N.	G.
384	22/iv/29	9/i/30	N.	C–P.
385	22/i/29	10/i/30	N.	A–P.
386	15/xi/29	13/i/30	N.	G.
387	14/x/29	15/i/30	P.	A–P.
388	9/iv/28	17/i/30	P.	A–P.
389	24/ix/29	17/i/30	P.	G.
390	3/v/29	18/i/30	P.	A–P.
391	12/i/28	20/i/30	PP.	G.
392	25/vi/29	22/i/30	P.	G.
393	2/xii/29	22/i/30	P.	A–P.
394	8/x/29	24/i/30	P.	G.
395	5/xii/29	27/i/30	N.	Abd.
396	18/iii/29	27/i/30	P.	G.
397	21/i/29	28/i/30	N.	Abd.
398	29/iv/29	29/i/30	P.	Abd.
399	22/i/29	29/i/30	P.	G.
400	9/vii/29	10/ii/30	P.	Abd.
401	26/vii/29	10/ii/30	P.	A–P.
402	18/i/29	12/ii/30	N.	A–P.
403	27/v/29	13/ii/30	N.	G.
404	29/vi/28	22/ii/30	N.	A–P.
405	21/ix/29	25/ii/30	P.	A–P.
406	28/viii/28	26/ii/30	P.	A–P.
407	16/x/29	27/ii/30	P.	A–P.
408	3/i/29	27/ii/30	P.	A–P.
409	28/viii/29	1/iii/30	N.	A–P.
410	3/xi/29	4/iii/30	P.	G.
411	4/x/29	12/iii/30	P.	G.
412	22/ix/29	12/iii/30	P.	B.
413	13/viii/29	15/iii/30	N.	Gen.
414	17/i/30	15/iii/30	P.	A–P.
415	16/i/30	16/iii/30	P.	A–P.
416	18/vi/29	17/iii/30	N.	G.
417	4/v/29	20/iii/30	P.	A–P.
418	3/vi/29	20/iii/30	PP.	A–P.
419	1/i/29	21/iii/30	N.	A–P.
420	25/ii/29	26/iii/30	P.	C–P.
421	28/viii/28	27/iii/30	P.	A–P.
422	21/i/30	28/iii/30	PP.	A–P.
423	25/vi/29	28/iii/30	P.	A–P.
424	21/iii/29	31/iii/30	P.	B.
425	25/vi/29	31/iii/30	N.	E.
426	7/ix/29	4/iv/30	P.	A–P.
427	1/iii/30	7/iv/30	PP.	A–P.
428	21/ii/30	7/iv/30	N.	A–P.
429	18/iii/30	8/iv/30	P.	Gen.

No.	Date of Test.	Date of Recognition.	Type of Reaction.	Type of Tuberculosis.
430	20/xii/29	9/iv/30	P.	A–P.
431	3/viii/28	10/iv/30	P.	A–P.
432	10/v/29	11/iv/30	PP.	A–P.
433	17/ii/30	12/iv/30	P.	A–P.
434	10/i/30	15/iv/30	PP.	G.
435	19/viii/29	15/iv/30	N.	A–P.
436	18/iii/30	17/iv/30	N.	Gen.
437	4/i/30	17/iv/30	P.	Abd.
438	11/iv/28	19/iv/30	N.	A–P.
439	3/vii/28	22/iv/30	P.	A–P.
440	5/iii/29	24/iv/30	P.	A–P.
441	15/vi/29	25/iv/30	P.	G.
442	12/x/28	26/iv/30	P.	A–P.
443	22/iii/30	28/iv/30	P.	A–P.
444	9/xi/28	28/iv/30	PP.	A–P.
445	17/xii/29	28/iv/30	P.	C–P.
446	21/i/30	27/iv/30	N.	A–P.
447	7/viii/29	29/iv/30	N.	A–P.
448	27/xii/28	5/v/30	N.	C–P.
449	2/vii/29	5/v/30	N.	G.
450	5/iii/28	5/v/30	P.	A–P.
451	6/vi/28	14/v/30	P.	B.
452	13/iv/28	15/v/30	P.	A–P.
453	15/i/29	15/v/30	N.	A–P.
454	24/iii/30	18/v/30	N.	E.
455	15/iv/30	20/v/30	P.	Abd.
456	10/xii/29	23/v/30	P.	A–P.
457	20/viii/28	24/v/30	P.	A–P.
458	/iv/28	/v/30	P.	G.
459	21/x/29	7/vi/30	P.	A–P.
460	12/xii/28	9/vi/30	P.	Gen.
461	29/x/29	10/vi/30	P.	A–P.
462	11/viii/28	10/vi/30	N.	A–P.
463	10/xii/29	11/vi/30	P.	C–P.
464	28/iv/30	11/vi/30	PP.	Gen.
465	29/xi/29	12/vi/30	P.	C–P.
466	25/xii/29	18/vi/30	N.	G.
467	19/x/29	19/vi/30	N.	A–P.
468	8/v/30	19/vi/30	N.	A–P.
469	3/x/28	23/vi/30	P.	A–P.
470	30/viii/29	25/vi/30	P.	C–P.
471	2/xi/29	26/vi/30	P.	A–P.

TUBERCULOSIS RESEARCH COMMITTEE.

TUBERCULIN TEST RECORDS.

To be sent quarterly to the Secretary, Tuberculosis Research Committee (Chamber of Mines), Box 809, Johannesburg.

*Mine*_____

*Period covered—From*_____ 19____

to _____ 19____

No.

Total Number of Natives received during period ... ... _____

Total Number Tuberculin-tested _____ viz.: (1) B.S.A. ... ... _____

(2) East Coast ... ... _____

Totals.

Positive-plus _____ Positive _____ Positive minus _____ Negative _____ _____

B.S.A. _____ B.S.A. _____ B.S.A. _____ B.S.A. _____ _____

East Coast _____ East Coast _____ East Coast _____ East Coast _____ _____

Total Number of Cases of Tuberculosis in Tuberculin-test Group _____

Type of Reaction.	Acute Pulmonary (A-P.).	Chronic Pulmonary (C-P.).	"Effusion"* (E.).	Abdominal (Abd.).	Bone (B.).	Glandular (G.).	General† (Gen.).	Total B.S.A.	Total East Coast.
P.-plus ...									
P. ...									
P.-minus									
N. ...									

Number of Pulmonary cases endorsed by Medical Bureau ... ... _____

Number of "Effusion" cases endorsed by Medical Bureau ... ... _____

* "Effusion" includes pleurisy and pericarditis.

† "General" includes miliary and meningitis.

(Signed) _____

Date _____ MINE MEDICAL OFFICER.

APPENDIX NO. 3.

TUBERCULIN TESTS ON INMATES OF MENTAL HOSPITALS IN THE UNION.

FROM DATA SUPPLIED BY DR. J. T. DUNSTAN.

Dr. J. T. Dunstan, Commissioner for Mental Hygiene, has prosecuted an enquiry into tuberculosis in his hospitals independently of the work of this Committee. Dr. Dunstan has been so good as to put the information he has secured at the disposal of this Committee and the matter is here considered.

Tuberculin-testing was performed by the Von Pirquet scarification method. In most hospitals the testing was commenced in 1923-24 and the first tests were made on patients resident at the time ; subsequently patients were tested on admission. This enquiry concluded in the course of 1926.

In the mental hospitals of the Union the tuberculosis rate for Native and Coloured inmates runs high as compared with the tuberculosis rate for the general community. One object of this enquiry was to learn what proportion of the inmates were *invaded by the virus of tuberculosis* after admission, in so far as such invasion is evidenced by the Von Pirquet reaction.

The total number of tests performed are the sum of three groups : (1) Patients resident when test was started ; (2) patients tested on admission ; (3) repeat tests on negative reactors.

The total number of tests performed was 5,164 with 3,687 positive reactions, or 71 per cent. " positive " (see Table I). It will be seen that the figure secured is very similar to that secured for mine Natives. On the one hand, other things being equal, one would anticipate a higher proportion of positives with Von Pirquet scarification and re-testing than with 1/5,000 intra-dermal tests and single tests ; while, on the other hand, there is no record of efficiency tests on the tuberculin used. In the test on Mine Natives the initial difficulty was to secure a satisfactory and uniformly potent tuberculin.

The extent to which Natives in the different districts are tuberculized as judged by their response to this reaction, is best shown from the group tested on admission. These figures are given separately in Table I and it will be seen that the districts served by the hospitals at Bloemfontein and Pietermaritzburg are least tuberculized.

Not all the subjects yielding a negative response to the first test were were re-tested but, of those re-tested, 28 per cent. of the males and 10 per cent. of the females passed from a negative to a positive response in the group tested for the first time on admission. The tuberculin used was assumed to be of uniform strength throughout, so it is to be supposed that in a considerable proportion of those passing from a negative to a

positive response the virus of tuberculosis had entered after admission to hospital. The figures secured are given in Table II and one is left wondering whether patients from some districts are more readily tuberculized than others or if hospital conditions be the deciding factor. Experience at Fort Beaufort suggests the latter (see Table IV) giving tuberculosis mortality before and after reconstruction of this hospital .

In connexion with the fall in incidence of tuberculosis at Fort Beaufort Hospital after reconstruction took place, Dr. Dunstan writes : "I would draw your attention to the fact that at the same time as the reconditioning took place a system of regular sterilization of the blankets used by the patients was introduced. I think this, too, was a factor, because there is not the least doubt that the blankets were not always used by the same patient, and a patient who was not infected with tuberculosis might have been liable to use blankets which had been used by infected patients. You are, no doubt, aware that Natives generally sleep with their heads covered by the blankets."

Figures are available giving the tuberculosis mortality for varying periods for the different mental hospitals. These figures are set out in Table III, and the tuberculosis mortality has been calculated per 1,000 inmates per annum.

In the case of mental hospitals, tuberculosis mortality must be almost identical with tuberculosis incidence taken over a period of years, and we are dealing with a semi-enclosed community of the "fixed" type as opposed to the "shifting" type dealt with on the mines. It will be learnt from Table III. that there is about twice as much tuberculosis *pro rata* amongst the Native and Coloured patients in the mental hospitals as there is on the mines, though the actual figures are comparatively insignificant ; the total number of deaths due to tuberculosis during 1927 was 45. It is of interest to note that while five of the seven hospitals considered show much the same tuberculosis rate, two of them have rates about thrice the general rate if their contribution be excluded. It is natural to associate such an occurrence with "feeding" and "housing" factors, and the record of Fort Beaufort, taken over 18 years (Table IV) bears out this hypothesis. The re-conditioning of this hospital in 1922–23 was followed by a fall in the tuberculosis rate towards the level obtaining in the other mental hospitals. There is considerable variation in the feeding and housing of mine Natives, but there is very little evidence to suggest that these factors play much part either in their tuberculosis or their general health, so it is instructive to learn that "housing" conditions may obtain such as will influence a tuberculosis rate.

Much the same type of tuberculosis appears to prevail among the Native inmates of the mental hospitals as prevails among mine Natives. The difficulty of diagnosing tuberculosis in mental patients has to be taken into account, but the Commissioner for Mental Hygiene considers from the data at his disposal that about 62 per cent. of the cases die within six months of recognition of the disease, and about 82 per cent. within 12 months. It is believed that about 70 per cent. of mine Natives

die within 18 months of recognition of the disease, but this figure applies to males in the prime of life, while mental hospital figures cover both sexes and most ages. Dr. Peter Allan has made some study of the clinical and pathological data available and reports: " . . . It would appear that in the Fort Beaufort and Queenstown institutions chronic tuberculosis is to be met with, whereas in Pretoria, Bloemfontein and Pietermaritzburg acute tuberculosis seems to predominate." The Commissioner for Mental Hygiene has stated that, in his experience, in Pretoria no attempt at repair of tuberculous lesions is to be recognized at post-mortems, while at Fort Beaufort and Queenstown attempts at repair are to be seen.

TABLE I.

TUBERCULIN TESTS ON INMATES OF MENTAL HOSPITALS.

Hospital.	Total No. Inmates Tested.	Total No. "Positive" Reactions.	"Positive" Reactors" per cent.	Negative to First Test "P" to Re-test.
Bloemfontein	998	510	52	70
Queenstown	632	609	96	65
Valkenburg	81	57	70	5
Port Alfred	377	301	87·5	29
Pietermaritzburg ...	641	301	47	37
Pretoria	1,448	1,224	84·5	138
Fort Beaufort ...	987	676	68·5	73
Total	5,164	3,687	71	417

NOTE.—Table includes both males and females and the "Positive" column includes those Negative at first test but Positive on re-testing.

PROPORTION OF CASES GIVING POSITIVE REACTION ON ADMISSION.

	%
Bloemfontein	40
Queenstown	86
Valkenburg	64
Pietermaritzburg	35
Pretoria	77
Fort Beaufort	65

TABLE II.

PATIENTS NEGATIVE ON ADMISSION RE-TESTED.

Hospital.	No. of Positive Reactions.		Per cent. of Total Re-tested.	
	Male.	Female.	Male.	Female.
Pretoria	49	6	37	11
Queenstown	19	20	63	80
Valkenburg	5	—	20	—
Pietermaritzburg	19	2	9	5
Bloemfontein	43	27	30	37
Fort Beaufort	57	16	52	43

TABLE III.

MORTALITY FROM TUBERCULOSIS IN MENTAL HOSPITALS.

Hospital.	Period.	No. of Deaths due to Tuberculosis.	Tuberculosis Deaths per cent. of Total Deaths.	Av. Mortality from Tuberculosis per 1,000 Inmates per Annum.
Bloemfontein ...	1918–27	92	27	16
Queenstown	1923–26	32	23·5	16
Valkenburg	1920–27	26	46	45
Port Alfred	1923–27	31	32	16
Pietermaritzburg ...	1919–26	49	19	14
Pretoria: Males	1919–28	45	15·5	10
Pretoria: Females	1919–28	27	26	18
Fort Beaufort ...	1910–27	395	41	38

TABLE IV.

FORT BEAUFORT MENTAL HOSPITAL: TUBERCULOSIS STATISTICS, 1910–27.

Year.	Av. No. Inmates.	Total Deaths.	Deaths from Tuberculosis.	Tuberculosis Deaths per cent. of Total Deaths.	Mortality from Tuberculosis per 1,000 Inmates per Annum.
1910	498	41	21	51·2	42
1911	503	30	9	30·0	17
1912	521	39	14	35·8	26
1913	575	44	17	38·6	29
1914	598	37	15	40·5	25
1915	594	57	27	47·3	45
1916	581	83	37	44·5	63
1917	566	56	24	43·2	42
1918	569	*121	38	†31·4 63·3	66
1919	554	44	29	65·1	52
1920	594	78	35	44·8	58
1921	613	65	37	56·9	60
‡1922	591	58	28	48·2	47
1923	568	39	22	56·4	39
1924	542	47	16	29·5	34
1925	520	31	8	25·8	15
1926	532	36	11	30·6	20
1927	553	38	7	18·4	12

* Of this number, 61 died during influenza epidemic.

† Excluding deaths due to influenza.

‡ Re-conditioning of hospital commenced in 1922.

APPENDIX NO. 4.

TUBERCULIN REACTIONS IN NATIVE COLLIERY WORKERS.

FROM DATA SUPPLIED BY DR. F. J. ALLEN.

This investigation was undertaken by Dr. F. J. Allen, of the Witbank Colliery, and the results secured were communicated by Dr. Allen to the Witbank Branch of the Mine Medical Officers' Association, the paper being subsequently published in the *Journal of the Medical Association of South Africa*, p. 3, Vol. III, 1929.

Dr. Allen has put the information secured at the disposal of this Committee, together with data collected since his paper was published.

The same tuberculin and the same strengths of tuberculin were used as in the tests on the gold mines.

The enquiry has followed rather different lines to that conducted on the gold mines, the main objects being to learn to what extent Natives became tuberculized during employment on the collieries as evidenced by a positive response to the intra-dermal tuberculin test with 1/5,000 tuberculin, and to learn whether Natives could become tuberculized in the above sense without going on to a clinical tuberculosis.

The procedure adopted was as follows :—

The Natives tested were divided into groups according to the lengths of their industrial histories in so far as these could be secured, and Table I gives the results secured on Natives who had worked on both gold mines and collieries. " Owing to the history being dependent on the Native's memory and veracity, neither of which can be depended on for strict accuracy, a similar classification was made of Natives who had worked only on collieries." Table II, approximately 50 per cent. of the total tested. This second classification was further checked by taking the histories of boys who worked only on the one colliery; approximately 50 per cent. of the whole colliery group. The length of service was ascertained for these from the company's register: Table III. It is important to note that it gives almost identical percentages as Table II. The importance lies in this: Dr. Allen's painstaking investigation suggests that the Native mine boy, as long as he has no axe to grind, gives a more accurate working history than he gets the credit for giving. It is true that when applying for compensation he will affirm that he has worked ten or twelve contracts, while if applying for a job he will only admit to one or two; such elasticity of recollection is, however, not confined to the South African Native mine boy.

TABLE I.

DISTRIBUTION OF RESPONSE TO INTRA-DERMAL TUBERCULIN TEST IN DIFFERENT TIME GROUPS OF WORK ON BOTH GOLD MINES AND COLLIERIES.

	1st 6 Months on Mine.		2nd 6 Months on Mine.		1 to 2 Years on Mine.		2 to 5 Years on Mine.		6 to 9 Years on Mine.		10 Years and Over.		All Lengths of Service.	
	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%
Definite Negative ...	60	50	83	42	120	35	254	34	81	33	107	43	705	37
All Positives ...	60	50	116	58	227	65	489	66	167	67	141	57	1,200	63
Totals ...	120		199		347		743		248		248		1,905	

TABLE II.

DISTRIBUTION OF RESPONSE TO INTRA-DERMAL TUBERCULIN TEST IN DIFFERENT TIME GROUPS OF WORK ON COLLIERIES ONLY.

	1st 6 Months on Mine.		2nd 6 Months on Mine.		1 to 2 Years on Mine.		2 to 5 Years on Mine.		6 to 9 Years on Mine.		10 Years and Over.		All Lengths of Service.	
	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%
Definite Negative ...	60	50	83	42	83	34	110	39	32	42	51	53	419	41
All Positives ...	60	50	116	58	159	66	169	61	44	58	45	47	593	59
Totals ...	120		199		242		279		76		96		1,012	

TABLE III.

DISTRIBUTION OF RESPONSE TO INTRA-DERMAL TUBERCULIN TEST IN DIFFERENT TIME GROUPS OF WORK ON ONE COLLIERY ONLY.

	1st 6 Months on Mine.		2nd 6 Months on Mine.		1 to 2 Years on Mine.		2 to 5 Years on Mine.		6 to 9 Years on Mine.		10 Years and Over.		All Lengths of Service.	
	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%	No. of Natives.	%
Definite Negative ...	60	50	83	42	46	32	9	39	11	40	13	62	222	42
All Positives ...	60	50	116	58	98	68	14	61	17	60	8	38	313	58
Totals ...	120		199		144		23		28		21		535	

Dr. Allen summarizes his conclusions as follows :—

There is a rapid increase in the positive reactions in the early periods of the Native's industrial life.

A fairly steady average is maintained in the next two time groups.

There is a decline below the average after ten years.

Initial invasion can take place without any clinical manifestations.

Clinical tuberculosis is generally the expression of a breakdown in the defensive mechanism of those already previously infected.

Two subsidiary investigations were performed :—

(1) A group of Natives who had given a negative reaction six months previously were re-tested. The results secured are given in Table IV.

TABLE IV.

TUBERCULIN INTRA-CUTANEOUS REACTIONS IN 191 NATIVES WHO WERE NEGATIVE SIX MONTHS PREVIOUSLY.

Present Reaction.	Length of Mining Service.				
	First Six Months. 40 Boys.	Second Six Months. 12 Boys.	One to Two Years. 37 Boys.	Two to Ten Years. 70 Boys.	Over Ten Years. 32 Boys.
Negative ...	23; 57·5%	6; 50%	13; 35%	21; 30%	12; 37·5%
Positive	17; 42·5%	6; 50%	24; 65%	49; 70%	20; 62·5%

Of the total 191 only 75, or 39·25 per cent., remained unchanged as definite "negatives."

(2) A group of Natives who had been tested a year before with 1/5,000 tuberculin were re-tested with an intra-dermal inoculation of 1/1,000 into one arm and 1/10,000 into the other. The results secured are given in Table V.

TABLE V.

920 NATIVES PREVIOUSLY TESTED WITH 1/5,000 TUBERCULIN RE-TESTED AFTER TWELVE MONTHS WITH 1/1,000 AND 1/10,000 TUBERCULIN.

Reaction.	1/1,000 Tuberculin.	1/5,000 Tuberculin. (Original Test.)	1/10,000 Tuberculin.
	%	%	%
Negative	4·9	37·0	12·6
Doubtful	6·0	7·6	14·0
Positive	89·1	55·4	73·4

Even with the 1/10,000 solution a considerable number passed from the negative group of a year before to the positive group. The 1/1,000 yielded as high a proportion of doubtful reactions as did the 1/5,000 but the weakening of the solution to 1/10,000 doubled the proportion of doubtfuls.

The reactions from the 1/1,000 were too powerful for its general use as a test; several boys were laid off work as a result.

The simultaneous use of a strong solution in one arm appeared to facilitate the response to a weak solution in the other; the reaction to the 1/10,000 solution given in these circumstances being more marked than the reaction to 1/5,000 given alone.

A certain proportion of subjects showing a negative reaction to a tuberculin test will always react positively to a second test, but the large proportion changing from negative to positive both in this group and in the group presented in Table IV suggests tuberculization on the mines. Compare the results of re-testing at the mental hospitals given in Appendix 3.

APPENDIX NO. 5.

TUBERCULOSIS PREVALENCE ON THE WITWATERSRAND GOLD MINES.

By A. Mavrogordato.

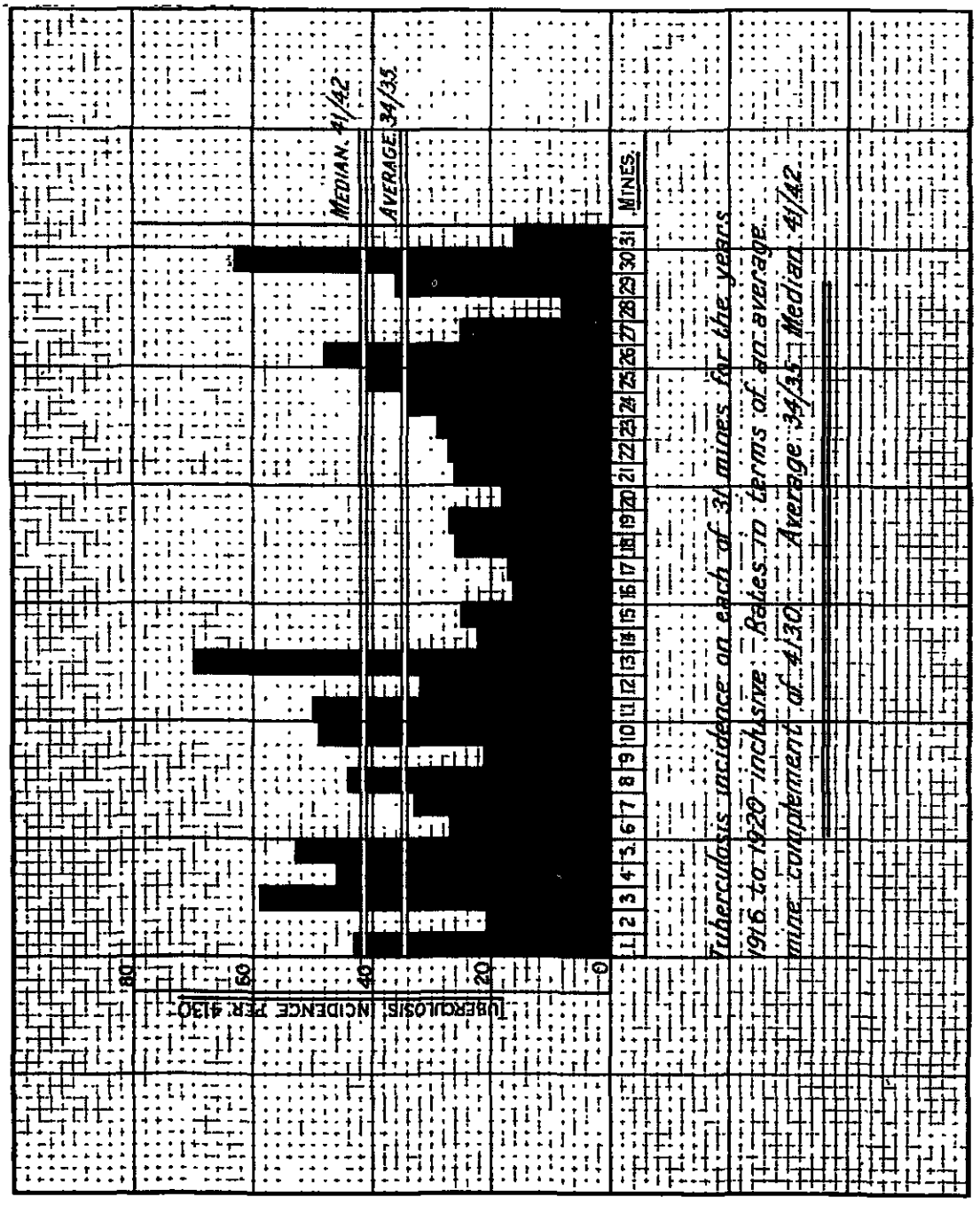
1. Comparison of Mine with Mine.

For comparison of mine with mine one requires a standard. The production of tuberculosis by each mine can be expressed as rate per 100,000, thus yielding a uniform series. This rate has not been adopted because, with the numbers to be discussed, differences would be unduly exaggerated. For each group of years or year under consideration a mean mine complement has been determined and, from the tuberculosis production of each mine, a mean tuberculosis production has been determined.

For the years 1916-20 the mean mine complement was 4,130, and the mean tuberculosis production was 40 to 41 cases per annum. For this period the standard mine was one with a Native complement of 4,130 and 40 cases of tuberculosis per annum. Aurora West, with a complement of under 1,000, had its tuberculosis calculated for a complement of 4,130, and Randfontein, with a complement of over 16,000, also had its tuberculosis calculated for a complement of 4,130. The figures for 1926-27 treated in similar fashion gave as standard mine one with a Native complement of 5,000 and a tuberculosis production of 41 to 42 cases per annum.

The rates for the 31 mines studied for the five years 1916-20 are shown in Graph I. Each vertical column represents the tuberculosis production per 4,130 for a mine. The two horizontal lines are the "median" rate per mine and the average rate per mine. The average comes from dividing the number of mines—31—into the annual tuberculosis production—1,075. It falls well below the "median" (34–35 as compared with 41–42). It will be seen that the production rate is very irregular. This variation shows better in Graph II, the "Distribution Graph." The distribution graph was prepared thus: The mines were divided into groups—a group with a production of under 10 per 4,130; a group with over 10 and up to 20 per 4,130; a group with over 20 and up to 30 per 4,130 and so on. Each vertical column represents one of these groups, and the height of the column is the number of cases in the group. It will be seen that it requires no less than 7 of these groups to cover the 31 mines. Here are the figures:—

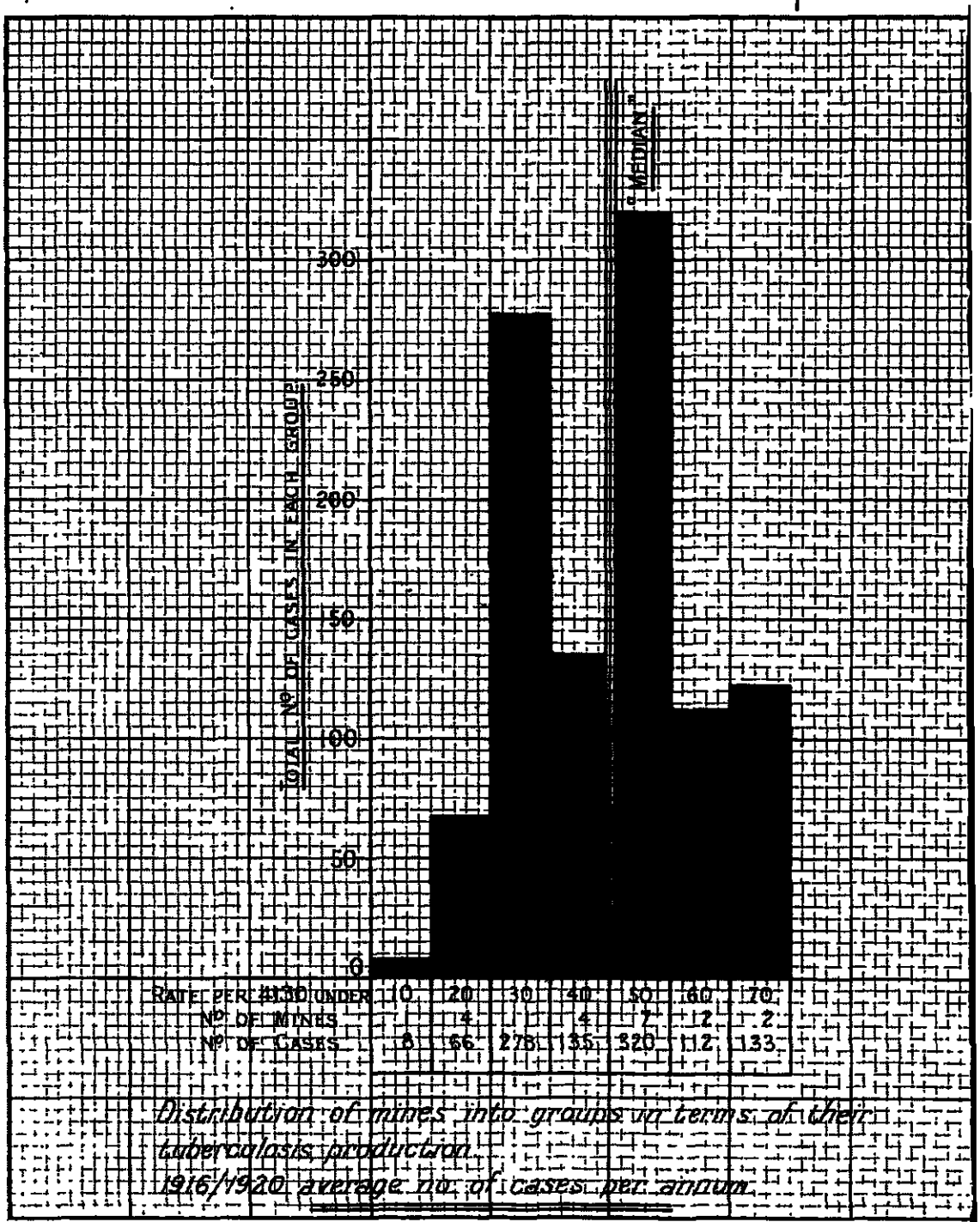
8	15	21	32	41	53	63
	16	21	33	42	59	70
	17	22	34	44		
	18	25	36	46		
		25		48		
		26		49		
		26		50		
		27				
		28				
		28				
		29				



Graph 1

Tuberculosis incidence on each of 31 mines for the years 1916 to 1920 inclusive = Rates in terms of an average mine complement of 4130. — Average 34/35 — Median 41/42.

