A SURVEY OF DENTAL CARIES

IN

THE ROYAL AUSTRALIAN NAVY
"A copy of this letter to be sent by road to Eng.

Send re ordered to the care of Mr. G. Jones

[Signature]

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SECTION II

The Analysis of the Diet of the R.A.N.

Part I. The Calcium content of the Cereals.
Part II. The Calcium content of the Fruits.
Part III. The Acid/Base balance of the Diet.

SECTION III

Investigation of the Incidence of Dental Caries.

Part I. Contrasting the incidence of caries between the Australian and English born of 14 years of age in H.M.A.S. "Tangara".
Part II. In Australian and English born ratings of 18 years in H.M.A.S. "Longan" and at Flinders Naval Depot.
Part III. In ratings of 20 years in H.M.A.S. "Canberra" and H.M.S. "Cumberland".
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Part V. Variation in incidence of Caries in relation to the birthplace of Australian born recruits.
Part VI. The influence of age of entry into Australia on English born recruits.
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Scurvy-Calcium in relation to Dental Caries.

SECTION IV

A resume of some of the literature discussing diet in relation to Dental Caries.
INTRODUCTION.

As a Dental Officer in the Royal Australian Navy I have in the course of my duties in the examination of recruits and in the systematic periodic surveys incidental to the care of their teeth, been appalled not only by the poor condition of those presenting for enlistment, but by the progressive deterioration of their teeth during subsequent service in the Royal Australian Navy.

Groups of Naval Ratings appeared to be in a number of ways singularly suitable material for the study of the development of Dental Caries, and for the analysis of factors that might conceivably have some etiological bearing upon it. Of possible factors, the consistancy of the dietary conditions offered attraction for study, especially with regard to the adequacy of the diet in Calcium and in certain particulars affecting Ca Metabolism. Accurate chemical analyses were accordingly made.

Observations on the incidence of caries in these recruits have been carried out during the past ten years, the original study being made in H.M.A.S. "Tingira" in 1927-1928. The second group were examined in H.M.A.S. "Penguin" in 1932-1933. Recently H.M.S. "Sussex" of the Royal Navy has been stationed in Australian waters whilst H.M.A.S. "Australia" has been on exchange in the Mediterranean. and I have been able to collect additional data for this comparison. During the past three years at Flinders Naval Depot, Victoria, where all recruits for the Royal Australian Navy are trained, the study has been continued and data has been collected using both the molar index and also the total percentage of carious teeth. For the purpose of studying the cause of the development of dental caries, the original index chosen was the condition
of the first and second molar, firstly because there is rarely any abnormality in either the eruption or development of these teeth, secondly because there is rarely any loss or damage due to violence, and thirdly because of the age of the ratings on whom these observations were first made.

Amongst the personnel of the Royal Australian Navy are a number of men who were born in England, having left their homeland at ages ranging from infancy to manhood, and have ultimately joined this Service, and during the course of these observations a striking difference in the incidence of caries, between the English and Australian born ratings was disclosed. This stimulated enquiry into the Serum-Calcium level of comparable groups and careful determinations were made on the blood-Serum of 25 English born and 25 Australian born of a similar age. More recently in an endeavour to correlate other factors the enquiry has been extended. A comparison of palatal measurements has been undertaken and a closer enquiry into the parentage and period of residence of parents and recruits in Australia in the hope of finding it possible to make an assessment of the influence of inheritance and home environment. The results of these investigations are set out in the following text. In each section relevant writing on the subject treated receive reference or commentary, and the significance of the evidence submitted is discussed. Where possible the evidence has been mathematically tested. In Section 4 a more extensive and general discussion of diet in relation to the development of dental caries is undertaken and summarised. In the appendix appears.

(a) Illustrations of palatal types met with in the course of this investigation and of the instrument devised by the author for their accurate measurement.
(b) Details of the method used for the Ca. analysis.

(c) Details of the general mess menus of the R.N. Ships and the Royal Australian Navy (Shore Depot).

An index of references is appended on each page.
CHAPTER I.

The Analysis of the Diet of the S.A.I.L.
Kegellum has stated that it is reasonable to consider that a limited number of the 37 elements required for normal metabolism may be intimately connected with the normal nutrition of the teeth, and a lack of one or more might predispose to caries. Calcium is obviously an important element for investigation as it constitutes 85 per cent of the tooth substance.

The factors of Ca-Metabolism are briefly that the calcium is derived chiefly from milk, green vegetables, animal tissues, and blood and is absorbed in the small intestine. The absorption only occurs in an acid medium as when the Hydrogen ion concentration is reduced to pH7, the calcium is precipitated as insoluble triphosphate or carbonate and excreted in the faeces. In any case in normal circumstances no additional calcium is retained unless the serum-Ca level is below normal limits. The calcium-phosphorus ratio, protein consumption in the dietary, Vitamin (D) and the acid-base balance all react on the metabolism of calcium.

The calcium requirements of individuals vary considerably and are affected by certain pathogenic conditions which are casually considered in this essay, as we are dealing with men who have been subjected to a screening medical examination before joining, which is repeated at regular intervals during their service career. In estimating the calcium intake two sources of supply have to be considered.

1. The drinking water.
2. The food in the dietary.

(1) Kegellum E.V. and Simmonds - Food Nutrition and Health 2nd Ed. 1931.
SECTION I.

PART I.

THE CALCIUM CONTENT OF DRINKING WATER IN RELATION TO DENTAL CARIES.
Whilst investigating the total calcium intake, the water supply necessarily comes under review in order that any calcium from this source may be ascertained.

From the following results it will be seen that the intake from the drinking water in Australia is negligible as only infinitesimal quantities of this element are supplied, but in England the amounts of calcium obtained from this source may be of importance.

Whilst examining the boys serving in H.M.A.S. "Tingira" it was noticed that boys born in different States showed a variation in the number of molars attacked by caries. As most of these boys were enlisted from Sydney and Melbourne it was decided to compare the calcium content of the drinking water of these two cities and then to contrast these figures with those given for the drinking water of various parts of England, to ascertain if there was any relationship between the calcium content of water and the incidence of caries.

As the "Tingira" was stationed in Rose Bay, Sydney, the water supplied was the normal Sydney water, and all ships of the R.A.N. take in water wherever possible, as the capacity of the storage tanks in the cruisers is only 170 tons and as about 70 tons of water is used daily, the evaporators are working most times the ships are at sea producing distilled water.

In industrial work a hard water is a disadvantage, consequently the city water is usually soft. The catchment areas in Australia are situated in sandstone country and the supply of calcium from Australian water is almost negligible.
The Chemical analysis of the Sydney water by Walton showed that the probable calcium content was \(0.00058\) per cent. of Calcium Sulphate \((\text{CaSO}_4)\) with slight traces of Calcium Phosphate and Calcium Carbonate. This calcium content is slowly diminishing and according to the author of this analysis, a much lower reading would be given at the present time.

A corresponding analysis of the Melbourne water supply gives the figure for Calcium Sulphate as \(0.00068\) per cent.

There is a slight difference in the calcium content of the two water supplies analysed but a marked difference is observed when they are compared with the English water supplies.

The average of the calcium contents of the water supplies at Chatham, Dartford, Portsmouth and Devonport, from whence most boys join the Royal Navy, is \(0.02325\) per cent. Dartford supply with \(0.03205\) per cent. shows the highest figure (\(0.02715\)\% of Calcium Carbonate, \(0.0019\%\) Calcium Sulphate and \(0.003\%\) Calcium Chloride).

Other water supplies from limestone districts in the south of England give a very great calcium content, ranging from Dover with \(0.024\%\) to Portsmouth with \(0.0135\%\) and even the water supplies in sandstone counties have a much greater lime content than the urban water supplies of Australia.

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(2) Melbourne & Metropolitan Board of Works Report 1928.
(3) Tresh & Beale - Examination of Water and Water Supplies pp. 399, 400, 451.
<table>
<thead>
<tr>
<th>City</th>
<th>Calcium in Water Supply</th>
<th>Percentage of Affected Molars at 14 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>.00058</td>
<td>50</td>
</tr>
<tr>
<td>Melbourne</td>
<td>.00068</td>
<td>45</td>
</tr>
<tr>
<td>English Naval Ports</td>
<td>.02225</td>
<td>18</td>
</tr>
</tbody>
</table>

The correlation of dental caries to drinking water was first noted by Cook, who claimed that in urban districts he found an inverse relation between dental caries and the lime content of drinking water. In a later work, Cook states that, in urban districts, the harder the water the better the teeth and also that there appears to be an association between excessive softness of water and an increase in dental caries. He does not regard this as necessarily indicating cause and effect.

We also find that Höss, in his examination of certain groups of people born in Sweden, maintains that the Gothlanders, although there was ample lime in the water, had the worst teeth in Sweden and attributes their dental condition to the consumption of soft sour black bread and sugar. He also found in rural parts of Baden and Thuringa, where the water was soft, that 95 per cent. of the children had caries whereas, in places where the water was hard, only 81 per cent. were affected. Walter, in his records on patients examines at Stilli, in Aargau, found that 18 per cent. of the

(4) Cook J.B. B.D.J. 1916 Vol. 26 p. 411
(5) Höss B.D.J. 1903 Vol. 26 p. 119
(6) Walter B.D.J. 1922 Vol. 33 p. 677
teeth were carious, with a hard drinking water, while in Augsburg with a soft water, the percentage of caries was twice as large.

Water is of course only one of the sources of Calcium and unless the accurate amount of drinking water imbibed with its contained hardness is known, observations and conclusions are liable to error, consequently no definite comparison can be made unless all the conditions are known and no conclusions can be drawn that the calcium content of drinking water alone is responsible for the difference in dental caries.

The data obtainable is inconclusive so that the apparent correlation cannot be regarded as significant however suggestive it may seem.

As a source of Ca the water supply cannot be ignored, but there is no satisfactory evidence that it plays an important direct role in the incidence of caries.

An an indicator of the availability of Calcium in the food supply of any one district, it may be of value as where the Ca. is abundant in the water, it is likely to be abundant in the food. Where it is low in concentration in the water, the content of the food is also liable to be low.

Only where the Calcium supply of the food is near the margin of physiological requirement is a high content in the water likely to be of direct significance. It is a conjunction which is possibly infrequent and of which no investigated instance is known to the writer.

In the case of Australian Naval conditions the Ca supply from water sources is negligible. As we shall see the Calcium supply from the food, even in the large amounts provided for consumption affords little if any margin above a level which may be regarded as critical.
SECTION 1.

PART II.

The Calcium content of the food.
We have observed that the calcium intake from Australian water supplies, is so small that it can have little or no effect on the total available calcium intake. We now present an investigation of the calcium content of the food.

