with special reference to the milk supply, the incidence of bovine tuberculosis, and the type of bacillus in the tubercular lesions of children with 33 tables and 10 graphs.

A Thesis for the degree of D.Sc. (Public Health.) Ed.

by

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B.Sc. (Public Health) 1909.

D.Sc. 1920
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so as to illustrate the differences at
the different age groups more clearly.
INTRODUCTION.

The medical visitor to New Zealand cannot fail to be struck, as I was after taking up my official duties with the New Zealand Government and the Otago University in 1910, with the relative paucity of visible tubercular lesions in the children and young adults met with in the public thoroughfares.

Returning from several years residence in Edinburgh, where the scars of tubercular cervical glands are sufficiently common to attract attention, not only in outpatient and dispensary practice, but in the public streets, one of my first impressions was the marked contrast in favour of New Zealand.

About this time (1910-11) the relationship of the milk supply of various towns to the incidence of Juvenile Tuberculosis was attracting the attention of hygienists, and was being made the subject of investigation, and I decided that as soon as opportunity offered I would investigate the matter as it affected New Zealand.

While awaiting the necessary fittings and equipment for my laboratory, a stimulus was given me in the form of alarming reports which appeared in the Press.
of several of the larger towns of the Dominion, alleging considerable infection of the milk supplies, being founded on the inaccurate and somewhat wild statements of a medical practitioner.

As a result of the uneasiness aroused in the minds of the public, I was asked to report on the condition of the milk supply of the City of Dunedin, of which, and the surrounding province I was at the time part time Government Medical Officer of Health.

After consideration of the matter I decided to extend the investigation and to make it the subject matter of this thesis. In the meantime the work of the Public Health Department and of the New Zealand Medical School had grown to such an extent that I was after 5 years service relieved of my administrative Public Health Duties, to become a whole time occupant of the University Chair of Bacteriology and Public Health, retaining a close connection with the Government Health Department as Government Bacteriologist, Dunedin, and acting from time to time for the Department when through illness or shortage of medical officers, an experienced M.O.H. was not available. It was in my University capacity that the work started in 1911 was continued.

Not only was the condition of the milk supply in my district, as regard living tubercle bacilli made the
subject of investigation, but at the same time I made a study of the incidence of tuberculosis in children in New Zealand. In the absence of any but the most meagre official returns this was by no means as easy as I had anticipated, as will be seen later.

In connection with this investigation and the supposition that a highly infected milk supply goes hand in hand with a marked incidence of the tubercular lesions of childhood, tuberculosis of glands, bones, joints, meninges and peritoneum, I decided to obtain as much ante- and post-mortem material of a tuberculous nature from children as possible, such as tubercular glands removed at operation, cerebro-spinal fluid from cases of tubercular meningitis, sputum from pulmonary tuberculosis, and other specimens such as one receives in a clinical laboratory. After subjecting this material to the usual procedure of animal inoculation, culture, and differentiation of cultures by rabbit inoculation, the type of tubercle bacillus in the tubercular lesions of New Zealand children could be determined.

Again acting on the supposition that a milk supply which is comparatively free from living tubercle bacilli goes hand in hand with a low incidence of tuberculosis in children, I hoped the study of the types of tubercle bacilli as found in the material which I might obtain would show a very low percentage of bac-
ili of the bovine type. Reference is also made in the
text to the views of those who hold that the milk sup-
ply is not necessarily the most important factor in
juvenile tuberculosis.

During the various stages of the investigation the
difficulty of gaining access to current literature, ex-
cept for the limited number of journals and books which
one received for one's own department, and the long de-
lays while reprints were obtained, or queries answered
from Great Britain or America, rendered the task much
more difficult and tedious than would have been the case
had one been fortunate enough to have worked near one of
the larger centres of scientific work, where large and
well equipped libraries are available for reference, and
those working along similar lines can be consulted. The
paucity of official returns in a young country of just
over 1,000,000 inhabitants greatly increased the task of
gaining accurate returns for the statistical portion of
the thesis. These difficulties and the interruption con-
sequent on the war must be my apology for the incomple-
ness of some of the returns, and for the lack of reference
to other than well known literature, or to reprints which
I was able to obtain from time to time.

Work was delayed until the end of 1911 pending the
arrival from Britain of a large electrical centrifuge, cap-
able of dealing with six milk samples of 100 cc. each at
one and the same time.

Workers in other countries were working along similar lines but were able to publish their results much earlier, because material in the large centres is plentiful and statistics and returns readily available. As will be seen later, my results are only now available, owing to the very few case of juvenile tuberculosis which are to be found in the Dominion, and the consequent paucity of specimens for the latter part of my investigation.

The thesis is divided into sections all of which have some bearing on the subject under consideration. For instance, in order that some idea may be gained as to the favourable position in which our people are placed as regards climate, standard of living and housing, lack of overcrowding and slums, absence of large industrial concerns other than those connected with produce, and other factors bearing on the health of the population, I have briefly referred to the Meteorology and Vital Statistics of the Dominion, upon which accurate Statistics are obtainable from the Registrar-General and others. The low death rate of about 10 per 1000, and the Infantile Mortality rate of about 50 per 1000 children born, are amongst the lowest in the world. This section emphasises the favourable position in which our people are placed, and would lead one to ex-
pect a low tuberculosis rate as compared with that of older and less favourably placed countries.

In the next section the incidence of, and death rates from all forms of tuberculosis are contrasted with similar returns for pulmonary tuberculosis, the only subdivisions which are recognised in official returns in New Zealand at present. These rates are compared in tables and by means of Charts with those of Australia and England and Wales in so far as has been possible with the information and returns available. Further, the age and sex incidence of tuberculosis is considered, but I should emphasise here that this section is intended merely as an introduction to the subject matter proper (juvenile tuberculosis) which follows, and no attempt has been made to analyse or discuss the figures and groups except in a general way. In this respect my investigation differs from that of Professor Hunter Stewart's analysis of the Mortality Rates in Scotland, in which amongst other things, effect of manual labour on the mortality rates of phthisis in women is clearly set out.

This section serves to show the position of tuberculosis (all forms), and of pulmonary tuberculosis, throughout the Dominion, and indicates that whatever may be the incidence of Juvenile Tuberculosis, there is more pulmonary tuberculosis of an age incidence very similar to that of Britain than one would expect under our open air, sunshine and favourable conditions of life.
The tables and graphs illustrating the age and sex incidence of tuberculosis in this section serve as a basis for the consideration of the incidence of Juvenile Tuberculosis in the following section.

The next section deals with Juvenile Tuberculosis, i.e. tuberculosis in children under 16 years of age. The incidence and death rates from all forms of tuberculosis and from phthisis in children in New Zealand and in Britain or Australia are contrasted, and charts serve to illustrate some of the more important points brought out by the tables.

It will be seen that Juvenile Tuberculosis is responsible for comparatively little of the morbidity and mortality in the earlier years of life as compared with England and Wales, while Australia is in almost as favourable a position as New Zealand. In later years the difference, though still in our favour, is less marked, and Pulmonary Tuberculosis may be regarded as responsible for our less favourable position in the 20-35 year periods. I should mention here that there is little industrial life in New Zealand which would adversely affect the phthisis rate.

Having shown that in so far as official returns, personal enquiries, tuberculin tests, and returns of School Medical Officers can be relied on, there is remarkably little Juvenile Tuberculosis in New Zealand. The next section deals with a personal investigation into the milk
supply of the town of Dunedin (65,000) in which I was stationed. The findings of the Government Agricultural Department in this respect, for other towns in New Zealand is also considered along with my own returns. The technique which I followed is discussed and described, and guinea pig inoculation relied on. There being no restrictions to animal inoculation in New Zealand, I was free to pursue this work without hindrance. At the same time I should point out that our animals are kept under the most hygienic conditions as to space, ventilation, sunshine, and housing possible, and the land as compared with Gt. Britain. Numerous papers have been published of recent years showing in some centres animal houses being spacious and equal in size to any a relatively high percentage of milk samples which contain living tubercle bacilli, and others showing the prevalence of tuberculosis in cattle and in dairy herds. From what has already been said about the milk supply of New Zealand one would expect very little bovine tuberculosis in our dairy herds or at our abattoirs. But the returns which I quote in this section of the thesis and for the accuracy of which I can touch, show that we have for a not very much lower incidence of bovine tuberculosis in cattle coming to the public abattoirs than in Gt. Britain. We have no byres such as one sees in Scotland, our cattle live in the open air practically all the year round, and there is abundant sunshine and food. A sample of this bovine tuberculosis is comparatively common, and inoculation of the sediment into each of two

The result of the examination of 200 samples of milk, each sample representing the mixed milk of one of 300 dairy farms supplying Dunedin with milk, and collected in the early morning by Inspectors, from the milk carts on their way townwards, are as striking as the low incidence of Juvenile Tuberculosis. Only 2 samples (1 per cent) were found after centrifugalisation of 80 cc. and inoculation of the sediment into each of two
guinea pigs to contain living tubercle bacilli, results which are supported by the returns of the Agricultural Department dealing with a much larger number of samples, but in a less thorough manner.

To those who believe that a tubercle free milk supply should go hand in hand with a low incidence of Juvenile Tuberculosis, the position in New Zealand at the present time is an excellent example.

The next section digresses a little to consider the question of tubercular infection in cattle in New Zealand as compared with Gt. Britain. Numerous papers have been published of recent years, showing in some centres a relatively high percentage of milk samples which contain living tubercle bacilli, and others showing the prevalence of tuberculosis in cattle and in dairy herds.

From what has already been said about the milk supply of New Zealand one would expect very little bovine tuberculosis in our dairy herds or at our abattoirs. But the returns which I quote in this section of the thesis, and for the accuracy of which I can vouch, show that we have a not very much lower incidence of bovine tuberculosis in cattle coming to the public abattoirs than in Gt. Britain. We have no byres such as one sees in Scotland, our cattle live in the open air practically all the year round, and there is abundant sunshine and food. In spite of this, bovine tuberculosis is comparatively common. This would seem at first sight difficult to correlate
with the low percentage findings of tubercle bacilli in the milk supply.

The reasons which are advanced by the officers of the Livestock Division of the Government Department of Agriculture are, I think, sufficient to explain the position.

As will be seen in this chapter there is a better, more frequent, and thorough system of veterinary inspection of our dairy herds throughout New Zealand than prevails elsewhere. Clinical examination is not altogether relied on, for, as pointed out by Beattie in a paper to which I refer in the text, about 10% of milk samples in Sheffield, taken from cows passed as clinically free from tuberculosis by a veterinary inspector, proved to contain living tubercle bacilli. Tuberculin testing of dairy herds is encouraged, and adequate compensation is paid for animals which are destroyed or found to be tubercular. It is also a serious offence for a farmer to dispose of a tubercular cow, which must be notified to the authorities in the same way as tuberculosis is in human beings. must be notified by the medical profession. A resume of the system is given in this chapter. On account of this frequent and thorough system of inspection, tuberculous cows are quickly removed from the dairy herds and destroyed.

Finally, the question of the type of tubercle bacillus found as an infecting agent in clinical and post-
mortem specimens removed from children under 16 years of age, and suspected of being tubercular, is considered. The technique employed and the different tests available are discussed, and the literature quoted. Briefly, most of the material handled was passed through guinea pigs, from which after an interval of from 4-5 weeks cultures on glycerinised and non-glycerinised media were prepared, and from these, rabbits were inoculated intravenously to further assist in the differentiation of the cultures.

As might have been expected from what has previously been said, considerable difficulty was experienced over several years in getting sufficient specimens to investigate, there being so little Juvenile Tuberculosis in New Zealand. Of the 30 cases investigated, and which are set out in tables in the text, 6 were either non-tubercular or yielded negative guinea pig tests. Twenty four (24) gave positive results, and of these only four (4), or 16.66 per cent, gave cultures which in cultural appearances and animal test corresponded with the bovine type of tubercle bacillus. Twenty of the twenty-four cases yielded cultures resembling the human type of bacillus.

The cultural appearances of the different types of bacilli, and the lesions produced in rabbits by intravenous injections of measured doses of culture, were controlled by typical cultures isolated from human and bovine sour-
ces, and which corresponded closely with the published accounts of these types of bacilli.

The results show a lower rate of bovine infections than appears from the literature to be prevalent in England, and a very much lower rate than has been found by several Scottish workers. My results are more in accord with those of American and Continental workers. One would have expected a still lower bovine infection incidence considering the results of the milk investigation, the low incidence of Juvenile Tuberculosis, but the results are not surprising when the incidence of tuberculosis in cattle in New Zealand, as already pointed out, is considered.

A summary of the results obtained and a Bibliography of the literature which I was able to consult in New Zealand, will be found at the end of the thesis.
A short account of the geographical position, area, climate and meteorology, and vital statistics of the Dominion, which relate to the matter under discussion, will serve to show that, whereas conditions of overcrowding, poverty, lack of ventilation, and severity of climate, which are frequently associated with outbreaks of infectious diseases, do not prevail here, we cannot look to these except in a very minor way as being responsible for the prevalence of Tuberculosis in New Zealand.

BOUNDARIES & AREA. The Dominion of New Zealand, which forms an outpost of the great British Empire, is bounded on all sides by the Pacific Ocean, and lies within latitude 34° - 48°S. and longitude 166° - 179°E. Like Great Britain it runs roughly North and South, but being in the Southern hemisphere, the Northern part of the Dominion has a semitropical to temperate climate, while the climate of the Southern part is more like that of the South of England.

The Dominion consists of three main islands with several groups of small islands. The main islands known as the North, South and Stewart Islands, have a coastline 4,330 miles in length.

The total area of the Dominion proper is 66,292,232 acres or 103,581 square miles.
According to our geologists, the New Zealand area was probably the foreshore of a great continent, but after the Trias-Jura sediments were deposited, far reaching changes involving the breaking up and disappearance of the continental land, took place. The New Zealand area was necessarily involved in these earth movements, and, as the result, the existing strata were folded, broken, and raised above sea level. After extensive denudations of its surface had taken place, New Zealand was again probably several times depressed or elevated, either in whole or in part.

FLORA & FAUNA: While there are several plants possessing poisonous properties, there are no native animals or insects which are in any way harmful to man, except a small spider, the Katipo, which is found on some of the sea beaches, and whose bite is followed by severe symptoms of poisoning.

TEMPERATURE & RAINFALL. The following table prepared from particulars supplied by the Government Meteorologist for the year 1918 shows, in comparison with an average of previous years, that the mean temperature was lower and the total rainfall higher in that year. In fact there has been a progressive increase in the average rainfall for the Dominion since 1915. The figures for Auckland in the North and Dunedin in the
South, and Wellington situate about midway between these two are given.

**TABLE I.**
Average Rainfall 1905 - 1916, North & South Islands.

<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.08</td>
<td>2.61</td>
<td>4.69</td>
<td>3.88</td>
<td>4.78</td>
<td>4.21</td>
<td>3.29</td>
<td>4.21</td>
<td>4.28</td>
<td>3.82</td>
<td>4.29</td>
<td>3.84</td>
</tr>
<tr>
<td>South Island</td>
<td>3.75</td>
<td>2.71</td>
<td>3.67</td>
<td>3.33</td>
<td>3.49</td>
<td>4.01</td>
<td>3.89</td>
<td>3.17</td>
<td>3.79</td>
<td>3.85</td>
<td>3.51</td>
<td>3.76</td>
</tr>
</tbody>
</table>

The average rainfall from 12 collecting stations was

|         | in 1915 = 37.85 in. | 1916 = 44.28 " | 1917 = 49.58 " | 1918 = 50.49 " |
|---------|-------------------|-----|-----|-----|-----|

The mean number of days upon which rain fell for the same
period (average) 1905 - 1916 was as follows:-

**TABLE II.**

<table>
<thead>
<tr>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.4</td>
<td>8.0</td>
<td>11.8</td>
<td>12.6</td>
<td>14.7</td>
<td>15.3</td>
<td>16.4</td>
<td>14.5</td>
<td>14.8</td>
<td>15.1</td>
<td>14.1</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>S. Island</td>
<td>12.4</td>
<td>8.9</td>
<td>12.2</td>
<td>12.1</td>
<td>12.1</td>
<td>13.6</td>
<td>13.3</td>
<td>14.6</td>
<td>13.8</td>
<td>14.4</td>
<td>14.1</td>
<td>13.0</td>
</tr>
</tbody>
</table>
The following comparative table, for 1918 gives an idea of the meteorological conditions generally prevailing in the Dominion. (3)

TABLE III

(see next page)
### TABLE III.

Comparative Table, Year 1918.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Temperature in shade.</th>
<th>Rainfall</th>
<th>Prevailing Winds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest &amp; Date</td>
<td>Lowest &amp; Date</td>
<td>Mean Max. Temp. for Year</td>
</tr>
<tr>
<td>Auckland</td>
<td>°Fahr. 78.0 Jan. 13</td>
<td>°Fahr. 35.0 July 26</td>
<td>°Fahr. 64.6</td>
</tr>
<tr>
<td>Wellington</td>
<td>79.3 Feb. 6</td>
<td>30.1 July 27</td>
<td>61.3</td>
</tr>
<tr>
<td>Christchurch</td>
<td>83.9 Jan. 18</td>
<td>27.2 July 17 Aug. 16</td>
<td>60.5</td>
</tr>
<tr>
<td>Dunedin</td>
<td>81.0 Feb. 13</td>
<td>28.0 Aug. 9</td>
<td>57.8</td>
</tr>
</tbody>
</table>
VITAL STATISTICS.

The population of the Dominion.

The estimated population of the Dominion including the Maoris and residents of the Cook and other Pacific Islands at the end of 1918 was 1,175,325. The Maori population in the census year 1916 was 49,776.

With the exception of the last two years of the war the population of New Zealand has shown a continuous, though not regular, increase in each year since 1855, the first year in which accurate records of births and deaths were obtained and used with the returns of immigration and emigration.

The population of the four principal towns including suburban areas as at the census of 1916 is as follows:

Auckland = 133,712
Wellington = 95,235
Christchurch = 92,733
Dunedin, = 68,716.

The average rate of natural increase for the period 1908-17 was 16.86 per 1000.

AGE AND SEX CONSTITUTION OF THE PEOPLE.

The withdrawal of a large body of men between the ages of 20 and 45 for military service overseas has materially altered the age and sex constitution of the population as estimated at the 1916 census. Now most
of these men, except those who paid the supreme sacrifice have returned, but during the period up till December 1918, they were still absent from the Dominion.

The following table, compiled from the census returns of 1896, 1906, and 1916 show the numbers of males and females in age groups 0 - 5, 5 - 20, 20 - 45 (military age), above 45.

**TABLE IV.**

<table>
<thead>
<tr>
<th>Age groups</th>
<th>1896 M.</th>
<th>1896 F.</th>
<th>1906 M.</th>
<th>1906 F.</th>
<th>1916 M.</th>
<th>1916 F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5 years</td>
<td>42,448</td>
<td>41,211</td>
<td>52,499</td>
<td>50,246</td>
<td>67,320</td>
<td>64,735</td>
</tr>
<tr>
<td>5 yrs. &amp; under 20 yrs.</td>
<td>126,969</td>
<td>125,257</td>
<td>133,902</td>
<td>130,261</td>
<td>162,884</td>
<td>160,563</td>
</tr>
<tr>
<td>20 &quot; &quot; &quot; 45 &quot;</td>
<td>131,121</td>
<td>117,874</td>
<td>193,256</td>
<td>169,723</td>
<td>199,499</td>
<td>220,908</td>
</tr>
<tr>
<td>45 &quot; &quot; over</td>
<td>70,292</td>
<td>47,376</td>
<td>90,860</td>
<td>66,888</td>
<td>121,381</td>
<td>100,893</td>
</tr>
</tbody>
</table>

A calculation of the proportion per cent at each age group to the total of males and females shows the effect of a declining birth rate on the ages under 15, the proportion of males at these ages being 30.19 per cent in 1911, against 34.81 per cent in 1896, and of females 32.58 per cent against 38.02 per cent respectively. When the proportions for 1916 are considered, it will be seen that the figures in all age groups for the male portion of the population have been material-
ly affected by the withdrawal of men between the ages of 20 and 45 for service overseas.

The increased proportion at the higher ages is due to the advanced age of the them mostly adult immigrants introduced during the early stages of settlement. These form the greater portion of the groups 60 years and over.

There has been a gradual equalisation of the sexes since 1861, the numbers of females to 1000 males having risen from 622 in 1861 to 903 in 1901. The proportion was slightly lower in 1906 and 1911 but has risen to 993 in 1916 mainly on account of the absence of so many men at the war.

VITAL STATISTICS IN BRIEF.

The Birth rate has fallen from 35.40 per 1,000 of the population in 1886 to 26.34 in 1901 and 25.69 in 1917. The proportion of births of males to every 1000 females in 1917 was 1030.

The Death Rate shows a very gradual decline, and is one of the lowest on record, the rate per 1000 of the population being as follows:-
-21-

**TABLE V.**
Crude Death Rates per 1000 Population.

<table>
<thead>
<tr>
<th>Year</th>
<th>New Zealand</th>
<th>Commonwealth Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1887</td>
<td>10.29</td>
<td>-</td>
</tr>
<tr>
<td>1901</td>
<td>9.81</td>
<td>-</td>
</tr>
<tr>
<td>1911</td>
<td>9.39</td>
<td>-</td>
</tr>
<tr>
<td>1917</td>
<td>9.58</td>
<td>-</td>
</tr>
<tr>
<td>1909-13 average</td>
<td>9.33</td>
<td>10.70</td>
</tr>
</tbody>
</table>

Male deaths to every 100 female deaths were 143 in 1908 and 134 in 1917.

**INFANTILE MORTALITY** rate, i.e. deaths under one year of age per 1000 births.

New Zealand has a remarkably low infantile mortality rate, and this has shown a progressive decrease since 1908. The rate in 1917 (48.16) was the lowest recorded in New Zealand.

**TABLE VI.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Infantile Mortality rate per 1000 births.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1908</td>
<td>67.89</td>
</tr>
<tr>
<td>1909</td>
<td>61.60</td>
</tr>
<tr>
<td>1910</td>
<td>67.73</td>
</tr>
<tr>
<td>1911</td>
<td>56.31</td>
</tr>
<tr>
<td>1912</td>
<td>51.22</td>
</tr>
<tr>
<td>1913</td>
<td>59.17</td>
</tr>
<tr>
<td>1914</td>
<td>51.38</td>
</tr>
<tr>
<td>1915</td>
<td>50.05</td>
</tr>
<tr>
<td>1916</td>
<td>50.70</td>
</tr>
<tr>
<td>1917</td>
<td>48.16.</td>
</tr>
</tbody>
</table>
Death Rate per 1,000 persons living in age groups and for both sexes for 1916, New Zealand and England & Wales.