Graph II



Distribution of mines into groups in terms of their tuberculosis production.
1916/1920 average no. of cases per annum.

Most mines occur in the group having over 20 and up to 30 cases per 4,130. Most cases occur in the group having over 40 and up to 50 cases per 4,130.

One might suppose that, broadly speaking, along the 70 miles of gold-reef the same sort of men were working under the same sort of conditions. A distribution graph of this shape disturbs confidence in such a supposition. This graph represents the state of affairs obtaining some years ago, and the question will be discussed in terms of the graph presenting the state in 1926-27.

The rates for the 36 mines studied for the year 1926-27 are shown in Graph III. Each vertical column represents the tuberculosis production per 5,000 for a mine. The two horizontal lines are the " median " rate per mine and the average rate per mine. The " median " is 41–42 and the average 38–39. For this year the production rate is much less irregular than in 1916-20, and the " median " and average come closer together. The position of the mode in Graph II accounts for the gap between " median " and average.

Graph IV is the distribution graph for 1926-27. Here are the figures :—

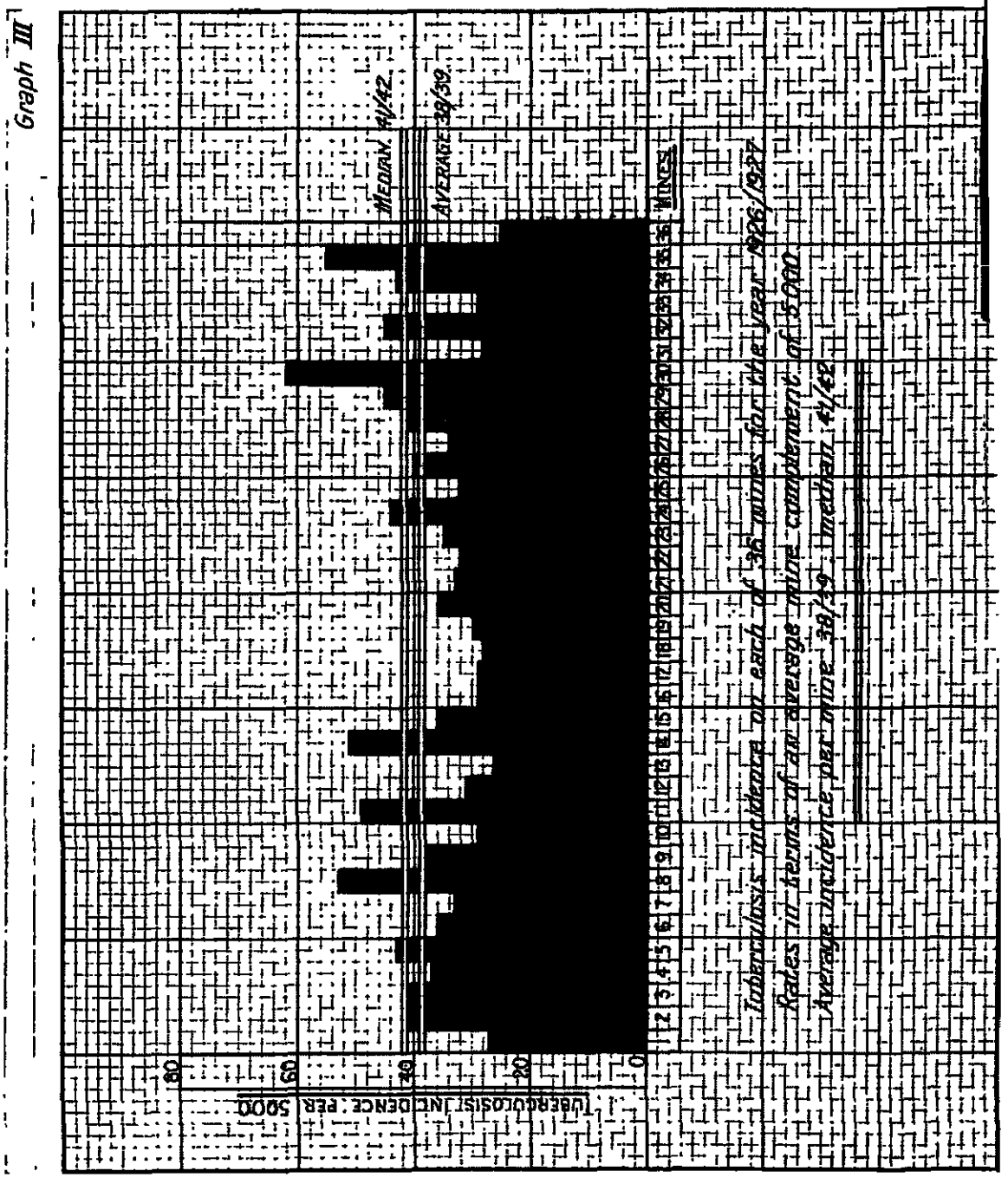
25	31	41	51	62
26	32	41	53	
27	32	42	55	
27	33	42		
28	33	43		
28	34	44		
29	35	45		
29	35	45		
29	36	49		
30	36			
	37			
	38			
	40			

This graph is much more regular than Graph II. There are five groups : Up to 30 per 5,000 ; over 30 and up to 40 per 5,000 ; over 40 and up to 50 per 5,000 ; over 50 and under 60 per 5,000 ; and over 60 per 5,000 (one mine only). Mode, " median " and average are all close together, while 22 of the 36 mines are grouped round the " median." There is a group of ten low-prevalence mines, and a group of four high-prevalence mines.

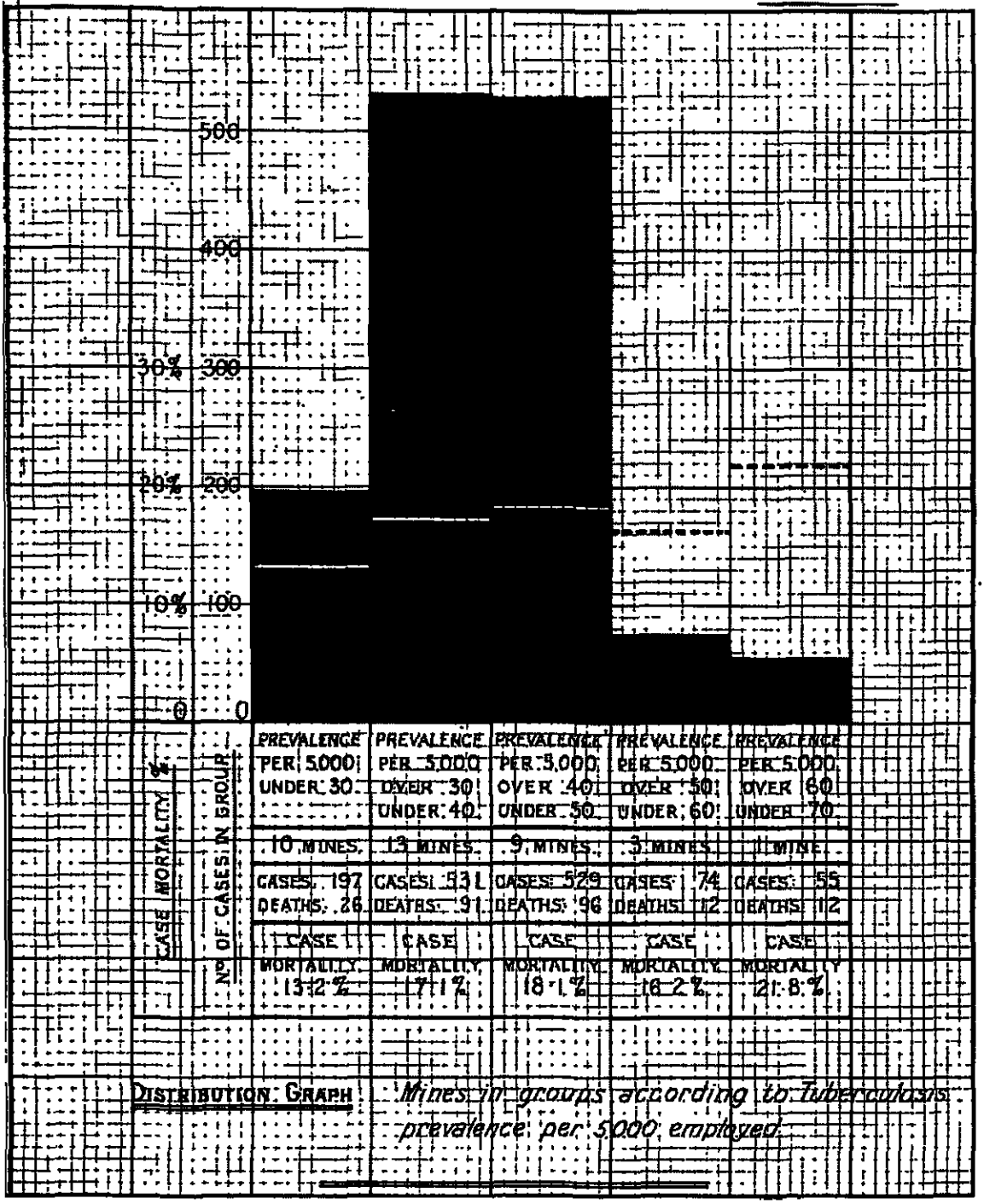
The prevalence rates for 1926-27 are far more uniform than they were in 1916-20, but there are still considerable discrepancies.

The most recent figures available are for 1929-30. One continues to take 5,000 as a standard mine complement and 32 mines are dealt with. The average incidence rate is 36 per 5,000, and the comparative rates are set out in Graph V, which shows the usual variation in prevalence per mine.

" Step-graphs " have been used throughout this section and the " medians " referred to are the " medians " of the step-graphs. The step-graph of tuberculosis incidence for 1929–30 is given here, as it illustrates a feature common to all step-graphs dealing with the tuber-


Graph III
TUBERCULOSIS INCIDENCE PER 5000
80
60
40
20
0
MEDIAN 41/42
AVERAGE 39/39
MINES
Tuberculosis incidence on each of 36 mines for the year 1926/1927
Rates in terms of an average mine complement of 5000
Average incidence per mine 39/39 : Median 41/42

Graph IV



DISTRIBUTION GRAPH

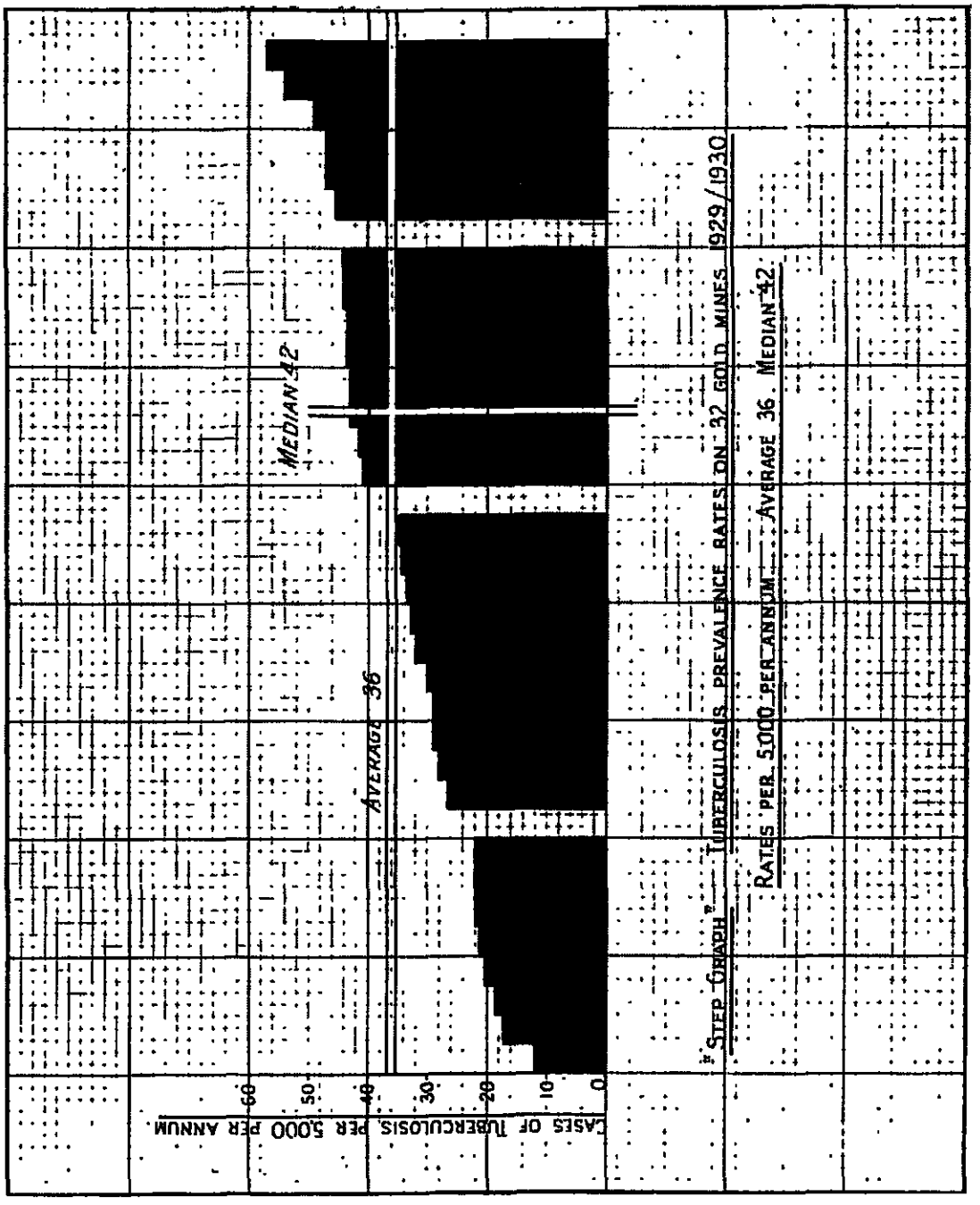
Mines in groups according to Tuberculosis prevalence per 5,000 employed.

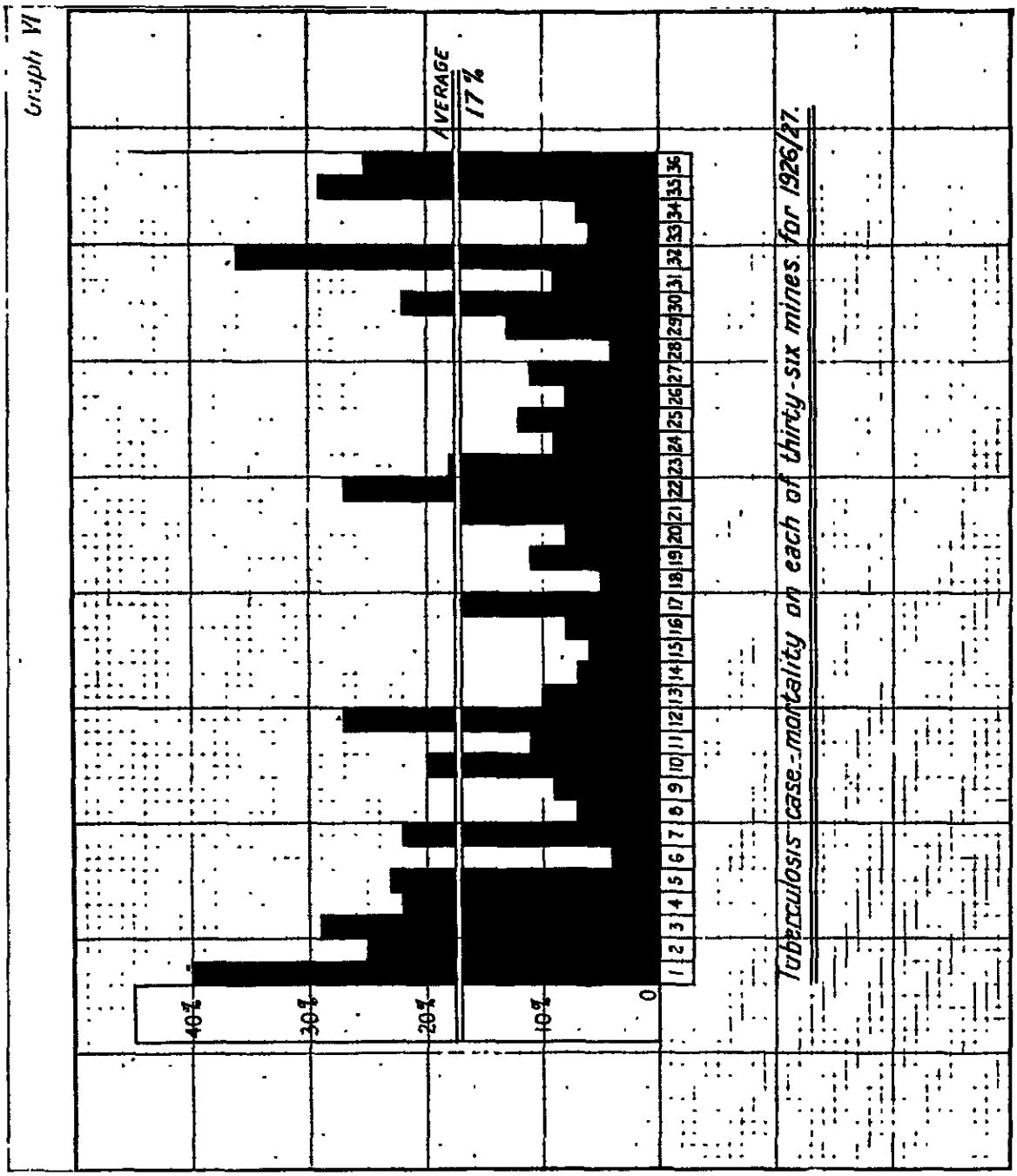
L

culosis incidence for each mine (Graph V). There is nothing in this curve to suggest that any new factor comes into play at any stage and, as far as this and similar curves for other years go, one must assume that the same factors are acting all along the Reef and merely vary in degree. It may be fairly asked: Why give "Distribution Graphs" since the divisions are arbitrary? A distribution graph is of value if there be indications that conditions differ in kind for each group, otherwise they may give a wrong impression. They have been used here because they are a convenient way of following a mine's tuberculosis rate over a period of years. One finds that the mines fall into two classes —*mines that remain at the same sort of rate year after year, and mines* whose rates alter. If one considers the mines that alter, there are two possibilities; they might alter erratically or regularly. One learns that the mines in the altering class alter regularly and fall into two sections—mines whose tuberculosis rate has been falling, and mines whose tuberculosis rate has been rising. A comparison between these two sections might yield useful information. This matter will be given further consideration, but it may be stated at once that very little has been learnt by this line of inquiry. To return to the 1929–30 distribution, the vertical line in Graph V is the median and gives a rate of 42 per 5,000 per annum, while the horizontal line is the average, giving 36 per 5,000 per annum. The mines have been distributed into four groups. Groups 1 and 2, taken together, include 18 mines having a complement of 96,871, yielding 541 cases of tuberculosis and a group rate of 28 per 5,000 per annum. (Group 1 rate is 19 per 5,000 per annum, and Group 2 rate is 31 per 5,000 per annum.) The lowest rate in Group 1 is 12 per 5,000, and the highest in Group 2 is 35 per 5,000. All the 18 mines have rates below the average. Groups 3 and 4, taken together, include 14 mines having a total complement of 95,808, yielding 859 cases of tuberculosis and a group rate of 45 per 5,000 per annum. Group 3 rate is 42 per 5,000, and Group 4 rate is 50 per 5,000. The lowest rate in Group 3 is 41 per 5,000, and the highest in Group 4 is 57 per 5,000. All the 14 mines have rates above the average.

It must be granted that the tuberculosis rates vary from mine to mine to a greater extent than might have been anticipated, and admitted that no explanation is forthcoming that covers the facts. One hypothesis may be considered to be dismissed. It has been suggested that mine tuberculosis prevalence rates depend chiefly upon whether the mine medical officer is or is not interested in tuberculosis. How can this amiable hypothesis be tested? Sir James Kingston Fowler has said: "Some tuberculosis officers recognize tuberculosis shortly before the post-mortem, others afterwards." On this line of enquiry, if a low prevalence rate implies an uninterested mine medical officer, the low prevalence mines should have a high case mortality. Graph VI gives the case mortality for the different mines and it varies as much as do the prevalence rates. The average is about 17 per cent. If one turns to Graph IV, the prevalence rates distribution graph, the horizontal lines give the case mortality for the different groups that go to make up this graph. The lowest prevalence rate mines have the lowest

Graph A


CASES OF TUBERCULOSIS PER 5000 PER ANNUM
0
10
20
30
40
50
60
MEDIAN 42
AVERAGE 36
STEP GRAPH — TUBERCULOSIS PREVALENCE RATES ON 32 GOLD MINES 1929/1930
RATES PER 5000 PER ANNUM — AVERAGE 36 MEDIAN 42


Graph VI
AVERAGE 17%
40%
30%
20%
10%
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Tuberculosis case-mortality on each of thirty-six mines for 1926/27.

case mortality—it is only just over 13 per cent. As far as this test goes, if there be such men as mine medical officers not interested in tuberculosis, they are distributed all along the Reef and not, as the Pelagians do vainly talk, concentrated in the low prevalence rate mines.

One cannot judge the hygiene of a mine from its vital statistics alone. A mine is popular not only because it is "comfortable" for work, but also because of the facilities it affords for housing and social amenities. The older and more experienced men go to such mines and stay there. Since it is the long-service men who bulk big in the vital statistics of industry, a "good" mine may have poor health returns for the same reasons as a health resort. This argument applies rather to the European miner than to the Native miner, but it does count. Graph 2 on p. 119 of the main Report suggests that about 30 per cent. of the labour force is in the poor-health zone; under twelve months' total service or over five years' total service. Mines drawing an excess proportion of their force from this zone will show it in their vital statistics. A "good" mine will have an excess proportion of "old" boys, a "bad" mine an excess proportion of boys not old enough to know any better. The health returns of both will suffer.

The more isolated mines and smaller mines tend to better health, while mines situated near townships and locations tend to worse health. Social amenity factor.

Physiological stress, feeding and housing have always to be considered in connexion with tuberculosis. Owing to the separation of the Native labour force into underground boys and surface boys, it is possible to draw some distinction between the parts played by these factors, because both underground and surface boys have feeding and housing in common. The Mine Medical Officers' Association have been good enough to supply an official definition of a "surface boy," and it reads as follows :—

(1) A Native fit for underground work, but employed on some surface occupation, *e.g.*, in the blacksmith or carpenter shop, the cook-house, etc.

(2) Fit Natives who have completed their underground service contract, and then transfer for surface work.

(3) Natives who engage "voluntarily" for surface work.

(4) Natives *ex* hospital, placed temporarily on surface work for recuperative purposes, and subsequently given permanent surface work.

(5) Natives unfit for underground work owing to some physical disability, *e.g.*, loss of limbs, fingers, or one eye, etc.

(6) Natives of poor physique who are unfit for transference underground.

(7) Natives suffering from some defect in the lungs other than known open or closed tuberculosis.

It will be seen that the surface group includes all Natives of inferior physique. During the year 1929–30 the average number of Natives employed underground was 153,462, and the average number employed on the surface was 38,279. The number of cases of tuberculosis from the underground group was 1,128, or 735 per 100,000, while the number of cases from the surface group was 205, or 535 per 100,000. On the whole, then, the physiological stress of underground work plays a greater part than does feeding or housing, as far as concerns the Native labour force. The fact that 22 per cent. of the tuberculosis in the surface group was tuberculo-silicosis renders the underground factor still more important.

Surface workers, constituting 20 per cent. of the total complement, only produce 15 per cent. of the total tuberculosis.

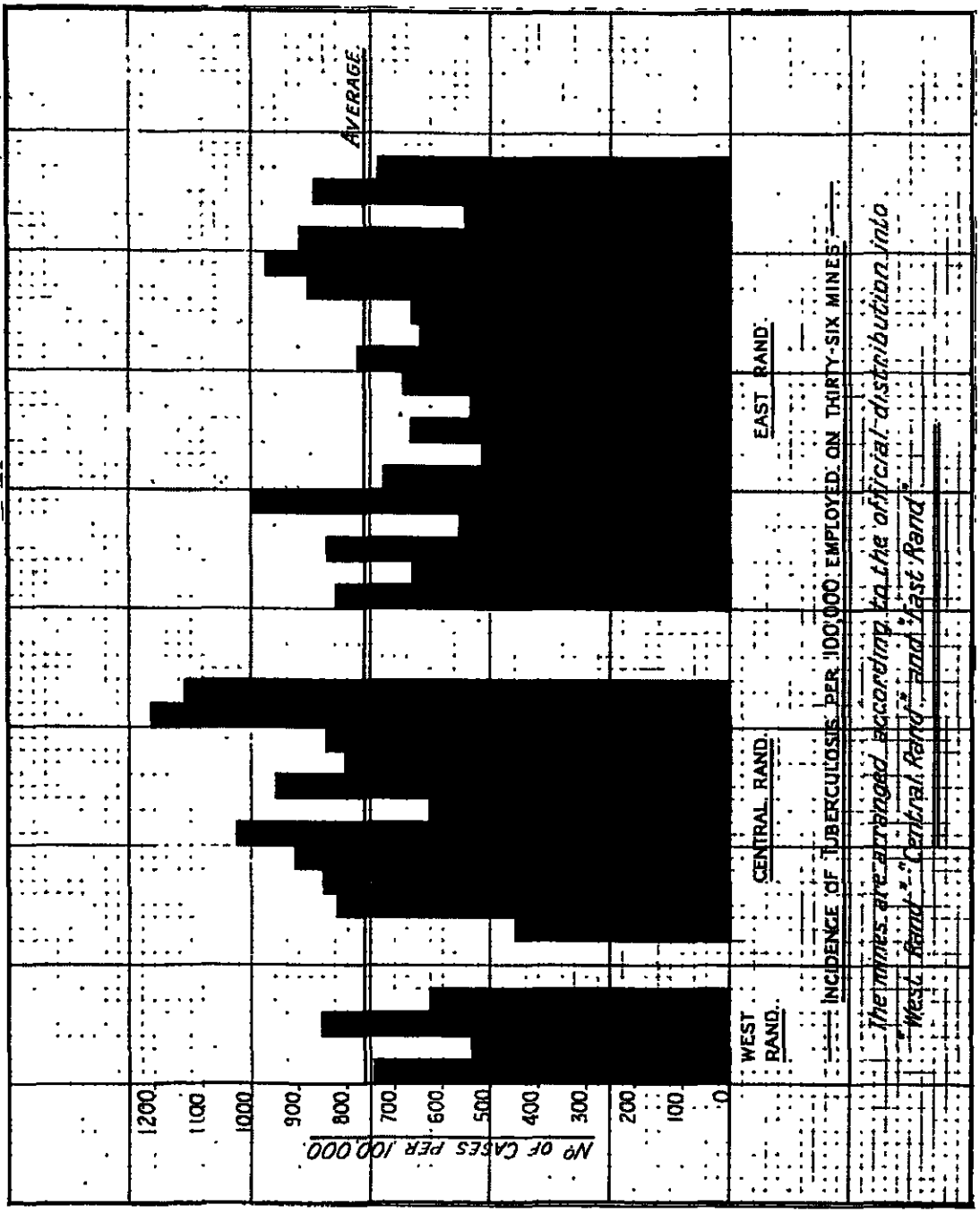
These surface workers include all Natives of inferior physique, including " old " boys, who constitute about 35 per cent. of the surface complement, although only about 10 per cent. of the total complement. Such " old " boys have a high tuberculosis mortality rate (see Graphs 1 and 2 in the main Report, pp. 118 and 119). Nevertheless, tuberculosis incidence in surface workers is less than that in underground workers.

Seeing that compound conditions (housing, feeding, etc.) are the same for the two groups, the inference seems irresistible that *underground factors are more important in the incidence of tuberculosis* than compound conditions.

There is one feature in an established mining industry which always calls for consideration. There come times in the history of a mine when the powers-that-be have to decide whether to sink a new shaft and revise the haulage or shut down. When they decide to carry on, that mine is likely to become increasingly uncomfortable until the new work comes into use. The transition period usually affects vital statistics adversely. Should it be decided to let the mine run down, then the " bone-picking " stage is often, though not always, associated with a falling-off in the health of the complement, particularly from the tuberculosis standpoint.

It is all very well to write of the physiological stress of underground work but—how does it come in? A mine's Native labour force resembles a body of athletes in training to the extent that 99 per cent. improve in physical condition, while 1 per cent. breaks down. One expects a Native to start putting on weight at once, and if he does not he is watched. It is not the physical labour that is the important element in physiological stress underground, it is the conditions under which this labour is performed. Tuberculosis rates tend to run higher on the older, deeper and steeper mines. These are to be found chiefly in the Central Rand area (see Graph VII). The deeper mines are the hotter mines. There are exceptions but, in the main, the hotter mines are the less healthy, though even this applies to health in general rather than to tuberculosis in particular. The lay-out renders impracticable really satisfactory districting and splitting of the air supply. The

Graph VII


AVERAGE
EAST RAND.
CENTRAL RAND.
WEST RAND.
No OF CASES PER 100,000
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
INCIDENCE OF TUBERCULOSIS PER 100,000 EMPLOYED ON THIRTY-SIX MINES
The mines are arranged according to the official distribution into
West Rand, "Central Rand" and East Rand.

more the working force is scattered the better for their health. If there be numerous back-stopes in use the vital statistics are apt to be adversely affected.

Certain general possibilities call for consideration in any attempt to account for the variations in tuberculosis prevalence from mine to mine. Professor Dalton and Mr. J. B. Kerrich, of the University, of the Witwatersrand, worked out a series of correlation coefficients in this connexion from data supplied to them.*

The Native labour force is made up of B.S.A. Natives and East Coast Natives in the ratio of about 10 : 8, but the proportions vary widely from mine to mine. The tuberculosis rate for "tuberculosis under the Act," runs higher for East Coast Natives than for B.S.A. Natives, so one might expect a mine's tuberculosis rate to be influenced by the proportion of East Coast Natives in its complement.† Dr. A. I. Girdwood, Chief Medical Officer of the W.N.L.A., has kindly supplied the following figures. During the four years 1927–30 the number of East Coast Natives compensated under the Act was 2,678, as compared with 1,659 B.S.A. Natives, so compensated. As far as "tuberculosis under the Act" is concerned, there is a marked difference between the two groups. The correlation between the mine's proportion of East Coast Natives and its tuberculosis rate was determined for one year with the surprising result that the correlation was only positive to the extent of 0·16 with a probable error of $\pm 0{\cdot}12$. The enquiry was pushed further. The group of mines with the highest complements were studied separately but they were not influenced by their proportion of East Coasters. One then took a group of mines with 50 per cent. or over of East Coasters in their complement. Still one did not find that the East Coaster and a high tuberculosis rate went together. Finally, one took the mines with the highest tuberculosis rates and did learn that they had above the average proportion of East Coasters in their complements. One can only conclude that susceptibility to effective infection by tuberculosis is unequally distributed among East Coast Natives. While the B.S.A. Natives as a whole have a very tolerable resistance to effective infection, the Basuto have a very poor resistance, and one must assume, until one knows more about it, that there is a group of East Coasters corresponding to the Basuto, and that they bear a higher proportion to the East Coast group as a whole than do the Basuto to the B.S.A. group as a whole.