The foodstuffs analysed were supplied by Naval contractors to the H.M.A.S. "Penguin" at Sydney, N.S.W. and presumably were produced and grown in and around Sydney. However in these days of swift transport it cannot be certain that foodstuffs supplied in one State are products of that State, and presumably there are variations in the calcium content of foodstuffs from different districts, but so far no figures are available except for Sydney, N.S.W. as the result of Hansman and Wilson's work.

Since the above was written an investigation into the mineral content of certain Queensland foodstuffs has been made by Professor D.H.K. Lee.

Differences were found between certain districts, but were not very great, and there was no evidence that there was a general deficiency in the mineral content of Queensland foods.

The Dietary of the Royal Australian Navy is standardised, varying somewhat though probably not importantly for our investigation with the cost of the commodities.

Although the ages of the ratings vary considerably, no additional or variation is made in the foodstuffs

available for recruits. It is noteworthy that recruits joining the depot at ages from 16 to 20 years, during their first period of training increase in height and weight, more especially weight to a marked degree.

During this first six months calcium must be withdrawn from the body stores to maintain the serum calcium at its normal level if adequate calcium is not made available and assimilated. It has been found that the incidence of caries increases during this period in most ratings, and this may be of considerable significance during a period of growth and readjustment.

The Australian Naval rating has set times for his meals and consumes large quantities of food as seen from the appended weekly menu. The main substances of his diet are meat, potatoes, bread, butter, tea with sugar and a small quantity of milk, and it will be seen that the calcium intake from these commodities will be less than the amount required for correct body metabolism unless great quantities of food are consumed.

To estimate the supply of Calcium available to ratings in the R.A.N., it was decided to analyse:

(a) The common articles of food supplied to the Australian Naval rating, in order to estimate the calcium content.

(b) The daily rations, in order to estimate the total daily calcium intake.

1. Appendix C.
(a) These analyses were carried out at Garden Island Sydney using foodstuffs as supplied by the Service, and the method adopted was that of Associated American Agricultural Chemists. The following table gives the author's analyses of the calcium contents of the Australian foodstuffs, expressed in percentage of total weight, and compares them with the best accredited American figures.

**TABLE No. 2.**

**CALCIUM CONTENT OF FOODSTUFFS.**

<table>
<thead>
<tr>
<th>Royal Australian</th>
<th>American (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>0.109</td>
</tr>
<tr>
<td>Bread</td>
<td>0.025</td>
</tr>
<tr>
<td>Butter</td>
<td>0.013</td>
</tr>
<tr>
<td>Meat</td>
<td>0.012</td>
</tr>
<tr>
<td>Sugar</td>
<td>nil</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0.047</td>
</tr>
<tr>
<td>Potatoes</td>
<td>0.008</td>
</tr>
<tr>
<td>Fish</td>
<td>0.024</td>
</tr>
</tbody>
</table>

*cooked in batter*

It will be seen that the writer's figures are slightly below the accepted American figures for the various foodstuffs, but they do not vary sufficiently to be of any significance.

(b) In the estimation of the daily calcium intake, the daily food allowance and all accessories were collected and carefully mixed and minced until a homogeneous mass was obtained.

(1) Appendix (B).

(2) Sherman H.G. - Chemistry of Food and Nutrition—3rd Edit. 1928
Duplicate samples of the mess were then analysed to test the uniformity of the mixing and were found to give similar readings so that the figures represent a fair sample. As the total weight of the food and also the weight of the sample were known the total calcium intake could be determined.

The daily calcium intake was found to average .91 gm. and the caloric value of the food to be over 4,000.

The following table shows the total weight and the calcium content of the normal weekly menu for a Royal Australian Navy depot. (See appendix C.)

**Table No. 3**

**Calcium Content of Weekly Menu.**

<table>
<thead>
<tr>
<th></th>
<th>Total Weight</th>
<th>Total Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>2601.2 gms</td>
<td>1.03009 gms</td>
</tr>
<tr>
<td>Monday</td>
<td>2243.6 &quot;</td>
<td>.9107 &quot;</td>
</tr>
<tr>
<td>Tuesday</td>
<td>2499.2 &quot;</td>
<td>.8074 &quot;</td>
</tr>
<tr>
<td>Wednesday</td>
<td>2658.0 &quot;</td>
<td>.91732 &quot;</td>
</tr>
<tr>
<td>Thursday</td>
<td>2527.6 &quot;</td>
<td>.8167 &quot;</td>
</tr>
<tr>
<td>Friday</td>
<td>2714.8 &quot;</td>
<td>.9054 &quot;</td>
</tr>
<tr>
<td>Saturday</td>
<td>2556.0 &quot;</td>
<td>1.0051 &quot;</td>
</tr>
</tbody>
</table>

Average daily intake of calcium .91 gm.

There are however several considerations which must modify our view of the adequacy of such a figure.

Great difficulty is experienced in obtaining correct figures for the daily calcium intake when dealing even with such a community as the R.A.N. ratings under observation owing to the diversities and irregularities introduced into the diet, caused by the consumption of cakes, pies and confectionery between meals.
In my experiments to obtain the daily calcium intake, all the foodstuffs allowed by scale per man were obtained together with all the accessories. It is however extremely doubtful whether the full amount is ever consumed by any individual, and consequently the daily calcium intake would probably be less than 0.91 gm.\(^{(1)}\)

A wastage survey carried out by C.N.C. on nutrition has shown that the food wastage from the table was 8.7 per cent, in a University College, where the daily average calorific intake was 3,000, this percentage being the weight of food returned from the Table compared with the weight of the food prepared for the meals.

The wastage from the table of an institution was also determined and although there was a greater daily calorific intake, viz. 3,796 the wastage was less, be ng 4.8 per cent.

From my own observations in the Navy quite an amount of food is wasted and it would be very reasonable to accept the larger percentage as representing the wastage from messing in the Royal Australian Navy.

This brings the daily intake to 0.831 gm, which is at the lower limit of maintenance requirements and leaves no margin for the possible demands of an active period of growth.\(^{(2)}\)

Sherman maintains 0.45 gm of calcium is the minimum amount required for a 2,500 calorie diet but Apperman is in favour of a much greater daily intake giving 1.0 gm as the correct figure for metabolism, others give intermediate figures.\(^{(3)}\)

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\(^{(2)}\) Sherman H.C., Chemistry of Food and Nutrition - 3rd Edn. 1928.

\(^{(3)}\) Apperman - Pental Cosmos, Sept. 1932.
While there is some divergence of opinion regarding the accepted necessary daily intake of calcium, the figure .91 gm. from the analyses made, falls at a level normally taken to be just sufficient for normal calcium metabolism.

Consequently for the diet to be beyond reproach it would appear that an increase in the daily intake of calcium to more than 1 gm. would prove beneficial, especially during the developmental period of the body and the teeth, "as it is better to exceed rather than meet the requirements for normal metabolism." (1).

Moreover there are other factors of importance to be considered, and when this average daily intake is reviewed in conjunction with the acid/base imbalance of the diet and the protein consumption, the adequacy of the intake is even more doubtful.

In the following part of Section i. the analysis of the food supplied to the Royal Navy and the Royal Australian Navy with regard to the acid/base balance is dealt with.

SECTION 1.

PART 3.

ANALYSES OF FOOD SUPPLIED TO THE ROYAL NAVY AND ROYAL AUSTRALIAN NAVY WITH REGARD TO THE ACID-BASE BALANCE.
Acidity of the saliva cannot itself play any part in the disintegration of the enamel of the teeth, but when suitable protection is found under mucous plaques the acidity of the saliva may easily increase to pH5, at which figure disintegration takes place. 

(1) Bunting et alii have found that the teeth are far less affected by caries when the foodstuffs are not acid forming.

An acid-base imbalance has been suggested as one of the factors in the incidence of caries by (2) Jones, who stated that active caries was always associated with a diet which contained an excess of acid over base elements and Kugelmann is of the opinion that the incidence of caries is low when the diet is of a strongly base forming character.

Consequently, it was decided to calculate the acid-base balance of the diets of the Royal Navy and Royal Australian Navy, using Sherman and Getler's figures and it will be seen from the following table that the daily and weekly diets of the latter are most definitely acid. As the weekly menus do not vary appreciably throughout the year, this excess of acidic radicals will be maintained throughout the rating's service career.

(2) Jones, N.R. - Dental Cosmos May 1930, pp. 439, 480.
(3) Kugelmann, I.V. and King, T.B. Arch Pediat 1933, 50 pp. 301-322.
### ACID-BASE BALANCE OF THE ROYAL NAVY AND ROYAL AUSTRALIAN NAVY DIETS (USING SHERMAN AND GILDER'S FIGURES).

#### Excess of Acid or Base in Terms of Normal Solution per Quantity in Diet.

<table>
<thead>
<tr>
<th>Foodstuff</th>
<th>Grammes in Diet</th>
<th>Acid</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal</td>
<td>113.6</td>
<td>3.67</td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>369.2</td>
<td>454.4</td>
<td>40.61</td>
</tr>
<tr>
<td>Potatoes</td>
<td>568</td>
<td>340.8</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>227.2</td>
<td>12.96</td>
<td></td>
</tr>
<tr>
<td>Bread (Flour)</td>
<td>340.8</td>
<td>454.4</td>
<td>22.28</td>
</tr>
<tr>
<td>Peas</td>
<td>113.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato</td>
<td>56.3</td>
<td>28.4</td>
<td>2.19</td>
</tr>
<tr>
<td>Lettuce</td>
<td>56.3</td>
<td>28.4</td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td>42.8</td>
<td></td>
<td>2.54</td>
</tr>
<tr>
<td>Currants</td>
<td>42.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egg</td>
<td>56.8</td>
<td>113.6</td>
<td>6.3</td>
</tr>
<tr>
<td>Butter</td>
<td>56.8</td>
<td>56.8</td>
<td>0.28</td>
</tr>
<tr>
<td>Sugar</td>
<td>142.0</td>
<td>142.0</td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td>28.4</td>
<td>28.4</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>284</td>
<td>284</td>
<td>6.73</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2166.8</strong></td>
<td><strong>2172.6</strong></td>
<td><strong>73.14</strong></td>
</tr>
</tbody>
</table>

#### Weekly Menu

<table>
<thead>
<tr>
<th>Foodstuff</th>
<th>Grammes in Diet</th>
<th>Acid</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>98</td>
<td>131</td>
<td>333.98</td>
</tr>
<tr>
<td>Potatoes</td>
<td>116</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>Flour</td>
<td>95</td>
<td>104</td>
<td>149.45</td>
</tr>
<tr>
<td>Vegetables</td>
<td>22</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Sugar</td>
<td>35</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>14</td>
<td>14</td>
<td>1.96</td>
</tr>
<tr>
<td>Milk</td>
<td>70</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Jam</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>454</strong></td>
<td><strong>537</strong></td>
<td><strong>485.39</strong></td>
</tr>
</tbody>
</table>

*/% Vegetable and Fruits have both been calculated separately but have been grouped together in Table.*

/ Average of three sets of figures.
In calculating the daily and weekly acid-base balance of the foodstuffs in the dietary of the Royal Australian Navy, a shore establishment menu was selected which contained more than the usual amounts of basic elements, as it included salads, which are rarely present in the diet at sea.