<table>
<thead>
<tr>
<th>Ages in years</th>
<th>New Zealand Males</th>
<th>New Zealand Females</th>
<th>England &amp; Wales Males</th>
<th>England &amp; Wales Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>17.47</td>
<td>13.69</td>
<td>30.9</td>
<td>25.2</td>
</tr>
<tr>
<td>5 and under 10</td>
<td>2.66</td>
<td>2.43</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>10</td>
<td>1.64</td>
<td>1.36</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>15</td>
<td>3.04</td>
<td>2.11</td>
<td>(2.9)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5.26</td>
<td>3.02</td>
<td>7.2</td>
<td>(3.2)</td>
</tr>
<tr>
<td>25</td>
<td>4.69</td>
<td>4.02</td>
<td>(3.9)</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>6.44</td>
<td>5.29</td>
<td>(6.3)</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>10.46</td>
<td>7.70</td>
<td>14.5</td>
<td>11.2</td>
</tr>
<tr>
<td>55</td>
<td>19.91</td>
<td>16.27</td>
<td>29.6</td>
<td>23.1</td>
</tr>
<tr>
<td>65</td>
<td>49.17</td>
<td>40.23</td>
<td>68.8</td>
<td>53.4</td>
</tr>
<tr>
<td>75</td>
<td>117.61</td>
<td>96.66</td>
<td>159.3</td>
<td>133.3</td>
</tr>
<tr>
<td>85 and over</td>
<td>225.27</td>
<td>248.63</td>
<td>305.8</td>
<td>284.9</td>
</tr>
<tr>
<td>All ages</td>
<td>11.23</td>
<td>8.13</td>
<td>16.9</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Besides advantages of climate New Zealand possess a population younger in age constitution than that of most other countries - conditions favourable to a low rate of mortality. In the above table the extremely low rate of mortality in New Zealand among children under five years of age is remarkable, and the difference at some of the groups at the more advanced age is considerable. It is noteworthy that in only one instance is the Dominion rate higher than the corresponding rate in England & Wales. This occurs in the female death rate for the age period 25-35 yrs.
Occupations of the people. The result of this Section of the 1916 census is not yet ready for publication, but it may be stated that New Zealand is a country where agricultural products form the main industry and where large numbers of the population are not engaged in dusty or other occupations, which might be said to predispose to tuberculosis.

In this respect we are more favourably situated than many more densely populated and older countries.

The occupations of deceased males during 1917 is furnished by the Government Statistician.^(4)^

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional</td>
<td>351</td>
</tr>
<tr>
<td>Domestic</td>
<td>131</td>
</tr>
<tr>
<td>Commercial</td>
<td>502</td>
</tr>
<tr>
<td>Engaged in transport</td>
<td>366</td>
</tr>
<tr>
<td>&quot; &quot; Manufacturing</td>
<td>478</td>
</tr>
<tr>
<td>&quot; &quot; Building and construction</td>
<td>302</td>
</tr>
<tr>
<td>Other industrial workers</td>
<td>792</td>
</tr>
<tr>
<td>Agricultural &amp; pastoral</td>
<td>1243</td>
</tr>
<tr>
<td>Working in Mines and Quarries</td>
<td>220</td>
</tr>
<tr>
<td>Other primary producers</td>
<td>51</td>
</tr>
<tr>
<td>Independent means</td>
<td>73</td>
</tr>
<tr>
<td>Dependant relatives</td>
<td>1342</td>
</tr>
<tr>
<td>Dependant on public or private support</td>
<td>36</td>
</tr>
<tr>
<td>Undefined or unknown</td>
<td>144</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6031</strong></td>
</tr>
</tbody>
</table>
The Density of the Population.

The number of persons, excluding Maoris to a square mile in each of the provincial districts at the 1916 census was as follows:

<table>
<thead>
<tr>
<th>Provincial District</th>
<th>Area in sq. miles</th>
<th>Persons to sq. mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auckland</td>
<td>25.364</td>
<td>12.17</td>
</tr>
<tr>
<td>Taranaki</td>
<td>3.732</td>
<td>14.99</td>
</tr>
<tr>
<td>Hawkes Bay</td>
<td>4.241</td>
<td>12.80</td>
</tr>
<tr>
<td>Wellington</td>
<td>10.807</td>
<td>21.48</td>
</tr>
<tr>
<td>Marlborough</td>
<td>4.225</td>
<td>3.93</td>
</tr>
<tr>
<td>Nelson</td>
<td>10.875</td>
<td>3.98</td>
</tr>
<tr>
<td>Westland</td>
<td>4.881</td>
<td>3.18</td>
</tr>
<tr>
<td>Canterbury</td>
<td>13.858</td>
<td>13.12</td>
</tr>
<tr>
<td>Otago</td>
<td>13.957</td>
<td>9.42</td>
</tr>
<tr>
<td>Southland</td>
<td>11.358</td>
<td>5.25</td>
</tr>
</tbody>
</table>

The number of persons excluding Maoris to a square mile at the 1916 census was 10.64

THE PEOPLE OF NEW ZEALAND.

Our people are mostly of English, Scotch and Irish ancestry, except for a few thousand natives.

Possibly because of our remoteness from the thickly populated centres of the Old World, the foreign element is small and our ancestry, conditions of life, and temperate climate have given rise to a freedom-loving,
democratic, and for the most part healthy-living and loyal people.

If we consider the combined populations of Glasgow and Edinburgh spread out over the whole of Great Britain we get some idea of the density of population for the Dominion as a whole. Even in the cities the people are well-housed, well-fed, and well-educated, and there is an absence of that poverty and overcrowding which is the curse of many of the larger cities in the Old World. Our industries are mainly connected with produce, wool, mutton, hides, butter, cheese, timber and subsidiary industries depending on these. Our workmen are well paid, and consequently the conditions of work, and living and housing, are such that epidemic diseases should not obtain as favourable a nidus as is the case in countries less favourably situated.

Yet with all these initial advantages, we are by no means free from infectious disease, as a glance at the following table will show. Tuberculosis (principally pulmonary) is all too rife, and Diphtheria, Scarlet Fever, Measles are common. Typhoid fever is relatively uncommon, except amongst the Native race, where it is impossible to maintain the sanitary standard and conditions of living found amongst the white population.
TABLE IX.

Number of cases for four years 1915 - 18, and rate of incidence per 10,000 of the population for 1917 of the principal infectious diseases notified.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Cases</th>
<th>Incidence per 10,000 of population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1915</td>
<td>1916</td>
</tr>
<tr>
<td>Scarlet Fever</td>
<td>2301</td>
<td>4278</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>1393</td>
<td>2376</td>
</tr>
<tr>
<td>Enteric Fever</td>
<td>821</td>
<td>806</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>998</td>
<td>950</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>10</td>
<td>1018</td>
</tr>
<tr>
<td>Meningococcal Meningitis</td>
<td>82</td>
<td>135</td>
</tr>
</tbody>
</table>

+ The returns for Enteric fever are chiefly due to cases amongst the native population.

o There was an epidemic of this disease in 1916 when 1018 cases were notified, as against 54 in 1917.

There was a marked drop in the number of cases of Scarlet Fever reported as compared with the previous years but there has been a great increase in the returns for Diphtheria.

The Colonial is said to be less resistant to respiratory and catarrhal diseases than those of the same age-groups in Great Britain, and there is some evidence to support this view in the greater prevalence of these diseases amongst Colonial troops in Great Britain than
amongst the British troops. Two reasons may be advanced to explain this difference:— first and of less importance is the fact that we live under considerably better climatic conditions than do those at Home, so that in the sudden translation to the severe winters there, our troops were less resistant to those diseases upon which climate may be said to have some influence. Secondly, and I think more important, is the difference in density of population. Given a population, the bulk of which is spread over a wide area in villages, on farms, sheep stations, etc., there are less opportunities for intimate intercourse, and therefore less opportunity for contracting respiratory diseases. A race exposed to and frequently suffering individually from catarrhal diseases must develop some immunity or a greater immunity on the whole, than people living as they do in New Zealand.

Our young people to whom this specially applies have therefore less immunity, and, given the opportunity for mass infection such as prevails in military camps, they are likely to show a higher incidence for respiratory and catarrhal diseases.

This is well borne out by the experience of military medical officers when at Home, and, to quote a specific instance, it was definitely proved that the country recruit was much more susceptible to meningococ-
Tuberculosis infection shortly after coming into camp than was the town recruit. So much so that special temporary camps were set up to receive country recruits before they were drafted to the main camps. Our experience in this respect is, I believe, similar to that of Medical Officers in Gt. Britain and America.

**Tuberculosis in New Zealand.**

**Table A.**

Although tuberculosis has been a notifiable disease in New Zealand since April 18th, 1901, the system of notification gives very little idea of the prevalence of the different forms of the disease. The official returns issued by the Public Health Department classify tuberculosis under two headings, namely: "All forms of Tuberculosis" and "Pulmonary Tuberculosis," and little further classification into age groups or sex distribution is at present attempted. In arriving at an estimate of the incidence of the disease there are three sources of information of which I have availed myself: viz.

1. The Annual reports of the Public Health Department.
2. The Hospital returns throughout the Dominion and
3. Personal application by circular letter to all medical practitioners.

In the present section I propose to deal with the incidence of the disease as a whole without reference to age or sex distribution, and to consider these in...
later sections.

Information under the first heading is contained in Table X, which is prepared from the annual reports of the Department of Public Health, and shows the total notifications from all forms of tuberculosis in the four Health Districts into which the Dominion has until recently been divided.

<table>
<thead>
<tr>
<th>Year</th>
<th>Auckland</th>
<th>Wellington</th>
<th>Canterbury and Westland</th>
<th>Otago</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>137</td>
<td>199</td>
<td>139</td>
<td>138</td>
<td>613</td>
</tr>
<tr>
<td>1911</td>
<td>177</td>
<td>278</td>
<td>130</td>
<td>134</td>
<td>719</td>
</tr>
<tr>
<td>1912</td>
<td>240</td>
<td>347</td>
<td>313</td>
<td>130</td>
<td>1030</td>
</tr>
<tr>
<td>1913</td>
<td>246</td>
<td>341</td>
<td>334</td>
<td>97</td>
<td>1018</td>
</tr>
<tr>
<td>1914</td>
<td>245</td>
<td>307</td>
<td>235</td>
<td>170</td>
<td>957</td>
</tr>
<tr>
<td>1915</td>
<td>345</td>
<td>247</td>
<td>194</td>
<td>212</td>
<td>998</td>
</tr>
<tr>
<td>1916</td>
<td>303</td>
<td>186</td>
<td>249</td>
<td>212</td>
<td>950</td>
</tr>
</tbody>
</table>

In 1914 Pulmonary Tuberculosis with which was included Tuberculosis (undefined) and Acute Miliary Tuberculosis, comprised 64 per cent of the total cases notified.

The next table (XI) prepared from the hospital returns of the Dominion is necessarily incomplete, but gives some idea of the number of cases of Phthisis and of other forms of Tuberculosis which were admitted to the various hospitals of the Dominion during the years 1914-1916, and which have
either been discharged during life or have died in the
institutions.

TABLE XI.

Hospital returns. Discharges and deaths from Tuberculosis
of the lungs and other forms of Tuberculosis, N.Z. 1914-
1916.

<table>
<thead>
<tr>
<th>Year</th>
<th>T. B. of Lungs</th>
<th>Other forms of T.B.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>1914</td>
<td>549</td>
<td>415</td>
<td>291</td>
</tr>
<tr>
<td>1915</td>
<td>537</td>
<td>354</td>
<td>310</td>
</tr>
<tr>
<td>1916</td>
<td>669</td>
<td>384</td>
<td>295</td>
</tr>
</tbody>
</table>

Of the total cases dealt with in the three years
1914-1916 there were 2651 males and 1767 females or a
total of 4418 persons. The table gives a rough idea of
the relative incidence of the disease in males and females
as seen in hospital practice - 2651 males as against
1767 females, for the three years, or an average of 1473
cases per annum, or an incidence of 1.25 per 1000 of the
total population.

A similar calculation from Table X. gives an inci-
dence of only 0.82 per 1,000 of the population. While
the latter figure is calculated from the official returns
of notifications received it is probably below the actual
figure, for where notification is asked for under such a
general heading many cases of tuberculosis other than pulmonary tuberculosis are not notified.

A comparison with the rates for Great Britain and Australia is difficult in that the returns available for Australia are for Pulmonary Tuberculosis only, while those for New Zealand include all forms of tuberculosis. The percentage of Pulmonary Tuberculosis to all forms of Tuberculosis noticed was in 1914, 64%. If on this basis the figures in Table X are examined it will be seen that on an average about 648 cases of pulmonary tuberculosis are notified annually, or nearly 0.6 per 1000 of the population. On this basis the comparative figures for England; Victoria; (Australia) and New Zealand are shown in Table XII.

**TABLE XII.**

Number of notifications (estimated) of Pulmonary Tuberculosis and rate per 1,000 of the population.

<table>
<thead>
<tr>
<th></th>
<th>No. of cases notified</th>
<th>Rate per 1000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>London (1913)</td>
<td>22,655</td>
<td>5.01</td>
</tr>
<tr>
<td>England, excluding London 1913?</td>
<td>68,446</td>
<td>2.32</td>
</tr>
<tr>
<td>Victoria 1913</td>
<td>1376</td>
<td>0.976</td>
</tr>
<tr>
<td>New Zealand 1914-16</td>
<td>648, average</td>
<td>0.60</td>
</tr>
</tbody>
</table>
The figures given are meagre and for one year only but they indicate the much more favourable position in which New Zealand is placed as regards the incidence of pulmonary tuberculosis. In a subsequent section I hope to show that this comparison is even more favourable when "Juvenile" tuberculosis is considered.

### TUBERCULOSIS - ALL FORMS.

The notification returns in age groups for the Otago Provincial district with a population at the 1916 census of 191,147 are shown in Table XIII. Otago has a more severe climate and one less favourable for respiratory complaints than other parts of the Dominion.

#### TABLE XIII.

<table>
<thead>
<tr>
<th>Year</th>
<th>Age 1-10</th>
<th>10-15</th>
<th>15-25</th>
<th>25 on</th>
<th>Total all ages</th>
<th>Rate per 1,000 population.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>10</td>
<td>17</td>
<td>58</td>
<td>127</td>
<td>£12</td>
<td>Average for 5 years.</td>
</tr>
<tr>
<td>1916</td>
<td>12</td>
<td>10</td>
<td>72</td>
<td>119</td>
<td>£13</td>
<td></td>
</tr>
<tr>
<td>1917</td>
<td>10</td>
<td>4</td>
<td>92</td>
<td>221</td>
<td>£27</td>
<td></td>
</tr>
<tr>
<td>1918</td>
<td>7</td>
<td>3</td>
<td>69</td>
<td>141</td>
<td>£20</td>
<td></td>
</tr>
<tr>
<td>1919</td>
<td>15</td>
<td>6</td>
<td>58</td>
<td>113</td>
<td>£19</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>54</td>
<td>40</td>
<td>329</td>
<td>721</td>
<td>1164</td>
<td>1.21.1</td>
</tr>
</tbody>
</table>
This table will be referred to later in connection with Juvenile Tuberculosis, but it indicates the incidence per 1,000 of the population of all forms of tuberculosis in the Otago Provincial district i.e. 1.742, being the average for a period of 5 years. The Otago returns are usually higher per 10,000 than those from the other provinces. For instance in 1917 the Auckland rate was 4.7, the Wellington rate 2.2, the Canterbury rate 1.61 and the Otago rate 1.742, the rate increasing from the North where better climatic conditions prevail, to the South. Rates based on notifications are however fallacious for they will depend a great deal on the system of notification, the fee paid for notification, and the pressure which the Public Health Department is able to exert in this direction. More reliable returns for purposes of comparison are to be obtained from mortality statistics.
Mortality from Tuberculosis in New Zealand.

The Deaths and Death rates from all forms of Tuberculosis per 10,000 of the population, and the percentage of total deaths are shown in the next table for the years 1907-1916.

(9)

TABLE XIV.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Population</th>
<th>Number of deaths from Tubercular Diseases</th>
<th>Rate per 10,000 population</th>
<th>Percentage of total deaths from all causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1907</td>
<td>919,105</td>
<td>856</td>
<td>9.31</td>
<td>8.50</td>
</tr>
<tr>
<td>1908</td>
<td>945,063</td>
<td>839</td>
<td>8.87</td>
<td>9.28</td>
</tr>
<tr>
<td>1909</td>
<td>971,784</td>
<td>800</td>
<td>8.23</td>
<td>8.93</td>
</tr>
<tr>
<td>1910</td>
<td>992,802</td>
<td>731</td>
<td>7.36</td>
<td>7.58</td>
</tr>
<tr>
<td>1911</td>
<td>1,014,896</td>
<td>738</td>
<td>7.27</td>
<td>7.74</td>
</tr>
<tr>
<td>1912</td>
<td>1,039,016</td>
<td>716</td>
<td>6.89</td>
<td>7.77</td>
</tr>
<tr>
<td>1913</td>
<td>1,068,644</td>
<td>612</td>
<td>7.60</td>
<td>8.02</td>
</tr>
<tr>
<td>1914</td>
<td>1,090,328</td>
<td>728</td>
<td>6.67</td>
<td>7.17</td>
</tr>
<tr>
<td>1915</td>
<td>1,099,394</td>
<td>693</td>
<td>6.30</td>
<td>6.95</td>
</tr>
<tr>
<td>1916</td>
<td>1,099,449</td>
<td>742</td>
<td>6.74</td>
<td>7.00</td>
</tr>
</tbody>
</table>

The corresponding rate for England and Wales was in 1907, 16.67 and in 1913, 13.39.

The mortality from all forms of tuberculosis decreased from 9.31 per 10,000 of the population in 1907 to 6.74 in 1916. The percentage of total deaths from all causes decreased from 8.50 to 7.00 in the ten years.

The decreasing death rate from Tuberculosis is
graphically represented in Graph I, and contrasted with that for England and Wales.

**GRAPH I.**

Death rate per 10,000 population New Zealand from all forms of Tuberculosis 1898-1916. • Eng. = Wales.
The only subdivisions of these figures possible from the returns available is into Pulmonary Tuberculosis, and other forms of Tuberculosis. The figures for 1910-1916 are as follows:

**TABLE XV.**

Deaths and Death Rates Pulmonary Tuberculosis and other forms of Tuberculosis New Zealand, 1910 - 1916 and corresponding rates for England and Wales 1910 - 1913.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number of Deaths</th>
<th>1910</th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
<th>1915</th>
<th>1916</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary Tuberculosis</td>
<td></td>
<td>582</td>
<td>584</td>
<td>567</td>
<td>656</td>
<td>576</td>
<td>562</td>
<td>591</td>
</tr>
<tr>
<td>Other forms of tuberculosis</td>
<td></td>
<td>149</td>
<td>154</td>
<td>149</td>
<td>156</td>
<td>152</td>
<td>131</td>
<td>141</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proportion for 10,000 of mean Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Pulmonary Tuberculosis</td>
</tr>
<tr>
<td>Tuberculosis (other forms)</td>
</tr>
</tbody>
</table>

The corresponding Rates for England & Wales for the years 1910 - 1913 are as follows:

<table>
<thead>
<tr>
<th>England &amp; Wales</th>
<th>Pulmonary Tuberculosis</th>
<th>10.1</th>
<th>10.6</th>
<th>10.1</th>
<th>9.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other forms</td>
<td>4.1 4.0 3.4 3.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table shows the much higher rates for England and Wales which is about double the phthisis rate in New Zealand, and nearly three times the rate from other forms of Tuberculosis.
A further comparison may be made between the figures for New Zealand, the Commonwealth of Australia, and England and Wales.

**TABLE XVI.**

Death rates for 10,000 of the population in New Zealand, Australia, and England and Wales from all forms of Tuberculosis 1910 - 1913.

<table>
<thead>
<tr>
<th></th>
<th>1910</th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>7.36</td>
<td>7.27</td>
<td>6.89</td>
<td>7.60</td>
</tr>
<tr>
<td>(11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>8.3</td>
<td>8.3</td>
<td>7.9</td>
<td>7.9</td>
</tr>
<tr>
<td>(12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>England and Wales</td>
<td>14.2</td>
<td>14.6</td>
<td>13.5</td>
<td>13.3</td>
</tr>
</tbody>
</table>

The New Zealand rate is lower than the Australian and considerably lower than that for England and Wales, but it has not improved in the same degree or with the same regularity as the Australian when the records for a number of years are compared, nor has the improvement been at the same steady rate as that for England and Wales. Starting with a rate of 12.7 per 10,000 of the population in 1871-76, the rate fell to 6.75 in 1912-1916, a fall of 47% in that period.

(13) Newsholme in his Report as Medical Officer of the Local Government Board for 1910-11 summarising the history of the fall of tubercle mortality in England and Wales, states that the English rate has
fallen from 24.0 per 10,000 in 1871 to 9.8 per 10,000 in 1913 - a fall of approximately 60%.

Probably the conditions in England in 1871 were, as now, much more favourable to a high tubercle mortality than in New Zealand, but the greater decline in the rate may be due to a greater activity in the control and towards the eradication of the disease than is the case in New Zealand. Here our climate, our housing conditions, and high wages favour a low tubercle rate, but judging from all accounts the antituberculosis propaganda is much more active in Great Britain than it is in New Zealand.

A comparison of the death rates from Tuberculosis and of the percentage of total deaths for England, Scotland, the Australian States, New Zealand, and Ireland is shown in the next table. The returns for 1913 and 1914 only are available.
The New Zealand rate again as well as those of the Australian States compares very favourably with those of England, Scotland and Ireland.

In Australia the rate was materially increased by the deaths of persons who have come from other countries either already suffering from phthisis or predisposed thereto. Of recent years, however, every effort has been made in New Zealand to prohibit such immigrants who often become a charge on the State, and under the Immigration Restriction Act any person suffering from tubercular disease and domiciled elsewhere, may be pro-
hindered from landing in New Zealand and must be returned by the Shipping Company from whence he or she came.

The Death rate from Tuberculosis in New Zealand is contrasted with that of the six most fatal diseases in Graph II and illustrates the important place occupied by Tuberculosis (15)

**CHART II.**

Showing the proportions of Deaths in 10 years 1894-1903 from the most fatal Diseases in New Zealand.

<table>
<thead>
<tr>
<th>Tubercular Diseases</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7617</td>
</tr>
<tr>
<td>Cancer</td>
<td>4577</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>3970</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3783</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>3190</td>
</tr>
<tr>
<td>Enteric Fever</td>
<td>929</td>
</tr>
</tbody>
</table>
A final comparison of the death rates per million of the population in the chief cities of the world and of the four chief towns in New Zealand for the decennium 1894-1903 demonstrates again our fortunate position in New Zealand.

**CHART III.**

Showing the number of deaths from Tubercular Diseases to 1,000,000 of the population of the Chief Towns in the World and corresponding figures for the chief towns in New Zealand.