* Speaking generally, correlation coefficients are of but little value unless the items correlated can be isolated from factors that are neutral or at least of minor importance. A consideration of the low coefficients obtained in the statistical analysis of the data about to be considered does but confirm our previous opinion—gained from experience—as to the impossibility of isolating any of the items enumerated as a dominant factor in the production of tuberculosis. This is all that these correlations do teach us; they do not even help us in arriving at the relative importance of the various items dealt with. The question of making an attempt at securing partial correlations was considered and dismissed for the present. The "scattergrams" emphasize the lesson taught by the "step-graphs," that there are several factors at play all along the Reef which exert a determining influence upon the varying tuberculosis incidence between some mines and others, and that we have failed to isolate any one of them.

† This does not apply to "Tuberculosis, all forms" (see p. 139 *et seq.*).

In the early days of the industry, when Drs. Irvine and Macaulay[46] made their investigation, a large proportion of "raw" boys were employed, and it was these raw boys who dominated vital statistics. The majority, though not all, of the raw boys working their first contract on the mines will come under the heading "recruited" as opposed to "non-recruited." Recruited boys run to about 56 per cent. of the total complement. The correlation between percentage of recruited boys in complement and tuberculosis prevalence is $-0{\cdot}23$ with a possible error of $\pm 0{\cdot}11$. This result is probably influenced by the fact that many non-recruited boys use the recruiting corporations as a convenience and appear under the caption "recruited." Still, the distinction between a non-recruited and a recruited boy is no longer significant from the tuberculosis point of view. The important section of "old boys," who now influence tuberculosis statistics so largely, and who are nearly all "non-recruited," did not exist in the early days.

Although old boys of continuous service have a high tuberculosis rate, the proportion of them in a complement, perhaps 4 per cent., is not sufficient to influence returns. Actually the correlation between percentage of old boys of more than five years' continuous service in complement and tuberculosis rate is $+0{\cdot}02$ with a possible error of $\pm 0{\cdot}12$.

The feeding question is always important. Mines differ widely in the amount spent per head on feeding their Native labour force. The managements have been good enough to supply the data and the correlation between cost of food per man per day and tuberculosis rate is $-0{\cdot}12$ with a possible error of $\pm 0{\cdot}12$. There cannot be much wrong with the feeding, since the vast majority of Natives put on weight and improve in physique during a contract; still, if there be a way of fending off tuberculosis by feeding, we have not found it. One does not like leaving the question there. To begin with, the Native has very definite views on the time and place for meals. He likes his main meal after work, yet there is some evidence pointing to the conclusion that the fuller the stomach the Native takes to work the better his health. The Native is not enthusiastic about eating underground, and a ration for consumption there must be tempting and readily accessible. To get such a ration where it is wanted and to provide tolerable facilities for consuming it is far from an easy matter. In some cases the difficulties have been overcome and encouraging results secured. A further complication is introduced owing to the fact that certain tribes will not willingly touch certain foods, *e.g.*, fresh vegetables of all inconvenient taboos. Experience with scurvy illustrates this feature. Despite intensive work, scurvy still is met with in the Native labour force and falls into two classes. One class is the scurvy of the new arrival, who reaches his mine in the pre-scurvy stage and develops the overt disease under stress of mining work. The other class is the old long-service boy. When such boys belong to tribes who reject fresh vegetables, after doing so for a long period they may develop scurvy. The baby new to earth and sky brings a store of vitamin into the world which will last for some time, and the boy arriving for work on the Reef usually brings

a sufficient store to see him through an ordinary contract, even though he rejects the vegetables provided. The old de-tribalized boy who is a permanent employee and never returns to his kraal and never restores his vitamin-content may work through his reserves and develop scurvy if he has rejected the vegetable portion of his diet for sufficiently long. We have to learn what is the source of anti-scurvy vitamin for tribes that taboo the ordinary vegetables.

The Native labour force being drawn from many different tribes with many different diet traditions, there are bound to be many and varied difficulties when it comes to housekeeping for a family of 200,000 changing at a rate of over 90 per cent. per annum.

Professor E. V. McCollum mentions similar troubles when the North American Indian takes to "living on the grocer" and South Sea Islanders have suffered greatly as the result of changing from their natural roots to cereals. There seems to be scope for further enquiry into the vitamin-content of the roots consumed by the dark races all the world over, as long as the European leaves them alone.

In this context mention may be made of an expedient on trial by certain mine managements. In the days when tropical Natives were recruited, they were not allowed to take part in underground work until three weeks after their arrival on the mine to which they had been allotted. The results as far as improvement in health was concerned were quite disappointing. The present idea is to put newly-arrived Natives on to training-gangs for three weeks after their arrival. These gangs are purely instructional and for acclimatization; there is no concern over output of work. All Natives in a training-gang are weighed once a week and experience shows that they usually start putting on weight at once. Any Native losing weight is put on an extra ration of fat meat three times a week. The results are encouraging; most Natives respond to this extra ration by recovering the weight lost, and Natives who start routine work on the rising weight-curve do not break down. It appears that 99 per cent. of the Native labour force are suited by the routine, but that a fraction of 1 per cent. will respond to individual attention. As to whether individual attention can be satisfactorily arranged in the case of mines having 20,000 to 30,000 Natives to deal with per annum is another question.* One remembers that in the Russo-Japanese War, and before the days of vitamins as a recognized consideration in diets, Dr. Takaki, head of the Japanese Medical Service, gained a great reduction in sickness in general and in beri-beri in particular by adding a meat ration to the diet. One has a suspicion that provided care be taken regarding the "animal-food" the vitamins will take care of themselves. Of course, the meat ration, as far as possible, should consist of fat meat to give vitamin A its chance.

* The procedure outlined above is at the stage of small-scale experiments and is not representative of general practice. The data so far secured are insufficient for far-flung conclusions to be drawn.

One does not associate the carnivora with deficiency diseases and Polar expeditions suffering from scurvy did not find this condition to be an abiding trouble for the Eskimo.

Since employment underground seems to be such an important factor and mines differ a good deal in the amount of time their Native labour force spends underground, one might expect some correlation between hours spent underground and tuberculosis prevalence. Actually the correlation secured was mildly negative. The Government Mining Engineer has explained to the writer that this is inconclusive because while the data supplied by him related to mean time spent underground on each mine, the time spent by those engaged on different classes of work on each mine varies considerably, and that differences within the mine may be greater than from mine to mine. The fact remains that one cannot help feeling that if time spent underground were of great significance, something other than a mildly negative correlation would have been secured. Managements give special attention to getting the Natives to and from their work with as little walking as possible.

One would like to correlate general health with tuberculosis by getting the factor for total shifts lost owing to sickness and tuberculosis. Unfortunately, all mines do not have the same system of keeping their sickness records. Two separate enquiries yielded positive correlations of 0·22 and 0·4.

Of course, it is suggested that a low sickness rate means that a mine repatriates sickly Natives in preference to trying to patch them up on the mine. If there were anything in this suggestion there would be a correlation between rate of change of complement and total shifts lost owing to sickness. A low sickness rate would mean a high rate of change of complement, and *vice versa*. There is no significant correlation either for total sickness or tuberculosis.

One important factor has been active during the last four years and accounts for a good deal. This refers to the special examinations of old boys (see p. 112). A mine whose return for a particular year includes one of these special examinations is bound to have the returns for that year adversely affected.

To summarize, 29 mine histories can be followed from 1916 to 1930. There have always been wide variations in tuberculosis prevalence from mine to mine. 14 mines have kept their rate pretty steady, whether low, medium or high. Of late years 9 mines have been showing a falling rate, and 6 mines a rising rate. Improvement appears to be associated with the overcoming of mining difficulties, increased scattering of working parties, reduction in number of back-stopes, improvements in feeding and housing, and special efforts at better ventilation. These suggested factors would be simpler of acceptance were it not that the same processes are at work in both the " dis-improving " and the stationary mines. A very wise and experienced consulting engineer, while rather astonished at the wide variation in prevalence rates, only got six actual surprises—three mines were, to him, unaccountably bad, and three mines were, to him, unaccountably good.

2. Tuberculosis in Boys of Long Service and Influence of Length of Service on Tuberculosis Prevalence.

These figures are particularly difficult to deal with, as they come from various sources and the sets of figures are more or less incomplete. The matter cannot be left out, because it has important bearings. Boys of long service are our nearest approach to a fixed population and thus afford the most direct comparison with conditions elsewhere. The group also yields some information as to the Native's ability to control his tuberculosis and direct it to a chronic course. In conclusion, one may learn something as to the comparative influence on tuberculosis incidence of acclimatization to our mining conditions and duration of exposure to our mining conditions.

The most complete set of data available are for "tuberculosis under the Act" (see p. 116 of main Report). For the past eight years the W.N.L.A and the Miners' Phthisis Medical Bureau have ascertained, as far as possible, the length of service of each boy compensated and the figures secured are on record.

The returns for the last four years and the average of these four years are given in Table I (p. 354). The annual total is from 25 to 30 per cent. below that for "tuberculosis, all forms," as given by the mine medical officers. In this latter return length of service data are not included and the extra cases are mostly those of "tuberculous septicaemia" and "surgical tuberculosis." One knows from other sources that most of these cases arise in the course of the first year of employment. Referring back to "tuberculosis under the Act" and Table I, it will be seen that more than half the cases detected arose during the first year of employment and that the actual figures for the third, fourth and fifth years are quite low. As to whether these figures are absolutely low or only relatively low depends upon the number of the labour force having a similar length of service. This matter will be discussed presently.

The next set of figures to be considered has the following history. It is well known that comparatively little "simple silicosis" is detected in the ordinary Native mine labourer, a fact that is more likely to be related to the duration and discontinuous nature of his underground service than to any special immunity. Several years ago the Miners' Phthisis Medical Bureau decided to hold a special examination of mine boys *known to be* of over five years' continuous service. While there are large numbers of Natives on re-engagements who will be of over five years' total service, those of whom one can be sure are those who have been not less than five years continuously on one mine. With the co-operation of the managements, the Bureau secured a random sample of just over a thousand of such boys. The investigation showed a silicosis rate of about the same order as that met with in European miners, but nearly 5 per cent. of the boys examined were found to be suffering from tuberculosis, mostly tuberculo-silicosis and chronic. On the strength of this enquiry, one of the first acts of the Tuberculosis Research Committee was to arrange for a systematic examination of these long-service boys to be held every year. In the first examination, 1926–27,

the number of boys examined was 2,508 and " tuberculosis, all forms," and silicosis was detected to the extent of 3·8 per cent. in those examined. The next year's examination was on a larger scale ; 12,383 boys were examined and the tuberculosis return was 3·2 per cent. It will be noticed that these two examinations found tuberculosis in long-service boys to the extent of over 30 per 1,000 of those examined. One result has been a big reduction in the number of cases of this type appearing as " tuberculosis under the Act "—a pool has been drained (see Table II, col. (3), p. 354). The cases appearing in the annual returns summarized in Table III are either boys in whom tuberculosis has been detected or boys presenting claims for compensation. The high rate in the special examinations presents cases which would have turned up sooner or later in the ordinary course but have been concentrated into a brief period ; tuberculosis has been sought and not left to obtrude itself.

Two other sources of information remain to be considered :—The investigation into tuberculosis prevalence, 1916 to 1920, conducted by the Mine Medical Officers' Association (Table IV), and Dr. Loeser's study on the Crown Mines.

The mine medical officers' figures are in terms of duration of employment on the mine where the boys were working when the investigation was made, and no attempt was made at securing total employment figures. The total number of cases considered for the five years was 5,703, and 69 per cent. of these arose in boys with under one year's working history on their particular mine. This would, therefore, include both raw recruits with under one year's total service and re-engaged boys who had worked before.

Taking total engagement figures (see Table I), 53 per cent. of the cases arise in boys with not more than one year's total mining history.

The higher figure found when re-engaged boys are included suggests that boys can de-acclimatize as well as acclimatize, so that the re-engaged boy coming back after a period away from the mines runs more or less the same risk as the raw recruit during his first year. This is not actually the case, because the number of boys who have been not more than one year on their present engagement is more than double that of the number of boys with not more than one year's total mining history, so the high *number* of cases in boys in the first year of present engagement does not mean a correspondingly high *rate* of incidence as compared with boys of less than one year's total mining history. (See further consideration on p. 352.)

This question interested Dr. H. A. Loeser when medical officer on the Crown Mines, and he has been good enough to put his records at the disposal of the Committee.

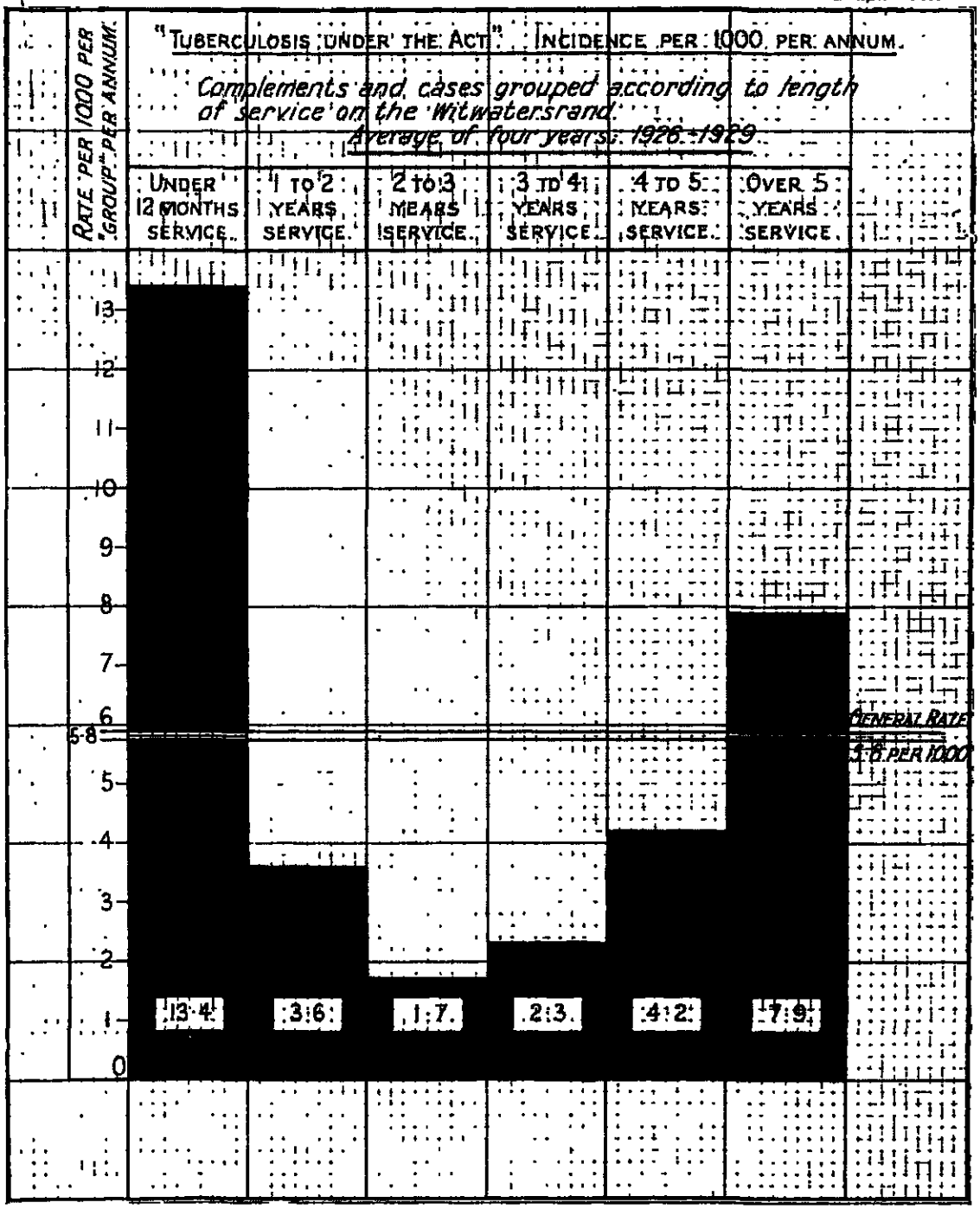
Dr. Loeser followed up over 1,000 cases of tuberculosis for the three years 1912–14 inclusive. In each case a record was made of the length of time the Native had been on his contract when tuberculosis was detected. The result was as follows, in round numbers :—25 per cent. within three months ; 55 per cent. within six months, and 78 per cent. within twelve months.

On summarizing some of the points brought out, it appears from the " tuberculosis under the Act " series that 53 per cent. of all the cases had had not more than one year's total employment; from the mine medical officers' series that 69 per cent. of all the cases had not been more than one year on present engagement; and from Dr. Loeser's series that 78 per cent. of all the cases had been not more than one year on present engagement. On turning to the other end, it is learnt from the " tuberculosis under the Act " series that over 13 per cent. of all the cases detected arose in boys of more than five years' service, while the special examinations showed rates of over 30 per 1,000 of those examined for boys of over five years' service, as compared with a general rate of about 7 per 1,000. The suggestion is that entering the mines, whether on first engagement or re-engagement, is to enter a danger zone for tuberculosis, and that staying on the mines for more than five years is to find oneself once more in a danger zone for tuberculosis. It is possible to get a little further by " marrying " the figures just discussed to the figures for estimated distribution of the labour force in terms of length of service as given in Graph 2 in the main Report (p. 119). The offspring of this "marriage" is given in Table V in so far as concerns the " tuberculosis under the Act " series, and again in Graph VIII. It will be seen that with a general rate of 5·8 per 1,000, the under twelve months group shows over 13 per 1,000, while the over five years group shows practically 8 per 1,000. The intermediate years are comparatively low. The average for the four years after the first year, taken together, is 353 cases of tuberculosis per annum in a complement of 123,113, or a rate of about 2·9 per 1,000 per annum. Since the rate of change of complement is about 100 per cent. per annum, one will not go far wrong in assuming that half the complement at any one time are in the first year of their present engagement. If this assumption be applied to the mine medical officers' series, we learn that over the five years 1916 to 1920 there were 3,930 cases, say 786 cases per annum, in boys in first year on present engagement. For that period the average complement was about 148,000, so that we arrive at 786 cases arising in a population of 74,000, or a rate of 10·6 per 1,000 per annum. For the same period there were, on the average, 355 cases per annum in boys who had been more than one year on present engagement, or a rate of 4·8 per 1,000 per annum. Turning back to the " tuberculosis under the Act " series, we find a rate of 3·5 per 1,000 in all boys of more than one year's total service.

One must admit that the data dealt with in this section are hardly such as " would yield a refined statistician intelligent pleasure," still, one does feel inclined to draw certain general conclusions.

The first year on the mine, whether on first engagement or re-engagement, is the great danger zone. The liability to contract tuberculosis is far greater on first engagement, however, than on re-engagement. As has been stated, the incidence of " tuberculosis, all forms," exceeds that of " tuberculosis under the Act " by from 25 per cent. to 30 per cent., and most of this excess falls on the first year, irrespective of first engagement or re-engagement.

Graph VIII


"TUBERCULOSIS UNDER THE ACT" INCIDENCE PER 1000 PER ANNUM.
Complements and cases grouped according to length of service on the Witwatersrand.
Average of four years: 1926-1929.
RATE PER 1000 PER GROUP PER ANNUM.
UNDER 12 MONTHS SERVICE.
1 TO 2 YEARS SERVICE.
2 TO 3 YEARS SERVICE.
3 TO 4 YEARS SERVICE.
4 TO 5 YEARS SERVICE.
OVER 5 YEARS SERVICE.
13
12
11
10
9
8
7
6
5·8
5
4
3
2
1
0
GENERAL RATE 5·8 PER 1000
13·4
3·6
1·7
2·3
4·2
7·9

Boys who run the gauntlet of the first year are in a good position for some time. In the "tuberculosis under the Act" series, the incidence from the end of the first year to the end of the fifth is under 3 per 1,000 per annum. For the decennial period 1901 to 1910 in England, the *mortality* from "tuberculosis, all forms," among males of from 20 to 40 years was nearly 2 per 1,000 per annum, and this means a prevalence rate of not less than 5 per 1,000 per annum. Even if we take the English figures for pulmonary tuberculosis as being more comparable with our "tuberculosis under the Act," we still get a death-rate of over 1·5 per 1,000 per annum.

After the close of the fifth year, the tuberculosis rate starts to rise as the baneful effects of duration of exposure to mining conditions overcome the beneficial effects of acclimatization to mining conditions.

The special examinations of old boys showed that there was a good deal of tuberculosis to be found if sought. Acute tuberculosis obtrudes itself, so one may assume that many of these cases were chronic. As is shown elsewhere (see Pathological Section of main Report), cases of chronic tuberculosis with lesions confined to the chest are practically always associated with more or less silicosis. Among mine Natives tuberculosis, in the absence of silicosis, appears to generalize at all ages. If a mine boy does get miners' phthisis (tuberculo-silicosis) he gets the same sort as does the European and gets no more of it than does the European either here or elsewhere. The silicotic element plays a large part in the rise of the tuberculosis rate after the close of the fifth year. It must be remembered that plenty of tuberculosis is found in old boys in the course of routine, quite apart from special examinations, and it is only the chronic cases that were picked out by the special examinations sooner than they would have forced themselves on notice if left to routine. Half the cases found by the special examinations were tuberculosis, such as would have been recognized at the same time in the ordinary course.

Of all boys working their first year on present engagement, about half will be raw boys and about half re-engagements. Since the rate of change of complement approximates to 100 per cent. per annum (see Table 13, p. 117 of main Report), these two groups together amount to about half the total complement of a mine at any one time.

There is a high rate for sickness in general for all boys in the early months of their first year on present engagement and to this extent they seem to "de-acclimatize" while away from mining. This de-acclimatization hardly applies to tuberculosis. About 65 per cent. of "tuberculosis, all forms," is now detected in boys working their first year on present engagement, giving a rate of about 10 per 1,000, but this group includes all raw boys whose rate is 13 to 14 per 1,000. If the re-engagements have the rate of 3 to 4 per 1,000 now usual for boys who have been more than one year on present engagement, the rate for first year on present engagement is accounted for without predicating any extra liability to effective infection by tuberculosis of those Natives who resume mining after an interval.

In so far as the gold-mining industry is concerned, the part played by duration of employment attains a peculiar significance when considered from the following standpoint.

The rate for simple tuberculosis, all forms, on the Native labour force is about 5 per 1,000 per annum, and the rate for simple tuberculosis, all forms, on the European labour force is about 2·5 per 1,000 per annum. The rate for tuberculosis, all forms, including tuberculo-silicosis and for silicosis on the Native labour force is 7 to 8 per 1,000 per annum, while the rate for tuberculosis, all forms, including tuberculo-silicosis and for silicosis on the European labour force is 28 per 1,000 per annum. In the one case, simple tuberculosis is the major risk; in the other case the dust-hazard is the major risk. In fact, as far as the European is concerned, *simple* tuberculosis is of negligible importance.

There is an explanation of this discrepancy. Of the 150,000 Natives employed underground at any one time, not more than 14,000 have been so employed for more than five years though, even for this group, the rate for tuberculosis, all forms, including tuberculo-silicosis and for silicosis, is only about 10 per 1,000. This is because their mean duration of employment does not exceed nine to ten years. If we turn to the Europeans, we find about 10,000 employed underground at any one time, and of these, 6,000 to 7,000 have been employed for more than five years, with a mean duration of employment of about fourteen years. It needs about thirteen years before the dust affects the general run of underground workers as opposed to a comparatively small group of men who are particularly susceptible. The mean duration of employment for the Native labour force is far short of the danger zone and only those who are particularly susceptible go down before the dust. The mean duration of employment for the European labour force is well into the danger zone.

If all dangerous trades with occupation maladies were run on the lines of the old British Army, with enlistment for a period of years as opposed to for working-life, one could reduce most occupation maladies to matters of no community importance. Enlistment would be permitted only for a period definitely short of the danger zone. Of course, any attempt to turn this idea into a working hypothesis lands one in a jungle of sociological difficulties. If you interfere with a man's liberty to the extent of limiting his period of enlistment, you incur some sort of obligation to enable him to maintain a decent standard of life after his discharge. It is impracticable to meet this contingency by the payment of a sufficiently large lump sum or by the provision of an adequate pension. To put it brutally, the man, from the community standpoint, is not worth it. There are plenty of reserves to fill gaps in the firing-line. It is of interest to learn that Russia, accepting this working hypothesis, has solved the problem—on paper.

So much for this section of our enquiry and in the words of the immortal Tony Weller, " Vether it's worth while goin' through so much to learn so little, as the charity boy said ven he got to the end of the alphabet, is a matter o' taste."

TABLE I.

NUMBER OF CASES OF "TUBERCULOSIS UNDER THE ACT" DETECTED PER ANNUM ARRANGED ACCORDING TO LENGTH OF SERVICE ON THE WITWATERSRAND.

(Figures supplied by the W.N.L.A.)

Year.	Number of Cases of under 12 Months' Service.	Number of Cases of 1 to 2 Years' Service.	Number of Cases of 2 to 3 Years' Service.	Number of Cases of 3 to 4 Years' Service.	Number of Cases of 4 to 5 Years' Service.	Number of Cases of over 5 Years' Service.	Complement.	Total Cases.	Rate per 1,000 per Annum.
1926	568	179	68	65	68	251	176,035	1,199	6 8
1927	564	198	68	50	56	104	180,533	1,040	5·8
1928	536	176	64	50	47	128	190,473	1,001	5·2
1929	604	170	51	56	47	97	187,968	1,025	5·4
Totals ...	2,272	723	251	221	218	580		4,265	
Annual Average	568	181	63	55	54	145	183,752	1,066	5·8

TABLE II.

TUBERCULOSIS INCIDENCE, AUGUST, 1926, TO JULY, 1930.

Year.	"Reef Complement."	(1) Tuberculosis All Forms and Silicosis.	(2) Tuberculosis All Forms Only.	(3) Pulmonary Tuberculosis All Forms Only.	Rates per 1,000 per Annum.			Tuberculosis other than Pulmonary.	Rate per 1,000 per Annum.	Silicosis.	Rate per 1,000 per Annum.
					No. 1.	No. 2.	No. 3.				
1926–27	183,154	1,596	1,395	1,159	8·7	7 6	6·3	236	1·3	201	1·1
1927–28	193,086	1,617	1,455	1,099	8·4	7·5	5·7	356	1·8	162	0·8
1928–29	193,493	1,445	1,279	852	7·5	6·6	4·4	327	1·7	166	0·8
1929–30	194,084	1,401	1,282	904	7·2	6·6	4·6	378	1·9	119	0·6

TABLE III.

TUBERCULOSIS RATES FOR NATIVE MINE BOYS, 1922 TO 1929.

Date.	Rate per 1,000 Tuberculosis, All Forms.	Rate per 1,000 "Tuberculosis" under the Act."	Average Complement.
1922	10·25	5·2	154,814
1923	8·20	4·7	170,259
1924	9·3	5·0	171,508
1925	9·25	5·1	168,794
1926	10·1	6·8	176,035
1927	7·75	5·7	180,533
1928	7·75	5·2	190,473
1929	6·7	5·4	187,968

TABLE IV.

SUMMARY OF INVESTIGATION BY MINE MEDICAL OFFICERS' ASSOCIATION INTO TUBERCULOSIS ON THE WITWATERSRAND GOLD MINES DURING THE YEARS 1916 TO 1920, INCLUSIVE.

TUBERCULOSIS, ALL FORMS, AND SILICOSIS.

Repatriations and Deaths.

Total number of cases detected: 6,037, or 1,207 per annum.
Average complement for this period: 148,163.
Rate per 1,000 per annum: 8·1.

Data available for 5,703 cases show following distribution, in terms of duration of employment. 25 shifts to the month:—

Worked 25 Shifts	303
Worked 50 Shifts	429
Worked 75 Shifts	483
Worked 150 Shifts	1,355
Worked 300 Shifts	1,360
Over 300 Shifts	1,773
Total	5,703

3,930 cases detected in the course of their first year on present contract.
Average, 786 cases per annum.
1,773 cases in subsequent years.
Average, 355 cases per annum.

TABLE V.

NUMBER OF CASES OF "TUBERCULOSIS UNDER THE ACT" DETECTED PER ANNUM. AVERAGE FOR THE FOUR YEARS 1926–1929.

Cases recorded according to Length of Service on the Witwatersrand with Estimated corresponding Complements.

Length of Service.	Proportion of Complement with this Service.	Number of Cases of Tuberculosis.	Rate per 1,000 per annum.
Under 12 months ...	42,263 (23%)	568	13·4
1 to 2 years	49,613 (27%)	181	3·6
2 to 3 years	36,750 (20%)	63	1·7
3 to 4 years	23,888 (13%)	55	2·3
4 to 5 years	12,862 (7%)	54	4·2
Over 5 years	18,375 (10%)	145	7·9
Totals	*183,751*	*1,066*	*5·8*

APPENDIX NO. 6.

BACTERIOLOGICAL INVESTIGATIONS IN CONNEXION WITH TUBERCULOSIS AMONG SOUTH AFRICAN NATIVES.

BY J. H. HARVEY PIRIE.

1. TYPE OF TUBERCLE BACILLI ASSOCIATED WITH TUBERCULOSIS AMONG SOUTH AFRICAN NATIVES.

In this investigation no general discussion of types and sub-types of tubercle bacilli is attempted, the position outlined by Cobbett[87] being accepted. This writer, although recognizing that some investigators of wide experience, *e.g.*, Rabinowitsch, do not hold the types to be so sharply defined or so distinct from one another as do most persons, concludes that the three types—human, bovine and avian—do really exist, in the main clear and distinct. Anomalous strains *are the exception* and, whatever we may think of them, they cannot upset the broad distinctions which separate the great majority of tubercle bacilli into these three types.

The investigation has been conducted mainly among mine Natives. Its scope was deliberately widened in a few instances (12 cases out of the 100), so as to include cases of tuberculosis of bone, joints and glands—types not commonly encountered amongst the mine Natives but by no means unknown in other sections of the Native community.

Herewith follows a summary of the sources of the materials from which the cultures were obtained :—

Sputum.—22 cases. 19 of these were mine Natives' sputa positive for tubercle bacilli, selected at random. 1 was from a mine Native with tuberculous cervical glands. 2 were sent by Dr. Allan from the Transkei from Natives who had previously worked on the mines.

Lungs.—13 cases. Post-mortem material ; all mine Natives.

Tracheo-bronchial Glands.—13 cases. All mine Natives except 1, which was a Native girl *aet.* one year and nine months, dying from tuberculous meningitis. The only other tuberculous focus was one caseous tracheo-bronchial gland. Of the 12 mine cases, 7 had no obvious pulmonary lesions. In 5 of the 7 the tubercle was limited to the tracheo-bronchial glands ; in 1 these glands and other gland groups were affected ; in 1 there was a tuberculous pleurisy.

In all of these 48 cases infection may be presumed to have been by the respiratory route and pulmonary tuberculosis is universally admitted to be almost entirely due to the human type of bacilli, the finding of bovine bacilli in pulmonary tuberculosis being exceedingly rare.

The other 52 cases were therefore selected so as to offer a greater chance of finding bovine types. In other words, material was taken for culture from lesions other than pulmonary. It must be admitted, however, that in many of these, although the main brunt of the disease was extra-pulmonary, the source of spread in many of them was obviously from the tracheo-bronchial glands. Abdominal tuberculosis, for instance, is commonly regarded as being frequent among mine Natives. So it is, if one only regards the site of the main incidence of the disease, but most of these cases are only secondarily abdominal, the original route of infection being respiratory and the initial lesion being in the tracheo-bronchial glands. It is noted below in how many instances the primary infection appeared to have been by the abdominal route.