It will be seen from the Table that the Royal Australian Navy diet contains even more acidic radicles than the Royal Navy diet, owing to the greater amount of meat consumed.

Since this acid preponderance in the diet of the Royal Australian Navy may possibly be one of the causes of the high incidence of caries in the Australian born rating, more especially during their developmental period, the writer has suggested that the menus now supplied be balanced, a relatively simple adjustment, in order that this continuous excess of acid radicles may be corrected.
SECTION II.

Investigation of the incidence of Dental Caries.
In relation to the general incidence of dental caries in any community, the adequacy and balance of the essential constituents of the diet is clearly an important matter to determine.

In the first instance, the high incidence of caries and the steady progressive deterioration of the teeth of the ratings in the R.A.N. presented itself as a general problem, which had possibly a general solution and was open to investigation of the following type.

All ratings in the R.A.N. have the same dietary and when the records which accumulated were carefully examined, it was found that there was a striking and remarkably constant difference to be observed between the incidence and rate of development of dental caries in English born and Australian born.

Clearly the incidence found on examination on enlistment could not be attributed to any influence of Naval dietary, but when it was established in the course of time that the difference was maintained in the rate at which dental caries developed under identical conditions in the two groups, the problem assumed a different aspect.

The following section gives the results of observations on the incidence and development of caries, contrasting the Australian and English born.

In this section, whenever the word "Cavity" is used, it is to describe a tooth affected by caries to an extent that an explorer will be admitted, and the phrase additional "Cavities" means the appearance of dental caries in a different tooth, or in a tooth previously affected by caries but not contiguous with the former cavity or restoration.
In these records all teeth that have been restored have been classed as carious, allowance being made for teeth damaged by accident.

In the Service root fillings in multi-rooted teeth are not attempted, and it is the practice to extract such teeth when the pulp becomes involved.

Hence a tooth is classed as "Irreparable" when it is involved by caries to such an extent that the pulp has become infected.
SECTION III.

PART I.

Original study made in H.M.A.S. "Tingira".
Until the year 1928 H.M.A.S. "Tingira" anchored in Rose Bay, Sydney, was the boys' training ship of the Royal Australian Navy. The boys undergoing training were between the ages of 14 and 16 years and in most cases came from good working class families. They were boys of good physique and before entry had been subjected to a searching medical examination. As Dental Officer of this ship during the years 1926-1927 I kept records of the condition of the first and second molars of 133 boys who were under training during that period. Of these boys 30 were born in England the remaining 103 in Australia.

The difference of birth place apparently reflected in the difference of oral condition was remarkable as the oral picture of the English born boys presented a full complement of twenty-eight teeth, practically no caries and a broad dental arch with a flat palate, the teeth giving correct centric and eccentric occlusion, whereas no Australian born boy of Australian parentage, had any immunity to caries. The palatal arches in comparison provided a similar contrast in variation from wide and flat to high vaulted and narrow.

On examination of the first and second molars of the Australian born boys I was amazed to find that 78 per cent. of the first molars were affected by caries, 22 per cent. had been extracted before joining the Navy, 29% were carious and 27 per cent. were found to be irreparable. The second molar owing to its position and to the ratings' ages, did not prove to be involved to the same extent, as only 44 per cent. needed attention, and but 5 per cent.
of the total were irreparable. The upper second molar was not so frequently attacked as the lower, due possibly to the proximity of the maxillary duct and consequent cleansing action of the saliva, an observation which incidentally supports Pickrell’s Theory of the protective agency of saliva.

TABLE No. 5

PERCENTAGE OF MOLARS AFFECTED AT 14 YEARS.

113 Boys AUSTRALIAN BORN

<table>
<thead>
<tr>
<th>Irreparable</th>
<th>Carious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Upper Right</td>
<td>45%</td>
</tr>
<tr>
<td>Upper Left</td>
<td>44%</td>
</tr>
<tr>
<td>Lower Right</td>
<td>54%</td>
</tr>
<tr>
<td>Lower Left</td>
<td>54%</td>
</tr>
<tr>
<td>Average</td>
<td>49%</td>
</tr>
</tbody>
</table>

Average percentage of molars affected - 61%

Therefore 39% of molars sound.

A contrast to the percentage of affected molars of the Australian born boys was shown by the 30 English born ratings who had but 18 per cent. of their molars affected. The first molar was lost in 7 per cent. of cases and 11 per cent. were carious. There was no case however of the loss of the second molar although 19 per cent. of them were carious. In most cases the caries was of the pin point variety and the teeth were filled as a prophylactic measure. Nevertheless, these teeth have been included in the table as teeth attacked by caries. These boys had arrived in Australia at ages ranging from 2 years

(1) Pickrell - Prevention of Dental Caries, Chapter 12.
to 12 years and from later observations there appears to be an association between the number of years of residence in Australia and the incidence of caries. It has been found that if the arrival in Australia was after the developmental period of the teeth, the incidence of caries was lessened even if the arrival in Australia was in the first year of life they did not suffer from Dental Caries to the same extent as the Australian born.

TABLE No. 6

30 BOYS O/C OF MOLARS AFFECTED AT 14 YEARS OF AGE - ENGLISH BORN OF ENGLISH PARENTS.

<table>
<thead>
<tr>
<th>Irreparable</th>
<th>Carious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Upper</td>
<td>6%</td>
</tr>
<tr>
<td>Lower</td>
<td>8%</td>
</tr>
<tr>
<td>Average</td>
<td>7%</td>
</tr>
</tbody>
</table>

Average percentage of Molars affected - 18%
72% sound Molars.

PART 11.

Observations made in H.M.A.S. *Penguin* and at Flinders Naval depot.

In the year 1928 the system of recruiting for the Royal Australian Navy was altered and direct entries at ages from 17 years onwards were substituted for entries at 14 years. Subsequent data has been collected from examinations of 350 accepted recruits in the years 1928 to 1933 and of 1750 during the years
1936-1938. During the years 1934-35 the writer was serving at sea in H.M.A.S. "Canberra."

Although a high physical standard is necessary for entry into the Royal Australian Navy, yet a low standard of dental fitness is allowable. This is emphasised by the following extract from the Recruiting instructions which show that only 14 teeth are required. This minimum was decided upon owing to the difficulty experienced in obtaining recruits with a higher standard of dental fitness.

"The condition of the candidate's teeth is most important, and very great care is to be exercised in examining and reporting on them. The minimum number of sound teeth for dental fitness is -

<table>
<thead>
<tr>
<th>Teeth</th>
<th>Minimum Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Occluding Incisors</td>
<td>i.e. 6 in all</td>
</tr>
<tr>
<td>2 Occluding Premolars</td>
<td>i.e. 4 in all</td>
</tr>
<tr>
<td>2 Occluding Molars</td>
<td>i.e. 4 in all</td>
</tr>
</tbody>
</table>

Credit may be given for the third molar when the tooth is well developed and there is good occlusion in the dental arch. Now when recruits are urgently needed owing to the rapid expansion of the Navy, even this low dental standard has been waived in order to enter sufficient recruits.

A record kept using the molar teeth as a standard of comparison of 350 Australian born recruits of 18 years of age shows in Table 7 that 88 per cent. of the first molars were affected by caries, 68 per cent. being lost or irreparable, the second molar being affected in 64 per cent. of cases, again the fact that upper molars were less affected than the lower was in evidence.

It will be seen when the percentages are compared at 14 and 18 years that the first molar at 14 years was
affected in 78 per cent. of cases and at 18 years the percentage was 88 per cent. an increase of 10 per cent. although it is to be noted the figures have been collected from different groups. The percentage of affected second molars increased from 44 per cent. to 64 per cent. during the 4 years. This can readily be understood as the teeth had only erupted at the age of 12 years and consequently had been liable to show caries for only 2 years when the original study was made.

**TABLE No. 7**

**PERCENTAGE OF MOLARS AFFECTED AT 18 YEARS**

350 RECRUITS AUSTRALIAN BORN

<table>
<thead>
<tr>
<th></th>
<th>Irreparable</th>
<th>Carious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Upper</td>
<td>62%</td>
<td>15%</td>
</tr>
<tr>
<td>Lower</td>
<td>74%</td>
<td>17%</td>
</tr>
<tr>
<td>Average</td>
<td>68%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Total percentage of affected molars - 76%
Therefore percentage of sound molars - 24%

A later batch of 700 recruits show very similar figures as seen from the following table.

**TABLE No. 8**

**PERCENTAGE OF MOLARS AFFECTED AT 18 YEARS**

700 RECRUITS AUSTRALIAN BORN

<table>
<thead>
<tr>
<th></th>
<th>Irreparable</th>
<th>Carious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Upper</td>
<td>42%</td>
<td>12%</td>
</tr>
<tr>
<td>Lower</td>
<td>61%</td>
<td>22%</td>
</tr>
<tr>
<td>Average</td>
<td>52%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Total percentage of affected molars - 74%
Total percentage of sound molars - 26%

In contrast to the above percentages of Australian
molars affected by caries at 16 years of age we find that the English born rating has only 35 per cent. of his molars affected. The first molar has been lost in 16 per cent. of cases and has been found to be carious in 16 per cent. of cases. The second molar was lost in 3 per cent. of cases and carious in 34 per cent. and again the majority of cavities were of the pit and fissure type.

<table>
<thead>
<tr>
<th>Table No. 2</th>
<th>PERCENTAGE OF MOLARS AFFECTED AT 18 YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90 RECRUITS ENGLISH BORN</td>
</tr>
<tr>
<td>Irreparable</td>
<td></td>
</tr>
<tr>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Average 16.3</td>
<td>3%</td>
</tr>
<tr>
<td>16.3%</td>
<td>34.5%</td>
</tr>
<tr>
<td>Carious</td>
<td></td>
</tr>
<tr>
<td>1st Molar</td>
<td>2nd Molar</td>
</tr>
<tr>
<td>Average 16.3</td>
<td>3%</td>
</tr>
<tr>
<td>16.3%</td>
<td>34.5%</td>
</tr>
</tbody>
</table>

Average percentage of molars affected = 35%
Therefore percentage of sound molars = 65%

Remarkable confirmation has been found in the results of these examinations of still more recent batches of recruits for the Royal Australian Navy. The latest batch of recruits was composed of 26 Australian born and 6 English born, 32 in all: when examined it was found that -

(a) Of the 26 Australian born:
   18 had all first molars missing
   2 had 3 first molars missing
   4 had 2 first molars missing
   1 had one first molar missing
   1 had all first molars present

(b) Of the English born:
   1 had 2 first molars missing
   2 had one first molar missing
   1 had all first molars present.