<table>
<thead>
<tr>
<th>City</th>
<th>Deaths per million population: 1894-1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrograd</td>
<td>4560</td>
</tr>
<tr>
<td>Vienna</td>
<td>4500</td>
</tr>
<tr>
<td>Paris</td>
<td>3750</td>
</tr>
<tr>
<td>New York</td>
<td>1500</td>
</tr>
<tr>
<td>Berlin</td>
<td>1215</td>
</tr>
<tr>
<td>London</td>
<td>1800</td>
</tr>
<tr>
<td>Naples</td>
<td>1750</td>
</tr>
<tr>
<td>Buenos Ayres</td>
<td>1650</td>
</tr>
<tr>
<td>Dunedin, N.Z</td>
<td>1513</td>
</tr>
<tr>
<td>Wellington</td>
<td>1339</td>
</tr>
<tr>
<td>Christchurch</td>
<td>1239</td>
</tr>
<tr>
<td>Auckland</td>
<td>1285</td>
</tr>
</tbody>
</table>
While the Rates for the New Zealand towns are less than those of any other town shown in the chart it will be seen that Dunedin, the Edinburgh of New Zealand in nationality, in general arrangement, and in climate, but with a much smaller population than that of the other New Zealand towns has the highest Tuberculosis rate.
PULMONARY TUBERCULOSIS.

The figures so far considered are for all forms of Tuberculosis; but whereas New Zealand has, as I shall show, a considerably lower incidence of Juvenile Tuberculosis (all forms), Pulmonary Tuberculosis appears to be more prevalent than should be the case considering all the factors which favour us.

The deaths from phthisis for the years 1901-1916 are recorded in table XVIII and the rate per 10,000 of the population. These are contrasted with the rates for England and Wales in the table and in Graph IV.

TABLE XVIII.

Deaths and D.R. for 10,000 population New Zealand 1901-1916 and D.R. for 10,000 England and Wales 1901-1914.

Pulmonary Tuberculosis.

<table>
<thead>
<tr>
<th>Year</th>
<th>Deaths from Pulmonary Tuberculosis, N.Z.</th>
<th>Rate per 10,000 N.Z.</th>
<th>Rate per 10,000 England &amp; Wales.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>596.</td>
<td>7.76</td>
<td>12.64</td>
</tr>
<tr>
<td>1902</td>
<td>617.</td>
<td>7.73</td>
<td>12.34</td>
</tr>
<tr>
<td>1903</td>
<td>570</td>
<td>6.95</td>
<td>12.06</td>
</tr>
<tr>
<td>1904</td>
<td>598</td>
<td>7.08</td>
<td>12.41</td>
</tr>
<tr>
<td>1905</td>
<td>496</td>
<td>5.70</td>
<td>11.46</td>
</tr>
<tr>
<td>1906</td>
<td>556</td>
<td>6.21</td>
<td>11.57</td>
</tr>
<tr>
<td>1907</td>
<td>612</td>
<td>6.66</td>
<td>11.48</td>
</tr>
<tr>
<td>1908</td>
<td>663</td>
<td>7.02</td>
<td>11.23</td>
</tr>
<tr>
<td>1909</td>
<td>624</td>
<td>6.42</td>
<td>10.94</td>
</tr>
<tr>
<td>1910</td>
<td>582</td>
<td>5.86</td>
<td>10.15</td>
</tr>
<tr>
<td>1911</td>
<td>584</td>
<td>5.75</td>
<td>10.62</td>
</tr>
<tr>
<td>1912</td>
<td>567</td>
<td>5.46</td>
<td>10.17</td>
</tr>
<tr>
<td>1913</td>
<td>656</td>
<td>6.14</td>
<td>9.80</td>
</tr>
<tr>
<td>1914</td>
<td>676</td>
<td>5.28</td>
<td>-</td>
</tr>
<tr>
<td>1915</td>
<td>562</td>
<td>5.11</td>
<td>-</td>
</tr>
<tr>
<td>1916</td>
<td>591</td>
<td>5.38</td>
<td>-</td>
</tr>
</tbody>
</table>
Professor Hunter Stewart gives the following rates for Scotland per 10,000 living at all ages.

1901-5 = 14.45
1906-7 = 13.58

The figures which he quotes are considerably higher than those for New Zealand, and higher than those for England and Wales for the same period.

Professor Hunter Stewart, in the paper quoted draws attention to this fact as regards England and Wales and shows to what this is due in the following words:

"At the present time the greater mortality from tuberculosis of the lungs among the entire population of Scotland as compared with that of England and Wales is due to the greater mortality among females, and this latter is due to the fact that the decrease in the rate of mortality among females has been much less than in England and Wales."

For the first three years shown under the New Zealand figures the numbers and rates refer only to those deaths definitely certified to as being due to phthisis or tuberculosis of the lungs. For later years, miliary tuberculosis and tuberculosis not otherwise defined are also included in official returns.

It will be seen that the average death rate in New Zealand from Phthisis for the 10 years 1906-1915 inclusive was 5.99 per 10,000 of the population and that for England and Wales for the 8 years 1906-1913 was 10.74 per
10,000 population. These figures are set out in Graph IV in which the contrast between the different rates in the two countries is well shown.

Graph IV.

Death rates from Phthisis New Zealand and England and Wales 1901-1916 per 10,000 population.
Besides demonstrating the comparatively low phthisis death rate in New Zealand, the graph shows a steady decline in the rate in England and Wales as compared with the irregular rate of decline in New Zealand. During the years in question a much greater effort has been made to control the spread of this disease in Great Britain than has been the case in New Zealand. Our low rate has probably induced a feeling of security when it has been contrasted with the higher rates in other countries. The position may be summed up by applying the term "co-ordinated effort" to the English Graph and the term "spasmodic effort" to the New Zealand Graph. The latter term accurately describes our New Zealand efforts, which have however been carried out until recently with a Public Health Staff totally inadequate to the needs of a growing country. It has required the disastrous lesson of the Influenza epidemic to impress on our Government and people the need for the expenditure of at least as much money on the Public Health Service, as is devoted without demur to the needs of our Live Stock Department.

Cobbett (19) (Cambridge) gives the death rates per million from pulmonary tuberculosis, which are probably more reliable than these for all kinds of tuberculosis, for some of the principal countries for which statistics
were available. The figures are for 1910 unless otherwise stated and refer to the country as a whole and not to towns as in Chart 3.

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate per million</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>1788</td>
</tr>
<tr>
<td>Ireland</td>
<td>1716 (excluding acute miliary tuberculosis)</td>
</tr>
<tr>
<td>Germany</td>
<td>1421</td>
</tr>
<tr>
<td>Denmark</td>
<td>1201 (1912) Principal cities only.</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1189</td>
</tr>
<tr>
<td>Italy</td>
<td>1174 Including general tuberculosis</td>
</tr>
<tr>
<td>Scotland</td>
<td>1142 Excluding acute miliary tuberculosis.</td>
</tr>
<tr>
<td>England &amp; Wales</td>
<td>1015</td>
</tr>
<tr>
<td>Belgium</td>
<td>972</td>
</tr>
<tr>
<td>Ontario</td>
<td>932 (1911)</td>
</tr>
<tr>
<td>Australia</td>
<td>700</td>
</tr>
<tr>
<td>New Zealand</td>
<td>587</td>
</tr>
</tbody>
</table>

These are crude death rates uncorrected for age and sex constitution of the population and are therefore only roughly comparable with one another.

These figures representing more recent statistics than those from which Chart 3 is prepared again show the very favourable position of New Zealand as regards pulmonary tuberculosis when contrasted with other countries.
THE AGE & SEX DISTRIBUTION OF TUBERCULOSIS (all forms) in New Zealand and a comparison with Australia and Gt. Britain.

TABLE XIX. a. & b.

Total death rates from all forms of Tuberculosis in each of the age groups indicated and in sexes 1910-1916, New Zealand.
NOTE: 5 yearly periods up to 40, then 10 yearly periods. Table xixb carries the 5 yearly periods on from 40 - 60.

<table>
<thead>
<tr>
<th>Year</th>
<th>Under 5</th>
<th>5-10</th>
<th>10-15</th>
<th>15-20</th>
<th>20-25</th>
<th>25-30</th>
<th>30-35</th>
<th>35-40</th>
<th>40-50</th>
<th>50-60</th>
<th>over 60</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>35.30</td>
<td>12.12</td>
<td>3.4</td>
<td>10.28</td>
<td>43.53</td>
<td>66.67</td>
<td>57.57</td>
<td>27.32</td>
<td>59.19</td>
<td>52.15</td>
<td>31.17</td>
<td>397.334</td>
</tr>
<tr>
<td>1911</td>
<td>29.28</td>
<td>11.8</td>
<td>9.9</td>
<td>16.39</td>
<td>37.55</td>
<td>48.71</td>
<td>54.34</td>
<td>52.25</td>
<td>76.34</td>
<td>40.14</td>
<td>33.16</td>
<td>405.333</td>
</tr>
<tr>
<td>1912</td>
<td>22.26</td>
<td>9.10</td>
<td>13.11</td>
<td>17.33</td>
<td>47.42</td>
<td>50.48</td>
<td>45.57</td>
<td>42.39</td>
<td>46.42</td>
<td>30.12</td>
<td>27.9</td>
<td>381.335</td>
</tr>
<tr>
<td>1913</td>
<td>26.20</td>
<td>12.8</td>
<td>5.16</td>
<td>26.47</td>
<td>40.53</td>
<td>54.56</td>
<td>57.56</td>
<td>59.39</td>
<td>59.48</td>
<td>41.25</td>
<td>42.23</td>
<td>421.391</td>
</tr>
<tr>
<td>1914</td>
<td>28.17</td>
<td>7.13</td>
<td>5.12</td>
<td>20.27</td>
<td>39.57</td>
<td>44.59</td>
<td>50.44</td>
<td>46.31</td>
<td>75.44</td>
<td>43.21</td>
<td>34.12</td>
<td>391.337</td>
</tr>
<tr>
<td>1915</td>
<td>23.14</td>
<td>9.10</td>
<td>5.11</td>
<td>14.35</td>
<td>43.47</td>
<td>45.49</td>
<td>43.59</td>
<td>54.37</td>
<td>69.33</td>
<td>25.14</td>
<td>29.15</td>
<td>359.334</td>
</tr>
<tr>
<td>1916</td>
<td>26.23</td>
<td>14.6</td>
<td>9.12</td>
<td>15.32</td>
<td>34.39</td>
<td>48.71</td>
<td>63.51</td>
<td>53.40</td>
<td>67.46</td>
<td>30.23</td>
<td>29.11</td>
<td>388.354</td>
</tr>
<tr>
<td>Total</td>
<td>189.168</td>
<td>74.67</td>
<td>51.75</td>
<td>118.241</td>
<td>283.346</td>
<td>363.421</td>
<td>369.338</td>
<td>333.243</td>
<td>51.265</td>
<td>261.124</td>
<td>226.103</td>
<td>2742.2418</td>
</tr>
</tbody>
</table>

Average: 24.07, 10.57, 9.57, 3.57, 17.0, 34.45, 40.43, 49.43, 50.7, 50.1, 22.7, 51.1, 47.57, 34.7, 37.5, 37.5, 32.1, 14.7
<table>
<thead>
<tr>
<th>Year</th>
<th>40-45</th>
<th>45-50</th>
<th>50-55</th>
<th>55-60</th>
<th>60-65</th>
<th>65-70</th>
<th>70-75</th>
<th>75-80</th>
<th>80 upwards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td>M. F.</td>
<td></td>
</tr>
<tr>
<td>1910</td>
<td>32</td>
<td>8</td>
<td>27</td>
<td>11</td>
<td>29</td>
<td>9</td>
<td>23</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>1911</td>
<td>40</td>
<td>21</td>
<td>36</td>
<td>13</td>
<td>18</td>
<td>5</td>
<td>22</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>1912</td>
<td>32</td>
<td>27</td>
<td>14</td>
<td>15</td>
<td>21</td>
<td>7</td>
<td>95</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>1913</td>
<td>39</td>
<td>33</td>
<td>20</td>
<td>15</td>
<td>24</td>
<td>17</td>
<td>17</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>1914</td>
<td>45</td>
<td>24</td>
<td>30</td>
<td>20</td>
<td>26</td>
<td>15</td>
<td>17</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>1915</td>
<td>37</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>15</td>
<td>9</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>1916</td>
<td>38</td>
<td>33</td>
<td>29</td>
<td>13</td>
<td>19</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Total for 7 years</td>
<td>263</td>
<td>166</td>
<td>188</td>
<td>100</td>
<td>147</td>
<td>75</td>
<td>114</td>
<td>49</td>
<td>89</td>
</tr>
<tr>
<td>Average</td>
<td>37.2</td>
<td>22.7</td>
<td>23.0</td>
<td>21.4</td>
<td>20.7</td>
<td>16.3</td>
<td>7.0</td>
<td>12.7</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Table XIX sets out the deaths (not death rates) from all forms of tuberculosis in each of the age groups indicated - for each sex. They cover the period 1910-1916 inclusive, and are prepared from the returns of the Registrar General as published in the New Zealand official year books for those years. From the total number of male and female deaths in each age group Chart 5 has been prepared.
CHART V

Total deaths from all forms of Tuberculosis 1910-1916 New Zealand in age groups and for sexes.
-50-

It will be noted that the female deaths exceed the male deaths from this cause between the ages of 8 and 29. It also appears that the number of deaths is greatest in the periods 20-40, the minimum number of deaths is greatest in the periods 20-40, the maximum number of deaths in males being in the 30-35 year age period, while the maximum deaths in females are in the 25-30 age period.

A somewhat different picture is obtained by comparing the Death Rates for males and females per 10,000 living at each age period: The age distribution being more certain in census years the statistics for 1916 have been used.

**TABLE XX.**

Deaths per 10,000 population in each age group and for both sexes. Tuberculosis (all forms). Deaths averaged for 1910-1916.

<table>
<thead>
<tr>
<th>Age period</th>
<th>Male rate per 10,000</th>
<th>Female rate per 10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>4.0</td>
<td>3.7</td>
</tr>
<tr>
<td>5 &amp; under 10</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>10</td>
<td>1.3</td>
<td>1.9</td>
</tr>
<tr>
<td>15</td>
<td>3.7</td>
<td>7.3</td>
</tr>
<tr>
<td>20</td>
<td>13.2</td>
<td>10.5</td>
</tr>
<tr>
<td>25</td>
<td>12.6</td>
<td>12.3</td>
</tr>
<tr>
<td>30</td>
<td>11.4</td>
<td>10.8</td>
</tr>
<tr>
<td>35</td>
<td>10.3</td>
<td>7.8</td>
</tr>
<tr>
<td>40</td>
<td>10.2</td>
<td>6.1</td>
</tr>
<tr>
<td>50</td>
<td>8.7</td>
<td>4.8</td>
</tr>
<tr>
<td>60 and over</td>
<td>7.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Chart VI from Table XX.

Death rates from all forms of Tuberculosis N.Z. in age groups and for males and females per 10,000 of the population in each age group. Average deaths for the 7 years 1910-1916.
From this table and from Chart VI which has been prepared from it, it will be seen that the female death rate exceeds that of the male rate to a slight extent only between the ages of 6 and 18 and after that age the male death rate is in excess of the female rate, the differences being very marked in the 20-25 year age period, due to the lesser number of males (30,419) as against (46,759) females in that age period.

After the age of 35 the female rate drops more quickly than the male, and at the 50-60 year age period there is a considerable difference in the rates (8.7 males) and 4.8 females). The male population at this age period was 42,734 as against 36,715 females in 1916. So that the incidence is proportionately heavier on males during the 20-25 year period and after 35 years of age.

The next table shows a comparison between the New Zealand, Australian and English Rates.

Average mortality rates from all forms of tuberculosis per 10,000 living at each age period and in sexes New Zealand, Australia, England and Wales.
The figures are not strictly comparable, for the English rate appears in the most unfavourable light, the only figures available being for the years 1901-10, while those for New Zealand are for 1910-1916, the English rate having fallen slightly since 1910.

The New Zealand combined rate (males and females) is very similar to the Australian rate up to the 30-35 year age period, after which the Australian rate is considerably higher. Later it will be shown in Graph VIII b. how strikingly the Australian male rate continues to rise after the 30-35 year age period when those for New Zealand both sexes, and Australia (female)
fall away. The Australian male rate continues to rise until the 55-60 year age period.

The Juvenile rates for the two countries are very similar.

When the New Zealand or Australian rates are compared with that for England and Wales a great difference is noted. At all age periods and in both sexes the rates in the latter country are higher and particularly is this noticeable in 0-15 year and in the 35-40 age period. These differences are strikingly shown in the following Chart VII.

**CHART VII.**

Death Rates all forms of Tuberculosis, N.Z. (1910-1916) and England and Wales (1901-1910) per 10,000 population in age groups and for both sexes.
At no period except between 20-30 years do the New Zealand rates anywhere approach the English figures, while the Juvenile rates, particularly those under 5 years are very much in New Zealand’s favour, and bear on the subject matter which is to follow in the discussion on Juvenile Tuberculosis in New Zealand.

The New Zealand and Australian mortality rates from tuberculosis although corresponding fairly closely for both sexes up to the 25-30 year age period differ markedly in the male rates after this age period. The New Zealand rate gradually falls, but the Australian male rate continues to rise until the 55-60 year age period when it reaches a maximum.

Table XXII which is supplementary to table XXI gives the mortality rates for the two countries in 5 yearly age periods and for both sexes from 40 years onwards.

**Table XXII.**
Average mortality rates from all forms of tuberculosis per 10,000 living at each age period from 40 years onwards in New Zealand and in the Commonwealth of Australia. For earlier rates see Table XXI.

<table>
<thead>
<tr>
<th>Age period</th>
<th>New Zealand 1910-16 M.</th>
<th>New Zealand 1910-16 F.</th>
<th>Australia 1909-13 M.</th>
<th>Australia 1909-13 F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-45</td>
<td>10.2</td>
<td>6.9</td>
<td>14.8</td>
<td>10.3</td>
</tr>
<tr>
<td>45-50</td>
<td>8.1</td>
<td>5.1</td>
<td>16.3</td>
<td>9.4</td>
</tr>
<tr>
<td>50-55</td>
<td>8.7</td>
<td>5.0</td>
<td>17.1</td>
<td>7.3</td>
</tr>
<tr>
<td>55-60</td>
<td>8.7</td>
<td>4.4</td>
<td>18.5</td>
<td>8.2</td>
</tr>
<tr>
<td>60-65</td>
<td>7.8</td>
<td>3.5</td>
<td>17.9</td>
<td>9.1</td>
</tr>
<tr>
<td>65-70</td>
<td>7.4</td>
<td>5.6</td>
<td>15.7</td>
<td>9.1</td>
</tr>
<tr>
<td>70-75</td>
<td>7.7</td>
<td>4.8</td>
<td>13.7</td>
<td>7.3</td>
</tr>
<tr>
<td>75-80</td>
<td>5.2</td>
<td>2.5</td>
<td>7.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Over 80</td>
<td>3.9</td>
<td>1.4</td>
<td>4.1</td>
<td>3.9</td>
</tr>
</tbody>
</table>
The male rate for Australia which unlike the female rate and the two rates for N.Z. continues to rise after the 30 year period, is well shown in the next chart.

**CHART VIII. A. & B.**

Death rates from all forms of tuberculosis per 10,000 living at each age period in New Zealand and Australia. Males and females. For convenience and to demonstrate the minor differences between the male and female rates in the two countries in the earlier years the Chart is divided into two sections A. & B.. The first section is double the scale of the second section and covers the age group 0-5, 5-10, 10-15, 15-20, and the second section of the chart covers the age groups from 15 to 80 and onwards. P.T.O.
Mortality rates all forms Tuberculosis New Zealand 1910-16 and Australia (1909-13) per 10,000 population for both sexes and for age period 0-20. Double scale of Chart VIIIb.
Death rates all forms of Tuberculosis New Zealand and Australia contrasted in age groups from 15 years and upwards, and for both sexes, per 10,000 living in each age group. Average of years 1910-16. The Graph is half the scale of Graph VIIIa.
Chart VIIa shows how closely the rates for both sexes correspond to one another in the two countries until the 10-15 year age group, when the female rate leaves the male and at the 15-20 year period exceeds it considerably. Reference to Table XXI will show that the same thing happens with the English rate, but the ascent is not so sudden and the female rate exceeds the male to much the same extent over both the 10-15 and 15-20 year age periods.

Chart VIIib shows how the male New Zealand rate exceeds the female from about 18 years onwards though the excess is by no means marked. The very considerable rise in the Australian male rate after the 30-35 year age period when the New Zealand rates fall, reaches a maximum at the 55-60 year age period. The English rate shows a similar though less marked rise in the 45-55 year period but falls away in the 55-65 year period.

That the maximum mortality in adult life is attained considerably later among men than it is among women was not always the case according to Jobbett (Causes of Tuberculosis, Cam. Univ. Press.) states that in 1861-70 both maxima occurred earlier in life, and very much about the same period in the two sexes; the maximum among women being then between 25 - 35 and that among men between 25 and 45. Thus we see that one of the important changes which have been taking place is the moving of the maximum mortality from tuberculosis to a
later period of life, and this to a greater extent among men than among women.

It will be interesting to see in years to come when sufficiently accurate and lengthy records are available for New Zealand, whether the same change takes place. In our case no such increase in the rate after the 25-35 year period is apparent and no explanation is offered in the official returns for the high senile male rate in Australia. It is a matter which I propose to investigate on my return, but the chart which sets it out so clearly was only prepared while I was travelling to this country.

---------

Table XVII and Graph IV, we see the same rise in considerably lower than that for England, yet in-
Mortality from Pulmonary Tuberculosis (N.Z. in age groups and according to sex.

Having briefly considered the mortality rates for all forms of tuberculosis and compared these with those of our sister dominion Australia and with those of the Home country, it will be interesting, before taking up the subject matter in which I am particularly interested, i.e. Juvenile Tuberculosis, to compare the mortality rates for phthisis in age groups and for males and females in these countries.

Of all forms of tuberculosis phthisis appears to be the most prevalent in New Zealand, although from Table XVIII and Graph IV, we see that the death rate is considerably lower than that for England and Wales.

Table XXXI shows the total deaths from Pulmonary Tuberculosis per 10,000 living in age groups and for both sexes in New Zealand.
TABLE XXIII.

Total deaths from pulmonary tuberculosis (including generalised tuberculosis) New Zealand in age groups and for both sexes 1910-1916.