Heart and Pericardium.—3 cases, all mine Natives. All 3 had older foci in the tracheo-bronchial glands.

Spleen.—12 cases, all mine Natives. Only 2 had no obvious pulmonary or tracheo-bronchial glandular lesions which might have been the primary lesions. In 1 the lesions were confined to the spleen, liver and abdominal glands, and in the other to the spleen and abdominal glands.

Liver.—1 case, a mine Native. There were caseous foci in the epididymis, seminal vesicles, retro-peritoneal glands and liver, but none in the thorax.

Abdominal Glands.—15 cases, all mine Natives. 1 case had tuberculous caries of the lumbar vertebrae, but there was caseation not only in the abdominal glands but also in cervical and thoracic glands. 1 case showed several large, partially calcified mesenteric glands with no other lesions. 1 had caseous abdominal glands and tuberculous peritonitis, but no tuberculosis beyond the abdomen. 2 had caseous abdominal glands and caseous nodules in the spleen, with a terminal general miliary spread but with no obvious older lesions outside the abdomen. The other 10, although showing mainly abdominal lesions, might have been cases of spread of infection from pulmonary or tracheo-bronchial glandular lesions.

Omentum or Peritoneum.—12 cases, all cases of tuberculous peritonitis. 10 of them mine Natives, the other 2 cases in Transkei Natives; material sent by Dr. Allan. In none of these cases was the tuberculosis entirely limited to the abdomen.

Epididymis.—1 case, surgically removed material sent by Dr. Macvicar, Lovedale.

Bone or Joint.—5 cases, none of them being mine Natives. In 2 cases the material was obtained by excision from the knee-joint; in 1 it came from a hip-joint; in 1 from a psoas abscess and in 1 (post-mortem) from a sacro-iliac synchondrosis in a Zulu girl *aet.* 17. In the last case there was also caseation in the pelvic organs and abdominal retro-peritoneal glands, with a terminal general miliary spread.

It will be noted that in only 8 out of the 52 later cases was it possible to say definitely that there were no old lesions in the thorax, or, in other words, that they were cases of infection by the abdominal route. In most of the others, although the lesions were predominatingly extra-thoracic, the source of spread was in all probability thoracic.

Technique.

The primary cultures were all obtained by following the method described by Petroff.[88] Although this method was recommended by him for isolating tubercle bacilli from sputum or faeces, it has proved to be satisfactory also when dealing with tissues. Completely caseous material was simply emulsified with the soda solution employed prior to planting on the media. More solid tissue was firstly cut up into small pieces with scissors and then ground in a small agate mortar, with or without sterile sand, as seemed desirable.

Actually, these 100 strains of tubercle bacilli were obtained from 166 attempts at cultivation. The 66 negatives may be accounted for in some instances because the material was not tuberculous. In others, the tubercle bacilli, although present, were probably not viable, *e.g.*, some cases of old, extremely calcified glands; also, probably, some cases in which several days had elapsed between the time of the death of the patient and the receipt of the material from which the cultivation was attempted. The largest number of failures, however, was probably due to spoiling of the cultures by the growth of moulds or other bacteria. It should be remembered that most of the material was obtained post-mortem and not under ideal conditions, and despite the supposed sterilization of the material by passage through soda, and the inhibitory action of the gentian violet in the media, contaminations were still rather common. Moulds and chromogenic bacteria which liquefied the culture media were the commonest types.

Fewer failures might have been recorded if systematic inoculation of guinea-pigs had been practised, the primary cultures being then obtained from the guinea-pigs, but the sacrifice of so many animals was not desirable at the time.

As a general rule, four culture tubes were inseminated from each specimen, two of Petroff's medium with glycerine, and two without glycerine.

From the primary culture all stock cultures were kept on non-glycerinated Petroff medium.

Each strain was grown for purposes of comparison in the first or second generation of sub-culture on glycerinated and on non-glycerinated Petroff medium. Also, at the same time, each strain was planted out on glycerine agar and glycerine veal-broth potato.

For comparison with the strains obtained from human sources, material was also obtained from the Johannesburg Municipal Abattoir, and I have to thank Col. Irvine-Smith, Director of the Abattoir, and Mr. Kirkpatrick, M.R.C.V.S., his assistant, for supplying me with this material. Specimens were received from 7 cattle and 8 pigs. These were treated in exactly the same way as the human material and growths of tubercle bacilli were obtained from 3 cattle and 4 pigs.

Description of Cultures.—This can be stated very briefly. Every one of the 100 obtained from human sources was of a luxuriant type of growth (eugonic) and was, in addition, glycerophilic, *i.e.*, grew even more luxuriantly on egg medium with glycerine than on egg medium without glycerine. They also grew luxuriantly on glycerine agar and on glycerinated potato.

They were not all perfectly equally eugonic in character, but it was not possible to arrange them in anything like a series according to luxuriousness—they were too nearly alike for that. Four cultures which seemed to be definitely less eugonic than the majority were submitted for an opinion to Dr. S. Griffith. He reported upon them as "typical eugonic human strains in cultural characteristics." If the least luxurious of the lot were so regarded by an expert on tubercle cultures such as Dr. Griffith, little doubt need be felt as to the eugonic character of the others.

Of the cultures obtained from animal sources, all three from cattle were of characteristic dysgonic type. From the pigs, one was typically dysgonic, the other three eugonic. One of these three was rather less eugonic than the others and was submitted to Dr. S. Griffith along with the four from human sources regarding which there was an element of doubt, but he reported upon this one as also being typically eugonic in cultural characters.

It may be mentioned here that many pigs in the vicinity of Johannesburg are fed largely upon refuse food material obtained from the mine compounds, so that contamination of their food with human tubercle bacilli is not unlikely to occur.

Biological Test of Cultures.

Eugonic and dysgonic cultural types can in the main be regarded as synonymous with human and bovine types, but there are some exceptions to this general statement.

Eugonic virulents have been described, *i.e.*, cultures combining the free growth on artificial media of the human type with the wide range of virulence of the bovine type, but according to Cobbett (*loc. cit.*) these have often been proved to be mixtures. In the other direction, there are some which combine the dysgonic growth of the bovine type with the limited range of virulence of the human type (a class which might be called the *dysgonic human* type), and some others which resemble the human and bovine types except that their virulence is not so high.

In view of the possibility of atypical strains being present in this series, rabbit inoculation was carried out with all the strains from cattle or pigs, with all the doubtful strains, and with the first 50 strains from human sources irrespective of any doubt as to their eugonic character.

The method employed was that described by Fraser[89] of inoculating the bacilli (primary cultures or first sub-cultures were always employed) into the knee-joint. This method has the advantage of giving within three weeks a clear-cut distinction in the degree of the local reaction within the joint. With the human type of bacillus the local reaction is slight, often practically nil, and at most a chronic synovial thickening. There is no stiffening of the joint, no pain and, moreover, the animal does not lose condition and there is seldom any spread of the disease beyond the synovia. With the bovine type there is an acute synovial tubercle, with caseous debris in the joint cavity and erosion of the articular cartilages. The joint becomes swollen, stiff and painful; there is a progressive loss of weight and finally a more or less generalized spread of the disease occurs with a fatal issue.

This differentiation was found to hold good for all the strains tested. With the dysgonic strains (three cattle strains and one pig strain) disorganization of the joint and a generalized spread occurred in all four cases. With the other three pig strains and all the strains from human sources synovial thickening was the most that occurred within the joint. In a few cases there were small caseous abscesses formed outside the joint, probably from leakage of bacilli into the subcutaneous tissues when introducing or withdrawing the needle, but in no case was there loss of weight or condition, or generalized spread of the infection.

With the second 50 strains from human sources, all typically eugonic culturally, rabbit inoculation was not carried out. It may be held, therefore, that it is not fully proven that they were of human type. This must be admitted, but, in view of Cobbett's dictum that atypical strains are rare and that in the case of the *eugonic virulents* many have been shown to be mixtures, it is improbable that many were other than they appeared (from cultural considerations) to be, *i.e.*, of typical eugonic human type.

Calmette's Bile Medium for differentiating Human and Bovine Types.

Calmette[14] describes a method of distinguishing between human and bovine types by planting them upon potato cooked in 5 per cent. glycerine bile and leaving them to grow in the presence of an excess of biliary fluid. According as one uses human or bovine bile, so he says, only the human or bovine bacillus can be grown on the medium.

This method was apparently first described by Calmette and Guerin in 1908, but it does not seem to be mentioned in any standard text-books of bacteriology, nor can I find any reference to its employment by others. Whether the method has been overlooked or it has been tried and found wanting without the failure having been recorded, I cannot say.

Calmette (*loc. cit.*, p. 44) describes the growth on such bile-treated potato as being very rapid and quite different in appearance from that on ordinary glycerine potato. By the end of ten days the whole surface becomes covered with a thin, creamy, greenish-grey layer of growth which thickens little by little to reach a maximum at the end of 45 days. At that time the potato is covered with a uniform glossy coating, of a light buff colour and resembling an old culture of glanders bacilli. Elsewhere (*loc. cit.*, p. 287) he says: "Bacilli of human type develop only with great difficulty and very sluggishly in the presence of ox bile, whereas they develop readily in the presence of human bile. Inversely, the bovine bacillus grows quickly and abundantly on potato with ox bile, while culture is very difficult on media with human bile."

This method was tried, but I can only record a complete failure to distinguish between the two types of bacilli by means of it. The instructions given for preparing the bile potato were strictly followed, and it was tried three times with three different lots of human bile and three different lots of ox bile. All the four bovine strains and 16 human strains were planted on these ox bile and human bile potato media, but in no single instance was a luxurious growth obtained. Slight growths of human type bacilli were obtained on both human bile and ox bile potato and *vice versa*, but no differentiation between the two types was possible.

I can only record, therefore, that in my hands this method did not prove to be of value in distinguishing between the two types of bacilli.

Acid Fast Bacilli other than Tubercle Bacilli.

During the course of this investigation a growth was obtained in four instances of acid fast organisms which proved not to be tubercle bacilli.

(1) Mine Native with 6 years' mining service.—Cultures made from a grossly caseous spleen showing numerous acid fast organisms probably tubercle bacilli, in smears. No growth of tubercle bacilli was obtained, probably because the particular batch of media employed was unsatisfactory (this was discovered later). On one of the four tubes inseminated, two colonies of acid fast organisms grew.

(2) Mine Native with eight months' mining service.—Cultures also from spleen, which was of the acute tuberculous "monkey" type. No growth of tubercle bacilli but one colony of an acid fast organism.

(3) New arrival on mines who, from the condition of his lungs, had obviously never had previous mining service. Tuberculin reaction positive. Death a few days after arrival from an acute confluent broncho-pneumonia. At the post-mortem examination a small bunch of much calcified glands was found in the mesentery opposite the uppermost loop of the jejeunum. This was the only focus which looked like an old tuberculous lesion. Smears of the ground-up glands showed no acid fast organisms. Inoculation of a guinea-pig with the calcified material produced no tubercle. Cultures yielded no growth of tubercle bacilli but two colonies of an acid fast organism appeared, one on a glycerinated, the other on a non-glycerinated tube.

(4) Mine Native with one year's service.—Death from primary cancer of the liver. Several of the retro-peritoneal glands presented an appearance to the naked eye which might have been due either to tuberculosis or to metastases from the liver growth. Actually, on section, they proved to be due to the latter condition. Cultures, however, had been made and in one tube a single acid fast colony made its appearance.

It should be noted that in three of the four cases the subjects from whom the material was obtained had worked on the mines, the fourth case had not. Also, that in each case the growths were very scanty, never more than two colonies.

In all four cases the growths were similar in appearance. The primary colonies were small, hemispherical, smooth, slightly moist and of a faint yellowish tint. They appeared sooner and grew more rapidly than is the case with primary tubercle cultures. In subcultures streaked from the original colonies, growth took the form of a smooth, moist layer of a considerably deeper yellow colour, looking, after a week or two's growth, like a smear of yellow paint on the surface of the medium. Growth also occurred to some extent into the medium as well as on the surface. It was found that growth took place almost as well at room temperature as at 37°C. The type of growth was more like that of avian tubercle bacilli than that of human or bovine types. Only in the oldest culture, after about a dozen transplants, does the surface growth begin to show some wrinkling suggestive of the human type.

Stained films show the individual organisms to be mostly much shorter than typical human tubercle bacilli, but some beading is to be observed.

All four cultures were tested on rabbits, guinea-pigs and fowls by subcutaneous inoculation, but in no instance was anything like tuberculous disease produced.

It was concluded that these cultures were not tubercle bacilli, but they were submitted to Dr. S. Griffith for a further opinion He examined them culturally and, in the case of one strain, also by rabbit, guinea-pig and fowl inoculation One guinea-pig, after subcutaneous inoculation of 50mg. of bacilli, showed an abscess in the abdominal wall, the pus of which contained numerous acid fast organisms This was the only animal which developed any lesion. Dr. Griffith gives it as his opinion that these organisms are acid-fast saprophytes which somehow or other have gained access to the body.

As regards their source, the possibility of mine water occurred to me when I remembered that I had heard Dr. Orenstein state that he had given up a hunt for tubercle bacilli in mine soils, etc., because of the common presence therein of other acid-fast organisms. To test this hypothesis, Dr. Orenstein kindly sent me six samples of water and mud from various mines. From three of these, six growths of acid-fast organisms similar to those described were obtained. Mine water or soil would, therefore, appear to be a likely source from which these

organisms gain access to the human body, although some other source would have to be postulated for the case which died before actual mine service had started and the organisms were recovered from an old lesion in the mesenteric glands.

2. Examination of Samples of Mine Dust, Soil and Air, and of Specimens of Sputum collected Underground for Tubercle Bacilli.

The object in view in making these examinations is discussed in Chapter IV of the main Report (p. 150). Briefly stated, it was to see whether direct evidence could be obtained that the mines themselves were infective.

(a) *Mine Dust and Soil.*

For this purpose, samples of mine dust, soil, mud, etc., were collected in various situations. The situations picked were such as seemed likely to offer a fair chance of tubercle bacilli being present in the material selected, *e.g.*, dust or moist scrapings from the floor, walls or roof of waiting-places, where Natives congregated for some time and where coughing or spitting was likely to take place. Drives, ladderways, the neighbourhood of working stopes, etc., were also investigated, rock surfaces on which air currents impinged being specially selected as likely to harbour air-borne germs. Actual deposits of sputum were avoided in this investigation, as these were the subject of a separate study later. After collection the samples were taken to the South African Institute for Medical Research and their subsequent treatment was carried out on the same day. The situations where the samples were obtained are given in the table at the end of this appendix.

The samples were treated as if they were specimens of sputum being investigated by the method of Petroff (*loc. cit.*). Each sample was first of all well shaken up with a small quantity of sterile water; the suspension thus obtained then had added to it an equal quantity of 3 per cent. NaOH, and was placed in the incubator at 37°C. for half an hour. After neutralization with HCl from 0·5 to 1c.c. of the suspension was injected subcutaneously into a guinea-pig.

As heavy infections were not expected, the guinea-pigs were kept six months before being killed for examination. 18 died before their six months was up; several of them within a few days of inoculation from septic infections, the others at various longer periods. None of the 18 showed any evidence of tuberculous infection.

From the first 40 or so samples, cultures were also planted on Petroff's medium in the hope that tubercle bacilli might be grown, but this practice was given up, as it was found that the tubes invariably became overgrown by moulds. Apparently, the Petroff technique, although highly satisfactory for eliminating most bacteria other than acid fast bacilli, is not sufficient to kill off the moulds, which seemed to be present in all such mine material as was being investigated.

Smears of the suspensions used for inoculating the guinea-pigs were also subjected to direct examination for acid-fast organisms and although no prolonged or exhaustive search was made, such bacilli were found in 48 of the 100 samples examined. These acid-fast bacilli varied considerably in number from one sample to another; sometimes only one or two were found, whilst in other samples they might be abundant, and in that case they were usually aggregated into clumps. In one sample (No. 63) they were particularly abundant. It had been noted at the time of collection that cockroaches were numerous near the site of collection and it was further observed that what appeared to be cockroach excrement was present in the sample. With the object of seeing whether these organisms flourished in the intestinal tract of the cockroach, a supply of these insects was later obtained from the same vicinity and their intestinal contents (Sample No. 66a) examined. Acid-fast organisms were not found in them, however, so it was concluded that they merely flourished well in the soil contaminated with the excrement. The acid-fast bacilli seen in the various samples varied not only in numbers but also in size and appearance. Some were short and stout, others long and thin; in some there was no obvious beading, whereas in others beading was very distinct. If was felt that it was quite impossible on morphological grounds alone to distinguish between tubercle bacilli and the non-pathogenic acid fast bacilli already referred to in the first part of this report.

Of the 82 guinea-pigs which survived their inoculations for six months and were then killed and examined, not one showed any trace of tuberculosis, either local or general.

It is realized that great caution has to be exercised in drawing conclusions from negative findings, and particularly so in this instance, when it is remembered that the samples with which it was possible to deal represent such very minute portions of the mines.

Seeing, however, that most of the samples were taken from picked spots where tubercle bacilli might have been expected to have lodged, it seems not unreasonable to draw the following deductions :—

(1) That the soil, mud and dust of the mines cannot be regarded as highly infective.

(2) That the tubercle bacilli (which must unquestionably frequently be expectorated underground), if they lodge in dry dust, become non-infective there, just as they have been shown to become in other similar situations (see, *e.g.*, Calmette, *loc. cit.*, p. 143), or they are immobilized or destroyed by the frequent limewashing which is carried out in the vicinity of all waiting-places.

(3) That tubercle bacilli lodging in moist places are either diluted in numbers to such an extent as to be harmless, or are carried away and lost.

(*b*) *Mine Air*

The ordinary methods of examining air for bacteria apply only to such organisms as will grow on gelatin or agar, so that in order to obtain possible tubercle bacilli from the air, a special technique had to be devised.

The method adopted was one which made use of the sugar-tube commonly employed on the mines of the Rand for dust estimation. These tubes have been shown to trap efficiently dust particles of the same order of size as tubercle bacilli. A description of these tubes of the "Lauf" pattern is given in the General Report of The Miners' Phthisis Prevention Committee, Appendix No. 3, p. 66. The tubes were sterilized and filled with separately sterilized sugar before use.

From 400 to 600 litres of air were drawn through the tubes on each occasion, the suction being obtained by an electrically driven apparatus of the type of a vacuum cleaner. The air volumes were not measured precisely because quantitative estimations of tubercle bacilli were out of the question, but a very close approximation could be obtained from a previous knowledge of the capacity of the apparatus when being used for accurately measured volumes.

On transference to the laboratory, the sugar-tube (the contents of which on each occasion showed more or less obvious discolouration from dust) was washed out with about 250c.c. of sterile distilled water and the sugary solution obtained was subjected to lengthy centrifugalization in a high-speed centrifuge. From each of the tubes in which the sugar solution was centrifuged, the deposit and the bottom few drops of liquid were taken, mixed together, and treated as described above for soil samples for injection into a guinea-pig

Direct examination of some of the deposit from the tubes for acid-fast bacilli was also made and in 3 out of the 14 specimens acid-fast bacilli were found.

Even if these acid-fast bacilli were only the non-pathogenic bacilli of the mine soil and water, their being found in the air is of some significance, for obviously, if they can be floating in the mine air, so can tubercle bacilli which happen to be expectorated in the mine.

Some attempts at cultures on Petroff's medium were also made with these air samples, but they were foiled by overgrowth of moulds, just as in the case of the soil samples.

The air samples were mostly taken at or near waiting places either whilst the Natives were actually present waiting to go off shift or just after they had gone. The situations where they were taken are given in the list at the end of the Report.

Four of the specimens were taken in skips when the skips were packed with Natives going off shift. On these occasions an apparatus of a similar type but on a somewhat smaller scale was employed. The main difference was that the suction was obtained as in the carburettor

of a motor car by release of oxygen from a cylinder; this had to be employed because electric power was not available in the travelling skips.

The collection of these specimens necessitated from six to ten trips up and down in order to give time to get a sufficiently large volume of air through the sugar-tube.

The Natives coming off shift pack into the up-going skips as tightly as they can and the skips are regarded by some mine medical officers as a situation where the inhalation of tubercle bacilli might very readily take place.

It may be noted that one of the three samples in which acid-fast bacilli were observed in the deposit from the sugar-tube was a skip sample.

Of the 14 guinea-pigs treated, 1 died a month after inoculation; the other 13 lived out their six months. None of the 14 showed any evidence of tuberculosis, local or general.

It would, of course, have only been the sheerest bit of luck if tubercle bacilli had been recovered from any of these air samples, and the failure to find any cannot be regarded as of any significance.

That the dust from the air in 3 of the 14 samples contained acid-fast organisms is not, however, without significance. for it indicates that, in addition to the possibility of tubercle bacilli being sprayed directly into the air by coughing, bacilli deposited on the soil or dust in sputum might again find their way into the atmosphere and so be inhaled. If their return to the air took place soon after their original deposition, they might quite well be infective.

(c) *Specimens of Sputum from Underground Workings.*

In Appendix No. 10 to the General Report of the Miners' Phthisis Prevention Committee, Dr. Watkins-Pitchford gives his results of the examination of 370 specimens of sputa; 250 collected from underground workings and 120 from surface premises.

He reports 38 of the underground specimens (15·2 per cent.) as being tuberculous, and 3 of the surface specimens (2·5 per cent.).

He accounts for the greater proportion amongst the underground specimens as follows: "I think the physical characters of tuberculous sputum account very largely for the discrepancy; it is usually opaque, creamy-white in colour, and disintegrates very slowly when immersed in water; non-tuberculous sputum, on the other hand, is usually translucent, inconspicuous and diffuses into water much more readily. For these reasons, tuberculous sputum deposited in dark places is more visible in the light of the examiner's lamp than non-tuberculous, and it is, moreover, less likely to become disintegrated when deposited on the surface of wet rock."

It is possible that this explanation put forward by Dr. Watkins-Pitchford may account either in whole or in part for the difference between the two series, but in view of the fact that his examination of these sputa was merely a bacterioscopic one, another possible explanation must be considered, viz., that all the underground specimens supposed to be tuberculous were not really so, the acid-fast bacilli seen being merely contaminating non-pathogenic organisms from the mine soil.

From personal experience, I know that it is practically impossible to collect a specimen of sputum underground without at the same time gathering up a certain amount of soil, mud or dust with it, so that the possibility of the sputum as collected containing acid-fast organisms derived from the soil cannot be ignored.

It must be remembered, however, that underground conditions in 1912-13 and in 1929 were probably not strictly comparable. It is quite likely that in the earlier period a higher percentage of truly tuberculous sputa would have been obtainable, but this cannot now be definitely ascertained, and we can only criticize the figure given by Dr. Watkins-Pitchford on the ground mentioned.

That tuberculous sputa are still expectorated underground may be taken for granted, and, in view of the possible error in the 1912-13 figures and of the long time which had elapsed since the observations were made, it seemed desirable to the Committee that another investigation of underground sputa should be made, the diagnosis of " tuberculous " this time only to be accepted after biological confirmation.

Unfortunately, the decision to have this examination made was only arrived at very late in the day by the Committee, and, six months having to be allowed for the guinea-pigs to live after inoculation, very little time was available for the tests without unduly hanging up the publication of the Report. Consequently, only 33 specimens have been examined, this being the most that could be done in the time available.

The mines where the specimens were obtained are recorded in the table at the end of this Report. As the exact localities in the mines where they were obtained were merely of fugitive interest, they are not specified.

Of the 33 specimens, direct observation of smears showed acid-fast organisms in 7 (20 per cent.).

5 of the 33 guinea-pigs inoculated died soon after inoculation, 1 of the 5 being an animal whose inoculum had shown acid-fast organisms. The test in these 5 cases cannot be regarded, therefore, as satisfactory. In the other 28 the guinea-pigs lived the full six months before being killed and examined.

1 guinea-pig (S11) developed a typical local tuberculosis in the gland corresponding to the site of inoculation (caseation, acid-fast bacilli and characteristic histology), but without generalization. The others showed no evidence, local or general. In the 1 positive case, direct examination of the sputum had not shown any acid-fast organisms.

Although acid-fast bacilli were found in 7 of these 33 sputa, conclusive proof of the presence of tubercle bacilli was, therefore, only obtained in 1.

From this investigation it must be inferred that the figures given by Dr. Watkins-Pitchford in 1916 should only be accepted with reservation.

Herewith follows a list of the situations where the various samples of dust, soil, air and sputum were collected.

LIST OF MINES AND OF SITUATIONS IN THESE MINES WHERE SAMPLES WERE COLLECTED FOR EXAMINATION FOR TUBERCLE BACILLI.

No.	Mine.	Situation in the Mine.	Nature of Material.
1	Village Deep	30. Ventilation shaft	Dust on floor.
2	Do.	30. E. drive	Scrapings from wall.
3	Do.	30. Main cross-cut, roof	Scrapings from timbers.
4	Do.	32. Main station	Dust from wall.
5	Do.	Do.	Do.
6	Do.	33. W.1 near working face	Scrapings from props and timbering.
7	Modder Deep	Waiting-place. Foot of vertical shaft	Wall dust.
8	Do.	Main E. waiting-place	Do.
9	Do.	Main incline, about midway along	Mud from walls.
10	Do.	Main W. waiting-place	Do.
11	Do.	Old waiting-place	Dust from walls
12	Do.	Main drive	Scrapings from props and timbering.
13	Consolidated Main Reef	20. Waiting-place, Main Leader drive	Scrapings from walls.
14	Do.	20. Mouth of old drive connecting two shafts	Do.
15	Do.	Near top of inclined shaft	Do.
16	Do.	35. W. drive, stope near the working-place	Dust from floor.
17	Do.	Near the top of same stope	Moist soil from floor.
18	Do.	28. Drive	Scrapings from roof timbers.
19	City Deep, No. 2 Shaft	18. W.3 working-place	Mud from floor.
20	Do.	18. W.3. Further from the working-place.	Do.
21	Do.	18. W.3 central stope, just above working-place	Do.
22	Do.	Do.	Do.
23	Do.	18. Station	Do.
24	Do.	Station, foot of vertical	Do.
25	Crown Mines, No. 5 Shaft	26, 15/16. Reclamation stope	Scrapings from hanging-wall.
26	Do.	Do.	Scrapings from floor.
27	Do.	Do.	Mud from floor.
28	Do.	19. Waiting-place, top of 2nd vertical	Scrapings, floor and walls.

No.	Mine.	Situation in the Mine.	Nature of Material.
29	Crown Mines, No. 5 Shaft	19. Waiting-place, foot of 1st vertical	Scrapings, floors and walls
30	Do.	19. Travelling-way between the two verticals	Do.
31	Govt. G.M. Areas, No. 4 Shaft	25. Main cross-cut S.	Scrapings from walls.
32	Do.	25. Stope E.1	Dust from supporting pillars.
33	Do.	26. Cross-cut E.3	Dust from walls and floors.
34	Do.	27. E.3 stope	Do.
35	Do.	24. W. haulage, waiting-place	Do.
36	Do.	26. S. cross-cut, waiting-place	Do.
37	Modder East, No. 2 Shaft	11. Cross-cut W. A mule haulage-way	Scrapings from walls.
38	Do.	11/6 stope. Original winze	Do.
39	Do.	13/5A. A main upcast air-way	Dust from walls.
40	Do.	13. 4S. Old stope near main haulage-way	Scrapings from a hanging.
41	Do.	11. Station waiting-place	Scrapings from wall.
42	Do.	Waiting-place, S. drive	Dust from walls.
43	W. Rand Cons. W. Shaft	16. Main station	Do.
44	Do.	18. Stope near original winze	Scrapings from pack and hanging
45	Do.	18. Junction of stope and drive	Scrapings from walls and timbering
46	Do.	20. Station	Wall scrapings.
47	Do.	27. Station.	Do.
48	Do.	Do.	Do.
49	Van Ryn Deep, W. Shaft	Main station, foot of vertical	Do.
50	Do.	10/3. Waiting-place on drive	Do.
51	Do.	11. E.5. Waiting-place in return airway	Do.
52	Do.	11. E.5. Stope	Dust from pillars and floor.
53	Do.	12. Drive at top of E.2 stope	Scrapings from wall.
54	Do.	11. Sub-shaft station	Do.
55	Rose Deep, No. 1 Shaft	Station waiting-place, foot of vertical	Do.
56	Do.	7. Station	Do.
57	Do.	7. E. drive	Scrapings from wall and hanging.
58	Do.	7. 20-foot high stope in line of upcast air	Scrapings from wall and floor.
59	Do.	7. W. Near main latrine	Scrapings from wall.
60	Do.	9. W. Travelling-way	Do.
61	Springs Mine, No. 2 Shaft	Foot of vertical. Waiting-place, W. haulage	Do.
62	Do.	Waiting-place, N. haulage	Dust from walls
63	Do.	Stope 8E, 1	Dust from pack and hanging.
64	Do.	Stope 7E, 41	Dust from packing.
65	Do.	Same stope, lower down	Scrapings from floor.
66	Do.	Around door of underground drill shop	Dust from walls.
66a	Do.	Same situation as No. 63	Cockroaches.

No.	Mine.	Situation in the Mine.	Nature of Material.
67	Langlaagte Ests., Hebbard Shaft	Foot of vertical station	Scrapings from walls.
68	Do.	26. W.3 stope	Dust from walls.
69	Do.	25/26. Top of stope opposite an upcast shaft	Scrapings from walls.
70	Do.	Do.	Do.
71	Do.	25/26 ladderway	Do.
72	Do.	27. Station	Dust from walls.
73	Randfontein Est. S. Vertical Shaft	29. Station	Scrapings from walls.
74	Do.	28. Waiting-place on main drive	Do.
75	Do.	27. Station. Dead-end used as waiting-place	Scrapings from wall and hanging.
76	Do.	27. Top of stope	Scrapings from floor.
77	Do.	27. Stope. Hanging on which upcast impinged	Scrapings.
78	Do.	Do.	Do.
79	Durban-Roodepoort Deep, Circular Shaft	17. Station	Dust from walls.
80	Do.	17. W. incline station	Scrapings from hanging.
81	Do.	17. Princess incline station	Do.
82	Do.	18/13 stope near station	Do.
83	Do.	18/6 stope. Top of S. Reef	Scrapings from timbering.
84	Do.	17. Main haulage-way	Scrapings from walls.
85	New Modder, I.C. Shaft	13. Station	Dust from walls.
86	Do.	15. E.1 stope near original winze	Dust from pack and hanging
87	Do.	16. E.2 stope	Scrapings from pack and hanging.
88	Do.	16. E.3 stope	Do.
89	Do.	16. Ladderway near station	Scrapings from wall.
90	Do.	14. Station	Do.
91	Nourse Mines, No. 3 Shaft	20. Station	Dust from walls.
92	Do.	22. E.3a stope, S. Reef	Scrapings from hanging.
93	Do.	25. E.11 stope, S. Reef. Upcast winze	Dust from walls and hanging.
94	Do.	27. E.1 S. Reef. Top of stope. Upcast	Scrapings from hanging.
95	Do.	27. Station, waiting-place	Dust from walls and floor.
96	Simmer & Jack, Rhodes Shaft	37. E. travelling-way	Scrapings from hanging.
97	Do.	37. E. stope	Do.
98	Do.	38. Station, waiting-place	Scrapings from walls and hanging.
99	Do.	38. Top of a stope. Ventilating manhole	Scrapings from hanging.
100	Do	35. Foot of vertical station	Dust from walls and piping.
A 1	Village Deep	Main cross-cut	Air.
A 2	New Modder	I.C. Shaft, 14 station	Do.
A 3	Durban Roodepoort Deep	Foot of vertical	Do.
A 4	City Deep	Main station, No. 4	Do.
A 5	Robinson Deep	———	Do.