The percentages for the latter 709 Australian born recruits shows a remarkable similarity to the former 350. There has been an increase in the percentage of first molars affected by caries but a compensating drop in the percentage of first molars irreparable. This I consider is due to the
increased activities of school dentists and the improved means of transport of dental equipment. Many of these molars would have been removed but for this attention, but having been restored have carried out their normal role during the period of development of the dental arch.

These records, compiled after my observations on the teeth of boys in H.M.A.S. "Tingira" indicate that, as at fourteen years an average of 78 per cent. of first molars were affected, and at eighteen years this percentage had increased to 82 per cent. Unless the first molar is carefully watched from its eruption and if necessary, treated at an early age, there will be very few Australians reaching their majority who will possess a full dentition.

This early loss of the first molar is the forerunner of many dental infections, the ultimate result being the loss or lowered efficiency of the other teeth, due to traumatic occlusion.
PART III.

The Oral Examination of English born ratings aboard H.M.S. "Sussex" and Australian born ratings of the same ages in H.M.A.S. "Canberra".
In continuation of the comparison of the first and second molars of the English and Australian born, a batch of 61 men taken at random from young seamen and stokers on board H.M.S. "Sussex", was examined and compared with a similar group of Australian born ratings in H.M.A.S. "Canberra". These ratings were between the ages of 18 and 24 years, the average age being slightly under 20 years.

In addition to the oral examination the heights and weights were recorded and the condition of the tonsils and the configuration of the palate were also noted in collaboration with Surgeon Lieutenant Commander H. Gault R.A.N.

The difference in the incidence of caries and the number of molars that had been lost was most marked.

Although the standard of oral hygiene of the English rating was not at all good, seven men had 32 well formed teeth without any sign of caries, and in every case a broad dental arch and flat palate completed the oral picture. Of the remaining 54 men 28 had no molars missing, and again this palatal configuration was in evidence.

Of the Australian examined, no mouth showed immunity from caries and only three men had no molars missing, although a higher standard of oral hygiene was evident.

The vast majority of conservative work in the teeth of the English born ratings were amalgam fillings of the pit and fissure type. Gross decalcification was the exception, despite the fact that the services of a dental officer had not been continuously available on
board since their departure from England.

On the other hand the Australian born rating rarely had a first molar and the second molar had usually been restored, the total percentage affected being 91 per cent. in comparison with 41 per cent. of the English born.

The physical development of these two groups was similar, the average height and weight showing very little difference.

TABLE No. 10.

<table>
<thead>
<tr>
<th></th>
<th>R.H.</th>
<th>R.A.H.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number examined</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Average Age</td>
<td>19.8</td>
<td>19.4</td>
</tr>
<tr>
<td>Average Height</td>
<td>5' 7&quot;</td>
<td>5' 7&quot;</td>
</tr>
<tr>
<td>Average Weight</td>
<td>10st. 8 lbs.</td>
<td>10st. 7 lbs.</td>
</tr>
<tr>
<td>Missing 1st and 2nd Molars</td>
<td>62 or 12.7%</td>
<td>238 or 48.7%</td>
</tr>
<tr>
<td>Carious 1st and 2nd Molars</td>
<td>140 or 28.7%</td>
<td>208 or 42.6%</td>
</tr>
</tbody>
</table>

Examination of the ships' complements of over 800 men for weight and height showed only a slight difference, the English born rating averaging 10st. 8 lbs. over one pound heavier than the Australian born, there being no difference in the average height of 5 feet 7 inches.

In this examination it was noticed that whenever there was a comparative immunity from caries, the flat palate was in evidence, and in cases where caries was present a high vaulted palate was seen but no theory is advanced, but
it is hoped to analyse this difference in palatal configuration in a later essay.

The following Table summarises and compares the results of the Examinations of ratings at different ages.

**TABLE No. II**

PERCENTAGE OF 1st and 2nd MOLARS AFFECTED IN DIFFERENT AGE'S GROUPS.

<table>
<thead>
<tr>
<th>Age</th>
<th>No. Examined</th>
<th>% Missing Molars</th>
<th>% Carious Molars</th>
<th>Total % Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 14 Years</td>
<td>30 103</td>
<td>4% 27%</td>
<td>14% 34%</td>
<td>18% 61%</td>
</tr>
<tr>
<td>At 18 Years</td>
<td>90 700</td>
<td>10% 34%</td>
<td>25% 40%</td>
<td>35% 74%</td>
</tr>
<tr>
<td>At 20 Years</td>
<td>61 61</td>
<td>12% 48%</td>
<td>28% 42%</td>
<td>40% 90%</td>
</tr>
</tbody>
</table>

A significant difference has been proved statistically in each age group.

The tests of significance between two different proportions have been calculated according to suitable (2) formulae given by Yule.

The difference between two proportions has been much more than three times its own standard deviation in each case and consequently it has been considered significant.

Delineating the contrast in the Incidence of Dental Caries between English and Australian born ratings, in various age groups.

at 14 years.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Born</td>
<td>61%</td>
</tr>
<tr>
<td>English Born</td>
<td>18%</td>
</tr>
</tbody>
</table>

Significant difference proved statistically.

at 18 years.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Born</td>
<td>76%</td>
</tr>
<tr>
<td>English Born</td>
<td>35%</td>
</tr>
</tbody>
</table>

Significant difference proved Statistically.

at 20 years.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Born</td>
<td>91%</td>
</tr>
<tr>
<td>English Born</td>
<td>41%</td>
</tr>
</tbody>
</table>

Significant difference proved Statistically.
Results obtained on substitution of the percentage of all teeth attacked for the molar index.

Since collecting the foregoing data using the first and second molars as an index for comparison, additional work has been carried out, but in this work the total number of teeth attacked by caries in relation to the total number of teeth in the mouth has been substituted as previous investigators have favoured this method of comparison.

This method in my opinion is less accurate as so many mouths show irregularities predisposing to caries and also the anterior teeth are often damaged or lost by accident.

All Ratings between the ages of 17 and 20 were examined on joining Flinders Naval Depot and it was found that 354 men of Australian parentage had 4,260 of their 10,379 teeth attacked by caries or 41 per cent. whereas the 57 English men had but 159 of their 1,520 teeth affected or 10 per cent.

Owing to the amount of conservative work on hand these men were unable to be seen, except for relief of pain, during their first six months in depot, and when called up for intensive dental treatment it was found that additional cavities had formed. The 175 Australian born ratings had an additional 240 cavities and 17 English born but 5.

These additional cavities may have been potentially present at the first examination but would only have been detected by radiographic evidence as every care was taken macroscopically.
Since compiling these records an additional 1,000 ratings amongst whom were 52 English born of English parentage, have been examined and the ratios still hold.

There may appear to be some discrepancy between the percentages given using the molar teeth as an index of the incidence of caries, and the percentage given when all the teeth are taken into consideration. However, when one considers the number of teeth seldom attacked by caries, e.g. the lower incisors, and the fact that in all records on this subject the molar teeth show the highest percentages of caries, the percentages 74 per cent. using the molar index and 41 per cent. of all teeth are really of corresponding significance.

Incidentally, as a matter of interest the Ratio of Carious upper incisors to the lowers was observed and 17 per cent. of the upper incisors were affected whilst only one per cent. of the lowers had proved susceptible. The molars show greater susceptibility in the lower jaw, as 70 per cent. of upper molars and 78 per cent. of the lower molars were carious in over 1,000 examinations.

The figures for the English born show the same superficial discrepancy 35 per cent. using the molar index and 20 per cent. when all teeth are taken into consideration.

These results apparently confirm the opinion that even when living under conditions almost identical certain groups are more resistant to dental caries than others, for instance when the English born ratings develop additional cavities the proportion is much lower than the Australian rate using all teeth as an index.
e.g. 1 per cent. compared with 8 per cent. in the first six months of their Service career.

From the foregoing observations and tables contrasting the incidence in caries the bare facts suggest two possibilities.

(1) The conditions of life in England were responsible

(2) The English heredity was responsible, although this statement appears untenable as the white population of Australia is mainly of English stock.
PART IV.

Birthplace and parentage of ratings in relation to dental caries.
Further confirmation of the association of dental conditions with birthplace and parentage was found on the examination of recruits at Flinders Naval Depot under the New Conditions of Entry.

In my dental examination of Australian born recruits of Australian Parentage, over 18 years of age, I have found it most exceptional to observe even one normal first molar and the second molar is carious in nearly all cases.

I observed, however, that when a recruit with a full complement of teeth was examined, it was usually found that his birthplace was England and usually the South and a rating having but one English forebear appears, from my observation, to have better teeth than a man with both his parents Australian born. This superiority in dental condition when the forebears are English is still in evidence even to the third generation as it has been observed that ratings whose grandparents were born in England have teeth more resistant to caries than an Australian whose grandparents were Australian born.

This evidence was supported when 100 Australian born ratings possessing teeth considered to be superior, i.e. less affected by caries, to the remaining Australian born ratings at Flinders Naval Depot were interrogated. It was learnt that nearly all of them had parents, (some few only) grandparents born in England.
Whether the forebear was male or female did not appear to influence the transmission of the resistance, but when the question of this influence was subjected to analysis, it was found in the series shown in the Table below, that when the father is English born, a slightly less incidence of caries is the result, but the difference is too small to be of any significance.

The rating having both forebears English and born in England himself suffers less from caries and the Australian born of Australian parentage is affected the most.

### Table 12:

<table>
<thead>
<tr>
<th>*</th>
<th>E/E</th>
<th>E/F</th>
<th>F/E</th>
<th>F/F</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. No of teeth affected</td>
<td>6</td>
<td>8.7</td>
<td>8.9</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Range</td>
<td>0 - 22</td>
<td>3 - 16</td>
<td>0 - 22</td>
<td>2 - 20</td>
<td>2 - 28</td>
</tr>
<tr>
<td>No. of cases</td>
<td>52</td>
<td>37</td>
<td>39</td>
<td>28</td>
<td>500</td>
</tr>
<tr>
<td>Av. % of Carious Teeth</td>
<td>21%</td>
<td>31%</td>
<td>31.8%</td>
<td>35.8%</td>
<td>43.2%</td>
</tr>
</tbody>
</table>

* Individuals birthplace.

** Male parents birthplace.

** Female parents birthplace.

E = England.

A = Australia.
From this table it will be seen that there is a gradual rise in the incidence of caries beginning with the English born of English parentage up to the Australian born of Australian parentage, the percentage of affected teeth being 21 per cent. and 43 per cent. In calculating these percentages the total number of teeth affected by caries was compared with the total number of erupted teeth.

It will also be noticed that although the influence of an English father is too small to be of any significance, the influence of one English parent does appear to affect the incidence of caries, as the figures for all these occupy a half way figure between the extremes, e.g. AA with the greatest percentage 43½ and BB with the smallest 21 per cent.