<table>
<thead>
<tr>
<th>Year</th>
<th>Under 5</th>
<th>5-10</th>
<th>10-15</th>
<th>15-25</th>
<th>25-35</th>
<th>35-45</th>
<th>45-55</th>
<th>55-65</th>
<th>65-75</th>
<th>75 up.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
<th>M.</th>
<th>F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>41</td>
<td>65</td>
<td>110</td>
<td>100</td>
<td>50</td>
<td>34</td>
<td>80</td>
<td>17</td>
<td>31</td>
<td>10</td>
<td>14</td>
<td>10</td>
<td>70</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>38</td>
<td>75</td>
<td>77</td>
<td>92</td>
<td>77</td>
<td>34</td>
<td>45</td>
<td>16</td>
<td>28</td>
<td>10</td>
<td>18</td>
<td>8</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1912</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>47</td>
<td>53</td>
<td>78</td>
<td>89</td>
<td>65</td>
<td>53</td>
<td>39</td>
<td>19</td>
<td>27</td>
<td>10</td>
<td>17</td>
<td>8</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1913</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>40</td>
<td>77</td>
<td>78</td>
<td>91</td>
<td>74</td>
<td>61</td>
<td>36</td>
<td>30</td>
<td>26</td>
<td>16</td>
<td>17</td>
<td>9</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1914</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>44</td>
<td>66</td>
<td>79</td>
<td>80</td>
<td>77</td>
<td>48</td>
<td>49</td>
<td>25</td>
<td>28</td>
<td>9</td>
<td>13</td>
<td>4</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>49</td>
<td>69</td>
<td>79</td>
<td>94</td>
<td>82</td>
<td>50</td>
<td>37</td>
<td>15</td>
<td>23</td>
<td>8</td>
<td>13</td>
<td>13</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1916</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>37</td>
<td>65</td>
<td>96</td>
<td>110</td>
<td>89</td>
<td>58</td>
<td>44</td>
<td>27</td>
<td>21</td>
<td>5</td>
<td>11</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total both sexes.</td>
<td>20</td>
<td>20</td>
<td>12</td>
<td>10</td>
<td>17</td>
<td>31</td>
<td>296</td>
<td>470</td>
<td>597</td>
<td>656</td>
<td>514</td>
<td>353</td>
<td>330</td>
<td>149</td>
<td>184</td>
<td>68</td>
<td>103</td>
<td>58</td>
<td>32</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.0</td>
<td>3.0</td>
<td>1.7</td>
<td>1.43</td>
<td>2.43</td>
<td>4.43</td>
<td>42.3</td>
<td>67.14</td>
<td>83.337</td>
<td>34.46.3</td>
<td>42.85</td>
<td>14.3</td>
<td>46.39</td>
<td>37.1</td>
<td>14.7</td>
<td>8.3</td>
<td>4.57</td>
<td>1.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From Table XXIII the average mortality rates for phthisis in New Zealand in age periods has been prepared. The Table is not comparable with Tables XXI and XXII, after the 10-15 year period as the returns from which it has been prepared are grouped in 10 yearly periods from 15-25 on. By adjusting the rates to correspond in the earlier tables mentioned, a graph has been prepared and shows the difference between the mortality rates from all forms of tuberculosis and from phthisis only, in both sexes and in the different age groups.

**TABLE XXIV.**

Average mortality rates (1910-1916) per 10,000 living at each age period and for males and females for Phthisis in New Zealand.

<table>
<thead>
<tr>
<th>Age period</th>
<th>Males</th>
<th>Females</th>
<th>Both Sexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>5 yrs. under</td>
<td>0.27</td>
<td>0.21</td>
<td>0.24</td>
</tr>
<tr>
<td>10</td>
<td>0.43</td>
<td>0.82</td>
<td>0.625</td>
</tr>
<tr>
<td>15</td>
<td>5.6</td>
<td>7.2</td>
<td>6.4</td>
</tr>
<tr>
<td>25</td>
<td>9.8</td>
<td>9.7</td>
<td>9.75</td>
</tr>
<tr>
<td>35</td>
<td>8.8</td>
<td>6.1</td>
<td>7.45</td>
</tr>
<tr>
<td>45</td>
<td>7.5</td>
<td>4.3</td>
<td>5.9</td>
</tr>
<tr>
<td>55</td>
<td>7.5</td>
<td>3.4</td>
<td>5.45</td>
</tr>
<tr>
<td>65</td>
<td>7.5</td>
<td>5.0</td>
<td>6.25</td>
</tr>
<tr>
<td>75 and over</td>
<td>4.5</td>
<td>1.9</td>
<td>3.2</td>
</tr>
</tbody>
</table>
TABLE XXIV a.

Average Mortality rates per 10,000 living in age groups from Tuberculosis (all forms) and from Phthisis in New Zealand. Average of 1910-16.

<table>
<thead>
<tr>
<th>Age period</th>
<th>All forms Tuberculosis per 10,000 both sexes</th>
<th>Phthisis only both sexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 years</td>
<td>3.8</td>
<td>0.4</td>
</tr>
<tr>
<td>5 yrs. &amp; under 10</td>
<td>1.5</td>
<td>0.24</td>
</tr>
<tr>
<td>10 &quot;</td>
<td>1.6</td>
<td>0.625</td>
</tr>
<tr>
<td>15 &quot;</td>
<td>8.67</td>
<td>6.4</td>
</tr>
<tr>
<td>25 &quot;</td>
<td>11.77</td>
<td>9.75</td>
</tr>
<tr>
<td>35 &quot;</td>
<td>8.8</td>
<td>7.45</td>
</tr>
<tr>
<td>45 &quot;</td>
<td>6.7</td>
<td>5.9</td>
</tr>
<tr>
<td>55 &quot;</td>
<td>6.1</td>
<td>5.45</td>
</tr>
<tr>
<td>65 &quot;</td>
<td>6.37</td>
<td>6.25</td>
</tr>
<tr>
<td>75 and over</td>
<td>3.25</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Graph IX. shows the average mortality rates per 10,000 living at each age period from Tuberculosis (all forms) and Phthisis, New Zealand (1910-1916 averaged). The Phthisis rate follows that of all forms of tuberculosis rather closely, except in the 0-15 year period. The rates diverge again about the 15-25 year period and converge from the 35-55 year periods. The rates almost coincide from 65 years on.

Graph X. shows the comparison between the rates rather more clearly. (For Graphs see over.)
Chart IX
Average Mortality Rates for 10-year blocks in apne forms of tuberculosis in Scotland 1910-1916

- Tuberculosis rate
- All forms tuberculosis
Graph X

Same as Graph IX but represented in a different manner. (P.T.O.)

A comparison between Graphs VII and X demonstrates the very low relative rate in New Zealand in the 0-5 year period as compared with England & Wales—3.8 per 10,000 as against 28.7 for 10,000. This will be referred to in the section on Juvenile Tuberculosis.

Exact information as to the forms of tuberculosis which are responsible for deaths other than phthisis is difficult to obtain over a period of years, but in the Report of the Chief Health Officer for 1907-08 is a table setting out the deaths from Tuberculosis including Microfula. In the 1-15 year period out of a total of 190 deaths from these causes, 28 were due to Tabes Mesenterica, 124 to Tubercular Meningitis, 18 to Phthisis, and 20 to other forms of Tuberculosis including Microfula. The comparatively small number attributed to abdominal tuberculosis and the relatively large number due to meningeal tuberculosis is interesting in view of what I have ascertained as regards our milk supplies, and tubercular cattle, and the types of bacilli responsible for human lesions, which I shall discuss later.

In the 15-45 year period out of a total of 361
Graph X

Average Mortality rates per 10,000 living in age groups - Tuberculosis & Phthisis, New Zealand

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>1</td>
</tr>
<tr>
<td>5-10</td>
<td>2</td>
</tr>
<tr>
<td>10-15</td>
<td>3</td>
</tr>
<tr>
<td>15-20</td>
<td>4</td>
</tr>
<tr>
<td>20-25</td>
<td>5</td>
</tr>
<tr>
<td>25-30</td>
<td>6</td>
</tr>
<tr>
<td>30-35</td>
<td>7</td>
</tr>
<tr>
<td>35-40</td>
<td>8</td>
</tr>
<tr>
<td>40-45</td>
<td>9</td>
</tr>
<tr>
<td>45-50</td>
<td>10</td>
</tr>
<tr>
<td>50-55</td>
<td>11</td>
</tr>
<tr>
<td>55-60</td>
<td>12</td>
</tr>
<tr>
<td>60-65</td>
<td>13</td>
</tr>
<tr>
<td>65-70</td>
<td>14</td>
</tr>
</tbody>
</table>

Legend: Red - Tuberculosis, Black - Phthisis
deaths from tuberculosis, 15 deaths were attributed to Abdominal tuberculosis, 22 to tubercular meningitis, 459 to Phthisis and 65 to other forms of tuberculosis.

A further analysis of the Charts is impossible owing to the lack of data but it is gratifying to note that since the Influenza epidemic in Nov. 1918, the public conscience has been awakened to the importance of having an adequately staffed Department of Public Health; quite recently a statistical officer has been appointed and an earnest attempt is being made to improve and amplify the system of notification and registration of all forms of tuberculosis.

Table XX and Chart VII show the mortality rates from Tuberculosis (all forms) per 10,000 of the population living at each age period 0-1, 2-10, 10-14, 14-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70 & over. The mortality rates are compared with those for England and Wales and for the Commonwealth of Australia. Chart VIII shows the advantage in the different mortality rates from all forms of tuberculosis in age groups in New Zealand and in England and Wales and the great difference in the 5-year period. A similar table comparing New Zealand and Scotland would be interesting for much work has been done in Edinburgh in recent years on the Juvenile Tubercu-
PART II.

TUBERCULOSIS IN CHILDREN IN NEW ZEALAND AND ITS INCIDENCE ON THE 0-16 AGE PERIOD.

In the previous sections dealing with the incidence of Tuberculosis and of Phthisis in age groups, tables, and graphs have been prepared which show that in New Zealand as in other countries, phthisis is a disease which is responsible for a very small proportion of the deaths between the ages of 0-10, and of a slightly larger proportion between the ages 10-15: It is to the other forms of tuberculosis that we must look for the principal mortality between these ages.

Table XX and Chart VI show the mortality rates from Tuberculosis (all forms) per 10,000 of the population living at each age period 0-5, 5-10, 10-15, for both males and females and in Table XXI these rates are contrasted with those for England and Wales and for the Commonwealth of Australia. Chart VII shows very clearly the different mortality rates from all forms of tuberculosis in age groups in New Zealand and in England and Wales and the great difference in the 0-5 year period. A similar table comparing New Zealand and Scotland would be interesting for much work has been done in Edinburgh in recent years on the Juvenile Tuber-
culosis problem. The necessary data are unfortunately not available here and the only paper I have i.e. that by Prof. Hunter Stewart (18), deals with Pulmonary Tuberculosis only.

Chart VIII A shows the Juvenile rates for males and females in Australia and New Zealand and it will be seen that while in the earlier years the New Zealand rate for both sexes is slightly lower than the Australian, from the 8th to the 10th year the Australian rate is lower than the New Zealand rate. Thereafter up to the 20th year the rates for males and females closely correspond: It has already been shewn in Graph VIII B how the Australian male rate increases in later years when the New Zealand rate is falling.

Table XXIV A and Charts IX and X contrast the mortality rates for tuberculosis and phthisis in New Zealand in age groups, and it is seen that of the Juvenile period 0-15, by far the heaviest incidence for all forms of tuberculosis is on the period 0-5, when milk and milk foods are the principal diet or when the child is brought into closest contact with its mother. While we are in a very favourable position in New Zealand and Australia as regards our Juvenile Tuberculosis as compared with the Home Land, we cannot take great credit unto ourselves for this fortunate position. As I have already pointed
out, we have the advantage in climate, in space, in wages and in food, and we should thus expect a lower incidence of such a disease as tuberculosis. Our fellow workers in the Old Country however, following the splendid example and teaching of Sir Robert Philip, have made, and are still making, a more sustained and a better organised effort to combat and control tuberculosis than is the case with us. In one respect, as I shall show more fully later, we in New Zealand are more in advance of the Old Country in our Anti-tuberculosis measures, and that is in the control of our milk supplies and of our tuberculous cattle. By these measures alone I think we prevent much of the early tuberculosis which is all too rife in Gt. Britain, and which is shown all too clearly in Chart VII.

Some years ago (1912) when I took up the question of Juvenile Tuberculosis in New Zealand, I endeavoured to ascertain not only the incidence of the disease in children, but the different forms in which the disease manifested itself. No official returns were then or are yet available, for tuberculosis is notified as such, or as pulmonary tuberculosis. Several methods for obtaining this information suggested themselves to me, and of these I adopted four, viz. (1) a circular letter was sent to each medical practitioner in New Zealand, asking for information, (2) the Out-patient returns of
the principal hospitals. (3) Pathological evidence.
(4) The returns of the School Medical Officers.
(5) The von Pirquet test carried out on children attending the Out-patient Departments of the main hospitals of the Dominion.

The plan which I found most satisfactory from the Dominion standpoint was the enquiry from medical practitioners. Early in 1914 a circular letter was sent to each of the 600 medical practitioners on the New Zealand Medical Register. A certain number were not in active practice, others had left the Dominion, or could not be found at the addresses given in the register, but 220 replies were received.

Along with the circular letter a stamped postcard, similar to the sample below, was sent so that as little trouble was given the doctor as possible.

Replies were received from all parts of N.Z. Of the

---

**Tuberculosis in Children under 16 years of Age, at present under Observation.**

<table>
<thead>
<tr>
<th>Pulmonary</th>
<th>Bone</th>
<th>Joints (name of Joint)</th>
<th>Glands (where situate)</th>
<th>Central Nervous System</th>
<th>Skin</th>
<th>Peritoneum</th>
<th>Elsewhere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Signature: [Signature]
Address: [Address]
220 medical men in active practice who replied, 120 reported no cases of Juvenile Tuberculosis among their patients.

It is gratifying to note this apparent scarcity of Juvenile Tuberculosis.

Several of the medical men who replied to my circular were kind enough to forward accompanying letters contrasting their experience in this respect, with that obtained elsewhere. Thus the late Captain Huntly Wood, R.A.M.C., writing from South Canterbury (S. Island) on August 2nd, 1914, stated "During three years' practice in this district of 2,500 inhabitants I have had three cases of tuberculosis in children, two being hip joint and one elbow joint. Compared with my orthopaedic experience in Newcastle-on-Tyne, Tuberculosis in children is relatively uncommon here."

Dr. Hayes, Wainateo (S. Canterbury) wrote to say that in 8 years' practice he had never seen a case of any of the tubercular conditions in children asked for. His practice is in a town and district of about 5,000 inhabitants.

Dr. Livesay of Fielding (Wellington district) stated that Juvenile Tuberculosis was very rare in his experience.

Dr. Young, Bay of Plenty (N. Island) wrote "This district is singularly free from Juvenile Tuberculosis."
Dr. J. P. S. Jamieson then practising in a growing town in the centre of the North Island on the main trunk railway line, stated "No cases of tuberculosis in any form in children under 16 during five years of practice in this district.

Table XXV gives the tabulated returns as received, and the population of each provincial district at the 1916 census. Cases amongst Natives are excluded as the Native population is very unevenly distributed and the Natives do not live under the same sanitary conditions as the European population. On this account tuberculosis has a much higher incidence amongst the Natives but more especially the Pulmonary type.
Table XXV.

Number of cases of tuberculosis in children under 16 years of age in the different provinces in New Zealand, 1914.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary</td>
<td>14</td>
<td>3</td>
<td>12</td>
<td>2</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Bone</td>
<td>15</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Joints</td>
<td>28</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Glands</td>
<td>16</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Central nervous system</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Skin</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Abdominal</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>12</td>
<td>70</td>
<td>4</td>
<td>56</td>
<td>30</td>
</tr>
<tr>
<td>Incidence for 10,000</td>
<td>2.55</td>
<td>2.21</td>
<td>2.43</td>
<td>0.66</td>
<td>2.83</td>
<td>1.5</td>
</tr>
<tr>
<td>population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A comparison between the different Provincial districts of New Zealand is not possible from Table XXV, for the age and sex incidence in the Provinces varies and no returns are issued by the Government Statistician showing the age incidence in the different Provinces. It is well known however that the population of the North Island and especially that of the Auckland province has a greater proportion of young children than has the South Island. The incidence of Juvenile Tuberculosis appears to be heaviest in the Canterbury-Westland province of the South Island and to be low in the Nelson-Marlborough district. It is interesting to note that the Director General of Agriculture informs me that tuberculosis in Cattle is practically unknown in this latter province.

Taken as a whole the table bears out what has previously been shown under mortality rates that Juvenile Tuberculosis is relatively uncommon in New Zealand. The remarks of those medical practitioners who have not seen cases for years in fairly extensive practices is worthy of note.

Referring to Table XIII it will be seen that during the 5 years 1915 -1919, 94 cases of tuberculosis in the age group 0-15, were notified in the Otago and Southland Provincial district or an average of 18.8 per annum. This gives a rate of 0.98 per 10,000 population and considerably lower than that obtained by personal
notification as a result of circularising the medical profession.

HOSPITAL OUT-PATIENT RETURNS.

These are available for the Dunedin General Hospital and have been abstracted from the Out-patient records by a former student, Dr. Hall, for the years 1915-19.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Cases of Juvenile Tuberculosis 0-15 diagnosed and treated</th>
<th>Number of Out-patients who attended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>3</td>
<td>14,584</td>
</tr>
<tr>
<td>1916</td>
<td>4</td>
<td>18,848</td>
</tr>
<tr>
<td>1917</td>
<td>7</td>
<td>24,601</td>
</tr>
<tr>
<td>1918</td>
<td>4</td>
<td>33,584</td>
</tr>
<tr>
<td>1919</td>
<td>7</td>
<td>46,985</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>138,602</td>
</tr>
<tr>
<td>Average 5 years</td>
<td>5</td>
<td>27,720.4</td>
</tr>
</tbody>
</table>

Thus out of an average of 27,720 outpatients who attended the Dunedin Hospital only 5 were cases of Juvenile Tuberculosis, a record which few countries could surpass and a fact which further bears out my previous
remarks as to the low incidence of tuberculosis in children in New Zealand.

**PATHOLOGICAL EVIDENCE**, of early infection by the tubercle bacillus.

The incidence under this heading which is available in New Zealand is disappointing. Only two of the larger hospitals, i.e. the Dunedin Hospital attached to the Medical School and the Christchurch General Hospital, have pathological units. The number of children who die in hospital is comparatively small.

My colleague, Professor Drennan has had his Post-mortem records searched and he informs me that he has only found evidence of previous tubercular infection in three children who have come to post-mortem in the past 2½ years.

Dr. Pearson, Pathologist to the Christchurch Hospital, also informs me that he has seldom seen evidence of tubercular infection in children, post-mortem, in eight years' experience.

Numerous statistics are available for comparison in other countries but as already indicated the lack of material in New Zealand renders any accurate comparison impossible. All one can say is that this is one more point in support of the contention that Juvenile Tuberculosis in New Zealand is relatively uncommon.

Beitzke (Berlin 1909) on the basis of 1100 autopsies gives the following results regarding
the prevalence of tuberculosis in early life:

<table>
<thead>
<tr>
<th>Age</th>
<th>No. of Autopsies</th>
<th>Tuberculous</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>newly born</td>
<td>.199</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0 - 1</td>
<td>109</td>
<td>11</td>
<td>10.1</td>
</tr>
<tr>
<td>1 - 5</td>
<td>63</td>
<td>26</td>
<td>41.3</td>
</tr>
<tr>
<td>6 - 10</td>
<td>26</td>
<td>17</td>
<td>65.4</td>
</tr>
</tbody>
</table>

Koplik quotes Ghon of Vienna who reported on 848 autopsies in children. The tuberculosis rate increased from infancy until it reached 70% in children 11-14 years of age.

Wallstein in New York (1909) in 862 autopsies found that in the first year of life 1.8% of the cases were infected in the first quarter, 11% by the second quarter, 16% by the third quarter, and 23% by the fourth quarter, figures which indicate that tuberculosis is due to causes which begin to act soon after birth.

McNeil (25) quotes figures from the autopsies of four European capitals, where Earlitz found tuberculous lesions in 42.5% of all children examined post-mortem in Christiania. (!)

Hamburger and Sluka found 40% infected in Vienna.

Gomby found 38.5% infected in Paris. Still found 35% infected in London. Eastwood and Griffith investigated on behalf of the Local Government Board,
England, 195 children post-mortem of ages between 2 and 10 years who had died from a variety of causes, and of these 118 or 60.5% showed evidence of tuberculous infection.

The figures from the post-mortem records in various countries show how widespread is tuberculous infection in children and how early in life much of the infection is contracted.

RETURNS OF SCHOOL MEDICAL OFFICERS

In reading the reports of School Medical Officers as to the incidence of tuberculosis in school children, it is apparent that they do not give a reliable guide as to the actual numbers of infected children. So much depends on the keenness, the clinical experience, and diagnostic acumen of the Medical Officer, and very different results necessarily follow.

We have, however, the weighty opinion of specialists who report their experience in different countries. Thus speaking at the Conference on Tuberculosis at Manchester in 1912, R. W. Philip (27) stated that there was ample evidence to show that tubercle existed in the majority of school children.

Priestly (28) at the same Conference, stated that the tuberculin test showed that at the age of 15 yrs.
75 per cent of children had been tuberculised. (Priestly's words).

Both these authorities record a very high tuberculosis rate in school children in Great Britain.

The School records in New Zealand are open to the same objections as those indicated for School returns elsewhere, but I have asked the senior School Medical Officer in New Zealand, Dr. Ada Paterson, whose returns will I know approximate as closely to actual percentage infections as clinical examinations can possibly do, for the number of children whom she suspected as suffering from tuberculosis in the Otago - Southland Provincial district during 1914. Her return is shown in Table XXVII.

TABLE XXVII.

Number of cases of suspected tuberculosis in 2951 school children in Otago of an average age of 10 years.

<table>
<thead>
<tr>
<th>District</th>
<th>Boys</th>
<th>Girls</th>
<th>Total examined</th>
<th>Suspected Tubercular</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>Otago &amp; Southland (1913)</td>
<td>998</td>
<td>1008</td>
<td>2006</td>
<td>6</td>
</tr>
<tr>
<td>North Otago (1914)</td>
<td>114</td>
<td>184</td>
<td>328</td>
<td>1</td>
</tr>
<tr>
<td>Dunedin (1914)</td>
<td>142</td>
<td>183</td>
<td>325</td>
<td>1</td>
</tr>
<tr>
<td>Otago Central (1914)</td>
<td>134</td>
<td>158</td>
<td>292</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>1418</td>
<td>1333</td>
<td>2951</td>
<td>7</td>
</tr>
</tbody>
</table>

Total percentage tubercular 0.5%
Dr. Paterson states that this is probably too low a percentage, but if her records are to be believed and I know of no reason to doubt them, 0.5% seems a very low infection rate compared with the high rates just mentioned for Gt. Britain and Europe.

Squire (29) (London) in speaking of tuberculosis in children with special reference to school attendance, states that glandular enlargements are far from uncommon in the children living in the poorer parts of the towns, but these are by no means always due to tubercle. Thus Gaffky and Rothe (30) of the Berlin Institute of Infectious Diseases, report that by inoculation from bronchial and mesenteric glands of 400 children into guinea pigs, tuberculous infection resulted in only 78 cases.

A. S. Griffiths (31) has also investigated bacteriologically lymphatic glands believed to be tuberculous and obtained by operations, and in all but three cases the glands were cervical. The cases investigated numbered 110 and they could be divided into 3 groups of 10, 29 and 71 individuals. The first 10 were not tuberculous macroscopically and were negative in the guinea pig. The 29 cases of group II were negative in the guinea pig but they were definitely tuberculous to the naked eye. In 15 of these, tubercle bacilli were found, but according to cultural experiments they were not living. This group showed that in
glandular tuberculosis there is a marked tendency to spontaneous cure. Of the third group of 71 cases both guinea pigs and cultures were positive.

Squire in the paper mentioned above, quotes Hamburger's opinion that tuberculosis should be looked on as a disease of children comparable with measles in its almost universal incidence - A sweeping remark that certainly does not apply to New Zealand and Australia.