No.	Mine.	Situation in the Mine.	Nature of Material.
A 6	Cons. Main Reef	———	Air
A 7	Langlaagte Ests.	Hebbard Shaft cross-cut between vertical and inclined	Do.
A 8	New State Areas	———	Do.
A 9	Springs	No. 2 Shaft	Do.
A10	Brakpan	No. 3 Shaft	Do.
A11	Crown Mines	No. 15 Shaft, in skip	Do.
A12	Nourse	No. 1 Shaft, in skip	Do.
A13	E.R.P.M.	Angelo W. Vertical Shaft, in skip	Do.
A14	Randfontein Ests.	S. Vertical Shaft, in skip	Do.
S 1–5	Crown Mines	Various	Sputum.
S 6–10	Modder B	Do.	Do.
S11–15	E.R.P.M.	Do.	Do.
S16–17	Durban Roodepoort Deep	Do.	Do.
S18–23	Cons. Main Reef	Do.	Do.
S24–27	Durban Roodepoort Deep	Do.	Do.
S28–33	Modder East	Do.	Do.

ACKNOWLEDGMENTS.

I have to express my indebtedness to Dr. S. Griffith, Cambridge, for examining the various cultures submitted to him, and for his permission to make use of his reports thereon.

In connexion with the collection of samples in the mines, I have to thank the Chamber of Mines for sanctioning the scheme and for making general arrangements for visiting the mines; numerous officials, too many to be mentioned in detail, of the various mines visited, for facilitating the collection in their particular mine; Messrs. McEwen and Buist, of the Dust Sampling Department of the Chamber of Mines for advice and assistance, and the latter in particular for his personal piloting round the mines and for the collection of the air samples; Dr. Orenstein for *designing the portable air-collecting apparatus used in the skips*; and Mr. Gordon, of the Rand Mines Sanitation Department, for collecting the specimens of sputum from underground workings.

SUMMARY.

(1) 100 strains of tubercle bacilli isolated from various types of cases of tuberculosis among South African Natives all proved to be of human type.

(2) Although about half the cultures were obtained from extra-thoracic lesions, in only 8 instances could it be asserted that the original infection had been by the abdominal route.

(3) Bovine tuberculosis is rare in South Africa, and a case of human infection with bovine type of bacilli has not yet been found.

(4) An attempt to differentiate between human and bovine types of tubercle bacilli by means of Calmette's bile media was unsuccessful.

(5) 4 cases are described of isolation of saprophytic acid-fast bacilli from human tissues.

(6) 100 samples of mine-dust and soil showed acid-fast bacilli present in 48, but biological tests failed to establish the presence of tubercle bacilli in any of them. The inference is drawn that the dust and soil of the mines cannot be regarded as highly infective.

(7) 14 samples of mine-air showed acid-fast bacilli present in 3 of them, but biological tests for tubercle bacilli were all negative. The presence of acid-fast bacilli in the air may be of significance as indicating that tubercle bacilli deposited in sputum might also again become suspended in the air and so be potentially infective.

(8) 33 samples of sputum collected underground showed acid fast bacilli present in 7, but biological tests for tubercle bacilli were only positive in 1 case. A diagnosis of "tuberculous" based on bacterioscopic examination alone is therefore not reliable in such conditions.

APPENDIX NO. 7.

PATHOLOGICAL ANATOMY OF TUBERCULOSIS AMONG NATIVE MINE LABOURERS ON THE WITWATERSRAND.

By J. H. Harvey Pirie and A. Mavrogordato.

This report is an analysis of 600 post-mortem examinations made during the years 1927, 1928 and the first half of 1929, on cases of tuberculosis, or on cases showing tuberculous lesions, amongst Native labourers on the gold mines of the Witwatersrand. The cases actually fall into three groups :—

(*a*) A group of 350, in which the autopsies were made by the writers. This group covers all the cases dying during the period mentioned in the Witwatersrand Native Labour Association's hospital, and includes, firstly, all cases of recruited labourers dying before they had been allotted to any mine—" new arrivals "—and, secondly, all cases diagnosed as tuberculous on the mines and sent to the W.N.L.A. for repatriation to their homes but dying before they could be repatriated.

(*b*) A group of 7 cases of mine accidents examined by the writers at the Johannesburg Government Mortuary. For permission to examine accident cases there we are indebted to the Chief Magistrate, Johannesburg, and to the District Surgeons—Drs. W. Girdwood, R. Ray and J. J. Levin—responsible for the pathological work at the mortuary. These 7 cases are all those showing any tuberculous lesions out of a considerable number of accident cases examined. They are included in this survey because they furnished some opportunity of seeing the disease in the process of development.

(*c*) A group of 243 cases dying on the mines and reported by various mine medical officers on the forms drawn up by the Tuberculosis Research Committee (Form 1, Pathological Section, see pp. 409–411).

The writers are responsible for the analysis only of the data recorded in the last group. It is probably inevitable in dealing with returns of this nature, made by a variety of individuals, that there should be some variation in standards and accuracy, especially as regards the smaller details. It has been possible, however, to have the reports checked in almost every case in so far as the lungs are concerned, by Dr. A. Sutherland Strachan, of the South African Institute for Medical Research, who is deputed by the Institute to conduct pathological investigations for the Miners' Phthisis Medical Bureau and, judging by the essential accuracy of the main mass of the reports on the lungs, it is felt that the reports as a whole may be taken as being sufficiently accurate and detailed to give a reliable picture. In one particular only

have we felt impelled to cut out a comparison of this group with our own group of 350, viz., with reference to the silicotic and tuberculous lesions of the various groups of lymphatic glands in the cases where the tuberculosis was associated with silicosis (see pp. 390 and 391).

It has seemed to be important to include the three groups of cases in one analysis as, by so doing, we cover every class of case of tuberculosis as it is encountered in the population under consideration, with the exception of one, viz., the Native repatriated with tuberculosis. The repatriates form a big proportion of the whole, as figures given below will show, but it has not been possible to obtain any pathological data about the anatomical evolution of the disease in the Native at his home after his return from the mines. Dr. Allan's clinical investigations in the Transkei, however, indicate that there is another side to the tuberculosis picture from that presented here. This report may suggest that tuberculosis here (apart from tuberculosis associated with silicosis) is largely "natural" tuberculosis. It is important to remember, therefore, that this is not necessarily the case and, indeed, is probably not the case.

The objects in view in making this report are :—

(1) To put on record the pathological anatomy of tuberculosis as seen in the Native mine labourers of the Witwatersrand, basing the record on a reasonably large amount of material. To any one accustomed to see many autopsies on Natives connected with the gold mines, tuberculosis is only too familiar, but there is surprisingly little available published accounts of such tuberculosis, and it was felt, therefore, that it would be of value to have this record made.

(2) To see how far pathological anatomy would go in helping to answer certain practical questions, such as the question of the portal of entry of the tubercle bacillus and the question of whether the mine Native's tuberculosis comes in the main from infection received after his arrival on the mines, or whether he comes already infected and the disease lights up either through super-infection or from physiological stress.

Population Dealt With.

The Native mine labouring population is a floating one, and exact figures cannot be given in this connexion, but from the data supplied by the Chamber of Mines it may be taken that the mean complement of Native labourers, including both surface and underground workers, on the Reef, over the year 1927, was 185,479. For 1928, the mean complement was 195,210, and for the first half of 1929 it was 196,897. The actual number of individuals passing through in any one year was probably about twice the mean complement.

Tuberculosis Production and Mortality Rates.

Returns from the mines on the Rand as regards their cases of tuberculosis and silicosis, for the year 1927, are as shown in Table I.

TABLE I.

TUBERCULOSIS AND MINERS' PHTHISIS PRODUCTION, WITWATERSRAND GOLD MINES, 1027.

Deaths on Mines.				Disposed of Otherwise.			
Pulmonary Tuberculosis.	Tuberculosis and Silicosis.	*Silicosis.*	Other Forms of Tuberculosis.	Pulmonary Tuberculosis.	Tuber- Tuberculosis and Silicosis.	*Silicosis.*	Other Forms of Tuberculosis.
138	35	12	60	694	240	130	213
245				1,227			

From the pathologist's point of view, one might query the absolute correctness of these figures as regards the returns for simple silicosis, but, taking the figures as they stand as giving a fair index of the production and mortality rates for tuberculosis and miners' phthisis, they show a production rate of 820 *per* 100,000 *per annum*, and a mortality rate *on the mines* of 132 *per* 100,000 *per annum*.

To get the mortality rate *on the Rand* from tuberculosis and miners' phthisis amongst the Native mine labourers, one must add to the 245 deaths which occurred on the actual mines, the 170 which took place in the W.N.L.A. hospital where the cases had been sent pending repatriation. This makes a total of 415, which gives a mortality rate of 223 per 100,000 *per annum*. Of course, this still takes no account of deaths that may have occurred amongst the remaining 1,107 cases, which either took their discharge locally or were (in the majority of instances) repatriated.

The corresponding figures for 1928 are shown in Table II.

TABLE II.

TUBERCULOSIS AND MINERS' PHTHISIS PRODUCTION, WITWATERSRAND GOLD MINES, 1928.

Deaths on Mines.				Disposed of Otherwise.			
Pulmonary Tuberculosis.	Tuberculosis and Silicosis.	Silicosis.	Other Forms of Tuberculosis.	Pulmonary Tuberculosis.	Tuberculosis and Silicosis.	Silicosis.	Other Forms of Tuberculosis.
134	37	8	82	490	330	174	293
261				1,287			

During 1928 there were 131 deaths from tuberculosis at the W.N.L.A. hospital.

The production rate for tuberculosis and miners' phthisis for 1928 works out at 793 *per* 100,000 *per annum*; the mortality rate *on the mines* at 134 *per* 100,000 *per annum*; and the mortality rate *on the Rand* at 201 *per* 100,000 *per annum*.

Age, Service and Tribal Distribution of Cases.

It is convenient to mention at this point, seeing that general statistical statements are being given, that when ages are referred to, these must always be regarded as only approximations. The Natives are, in most cases, rather vague as regards their age, and many of the ages given are really only estimates.

Similarly, records of mining service cannot always be taken as strictly accurate. These records are kept by the mines and, so far as any one mine is concerned, may, of course, be taken as accurate. When a boy's service is not continuous, however, and may, moreover, have been on several different mines, it is possible for some of his service to be overlooked. It may be taken, therefore, that the records of service given are never over-statements, but they may sometimes be under-statements. We have had to exercise our discretion and discard some of the records given, as they simply did not accord with the physical state of the lungs. For example, it would be absurd to accept as correct the statement of only a few months' service in a case showing deeply pigmented lungs and well developed tuberculo-silicosis. Such a condition can only mean several years' mining service.

The Native mine labourers are divided into two large groups—firstly, those recruited in Portuguese East Africa, known generally as "East Coast Natives," including the following tribes: Tonga, Mchopi, Nyambaan and Shangaan; secondly, those recruited from within the Union and neighbouring Protectorates, known generally as "British South African (B.S.A.) Natives." These include Xosa, Pondo and Fingo from the Transkei; Zulu from Natal; Msutu from both Basutoland and the Northern Transvaal; Swazi from Swaziland; and Bechuana from British Bechuanaland.

For 1927 East Coast Natives constituted on an average 44·31 *per cent.* of the total complement, and for 1928 46·53 *per cent.* For the total period 1927, 1928 and first half of 1929, East Coast Natives constituted 50·6 *per cent.* of the 600 tuberculous cases, so that from this point of view there is nothing to indicate that there is any great difference between the one group of Natives and the other as regards their susceptibility to tuberculosis.

The 243 cases reported by various mine medical officers are simply such cases dying from tuberculosis (or showing tuberculous lesions) in the mine hospitals as were voluntarily reported by them during 1928 and the first half of 1929 to the Tuberculosis Research Committee.

The 350 cases in the writers' group come from a total of 467 post-mortem examinations made, being an examination of every case dying in the W.N.L.A. hospital. As this figure of 467 includes the vast majority of new recruits dying before commencing service (excluding only those cases engaged directly by mines and not passing through recruiting depôts), it may be of interest to refer briefly to the 117 cases in whom no tuberculosis was found.

Of these 117 cases, 109 occurred in new recruits who had not been drafted to any mine, or who had under one month's service; 90 of these being East Coast and 19 B.S.A. Natives. Only 8 cases were not new recruits, their service periods ranging from six months to eleven years.

The causes of death in those 117 cases were as follows :—Influenza or other broncho-pneumonias, 33; lobar pneumonia, 24; dysentery, 9; meningococcal meningitis, 16; cancer of the liver, 8; empyaema, 4; enteric fever, 2; valvular disease of the heart, 3; cerebral injury and softening, 2; pyonephrosis, 2; pneumococcal meningitis, pericarditis, appendicitis, gumma of the brain, carbon tetrachloride poisoning, "acute mania," congenital cystic kidneys and haemorrhage into suprarenal, chronic nephritis, cirrhosis of the liver, volvulus and ruptured aortic aneurism, 1 case each; "nothing discoverable," 3 cases.

The 600 cases dying from tuberculosis or showing tuberculous lesions have been grouped for descriptive purposes as is shown in Table III.

TABLE III.

600 Cases of Tuberculosis Examined Post-mortem.

Tribe.		A. Tuberculosis but not as Cause of Death.		B. "Chronic." Associated with Silicosis.		C. "Acute." Lesions mainly Thoracic.		D. "Acute." Lesions mainly Extra-Thoracic.		Totals.	
East Coast	Shangaan ...	18	41	66	117	54	95	27	51	165	304
	Nyambaan ...	8		21		18		6		53	
	Mchopi	11		22		13		8		54	
	Tonga	2		7		8		8		25	
	"Tribe Uncertain"	2		0		1		1		4	
	Blantyre ...	0		1		0		0		1	
	Mozambique ...	0		0		1		1		2	
B.S.A.	Msutu (Basuto)	3	21	15	83	71	145	18	46	107	295
	Xosa	8		29		44		19		100	
	Pondo	4		16		8		3		31	
	Fingo	1		10		7		2		20	
	Swazi	3		4		5		1		13	
	Bechuana ...	0		4		10		1		15	
	Zulu	2		5		0		2		9	
Unidentified		0		0		1		0		1	
Totals		62		200		241		97		600	

Note.—The Blantyre and Mozambique cases, although coming from farther north than the recognized "East Coast" recruiting limits, have for convenience been included with the East Coast cases.

There is only one feature brought out by Table III in relationship to tuberculosis in its tribal aspects that seems to us to be of much significance, and that is the preponderance of Basutos, which figure in

the "acute" section, especially with lesions mainly thoracic. With this exception, there is nothing very much indicative of any great difference between one tribe and another in so far as its reaction to tuberculosis goes.

GROUP A.

62 *Cases showing Tuberculous Lesions, but in which Tuberculosis was not the Cause of Death.*

Of these 62 cases, 41 occurred in East Coast Natives and 21 in B.S.A. Natives.

Herewith follow brief summaries of the case findings. The numbers given to the cases are their serial chronological numbers; those with a number only being in the writers' series of 350; those with an M are from the mine medical officers' series of 243, and those with an A are accident cases.

It will be noted that in this group the service record was frequently not obtained. This is explained by the fact that when death is not due to tuberculosis or there is no pulmonary tuberculosis, there is no statutory return made to the Minors' Phthisis Medical Bureau, and the official machinery for obtaining the record of service is not set in motion.

(57) Shangaan, *aet.* 34.—Service not obtained but probably quite short. Death from valvular disease of the heart. Had a few early white tubercles in the tracheo-bronchial glands. In the lungs there were a few sub-pleural commencing silicotic foci but no obvious tuberculous lesions.

(66) Shangaan, *aet.* 29.—Death from meningitis. Service not obtained but condition of lungs and bronchial glands suggested about one year. There was enlargement of many of the mesenteric glands, but only one had an appearance suggestive of tuberculosis. Its tuberculous character was confirmed by section.

(70) Nyambaan, *aet.* 27.—New recruit. Given 3c.c. carbon tetra-chloride for treatment of ankylostomiasis. Death with features of poisoning by this drug. Must have had previous service, as the tracheo-bronchial glands and lungs showed well-developed tuberculo-silicosis. There was also caseation and recent acute spread of the lung tubercle and tuberculous ulceration in the ileum. He would probably very soon have died from the tuberculosis.

(88) East Coast Native, *aet.* 32.—New recruit with no signs of previous service. Epileptic fits. Had cysticerci and cortical haemorrhages in brain. Had a recent development of tubercles in a bunch of glands in the mesentery of the uppermost loop of the jejeunum. The tuberculous nature was confirmed by smears and sections.

(99) Nyambaan, *aet.* 40.—Death from cancer of liver. Service not obtained but must have had a year or two, as he had a few small tuberculo-silicotic nodules in one lung and definite tuberculo-silicosis of the tracheo-bronchial glands. There were no other tuberculous lesions.

(115) Unidentified East Coast Native, just arrived, wildly maniacal. The degree of pigmentation of the lungs and tracheo-bronchial glands suggested at least a year's previous mining service. Two of the tracheo-bronchials were definitely caseous. There were also caseous hilus glands. Tubercle bacilli of human type were grown from these. No actual tuberculous foci were found in the lungs. There was no tuberculosis anywhere else. A case which could not have been detected by the stethoscope but might have been by X-rays.

(137) Shangaan, *aet.* 30, with six years four months mining service.—Death from lobar pneumonia. Had early silicotic lesions and, in the right lung especially, a fair number of tuberculo-silicotic nodules and small areas. The trachco-bronchial glands

were also tuberculo-silicotic, but without any breaking down. The portal glands were pigmented but not apparently tuberculous. The upper retro-peritoneal glands were also pigmented and with probably early tuberculous lesions. Other glands and organs showed no tuberculosis.

(142) Zulu, *aet.* 46, with eight years' mining service.—Death from lobar pneumonia. Lungs considerably pigmented in large black discrete islands. No obvious tuberculous lesions. Tracheo-bronchial and hilus glands deeply pigmented, but not much enlarged nor fibrosed. One calcareous gland shelled out. Almost certainly an old healed tuberculous focus, but no tubercle bacilli found. Other glands and organs show no tuberculous lesions.

(148) Pondo, *aet.* 30.—Death from lobar pneumonia. Mining service not obtainable, but probably not very long, as there was very little pigmentation of the lungs. The tracheo-bronchial glands, however, contained a fair amount of pigment and one presented the typical appearance of a tuberculo-silicotic gland. Another para-tracheal gland was markedly calcified. There was also a single calcified gland in the mesentery, about the middle of its length. Apparently a case with old healed tuberculous glandular lesions.

(167) Shangaan, *aet.* 46, with 15½ years' mining service.—Death from cancer of liver. Had a bilharzial bladder. There were tuberculo-silicotic lesions in the lungs and tracheo-bronchial glands.

(185) Mchopi, *aet.* 36.—Mining history unobtained. Death from lobar pneumonia. Had fairly extensive tuberculo-silicotic lesions in the lungs and tracheo-bronchial glands.

(193) Shangaan, *aet.* 24.—A new recruit. Death from influenza. Lungs unpigmented, no scarring of tuberculous lesions detected. Tracheo-bronchial and hilus glands unpigmented. One gland at root of right lung the size of a hazel-nut and largely caseous; two others nearby with small recent tubercles in them.

A clear case of a Native coming from his kraal with infection already present in the root glands. Could not have been detected by stethoscope. Query: Would X-rays have shown up *lesion either*?

(203) Mchopi, *aet.* 39.—Mining service not obtained, but probably not very long, as lungs only moderately pigmented. Calcified mitral cusps and evidence of chronic back pressure. Tracheo-bronchial and hilus glands pigmented and fibrosed, probably early tuberculo-silicotic. Definite tuberculosis of portal and lower retroperitoneal glands and of one gland of a high loop of the mesentery. A caseous nodule in the wall of the right auricular appendix, which is thrombosed. No involvement of the pericardium. Query: Is the limitation of the tuberculosis an example of the antagonism between valvular heart disease and tuberculosis? The auricular thrombosis was probably at least a factor in the cause of death, and in this sense, perhaps, the tuberculosis might be said to have been a cause of death.

(214) Msutu, *aet.* 36.—Mining history not obtained, but cannot have been long, as lungs showed very little pigment. Death from acute osteomyelitis of dorso-lumbar spine with myelitis and paraplegia. Very small caseous areas in one "clavicular" gland, tracheo-bronchial and portal glands. Slight scarring at apex of left lung with some recent caseous tubercles in the immediate vicinity of the scar.

(215) Nyambaan, *aet.* 28.—Mining service not obtained, but lungs show very little pigment. Death from *sweating sickness.** There were also several cysticerci in the cerebral cortex. No lung lesions found but the tracheo-bronchial glands showed definite caseation, and there was probably commencing caseation in the portal and upper retro-peritoneal glands.

(222) Shangaan, *aet.* 22.—Mining service, ten months' lashing. Death from carcinoma of bladder and pyonephrosis. Bladder bilharzial. Lungs show practically no pigment and no tuberculous lesion detected. Tracheo-bronchial glands show very definite enlargement and caseation. No other tuberculous lesions found.

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* "Sweating sickness" is the term applied locally to a disease not uncommon amongst Native miners, in which profuse perspiration is one of the most striking symptoms. The disease is frequently fatal, but its etiology has not yet been discovered.

(229) Swazi, *aet.* 52.—Mining service, eight years five months.—Death from pneumonia. Had old healed fibrotic scars at both apices, almost certainly tuberculous, also one small bronchiectatic cavity, but apparently a recent acute thing not tuberculous. The tracheo-bronchial glands were enlarged and fibrosed, but showed no definite tuberculous character.

(234) Xosa, *aet.* 23.—New recruit. Death from dysentery. Had two small subpleural calcified nodules in each lung, probably healed tuberculous foci. No other evidences of tuberculosis.

(243) Nyambaan, *aet.* 26.—At least one year's mining service, perhaps two years. Death from enteric fever. Caseation in one gland at the bifurcation of the trachea. No other tuberculous foci found.

(252) Xosa, *aet.* 42, with two years eleven months' service.—Death from sub-acute mitral endocarditis. Had fibrosed and slightly caseous retro-peritoneal glands, mainly the lower group, and one small caseous spot in the spleen (tubercle bacilli present in smears). Some pleural adhesions on both sides. ? Tuberculous.

(255) Nyambaan, *aet.* 39.—Mining service not obtained. Lungs show a considerable degree of pigmentation. Death from pneumonia. One small chronic caseous focus in tracheo-bronchial gland. Right pleural effusion and some granulation tissue, possibly tuberculous. One small calcified nodule found near apex of left lung.

(256) Shangaan, *aet.* 24, new recruit.—Lobar pneumonia and an enteritis of undetermined origin. Bilharzial bladder and cirrhotic liver. The spleen was considerably enlarged and showed numerous carneous areas. These suggested tubercle but there was no definite caseation and it was only on microscopic section that it was found that they were definitely tuberculous. No other tuberculous lesion found. It is possible, in view of the opinions generally expressed *re* primary tuberculosis of the spleen, that some small glandular focus was overlooked, but it must have been very small, and this case must be regarded as nearly approaching a primary splenic tuberculosis as it is possible to meet with.

(258) Xosa, *aet.* 40.—Mining service not ascertained. Death from acute generalized peritonitis, origin not further determined. Had well-marked tuberculosis of clavicular, tracheo-bronchial, diaphragmatic, upper and lower retro-peritoneal and portal glands, but no obvious involvement of any organs. The tracheo-bronchial glands were practically tuberculo-silicotic in type and were probably the originally infected group. The lungs, it may be said, showed some excess of pigment, but nothing that could be called silicosis.

(289) Shangaan, *aet.* 54.—Mining service not obtained. Death from pneumonia. Had discrete tuberculo-silicotic nodules in both lungs and a tuberculo-silicotic condition of the thoracic, portal and upper retro-peritoneal glands.

(292) Shangaan, *aet.* 24.—New recruit. Death from pneumonia. Scarring at right apex and some pleural adhesions over left lung, possibly tuberculous. Definite tuberculous caseation in one of the tracheo-bronchial glands on the right side.

(306) Mchopi, *aet.* 25.—New recruit. Death from lobar pneumonia. Tuberculin test on arrival, positive. Lungs and thoracic glands quite free from pigment. An isolated caseo-calcareous gland was found in the mesentery of the uppermost loop of the jejeunum.

(327) Swazi, *aet.* 47.—New recruit. Lungs not suggestive of any previous service. Death from enteric fever. Showed two old densely-calcified masses, one in a gland of the paratracheal group, the other embedded in the pericardium.

(341) Nyambaan, *aet.* 35, with four years' service.—Death from septic abscess in lung. Tuberculin reaction PP six months before death. Had several caseous tracheo-bronchial glands and a caseous patch in one kidney.

(349) Zulu, *aet.* 50.—Service not ascertained. Cause of death not obvious. Had well-marked tuberculo-silicotic lesions in the tracheo-bronchial and upper retro-peritoneal glands, although only very slight lesions (pigmented scar at one apex) in the lungs. One of the tracheo-bronchial glands was breaking down and was on the point of perforating the œsophagus.

(355) Swazi, *aet.* 42.—Service not ascertained. Death from lobar pneumonia. Had slight tuberculo-silicotic lesions in lungs and tracheo-bronchial glands.

(358) Nyambaan, *aet.* 24.—New recruit. Death from lobar pneumonia. The tuberculin reaction was negative but one tracheo-bronchial gland was found to be caseous. Sections of the gland showed a healing tuberculous process but cultures yielded a growth of tubercle bacilli of human type.

(364) Shangaan, *aet.* 50.—Service not ascertained. Death from lobar pneumonia. Had tuberculo-silicotic tracheo-bronchial and upper retro-peritoneal glands, also recent caseation in one cervical gland.

(369) Shangaan, *aet.* 54.—Service not ascertained. Death from broncho-pneumonia. Had several small pigmented fibrous nodules, apparently healed tubercle, in different parts of the lungs.

(401) Shangaan, *aet.* 28.—Service not ascertained. Death from lobar pneumonia. Positive tuberculin reaction. The only thing noted at the post-mortem examination that was suggestive of tuberculosis was a porcellaneous thickening of the capsule of the spleen, a type of chronic inflammatory reaction which is suspect of being sometimes, at all events, tuberculous. Near the hilus of the spleen was a small body which was cut to see whether it was a splenunculus or a haemo-lymph gland. It proved to be the former and, to our surprise, also showed acute tuberculous lesions. These had not gone the length of caseation and to the naked eye raised no suspicion of tubercle. The true spleen was, unfortunately, not examined microscopically.

(406) Shangaan, *aet.* 48.—Service not ascertained. Death from gangrene of lung. Well-marked tuberculo-silicotic lesions in lungs, with much scarring. Tracheo-bronchial glands also markedly affected; one just below the bifurcation had broken down, established an oesophageal fistula, and was also on the point of opening into the left bronchus.

(420) Mchopi, *aet.* 25.—Service not ascertained. Death from dysentery. Extensive caseation in the lower retro-peritoneal glands, with an apparently more recent extension to the upper retro-peritoneal glands and slightly to the tracheo-bronchial glands.

(422) Mchopi, *aet.* 36.—Mining service two years eleven months. Death from empyaema. Tuberculin reaction, positive. Had slight caseation in two tracheo-bronchial glands.

(438) Pondo, *aet.* 47.—Service not ascertained. Death from typhus. Lungs had very little pigment in them, although there was a little, mostly sub-pleurally. The tracheo-bronchial glands were fairly heavily pigmented—practically tuberculo-silicotic in character—and there was definite caseation in one gland of the pancreatico-lienal group. The appearances suggested previous service some considerable time ago, the lungs having almost cleared themselves of pigment in the interval.

(441) Xosa, *aet.* 42.—Service three years eleven months. Death from lobar pneumonia. Lungs showed several fair-sized tuberculo-silicotic nodules; the tracheo-bronchial glands were also tuberculo-silicotic.

(444) Xosa, *aet.* 38.—Service four years six months. Death from lobar pneumonia. Slight tuberculo-silicotic lesions in the lungs and well-marked lesions in the tracheo-bronchial and upper retro-peritoneal glands. Breaking down of gland below the bifurcation of the trachea and establishment of an oesophageal fistula.

(447) Nyambaan, *aet.* 45.—Service not ascertained. Death from cancer of liver. Pigmented fibroid scar at the apex of the right lower lobe, presumably a healed tuberculous focus.

(452) Xosa, *aet.* 45.—Service, two years nine months. Death from lobar pneumonia. Slight tuberculo-silicotic lesions in lungs and tracheo-bronchial glands.

(457) Shangaan, *aet.* 45.—Service, four years one month. Death from broncho-pneumonia. Slight tuberculo-silicotic lesions in lungs and tracheo-bronchial glands.

(459) Msutu, *aet.* 45.—Service, six years nine months. Death from enteric fever. Slight tuberculo-silicotic lesions in the tracheo-bronchial glands only.

(462) Shangaan, *aet.* 22.—*New recruit. Death from lobar pneumonia. Lungs not* indicative of any previous service. Tuberculosis of tracheo-bronchial, pancreatic and portal glands. Histologically all the affected glands considerably fibrosed with a very striking hyaline degeneration of the fibrous tissue.

(464) Xosa, *aet.* 26.—Service, two years six months. Death from lobar pneumonia. Calcified tuberculo-silicotic tracheo-bronchial glands.

(M 3) Msutu, *aet.* 25, with one year's service.—Death from enteric fever. He had caseo-calcareous tracheo-bronchial glands, fibrosis of most of the groups of abdominal glands but without obvious caseation, and miliary tubercles in the spleen and liver.

(M 34) Shangaan, *aet.* 25, with four years nine months' service.—Death from acute dysentery. The apices of both lungs showed pigmented scars, the portal and upper and lower retro-peritoneal glands were caseous, and there were numerous caseous areas in the spleen.

(M 50) Shangaan, *aet.* 22, with one year's surface work on the mines.—Death from enteric fever. He had tuberculous glands on the left side of the neck, and the right suprarenal was tuberculous.

(M 54) Mchopi, *aet.* 34, with 3½ years' mining service.—Death from lobar pneumonia. There was a small area of early tuberculous caseation near the base of the right lung and the tracheo-bronchial glands showed characteristic tuberculo-silicotic appearances.

(M 79) Tonga, *aet.* 20, with six months' service.—Death from ulceration of urinary bladder and bilateral pyonephrosis. There was a small caseous focus at the apex of the left lung with caseous tracheo-bronchial glands and a slight direct spread into the hilus region of the right lung from these glands.

(M 94) Pondo, *aet.* 30.—Service not obtained. Death certified as being from oedema of the larynx. There were caseous cervical glands. No other lesions of any sort found.

(M 128) Tonga, *aet.* 55.—Service, three years six months. Death from chronic myocarditis and heart failure. Had scarred apices, presumably old healed tuberculous lesions.