It will also be noticed that Australian born mothers have at least as good a record as English mothers as far as the resistance of the teeth of their children to caries is concerned when the father is English born.

Since no records are available as to the behaviour of the deciduous teeth, we may assume from the behaviour of the permanent teeth that the maternal nutritive transmission was equally satisfactory in the two cases.
PART V.

The Incidence of Dental Caries and the birthplace of Australian born recruits.
Following on the former results, it is pertinent to discover whether any difference in the incidence of caries can be traced in recruits born in different states of the Commonwealth.

The data has been collected from recruits who have enlisted from all over the Commonwealth, and it is interesting to note that the incidence of caries varies in different states and that the Tasmanian born of Australian parentage have the greatest number of teeth affected by dental caries.

It was previously observed whilst serving in H.M.A.S. "Tingira" that the Tasmanian boys had the worst teeth, i.e. most affected by caries, but there were insufficient cases to make any comparison with boys born on the mainland.

However, owing to the expansion of the Royal Australian Navy further data has been obtained on 139 Tasmanians who have been enlisted between 1st January, 1938, and 1st May, 1939, and it has been found that 51 per cent. of their teeth were affected by caries at an average age of 18 years.

The West Australian born, of Australian parentage have the best teeth of the inhabitants of the mainland having 35 per cent. of their teeth affected by dental caries and the New South Wales and Victorian born ratings the worst with 45 per cent.

A possible explanation of this variation is that a greater number of recruits from country districts are enlisted in West and South Australia, also Queensland, whereas the majority of the Victorian and New South Wales entries are from the cities.

The State in which the parents were born has not been considered.
<table>
<thead>
<tr>
<th>Birthplace</th>
<th>W.A.</th>
<th>S.A.</th>
<th>Q’land</th>
<th>Vic.</th>
<th>N.S.W.</th>
<th>Tas.</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of affected teeth</td>
<td>35</td>
<td>36</td>
<td>42</td>
<td>45</td>
<td>45</td>
<td>51</td>
</tr>
<tr>
<td>No. of recruits examined</td>
<td>85</td>
<td>117</td>
<td>88</td>
<td>219</td>
<td>235</td>
<td>139</td>
</tr>
</tbody>
</table>
PART VI.

The influence of time of residence in Australia on English born recruits in relation to the incidence of Dental Caries.
In examining a recent group of English born ratings, the percentage of carious teeth found per man was 20%, a greater incidence than found previously, although the men were in the same age group.

This variation in the percentage of carious teeth observed in English born recruits of different groups but of the same age, appeared to be associated with the time of their arrival in Australia.

Enquiry has recently been started on this subject, by interrogating recruits at their first oral examination, and it has been found that those ratings who arrived in Australia after the age of eight years have the least incidence of caries and those arriving before that age the greatest in the English born of English parentage group.

Although it is realised that insufficient cases have as yet been tabulated to base any theory, it will be seen that ratings who have left England in infancy and up to 8 years of age suffered from dental caries to such an extent that 27% of each rating's teeth were involved. And a further division into separate year groups shows that there is apparently a slight decrease in the incidence after 6 years of age, those ratings who left England for Australia from the first year up till the 5th year of their life had an average percentage of 29% carious teeth per man.

The Ratings who had arrived after their eighth year have not been divided into age groups as so far there are insufficient cases to warrant it, but for the eleven examined in this group it was found that the average percentage of carious teeth per man numbers 17 per cent.
<table>
<thead>
<tr>
<th>Age of entry to Australia in years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>over 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cases examined</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>% of teeth affected by caries at 19 years</td>
<td>30</td>
<td>30</td>
<td>25</td>
<td>34</td>
<td>28</td>
<td>23</td>
<td>21</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>
PART VII.

Influence of Heredity on Dental Caries.
In discussing the probability of a genetic influence on the production of teeth immune to dental caries it is not possible to assess its value in this instance, for it cannot be certain that those who are unaffected were exposed to the same risks of infection as those who are.

Whether the parentage of the English born, or the nutrition of the mother pre-natally, is responsible for the resistance to caries cannot be demonstrated, nor have we sufficient evidence to confirm which of the forebears influence the transmission of the resistance.

However, from statements of ratings about their relatives, certain abnormalities, e.g. irregularities in the arch due to misplaced pre-molars and unerupted and unformed lateral incisors, would appear to be family characteristics in this series, but there are not sufficient cases or verifiable data to make satisfactory family group analysis.

This then throws us back on the supposition that some influence on the habits of the children is imposed by the fact that the parent is English - the affect of such an influence will be maximal when both parents are English and the child lived in England.

The intermediate condition shown by ratings born in Australia of English parenthood may be ascribed to a defect in essential constituents in Australian foods, or to some relaxation of English standards, imposed by Australian environment, since
for example a child is influenced especially at school age by the habits of people other than his parents.

Beyond the fact that both parents were born in England, it has not been possible to ascertain at what age they have left their homeland for Australia and consequently unless the rating himself is E.E., born in England of English parents, there is no certainty that this influence of place of birth on parental nutrition had not ceased long ago, as the length of residence in Australia, more particularly that of the mothers would be a relevant matter for enquiry.

However, the fact of having an English father is apparently enough to exercise some restraint on the development of dental caries, and this must be either through some hereditary influence or through some influence on the family dietary practices. The present enquiry does not provide data for a genetic analysis.

From the considerations mentioned, it appears highly improbable that hereditary immunity in the genetic sense operates. If that were a prominent factor it should also be appreciable in a certain proportion of Australian born. The suggestion, however, that palatal conformations are hereditarily transmitted makes parallel observations on the same populations of some interest.

As yet insufficient measurements have been collected to warrant any dogmatic statement, but such as have been made show differences that promise to be as striking as those of the Dental Caries series.
The bearing of such facts as the occlusal factors in the incidence of caries is obvious, but the point of interest lies in the etiological factors that can in one or even a few generations alter beyond recognition a feature regarded as of some significance as a racial characteristic.

Prima facie the evidence might be held to point to some element of transmission in resistance to caries, but from my own observations of palatal characteristics seems to be of the same order, and if palatal conformation is to have any validity as a racial characteristic, the comparison must be between individuals whose dietary has been comparably adequate.
PART VIII.

Palatal Conformation in relation to Dental Caries.
Immunity of the teeth to caries may be due to many factors but it is usually associated with a well formed arch and a flat palate. Consequently dental caries would appear to have, with the bony development of the face, some association which requires further examination.

Research work relating to the palatal measurements has been carried out by Shaw Brasch (1) Campbell et alii and the writer hopes in a later essay to more fully analyse measurements of the palate more especially the heights, obtained from models of the Australian born ratings from the various States and compare them with English born ratings serving in the Royal Australian Navy when sufficient cases have been obtained.

In order to measure the height and width of the palate an instrument was constructed to the design of the writer on the micrometer screw principle giving reading to 1/100 of a millimetre, and is illustrated in Appendix A.

(1) Campbell T.D. The Dentition and Palate of the Australian Aboriginal.

Shaw J. Middleton - "The Teeth, The Bony Palate and the Mandible in Bantu Races of South Africa."

Brasch J.C. - The growth of the Jaws normal and abnormal in health and disease P 67 et seq.
Dentocoll impressions were taken and stone models cast and the two measurements were taken simultaneously.

The measurements were taken between the upper six year molars at the gingival margin and the depth of the palate from the line from the neck of these teeth to the deepest part of the vault.

From the data so far collected the English born rating is found to have a wider and flatter palate than the Australian born the average being 35.4 mm width 17.64 mm height to the Australian 32.2 mm, 16.99 mm.

However until many more models have been cast and measured no theory can be advanced but there appears to be some difference in the construction of the palates.

Most prehistoric skulls had a high Dental Index (Megadont) and a low palatal index (Leptostaphyline) and caries, if not entirely absent was rare among these races if any conclusion can be made from the small number examined, but all arch measurements of the uncivilized races are far greater than those of the modern races.

Whilst on the subject of Palatal measurements it has been observed that the Australian Aborigines and the Esquimaux had the same width of palate 2¾" - 2 6/8ths", although the Esquimaux suffered less from dental caries and that these are slightly larger than the early Anglo-Saxons and Romano Britons 2¼" - 2½".
Again the Australian Aboriginal has a slightly wider arch than the Tasmanian Aboriginal and suffered less from dental caries and nowadays this difference in the incidence of Dental Caries is still maintained with their successors in occupancy, as from my observations the inhabitants of the mainland are less affected by dental caries than the Tasmanians.

SUMMARY of SECTION 11.

From the foregoing observations on the incidence of Dental Caries, and a comparison of the tables of percentages of affected teeth which have been compiled over a number of years, it has been found that -

(1) There is a significant difference between the English born and Australian born.

(2) There is a difference both in severity and rate.

(3) The parentage of the Australian born appears to affect both the rate of incidence and also the severity.

(4) The evidence of parental origin supports neither maternal transmission nor heredity as dominant factors.

(5) The difference persists in rate and severity under Royal Australian Naval conditions of diet.
SECTION III.

SERUM CALCIUM IN RELATION TO DENTAL CARIES
It was considered that in view of the marked difference between the English and Australian born ratings, a comparison of the levels of their Serum-Calcium might prove of interest, so accordingly after analysing the Calcium intake of the Royal Australian Navy Diet it was decided to estimate the Serum Calcium of some English and Australian born ratings. These men had been living on the same dietary for over six years with the exception of leave periods and their own personal purchases at canteens of foods usually eaten between meals. These two groups were of similar physique but from a dental standpoint the English born ratings were definitely superior.

The ages of these ratings were between 20 and 30 years and therefore were not undergoing any great developmental changes and all gave readings within the normal range, the method adopted being that of (1) Kramer and Tisdall.

Whilst estimating the serum calcium, a red cell count, total and differential white cell count also the haemoglobin percentage and colour index were determined but there were no deviations from the normal consequently it can be assumed from this experiment that no changes in the blood are induced by Dental Caries.

A marked difference was seen when the serum calcium of the Fesai and Aikikuyu tribes was compared. It was found that 42 cases of the Fesai, or milk and blood drinking tribe, gave an average reading of 10.3 mgms. per 100 c.c. whilst the figure for 50 cases of the Aikikuyu tribe, who have calcium low diet

(1) Kramer B; and Tisdall E.E. Jour. Bio Chem. 1921 Vol. XLIII p. 475
(2) IRC. Special Report No. 155
was 9.2 mgs. McCallum in Nigeria found the average
serum calcium of the natives to be 8.2 mgs. and
attributes this figure to a diet low in calcium.
The average serum calcium of 13 Englishmen living
in Kenya was 11.2 mgs. per 100 c.c. 11 per cent.
higher than the average English figure but no mention
is made of their calcium intake suggesting that
the above low figures for the native tribes was at
least not influenced by climatic conditions.

In cases of natives receiving extra calcium or
cod liver oil, the percentage of calcium in the serum
increased and this is said to be possible only when
the serum calcium is sub-normal.