In examining 1670 London School children with regard to tuberculosis of the lungs, Squire and Gowdey in 1906-7 found less than 5 per 1,000 who had signs in the chest that could be attributed to tuberculosis. Squire examined 672 children of a school in a poor part of London and found less than one per cent with signs indicative of tuberculosis of the lungs.

Dr. Paterson's results of the examination of New Zealand School children i.e. 0.5% with signs indicative of tuberculosis of any sort, compare very favourably with those of Squire and other British Observers.

TUBERCULIN TESTS.

Delepine, (32) quoting Klebs, says that it is obvious that the number of cases of infection without symptoms cannot be estimated by ordinary clinical methods; when, however, the tuberculin test is added to the older methods, information is available which, for
what it is worth, is strongly confirmatory of the pathological findings previously discussed. The diagnostic use of tuberculin is open to many objections which are well known to those who have had any experience of its use and need not be further discussed here. Results are just as difficult of comparison as those obtained by clinical examination, for several methods of applying the test and numerous makes of tuberculin are available. Even when the Von Pirquet test, the usual method applied to children, is used, there are several modifications of the original test in use, and several strengths of tuberculin are used in diagnosis by different workers. Moreover, we know that the Von Pirquet test merely indicates a previous or present tuberculous lesion, not necessarily active at the time, and hence its value progressively diminishes with the age of the child.

A large number of results are available as to the numbers of children of various ages who have reacted to the test, and some of these may be compared with results which I have obtained in New Zealand.

The technique which I have employed for several years is the modification of the Von Pirquet test described by McNeil. The old tuberculin of the Lister Institute was used and put up in two capillary tubes, one containing human old tuberculin, and the other bovine old tuberculin. The two tubes were of different
colours to avoid confusion. The tests were carried out by myself in Dunedin and by one or more of my senior students in the other centres during the vacation. The tests were carried out in the children's wards of the General hospitals of the Dominion, under the supervision of the Medical Superintendents or of the Hon. Medical Staffs, and the results brought to me and discussed when the students returned from vacation.

The ages of the children varied from a few weeks up to 15 years of age. In all, 383 tests were carried out over the years 1913 and 1914 and of these 68 were positive, giving a percentage of 24% of positive reactions. This percentage is higher than one would expect, after considering the mortality rates and other data relating to tuberculous infections in New Zealand children, but it must be remembered that they were carried out on children in hospital suffering from all varieties of diseases and in such a collection of children, i.e. those of the hospital class, the positive returns would naturally be much higher than those obtained in children attending school. It is not an easy matter to perform such tests on school children here, for the consent of every parent would be required and much useless explanation involved: Although this percentage is unfavourable to New Zealand if used as an index of the amount of latent tuberculous infection, it is still considerably...
below the figures obtained in other countries. Thus Von Pirquet quoted by Delépine found that nearly all adults react. He found in 1407 children under 15 years of age that 5% reacted during the first year, 25% during the second year, and that the proportion continued to increase rapidly until the tenth or eleventh year when it was 80%. Between 90% and 95% of the children in their fourteenth year reacted. Only a small proportion of the persons of all ages giving a positive reaction showed ordinary clinical evidence of tuberculosis.

Hamburger (33), using tuberculin subcutaneously, found fully 95% of children gave a positive reaction between the 12th and 13th years of life.

McNeil tested 371 hospital cases whose ages ranged from a few weeks to 12 years, using his modification of the Von Pirquet test, and found 37.7% reacted positively. He states that an investigation into the age periods of the hospital cases suggested that tuberculous infection is already apparent as a chronic process during the first year of life, and it rapidly increases and reaches a maximum during the 4th and 5th years — the greatest proportion of tuberculous infection being effected in the first five years of life.

McNeil's Edinburgh figures differ from the continental statistics in the heavier incidence of tuberculous infection in infancy, and the attainment of the maximum at an earlier period.
Thomson & Fordyce quoted by McNeil show that abdominal tuberculosis is clinically much more common in British children than in those of certain other countries and in Britain reaches its maximum in Edinburgh and Glasgow. McNeil thinks the infection is largely bovine from tubercular milk, and his opinion has since been supported by the work of Fraser & Mitchell in Edinburgh.

O. Laçoage working in Manchester found that among 1000 hospital children, 32% of those 2 years and under reacted positively to tuberculin, and 60.8% of those between 10 and 14 years of age gave a positive reaction.

We have thus seen as a result of the four methods of enquiry just described that New Zealand children do not contract tuberculosis to anything like the same extent as children of many other countries, and these results in the living are borne out by the comparatively low mortality rates already discussed.
PART III.

THE MILK SUPPLY IN RELATION TO JUVENILE TUBERCULOSIS.

Before discussing the importance of the milk supply, and to see how our milk supply compares with that of other countries as regards the presence of tubercle bacilli. We should expect that comparatively little tubercular milk is drunk in New Zealand, and if that is so we should expect to find our dairy herds under sufficient supervision to eliminate tubercular cases and prevent tubercular milk being put on the market.

Prior to Koch's announcement at the British congress on Tuberculosis in 1901, that the risk of infection by the milk and flesh of tuberculous cattle was insufficient to warrant special measures being taken to prevent it, the weight of experimental and other pathological evidence supported the view that bovine tuberculosis was communicable to man. The evidence of the final report of the British Royal Commission on Tuberculosis in 1911 finally settled the matter. The following passage from the report refers directly to the question of milk. A considerable
amount of tuberculosis of childhood is to be ascribed to infection with bacilli of the bovine type transmitted to children in meals consisting largely of the milk of the cow."

Before discussing the importance of a tubercle free milk supply, I propose to consider the condition of the milk supply in New Zealand and more particularly that of Dunedin, and to compare the results with those found in other countries.

In the introduction I have indicated that considerable attention had been drawn to this question in New Zealand as a result of the rash statements of a medical practitioner as to the prevalence of tubercular infection through milk, - statements which were not based on any experimental evidence whatever. As a result I was asked to investigate the Dunedin City supplies, and after some delay in importing a suitable centrifuge I commenced the investigation in 1912 and examined samples from time to time until the middle of 1915 when 200 samples had been examined.

**TECHNIQUE:**

**Collection of milk samples.**

In New Zealand the control of the dairy herds supplying the public with milk is in the hands of the Dairy division of the Government Agricultural Department, which administers the Dairy Industry Act, 1909. The control of the milk supply was at first left to be undertaken by each supply firm, and it is only within the sphere of the Department's activities that tubercle testing of milk has been introduced.
Department, which administers the "Dairy Industry Act, 1908". The control of the milk supply does not come within the sphere of the Public Health Department until it leaves the dairy farm. This divided control appears at first sight to be a disadvantage, but in practice works satisfactorily. It is obviously an advantage to have cows under the direct supervision of a highly efficient department whose administrative officers are for the most part qualified veterinary surgeons. By means of this supervision the percentage of tuberculous cows is kept at a minimum, and the system of compensation ensures that there is no incentive to hide or sell a diseased animal, which is invariably killed as soon as detected.

The Public Health Department exercises its control over the distribution of milk to the public under the Sale of Food and Drugs Act, and every Sanitary Inspector under the Public Health Act 1908 is also an Inspector under the Food and Drugs Act.

Samples of milk are taken from the milk carts by these Inspectors in the early morning hours as they enter the Cities for distribution of the milk, thus avoiding the errors likely to arise when milk is purchased from a milk shop. Before proceeding to examine the milk supply of Dunedin I obtained an electrical centrifuge with 6 buckets each bucket holding a stout glass centrifuge tube of 100 cc. capacity. When fully
loaded the centrifuge attained 3,500 revolutions per minute.

Before collecting the milk samples which were all mixed milk, representing the mixed milk from a particular dairy farm, the inspectors were provided with long strips of galvanized iron each about 3 feet long, the lower 3 or 4 inches being bent on shaft at an acute angle. These were wrapped in paper and sterilised so that a sterile strip was available for mixing the milk in the can from which the milk sample was to be taken.

Samples were collected in sterile, corked glass bottles of about a pint capacity, and usually six samples were collected from as many carts on each occasion. Each sample represented the mixed milk of one dairy farm. The samples were collected as the inspectors had time and opportunity, and were brought within an hour or two to the laboratory and placed in the ice chest until examined.

In this way 200 samples were collected and submitted for examination, and this represented 200 of the 300 herds which supply the City of Dunedin with milk.

LABORATORY TECHNIQUE.

The milk samples were numbered and the corresponding centrifuge tube likewise. Although the centrifuge tubes held 100 c.c. each, they were not of equal weight, and it was found more convenient to measure 80 c.c. of
of milk into one tube and to balance the other tubes against this. The technique recommended by Delepine (26) was followed throughout except that whereas he used from 40-50 cc. of each milk sample I used at least 80 c.c.

The six tubes being filled and balanced they were spun in the centrifuge for 10 minutes and the cream which had collected on the surface in that time stirred up again in the milk as far as possible. The machine was then spun for 20 minutes at 3,500 revolutions per minute, a gauge on the machine registering the rate of the revolutions. The disc of supernatant cream was separated from the glass centrifuge tube by means of a wire and all but about 2 c.c. of the milk poured off. The remaining sediment was mixed thoroughly with the small quantity of milk left in the tube was then ready for inoculation. When the milk sample was dirty the sediment was washed once and again centrifuged before being injected.

At first microscopical films were made from the sediment and examined for tubercle bacilli. Numerous observers have found the results greatly inferior to the inoculation method, and Delépine (37) says "that in the case of single cows it is possible by carefully conducted microscopical examination to detect the presence of tubercle bacilli in about 90% of the cases proved to be tuberculous by inoculation, but in the
case of mixed milk such as reaches towns, the micro-
scopical examination fails to reveal the presence of
tubercle bacilli in over 60% of the cases detected by
the inoculation method.

Subsequently the inoculation method alone was re-
lied on, and the sediment inoculated subcutaneously
in the left leg about the femoro-tibial joint in equal
portions (usually about 1.5 c.c.) into two guinea pigs.
The guinea pigs were examined after an interval from
four to five weeks and films and cultures made from
any suspicious glands, especially those in relation to
the site of inoculation. Of the 200 samples examined in
this way Nos. 64 and 84 gave positive results in both
pigs. All other samples were negative, so that only
1% of samples proved to contain living tubercle bacilli.

Very little trouble was experienced with premature
deaths of the guinea pigs due to sepsis. In samples
63 and 66 one of the two pigs died a few days after in-
oculation but the second animal remained alive and well
in each case. After injection of No. 80 sample (18/4/14)
both pigs were found dead the following day from an
acute staphylococcal infection, but a further specimen
was obtained from the same farm and the test completed
satisfactorily.
FURTHER EVIDENCE RELATING TO THE MILK SUPPLIES OF THE
CHIEF TOWNS OF NEW ZEALAND.

During the time I was examining the milk supply of Dunedin, the Dairy Division of the Agricultural Dept. undertook a similar task with the milk supplies of several of the larger cities as a control to their veterinary supervision of the dairy herds. For these figures and other information relating to live stock, I am indebted to Mr. Young, M.R.C.V.S. Director Live Stock Division, Dept. of Agriculture.

During the years 1911-1919 - 663 milk samples were examined for tubercle at the Veterinary laboratory, Wallaceville, Wellington, including 131 samples from Dunedin. None of these milks on examination were found to contain living tubercle bacilli. The technique employed was by guinea pig inoculation but since 1916 each milk has also been examined microscopically with negative results.

The objection to the technique followed was that the samples had to be forwarded by post in many cases and were therefore not fresh when received and only 15-20 cc. of the mixed milk was centrifuged as against 40-50 cc. recommended by Delépine and the 80 cc. used by myself. It is safe to say however that the evidence produced indicates that there was no gross infection by tubercle bacilli of any of the milk samples tested.
by the Agricultural Department.

The technique of Mitchell (38) is I think an improvement on that which I followed, in that he allowed one pint of milk sample to sediment in the ice chamber during the day in a sterilised separation funnel and the sediment was withdrawn and centrifuged in the evening. He does not mention what quantity of the lower milk he finally centrifuged, but in some later samples which I have examined for private persons I have used a 500 cc. separation funnel and centrifuged 80 cc. of the lower milk, which washed out the sediment into the centrifuge tubes.

A COMPARISON OF THE NEW ZEALAND RESULTS WITH THOSE OBTAINED IN OTHER COUNTRIES.

Mitchell (38) examined the milk obtained from 201 milk shops in Edinburgh and found 41 samples (20%) contained living tubercle bacilla. This does not represent the state of the Edinburgh City milk supply as Mitchell admits, for one country byre frequently supplies several milk shops in the same street or district. Mitchell gives a table showing the results of the examination of mixed milk samples in some other large towns. For instance Liverpool country samples gave the low positive percentage of 3.3% in 1908,
1.8% in 1909 and 4.1% in 1910. Sheffield for the same years showed percentages of 9.9, 10.9 and 10.4; Birmingham 11.3; 7.5, and 7.3, and Leeds the highest percentages of 25.3 and 16.4 for 1908 and 1909 respectively.

Delépine gives the figures for Manchester for the same years as 8.7 and 5.5; 5.9% although the percentage rose in 1911 to 9% in 1912 to 11.5%.

The splendid results achieved by Delépine one of the pioneers in this work in reducing the positive percentages from 17.2 in 1897-1899 to 5.9 in 1910 are now well known, and it must be very disappointing to find that his percentage findings of tubercle bacilli have recently risen.

In London C. J. Martin stated in the discussion following on a paper by Delépine before the Royal Society of Medicine "that about 3,500 mixed milk samples had been examined in London, and that the proportion of milk containing tubercle bacilli fluctuated considerably in the markets which supplied London. In successive series of 500 samples it hovered about 10 per cent."

Marie Grund and Harriet L. Wilcox report on the market milk of New York City. Samples were taken from the large 40 quart cans in which the market milk reached the city, 15-20 c.c. of each sam-
ple were forwarded to the laboratory for report and were centrifuged for 15 min. at 2,400 revolutions per minute. Of two guinea pigs inoculated, one received 1 c.c. of the cream and the other 1 c.c. of sediment subcutaneously in the left groin. After 7 weeks each surviving guinea pig received a subcutaneous injection of tuberculin (2 c.c.). None of those which survived this dose showed any tuberculosis. 120 samples were examined, but of these the results in 78 only could be depended on, and of these 9 or 11.5% contained virulent tubercle bacilli. (42) A. Hess also reported on the New York milk, and found 16% of samples contained virulent tubercle bacilli.

These results placed together in the form of a comparative table give some idea of the amount of tuberculous milk which is drunk by children in several of the principal cities of Great Britain, in contrast with the very slight risk of such infection in New Zealand.
Milk samples found to contain tubercle bacilli in different centres, and percentage of Tubercular

<table>
<thead>
<tr>
<th>Place</th>
<th>No. of Samples examined</th>
<th>% Tubercular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edinburgh</td>
<td>201 from milk shops</td>
<td>20.0</td>
</tr>
<tr>
<td>Liverpool, 1910</td>
<td>Country samples</td>
<td>4.1</td>
</tr>
<tr>
<td>Sheffield, 1910</td>
<td></td>
<td>10.4</td>
</tr>
<tr>
<td>Birmingham, 1910</td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>Leeds, 1909</td>
<td></td>
<td>16.4</td>
</tr>
<tr>
<td>Manchester, 1910</td>
<td>(1697-99: 17.2%)</td>
<td>5.9</td>
</tr>
<tr>
<td>London</td>
<td>3,500</td>
<td>10.0</td>
</tr>
<tr>
<td>New York</td>
<td></td>
<td>11.5-16.0</td>
</tr>
<tr>
<td>Dunedin, 1913-15</td>
<td>200</td>
<td>1.0</td>
</tr>
<tr>
<td>New Zealand (Agricultural Dept.)</td>
<td>663</td>
<td>0.0</td>
</tr>
</tbody>
</table>

With reference to the Sheffield figures, Beat
tie (43) states that from 1908-1914, in 59 out of 558 samples, or in about 10 per cent, tubercle bacilli were found in the milk produced by cows which were passed by a skilled veterinary inspector who was specially on the outlook for tuberculosis. Under such
conditions one would expect the ordinary milk supply to show a higher percentage infection.

Delépine's dictum that there is clear and cumulative evidence that cow's milk plays a very important part in the production of infantile tuberculosis in England and Scotland, is borne out by his own work and that of numerous workers in those countries. Thus Mitchell, reporting on his examination of tubercular cervical glands in 72 children, found that 84% of the children in his series, two years of age and under, had been fed on unsterilised cow's milk since birth. The correlation between this observation and that of the high incidence of bovine cervical glandular tuberculosis, during the same age period, points in Mitchell's opinion, wholly to the drinking of tubercular milk as the most probable source of infection. Delépine stated at the Conference on Tuberculosis at Manchester, 1912, that probably 80% of fatal cases of tuberculosis in children were caused by infection through the alimentary canal, and that in 52% of persons dying at various ages from tuberculosis of various organs, there was evidence that the infection was of bovine origin. He concluded that infection through the alimentary
canal was predominant in infancy, and that infection through the air passages became more and more common after the ages of 10 to 15, and that bovine tubercle bacilli were one of the most important factors in determining tuberculosis other than phthisis before the age of 5. No less than 25% of children under the age of 5 years suffered from tuberculosis of bovine origin. Delépine, in another communication, refers to Fraser's work in Edinburgh on Bone and Joint Tuberculosis in children, and he has prepared a table from Fraser's paper showing that of 57 cases of bone and joint tuberculosis in which there was a history either of breast feeding or of having been fed on cow's milk, and in which the bacteriological findings agreed with the clinical history, 38 were fed on cow's milk and 19 were breast fed, and in the latter the evidence is in favour of infection with bacilli of human origin.

Dr. Bishop (M.o.H., States of Guernsey) in an interesting letter, states, "There is a tuberculosis rate amongst Guernsey cattle of about $\frac{1}{6}$ compared with the estimate of Sir John McFadyean of 20% of adult cows in England. The forms of human tuberculosis (tubercular glands of neck, abdominal tuberculosis) chiefly caused by bovine infection are exceedingly rare in the Island of Guernsey."
A letter from Dr. Lassablière, in the Brit. Med. Journal, July 11th, 1915, p. 96, advocating the use of condensed milk for the feeding of infants so as to lessen the risk of bovine infection, called forth a letter from Dr. T. Hill Jamieson from Penang (48) who as a result of 17 years practice in the Straits Settlements, states that fully 95% of Straits born Chinese babies are fed on condensed milk imported from Europe, and tubercular peritonitis, bone and joint disease, and adenitis, and meningitis are very rare amongst them. This is interesting in view of the fact that in adults of the same race phthisis is one of the greatest causes of mortality. Jamieson further states that if tubercular peritonitis, meningitis, etc. were due to the human type bacillus, it is certain that these diseases would be very common, so that their rarity would point to their being due to the bovine tubercle bacillus which is presumably destroyed in the process of manufacture of condensed milk.

These observations, even without the bacteriological evidence which I shall deal with in a subsequent chapter, seem to support Delépine's dictum already quoted that cow's milk plays a very important part in the production of infantile tuberculosis.
Delepine refers to those countries in which there is a high mortality from tuberculosis among children, but where the drinking of cow's milk is almost unknown. He states, "The share of milk as a factor has also been discounted on the ground that in Japan where there is a high mortality from tuberculosis among children, the drinking of cow's milk is almost unknown. The same has been said of other countries such as China, Roumania and certain parts of Germany. I do not think much weight can be attached to arguments of this kind. The fact that tuberculosis is prevalent in countries where no cow's milk is consumed, does not prove either that it would not be more prevalent still in those countries if tuberculous cow's milks were added to the other causes, or that, if the causes that are at work in Japan were prevalent in England, the total mortality from tuberculosis would not be much greater here than it is."

I propose now to show how our favourable position in New Zealand depends, not only on better climatic, housing, and general social conditions, but also on the system of control of dairy herds and tubercular cattle generally.
Tuberculosis amongst cattle in Great Britain, and New Zealand and the means adopted to control it.

An accurate estimate of the amount of tuberculosis amongst cattle in Great Britain seems to be difficult to obtain, but various authorities place it between 20% and 30%. Thus MacKintosh, Pennington and Williams, (quoted by Beattie) estimate that 30% of the dairy cattle in Great Britain are tubercular, and of these not more than 2% will be in such an advanced state of the disease as to be affected by the recent Tuberculosis Order. The other 28% will remain sources of infection to other cattle and to human beings. Mitchell gives a table showing that during 1910–12, of an average of 2491 cows supplying Edinburgh with milk an average of 29 were removed for tuberculosis of the udder, lungs, or on clinical grounds.

This by no means indicates the prevalence of the disease nor the danger from tubercular milk, for Schroeder in America, and the British Royal Commission on Tuberculosis (both have shown that tubercle bacilli may and do gain access to the
milk of cows which clinically show no signs of udder tuberculosis, and Delépine and others have shown that it is impossible for the Veterinary Surgeon unaided, to discover, by ordinary inspection, early tuberculous diseases of the udder. This is borne out by Beat-
tie (43) who found about 10% of milk samples from cows passed by a Veterinary Surgeon, contained tubercle bacilli. Delépine, however, expressed the opinion in 1910 that cows in an advanced state of tuberculosis and emitting discharges loaded with tubercle bacilli constitute the chief factor in determining the distribu-
tion of bovine tuberculosis. The number of cows suffering from tuberculosis is so great that there are only very few farms that are entirely free from tuberculosis, and he was led to the conclusion that bovine animals suffering from ulcerative tuberculous diseases, more especially of the respiratory organs, alimentary canal, genito-urinary organs, and udder, constitute the chief factor in determining the excessive prevalence of bovine tuberculosis in certain districts.

In a discussion at the annual conference of the Veterinary Association at Manchester, Prof. Wil-
son (54) of Edinburgh said he did not hesitate to say that 40% of the dairy animals were affected with
tuberculosis.

Delépine, as a result of the inspection of dairy farms supplying Manchester with milk between 1896 and 1909, reports that of 1524 farms tested, 326 or 21.3 per cent were found tuberculous, and of 298 tuberculous farms inspected, in 211 or 70.8 per cent tubercular udders were found.

The available evidence shows that in North England and Scotland a considerable proportion of dairy cows are tuberculous and supply milk which contains tubercle bacilli. On the evidence it is a wonder that the infantile tuberculosis rates are not higher than they are, and it is a wonder that, knowing the existing state of affairs, more drastic provisions were not made than those contained in the 1913 Tuberculosis Order, which covers only those cattle suffering from tuberculosis of the udder, tuberculosis with emaciation, and cows giving tuberculous milk.

At the Melbourne City Abattoirs, it was found in 1884-5 that 5.6% of the cattle slaughtered were tuberculous. During 1912-15, 354,646 cattle were examined at the Abattoirs and 3,611 or 1.01% were found tubercular (i.e., all and every form of tuberculosis). There has thus been a reduction in 30
years from 5.6% to 1.01%, as far as Melbourne (Australia) is concerned.