(M 170) Fingo, *aet.* 52.—Service, five years eleven months. Death from lobar pneumonia. Had tuberculo-silicotic lesions in the tracheo-bronchial glands only.

(M 239) Mchopi, *aet.* 40.—Service, four years five months. Death from acute pericarditis (non-tuberculous). Had slight tuberculo-silicotic lesions in lungs and tracheo-bronchial glands.

(A 5) Xosa, *aet.* 40.—Service not ascertained. Accident. Had slight tuberculo-silicotic lesions in lungs and tracheo-bronchial glands.

(A 7) Mchopi, *aet.* 28.—Died two months after admission to hospital for an injury to one knee. Death partly from septic infection, partly from an acute tuberculous spread which had apparently taken place during the two months. He had tuberculo-silicotic lesions in the lungs and various gland groups with recent fairly extensive caseation in the spleen, liver and kidneys.

(A 9) Pondo, *aet.* 37.—Service not ascertained. Accident. Slight tuberculo-silicotic lesions in the tracheo-bronchial glands only.

(A 13) Mchopi, *aet.* 33.—Service not ascertained. Slight silicotic lesions in lungs and tuberculo-silicosis of tracheo-bronchial and pancreatic glands.

(A 16) Mchopi, *aet.* 26.—Service not ascertained. Accident. Slight tuberculo-silicotic lesions in the tracheo-bronchial glands only.

(A 17) Shangaan, *aet.* 21.—Service, ten months. Accident. Very little pigment in the lungs. One caseous clavicular gland.

(A 21) Mchopi, *aet.* 30.—Service not ascertained. Accident. Slight tuberculo-silicotic lesions in tracheo-bronchial glands only.

Notes on these 62 Cases.

These cases showing tuberculous lesions but dying from causes other than tuberculosis may conveniently be classified into three groups according to their length of service, viz. :—

Group I, with over one year of service, the evidence being either certain (documentary) or probable (pathological).

Group II, with service of under one year's duration.

Group III, new arrivals.

Group I.—34 cases are regarded as falling in this group (18 certain, 16 probable). Of these 34, 29 had more or less well-marked tuberculous or tuberculo-silicotic lesions, and would probably have died sooner or later from tuberculosis had the evolution of the disease not been cut short by death from other causes.

In 5 cases (142, 229, 369, 447 and M 128) the lesions were slight and apparently completely arrested or healed. They may be regarded, therefore, as evidence that tuberculosis may become arrested in the Native.

Case 203 is interesting as possibly an example of the alleged antagonism between heart disease and tuberculosis, but it is fairly clear that the tuberculosis played an actual part in the end in the causation of death through invasion of the wall of the auricle.

In 2 cases (406 and 444) with tuberculo-silicosis there were fistulae established between the oesophagus and breaking down tracheo-bronchial glands, and in a third case (349) a similar fistula was just on the point of forming.

Case 438 is a good example of lungs which had cleared themselves of pigment in the time between periods of mining service.

Group II.—16 cases with evidence of mining service, but either certainly or probably of under one year's duration. Of this group, 8 cases (66, 214, 215, 222, M 3, M 50, M 79 and A 17) showed active tuberculosis which would probably have spread had its course not been interrupted through death from other causes.

Case 57 is possibly another example of the antagonism between heart disease and tuberculosis, the tuberculous lesion being very limited, although this might equally have been because it was only of quite recent origin.

Case 148 is an example of a healed mesenteric gland lesion, but also showing slight lesions in thoracic glands.

Case 401 shows (?) chronic and recent acute tuberculosis limited in its distribution to the spleen.

In Case M 94, the tuberculous glands in the neck appeared to be the only lesion present beyond the fatal acute oedema of the larynx, and the two conditions may have been connected.

Case A 17 is a good example of commencing tuberculosis, limited to a "clavicular" gland, of the type reported by Borrel as commonly seen amongst the Senegalese troops in France.

Group III.—12 cases, new arrivals, but in 3 of these there was unmistakable evidence of previous service. Case 70 would, indeed, practically certainly soon have died from active tuberculosis. Case 99 had some tuberculo-silicotic foci in the lungs and tuberculo-silicotic tracheo-bronchial and pancreatic glands, but no signs of any very active tuberculosis. Case 115 had evidence of active tuberculosis in hilus and tracheo-bronchial glands, but nowhere else. It was a case which could probably not have been detected by stethoscopic examination, but might have been by X-ray examination.

The remaining 9 cases are of greater interest, as they were certainly new arrivals with no previous service and may, therefore, be regarded as definite examples of raw recruits arriving on the Rand already infected with tuberculosis.

Case 88 showed a quite recent development in mesenteric glands, but it is difficult to answer the query: Did this development begin just before leaving his kraal, on the journey to Johannesburg, or in the ten days or so during which he was in Johannesburg (mainly in hospital prior to his death)? Another point of interest about the case is the situation of the glands in which the infection occurred, viz., glands in the mesentery of the highest loop of the jejunum.

Case 306 is another example of tuberculosis limited to the same glands, but in this instance the lesion was obviously of considerable age, and must have been acquired in the kraal.

Case 193 is a clear case of infection in the thoracic glands, brought with him on first arrival on the Reef. This case, also, was one which would probably have defied stethoscopic detection, but might have been detected by X-rays.

Cases 234 and 327 furnish further evidence that healed tubercle may be found in the Native.

Case 256 is interesting as a case of apparently primary and isolated tuberculosis of the spleen. We are not prepared to assert that a microscopic or X-ray examination would not have revealed some more primary (*sic*) focus in lung-tissue or in some gland, but any such lesion, if present, must have been very small, as a careful search showed no obvious macroscopic lesion either in the lungs or in any other organ or in any of the gland groups.

Case 292 is another clear case of infection being brought to the Reef from the kraal—in this instance lung-scarring with caseation in the corresponding tracheo-bronchial gland.

Case 358 was a Native *aet.* 24 who gave a negative tuberculin reaction but who proved to have one caseous tracheo-bronchial gland from which tubercle bacilli were grown.

Case 462 showed lesions of a rather curious chronic type in both tracheo-bronchial and abdominal glands.

538 Cases in which Tuberculosis was the Cause of Death.

Group B.—200 Cases associated with Silicosis.

In 200 cases, *i.e.*, a third of the whole, the tuberculosis was associated with a greater or lesser degree of silicosis.

The tribal distribution of the silicotic cases is shown in Table III on p. 378.

As silicosis is a disease which takes some time to develop, it would naturally be expected that the cases would be found mainly amongst boys of older age groups, and in those with longer periods of service, as compared with the incidence of tuberculosis pure and simple. That this is so is brought out by the figures in Table IV, which shows the age-distribution by decennial periods. Compare with Table VIII on p. 397 and Table X on p. 404.

TABLE IV.

Age Distribution of Cases of Tuberculosis Associated with Silicosis.

Under 20	0
20–29	14
30–39	50
40–49	113
50 and over	19
Not ascertained ...	4
	200

Even allowing for the fact that ages as given are not exact, it may be taken that this table shows with reasonable certainty that the great majority of the silicotic cases occur in subjects in the thirties and forties.

As regards length of service, returns were not obtainable, or were deliberately excluded for reasons already referred to on p. 377, in 45 cases. In the remaining 155, the mean period of service works out at 6 years 3½ months, the extremes being 1 year 5 months and 21 years 2 months. But, as already explained, also on p. 377, it is impossible to be certain as to the accuracy of all records of service. It is practically impossible that they should be overstated, but they may be understated. In the case mentioned as having 1 year 5 months' service, the silicotic lesions were of the very earliest stage detectable macroscopically. Compare with Table IX (p. 398) and Table XI (p. 404).

For the purposes of this report, which is concerned essentially with tuberculosis, it is not necessary to deal minutely with the pathology of silicosis further than to consider its relationship to tuberculosis and the modifications which the combination of the two conditions imposes upon the latter.

The inhalation of silica on the Rand is so intimately associated with the inhalation of carbon that silicosis is always a pigmented disease, and it becomes convenient practically to speak of silicosis in terms of pigmentation, although always bearing in mind that it is not

the pigment which is the cause of the pathological processes, but the associated silica. The essential feature of silicosis is fibrosis, and, therefore, it may be taken that pigmentation *plus* fibrosis means silicosis.

The earliest visible manifestation of silicosis may take the form of a fairly uniform diffuse pigmentation of the lungs. Microscopically, there will be found to be a fine fibrosis in and around the interlobular, peribronchiolar, and perivascular lymphatics. This fibrosis may be sufficient to be just visible and palpable, and unless it is so, the case is not regarded as definitely one of silicosis.

More commonly, instead of the diffuse pigmentation and fine fibrosis, the pigment tends to become aggregated in the form of discrete black specks dotted more or less evenly throughout the whole of the lung surface and under the pleurae. These specks are not distinguishable at first by touch from the rest of the lung substance, but as they increase in size and the degree of fibrosis increases, they become definitely palpable as hard little nodules and on a freshly cut lung surface they project visibly above the surrounding lung substance. These simple silicotic nodules are shiny and of a uniformly jet black colour in the lung substance; and they attain a size up to about 2m.m. in diameter. Sub-pleurally, they tend to be more flattened out, not so raised but of a greater diameter and frequently have a white centre of unpigmented fibrous tissue, with a surrounding pigmented black ring.

It is doubtful if uncomplicated silicotic nodules in the lung ever get much bigger than about 2m.m. in diameter. Anything bigger than this may be looked upon with suspicion as being caused partly by an infective element, tuberculous or otherwise, in addition to the silicosis. An increase in the degree of simple silicosis is expressed rather by an increase in the number of the nodules than by an increase in their size.

The association of silicosis and tuberculosis may take any one of several forms (see footnote on p. 163) :—

(*a*) Their development may be independent, *i.e.*, one may have simple silicosis in the lungs and the development of a focus or foci of caseating tuberculosis quite unconnected with each other. This is sometimes seen, but it is not common.

(*b*) The tuberculous element may be definitely more prominent than the silicotic. This combination takes the form of a caseating area in or about which most of the pigment in the lung collects. There is never much fibrosis accompanying this accumulation of pigment, and it seems more reasonable to speak of this condition as pigmented tuberculosis rather than as tuberculo-silicosis, although there may be a slight silicotic element in it.

(*c*) The development of the two conditions may be intimately associated, taking the form of a mixed process which gives rise to very characteristic lesions generally spoken of as "tuberculo-silicosis."

Tuberculo-silicosis may manifest itself in the following forms :—

(1) Discrete nodules varying in size from about 2–6m.m. in diameter, usually very hard, more or less pigmented, but never of the shiny jet-black colour of the simple silicotic nodule. They are best described as of a steel-grey colour—dark steel-grey or light steel-grey, as the case may be—never quite uniform throughout the whole nodule but rather mottled or shading from one part to another. These variations in colour are accounted for by varying proportions of pigmentation, fibrosis, fatty degeneration and caseation, the four conditions which go to make up the tuberculo-silicotic nodule.

(2) Larger areas which are obviously composed of discrete nodules which have spread and met and have, to some extent, coalesced, but in which the outlines of the originally discrete nodules are still discernible.

(3) Gross areas of dense fibrotic consolidation which may be the end result of completely fused discrete nodules, but which more often look as if they represented a development which had been continuous over a fair-sized area from the outset. These areas may measure anything up to 7 or 10cm. across ; there may be only one, involving part or even the whole of one lobe, or there may be several smaller areas in different parts of both lungs. Combinations of the three types of tuberculo-silicotic lesions may also be encountered. The more massive developments, it may be said, are now rather rarely seen and only in cases with very long service.

(4) Caseation may go on to excavation even in the smaller discrete nodules, but it is more commonly seen in the gross areas. When excavation occurs, and sometimes even without it, there may be a spread of the tuberculous process beyond the limits of the tuberculo-silicotic foci, either as a limited acute caseation in the immediate neighbourhood of the tuberculo-silicosis, or as a more generalized caseating phthisis or miliary tuberculosis.

Great variations in the picture presented by tuberculo-silicosis are, therefore, possible, and in the analysis given below an attempt is made to indicate the extent of these variations.

Tuberculo-silicosis in Lymphatic Glands.

The lesions of silicosis and tuberculo-silicosis are not limited to the lungs but may be found also in various groups of lymphatic glands. Glands (especially the tracheo-bronchial and hilus glands, but not these exclusively) may be pigmented but still quite soft ; they may be pigmented and fibrosed, *i.e.*, silicotic, or they may show pigmentation, fibrosis and caseation, *i.e.*, tuberculo-silicosis. In appearance, such glands closely parallel the features of the lung lesions. In simple silicosis they are uniformly black and hard ; in tuberculo-silicosis they are not uniformly black, but show the same steel-grey tints, varying in shade from part to part of the gland Hardening is the rule, but

locally there may be softening where caseation predominates. Calcified foci are also sometimes present, as, indeed, they are sometimes also in pulmonary tuberculo-silicotic lesions.

Just as in tuberculosis uncomplicated by silicosis it is no uncommon thing to find obvious caseation in the tracheo-bronchial glands with either no foci in the lungs or foci only discernible by microscopic or X-ray examination, so, in the case of tuberculo-silicosis, it is not rare to find the first macroscopic evidence in the tracheo-bronchial glands. It is distinctly less common to find tuberculo-silicosis of any considerable degree of development in the lungs without a corresponding involvement of the tracheo-bronchial glands.

Any or all of the sub-groups of the tracheo-bronchial group may show tuberculo-silicotic changes, *i.e.*, the broncho-pulmonary or hilus glands lying between the branches of the bronchi, the superior and inferior tracheo-bronchials lying respectively above and below the main bronchi, and the para-tracheals lying higher up alongside the trachea.

Tuberculo-silicotic changes are, however, not limited in their distribution to the lungs and the tracheo-bronchial glands; they may be found in other glands in addition, both higher up and lower down.

Higher up they may be found not uncommonly in the "clavicular," in the sternal or internal mammary glands, and occasionally in the lower cervical glands in the anterior triangle of the neck. (NOTE: For a definition of the term "clavicular," see p. 399.)

Lower down they may be found (*a*) in the diaphragmatic glands above the diaphragm. These glands occur around the reflection of the pericardium from the diaphragm, one being very common just behind the xiphisternum and others close to the oesophagus. (*b*) Below the diaphragm, very frequently in the portal glands lying in the hepatic fissure and in the glands which, for convenience, we have grouped together under the terms "upper retro-peritoneal" or "pancreatic." This really includes three distinct groups, viz., the coeliac group of the pre-aortic glands around the origin of the coeliac artery, the paracardial glands lying like a chain of beads round the neck of the stomach, and the pancreatico-lienal glands on the upper border of the pancreas. Very occasionally tuberculo-silicotic changes extend a little lower still into some of the lower retro-peritoneal (superior mesenteric group of the pre-aortic) glands below the level of the pancreas.

When tuberculo-silicotic changes are at all well developed in the lungs and tracheo-bronchial glands, similar changes are so commonly to be found in the diaphragmatic, portal and "pancreatic" glands that we have come to look upon this combination as "the normal zone of tuberculo-silicosis" or, "the tuberculo-silicotic zone."

The following table (Table V) shows numerically the frequency of occurrence of the various types of silicotic and tuberculous lesions in the lungs.

TABLE V.

PULMONARY LESIONS IN CASES OF TUBERCULOSIS WITH SILICOSIS.

Lungs showing only Excess of Pigment without Fibrosis	2
Pure Silicotic and Pure Tuberculous but no Tuberculo-silicotic Lesions	11
Silicosis only	5
Tuberculosis only	19
Pure Silicotic and Tuberculo-silicotic Lesions both present ...	95
Tuberculo-silicotic but no Pure Silicotic Lesions	70
Tuberculo-silicotic Nodules noted as only "Scanty"	78
Tuberculo-silicotic Nodules noted as "Numerous"	36
Tuberculo-silicosis in Gross Areas without Excavation	37
Tuberculo-silicosis in Gross Areas with Excavation	36
Caseating Phthisis without Excavation	37
Caseating Phthisis with Excavation	70
Miliary Tuberculosis	37

It should be noted that in making the diagnoses going to make up Table V (and also Tables VI and VII), naked-eye appearances only were available in most instances. It is possible that if microscopic examinations had been made in every case, the figures would have been slightly different. It is not always easy, for instance, to recognize the beginnings of tuberculosis in a tuberculo-silicotic process; until caseation has become definite it might pass as a simple silicosis. To have checked all cases by microscopic sections would, in most cases, however, have entailed making a considerable number of sections from each lung, an amount of labour which, with the time at our disposal, did not seem justified in order to secure only a slighter degree of accuracy in our results.

It will be obvious, of course, from the figures in the table, that many lungs showed several types of lesion present. One might, for instance, have tuberculo-silicosis present in the form of both discrete nodules and gross areas; or silicotic and tuberculo-silicotic lesions together with *caseating phthisis*; or *gross areas of tuberculo-silicosis* with excavation together with miliary tuberculosis, etc.

The next table (Table VI) shows numerically the frequency of involvement of the various gland groups by silicosis and tuberculosis, either separately or combined. In this instance, and in Table VII, only 178 cases are included in the analysis, and in the case of the "clavicular" and "diaphragmatic" glands only 87 cases are included, because in some of the mine medical officers' returns and in some of our own earlier cases, the condition of these two groups of glands was not noted in sufficient detail.

TABLE VI.

TUBERCULOUS AND SILICOTIC LESIONS IN VARIOUS GROUPS OF GLANDS.

Cervical Glands:		
No Tuberculosis or Silicosis	155	178 cases.
Tuberculosis only	14	
Pigmentation only	2	
Tuberculo-silicosis	7	
"Clavicular" Glands:		
No Tuberculosis or Silicosis	44	87 cases.
Tuberculosis only	9	
Silicosis only	10	
Tuberculo-silicosis	24	
Tracheo-bronchial Glands:		
Pigmentation only	1	178 cases.
Silicosis only	8	
Tuberculosis only	2	
Tuberculo-silicosis	167	
Diaphragmatic Glands:		
No Tuberculosis or Silicosis	20	87 cases.
Tuberculosis only	3	
Silicosis only	22	
Tuberculo-silicosis	42	
"Pancreatic" Glands:		
No Tuberculosis or Silicosis	51	178 cases.
Tuberculosis only	16	
Silicosis only	31	
Tuberculo-silicosis	80	
Lower Retro-peritoneal Glands:		
No Tuberculosis or Silicosis	122	178 cases.
Tuberculosis only	43	
Silicosis only	1	
Tuberculo-silicosis	12	
Portal Glands:		
No Tuberculosis or Silicosis	61	178 cases.
Tuberculosis only	20	
Silicosis only	34	
Tuberculo-silicosis	54	
Mesenteric Glands:		
No Tuberculosis or Silicosis	114	178 cases.
Tuberculosis only	64	
Inguinal Glands:		
Tuberculosis only	1	

Table VII shows the distribution of tuberculosis plus silicosis either as separate lesions or as a combined condition.

TABLE VII.

DISTRIBUTION OF THE LESIONS OF TUBERCULOSIS PLUS SILICOSIS.

In Lungs only	6
In Lungs and Thoracic Glands	67
In Thoracic Glands only	5
In Lungs, Thoracic and Pancreatic Glands	27
In Lungs, Thoracic and Portal Glands	13
In Lungs, Thoracic, Pancreatic and Portal Glands	56
In Thoracic and Pancreatic Glands only	1
In Thoracic, Pancreatic and Portal Glands only	3
	178

Tuberculo-silicosis, in one respect, resembles the ordinary chronic phthisis of the European adult, viz., that much fibrous tissue formation occurs. Amongst these 200 silicotic cases, however, 4 cases (314, 322, 407 and 446) were encountered in which the fibrosis appeared to be associated with a purely tuberculous condition, independent of the silicotic lesions present. In other words, these 3 cases were examples of the European adult type of tuberculosis and merely incidentally silicotic.

Two other similar cases (189 and 439) quite unassociated with silicosis are referred to in the " acute " section (see pp. 402 and 403).

In 4 cases there was noted scarring of the lungs (presumably healed tuberculous foci) quite independent of any tuberculo-silicosis.

Similar scarring was noted in 9 cases falling into Groups C and D.

These cases furnish further evidence to that already adduced on pp. 384–385 that healing or arrest of tuberculosis does occur in the Native.

In another respect, also, these tuberculo-silicotic cases have some resemblance to the European adult type of tuberculosis, viz., the comparative frequency with which the tuberculosis is limited to the lungs or, at all events, to the tuberculo-silicotic zone, *i.e.*, to the lungs, thoracic, portal and pancreatic glands.

Of the 200 cases it was completely limited to this zone in 70; in another 49 the tuberculous involvements outside this zone were very slight. *In fully half the cases, therefore, 119 to be exact, the tuberculosis was limited, or almost limited, to the tuberculo-silicotic zone*; in the other 81 cases, there was more or less extensive spread of tuberculosis outside of this zone.

Herewith follows a list of the tuberculous involvements of other organs and tissues :—

Pleurae.—Definitely tuberculous pleurisy in a more or less acute form, showing effusion, caseation or tuberculous granulation tissue, *was present in 37 cases. There were well-developed old adhesions,* probably largely of tuberculous origin, in another 64 cases. In quite a number of the remaining 99 there were some adhesions, very few showing absolutely smooth pleurae.

Heart and Pericardium.—*In 21 cases there was definite tuberculous* pericarditis, generally taking the form of a thick caseous layer binding the whole of the two surfaces of the pericardium together. Two cases (182 and 432) with marked involvement of the myocardium are specially referred to in the list of cases of individual interest given below. In 21 other cases the pericardium was more or less adherent, but there was not definite evidence that this was of tuberculous origin.

Spleen.—The spleen showed tuberculosis in 81 cases. The splenic involvement was sometimes only by miliary tubercles, sometimes a few caseous nodules, sometimes numerous caseous nodules with gross enlargement of the organ. " Monkey spleens " were, however, rarely seen in this group of cases as compared with their occurrence in the group of acute pulmonary cases (see p. 400).

Liver.—Tuberculosis of the liver and tuberculosis of the spleen usually occurred in the same cases, although sometimes one might be found involved and not the other. The actual number of cases showing liver involvement was 74. Here, again, there might be only miliary tubercles or scanty small caseous nodules; occasionally there were numerous caseous nodules of some size, but in only one case were the nodules breaking down with the formation of "bile abscesses."

Kidneys.—Tuberculous lesions were noted in 43 instances, but in the majority of these there were only either miliary tubercles or scanty small isolated caseous foci, sometimes only in one kidney, sometimes in both. Only in two cases was an extensive renal phthisis encountered.

Suprarenals.—Suprarenal involvement was noted in 23 cases. In all the tuberculosis appeared to have gained access to the gland or glands (usually only to one) by direct extension from neighbouring caseous lymphatic glands. In most of the cases there were only a few small tubercles or small caseous nodules present, without much glandular destruction. Only in 3 cases (297, 363 and 411) was the lesion a gross one.

Peritoneum.—Tuberculous peritonitis was present in 18 cases.

Intestine.—Tubercles in Peyer's patches or actual tuberculous ulceration was present in 40 cases. Usually only the ileum was affected, but in a few instances there was also involvement of the caecum. In every case the intestinal condition could be attributed to the swallowing of bacilli from a pulmonary lesion.

Brain or Meninges.—Involved in 6 cases.

Bone or Joint involvement was present in 3 cases.

Genitalia.—Involved in 3 cases.

CASES OF INDIVIDUAL INTEREST.

(7) Bechuana, *aet.* 30, with 3½ years' mining service.—Lungs showed merely a diffuse pigmentation with a just palpable and visible fine fibrosis, *i.e.*, an "ante-primary" silicosis. Left lung pleura smooth, early broncho-pneumonic caseation in upper lobe. Right lung pleura shows a recent tuberculous exudate and there is acute broncho-pneumonic caseation throughout the lung. The hilus glands are pigmented and slightly fibrosed but show no obvious caseation. There are numerous large caseous mesenteric glands and some of the retro-peritoneal glands close to the head of the pancreas and the suprarenals are also markedly enlarged, hard and partially caseous. Other glands and organs unaffected. This would appear to be a case of primarily abdominal infection with spread to the lungs, and merely an incidental commencing silicosis.

(33) Nyambaan, *aet.* 35, with six years' underground and eight years' surface work on mines. Numerous silicotic and tuberculo-silicotic nodules distributed fairly evenly over both lungs. Caseation and early cavity formation in left upper lobe. Right pleura much thickened and adherent. Tuberculo-silicosis of sternal, tracheo-bronchial, portal and pancreatic glands. Ulceration of intestine and recent caseation of mesenteric glands. Hydropericardium, but serosa everywhere smooth. Query: Tuberculous? Thrombosis of right auricular appendix. Sections did not show any definitely tuberculous structure in the thrombus.

(34) Msutu, *aet.* 40.—Only record of service given, one year five months. Lungs show only scanty simple silicotic nodules but in the right lung there is a small tuberculous cavity near the root derived from an adjacent caseous hilus gland. Huge mass of tracheo-bronchial and mediastinal glands, some showing early tuberculo-silicotic changes, the majority extensive caseation. There are also numerous tubercles throughout the loose areolar tissue of the mediastinum. Elsewhere only a few small caseous foci in the spleen and numerous small foci in the liver.

(59) Shangaan, *aet.* 23, with four years eight months' service.—Lungs show only scanty tuberculo-silicotic nodules rather more numerous in the right lung than in the left. Tracheo-bronchial glands pigmented, quite soft, and not caseous. Portal, upper retro-peritoneal and splenic lymphatic glands much enlarged and caseous, lower retro-peritoneal glands slightly involved. Spleen enormously enlarged with gross areas of caseation. Liver shows a few caseous nodules. This also appears to be a primarily abdominal case. Query: Are the tuberculo-silicotic nodules in the lungs to be considered an entirely independent development, or has there been a spread of tubercle bacilli from the abdomen to the lungs with a development limited by the coincident silicosis?

(61), (80), (86) and (302) These four cases may be referred to together, the point of interest in each being the formation of a fistulous opening into the oesophagus. In two cases the fistula had formed by the breaking down of a tuberculo-silicotic tracheo-bronchial gland, with extension of the process through the adjacent oesophagus. In the third case, in addition to tuberculo-silicosis of these glands, there was a massive tuberculous pericarditis and a large breaking down mass of caseation in the lower mediastinum which had ulcerated through the oesophageal wall. In the fourth there was a breaking down inferior tracheo-bronchial gland, mediastinal adhesions and some dragging-up and distortion of the position of the pericardium and heart. The oesophageal fistula appeared to connect both with the breaking-down gland and the upper fornix of the pericardium.

(129) Shangaan, *aet.* 47.—Mining service not obtained. The lungs showed some simple silicotic nodules and also a few tuberculo-silicotic nodules, but no active tuberculosis. The tracheo-bronchial glands were tuberculo-silicotic, the portals and "pancreatics" silicotic but without obvious caseation. The right pleura showed recent adhesions. The left pleural sac contained a large effusion, there were no obvious tubercles on the pleura, but there was an unusual occurrence of rather extensive caseation in the substance of the diaphragm under the left pleura and in its pillars.

(158) Nyambaan, *aet.* 38, with twenty years' service, all on "hammers."—This case was remarkable from the very slight lesions of the lungs in view of the length of service. The lungs showed quite a slight degree of pigmentation (we had estimated his service before obtaining his record at only about three years). There was no general fibrosis and only scanty sub-pleural silicotic plaques. Miliary tubercles were present. The tracheo-bronchial glands were tuberculo-silicotic with some calcification in one gland. Below the diaphragm only one pancreatic gland showed slight tuberculo-silicotic changes. There was a tuberculous peritonitis.

(182) Pondo, *aet.* 47, with two years three months' service.—Lungs show rather numerous simple silicotic nodules with occasional tuberculo-silicotic nodules. A little caseous broncho-pneumonia and a terminal miliary tuberculosis. Tuberculo-silicosis of clavicular, tracheo-bronchial, sternal, diaphragmatic, portal and pancreatic glands. A few caseous nodules in the spleen, many small foci in the liver and a few in each kidney. Tuberculous peritonitis. The interesting feature lay in the heart—the pericardium was thickened and adherent but showed no gross tuberculous character, but there was a big caseating mass in the wall of the right auricle, extending through the wall and protruding into and almost filling up the cavity of the auricle although not leading to thrombosis or adhesion to the inner wall.

(212) Mchopi, with 17 years 11 months' service.—Very slight silicotic and tuberculo-silicotic lesions in lungs. Fairly well-marked tuberculo-silicotic lesions in cervical, clavicular, thoracic, diaphragmatic and abdominal glands. Nothing else found to account for death beyond caseation in various glands.

(227) Fingo, *aet.* 40, with about four years' service.—Very striking involvement of cervical and mesenteric glands with recent acute caseating excavating phthisis of lungs on top of older tuberculo-silicotic lesions.

(231) In addition to gross areas of tuberculo-silicotic fibrotic consolidation with excavation, there was well-marked tuberculous ulceration of the larynx.

(275) Bechuana, *aet.* 45, with ten years' mining service.—Had numerous simple silicotic nodules and a little tuberculo-silicosis. There was recent acute caseating tuberculosis in various glands and organs, including erosion of the lumbar vertebrae with formation of a psoas abscess.

(276) Shangaan, *aet.* 42.—There was very little pigment in the lungs and his mining service was estimated at one or two years, but enquiry proved that he had ten years five months' service. There were a few discrete tuberculo-silicotic nodules in the lungs but in contrast with the lung condition there was a striking pigmentation or actual tuberculo-silicotic condition in the clavicular, tracheo-bronchial, diaphragmatic, upper and lower retro-peritoneal glands, but missing the portals.

(291) Shangaan, *aet.* 48, with eight years' mining service.—Slight simple silicotic and tuberculo-silicotic lesions in the lungs. Both chains of internal mammary glands rather striking, tuberculo-silicotic in character. The topmost made a good clavicular gland. Diaphragmatic glands, both anterior and posterior, were also well-marked tuberculo-silicotic in character. No noticeable sub-parietal-pleural pigment.

(293) Swazi, *aet.* 53.—Only mining history obtained was of one year's service, ten years previously. Recently had done only a few days' surface work. Had fairly well-marked tuberculo-silicosis in lungs and glands, but the striking feature was the enormous spleen with huge caseous areas.

(297) Shangaan, *aet.* 40, with nine years eleven months' service.—Advanced tuberculo-silicotic lesions in lungs and numerous groups of glands and a striking chronic fibro-caseous tuberculosis of the left suprarenal. There was tuberculo-silicosis in the adjacent retro-peritoneal glands.

(304) Tonga, *aet.* 40, with six years five months' service.—Scanty silicotic and tuberculo-silicotic nodules in the lungs and tuberculo-silicosis of tracheo-bronchial glands. Caseating phthisis with excavation of right lung. Considerable glandular spread and small lesions in liver, spleen and one suprarenal. Extensive caseation in testicles, seminal vesicles and prostate with early ulceration in bladder. Nothing in kidneys.

(309) Shangaan, *aet.* 32.—Service not obtained. Tuberculo-silicotic lesions of whole "tuberculo-silicotic" zone and also the lower retro-peritoneal glands. Caseating pulmonary phthisis, scanty caseous foci in liver. Early ulcers in ileum and caseation in both epididymes.