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Examined</th>
<th>Range</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>European (Kenya)</td>
<td>13</td>
<td>10.70 to 12.50</td>
<td>11.2</td>
</tr>
<tr>
<td>English</td>
<td></td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>English born</td>
<td>25</td>
<td>9.25 to 11.25</td>
<td>10.4</td>
</tr>
<tr>
<td>in Kauai</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian born</td>
<td>25</td>
<td>7.90 to 11.84</td>
<td>9.2</td>
</tr>
<tr>
<td>in Kauai</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faso</td>
<td>42</td>
<td>7.30 to 11.00</td>
<td>10.3</td>
</tr>
<tr>
<td>Nkonyu</td>
<td>70</td>
<td>7.30 to 11.00</td>
<td>9.2</td>
</tr>
</tbody>
</table>

From these results a relationship appears to
exist between the serum calcium and the character of
the teeth, as subjects with the higher serum calcium
eg. the English and Faso, have better teeth and are
less affected by caries.

(1) C.R. Special Report No. 159
(1) Hanke, however, says there seems to be no relationship between the serum calcium and the development of caries, and M.B. Richards, in her work in Trinidad, suggests there is no direct relationship between the serum calcium and the structure of the teeth. She found that the average serum calcium for 24 healthy individuals in spite of a calcium deficiency in their diet, was 10.7 mgs. per 100 c.c. the range being from 9.5 to 12.2 mgs, and in six cases where dental caries was present, the serum calcium ranged from 7.7 to 13.5 mgs. per 100 c.c.

(2) Again Kanshaw, Krasnov and Krejci (1931) studied blood serum in relation to immunity and susceptibility to Dental Caries and found such slight differences as to consider they lacked significance.

From the data to hand from 25 English and 25 Australian born men, the English born rating has an arithmetical average serum calcium slightly higher than the Australian born. Twenty five English born ratings ranged from 11.25 mgs. to 9.25 mgs. per 100 c.c. an average of 10.4 mgs. while the same number of Australian born ratings ranged from 11.84 mgs. to 7.9 mgs. per 100 c.c. an average of 9.9 mgs.

However later this year it is hoped to determine the calcium-serum level of a class of recruits on entry, and again after a period of six months' training. During the original six months at Minders Naval Depot rapid physical development takes place and also the incidence of caries has been found to increase during this period.

(1) Hanke F.T. J.D.R. 1932, 12, p. 518-523
(2) Kanshaw G. Krasnov N. Krejci Le, Jour. Dent. Res. 11. 573 : 1931
Obviously considerable variations are at least possible and no significance can be considered to be established at this stage of research on calcium serum level and Dental Caries.
### Table No. 16

**Comparison of the Serum Calcium of 25 English and 25 Australian Born Patients**

<table>
<thead>
<tr>
<th>English Born</th>
<th>Australian Born</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.25</td>
<td>11.80</td>
</tr>
<tr>
<td>11.20</td>
<td>11.70</td>
</tr>
<tr>
<td>11.10</td>
<td>11.30</td>
</tr>
<tr>
<td>11.00</td>
<td>11.15</td>
</tr>
<tr>
<td>10.90</td>
<td>11.00</td>
</tr>
<tr>
<td>10.80</td>
<td>10.90</td>
</tr>
<tr>
<td>10.60</td>
<td>10.40</td>
</tr>
<tr>
<td>10.60</td>
<td>10.40</td>
</tr>
<tr>
<td>10.50</td>
<td>10.15</td>
</tr>
<tr>
<td>10.50</td>
<td>10.00</td>
</tr>
<tr>
<td>10.40</td>
<td>10.00</td>
</tr>
<tr>
<td>10.40</td>
<td>9.90</td>
</tr>
<tr>
<td>10.40</td>
<td>9.70</td>
</tr>
<tr>
<td>10.40</td>
<td>9.70</td>
</tr>
<tr>
<td>10.30</td>
<td>9.60</td>
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<tr>
<td>10.30</td>
<td>9.60</td>
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<tr>
<td>10.20</td>
<td>9.60</td>
</tr>
<tr>
<td>10.20</td>
<td>9.50</td>
</tr>
<tr>
<td>10.10</td>
<td>9.50</td>
</tr>
<tr>
<td>10.00</td>
<td>9.50</td>
</tr>
<tr>
<td>9.80</td>
<td>9.40</td>
</tr>
<tr>
<td>9.80</td>
<td>9.10</td>
</tr>
<tr>
<td>9.75</td>
<td>9.05</td>
</tr>
<tr>
<td>9.70</td>
<td>8.90</td>
</tr>
<tr>
<td>9.20</td>
<td>7.90</td>
</tr>
</tbody>
</table>

**Average:** 10.4

**Arithmetical Average:** 9.9
SECTION IV.

A RESUME OF SOME OF THE LITERATURE DISCUSSING RUST IN RELATION TO DENTAL CARIES.
1. **Historical References**.

2. **Causes of Dental Caries**.

3. **References to Diets with striking Characteristics**.
   (a) Inhabitants of Tristan Da Cunha.
   (b) Indians and Chinese in Malay.
   (c) Masai and Akikuyu in Africa.

4. **Discussion on the Calcium Intake**.

5. **Vitamins (C) and (D)**.

6. **Discussion of the Carbohydrate Intake**.

7. **Discussion on Inheritance**.

8. **Hygiene**.
The most satisfactory definition that the writer has found is that of G.G. Macphese who states that "Dental Caries is the progressive destruction of a living tooth, not due to attrition, abrasion or erosion, or the process of resorption."

Dental caries has been found in the earliest of skulls excavated and has affected mankind right through the ages until nowadays over 95 per cent. of individuals of civilized races are susceptible.

In our civilized communities natural selection has almost ceased and everything is done to protect the weak and unfit. Consequently we find that after a war the unfit predominate amongst the males, as the fittest members are killed off, causing a decline of the physical standard in which naturally the teeth are included.

In the primitive races we find that the savages with decayed teeth less fitted to survive in the struggle for existence because of the likelihood of being less generally fit (less well nourished) and consequently amongst savages sound teeth are the rule. Nowadays Dental Caries is so widespread that the selection of a heredity of sound teeth is no longer operative.

(2) Nunnery states that in England the most primitive Races, the Stone Age men, had the best teeth, and the most highly civilized race the Romano British the worst, and that after the departure of the Romans and the invasion by barbarous tribes the standard of luxury fell and the teeth improved. This has been substantiated by Fullerton's examination of Anglo Saxon skulls in which no Dental Caries was found.

(1) Macphese G.G. Study on Etiology of Caries p.19 Chap. II
(2) Nunnery J.R. Odmt. Society of Great Britain 1869-70 Vol II
The skulls of very ancient Egyptian show little sign of Dental Caries and later when the people lived luxuriously only in the richer classes did caries become common.

This has been proved correct by the fact that more than 500 skeletons of aristocrats of the time of the Pyramid builders, excavated by the Hearst expedition from the cemetery of the Ancient Empire at Gizeh, suffered from Dental Caries to an extent comparable with the inhabitants of Modern Europe today.

At every subsequent period in Egyptian History one finds that Dental Caries was prevalent among the wealthy people on a luxurious diet and a relative immunity from it amongst the poorer classes who lived mainly on a coarse uncooked vegetable diet.

CAUSES.

There are at least two Schools of thought on the cause and nature of Dental Caries — Firstly the Local Environment or Chemico Parasitic Theory of Miller, Black and Williams and secondly the group who maintain that the carious process begins within the tooth and is caused by defective tooth structure or some nutritional disturbance.

The exponents of the latter theory claim that by modifying the diet and improving nutrition they have reduced the incidence of caries in children but they have never had complete control nor have they agreed on the specific nature of the food deficiency causing dental caries.
Their objections to the Chaddock-Rasputic theory are briefly that no satisfactory answer is given to the effect of dental caries, or the fact that teeth occasionally cleaned not infrequently decay, and many cases with neglected youths have an immunity to caries.

Such work supposedly done on diet in relation to dental caries has been diet actually in relation to the teeth environment and regarding the saliva which is a constantly changing medium. Very few conclusions have been reached which are of any import relating to dental caries, from the innumerable studies on it and no difference has ever been demonstrated between the salivae of susceptible and immune persons.

Diets must play an important part in the formation of enamel up to the eighth year, but after it formation there is little work to show that the enamel can be affected by alteration to the diet as it has never been satisfactorily demonstrated that enamel once formed is permeable. However there is no doubt that dentine is continuously laid down whilst the tooth is vital, as before and on eruption the pulp chamber is large and during the tooth's life this contracts as more and more dentine is laid down until late in life the pulp chamber is almost obliterated.

It is generally agreed that the Bacillus acidophilus is the organism most concerned in the production of dental caries but there is a lack of uniformity as to its action. Experiments carried out lately show that the Bacillus acidophilus cannot cause dental caries per se but must be associated with a yeast.

However, from my own observations the predisposing factors must be given consideration as without these, the exciting causes, and subsequently the Bacillus acidophilus or whatever organism it may be cannot cause the disease.

In this paper I will not discuss any further the other theories regarding the etiology of dental caries but suggest that the weight of evidence supports the chemical-parasitic theory first expounded by Miller.

The calcification of the deciduous teeth commences at the seventh week of intra-uterine life, the first permanent molar at the 26th week and the last permanent teeth are completed between the ages of 16 and 21 years. Regarding the development of the teeth, according to radiographic evidence, Hess, Lewis and Roman maintain that the post-natal period is more important than the pre-natal, and that, as calcification is a post-natal phenomena and extends over many years, it is advisable to provide the child with all calcifying factors throughout the first twelve years rather than limit the effort to the period of infancy.

So far as I am aware no completely convincing evidence or crucial experiment has yet been put forward to clinch their statement. The statement regarding the need of calcium salts during the post-natal period of development of the teeth appears most reasonable. The evidence submitted in this Thesis fits with such an hypothesis and to that extent confirms it.

It is generally admitted that dental decay is a specific infectious process and occurs in 95 per cent. of

(1) Hess A.F, Lewis J.H, Roman R. - Dental Cosmos 1932 p-p. 1053, 1061
civilised people, and its activity depends on certain metabolic changes. The rate at which it progresses varies evidently according to the degree of predisposition existing in different people and, regarding the theory of predisposition to caries, Boswell states "that types of tissue cells having susceptibility, and governing mechanisms permitting poor metabolism are transmitted" and uses the Mendelian Law to explain the reason why children of the same family reared under identical conditions have such various dental conditions.

(3) In America, Bunting and his collaborators stated that certain dietary measures appear the most important method of combating dental caries. Whilst in England the Medical Research Council reported as follows:- "For practical purposes the ideal to aim at is correct feeding during pre-natal life, infancy and childhood, to encourage the production of the normal or perfect mouth in the adult; this with a continuance of a sound dietetic regime throughout life should result in a very greatly diminished incidence of dental caries in the community."