In New Zealand, during the years 1915-1919, 243,010 cattle were slaughtered at the abattoirs in the four main cities, and of these 15,363 or 6.39% were found to be affected with tuberculosis, whereas in 1903-5 the percentage was 6.8, so that New Zealand as a whole does not show the improvement effected in Melbourne. During the same period 1915-19, 70,868 cows were slaughtered in the abattoirs of the four principal cities, and of these 6,314 or 9.08% were found tubercular. This somewhat high percentage is explained by the Director of the Live Stock Division of the Dept. of Agriculture as being due to the fact that in two of the cities (Wellington and Dunedin) there are large meat canning works, and that a large number of cows which are not in good condition are sent in to be killed for this purpose, and are condemned after slaughter.

I have been unable to obtain particulars of the numbers of cows found tuberculous in dairy farms in New Zealand by the Veterinary Inspectors, but Mr. Young, Director of the Live Stock Division, has kindly supplied me with his opinion on the point which I
shall refer to under the administrative measures adopted to control tuberculosis in cattle in New Zealand.

Administrative measures dealing with tuberculous cattle.

The position in Great Britain in this respect still appears to be unsatisfactory. There is abundant evidence of the prevalence of tuberculosis in the dairy herds upon which the public depend for the milk supply, and further striking evidence of the relation between the ingestion of tubercular milk and juvenile tuberculosis. Until the issue of the Tuberculosis Order of the Board of Agriculture and Fisheries which came into operation on May 1st, 1913, the position as far as administrative machinery was concerned in the country as a whole was lamentable. Apparently cows with tubercular mastitis or advanced tuberculosis only are included under the order, and I have already given Prof. Beattie's opinion that not more than 2 per cent of the total cattle will be in such an advanced state of tuberculosis as to be affected by the Order, although about 30% of the cattle of Great Britain are said to be affected by tuberculosis. Beattie further states in the paper which I have
previously quoted (p.4) that it is estimated that not more than 25% of the clinically tuberculous animals have been reported during the first year of the operation of the Order, and he regards failure as being written in big type even in this good but imperfect attempt at legislation. He states that in the smaller towns in Scotland there is practically no veterinary inspection whatever. In the larger towns there is a certain amount, but it is inadequate. He states that the inadequacy of the existing veterinary inspection of the cows in the city and country byres is apparent when it is stated that one veterinary inspector, besides endeavouring to look after fully 2000 cows in the city byres of Edinburgh is also expected to supervise the cows in some 250 country byres. Apparently, in different municipalities there are supplementary provisions enabling the local authority to deal with tubercular dairy cows, such as the Manchester Milk Clauses Bill. The owner of a tuberculous cow is ordered to have it removed within a specified time after the notice is served, but he can dispose of it as he likes; and this method of passing on tubercular cows, and the inadequate system of compensation, have defeated the good intentions of those who have en
deavoured to minimise this public danger.

Under the Tuberculosis Order 1913, Local Authorities are called on to take immediate steps for the provision of a sufficient and competent veterinary staff, but as far as my information goes, cows suffering from lung tuberculosis are not included, nor has the tuberculin testing of cows been made compulsory.

The Treasury will refund to Local Authorities half the net amount payable by way of compensation for animals slaughtered during a period of 5 years from the coming into operation of the Order. The amount of compensation varies with the condition of the animal at slaughter. Whether Local Authorities make up to the owner the full value of the animal, less the value of hide or of the carcase for boiling down purposes I do not know, but I will show how our system of inspection and compensation in New Zealand is carried out with apparently satisfactory results.

Delépine wrote in 1910 "That it does not appear safe under present conditions to rely chiefly upon ordinary sanitary measures for the purpose of controlling bovine tuberculosis. The partial or complete failure of ordinary sanitary measures indicates that the action of the infective material is more or less independent of these measures, when it
is either very abundant or very virulent." He stressed the importance of inspecting every animal; of removing without delay all those that are actively infective, and of not allowing healthy animals to remain in places that have been infected, until they have been rendered non-infective.

New Zealand and the States of the Australian Commonwealth afford striking examples of the need for something more than improved sanitary measures if bovine tuberculosis is to be eradicated.

The figures supplied me by the Dept. of Agriculture show that 6.39% of the cattle coming to the principal abattoirs of the Dominion are tuberculous, and about 9% of the cows. Yet we have none of the byres and other systems of housing cows in sheds, for the greater part of the day and night such as prevail in many parts of Great Britain. If fresh air and sunshine are of value in the treatment and prevention of tuberculosis, how is it that we have such a relatively high percentage of tubercular cattle? From birth and throughout life our cattle are in the fresh air, and there is a considerable proportion of sunshine. I am informed by Mr. Young, Director of the New Zealand Live Stock Division of
the Dept. of Agriculture and who was previously a Veterinary Inspector in Edinburgh, that in Queensland, where there is a maximum of sunshine, and where the whole of the lives of the cows spent in the open, there is much more bovine tuberculosis in proportion, than he experienced in Edinburgh, with its dull skies and cow byres. He is of opinion that fresh air and sunshine does not seem to have the same influence on bovine tuberculosis as it does on human tuberculosis.

He also informed me of another interesting fact, in which he was supported by the Veterinary Inspector for the Dunedin Abattoirs, that tubercular glands in cattle are much more noticeable in New Zealand as distinct from general internal infection with which they were familiar in Scotland.

Some weight can be attached to Young's opinion that the New Zealand rates for tubercular cattle are not comparable with those of Great Britain, for he says that under our more complete system of inspection and compensation more tubercular cattle are discovered, and thus a higher comparative rate recorded than would be the case if the same measures were applied in Great Britain.

If we accept Delépine and Young's opinions, then
the solution lies neither in improved sanitary measures nor in fresh air and sunshine. No doubt these are important contributory measures however.

Beattie regards the failure to deal effectively with Bovine tuberculosis in Great Britain as due to several causes of which he discussed the following three in detail:

(1) The failure accurately to diagnose the disease in cattle.

(2) The attempt to treat the question as a local one, instead of a national one.

(3) The persistent advocacy of sterilisation as a universal safeguard.

I have already quoted authorities to show how important is a thorough inspection of every animal at frequent intervals and by a competent veterinary surgeon; and I have also shown how with this procedure a considerable proportion of tubercular animals may be missed and continue to supply milk containing tubercle bacilli. Most authorities are agreed that in any more or less perfect scheme clinical inspection of dairy herds must be supplemented by the tuberculin testing of the cows and by the bacteriological examination of mixed samples, and even of the milk from individual cows. As the bacteriological examination
involves guinea pig inoculation, such a procedure as I have outlined involves a considerable staff and some expense, but it is surely less expensive in the long run than the present tinkering methods, with the consequent loss of infantile life and the attendant charges on the poor rates and hospital rates. Beattie's second point is an important one: namely, "the attempt to treat the question as a local one instead of a national one." However careful and adequate the measures adopted by one Local Authority these must be greatly hampered and the national effort dissipated, if a farmer on discovering a tuberculous cow can only be advised to destroy it, and if he wishes, can dispose of it to someone in the district of an adjoining Local Authority where the whole process must be gone over again, if, and when, the diseased cow is discovered.

It is in the national nature of our effort in New Zealand that we have the advantage, and if the percentage of tubercular animals is higher than it should be, the system of inspection and compensation does prevent the placing on the market of any but a small amount of tubercular milk. Our efforts then may be said to be wanting in complete success as far as cattle are concerned, but they merit the
trouble if the danger to our infant population is mini-
mised.

I do not propose to deal with Beattie's third
point: namely, "the persistent advocacy of sterilisation
as a universal safeguard", as it does not come within
the scope of this thesis, but I shall conclude this sec-
tion with an account of the procedure which is followed
in New Zealand in dealing with tubercular cattle, as a
contrast to what has been said of the position in Great
Britain. This account for which I am indebted to the
Director of the Live Stock Division (Mr. Young, M.R.C.V.S.)
covers Beattie’s first two points. It is an attempt
to bring the diagnosis of the disease in cattle as near
perfection as possible, and it is truly a national ef-
fort:

"In connection with the control of disease
amongst stock in New Zealand, a staff of experienced
officers holding warrants as Inspectors under the
"Stock and Dairy Industries Acts respectively are em-
ployed, their designation being "Stock Inspectors"
These officers are located throughout the whole of
the Dominion, each having a defined district. Quali-
fied Veterinarians holding the diploma of one of the
Colleges of the United Kingdom are also engaged, and
one is located in each of the principal centres of
of the more important Stock Districts, their duty being to assist the work of the Stock Inspectors by their professional advice and assistance in any direction necessary, also to apply the tuberculin test when required."

"In order to control diseases in stock, of which tuberculosis is the worst we have to contend with, wide powers are given under the provisions of the Stock Act, and Stock Inspectors have power to enter upon any land for the purpose of inspecting the stock thereon, and should there be any which in his opinion show symptoms of tuberculosis, he has the power to order its destruction forthwith, and effectively to dispose of the carcase. Should the animal on post-mortem examination be found to be affected with tuberculosis as suspected, the owner is entitled as compensation to half the market value of the animal at the time of condemnation, up to a maximum value of £12 as the Act at present stands, and full value if not found on postmortem to be affected with tuberculosis. Should the Inspectors be in doubt, they have power to order any animals to be subjected to the Tuberculin test, which is then applied by one of the Government Veterinary Surgeons at no expense to the owner.
Further should any owner desire it he may on application have his herd in whole, or in part, subjected to the test without any expense to himself. This provision is largely availed of by breeders and others desirous of keeping their herds free from tuberculosis.

"All cattle imported to New Zealand from abroad are required to show a 'no reaction' certificate before being allowed admittance.

"The tuberculin test is considered a reliable test for tuberculosis in cattle. Notification of tubercular cattle is also compulsory.

"By the constant watch kept on cattle throughout the Dominion, tubercular cows in particular are cleared out of herds whenever it is possible by clinical examination to detect them; and thus it comes about that tuberculosis of the udder is rarely met with either by the Meat Inspector doing duty at the Abattoirs, or Meat-Export Slaughterhouses. During the twelve months ended 31st March, 1919, 2,914 head of cattle were condemned by Stock Inspectors in the field as being affected with tuberculosis; compensation to the amount of £11,550 being paid for cattle condemned.

"With regard to dairy herds supplying the principal cities with milk, the health of the cows comprising the different herds as also the dairy pre-
mises, cow sheds, etc., are given frequent attention by officers specially selected for this duty, whose whole time is devoted to this particular work in the respective districts from which milk is drawn.

"Each dairy is visited at numerous intervals throughout the year, particularly at milking time, in order that each individual cow may be carefully examined, and in order to see that thorough cleanliness is exercised in regard to the milking, the utensils, buildings, yards, etc., and the care of the milk while remaining on the premises."

Mr. Young expresses the opinion that from his experience as a Veterinary Surgeon in Scotland and in New Zealand, that there is less tuberculosis in New Zealand cattle than in the United Kingdom, and he is satisfied that this position has been largely attained through the operations of the Department; but he holds that a comparison with the United Kingdom or any other country as regards tubercular cattle cannot well be made, for no other country to his knowledge has the same, or any similar, system of inspection or method of paying compensation for diseased animals.

While New Zealand statistics may seem somewhat high, this is accounted for by the fact that all the
animals are accounted for in order to obtain the compensation and are not quietly got rid of when they can no longer be kept, as probably applies in other places.

The Inspection exercised by the Veterinary Officers and Stock Inspectors has to a very great extent eliminated the possibility of tubercular milk being sent into the homes for consumption, and has also kept the spread of tuberculosis in cattle in check by reducing the number of tubercular animals likely to convey infection.

The last statistics indicate a reduction in all classes of stock as regards tuberculosis. As regards the inspection of meat, all municipalities of a population of over 2000 are required by law to have their public abattoirs, in which all stock for human consumption within the areas defined must be slaughtered under Government inspection, compensation being also paid in the case of animals condemned after slaughter for disease (including tuberculosis). Last year the sum of £10,888 was paid out for meat so condemned at Abattoirs or Meat-Export Slaughterhouses, where a rigid inspection is also made of all animals slaughtered for export.

In the case of small slaughterhouses, a system
of licensing and inspection is also in vogue, and any carcasses found or reported as suspected to be affected with tuberculosis are examined, and if condemned are compensated on the same lines as applies in the Abattoirs or Meat-Export Slaughterhouses where regular inspection obtains.”

Thus far I have briefly considered the incidence and mortality rates of tuberculosis in New Zealand and the incidence and mortality rates for the same disease in children, and compared the New Zealand figures with those of Australia or Great Britain or both.

The comparison has been in New Zealand’s favour, and this has been even more marked when the examination of milk supplies for tubercle bacilli have been considered and contrasted. The comparison of tuberculosis in cattle does not show New Zealand in so favourable a light, and it is at first a little difficult to understand why there should apparently be so little tubercular milk on the market when tuberculosis is common amongst cattle. That it is so, however, is borne out by the comparatively low incidence of tuberculosis in the infant population: i.e., those who are most exposed to the influence of the
milk supply, and by the report of the Director of Live Stock in New Zealand, which shows what can be done to protect the health of the community by an active Department exercising its powers over the whole Dominion.

There only remains to be considered the bacteriological aspects of juvenile tuberculosis in New Zealand, more particularly the type of tubercle bacillus which predominates in the lesions examined. This is considered in the next section.

I was aware from casual observations that the amount of juvenile tuberculosis was less than I had been accustomed to expect, but I anticipated so little difficulty as to be unequal to the task of dealing with the material when I hoped to produce our results. The work was then being undertaken on a limited scale and by other workers in another country. When, however, Fraser's results and those of Mitchell and Griffiths were published, I was unable to find very few specimens, so that the manner of what my services were required to test. We had only been able to add to the bacteriological examinations, a small amount of work which had previously been added to the

The type of tubercle bacillus found in tubercular diseases of children up to 16 years of age in New Zealand, 1912-1919.

When in 1912 I undertook the examination of certain milk supplies for tubercle bacilli. I decided to investigate at the same time the type of tubercle bacillus in the tubercular lesions of children of from 0 - 16 years of age in the Dominion of New Zealand.

I was aware from clinical experience alone that the amount of juvenile tuberculosis was much less than I had been accustomed to see in Scotland, but I anticipated no difficulty in obtaining by 1914, when I hoped to publish my results, sufficient material to make the results comparable with work which was then being undertaken by Dr. Fraser in Edinburgh and by other workers in various parts of the world. When, however, Fraser's results, and later those of Mitchell and Griffiths, were published, I had secured very few specimens. With the advent of war, my services were required in other directions, and it has only been since the end of 1918 that I have been able to add to the comparatively few specimens which I had previously been able to obtain.
My first scheme was to obtain specimens from the four main hospitals of the Dominion and from the leading surgeons in the principal cities. A circular letter was dispatched, supported by personal appeals, and it was requested that any material removed at operation or obtained in clinical work should be sent me with details of its source, age, and sex of the child, presence of tuberculosis in members of the same family, or in near relatives, history of breast feeding or the use of cow's milk in infancy, etc. Specimen jars and outfits were sent out to each of the surgeons and hospitals approached. As very little came of my efforts, I impressed on my students, and particularly those who were about to qualify, that I was in urgent need of every suitable specimen available, and asked them to forward these when they became house surgeons in the different hospitals of the Dominion. I offered to pay the young graduates for every specimen forwarded. Still, only an odd specimen reached me, and either the specimens were putrid or useless for microscopical examination, or formalin or other antiseptic had been added in spite of my warning, making the specimens useless for cultural purposes and for inoculation of animals.
After repeated trials I was forced to restrict my investigations to Dunedin and district, where I could by personal effort and frequently repeated appeals, secure those specimens which were available. I should add that my lack of success in securing specimens from other centres was not so much from lack of enthusiasm on the part of my colleagues, but, as will be seen from previous tables and charts, and particularly Table XXV, and the accompanying remarks, cases of juvenile tuberculosis from which specimens could be obtained were very uncommon in New Zealand. My subsequent remarks therefore apply to specimens which I obtained from Dunedin and those surrounding districts from which the Dunedin General Hospital draws its clinical material - districts represented by a population of about 100,000 people.

**Technique:** Most of the specimens received consisted of cerebro-spinal fluids, which were placed in the ice-chest and centrifuged as soon as possible. Centrifugalisation was continued at a high rate of speed for 30 minutes and the usual biochemical and microscopical tests applied, and the results entered under the appropriate heading for each case. Where tubercle bacilli were detected microscopically at-
tempts were made to grow the cultures from the sediment, but in every case animal inoculation was resorted to as well.

A few lymphatic glands were received and suitable portions of these were selected for microscopical section, the balance being minced under aseptic precautions and finally ground in a mortar with a little sterile saline, until the emulsion could be drawn readily into a hypodermic syringe through the needle used for injection. Guinea pigs were subsequently inoculated.

Pus was injected direct into guinea pigs, and only treated with antiformin when secondary organisms, such as streptococci were present, which would probably have been fatal to the test animals.

Sputum was washed and selected portions emulsified in sterile saline, the resulting emulsion being centrifuged, and after throwing off the coarser particles the balance further centrifuged, and the sediment inoculated. Antiformin, which has been recommended for use in growing tubercle cultures direct from sputum, was not used unless the associated microorganisms were numerous or likely to interfere with the animal test. I am of the opinion that antiformin lessens the chance of successful inoculation when
the tubercle bacilli in the suspected tissue are very scarce, or of feeble virulence, although it is valuable when dealing with material in which there are a moderate number of bacilli and associated microorganisms, which would otherwise contaminate the cultures or interfere with the success of the animal test.

Guinea pig inoculation with suspected material.

It is universally agreed that this is the most satisfactory method of obtaining pure cultures of tubercle bacilli in routine work. Villemin (1865) was apparently the first to use this method and it was revived by Delépine in Great Britain, who showed that Villemin's method of subcutaneous inoculation gave most definite and reliable results. Delépine agreed with Arloing that this route gives in practically the same time far more typical results than intraperitoneal inoculation.

Delépine in the above paper shows the sequence in which the lymphatic glands in the guinea pig are affected.

In a later paper he states that one may subdivide the development of experimental tuberculosis-lesions in the guinea pig into four stages, which are indicated by the lesions produced in a certain
length of time by subcutaneous injection of \( \frac{1}{20} \)th milligramme of pure culture of tubercle bacilli of moderate virulence into the inner aspect of one hind leg at the level of the femorotibial articulation.

The stages depend on the degree of infection after periods of 10, 20 and 35 days and over, after inoculation. In 10 days the subcutaneous tissue at the seat of inoculation and the adjacent popliteal gland in the left leg are affected with lesions visible in an ordinary dissection. Delapine states that under these circumstances the popliteal gland on the side of inoculation is usually infective 48 hours after inoculation, and the spleen in from 96 - 120 hours.

The extent of the lesions is influenced both by the duration of life after inoculation, by the number of bacilli in the material tested and by their virulence.

For the purpose of the investigation under discussion I adopted a period of 5 weeks following inoculation, after which the guinea pigs were killed and cultures made from the lesions.

The glands usually selected for examination were the deep inginal or the sublumbar, and the spleen.

These glands were seared on their surfaces and the
softened caseous material extracted with a loop or pipette, smears made, and cultures put on as subsequently described. Where the glands were only moderately enlarged, or where there was insufficient material obtained from them, spleen emulsion was also used for the smears and cultures. The smears were immediately stained by Ziehl Neelsen and Gram and the results entered in the records of the case, particular attention being paid to the morphology of acid fast bacilli present, although this was found of little help in differentiating human from bovine type bacilli.

Cultural tests.

Material from the softened caseous glands or from the spleen was rubbed over the surface of several freshly prepared tubes, each of plain Dorset egg medium and glycerin egg medium, these two media being now almost universally employed in the propagation of primary tubercle cultures. Tubes so inoculated were sealed with rubber caps to prevent evaporation. I found it an advantage to place about 1 c.c. of sterile broth at the bottom of each tube, and carefully to flame the cotton wool plug and cover at once with a sterile rubber cap to diminish the risk of contamination. Paraffin was avoided for sealing the tubes,
as I found that if the cap were removed for a few minutes and the plug loosened every week, a more luxuriant growth resulted. The effect of the addition of the oxygen of fresh air on the growth of the cultures was often quite noticeable within a few days, especially when the rate of growth was slow. The capped tubes were placed in the 37°C incubator in a sloped position.

During the course of the investigation, the addition of a few drops of alcoholic basic fuchsin to the plain egg and glycerin egg medium, as advised by Cruckshank, was found to be an advantage, and this addition was carried on throughout the greater number of cultures made. It is advantageous in recognising early and slight quantities of tubercle. Growth was usually apparent in two weeks, but the cultures were continued for several weeks until sufficient growth was obtainable for the inoculation tests.

Appearance of growth on Dorset egg medium.

Glycerin is said by Cobbett to exert a stimulating effect on the growth of the human bacillus, and to retard the growth of the bovine bacillus. This applies principally to primary cultures, for Mitchell has shown that in subcultures on gly-
cerin egg medium the tendency of bovine viruses is to grow better than on plain egg medium, and therefore primary cultures must be used for differentiation.

(66) Cobbett and Griffiths and others have had a similar experience. On the plain Dorset egg medium the human type of tubercle bacillus grows readily, growth generally being visible in from 12 - 14 days, and as the growth becomes more luxuriant it is usually raised granular, but in all my primary cultures the colonies were discrete. The bovine type tubercle bacillus on plain egg medium does not appear so soon as is the case with the human type, and growth is hardly recognisable before the third week. It develops slowly and at best the colonies are small, scanty and discrete. On glycerin egg medium the difference between the growths is more marked and the human culture grows more luxuriantly than on plain egg. Many eventually develop a film with a wrinkled surface. The large majority of bovine strains fail to develop on glycerin media in primary culture, or give so slight a growth that it is scarcely noticeable to the naked eye.

(67) The British Royal Commission found such a constant distinction between human and bovine types
of bacilli that they formulated two classes: a "Eugonic" or luxuriantly growing class, and a "Dysgonic" or sparsely growing class. The great majority of human type tubercle bacilli belong to the eugonic and the majority of the bovine strains to the dysgonic class. With certain exceptions: i.e., certain strains which have some of the characteristics of both classes, a rapidly and luxuriantly growing strain is likely to be human in type, and a slowly and sparsely growing strain, bovine in type.

Fraser mentions three tests which give trustworthy evidence of the type of tubercle bacilli. The first or the use of glycerin in egg medium is of considerable value as an indicator of the probable type present, and has just been described. The second bears the name of Theobald Smith, and is described by Fraser in his book on Tuberculosis of the Bones and Joints, and again in less detail in the Journal quoted above. Fraser says "that in 1905 Theobald Smith formulated a test which depended upon the changes produced in glycerin broth by the growth of the tubercle bacillus. The glycerin broth is rendered faintly acid and the acidity is carefully estimated by titration at intervals of 10 days. In
the case of the human bacillus the degree of acidity progressively increases, in the case of bovine bacillus the acidity diminishes, and the medium may even become alkaline. The test is reliable, but it is difficult to perform; and mixed infection of the medium is very hard to prevent."

I have no experience of this test, which does not appear to be very generally employed, and A.S. Griffith working for the Royal Commission and Grund working in New York under the general direction of Park and Krumweide reported unfavourably on the reaction.