(314) Xosa, *aet.* 55.—Record of continuous service for 18 years, but only the first month of this was underground. There are small inconspicuous foci in the lungs that might be called tuberculo-silicotic and some of the tracheo-bronchial glands are definitely of this type, hence the inclusion of the case in this group. Actually, the case might be described as one of ordinary chronic phthisis of European type. Lungs very adherent. Lungs considerably pigmented. Very little caseation apparent, the condition being one of chronic fibroid phthisis with gross excavation. There had been a terminal haemorrhage of about 10oz. blood. Sternal glands pigmented, but not hard. Pericardium thickened, opaque and adherent in places. Pigmentation but no fibrosis or caseation of upper and lower retro-peritoneal glands. No tuberculosis of any of the abdominal organs. One calcified gland in the lowest loop of the mesentery which, in this situation, was thick and opaque. There was no ulceration in the bowel, and no other tuberculous glands in the mesentery. The appearances suggested old attacks of localized peritonitis and pericarditis which had been completely arrested, leaving only the chronic fibroid phthisis.

(322) Fingo, *aet.* 46.—Had four years nine months' mining service prior to 1916, in which year he received compensation for tuberculosis. Death in 1928. The left lung was fairly uniformly pigmented throughout and showed some silicotic and tuberculo-silicotic nodules. The right lung showed a collapsed lower lobe, evidently of old standing from a tuberculous pleurisy. The collapsed lobe was much fibrosed, with bronchiectatic

cavities and areas of recent caseation. The collapsed lobe and the middle lobe were practically free from pigment, whilst the upper lobe was deeply pigmented, but there were no silicotic lesions in the right lung. Clavicular and tracheo-bronchial glands tuberculo-silicotic. No lesions below the diaphragm.

(346) Fingo, *aet.* 48.—Service not ascertained. Lungs pigmented but no palpable fibrosis. Tracheo-bronchial glands tuberculo-silicotic; one breaking down with some caseation in the lung nearby=hilus tubercle. There was also a fistulous opening into the oesophagus.

(363) Shangaan, *aet.* 42.—Service not ascertained. Sent to hospital as a case of epilepsy. Had slight tuberculo-silicotic lesions in lungs, thoracic and abdominal glands, also tuberculous ulceration of the intestine. There were large tuberculomata (*a*) of the right suprarenal, (*b*) in the right lobe of the cerebellum.

(365) Mchopi, *aet.* 47, with eleven years ten months' service.—Tuberculo-silicotic lesions in lungs, thoracic and abdominal glands. Caseation in spleen, liver and one suprarenal. Erosion of mid-dorsal vertebrae by direct extension backwards of caseation from thoracic glands.

(371) Shangaan, *aet.* 35, with two years six months' service recorded, but almost certainly must have had more.—Tuberculo-silicotic lesions in lungs and well-marked in clavicular, tracheo-bronchial, diaphragmatic, portal and pancreatic glands. Numerous adhesions and some caseous nodules in peritoneal cavity=a partially-healed tuberculous peritonitis. Oesophageal fistula connected with a breaking down tracheo-bronchial gland.

(383) Zulu, *aet.* 58, with one year four months' service recorded, but almost certainly must have had more.—An acute caseating excavating phthisis. Tuberculo-silicotic lesions in tracheo-bronchial glands only; one of these is breaking down and there is an ulcer in the oesophagus just opposite the gland, *i.e.*, an oesophageal fistula in the process of formation.

(392) Pondo, *aet.* 42, with two years eleven months' service.—Lungs show scanty small silicotic nodules and an excavating phthisis of the left upper lobe. Tuberculo-silicotic lesions of the tracheo-bronchial and diaphragmatic glands. Oesophageal fistula connected with one of the former; looks as if it were of some standing.

(407) Shangaan, *aet.* 42.—Service not ascertained. Scanty tuberculo-silicotic nodules in lungs and lightly affected tracheo-bronchial glands. Both apices show extensive excavation with a certain amount of fibrosis tending to wall-off the cavities, *i.e.*, an approach to the European adult type.

(411) Nyambaan, *aet.* 43.—Service not ascertained. Silicotic and tuberculo-silicotic lesions in lungs, also extensive caseation. Well-marked tuberculo-silicosis of clavicular, tracheo-bronchial, diaphragmatic and pancreatic glands, many of them being partially calcified. Tuberculo-silicotic glands alongside the suprarenals, one of which is largely caseous and partly calcified, the other being almost entirely caseous.

(430) Pondo, *aet.* 51, with five years' service.—Chronic hilus tuberculosis spreading from tuberculo-silicotic root glands. Adhesions between these glands and the oesophagus, suggesting a step towards fistula formation.

(431) Shangaan, *aet.* 44, with four years ten months' service.—Chronic lung and thoracic glandular lesions which might be labelled either pigmented tubercle or early tuberculo-silicosis. Also fairly extensive involvement of both kidneys, testicles, vesiculae seminales and prostate.

(432) Msutu, *aet.* 45, with seven months' recorded service, but almost certainly must have had more.—Definite gross areas of tuberculo-silicotic fibrotic consolidation in one lung. Adherent pericardium and a large tuberculoma involving the wall of the right auricle and ventricle.

(446) Mchopi, *aet.* 34, with seven years six months' service.—Lungs show a fair amount of pigmentation and some light steel-grey coloured nodules of tuberculo-silicosis, but the main pulmonary lesion is an excavating phthisis with a considerable amount of fibrosis, *i.e.*, of adult European type.

(M 52) Nyambaan, *aet.* 34, with six years three months' service.—Lungs show scanty discrete tuberculo-silicotic nodules and slight development of acute caseating broncho-pneumonia. Tuberculo-silicosis of tracheo-bronchial glands. Immediate cause of death was a tuberculous meningitis, the only lesion other than those mentioned.

(M 57) Mchopi, *aet.* 40, with nine years eight months' service.—Some silicotic and more numerous tuberculo-silicotic nodules in the lungs; also miliary tuberculosis. Old pleural adhesions. Tuberculo-silicosis of tracheo-bronchial, diaphragmatic and portal glands. Tuberculosis of upper and lower retro-peritoneal and mesenteric glands. Miliary tubercles in liver and spleen. Tuberculous peritonitis. Tuberculous meningitis. An abscess in the right thigh going down to bone (for which he was originally admitted to hospital and which did not heal up). Query: Tuberculous?

(M 238) Shangaan, *aet.* 46, with ten years five months' service.—Admitted to hospital with necrosis of right foot, which histological examination showed to be tuberculous. Death five months later. Condition still present in foot, inguinal glands also affected. The only other lesions found were slight silicosis of lungs and tracheo-bronchial glands.

(M 240) Mchopi, *aet.* 54, with four years three months' service.—Admitted to hospital for persistent headache. This lasted, with intermissions, until death about five months later. At the post-mortem examination there was found extensive tuberculous meningitis. The lungs showed silicotic fibrosis with foci of active caseating tuberculosis.

TUBERCULOSIS UNCOMPLICATED BY SILICOSIS AS THE CAUSE OF DEATH.

Under this heading fall 338 cases, and all, with two exceptions (see Cases 189 and 439 below) may be said to be cases of approximately "natural" tuberculosis. The cases may be further divided into two groups:—

(*a*) Group C, comprising 241 cases, referred to as "thoracic cases," in which the lesions are either predominatingly thoracic, or in which, although the lesions might be about equally prominent in the thorax and in the abdomen, the starting point was almost certainly in the thorax.

(*b*) Group D, comprising 97 cases, referred to as "extra-thoracic cases," in which the main lesions are not in the thorax, but in the abdomen or elsewhere. This does not imply, however, as will be seen in the analysis of these cases, that the starting point of the disease may not have been in the thorax, although the brunt of the disease has not been felt there.

GROUP C.—241 THORACIC CASES.

For tribal distribution, see Table III (p. 378). Tables VIII and IX show their age and service distribution.

TABLE VIII.

AGES.

Under 20	10
20–29	134
30–39	46
40–49	36
50 and over	2
Not ascertained	13
	241

TABLE IX.

SERVICE.

Under 1 month	24	
,, 2 months	15	
,, 3 ,, ...	16	127
,, 6 ,, ...	29	
,, 12 ,, ...	43	
1–2 years		34
2–3 ,, ...		20
Over 3 years		45
Not Ascertained		15
		241

It will be noted that this group presents a marked contrast to Group B—the cases associated with silicosis. More than half the cases occur in boys under 30 and rather over half have died before completing one year's service. Further, it may be noted that 126 out of the total 241 occur in the mine medical officers' series of 243 cases, which means that half of their deaths were cases running so acute a course that there was never any question of sending them to the W.N.L.A. hospital for consideration of repatriation.

Character and Distribution of the Various Lesions.

LUNGS.

Acute Caseating Tuberculosis	70
Acute Caseating Tuberculosis with Excavation ...	102
Miliary Tuberculosis only	53
No Tuberculosis in Lungs	16
	241

Of the 16 cases showing no pulmonary tuberculosis, 8 were cases of tuberculous pericarditis; 3 had both tuberculous pericarditis and tuberculous pleurisy; 3 were cases of tuberculous pleurisy in which, in one case, there was also some spread below the diaphragm, and in another there was also tuberculous peritonitis; one showed caseation in the paratracheal glands and a few caseous specks in both liver and spleen, otherwise there was only thickening of one pleura, possibly tuberculous; one showed extensive caseation of various thoracic glands with some direct spread on to both pleurae, but no involvement of actual lung substance.

Of the 53 cases showing miliary tuberculosis only, 42 occurred in the mine medical officers' series. In one case there was a tuberculous pericarditis. With the possible exception of two cases (quoted below, Nos. M 65 and M 87), the origin of the miliary spread appeared to be from thoracic glands, hence the inclusion of those cases in the " thoracic " group, although the miliary spread practically always involved the abdominal organs equally with the lungs. Miliary tuberculosis was, of course, present also in some of the cases of caseating phthisis, but it did not seem to be of any importance to enumerate these separately.

Microscopic examination of sections showed that much of the "miliary tuberculosis" of lungs was really a caseous acinar pneumonia rather than miliary tuberculosis *sensu stricto*.

In 3 cases (quoted below, Nos. 55, 117 and 196) the probable original focus was abdominal, although the cases are included in this group from the character of the thoracic lesions. Case 272 may also possibly belong to this category.

Amongst the cases of caseating phthisis only 2 could be said to be of the frankly "pneumonic" type (Nos. 56 and 433 quoted below). The great majority were of broncho-pneumonic type, although in at least 6 or 7 of these there were more or less extensive areas of confluent broncho-pneumonia giving rise to appearances very similar to true pneumonic phthisis. In a few the spread was rather a direct local one in the neighbourhood of infected hilus glands, *i.e.*, "hilus tubercle."

Pleurae.—Definite tuberculous pleurisy was present in 89 cases.

Heart and Pericardium.—Definite tuberculous pericarditis was present in 54 cases. In 8 cases the pericardium was adherent, possibly, although not certainly, as a result of tubercle. In 3 cases (Nos. 25, 68 and 216) there were tuberculomata involving the wall of the right auricle without any generalized pericarditis.

Lymphatic Glands.—The total number of cases in which the various glandular groups were the seat of tuberculous adenitis is shown in the following list :—

Cervical	45
Clavicular	58
Tracheo-bronchial	235
Diaphragmatic	75
Portal	109
Pancreatic	111
Lower Retro-peritoneal	55
Mesenteric	75
Inguinal	1
Axillary	2

The involvement of the cervical glands was seldom very extensive. Practically always it was only the lowermost glands which were involved, and the process appeared to be usually of the nature of a spread upwards from the paratracheal glands rather than a primary involvement. Cases of primary involvement of the cervical glands are probably not so very uncommon, but no recruit showing them would be accepted, so it is not surprising that they should not figure in this series. Even as it is, possibly some of the cases included in this group should more properly have figured in the next, the "clavicular."

The term "clavicular" glands has been introduced to cover the glands termed by Borrel[2] "sus-claviculaire." He states that this gland (or glands) may be felt on deep palpation above and behind the clavicle either just internal or just external to the insertion of the sterno-cleido-mastoid. Amongst the Senegalese he found the presence of a palpable gland in this region to be the earliest objective sign of the onset of

tuberculosis in about 64 per cent. of cases. At autopsy, its involvement appeared to be dependent upon the condition of the tracheo-bronchial glands—if the claviculars were affected in 75 per cent. of cases, the tracheo-bronchials would be affected in 85 per cent. He quotes Sergent as having previously related affection of these glands with an apical pleuritis, but does not agree that this is necessarily the case. Amongst the Malagasy he found involvement of this gland in an average of only 30 per cent. of cases. He states that the tuberculosis of Madagascar differs from the tuberculosis of Senegal and more nearly approaches the European type.

It appeared to us to be of interest to see what the South African Native would show in this connexion. Clinically, we had no information as to what would be found. At autopsy we must confess we have comparatively seldom found a gland occupying exactly the position described, although more frequently we have found a gland or glands lying fairly near that position, but such glands might apparently belong to any one of the following four groups, viz., the cervical (a very low member), the internal mammary or sternal (a rather high member), the anterior mediastinal or even the tracheo-bronchial. We consider that we have strained the definition to the utmost by including so many as 58 cases under this heading, but in any case it would seem that amongst the South African Natives the position more nearly resembles that found in the Malagasy rather than that found in the Senegalese.

Spleen.—Involved to a greater or lesser extent in 174 cases. In many the condition was that of the typical " monkey spleen," numerous rounded caseous areas varying in size up to about 2c.m. in diameter, and often of soft consistence.

Liver.—Involved in 145 cases. Often only a miliary tuberculosis ; when definitely caseous, the nodules were seldom of any great size.

Kidneys.—One or both kidneys involved in 73 cases. Here again the tuberculous process was never extensive, consisting either of miliary tubercles or of a few small areas of caseation.

Suprarenals.—One or both affected in 20 cases. No case of extensive caseation of these glands.

Intestine.—Tubercles or actual ulceration in 59 cases. Always secondary to the swallowing of tubercle bacilli from the lungs.

Peritoneum.—Tuberculous peritonitis in 56 cases.

Brain and Meninges.—Moningitis recorded in 3 cases but the brain and meninges were only examined in cases where definite head symptoms had been noted. It is possible, therefore, that further early cases would have been detected had systematic cranial examinations been made.

Bone and Joint.—3 cases certain, 2 others possible (see Nos. 40, 131, M 15, M 30 and M 104 below).

Cases of Individual Interest.

(25) Shangaan, *aet.* 21, with one year eleven months' service.—An acute caseating tuberculous broncho-pneumonia in both lungs with commencing cavity formation. Several of the tracheo-bronchial glands show small areas of caseation. Recent ulceration in the ileum just above the ileo-caecal valve and some caseation in the corresponding glands in the mesentery. The only other involvement was a caseous mass in the wall of the right auricle extending through the wall and projecting into the lumen, in which there was an additional thrombosis. There was no pericarditis or direct extension into the auricular wall of the caseation from outside.

(40) Shangaan, *aet.* 25, with ten months' service.—Acute caseating tuberculous bronchopneumonia in right lung. Left similar but not so advanced. Lowermost cervical glands show several which are hard, but with some caseation. Tracheo-bronchial glands much enlarged, very little pigment, some fibrosis, much caseation. Portal and both upper and lower retro-peritoneal glands caseous. Spleen and both kidneys show a few caseous foci. Recent ulcers in ileum. Upper dorsal vertebrae, clavicles and sternum showing acute tuberculous caries.

(55) Shangaan, *aet.* 20.—New recruit and from condition of lungs had obviously not been on the Reef before. Death after 21 days in hospital. Lungs completely free from pigment. Some recent haemorrhagic pleural adhesions. An acute tuberculous broncho-pneumonia involving the whole of both lungs—caseation but no cavitation. The tracheo-bronchial glands show no pigment; they are considerably enlarged, succulent and show a few early tubercles. The upper retro-peritoneal glands show some enlargement with one gland considerably caseous and apparently older than any other focus. No other involvements. This case is of interest from two points of view: (1) As probably a primarily abdominal case, and (2) as indicative of the rapidity with which tuberculosis can develop and run to a fatal issue. Apart from the initial infection, the whole course here must have been run within a month.

(56) Pondo, *aet.* 26, with two years two months' service.—Tuberculous pneumonia affecting the whole of the left lung except a small wedge at the base. Commencing cavity formation in the centre of each lobe. Haemorrhagic pleural exudate and thickening. Right lung shows acute bronchopneumonic and miliary tuberculosis. Tracheo-bronchial glands enlarged, centrally black and fibrosed with periphery showing numerous recent tubercles. Portal and upper retro-peritoneal glands also showing recent tubercles. Typical "monkey spleen" and numerous minute caseous foci in the liver.

(68) Msutu, *aet.* 45.—Mining service not obtained. Very little pigment in the lungs, rather more in the bronchial glands. Left lung collapsed from a thick tuberculous pleurisy, no tubercle in the lung itself. Right lung shows some caseous areas between the hilus and base due to direct spread from inferior tracheo-bronchial glands. Several of these tracheo-bronchial glands show caseation, and one has broken down and shows a direct opening into a bronchus of the right lower lobe. There is a caseous nodule in the wall of the right auricular appendix with thrombosis internally, but no pericarditis. The spleen shows early "monkey spleen" tuberculosis and there are a few white tubercles in the liver.

(117) Mchopi, *aet.* 38, with five years five months' service.—Little pigment in the lungs. Dense pleural adhesions over right lung, which has a large cavity in the upper lobe into which there has been considerable haemorrhage. Pneumonic phthisis (probably confluent broncho-pneumonic) of the rest of the upper lobe and broncho-pneumonic phthisis of the other two lobes. Left lung shows only a few caseous nodules. Tracheo-bronchial glands enlarged, pigmented and caseous, almost tuberculo-silicotic in character. Pigmentation and caseation in portal and upper retro-peritoneal glands. In the mesentery are several calcified glands, indicating what was probably the original focus of infection in the body.

(131) Shangaan, *aet.* 20, a recent arrival but service not definitely ascertained.—Lungs practically unpigmented, but showing an acute caseating phthisis spread over the whole of both lungs. Recent pleural adhesions present. Tracheo-bronchial glands show no obvious tubercles. Miliary tubercles in spleen, liver and kidneys. Tuberculous

ulceration in ileum and appendix with fairly numerous recently caseated mesenteric glands. There is a well-marked lateral curvature of the spine involving practically the whole of the dorsal spine, possibly evidence of old tuberculosis, although there is no definite signs of it in any of the vertebrae.

(189) Tonga, *aet.* 46, with six years eight months' service.—Very little pigment in the lungs; rather more in the tracheo-bronchial glands but nothing that could be called silicosis. Lungs approaching the European type of ordinary chronic phthisis; they show excavation in both lungs, but there is a definite fibrosis going on around the cavities. Some tuberculous granulation tissue on both pleurae. Some recent tubercles in the tracheo-bronchial glands, and one with an old calcareous lesion. Portal glands slightly caseous, but there is a marked involvement of the whole retro-peritoneal chain from the diaphragm down to the iliacs. Both kidneys show fairly large caseous areas *beginning to break down. Recent tubercles in Peyer's patches in the ileum.* There was not much caseation in the retro-peritoneal glands, the glands being rather of the "large cell hyperplasia" type, as is the case in most instances where there is this extensive glandular involvement. The naked eye appearance is very like that of Hodgkin's disease. From one of the glands an acid-fast organism with characters rather like an avian tubercle bacillus was grown.

(190) Nyambaan, *aet.* 26, with three years eleven months' service, but last worked nearly three years ago. Very little pigment in the lungs or tracheo-bronchial glands and illustrative of the way in which the lungs can become cleared of pigment on absence from the mines and in the absence of pulmonary lesions. There was no discoverable lung lesion in this case, although the left lung was considerably collapsed, the pleura much thickened and showing organizing granulation tissue. This did not appear to be tuberculous, however. One paratracheal gland showed marked enlargement and caseation. The portal glands were caseous and there were small tubercles just beginning to caseate in the liver and spleen. Although the lesions present seem scarcely sufficient to account for death, no other cause was found.

(196) Msutu, *aet.* 40, with two years six months' service.—Acute caseating broncho-pneumonic phthisis with excavation. Some caseation in the tracheo-bronchial glands and in the spleen. In the mesentery of the uppermost loop of the jejeunum were several caseo-calcareous glands, apparently the oldest focus in the body.

(216) Swazi, *aet.* 40.—New recruit, but lungs suggested that he had had previous service. Miliary tuberculosis in lungs and spleen with caseation in some groups of glands. Pericardium adherent all over, but for the greater part shows no gross tuberculosis. In the right auricle there is a mass about the shape and size of a goose egg, extremely caseous.

(272) Xosa, *aet.* 34, with one year eight months' mining service.— Acute excavating phthisis of left lung. Very few recent tubercles in tracheo-bronchial glands. Two calcified glands in the mesentery, one the size of a pigeon's egg, the other rather smaller. Query: Were they the original focus of infection?

(277) Fingo, *aet.* 23.—Service not obtained. Miliary tuberculosis of lungs without *older lesions. Tracheo-bronchial and paratracheal glands extensively fibrosed and* caseous. Generalized tuberculous peritonitis. There is also spread of the tuberculosis into the substance of the pancreas.

(323) Bechuana, *aet.* 30.—New recruit, nothing suggestive of previous service. Large, acute cavity in right apex and recent caseating broncho-pneumonic spread throughout the rest of the lungs. A few recent tubercles in the tracheo-bronchial glands but no gross caseation. No other lesions.

(333) Bechuana, *aet.* 25, with three months' service.—Large caseous clavicular and tracheo-bronchial glands. Big caseous areas in spleen. Miliary tubercles in lungs and liver.

(354) Nyambaan, *aet.* 26, with three years four months' service.—Acute caseting broncho-pneumonic tubercle of lungs. Caseation in spleen, liver, kidneys and many gland groups. Ulcerated larynx. Tuberculous mediastinitis and haemorrhagic caseous areas in the pancreas, near its tail. The oldest lesions appear to be those in the tracheo-bronchial glands.

(360) Msutu, *aet.* 23, with four months' service.—Apparently primary focus in tracheo-bronchial glands. Caseation in many other gland groups, also in spleen and liver. Acute cascating pulmonary phthisis. Caseous areas in pancreas apparently caused in this instance by direct extension from pancreatico-lienal glands.

(361) Msutu, *aet.* 29, with one year nine months' service.—Caseation in all the internal gland groups, also in the axillary glands. Lungs, trachea, liver, spleen and pancreas all affected, the last by direct extension from neighbouring glands.

(433) Xosa, *aet.* 38, with three years eight months' service.—Pneumonic phthisis affecting whole of right upper lobe. One caseous tracheo-bronchial gland and numerous glands of that group pigmented but not obviously tuberculous. No other lesions.

(439) Xosa, *aet.* 36, with one year nine months' service.—Excavating phthisis but with a certain amount of repair, an approach to the ordinary European type. Most of the pigment in the lungs is collected around cascating areas.

(442) Xosa, *aet.* 36, with three years' service.—Extensive involvement of thoracic glands—a huge packet of matted caseous glands. Some hilus tubercle in each lung by direct spread out from root glands. Some abdominal glands also fairly large and caseous.

(M 12) Mchopi, *aet.* 22, with only 17 days' surface service.—Marked caseation in the tracheo-bronchial and portal glands and some in the diaphragmatic and upper retro-peritoneal. Left tuberculous pleurisy. Miliary tubercles in lungs, pericardium, spleen, liver and kidneys.

(M 15) Nyambaan, *aet.* 25, with one month's service.—Caseous tracheo-bronchial glands. Excavation of right lung. Left tuberculous pleurisy. Miliary tuberculosis of lungs, spleen and liver. Pus in the right hip-joint, probably tuberculous.

(M 30) Shangaan, *aet.* 22, with one month's service.—Acute caseating phthisis of left lung with excavation and of right lung without excavation. Pleural effusion on left side. Capsule of left hip-joint disorganized with almost complete erosion and dislocation of the head of the femur.

(M 65) Msutu with one month's service.—Miliary tuberculosis of lungs, spleen, liver and kidneys. No definite source for the spread reported, although the cervical, clavicular and thoracic glands were reported as fibrosed, but not caseous.

(M 87) Nyambaan, *aet.* 22, with one month's service.—Miliary tuberculosis of lungs, spleen, liver and kidneys, but no source for the spread reported.

The above 5 cases, apart from any individual interest they may have, show in common the rapid and extensive development which tuberculosis may have within a very short period.

(M 77) Msutu, *aet.* 22, with six months' service.—Pericarditis and caseous mediastinal glands. No obvious lung involvement (checked by Dr. A. Sutherland Strachan), although one sputum (out of five specimens examined) was reported positive for tubercle bacilli. No other lesions.

(M 90) Msutu, *aet.* 24, with one year three months' service.—Miliary tuberculosis in lungs, spleen and liver. Pleural effusion. No definite origin for the miliary spread reported.

(M 104) Xosa, *aet.* 25, with one year six months' service.—Tracheo-bronchial and many other glands affected. Tuberculous pleurisy. Caries of 11th and 12th right ribs and transverse vertebral processes. Terminal general miliary spread.

(M 106) Msutu, *aet.* 22, with one year six months' service.—Admitted to hospital as a case of broncho-pneumonia. 23 specimens of sputum showed no tubercle bacilli; in the 24th, collected shortly before death, they were found. Tracheo-bronchial and other glands were caseous, the lungs showed only miliary tuberculosis.

(M 112) Swazi, *aet.* 23, with two months' service.—In hospital for four days only; said to have felt ill for a week before that but had not been off work. Caseating phthisis with excavation in right lower lobe. Tuberculous peritonitis and caseous areas in liver and spleen.

(M 120) Pondo, *aet.* 26, with one year four months' service.—Admitted to hospital with much enlarged cervical glands, which soon broke down. Died with tuberculous pleurisy and peritonitis and a generalized miliary spread.

(M 214) Xosa, *aet.* 38, with three years six months' service.—Tuberculous pericarditis with caseation in spleen, liver and both testes. No pulmonary lesions.

(M 219) Msutu, *aet.* 25, with one month's service.—Admitted to hospital as suspected enteric, but progress of case negatived that diagnosis. 15 negative sputa, then 1 positive for tubercle bacilli. Caseating phthisis of left lung. Tuberculous pleurisy and peritonitis. Caseation in spleen, liver, kidneys and suprarenals.

(M 225) Pondo, *aet.* 46, with three years' service.—Worked on "hammers" up to two days before death. Tuberculous pericarditis and peritonitis. Caseation in spleen and liver. No pulmonary lesions.

Group D.—97 Cases with Lesions Mainly Extra-thoracic.

In this group of cases, although pulmonary lesions may have been present, *the main brunt of the disease fell elsewhere—in abdominal*, genito-urinary or cerebral organs, or on bone or joint. This does not imply, however, that the initial lesion was necessarily also extra-thoracic, indeed, in the great majority it certainly was not, but was located either in the lungs or in the tracheo-bronchial glands. Only in a small minority of cases did the initial lesion appear to be definitely extra-thoracic.

Tables X and XI show the age and service distribution of this group.

TABLE X.

Ages.

Under 20	4
20–29	40
30–39	31
40–49	16
50 and over	4
Not ascertained	2
	97

TABLE XI.

Service.

Under 1 year:		
Under 1 month	4	
„ 2 months	4	
„ 3 „	3	37
„ 6 „	7	
„ 12 „	19	
1–2 years		14
2–3 „		10
Over 3 years		24
Not ascertained		12
		97

It will be noted that the distribution as shown in these tables approximates more nearly to that occurring in Group C—the "thoracic" cases"—than to the cases in Group B—those cases in which the tuber-

culosis was associated with silicosis—although the proportion of cases of boys under 29 is not quite so high, nor is the proportion of cases occurring in those with under one year of service so large.

Table XII shows the number of times various organs and structures were involved in these 97 cases.

TABLE XII.

INVOLVEMENT OF VARIOUS ORGANS IN 97 "EXTRA-THORACIC" CASES.

Glands.	
Cervical	8
Clavicular	12
Tracheo-bronchial	65
Diaphragmatic	29
Pancreatic	54
Lower Retro-peritoneal	48
Portal	46
Mesenteric	39
Axillary	1
Lungs.	
Caseation	16
Miliary Tuberculosis only	34
Pleurae.	
Marked Old Adhesions	13
Definite Tuberculous Pleurisy	19
Heart and Pericardium.	
Definite Tuberculous Pericarditis	5
Adhesions, possibly Tuberculous	4
Spleen	74
Liver	61
Kidneys	32
Suprarenals	15
Peritoneum	50
Intestine	12
Brain or Meninges	5
Bone or Joint	9
Genitalia	4

In 6 cases only (see Nos. 2, 13, 63, 75, 388 and M 218) did the primary invasion appear to have been by the abdominal route with the initial lesion in mesenteric or other group of abdominal glands. At all events, it can be said definitely of these 6 cases that there was no obvious old caseation or scarring either in the lungs or tracheo-bronchial glands, but the possibility of there having been minute foci in the lungs which might have been detected by X-rays, although they were not discoverable by ordinary methods of examination, cannot be excluded.

In 8 other cases the invasion was possibly by the abdominal route, but it was not quite certain, as these cases showed some fibrosis of tracheo-bronchial glands which might have been tuberculous in origin, although it did not appear to be so.

Amongst the mine medical officers' cases there were also 3 cases reported with tuberculous lesions limited to the spleen; 1 with lesions limited to the spleen, cervical and axillary glands; 1 with lesions

limited to one kidney; 1 with lesions limited to one kidney and a *mesenteric gland*; 1 with *lesions limited to the genito-urinary tract*, except for a terminal miliary involvement of the lungs; and 1 with lesions limited to the cerebellum and meninges. In these 8 cases, however, we are not satisfied that the examination of all the gland *groups was sufficiently meticulous to exclude the possibility of small* old lesions in some of the thoracic glands.

In the other 75 cases, although the main lesions were extra-thoracic, invasion had practically certainly occurred by the thoracic route.

Bone or joint involvement was noted in 9 cases (see Nos. 9, 381, 388, M 1, M 21, M 60, M 85, M 96 and M 224). In 6 of these the spine was involved and in 1 each the hip-joint, the foot, and the sternum, the last being a case of direct extension of the disease from clavicular glands.

In 5 cases (237, M 82, M 189, M 194 and M 218) the lesions were almost limited to the genito-urinary tract, and in 2 cases (M 6 and M 41) to the nervous system.

Cases of Individual Interest.

(2) Xosa, *aet.* 25, with seven months' service.—Lungs show only a slight terminal miliary tuberculosis. Cervical and thoracic glands unaffected. Considerable enlargement and caseation of mesenteric glands and still more markedly of the lower retro-peritoneal glands. Liver shows miliary tubercles and also "bile abscesses" of some size from breaking down of caseous nodules. Miliary tubercles in spleen. Only one kidney present—this shows several large caseous areas, and there is caseation in the testicles, seminal vesicles and prostate, and early tubercles in the mucosa of the bladder. Tuberculous meningitis also.

(9) Shangaan, *aet.* 37.—Service not obtained. A few small caseous foci in lungs. Pleurae show diffuse old thickening. No caseation in any glands except some just above the right Poupart ligament. Spleen, liver and kidneys all show some small caseous *foci. There is lordosis and lateral curvature of the lumbar spine. No apparent* bare bone about the lumbar vertebrae but some about the right iliac synchondrosis. Infection has tracked from there along the psoas with some involvement of the right pubic bone. Abscess discharging in Scarpa's triangle and many enlarged casco-purulent inguinal glands.