That a well-balanced diet rich in mineral elements is a cardinal factor in producing mouths free from caries is shown by the recent oral examination of the 163 inhabitants of the Island of Tristan da Cunha. This examination was carried out by Surgeon Lieutenant Commander Sampson, serving on board H.M.S. "Carlisle."

(2) Boswell - J.A.D.A. - January 1926 p. 101
(3) Bunting - J.D.R. Vol 14 p 9 1932
and revealed that, in the 4050 teeth examined, only 1.84 per cent. of caries was present and that 83.3 per cent. of this well nourished and physically fine community had immunity from caries. In this examination the splendid condition of the mouths of the inhabitants between 1 and 32 years of age was noted, and 96.87 per cent. of the mouths examined in this age group were free from caries.

Cereals cannot be grown owing to the ever increasing number of rats, so supplies of flour and sugar are obtained in small amounts at various times, but usually once a year. This is a recent innovation as previously the inhabitants did without these commodities but, according to Sampson, the younger members of the community have shown no deterioration in the condition of the teeth since the addition of small quantities of Carbohydrates to their diet. But in a later survey in 1937 an increase in dental Caries is commented on.

The staple articles of food are fish, eggs, milk, potatoes and some cabbage and turnips; this diet on analysis is better balanced and has a Ca. and P. content that is greater than that of individuals living under civilised conditions.

Nothing is said of the mineral content of the water, but milk, which contains a high percentage of calcium and Phosphorus is the common drink. All the children are breast-fed and are not weaned until the age of 12 to 15 months, then being put on to the Islanders' usual diet. This method of feeding the children, with the exception that the breast feeding was carried on until later in life, was usual with the Australian Aboriginals whose teeth were relatively immune from caries.
Regarding the oral hygiene of these people, teeth brushes are unknown, the Islanders never cleaning their teeth by any artificial means.

A very detailed survey of the mouths and teeth of the Asiatic workers in the Singapore Naval Base was carried out by Surgeon Captain Given, R.N., and Captain Coins, R.A.M.C., and a comparison made with those of the British bluejacket. These naval ratings represent a highly selected community from which men with the worst mouths are excluded, and their teeth are kept up to a high standard by repair. The Asiatic, on the other hand, has a natural standard, unselected and without the services of skilled Dental Surgeons.

84.1 per cent. of the 1000 Indians examined had no dental defects. In the group under 25 years of age, 83.8 per cent. had no dental defects, the percentage falling to 85 per cent. between the ages of 25 and 30 years.

Of 1000 Chinese examined, 69 per cent. of all ages had no dental defects, but there was a decided fall in the percentage of mouths immune from caries in the group between 25 and 30 years of age. This fall was from 77 per cent. to 66 per cent. i.e. 11 per cent. whereas the Indian percentage between these ages fell but 3 per cent.

When the British bluejackets were compared, 2.78 per cent. of the 575 ratings of all ages examined were immune to caries and had 32 well-formed teeth, the

percentage falling from 7.4 per cent. at 25 years to
1.9 per cent. at 30 years. In my examination of the
ratings in H.M.S. "Susan" 11 per cent. under 21 years of
age were immune from caries. The percentages of normal
mouths for both these groups of British ratings appear
very low in comparison with that of the Asiatic workers
but, in the writer's own experience of Australian born
naval ratings of Australian parentage only two men out
of over 7,000 examined had 32 teeth unaffected by caries.

During the examination of the Asiatic workers
other interesting features came to light, one being the
marked superiority of the Indian's oral hygiene. His
teeth are far more regular than those of the Chinese.
The method adopted by the Indian to cleanse the mouth
and polish the teeth is the use of a ringer plus a little
wood ash, followed by a rinse with water provided it is
from a running stream. On the other hand the Chinaman
uses a toothbrush but is not so proud of his teeth as
the Indian although, when he can afford to, he buys
ornamentations of gold to crown or fill his otherwise
perfect teeth, and so predisposes his mouth to dental
maladies.

These workers retain primitive dietetic habits which
appear to be a factor in combating dental caries.

Regarding the diet of the Indian, it consists of
tea and milk, half and half, at 6.30 a.m. and 4 p.m., at
11.30 and 7.30 rice, curry and vegetables, with a little
egg, meat or fish are eaten. An examination of the
mouths of the children of these workers, however, showed
an enormous increase in the incidence of caries, as 73
per cent. of the Indian and 96 per cent. of the Chinese
children were suffering from caries. There can be little doubt that this increase in the younger generation must be ascribed to the difference in diet from that of their forebears and their new environment introduced by contact with Western civilisation. Recently compiled figures in the Malay States show that wherever the population is most dense so the percentage of caries is at its highest and dental decay appears to be following Western civilisation.

That milk can affect nutrition to a marked degree is well known, and further evidence is shown by the following table compiled while serving in H.H.A.S. "Tingira". During the course of their training the boys invariably became taller and increased their weight and chest measurement to a marked degree. Any boy not showing the usual increase in weight had an additional pint of milk added to his rations. The milk was taken one half pint after breakfast at 8.45 a.m. and the other half pint at 3.45 p.m. This table records the increases after two months.

<table>
<thead>
<tr>
<th>Table No. 17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
</tr>
<tr>
<td>1. 133 lbs.</td>
</tr>
<tr>
<td>2. 119½ &quot;</td>
</tr>
<tr>
<td>3. 108 &quot;</td>
</tr>
<tr>
<td>4. 113 &quot;</td>
</tr>
<tr>
<td>5. 112 &quot;</td>
</tr>
<tr>
<td>6. 113½ &quot;</td>
</tr>
<tr>
<td>7. 102 &quot;</td>
</tr>
<tr>
<td>8. 134 &quot;</td>
</tr>
<tr>
<td>9. 121½ &quot;</td>
</tr>
<tr>
<td>10. 98 &quot;</td>
</tr>
<tr>
<td>11. 109½ &quot;</td>
</tr>
</tbody>
</table>

The exception (Case No.11) on medical examination
proved to be suffering from Pulmonary Tuberculosis.

As this was an uncontrolled experiment, no
significance can be attached to the increase but
(1) Turbott et alii have carried out controlled experiments
and the efficiency of milk in increasing both height
and weight over limited periods has been demonstrated
satisfactorily.

An experiment, carried out in New Zealand by
(1) Turbott and Howland, on a group of Maori school
children using a second group as a control, showed that
the 93 children receiving an extra half pint or pint
of milk each per day, increased their weight by 2.5
times and their height by twice, when compared with
the increase of the children in the controlled group,
who had no additional milk.

The experiment carried out in England by
(2) Grr showed that, over a limited period, the addition
of milk to the ordinary diet of children resulted in a
20 per cent. increase in weight and height over children
not receiving milk. It also suggests that for this
increase the solids of milk are more important than the
fat.

It cannot be suggested, however, that there was
any improvement in the teeth of the "Tingira" boys due
to this additional supply of calcium, as no such evidence
can be submitted, but it is suggested that if the
additional calcium had not been available at this period
of development of teeth and bones the boys might have
suffered from dental caries to an even greater extent.

The details of the work carried out in Kenya on
the two types of natives met with there, who have a

Vol. 31 pp 109, 111.
(2) Grr J.B. Lancet 1928 Vol. 1 p 202
(3) N.C. No. 155
Special Report
great difference in diet give an indication of the affect of a low calcium daily intake. The tribe Akikuyu, who subsist on a diet high in carbohydrates and low in calcium, present marked differences in comparison to the Masai, who have a diet high in protein, fat and calcium.

The Masai are much bigger and better developed physically and do not suffer from nearly the same number of disabilities as the Akikuyu. Dental caries and the associated dental diseases are almost negligible, whereas the Akikuyu tribe suffer quite appreciably. The females of the tribe who have a much higher calcium intake obtained by eating certain green leaves, show far fewer dental defects and are far better specimens physically.

<table>
<thead>
<tr>
<th></th>
<th>Masai</th>
<th>Akikuyu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries</td>
<td>1.6%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Female</td>
<td>3.6%</td>
<td>13.1%</td>
</tr>
<tr>
<td>All dental defects 8.3%</td>
<td>7.3%</td>
<td>40%</td>
</tr>
</tbody>
</table>

The females of the Akikuyu tribe highly prize the red millet as an article of food for its special medicinal properties. Its chemical composition is markedly different from the ordinary millet as it contains on an average 14 times as much calcium and 16 times as much manganese. They have a much better balanced diet than the males due to the addition of leaves and salt substitutes, which also contain large amounts of calcium and soda.

The male Akikuyu normally obtains 28 gm. of calcium daily and the female 46 gm. but by the addition of leaves, some of which give the highest calcium content ever recorded in any natural foodstuff, the daily intake of the female is raised to 1.86 gm. but even this extra
intake of calcium does not bring them within the limits of the Masai calcium intake which is 2.94 gms. for males and 2.03 gms. for females daily.

The primitive diets discussed appear to be better balanced, have a smaller protein and carbohydrate intake together with a higher mineral content, in contrast to those consumed by modern civilised races and according to Sherman the ordinary mixed diet of Americans and Europeans, at least among dwellers in cities and towns, is probably more often deficient in calcium than in any other chemical element and maintains that at least .45 gms. daily for correct calcium metabolism together with the proportionate amount of Phosphorus and Vitamin "D". McCallum says that any diet is better containing more calcium in actual percentage of element than it does of Phosphorus, and the American diet does not do so unless the calcium rich foods are abundantly supplied.

Vitamin (D) and Vitamin (C) must also come under review owing to their relationship to both Dental Caries and the absorption of the calcium salts.

Vitamin (C) has been shown to have a relationship to the structure of dentine, as when a condition of sub-scurvy is caused, due to the lack of this particular vitamin the odontoblasts are partly degenerated, and consequently an irregular formation of dentine results.

In severe cases of scurvy the odontoblasts are completely degenerated no new dentine being laid down.

Vitamin (D) appears to have the property of promoting the absorption of Calcium from the bowel, as

(1) Sherman H.C. Chemistry of Food & Nutrition p 308
(2) McCallum E.W.D.J.A. March 1933 p 188
When there is an absence of this substance, adequate absorption does not take place and the calcium level of the serum falls.

The bones are thus supplied with blood deficient in the mineral constituents so essential for complete ossification, resulting in soft and irregular bone formation.

(1) Experiments on dogs proved that the factors which regulate the calcification of bone are concerned with the development of the teeth and when Vitamin (D) was deficient in the diet the teeth were poorly calcified.

(2) Apperan states that 1 gm. of calcium oxide, together with Vitamin "D", is necessary for adults for maintenance, and a greater requirement for children to avoid decalcification of the teeth. As Stitt says there does not seem to be any objection to an excessive intake of calcium it would appear better to exceed rather than to meet the requirements, especially in the case of children.