The difficulty which is sometimes experienced in placing strains of tubercle bacilli under investigation in their proper class on cultural grounds, depends to a certain extent on the difficulty of preparing different batches of culture media of constant value, and when working, as I have had to do, with strains which only become available at infrequent intervals, it was obviously impossible to test all strains with the same batch of medium. As constant a composition was maintained as possible and all media for these tests made up by the same person. Certain of my cultures were subcultivated because there was doubt as to the type, and although stress is laid on
the value of primary cultures, Cobbett holds that it is impossible always to rely on primary cultures, and that there is no need to hurry the investigation of cultural characters unduly, for many months at least are available before the distinction in the cultural characters of the type tends to become obscured, but he recommends that the stock cultures should be kept rigidly from glycerin.
The third test mentioned by Fraser which he describes as the simplest and yet the most reliable, is that usually termed the animal test, which is based on the fact that the bovine bacillus is especially virulent for certain animals such as the calf and rabbit. In the work for the Royal Commission both animals were extensively used, but in much of the recent work the rabbit alone has been used for obvious reasons.

The rabbit is very highly susceptible to infection with the bovine type of tubercle bacillus, and usually succumbs rapidly to an acute and generalised disease if the dose of bacilli be moderately large, the age and susceptibility of the animal to a certain extent determining the rapidity of infection.

The dose of bacilli and the route of injection are important factors, and both must be considered in differentiating human and bovine strains.

With a suitable dose, the rabbit is resistant to infection with the human type of bacillus, lesions of a chronic and retrogressive or slowly progressive type only being produced, although if the dose of bacilli be excessive a fatal result may follow.

Chung Yik Wang (71) summarises the modes of injection and dosage as follows:
"In using rabbits four methods of inoculation can be employed:

1. "Intra-articular, introduced by Fraser (1912 B.M.J. Vol. II p. 1432) The knee joint of the rabbit is chosen as the most convenient and accessible. The test is judged by the degree of reaction, clinical and pathological, consequent upon inoculation into the joint with 1 c.c. of bacillary emulsion."

This method does not appear to have been adopted to any extent, and is not mentioned by Cobbett or by Eastwood or Griffith in their publications already quoted.

2. "Subcutaneous route - injection between the Scapulae or in the abdominal wall of 10 mgm. of dried bacilli."

This route is not favoured by Cobbett owing to the ulceration of the local lesion.

3. "Intraperitoneal route: which is said to take longer for the animal to show indications of disease."

Cobbett states that this method has few supporters, but in his opinion it is preferable to the other methods. He holds that with 1.0 mgm. of culture it gives a very sharp and decided result in the immense majority of cases; and thinks it is not more generally employed owing to the groundless fear of wounding some part of the intestine when giving the injection.

4. "The Intravenous route. The British Royal Com-
mission on Tuberculosis is of opinion that for an intravenous injection into the rabbit for purposes of identification, a dose of 0.01 mgm. of tubercle culture should be used.

Cobett (73) says that the best method will be that which gives the clearest difference in the effect produced by the two types of bacilli, and other things being equal a quick result is to be preferred. It is also desirable to avoid such methods as lead to a discharging tuberculous lesion. He quotes Oehlecker, Forke and Krumwiede and A. S. Griffith, as preferring this method. It has also been followed by Fraser, Mitchell, and Wang in Edinburgh.

PARTICULARS OF DOSAGE USED IN MY OWN EXPERIMENTS.

Adult white rabbits were used, one rabbit being injected intravenously in the ear vein with cultures which from their cultural appearances appeared to be definitely Eugonic or Dysgonic, and two rabbits were used for those cases where the cultural appearances left any doubt. The growth was scraped from the surface of egg medium slopes and dried on watch glasses in the incubator. As far as possible primary cultures of not more than 4 weeks growth were used except in some of the dysgonic strains when subcultures were necessary to secure sufficient bacillary substance.
The dried culture was weighed in a chemical balance and emulsified in saline so that 0.5 c.c. of emulsion contained 0.01 mgm of bacillary substance, which was the dose employed.

A. S. Griffith did not dry his culture growth, and Wang dried it over concentrated sulphuric acid; this is a point which is rather overlooked in the descriptions given by many authors of the doses employed. Probably Wang's method has much to commend it, for the size of different doses is liable to less variation than cultures dried more or less in the incubator, or culture growths which have not been dried. The latter method seems open to considerable objection on the score of irregularity in size of different doses.

The rabbits were weighed before injection and at death. At the end of three months the rabbits were killed and examined unless they had died previously.

**Lesions observed in rabbits.**

Reliance was placed on the appearance of the lesions for differentiation.

In those which died within 6 weeks a severe generalised tuberculosis was noted.

The lungs were the organs principally affected and these were large and studded with numerous tubercles of varying size. These were in some cases small and closely packed, or confluent and with caseation centres.
The kidneys were studded with a varying number of caseous tubercles which on section were seen to lie in the cortex. The nodules varied in size from small granules to the size of a pea.

The Spleen in one case was considerably enlarged and studded with small yellow white tubercles, likewise the liver. Otherwise there was usually some enlargement of the spleen and a moderate number of small tubercles. The liver was similarly affected tho' to a less extent.

Rabbits showing a rapidly progressive tuberculosis fatal within six weeks, with the lesions described above were regarded as being affected with a bovine type of tubercle bacillus. Rabbits which had not lost weight, or only to a slight extent, and which did not show obvious emaciation and illness were killed in three months' time: this time limit was observed, for in spite of the statement that the human type of bacillus produces a retrogressive disease in the rabbit, numerous workers note that progressive tuberculosis is occasionally induced in the rabbit by human tubercle bacilli, especially when doses larger than 0.01 mhm. of bacilli are employed.

Those rabbits showing a slowly progressive tuberculosis, with limited lesions usually confined to the lungs and to a less extent to the cortices of the kidneys, and without generalisation or death within the
time period allowed; were classed as having been infected with the human type of tubercle bacillus.

Cobbett sums up his experience of the value of the animal (rabbit) test in differentiating the two types of tubercle bacilli under discussion as follows:

"It may be said that the rabbit is one of the most susceptible of all animals to infection with the bovine type of tubercle bacillus however injected, that it shows as a rule a high, but somewhat variable resistance to the human type of tubercle bacillus, lesions of a chronic type being not infrequently seen in the lungs, and sometimes in the kidneys. Some considerable experience therefore is necessary in the use of this animal to avoid being misled by exceptional results, unless a number of animals are used in each experiment."

Having considered the technique followed in my investigation and the opinions of various authorities thereon, I have set out in the following pages a short summary of the cases investigated, with the patients' age, sex, and lesion, and the result of the guinea pig, cultural and inoculation tests, and the conclusions as to type of infecting bacilli derived therefrom. Thereafter follows a comparison of the results obtained by other workers in other countries. The reasons for the
small number of cases which it has been possible to obtain for investigation have already been discussed.

BRIEF REPORT IN EACH CASE.

NOTE:— Guinea pig in the following summary means that two guinea pigs were inoculated subcutaneously with the suspected material.

Positive: means, tubercular lesions present, either glands, spleen, or liver and T.B. demonstrated microscopically in the lesions.

Negative: means, - No tuberculosis found in either of the guinea pigs used.

Rabbit - means - animal inoculated intravenously with 0.5 c.c. saline emulsion containing 0.01 mgm of dried tubercle bacilli.

Cultures: - means 3 slopes each of plain and glycerine egg-medium were used.

Eugonic: - means, numerous raised, granular nodular or warty colonies; - growth, visible in 10-14 days and in 3-4 weeks luxuriant.

Colonies on glycerine egg larger and confluent in lower part of tubes.

Dysgonic: means - Slight growth of small rounded and flattened colonies not appearing for about 18-21 days on plain egg medium. No growth or at most very scanty growth on glycerine egg medium.
Case I. B.K. age 7 months, male. General subcutaneous tubercular lesions, including inguinal glands enlarged and caseous; infection followed circumcision by a medical practitioner himself suffering from tubercular laryngitis.

Material for examination. Pus aspirated from an inguinal gland. Moderate number medium and large granular acid fast bacilli in pus.

Guinea-pig inoculation. Both positive.

Cultures. Eugonic.

Rabbit, killed after 3 months. P.M. Lungs - a few moderately large nodules. Spleen - Nil. Kidneys - one small tubercle in cortex of left kidney. Type: Human.


Guinea pigs inoculated: Both positive. Cultures. Eugonic.

CULTURES: Plain and glycerine egg, Luxuriant raised granular colonies, most profuse in glycerine egg, confluent lower part of tubes. Eugonic


Kidneys - Nil. Type: Human.

Material for examination: Enlarged cervical glands.
Section - no tubercular foci. Histologically - Chronic inflammation. No tubercle bacilli found.

Guinea pig: Negative.

Material for examination: Enlarged cervical glands; removed at operation. On section - no tubercular foci naked eye.
Histologically tubercular. No tubercle bacilli found in sections.
Guinea pigs: Negative. Cultures from spleen: Negative.

Material for examination: Cerebro-spinal fluid.
Tubercle bacilli found in centrifuged sediment.
Guinea Pig: Positive
Cultures Eugonic: Colonies well separated large.
Type Eugonic.
Rabbit: Few tubercles in lungs, nil in spleen, kidney or liver.
Judged from appearance of cultures and non-progressive nature of lesions in rabbit to be human type.

Guinea pigs inoculated and both died 10 days later, of acute pulmonary congestion. Tests repeated with a fresh specimen of sputum. - positive.

Cultures Eugonic. Very vigorous and slightly pigmented growth.

Rabbit: Killed in 3 months. Slight loss of weight.

Moderate number small tubercles in lungs - few in kidneys. One small tubercle spleen.

Type: Human.


Material for examination. Sputum containing numerous tubercle bacilli.

Guinea pigs inoculated, - died 12 days later from acute pulmonary congestion. One small superficial inguinal gland enlarged and smears showed tubercle bacilli.

Cultures plain egg and glycerine egg. Moderate number small raised granular colonies, confluent in lower part of glycerine egg tubes.

Subcultures on plain egg and glycerine egg media gave much more copious growth and these were used for animal inoculation.

Type - Probably Eugonic but 2 Rabbits injected intravenously with 0.01 mgm each of bacillary emulsion. Both killed in 3 months. Two small tubercles in lungs. A few tubercles in kidneys. Nil in spleen.

Type: Human - virulence for rabbit less than that usually exhibited by bovine strains. Primary cultural
appearances probably due to culture medium.

Case 8. L. A. Age 9 Female. Wall of ganglion of hand.

Material for examination. Wall of tubercular ganglion removed by curette. No tubercle bacilli found in smears. Guinea pigs - positive.

Cultures Dysgonic: Subcultures made for inoculation purposes.

Rabbit - inoculated intravenously. 0.01 mgm. from subcultures. Died after 20 days. P.M. Acuted generalised miliary tuberculosis with emaciation.

Type: Bovine.


Material for examination. Cerebro-spinal fluid - tubercle bacilli found in sediment rather shorter and stouter than human type bacilli.

Guinea pigs. - Positive. Bacilli from caseous lumbar glands being slender and granular.

Cultures Eugonic

Rabbit. Killed after 3 months. Lungs - a few tubercles and nodules. Nil elsewhere.

Type - Human.


Cultures: put on direct without guinea pig inoculation

Type: Eugonic.

Rabbit killed after 3 months.  Lungs showed several small caseous nodules.

Kidneys - A few tubercles.  Nil elsewhere.

Type: Human.

Case 12.  W. B.  Age 16 yrs.  Tubercular abscess?

Material for examination.  Scrapings from abscess wall and pus.  Abscess on inner side of leg above ankle.

Previous history of osteomyelitis in opposite femur.

No tubercle bacilli found in smears.

Guinea pigs inoculated.  - Negative.

Cultures from Spleen.  No growth.


Material for examination.  Sputum with tubercle bacilli in direct smears.

Guinea pigs.  Positive.


Material for examination. As above. Tubular foci naked eye. T. B. demonstrated microscopically.

Histology that of tubercle.

Guinea pigs. Positive

Cultures. Dysgonic.

Rabbit died 34 days - Extensive general tuberculosis of lungs - liver - kidneys - spleen.

Type: Bovine.


Material for examination. As above removed at operation - suspected tubercular. No tubercule bacilli demonstrated microscopically.

Histology - Chronic inflammatory.

Guinea pigs. Negative.

Cultures from Guinea pig spleen. - negative.


Material for examination. Mesenteric gland removed post-mortem. Patient had been ill 7 weeks and had had effusion into peritoneal and pleural cavities.

Guinea pig. One died. Other positive.


Rabbit: Killed after 3 months. Lungs - enlarged.

Several large nodules with caseous centres. Few minute nodules in kidneys and liver. Nil in spleen.

Type: Human.
Case 17. A. P. five years. male. Tubercular cervical glands.


Cultures. Dysgenic. No growth on glycerin tubes. Very minute colonies on plain egg medium.

Rabbit: Died in 28 days - emaciation and generalised tuberculosis.

Type - Bovine.

Case 18. G. age 2 years, female. Meningitis.

This baby was fed on cow's milk from birth. The farm supplying same was reported clinically free from tuberculosis and milk samples were negative bacteriologically.

Material for examination. Cerebro-spinal fluid. Two acid past bacilli found in several smears of sediment examined.

Guinea pig. Both positive.

Cultures. Eugenic - owing to rather poor growth on primary cultures, subcultures put on. Wrinkled films on glycerin egg.

Rabbit. Increased weight - well after 3 months then died suddenly from enteritis. Two retrogressive tubercles in lungs. Nil elsewhere.

Type - Human.
Case 19. - C. age 1 year 11 mos. male - Meningitis.

Mother was in hospital at time suffering from pulmonary tuberculosis.

Material. Tubercles from meninges removed post-mortem.

Guinea pig. Both positive.

Cultures. Markedly Eugonic - Growth very profuse.


Spleen - Nil.

Type - Human.

Case 20. J. M. Age 2 years 6 mos. female - Meningitis.

Child had a caseous abscess on hand opened several days previously.

Material for examination. Clear cerebro-spinal fluid. A few short granular acid fast bacilli found in smears of sediment.

Guinea pigs. Both positive.


Rabbit. Killed in 3 months. Lungs - several nodules some softening.

Kidneys. A few tubercles. Spleen and liver Nil.

Type - Human.

Material for Examination. Urine - sediment showed moderate number acid past bacilli. No bacteria found by gram. Patient ill for several months.

Cultures direct from centrifuged deposit of catheter specimen of urine. Eugonic growth not luxuriant.

Subcultures for inoculation
2 Rabbits. Both killed after 3 months.

Lungs: A few retrogressive tubercles. Liver, spleen, kidneys, Nil.

Type: Human.


Material for Examination. Cerebro-spinal fluid. One acid past bacillus found in smears from sediment.

Guinea pigs. Positive.

 Cultures. All contaminated but one. Subcultures from this - Eugonic.


Type: Human.


acid fast bacilli previously found in Cerebro Spinal fluid ante-mortem.

Guinea Pigs: One negative - one showed a somewhat enlarged sublumbar gland. No caseation. No T.B. in smears.

Cultures: from gland emulsion and from Spleen. - No growth.

Guinea Pig. inoculated with same emulsion. Negative.

**Case 27.** D H. Age 5 years 5 months. Male. - Meningitis

Material for examination. Cerebro spinal fluid. No acid fast bacilli found in sediment.

Guinea Pigs. Both positive

Cultures. Eugonic - growth luxuriant.

Rabbit. Killed in three months.

Lungs. - Retrogressive tubercles near marquis

Spleen - nil.

Kidneys One tubercle in left cortex.

Type - Human.

**Case 28.** S. age 2 yrs. 6 mos. female. Meningitis.

Material for examination. Cerebro Spinal fluid - no acid fast bacilli found in sediment.

Guinea pigs. One positive.

Cultures. Dysgonic. No growth on glycerin egg medium

Subcultures, very slow rate of growth on plain egg medium.

Rabbit. Died in 35 days - Generalised tuberculosis.

Type Bovine.
Case 29. T.T. Age 8 years female. Meningitis.

Material for examination. Cerebro-spinal fluid - Few acid fast bacilli in smears from sediment.

Guinea pig. Positive.

Cultures. Eugonic - Luxuriant growth on glycerin egg medium.

Rabbit. Killed in three months

Lungs. Numerous caseous tubercles.

Spleen Nil.

Kidneys. A few minute tubercles.

Type. Human.

Case 30. B.R. Age 14 Female - Pulmonary tuberculosis - Sister of Case 22.

Material for examination. Sputum - moderate number of tubercle bacilli in smears.

Guinea Pigs. Injected with washed sediment from antiformin treated specimen - Both positive.

Cultures. Eugonic. Growth moderate on both media more profuse on Glycerin egg. Subcultures gave more luxuriant growth with Eugonic characters.

Rabbit Died after 74 days. Initial weight 2,850 grs.

Weight at death 2,120 grs. Lungs - several small caseous nodules. A few tubercles in kidneys.

Another rabbit inoculated from subcultures lived up to three months and was killed. It did not lose weight and the lesions were those associated with
the human type.

Type: Human.

This strain is probably one of those intermediate strains whose Eugonic characters are not marked in primary cultures, but one of low virulence for the rabbit.

These results are tabulated and grouped together in age groups in Table XXIX and grouped under lesions in Table XXX.

**TABLE XXIX.**

Cases of Juvenile Tuberculosis grouped according to ages - with type of tubercle bacillus found in each.

See next page.
TABLE XXIX.
Cases of Juvenile Tuberculosis grouped according to ages - with type of tubercle bacillus found in each.

<table>
<thead>
<tr>
<th>No. of case</th>
<th>Age in years</th>
<th>Character of Disease</th>
<th>Tissues examined</th>
<th>Character of tubercle bacilli found</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2.6</td>
<td>T.B. Meningitis</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>19</td>
<td>1.11</td>
<td>T.B. Meningitis</td>
<td>Tubercles from Meninges</td>
<td>Human.</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>Tubercular Meningitis</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>28</td>
<td>2.6</td>
<td>&quot;</td>
<td>Cerebro sp. fluid</td>
<td>Bovine</td>
</tr>
<tr>
<td>18</td>
<td>2.11</td>
<td>&quot;</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Human.</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>Tubercular glands</td>
<td>Cervical glands</td>
<td>Bovine</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Bovine</td>
</tr>
<tr>
<td>23</td>
<td>5</td>
<td>T.B. Meningitis</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>27</td>
<td>5.5</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Human.</td>
</tr>
<tr>
<td>25</td>
<td>5.6</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Human.</td>
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<td>29</td>
<td>8</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Human.</td>
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<tr>
<td>9</td>
<td>9</td>
<td>Tubercular Ganglion hand</td>
<td>Wall of Gangliant</td>
<td>Bovine</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>Cervical adenitis</td>
<td>Cervical glands</td>
<td>Human.</td>
</tr>
<tr>
<td>11</td>
<td>9</td>
<td>T.B. Meningitis</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>Pulmonary T.B.</td>
<td>Sputum</td>
<td>Human.</td>
</tr>
<tr>
<td>21</td>
<td>10</td>
<td>T.B. Meningitis</td>
<td>Cerebro sp. fluid</td>
<td>Human.</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>Pulmonary tub.</td>
<td>Sputum</td>
<td>Human.</td>
</tr>
<tr>
<td>Disease</td>
<td>No. of Tissues examined</td>
<td>Character of Tissue</td>
<td>Type of bacilli found</td>
<td></td>
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<tr>
<td>-----------------------</td>
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<td></td>
</tr>
<tr>
<td>Pulmonary tuberculosis</td>
<td>14</td>
<td>Sputum</td>
<td>Human Human Human</td>
<td></td>
</tr>
<tr>
<td>Pulmonary tub. gland</td>
<td>14</td>
<td>Sputum</td>
<td>Human Human Human</td>
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</tr>
<tr>
<td>Meningitis</td>
<td>14</td>
<td>Cerebro Sp. Fluid</td>
<td>Human Human Human</td>
<td></td>
</tr>
<tr>
<td>Peritonitis</td>
<td>15</td>
<td>Mesenteric gland</td>
<td>Human Human Human</td>
<td></td>
</tr>
</tbody>
</table>

Total 24 cases. Human type 20 cases or 83.33% or 16.66%
### TABLE XXX. Conti.

Cases of Juvenile Tuberculosis from Table XXIX arranged according to Character of Lesion.

<table>
<thead>
<tr>
<th>No. of Case</th>
<th>Age in years.</th>
<th>Disease</th>
<th>Type of tubercle bacillus isolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>7 mos.</td>
<td>T.B. Inguinal Glands, etc</td>
<td>Human</td>
</tr>
<tr>
<td>14</td>
<td>4 yrs.</td>
<td>T.B. Cervical Gland</td>
<td>Bovine</td>
</tr>
<tr>
<td>17</td>
<td>5 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Bovine</td>
</tr>
<tr>
<td>2</td>
<td>9 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>19</td>
<td>1 yr. 11 mos.</td>
<td>T.B. Meningitis</td>
<td>Human</td>
</tr>
<tr>
<td>18</td>
<td>2 yrs.</td>
<td>T.B. Peritonitis</td>
<td>Human</td>
</tr>
<tr>
<td>20</td>
<td>2 yrs. 6 mos.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>28</td>
<td>2 yrs. 6 mos.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Bovine</td>
</tr>
<tr>
<td>22</td>
<td>3 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>23</td>
<td>5 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>5</td>
<td>2 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>27</td>
<td>5 yrs. 5 mos.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>25</td>
<td>5 yrs. 6 mos.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
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<td>29</td>
<td>8 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>11</td>
<td>9 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>21</td>
<td>10 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>9</td>
<td>14 yrs.</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>Human</td>
</tr>
<tr>
<td>No. of Case</td>
<td>Age in years</td>
<td>Disease</td>
<td>Type of tubercle bacillus isolated</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>----------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>Pulmonary tuberculosis</td>
<td>Human</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>&quot;</td>
<td>Human</td>
</tr>
<tr>
<td>30</td>
<td>14</td>
<td>&quot;</td>
<td>Human</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>&quot;</td>
<td>Human</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>Tubercular ganglion</td>
<td>Bovine</td>
</tr>
<tr>
<td>24</td>
<td>13</td>
<td>Pyelitis &amp; cystitis</td>
<td>Human</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
<td>T.B. Peritonitis</td>
<td>Human</td>
</tr>
</tbody>
</table>

Total 24 Cases. Human 20 Bovine 4
SUMMARY OF RESULTS OBTAINED

From 20 of the 30 cases investigated the human type of tubercle bacillus was isolated, from 4 the bovine type of tubercle bacillus was isolated, and from six cases no tubercle bacilli were recovered. Of these six cases, Nos. 3, 10, 12 and 15, were either histologically non-tuberculous or no tubercle bacilli were demonstrated in the tissues received for examination, so that presumably the clinical diagnosis was at fault. Two of the six cases, Nos. 4 and 26, were histologically tuberculor but the guinea pig tests were negative. In No. 4 the bacilli were probably dead, but in case 26 this could hardly be so, and the material injected must have contained either too few bacilli to be infective or none at all.

Of the 24 cases which yielded tubercle bacilli in cultures there were four, or 16.66 per cent, which gave the characters of the bovine type of tubercle bacillus, and 20, or 83.33 per cent, which gave the characters of the human type of tubercle bacilli.