(13) Tonga, *aet.* 39.—Service not obtained. Lungs, cervical and thoracic glands normal. Mesenteric and retro-peritoneal glands similar to Case (2) above. Caseous areas in spleen and liver.

(39) East Coast Native, *aet.* 45.—Service not ascertained. Tuberculous peritonitis and mass of old glands at root of mesentery breaking down in centre to form a cold abscess. No definite involvement of any organs. One old pigmented fibrotic tracheo-bronchial gland, but showing no definite caseation.

(63) Tonga, *aet.* 22.—Rejected by mine on arrival. Death after 23 days in hospital. Total time on Reef, therefore, about one month. Lungs and thoracic glands practically *entirely unpigmented. Miliary tubercles in lungs and some recent haemorrhagic adhesions* over right pleura. Cervical and thoracic glands normal. Marked enlargement and caseation of portal and retro-peritoneal glands from the diaphragm down to the iliacs. Mesenterics only slightly enlarged and a few caseous. Spleen about three times normal size and of "monkey" type. Miliary tubercles in liver and kidneys. The left kidney *also shows one large caseous focus.*

(75) Msutu, *aet.* 24.—Service not obtained. Very little pigment in lungs or glands. Lungs, cervical and thoracic glands show no lesions. One large portal gland with early caseation and whole chain of retro-peritoneal glands enlarged and caseous. Mesenterics practically unaffected. "Monkey spleen," miliary tubercles in liver and kidneys.

(76) Msutu, *aet.* 26, with seven months' service.—No tuberculosis in lungs but right collapsed from pleural effusion. Some caseation in sternal and tracheo-bronchial glands. Caseation in lower retro-peritoneal group only of abdominal glands. Tuberculous peritonitis and a few caseous nodules in liver and spleen.

(77) Shangaan, *aet.* 30, with one year nine months' service.—Lungs show a little caseating broncho-pneumonic phthisis in each lung. Some caseation in tracheo-bronchial and sternal glands. Portal glands, mesenteric glands and whole chain of retro-peritoneal glands from diaphragm to pelvis much enlarged, hard, with some caseation. Large caseous areas in spleen and kidneys, numerous small caseous areas in liver, ulcers in ileum.

(120) Msutu, *aet.* 28, with two months' service.—Miliary tubercles only in lungs, but some caseous nodules on pleurae. Some caseation in tracheo-bronchial glands. Marked caseation in many abdominal glands and in the spleen and liver.

(124) Xosa, *aet.* 27, with 9½ months' service.—Extensive caseation in almost all the abdominal glands, also in spleen and liver. Lungs show miliary tubercles throughout and there is a small cavity of recent origin near right apex and a few caseous areas elsewhere. Tracheo-bronchial and diaphragmatic glands caseous.

(128) Msutu, *aet.* 35.—Service unobtained but probably about one year. Miliary tubercles only in lungs but some caseation and fibrosis of tracheo-bronchial glands. Caseation of many abdominal glands; in the mesenteries those of the uppermost loop of the jejeunum being most affected. Tuberculous peritonitis and caseation in both kidneys and suprarenals.

(208) Shangaan, *aet.* 25, with two months' service.—Lungs and thoracic glands practically unpigmented. Acute caseation in lungs, spleen and liver. Tracheo-bronchial glands caseous. Abdominal glands extensively involved, hard, but with a considerable amount of caseation also.

(209) Xosa, *aet.* 30, with under one month's service.—Practically no pigmentation. Scar at left apex with some caseation and a small cavity underneath. Calcified gland in gastro-hepatic omentum and caseo-calcification of portal and pancreatic glands. A similar condition in the mesenteric glands, corresponding to the lower end of the ileum and the upper end of the jejeunum. Small caseous foci in liver and right suprarenal.

(237) Msutu, *aet.* 42, with one year seven months' service.—Kidneys, ureters and bladder severely affected, also the spleen. Slight recent caseation in lungs. Some caseation in both thoracic and abdominal glands.

(268) Shangaan, *aet.* 22, with under a month's service.—Recent acute and extensive caseation in tracheo-bronchial, upper retro-peritoneal and portal glands, also in the spleen and liver.

(274) Msutu, *aet.* 24, with eight months' service.—Extensive and all apparently recent caseation in all groups of glands except the mesenterics. Tuberculous peritonitis and some caseation in spleen, liver and suprarenals.

(294) Shangaan, *aet.* 24, with eight months' service.—Tuberculous peritonitis, "monkey spleen," small caseous areas in liver, kidneys and lungs. Some caseation in practically all gland groups, but the tracheo-bronchials show some fibrosis, which none of the others do, and are probably the oldest affected.

(318) Shangaan, *aet.* 24, with five months' service.—Has a small scar at right apex with some caseation and calcification underneath. A caseous gland right on top of this scar ("clavicular"?). Little pigment in the lungs but a fair amount in the hilus glands. Tracheo-bronchial glands not obviously caseous but the posterior mediastinals are, and there is a very striking enlargement of all the abdominal glands, right down to the iliacs, and also of the inguinals. The glands are all of the "large cell hyperplasia" type with little caseation. The involvement of the whole mesenteric chain is very striking, being obviously a spread against the lymph-flow from the retro-peritoneals.

(381) Shangaan, *aet.* 20.—Worked three shifts only. Was 50 days in hospital before death. Tuberculin reaction positive. Tuberculous erosion of the lumbar vertebrae and early psoas abscess formation. A few caseous nodules in both liver and spleen and miliary tubercles in lungs. Some caseation in almost all gland groups except the mesenteric.

(388) Fingo, *aet.* 34.—Only service recorded was five months' surface work. Tuberculous caries of lumbar spine with well-developed left psoas abscess. Caseation in both kidneys and suprarenals. Terminal miliary tubercles in lungs but no other lesion found above the diaphragm.

(427) Xosa, *aet.* 36, with ten months' service.—Remarkable mainly for the degree of involvement of the pancreas, almost the whole organ being entirely caseous. Elsewhere there were a few nodules in the spleen, and numerous small caseous areas in the liver. Slight involvement of tracheo-bronchial and of various abdominal glands.

(M 1) Pondo, *aet.* 26, with four years' service.—Caseous clavicular, tracheo-bronchial, upper and lower retro-peritoneal glands, some of the last mentioned being calcareous. Necrosis of sternum and second right costal cartilage by extension from the clavicular glands. Some pleural effusion and early tuberculous nodules on the pericardium. Caseous areas in right kidney.

(M 6) Msutu, *aet.* 28, with one year three months' service.—Tuberculous meningitis and two tuberculomata in the cerebellum. No other tuberculous lesions recorded.

(M 21) Shangaan, *aet.* 35, with 13 days' service only.—Tuberculous arthritis of left hip-joint. Miliary tubercles spleen, liver, kidneys and lungs, and on pericardium. Some pleural effusion. Caseous tracheo-bronchial and abdominal glands.

(M 41) Shangaan, *aet.* 28, with two years two months' service.—Tuberculous meningitis. Only other focus recorded was one small calcareous tracheo-bronchial gland.

(M 43) Msutu, *aet.* 30, with three years ten months' service.—Tuberculous peritonitis and terminal miliary spread. Tuberculous pleurisy. Tracheo-bronchial and all abdominal groups showing caseation.

(M 60) Tonga, age not ascertained, six years four months' service—Tuberculous arthritis of right fourth metatarsal-phalangeal joint. Caseous tracheo-bronchial, upper and lower retro-peritoneal and portal glands. Everything else reported free from tubercle, but cause of death not stated.

(M 82) Shangaan, *aet.* 50, with nine years one month's service.—Miliary tuberculosis of lungs. No record of any focus in thoracic or other glands. Caseation in left epididymis and in the prostate, also a few small foci in the kidneys.

(M 85) Mohopi, *aet.* 40, with three years' service.—Tuberculous caries of bodies of sixth, seventh and eighth dorsal vertebrae. Miliary tubercles in lungs, liver and spleen. Tuberculous pleural effusion on both sides. Caseous mediastinal and upper and lower retro-peritoneal glands.

(M 96) Shangaan, *aet.* 26, with five months' service.—Extensive caries of dorsal and lumbar vertebrae. Caseous spleen, miliary tubercles in lungs and liver. Caseous tracheo-bronchial, upper and lower retro-peritoneal glands.

(M 189) Shangaan, *aet.* 60.—Service not recorded. Had caseous tracheo-bronchial glands and caseation in right kidney, testes and prostate.

(M 194) Shangaan, *aet.* 22, with eleven months' service.—Only lesions recorded in right kidney.

(M 218) Msutu, *aet.* 23, with nine months' service.—Caseation in left kidney and one mesenteric gland.

(M 224) Pondo, *aet.* 48, with two years six months' service.—Caries of third and fourth cervical vertebrae with complete disorganization of the joint between. Caseation in low cervical and clavicular glands.

Form used in making reports upon which this analysis is based :

(*Form* 1 (*Path.*).)

TUBERCULOSIS RESEARCH COMMITTEE.

POST-MORTEM RECORD OF A CASE OF TUBERCULOSIS
or of
A CASE SHOWING TUBERCULOUS LESIONS.

Name ..... Tribe ..... Age .....

Mine ..... P.P. No. ..... Mine No .....

Underground Service { On Machines ..... y. ..... m. / Other Work ..... y. ..... m. } Tuberculin Test (if any) { Date ..... / Result ..... }

Surface Service ..... y. ..... m. Date of P.M. .....

.....
Medical Officer.

GLANDS.	NORMAL.	ABNORMAL.				
		Enlarged.	Pigmented.	Fibrosed.	Caseous.	Calcareous.
(a) Cervical						
(b) "Clavicular"						
(c) Hilus, Tracheo-bronchial and Mediastinal ...						
(d) Glands just above the diaphragm						
(e) Upper Retro-peritoneal ...						
(f) Lower Retro-peritoneal ...						
(g) Portal						
(h) Mesenteric						

LUNGS. (Types of Lesions to be Recorded.)	Lesion not Present.	Lesion Present.	
		Right.	Left.
(a) Excess of Pigmentation without Palpable Fibrosis			
(b) Small Black Simple Silicotic Nodules			
(c) Discrete Steel-grey Tuberculo-silicotic Nodules			
(d) Gross Areas of Tuberculo-silicotic Fibroid Consolidation			
(e) Gross Areas of Tuberculo-silicotic Fibroid Consolidation with Excavation			
(f) Miliary Tuberculosis			
(g) Caseating Tuberculosis, Broncho-pneumonic or Pneumonic...			
(h) Caseating Tuberculosis, Broncho-pneumonic or Pneumonic with Excavation			
(i) Chronic Fibroid Phthisis without Silicosis ...			
(j) Old Healed Fibroid or Calcareous Scars ...			
PLEURAE.			
(a) Old Adhesions			
(b) Effusion			
(c) Tuberculous Granulation Tissue			
(d) Gross Caseation			

	No Tuberculosis.	Tuberculosis Present.	
		Miliary.	Caseating.
Pericardium			
Heart			
Spleen			
Liver			
Kidneys			
Suprarenals			
Peritoneum		Plastic.	With Effusion.
Small Intestine		Tubercles only.	Actual Ulceration
Meninges and Brain (delete if not examined) ...		Meningitis	Tuberculoma.
Bones and Joints		*Give Details of Lesions* :	

Any other Disease or Diseases Present at Time of Death

Past Medical History
- (a) Not known
- or, (b) No previous Admissions to Hospital
- or, (c) Causes of previous Admissions to Hospital, with dates.

Cause of Death, as certified

Notes on any Special Features or Points of Interest:

When filling up this Record Form, if a + be put against any item in the "Normal," "Lesion not Present," or "No Tuberculosis" columns, then no entry need be made in the corresponding "Abnormal," "Lesion Present," or "Tuberculosis Present" columns.

Degrees of lesions should be indicated thus :—

Slight + ; Moderate ++ ; Extensive +++.

Completed Record Forms to be sent to "*The Chairman, Tuberculosis Research Committee. South African Institute for Medical Research, P.O. Box 1038, Johannesburg.*" Any pathological material which the recorder thinks might be of interest, or concerning which he is in doubt, may also be sent.

This Record is quite independent of the Statutory Report and Lungs sent to the Miners' Phthisis Bureau, although it may deal with a Bureau case.

Additional copies of this Form may be obtained on application to the "Chairman, Tuberculosis Research Committee," at the above address.

APPENDIX NO. 8.

CLASSIFICATION OF CLINICAL TYPES OF TUBERCULOSIS IN NATIVE MINE WORKERS FROM THE X-RAY AND CASE RECORDS FILED AT THE MINERS' PHTHISIS MEDICAL BUREAU.

By Dr. L. G. Irvine and Professor Lyle Cummins.

1. In all, records of 512 cases of "simple tuberculosis" and 250 cases of tuberculosis with silicosis were examined, and the results entered on special cards devised for the purpose of this investigation (see p. 419).

2. A preliminary grouping of the cards of simple tuberculosis cases according to sputum findings and by years of service on the mines is set forth in Table I.

TABLE I.

Simple Tuberculosis.

Distribution of Cases by Years of Work on Mines.

Years.	Sputum-Positive.		Sputum-Negative.	
	Number.	Per Cent. of Total.	Number.	Per Cent. of Total.
1st year	66	17	36	30
2nd year	43	10	20	17
3rd year	54	14	18	15
4th year	75	20	10	8
5th year	50	12	11	9
Over 5 years	104	27	25	21
Total	392	100	120	100

From this table it will be seen that, of the 512 cases, 392 were sputum-positive and 120 sputum-negative. It will be noticed, too, that, while the numbers for each year up to the fifth, inclusive, are fairly constant in the sputum-positive group, the numbers fall with each year of service in the sputum-negative group; suggesting that the lung lesions tend to be more "open" in the mine boys who have worked longest on the Rand.

3. The next grouping was based on the *extent of disease* as evaluated by an examination of the X-ray films; the results being entered under three headings: A, minimal; B, moderate, and C, maximal extent.

TABLE II.

SIMPLE TUBERCULOSIS.

Distribution of Cases according to Extent of Lesions as seen by X-ray.

A=Minimal. B=Moderate. C=Maximal.

Years.	Sputum-Positive.						Sputum-Negative.					
	A.		B.		C.		A.		B.		C.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1st year	13	20	26	39	27	41	13	36	19	53	4	11
2nd year	8	18	17	40	18	42	1	5	12	60	7	35
3rd year	11	20	24	45	19	36	—	—	11	61	7	39
4th year	6	8	36	48	33	44	1	10	6	60	3	30
5th year	6	12	20	40	24	48	1	9	7	65	3	26
Over 5 years	22	21	37	36	45	43	3	12	13	52	9	36
Totals	66	17	160	41	166	42	19	16	68	57	33	27
Grand Total			392						120			

As will be seen from Table II, there was a higher percentage of cases in the C group amongst the sputum-positive cases than amongst the sputum-negative; the difference being most marked in the "first-year" cases.

4. As will be seen on referring to the specimen card (p. 000), a further attempt was made to divide up the cases (1) according to the degree of systemic disturbance, as assessed by loss of weight and by the description of the patient's state, and (2) according to the degree of pyrexia. The systemic disturbance was entered on the cards under the four headings, "Nil," "S1," or slight, "S2," or moderate, and "S3," or severe. The temperature, too, was entered under one of four headings, Normal, T+, T++ and T+++, which explain themselves. This meant considerable sub-division of the cards falling under each period of service, and the totals are given in Table III.

A more interesting aspect of this part of the investigation is brought to light in Table IV, where the results are expressed as percentages of the total numbers in each time period. In order to make the groups numerically larger, the second and third year cases are taken together, and also those of the fourth and fifth year of underground work.

TABLE III.—SIMPLE TUBERCULOSIS.

DISTRIBUTION OF A, B, AND C CASES ACCORDING TO SYSTEMIC DISTURBANCE AND TEMPERATURE.

Total Numbers under each Heading.

Year.	Extent of Disease.	Sputum-Positive Cases.								Sputum-Negative Cases.							
		Systemic Symptoms.				Temperature.				Systemic Symptoms.				Temperature.			
		Nil.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.	Nil.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.
1st Year	A	—	4	3	6	4	2	4	3	—	2	3	8	3	3	3	4
	B	—	6	10	10	7	8	4	7	—	1	5	13	1	3	9	6
	C	—	3	6	18	3	3	7	14	—	—	—	4	—	—	1	3
2nd Year	A	—	1	2	5	2	—	1	5	—	1	—	—	1	—	—	—
	B	—	4	4	9	3	4	7	3	—	1	3	8	2	1	7	2
	C	—	2	6	10	1	0	4	4	—	1	2	4	3	1	1	2
3rd Year	A	—	6	2	3	8	1	1	1	—	—	—	—	—	—	—	—
	B	—	5	10	9	12	6	4	2	—	1	6	4	3	3	5	—
	C	—	5	4	10	5	3	6	5	—	2	—	5	2	—	2	3
4th Year	A	1	1	4	—	3	3	—	—	—	—	—	1	1	—	—	—
	B	1	10	13	12	14	8	9	5	—	1	4	1	1	1	3	1
	C	—	7	10	16	10	14	7	2	—	—	1	2	1	—	1	1
5th Year	A	—	2	2	2	5	—	—	1	—	—	1	—	—	—	—	1
	B	—	4	9	7	6	6	6	2	—	1	2	4	1	3	1	2
	C	—	6	9	9	6	9	3	6	—	—	3	—	3	—	—	—
Over 5 Years ...	A	3	7	9	3	13	6	2	1	—	—	—	3	2	—	1	—
	B	—	6	17	14	15	7	11	4	—	6	2	5	7	1	4	1
	C	1	4	17	23	12	14	15	4	—	2	4	3	5	1	3	—
Grand Total ...		392				392				120				120			

Systemic Disturbance, Stages: Nil. / S1=Slight Disturbance. / S2=Moderate Disturbance. / S3=Severe Disturbance.

Temperature: Normal. / Minimal Pyrexia T+. / Moderate Pyrexia T++. / Marked Pyrexia T+++.

TABLE IV.—SIMPLE TUBERCULOSIS.

PERCENTAGE DISTRIBUTION OF CASES ACCORDING TO SYSTEMIC DISTURBANCE AND TEMPERATURE AND ACCORDING TO PERIODS OF WORK ON THE MINES.

YEARS	SPUTUM-POSITIVE CASES.								SPUTUM-NEGATIVE CASES.							
	Systemic Symptoms.				Temperature.				Systemic Symptoms.				Temperature.			
	Normal.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.	Normal.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.
1st Year ...	—	20	28	52	21	20	23	36	—	8	22	70	11	17	36	36
2nd and 3rd Years ...	—	23	28	48	32	24	24	20	—	15	30	55	30	13	39	18
4th and 5th Years ...	1	24	38	37	35	32	20	13	—	10	52	38	33	19	24	24
Over 5 Years	4	16	41	39	38	26	27	9	—	32	24	44	56	8	32	4

Systemic Disturbance { Nil; Slight Disturbance=S1.; Moderate „ =S2.; Severe „ =S3. }

Temperature { Normal; Minimal Pyrexia =T+.; Moderate „ =T++.; Marked „ =T+++. }

In this table an interesting result comes to light, the first-year boys proving to include a higher percentage of cases with severe systemic disturbance, and a higher proportion of markedly pyrexial cases than the boys with longer periods of mine service. In the case of temperature, the first-year boys, both in the sputum-positive and the sputum-negative groups, present 36 per cent. of T+++ cases, while, in the case of boys with mine-service of over five years, the percentages are only 9 and 4 respectively. In the same way, the proportion of cases with a *normal* temperature *increases* with years of service; and the same is true, in the sputum-negative group, for cases with "slight" systemic disturbance only. It is probable that the secondary infections incidental to open cases have obscured a similar tendency in the sputum-positive group.

This increased power of holding in check the more severe types of pyrexia and of limiting the tendency to loss of flesh and general health appears to be characteristic of the older mine boys and suggests that the latter have acquired, in the course of some years' exposure to tuberculous contact on the Rand, some degree of resistance sufficient, if not to bring the disease to a standstill, at least to ameliorate its worst manifestations.

5. In the tuberculo-silicotic series, similar card entries were made but, in view of the suggestions of Professor Dalton as to the advisability of regarding this group as statistically distinct, the 250 cases of this type have been tabulated separately. As was to be expected, these cases fall almost exclusively into the "five years" and "over five years" service groups. Those returned as having shorter mine service are open to some suspicion of inaccuracy in that respect. An analysis of the 250 cards is given in Tables V, VI, and VII.

In this group the same tendency to keep the temperature within normal limits is evident in the long-service boys, especially in the sputum-negative cases where the chance of secondary infection with catarrhal organisms is less than in the "open" cases.

6. In attempting to draw conclusions from these records, it is to be remembered that only those cases with an X-ray film could be included, the more severe cases of simple tuberculosis dying in the mine hospitals or the W.N.L.A. hospital without the possibility of X-ray photography were necessarily excluded. Had these cases been added, it might have been expected that they would have still further accentuated the evidence of lack of resistance manifested by the "first year" boys as compared to the cases contracting tuberculosis after a longer acclimatization to mining conditions.

The investigation, as far as it goes, serves to show that the "new" mine Natives tend towards a very acute and severe type of disease, whereas the "long-service" boys learn to tolerate tuberculosis to a greater extent. In this respect, these clinical observations fall into line with the pathological findings of Mavrogordato and Pirie as well as the statistical studies of Professor Dalton.

TABLE V.

TUBERCULOSIS WITH SILICOSIS.

Distribution of Cases by Years of Service.

Years.	Sputum-Positive.	Sputum-Negative.
1st year	—	—
2nd year	2	1
3rd year	4	2
4th year	11	2
5th year	19	1
Over 5 years	176	32
Totals	212	38

TABLE VI.

TUBERCULOSIS WITH SILICOSIS.

Distribution of Cases according to extent of Tuberculous Lesions.

(A, B and C have the same meanings as in Table II.)

	Sputum-Positive.				Sputum-Negative.			
Years.	A.	B.	C.		A.	B.	C.	
1st year	—	—	—		—	—	—	
2nd year ...	—	2	—		—	1	—	
3rd year	—	1	3		—	1	1	
4th year	—	8	3		—	2	—	
5th year	4	5	10		—	1	—	
Over 5 years ...	15	75	86	=176	2	19	11	=32
Totals ...		212				38		

TABLE VII.—TUBERCULOSIS WITH SILICOSIS.

DISTRIBUTION OF A, B AND C CASES ACCORDING TO SYSTEMIC DISTURBANCE AND TEMPERATURES.

(Total Numbers under each Heading.)

Year.		Sputum-Positive.								Sputum-Negative.							
		Nil.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.	Nil.	S1.	S2.	S3.	Normal.	T+.	T++.	T+++.
1st Year ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2nd Year ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	B	—	—	1	1	2	—	—	—	—	—	—	1	1	—	—	—
	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3rd Year ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	B	—	—	1	—	—	—	1	—	—	—	1	—	—	—	—	1
	C	—	1	—	2	1	2	—	—	—	—	—	1	—	1	—	—
4th Year ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	B	—	1	5	2	5	2	1	—	—	1	—	1	1	1	—	—
	C	—	—	3	—	1	1	1	—	—	—	—	—	—	—	—	—
5th Year ...	A	1	1	1	1	3	—	—	1	—	—	—	—	—	—	—	—
	B	—	1	4	—	2	2	1	—	—	—	—	1	—	1	—	—
	C	—	2	4	4	5	2	2	1	—	—	—	—	—	—	—	—
Over 5 Years	A	—	7	6	2	10	3	2	—	—	—	1	1	1	—	1	—
	B	—	24	31	20	40	18	5	12	—	7	4	8	10	3	3	3
	C	—	12	28	46	24	18	21	22	—	3	3	5	7	2	2	—
Per cent. over 5 Years		—	24	37	39	42	22	16	20	—	31	25	44	56	16	19	9

Card used for the purpose of the investigation.

TUBERCULOSIS RESEARCH COMMITTEE.

SIMPLE PULMONARY TUBERCULOSIS. Card No.....

Tax Index No ..... (Cases of *Tuberculosis of other Organs only* not included.) *Disc No.* .....

Name..... *Tribe* ..... *PP No*.....

Bureau No..... *Mine* ..... *Mine No* .....

Last worked underground..... Date admitted Mine Hospital.....

Year of Service underground 1st 2nd 3rd 4th 5th over 5.

Extent of Disease A. Minimal B. Moderate. C. Maximal. M. Miliary. O.O. Other Organs

Systemic Disturbance, NIL— (1) Slight (2) Moderate (3) Severe

Sputum, positive; negative; not examined.

Temperature, normal;
" +, ++, +++.

Final Classification .....

Repatriated, Date..... Died, Date .....

NOTE.—Strike out all inappropriate items under each heading. A temperature of 99 4°F. on more than one day during the last two weeks of observation to be recorded as Temp. +. The extent of disease to be determined by radiographic examination.

EXAMPLE.—A case of moderate extent, with moderate systemic disturbance, in which the sputum was positive, and temperature was " plus," and with over 5 years' service, would be returned in Final Classification as " B, S(2), T+, Sp+, 5+."

APPENDIX NO. 9.

REPORT ON THE EXAMINATION OF 500 X-RAY FILMS FROM "NEW" MINE NATIVES.

By Professor Lyle Cummins.

Through the kind assistance of Dr. A. I. Girdwood, and also, during his absence, of Dr. Young and Dr. Watkins of the W.N.L.A. Medical Staff, I have been enabled to examine X-ray films from 500 Native mine recruits, all "new" boys, arriving for service on the Rand and passed as fit for mine work.

In order to record any abnormal appearances on systematic lines rough "Forms" were prepared on which the patient's W.N.L.A. number and the date of X-ray examination were entered, for each film, together with such entries as were thought justified under the following headings :—

"Old Foci," "Glands definite," Glands suspicious,"

"Peri-Mediastinal Opacities," "Lung Infiltration" and

"Other Pathological appearances"

The results are set forth in the following tabular statement :—

Lesions Visible.	Number.	Per Cent.
Old (Calcareous) Foci	168	32·6
Glands (Broncho-pulmonary or Root), Definite	12	2·4
Glands (Broncho-pulmonary or Root), Suspicious	39	7·8
Peri-mediastinal Opacities	27	5·4
Lung Infiltration	21	4·2
Other Pathological Appearances	58	11·6

Of much importance is the observation that no less than 32 per cent. of "new" boys arrive with radiological evidence of previous respiratory infection with tuberculosis. The lesions were fairly easy to detect as rounded opacities, usually under 15m.m. in diameter, and situated in various parts of the lung without any special preference for the apices. Their tuberculous nature has been verified in recent months by the combined radiological and pathological researches of Mavrogordato and Pirie who have applied Opie's technique with interesting results.

The small percentage of definitely visible broncho-pulmonary and outer root glands is to be noted and corresponds with recent findings at the Laennec Hospital in Paris, where it has been shown that the more important deep tracheo-bronchial glands, even if enlarged, are hidden by the great vessels and the mediastinum and lost in the deep shadows of the vertebral column and sternum.

Even with the help of X-rays, it is impossible either to diagnose with certainty or to exclude tuberculous enlargement of the tracheo-bronchial glands. In a fairly high proportion of the films, there were appearances *suggestive* of glandular enlargement or of such a widening of the central thoracic shadows or such irregularities in the outlines of the mediastinum as to suggest some degree of glandular enlargement, itself invisible but pressing surrounding structures outwards. In recording these appearances, merely suggestive of abnormality but not by any means diagnostic, I desire to express my uncertainty as to their exact significance. Through the kindness of Dr. Girdwood, I am bringing home with me a series of films chosen at random, to compare with X-ray films of "healthy" coal-miners, in the hope that the comparison may afford some grounds for judgment.

The recording of 4·2 per cent. of "lung infiltration," again, while it might be better to express it as "no less than 95·8 per cent. of films quite free from lung infiltration," is less suggestive than it seems, as it is quite likely that some of these opacities were, in reality, postural and not pathological at all.

Of the "other pathological appearances," all except one, suggestive of old pleurisy, were varying degrees of what Dr. L. G. Irvine calls "more fibrosis than usual." It is probable that some, at least, of these increased peri-bronchial shadows were due to inhalation of dust, not in industry but in the every-day life of a dusty country.

APPENDIX NO. 10.

SUMMARY OF INFORMATION RECEIVED FROM VARIOUS MUNICIPALITIES *RE* PREVALENCE OF TUBERCULOSIS IN ANIMALS.

Bloemfontein.

Totals of cattle slaughtered not given, but over five complete years (1924–29) the percentage of tuberculous animals averaged 0·33 per cent. per annum.

Cape Town.

Total of cattle slaughtered not given, but of 8,348 cows slaughtered during the year ended 30th June, 1929, there were 67 showing tuberculous lesions, *i.e.*, 0·80 per cent. It is stated that the majority of cows slaughtered were veld-bred, only a few being dairy cows and these mainly animals which had reacted positively to a tuberculin test.

Durban.

For nine years (1921–29) the average number of cattle slaughtered annually was 29,800, and the average incidence of tuberculosis in them was 0·053 per cent. per annum. It is stated that very few of these animals came from dairy herds, only positive reactors within the borough going to the abattoir. Further stated that approximately 5 per cent. of milk samples tested had shown the presence of tubercle bacilli, and that it was estimated on the basis of tuberculin tests that approximately 15 per cent. of raw milk-supplying dairy herds locally were tuberculous.

East London.

Tuberculosis in bovines reported to be almost non-existent, only three cases having been seen in seven years. Total number of animals slaughtered not given. Rarity attributed to the fact that very few cattle in the district were stall-fed, their whole lives being spent in the open.

Johannesburg.

	Totals Slaughtered.	Infected with Tuberculosis.	Percentage.
Total Cattle during period 1910-29 ...	1,823,278	1,450	0 079
Bulls, Oxen, etc., period 1917-29 ...	1,067,700	330	0 031
Cows, chiefly of Native and Afrikander Breeds, period 1917-29	228,435	347	0 152
Pigs, period 1910-29	789,335	2,524	0 319

Remarked that the table only shows the incidence in slaughter stock and is not indicative of prevalence in dairy herds.

Pietermaritzburg.

19,120 cattle slaughtered during two complete years (1927–29) and 26 of these were found to be tuberculous. This gives a figure of 0·065 per cent. per annum. It is reported also that tuberculosis was common in pigs; for the year ended 30th June, 1929, 1·53 per cent. being tuberculous.

Port Elizabeth.

For the three years 1926–28 there were 9 cows found to be tuberculous out of 6,675 slaughtered. This gives a figure of 0·046 per cent. per annum. Figures for total cattle not given.

Pretoria.

For the year ended 30th June, 1929, there were 43 cases of tuberculosis in 24,422 cattle slaughtered, *i.e.*, 0·176 per cent. A considerable proportion of these were in cows from dairy herds. Considering cows alone, there were 18 cases amongst dairy cows and 8 in other cows; 26 in all, out of 5,112 cows slaughtered, *i.e.*, 0·51 per cent. Pigs showed 46 cases out of 6·808 slaughtered, *i.e.*, 0·67 per cent.

Considering these reports as a whole, the incidence of tuberculosis amongst cattle in South Africa, as shown by the figures for slaughter stock, appear to be very small.

Little exact information is available as to the incidence in dairy herds but the indications, so far as they go, are that the incidence amongst these stall-fed cows is higher (perhaps much higher) than among cattle generally.

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