The cases are almost too few in number to further subdivide or classify, but in the age groups 0-5-6 yrs. there were 12 cases, and it is interesting to note that from nine of these the human type of bacillus was recovered, and from three the bovine type of bacillus. Thus during the age period when
milk forms the principal article of diet, three of the four cases of bovine infection were found.

Referring to Table XXX it is seen that the cases fall into three principal groups. In the first, Tubercular adenitis, there are four cases, and of these two gave human and two bovine bacilli. The second group, Tubercular meningitis is the largest, probably because this class of case is more frequently sent to hospital in New Zealand, and was therefore available for the purposes of my investigation.

Of the 13 cases in this group, only one gave the bovine type of bacillus, whereas from twelve the human type of bacillus was recovered.

In the third group, "Pulmonary Tuberculosis" are four cases, all yielding bacilli of the human type.

A fourth group of three miscellaneous cases yielded one bovine and two human type of bacilli, although one of these, No. 16, might equally have been included under the group "Tubercular Adenitis."

The results, which are spread over several years, have been disappointing, in that the paucity of material has rendered a comparison of New Zealand figures with those of other countries of little value, for the numbers of cases in any one group are too few to render percentage estimations of any com-
comparative value. In most of those countries where Juvenile Tuberculosis is more common than it is in New Zealand a sufficient number of cases under each heading has been investigated to render the results comparable with those of other workers. Thus Mitchell's series of cervical glands, and Fraser's series of bone and joint cases which were each sufficiently numerous, and at the same time the material was available in a comparatively short space of time.

The only satisfaction to be derived from the knowledge that a paucity of such material exists in a young country like New Zealand is that Juvenile Tuberculosis does not claim the toll of Juvenile life and health, that it does in those countries where workers have obtained such a wealth of material for investigation.

It only remains in conclusion to briefly consider the results obtained by other workers, and to see how my results compare with them in a general way. In the first place I have quoted the results obtained in the three sub-groups into which I have been able to divide my cases, namely: Tubercular adenitis, Tubercular meningitis and Pulmonary Tuberculosis. In another variety of tuberculosis com-
mon in children – viz., that of the bones and joints (76). I had no cases but Fraser in Edinburgh found in 70 cases in children under 12 years of age a percentage of 60% infected with the bovine bacillus. Fraser's results have been criticised by Möllers (77) who investigated personally only 12 cases and only three of these were between the age of 5-16. He quotes the results of 15 workers in 163 cases including his own, from only 2.45% of these was the bovine type of bacillus recovered.

Eastwood & F. Griffith (78) examined 217 cases under 16 years of age and found 52 or 23.3% infected by the bovine type, and 158 infected by the human type of bacillus; while from 4 atypical strains were recovered. Subsequently A Stanley Griffith (79) working on material from England and Wales and from Scotland, found in 315 cases of bone and joint tuberculosis in children under 16 years, 67 or 21.2% were due to the bovine bacillus and 237 to the human bacillus, while 11 gave atypical cultures.

Apparently bone and joint tuberculosis is more frequently due to the human than the bovine bacillus in England and Wales, where it would appear to be carried by the bovine tubercle bacillus in about one case in five in children under 16 years. Three and in Fraser's cases to 2 out of every three. In Scotland the proportion of bovine infections is higher amounting in Griffith's series to about one in three in Fraser's cases & two out of every three.
TUBERCULAR ADENITIS. The types of bacilli in tubercular adenitis have been extensively investigated by Mitchell in Edinburgh, who found in 70 cases investigated that 65 or 90% were due to bovine infection and 7 or 10% were due to human type infection. Mitchell's high percentage findings have been criticised by Cobbett(80) who quotes A. S. Griffith as finding at similar age periods 61% of bovine type infections, and the American investigators whose figures for bovine infections reached a little over 53% (81).

A. S. Griffith has investigated bacteriologically lymphatic glands believed to be tuberculous and obtained at operations, and in all but three cases the glands were cervical. The cases investigated numbered 110, and they could be divided into 3 groups of 10, 29, 71, individuals.

The first 10 were not tuberculous macroscopically and gave negative guinea pig tests. The 29 cases of the 2nd group gave negative guinea pig tests but were definitely tuberculous to the naked eye. In 15 of these tubercle bacilli were found, but according to cultural experiments they were not living. This group showed that in glandular tuberculosis there is a marked tendency to spontaneous cure, and may explain the negative results obtained in some of my negative cases.
In the third group of 71 cases Guinea pigs and cultures were positive, and from 37 of these human type bacilli were obtained, and from 34 or 47.8 per cent bovine type bacilli were obtained.

**Tubercular Meningitis.**

Tubercular meningitis of which my series includes 13 cases with one bovine infection, have not been investigated so fully as have lesions of bones and joints and of the lymphatic glands.

This is probably due to the fact that cases are less numerous than is the case with local tubercular lesions, and that tubercular meningitis is usually part of a more or less general tuberculosis starting in bronchial or other lymphatic glands and involving other organs as well.

Thus in a series of 545 cases of tuberculosis in children under 16 reported by W. H. Park and C. Kürmwiede Junr., which included their own and the results of several German workers and cases given in the final report of the Royal Commission, with the exception of Virus H.16, J.H., only 35 were ascribed to Tubercular meningitis, and of these 35 only 4, or 11.2% were of bovine origin.

Of their own cases, there were 30 of Tubercular meningitis in children under 16 years, 28 of which were infections by the human type of bacillus and 2 or 6% by the bovine type.
In the Royal Commission final report quoted by Cobbett, p. 570, three cases of tuberculous meningitis were subjected to investigation, but the abstracts of the post-mortem examinations make it clear that either the meninges or the brain itself were involved in 19 of their cases, but from only eleven of these 19 cases were the tubercle bacilli investigated taken from the brain or cerebro-spinal fluid. Eight of these proved to be of human type and three of bovine type.

Among the cases investigated in the Gesundheits-samt by Kossel, Weber and Heuss and by Weber and Taute were 10 cases of general tuberculosis with meningitis or cerebral tubercle in children, in seven of which the infection was due to human type bacilli and in three to bovine bacilli.

Summarising the results of the Royal Commission, Cobbett finds that of material obtained from meningeal tubercles, brain or cerebro-spinal fluid there were in children under 16 years of age 38 cases of human type infection and 10 of bovine infection, a bovine infection percentage of 26.3.

Numerous investigations of the types of tubercle bacilli in sputum have been published but as pointed out by Cobbett the results are weakened by the possibility
of contamination of the specimen by bovine bacilli derived from food. Where however the results show no bovine infection—this objection is overruled.

In my series there were four cases of pulmonary tuberculosis in children all yielding bacilli of human type. Koch at the International Congress on Tuberculosis at Washington in 1908(85) claimed that up to that time in no case of pulmonary tuberculosis had the bovine type of tubercle bacillus been definitely demonstrated, a statement which was challenged by Arloing.

I have been unable to obtain details of the ages of the cases in this group other than those tabulated by Cornet and Kassel of different workers, the literature available quoting cases without reference to age.

At the same time the number of bovine infections in this variety of tuberculosis is very small. Thus A. S. Griffiths published in 1914 a table of the results of various authors including 105 London and 43 Edinburgh cases of his own. In all 938 cases are mentioned, 932 of which yielded bacilli of human type and 4 bacilli of bovine type, and two being mixed infections. Of the 4 cases of bovine infection mentioned only two, those of Griffith himself seem to be beyond dispute.

Cornet & Kassel (67) in their table summarising the types of tubercle bacilli found in cases of human tuberculosis by various investigations gave particulars of 732
cases of pulmonary tuberculosis, of which 25 were children under 16 years of age. All were examples of human infection.

**Tuberculosis of the Genito-Urinary Tract.**

I have only one case of infection of the Genito-Urinary tract from it a human type of bacillus was recovered. Although the variety of tuberculosis is not uncommon in New Zealand, it is confined very largely to more advanced age periods than those I have included in my investigation.

Eastwood and F. Griffith (88) investigated the types of tubercle bacilli in 17 cases of tuberculosis of the human genito-urinary tract. Human bacilli were found in 14 cases, and bovine bacilli in three cases, the three bovine cases involving kidneys in persons aged 25, 19 and 20 years, and being outside the 0-16 years period under discussion.

Thus far I have briefly summarised some of the better known published results, showing the relative proportions of human and bovine infections in selected groups of tubercular infection in children. From them it will be seen that bovine infections in children appear to be higher in Scotland than in England.
and higher in these countries than in America and Germany. My own cases in New Zealand are too few to offer any reliable comparison and if considered at all must be taken together under such a heading as "All forms of Juvenile tuberculosis. Thus in my 24 cases, 20 were examples of human infection and 4 of bovine infection, a percentage of 16.66% bovine infections.

Park and Krumwiede collected the statistics of several Continental workers including their own, and found in 545 children of 0-16 years, that 423 were examples of human infection and 122 of bovine infection, or a percentage of 22.38% of bovine infections. These results are somewhat higher than New Zealand figures.

Rabinowitsch and Dammann reported on 60 cases of tuberculosis in children and adults found 11.66% of the sixty strains were bovine, while if the cases of children alone were taken into account the percentage of bovine infection was 29%.

A. S. Griffith reporting to the Medical Officer of the Local Government Board on a series of Autopsies into the occurrence and distribution of tuberculosis in children found in his first series of 78 cases in which cultures of tubercle bacilli were obtained that 65 or 83.3% yielded tuber-
cle bacilli of human type and 13 or 16.7 per cent yielded cultures of the bovine type.

In his second series of 20 cases, bacilli of human type were found in 80% and bacilli of bovine type in 25%. Taking both series of 98 cases, bacilli of human type were obtained in 82.7 per cent, bacilli of the bovine type in 18.4 per cent.

Cornet and Kossel in a table summarising the types of tubercle bacilli found in cases of human tuberculosis by various investigators report on 1290 cases of various kinds of tuberculosis in adults and children.

Of children under 16 years of age in this series, 21.3 per cent yielded bacilli of bovine type.

Griffiths results show a lower percentage of bovine infections in children than those of Park and Krumwiede and of Cornet and Kossel, while the New Zealand figures as far as they go show a lower percentage of bovine infections still. Taking all forms of juvenile tuberculosis together, the various authorities find from 16 to 22 per cent of bovine infections, the latter figure representing the position in Gt, Britain.

These results are summarised in Table XXXI and the later figures of Griffith, abstracted in an Addendum, being included, as they represent a large
number of cases from various sources

TABLE XXXI.

Percentage infections by the human & bovine tubercle bacillus in all forms of tuberculosis in children under 16 years of age.

<table>
<thead>
<tr>
<th>Author</th>
<th>No. of Cases</th>
<th>% Human</th>
<th>% Bovine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park &amp; Krumwiede</td>
<td>545</td>
<td>77.62</td>
<td>22.38</td>
</tr>
<tr>
<td>Griffith, A.S.</td>
<td>98</td>
<td>82.7</td>
<td>18.4</td>
</tr>
<tr>
<td>Griffith, A.S. Summary of various workers results in Gt. Britain (Addendum)</td>
<td>930</td>
<td>79.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Cornet &amp; Kossel</td>
<td>-</td>
<td>78.7</td>
<td>21.3</td>
</tr>
<tr>
<td>New Zealand Cases</td>
<td>24</td>
<td>83.33</td>
<td>16.66</td>
</tr>
</tbody>
</table>

The consideration of the types of tubercle bacilli found in a very limited number of cases of juvenile tuberculosis and the reference to similar work by authors in other countries in so far as has been possible with the literature available, completes this section of my investigations. I have already explained how scanty is the tuberculous material (in the Southern parts of New Zealand) upon which I have been able to draw, a fact which is for-
It has only been possible in 5 years to obtain, after repeated efforts, some 30 specimens for investigation.

The lack of facilities for wide reference has greatly hampered reference to the work of others, and one has had to depend largely on the 20 odd journals and the text books which regularly come to hand for one's private use. The future will show an improvement in this respect, for a growing medical School must have a good reference library and now that funds are becoming available this important department is receiving the attention it requires.

It only remains to summarise the position of Juvenile Tuberculosis in New Zealand as set forth in the preceding pages and to draw the necessary conclusions therefrom.
1. The area of the Dominion of New Zealand is 103,581 square miles and the population at the 1916 census was 1,175,000. The density of the population (10.64 persons to the square mile) is such that there is little question of overcrowding and its attendant drawbacks as far as the health of the population is concerned.

2. The climate, as reflected by the amount of sunshine, moderate rainfall, prevailing winds, and temperature, is one which on the whole is favourable for those subject to respiratory catarrhs, or other respiratory diseases including tuberculosis.

3. The social conditions of the people are in advance of those obtaining in many older countries, and are partly reflected in the low death rate, which averaged 9.33 per 1,000 of the population in 1909-13, and in the low infantile mortality rate, which is under 50 per 1,000 births.

4. Tables and Graphs show that the mortality from all forms of Tuberculosis, and from Pulmonary Tuberculosis is very much lower in New Zealand and Australia than in most other countries. There has not been the same
steady decline in this mortality in New Zealand as there has been during the same period in England and Wales, although at all times the New Zealand rate has been lower. Thus the death rate from Tubercular Diseases fell from 9.31 per 10,000 of the population in 1907 to 6.74 in 1916. In England and Wales the rate in 1907 was 16.67 and in 1913 it had fallen to 13.39.

The effort to control Tuberculosis in Gt. Britain has been greater and more sustained than has been the case in New Zealand.

5. The improvement in the tubercle mortality may also be expressed in percentages. Thus during the period 1871-1913 the New Zealand rate had fallen 47%, while the rate for England and Wales has fallen approximately 60%.

6. The mortality rates for Pulmonary Tuberculosis are also much lower in New Zealand than in Great Britain. The rate in New Zealand has fallen from 7.76 per 10,000 of the population in 1901 to 5.38 in 1916. That for England and Wales for 1901 was 12.64 and for 1913, 9.80. In Scotland during 1901-5 the rate was 14.45 and during 1906-7 it was 13.58.

7. A study of the age and sex distribution of tubercle mortality shows that the female death rate exceeds
the male rate to a slight extent only, between the ages of 6 and 18, but after that the male rate exceeds the female rate, especially in the 20-25 year age period. The female rate falls more quickly than the male rate after the age of 35 years.

The incidence is thus marked in males during the 20-25 year period and after 35 years of age.

8. A study of the age and sex distribution of phthisis mortality shows that the rate in males rises from 0.43 per 10,000 in the 10-15 year age period to 5.6 in the 15-25 year period, reaching a maximum in the 25-35 year period of 9.8 per 10,000.

The female rate is higher than the male during the 10-15 year period (0.82 as against 0.43 in males) and also exceeds the male rate in the 15-25 year age period (7.2 as against 5.6). Thereafter the male phthisis rate exceeds the female in each age group, the female rate falling much more rapidly than the male rate after the 35-45 year age period.

9. Evidence has been collected from various sources (viz. by circularising medical practitioners, from hospital outpatient returns, from post-mortem records, from the returns of School Medical Officers, and as the result of Tuberculin tests), which go to show that tuberculosis in children in New Zealand is very much
less than in most other countries, and this good fortune is shared by Australia. The striking difference between New Zealand and England & Wales, and in New Zealand's favour, is shown in the Tables and Graphs.

10. An investigation of the milk supply of Dunedin in which 200 samples of mixed milk were submitted to the usual tests for the detection of living tubercle bacilli, showed that only two, or one per cent, were positive. An examination of over 600 samples from the various parts of New Zealand was undertaken by Government Agricultural Dept. and all were found negative. On the other hand, it is estimated that about 10 per cent of milk samples in Britain are tubercular. This great difference in New Zealand's favour is pointed out, and the conclusion come to that it is partly responsible for the low incidence of Tuberculosis in New Zealand children.

11. Tuberculosis is not uncommon in cattle in New Zealand, and when the figures given in the text are considered with the results of milk examinations for tubercle bacilli, one would expect a greater percentage of tuberculous milk. The reasons advanced are that the system of Inspection in New Zealand is under control, and is much more thorough than in Gt. Britain.
The system of compensation and compulsory notification, along with this inspection, tends to eliminate the tuberculous dairy cow before it becomes a source of danger, and when once detected prevents its milk from again being used for human consumption.

12. The type of tubercle bacillus in the tubercular lesions of New Zealand children has been investigated. The technique followed has been fully explained. Suspected material was after suitable treatment injected into guinea pigs and from the lesions which developed cultures were prepared, and from the growths obtained rabbits were inoculated to determine the type of tubercle bacillus in each case.

Thirty specimens only were obtained over a period of several years. From these, cultures were obtained and rabbits inoculated in 24 cases. In six cases the guinea pig tests were negative, the material being either non-tubercular or the tubercle bacilli dead.

Twenty of the 24 cases were infected by the human type of tubercle bacillus and four by bovine type of tubercle bacillus, the percentages being 83.33% human, and 16.66% bovine. The percentage of bovine infections is lower than that recorded by many other workers.

The difficulty of obtaining tubercular material for this part of the investigation further emphasises
the low incidence of Tuberculosis in New Zealand children. That 16.66 per cent of the lesions investigated were due to the bovine tubercle bacillus is not surprising considering the prevalence of tuberculosis in cattle in New Zealand.

In cases above these ages the bovine percentage was 7.4 p.c.

Series II. All examinations in children

| Age Group | Number of Cases | Percentage
|-----------|----------------|------------
| Under 5 years | 26 | 36.57 |
| 5 to 10 | 11 | 14.74 |
| 10 to 16 | 6 | 8.16 |
| 16 to 20 | 2 | 2.71 |
| 20 to 25 | 12 | 16.21 |
| 25 to 30 | 11 | 14.74 |
| 30 to 35 | 10 | 13.51 |
| 35 to 40 | 9 | 12.35 |
| 40 to 45 | 8 | 10.81 |
| 45 to 50 | 7 | 9.46 |
| 50 to 55 | 6 | 8.16 |
| 55 to 60 | 5 | 6.79 |
| 60 to 65 | 4 | 5.41 |
| 65 to 70 | 3 | 4.05 |
| 70 to 75 | 2 | 2.71 |
| 75 to 80 | 1 | 1.35 |
| 80 to 85 | 1 | 1.35 |
| 85 to 90 | 1 | 1.35 |
| 90 to 95 | 1 | 1.35 |
| 95 to 100 | 1 | 1.35 |
ADDENDUM. Summary of work done in Great Britain up to 1917.

A. Stanley Griffith: Types of Tubercle Bacilli in Human Tuberculosis. (Journ of Tuberculosis, 1917, XI. 160. The total number of cases dealt with are 930, 735 being infected with human bacilli, 169 with bovine, five with a mixture of the two, and 21 with atypical bacilli. The cases are grouped in ten series, and include a complete summary of the work done in Great Britain by investigators using similar methods of investigation to those employed by the Royal Commission.

Series I. Cases actually examined by the Commission.

Under 5 years: 35 cases; 19 human; 14 bovine; 2 a mixture. Bovine infection: 45. 46. 71 per cent.

5 to 10. 11 cases. 8 human; 3 bovine. Bovine p.c. 27. 27 per cent.

10 to 16. 6 cases. All human
In cases above these ages the bovine percentage was 7.4 p.c.

Series II. P.M. Examinations in Children.


5 to 12. 52 cases; 45 human; 5 bovine; 1 mixed; 1 atypical. Bovine p.c. 11.53 p.c.

12 to 16. 113 cases; 93 human; 19 bovine; 1 mixed; 1 atypical. Bovine p.c. 16.81. p.c.
Series III. Examination of Sputum.

6 cases. All human.

Series IV. Bone and Joint Tuberculosis.

Under 5 years: 84 cases; 57 human; 25 bovine; 4 atypical. Bovine p.c. 29.75 p.c.

5 to 10. 167 cases; 121 human; 42 bovine; 4 atypical. Bovine p.c. 25.15 p.c.

10 to 16. 89 cases; 76 human; 8 bovine; 5 atypical. Bovine p.c. 8.96 p.c.

Series V. Genito-Urinary Tuberculosis.

10 to 16. 2 cases. Human.

Series VI. Cervical Gland Tuberculosis.

Under 5 years: 14 cases; 2 human; 12 bovine. Bovine p.c. 85.7 p.c.

5 to 10. 29 cases; 10 human; 19 bovine. Bovine percentage 65.51 p.c.

10 to 16. 22 cases; 13 human; 8 bovine; 1 atypical; Bovine p.c. 36.36 p.c.

Miscellaneous Cases.

Under 5 years: 2 cases; 1 human; 1 bovine.

5 to 10. 6 cases; 5 human; 1 bovine.

10 to 16. 2 cases; both human.

Cases of Lupus investigated for the Commission.

Under 5 years: 11 cases; 4 human (1 standard Virulence, 3 attenuated); 7 bovine (2 standard Virulence, 5 attenuated); bovine p.c. 63.6 p.c.

5 to 10. 19 cases. 9 human (2 standard Viru-
ience, 7 attenuated); 10 bovine (2 standard virulence, 8 attenuated); Bovine p.c. 52.6 p.c.

10 to 16. 6 cases; 3 human (attenuated); 3 bovine (attenuated); bovine p.c. 50 p.c.

All the atypical bacilli found in varieties of human tuberculosis other than lupus more closely resembled the human than the bovine type, whilst 50 per cent. of the atypical strains from lupus fell within the bovine group. The highest percentage of bovine was in cervical gland tuberculosis and in that of the intestines.

Of cases in children under 10, investigated by the Local Government Board, in which evidence pointed clearly to alimentary infection, 14 of 19 cases (74 p.c.) were due to the bovine bacillus.

Rothe published the results of the examination in 100 cases of the bronchial and mesenteric glands in children dying from any cause. (Children under 5 years). In 21 cases he found tuberculosis, 20 (95.24 p.c.) being human, and 1 (4.76) bovine. In the latter case there was swelling of the mesenteric glands, considered non-tuberculous macroscopically. On inoculation one of four guinea-pigs became tuberculous.

The writer gives a Table showing the percentage incidence of bovine infection.
Children 5 to 16. Pulmonary Tuberculosis; bovine infection 0.0 p.c.

Abdominal Tuberculosis: " 46 p.c.
Tubercul. Mening. with or without Gen. Tuber. 0.0 p.c.

Children under 5.

Pulmonary Tuberculosis: " 4.1 p.c.
Tuberculous Cervical Adenitis: " 58 p.c.
Abdominal Tuberculosis: " 59 p.c.
Generalised Tuberculosis: " 23 p.c.
Tubercul. Mening with or without gen. Lesions: 13.6 p.c.
Tuberculosis of Bones & Joints: 0.0 p.c.

In regard to the cultures from lupus 20 cases were examined, but in only one bovine and two human cases were they of typical virulence. They were tested by inoculation into calves, rabbits, monkeys and guinea-pigs, and in a few of them it was found possible to raise a markedly diminished virulence to a typical degree.

They were quite unable to produce any modification of type by passage experiments and other methods, and conclude that, while they are inclined to regard transformation as exceptional in the laboratory, in view of certain instances, in which they obtained both types of bacillus from the same body, they are not prepared to deny that it may possibly occur naturally.
References

2. " " " " loc. cit. " 1917 pp.56-59
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