In my experience, the Australian consumes meat and bread in large quantities, and drinks tea with a very small amount of milk frequently during the day. It is probable consequently that his daily intake of calcium is at a low level.

(3) Bunting et alii, on the other hand proved that the teeth of children may be free from caries when the calcium content of the diet had been decidedly below


a high intake of iron. The experiments of Agnew, Agnew and Tisdall, suggested that the amount of calcium in the diet apparently had no influence on dental caries.

Hansman and Marshall concluded that in general calcium deficiency is not of aetiological importance in dental caries, as there is ample evidence that children on an average mixed diet of adequate caloric value cannot have a deficiency of calcium or of phosphorus of a degree that would determine hypoplasia of the enamel of any significance. We are however far from complete understanding of the interplay of the factors that determine the possible minimum of calcium intake.

A diet abundantly supplied with calcium might benefit the future Australian dentition by increasing the margin of safety and lessen the tremendous incidence of caries, as sunlight to activate the vitamin "D" is certainly plentiful and it is considered that the present Australian diet which has a very high protein intake is probably deficient in calcium.

Despite opinions to the contrary, there appears to be some evidence in favour of a high intake of calcium as it has been seen that in some circumstances certain people, with a low intake of calcium, suffer far more from dental maladies than those with a diet richer in calcium.

Whether calcium therapy has any internal effect on the enamel of an erupted tooth is questionable but if there is any such action it must be through the pulp, Dentinal tubules and to the enamel if any such a circulation exists.

However an action probably does occur during a period of rapid growth, and the proverbial recognition of the association of caries and pregnancy must have some foundation as the clinical observation would not appear to be in doubt, and the serum calcium has been found to

(1) Agnew, Agnew and Tisdall, J.A.P.A. 1933 vol. 20 P 193
be lower during this time, e.g. 9.1 mgms - 10.2 mgms.

Consequently if Calcium therapy has any effect in diminishing the incidence of dental caries, and the writer holds that opinion, it must be dependent on the effect of calcium salts arriving via the pulp to the dentine.

There is no evidence that a circulation exists, or that human enamel is significantly permeable in either direction. (Permeability of the enamel has been demonstrated however in the teeth of dogs and pigs by Fish). Hence a nutritional control via the saliva is highly improbable.

Dentine however has such a circulation and is probably subject to a maintenance metabolism.

Consequently any protective effect of calcium therapy must be dependent on the effect of calcium salts arriving via the pulp, providing the odontoblasts with sufficient calcium to oppose any deleterious agency operating through the enamel, by the deposition of secondary dentine.

After the tooth’s eruption its principal physiological function commences, i.e. the gradual slow recession of the pulp by replacement dentine laid down by the odontoblasts. According to Fish it is possible, for certain substances introduced into the general circulation to appear in the dentine which has already been formed, as in normal dentine all the tubules are in direct fluid communication with the pulp, and therefore within the pale of nutrition through the general circulation of the body.

(1) Hunter Donald. Lancet April 26 1930.
(2) Fish E.W. An Experimental Investigation of Enamel Dentine and the Dental Pulp p 31. 1933
By experiments, he showed that apparently solid particles can be carried down the tissue fluid between the Fibril and the wall of the Tubule, which fluid is possibly secreted by the odontoblast.

Can the dentine once laid down be changed in calcium content? Apparently so, for Fish finds that the Calcium content of the dentine in human teeth increases appreciably with age, and is remarkably stable between the ages of 30 and 45 years. This would naturally be expected as it is rarely that any great changes are taking place at this period and dental caries is rarely prevalent at this age.

He, however, finds that at the age of 60 years the calcium content of human dentine is lower than at the age of 45 but greater than at the age of 14 years.

Consequently it must be assumed that the normal human dentine has had additions of calcium up till the age of 45 years and had calcium removed from it until the age of 60 at which stage the pulp chamber has become so restricted as to be almost obliterated.

No data can be gathered from his tables relative to the calcium content of human dentine from the ages of 14 to 18 years when from the writer's experience the greatest growth is taking place and it would be most illuminating to know whether the normal gradual increase in calcium he postulates takes place, at this period.

In my opinion in many cases this increase would not be found in Australian born individuals at this period, in fact I would expect a decrease in the calcium content of the dentine, as I have observed that the

(1) Fish F. Wilfred. An Experimental Investigation of Enamel Dentine and the Dental Rulp. p. 31 1933

(2) * * * * * * * pp. 38, 39, 40 1933
boys making the most rapid growth present teeth which offer hardly any resistance to dental caries. In other words once the carious lesion has penetrated the enamel to the junction of the dentine, the odontoblasts have either been killed outright or fail to react, and hence in either the case no barrier of newly formed dentine to the carious process is formed, and any secondary dentine is laid down in the pulp.

Consequently almost all cavities in young growing Australian males are extensive, a finding which is in keeping with such an hypothesis.

As it has been seen that the calcium content of human dentine does decrease with age, is it not reasonable to suggest that a decrease would occur during a period of rapid growth, if calcium were not supplied in a sufficiency.

Since it has been shown by feeding calcium only to a normal individual that a hypercalcaemia will not be caused and the excess calcium is excreted and also that if increased amounts of available calcium are fed to individuals suffering from Hypocalcaemia a normal balance will be restored it would appear better to have too much rather than too little calcium in the diet.

Apparently no comparison of English born with Australian born in relation to caries has been published but Wilkins in his general comparison of New Zealand and Birmingham mouths, finds that the inhabitants of Birmingham, England, in groups up to the age of 22 years are less affected by caries than the inhabitants of New Zealand.
His studies were carried out on groups which, though not precisely coinciding, were sufficiently approximate for a general comparison.

He found, in the age group 12 to 14 years, that of the 744 examined in Birmingham 181, or 24.3 per cent. had perfect teeth, yet an examination of 645 New Zealanders only 4 or .6 per cent. were free from caries. In the group 14 to 22 years, of 351 examined 64, or 18 per cent. of the inhabitants of Birmingham had perfect teeth yet only one New Zealander showed complete immunity from caries, although 344 were examined.

<table>
<thead>
<tr>
<th>Age</th>
<th>No. Examined</th>
<th>% of Perfect Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 - 14</td>
<td>Birmingham</td>
<td>744</td>
</tr>
<tr>
<td></td>
<td>New Zealand</td>
<td>645</td>
</tr>
<tr>
<td>14 - 22</td>
<td>Birmingham</td>
<td>351</td>
</tr>
<tr>
<td></td>
<td>New Zealand</td>
<td>344</td>
</tr>
</tbody>
</table>

The ratio of perfect teeth in the age group 12 to 14 years was 40.5 to 1 in favour of the English born and in the groups from 14 to 22 years the figures are even more favourable, the ratio being 60 to 1. In contrasting the number of infected teeth between the New Zealand and Birmingham children, Wilkins found that in the group 12 to 14 years of age 3.7 times as many New Zealand children were affected.

This figure shows a similarity to the writer's figure contrasting English born with Australian born as the ratio of affected molars at the age of 14 in Australian born ratings was 61 per cent. to 18 per cent. or 3.4 times the number in the English born.

(1) Wilkins. Extract Annual Report to Chief M.O. Board of Education 1927.
Discussing the various reasons for this dissimilarity in the amount of infection by caries, Wilkins regards the rapid growth of the New Zealanders as causing some nutritional deficiency, as from his observations the Colonial is heavier and taller for his age than the English born. He maintains that the New Zealanders, although receiving a dietary far superior in dairy produce and meat foods, are more addicted to eating between meals and probably have a greater consumption of sugar and confectionery.

In my observations, however, I find very little difference between the physiques of the Australian and English born serving in the Navy. Whether the English dietary is at all inferior is a debatable point.

Undoubtedly the Australian rating eats far more between meals and consumes far more meat and confectionery, this latter fact being well shown by the difference in sales of confectionery in the canteens of H.M.A.S. "Canberra" and H.M.S. "Sussex". The resulting increase in the intake of carbohydrates and the consumption of far more acid forming foodstuffs are the main differences in diet of the personnel of these ships, where a significant difference in the incidence of caries, in favour of "Sussex" has been proved.

The incidence of caries in relation to the intake of fermentable carbohydrates has been pointed out by many workers and it has been shown that the races with the teeth least affected by caries are small carbohydrate eaters.

The increased consumption of sugars and starches in relation to the increase in the incidence of caries has

(1) Wilkins - Extract Annual Report to Chief M.O. Board of Education 1927.
been shown by Waugh in his examination of the different tribes of Eskimos: the less these foodstuffs were eaten the less the incidence of caries. Bunting has also been able to induce active caries in children relatively immune by adding sugar to their diet, and these results have been supported by Rodriguez.

In support of these contentions we find the results of an examination of 600 Johannesburg, South Africa, school children only 6.6 per cent. of whom had sound teeth, the remaining children having one or more carious teeth. However, the average of four different orphanages in this district showed that 37.5 per cent. of their children had sound teeth and from these figures Shaw and Friel inferred that this was due to the fact that the diet was different, the school children having much richer and more irregular meals.

In all researches on the problem of dental caries it has been found that the inhabitants of the large towns suffer far more from caries than the people who live in the country, and those who live practically cut off from civilization. In my own observations the Australian country lad has better teeth less affected by caries than the recruit from the city. From the foregoing data, it appears that the diet consumed by the primitive races is an important factor influencing the low incidence of caries. It will be noticed that they are almost immune from caries whilst existing on their natural diet, but when associated with Western civilisation they, and their children, form new dietary habits and become amongst other things, sweet eaters, and the latter then suffer from caries to a marked degree.

(2) Rodriguez.
(3) Shaw and Friel - B.D.J. 1932 No. 7 pp 309, 320
This fact perhaps is due in part to the change from hard to soft food which does not need such vigorous mastication and which according to the popular theory causes stagnation and consequent acid production which may be the exciting cause laying the tooth open for an attack by the actual specific cause, whatever it may be, and so cause dental caries. Also the Westernised races are far greater meat eaters and this excess of acidic radicles may be an added reason for the difference in the incidence of caries.

This increase in consumption of meat, fermentable carbohydrates, and the habit of eating between meals may be factors determining the difference of the incidence of caries between the English and Australian born in the Royal Australian Navy, but it has been observed that, even when an Englishman comes to Australia at an early age and develops the sweet eating habit and also the habit of eating between meals, e.g. some at least of the English born ratings in the Royal Australian Navy, he does not suffer from caries to the same degree as the Australian born. His resistance is already established and the influence of change of conditions at an early age is shown by the fact that the Englishman who arrives in Australia after the development of his teeth - 8 years of age suffer less from caries than those who arrive at an earlier age.

This immunity may be confirmed by some physical factor, which may influence the incidence of caries, such as well and regular formed teeth and shallow fissures in the occlusal surfaces of the molars, or to chemical factors such as the composition of the saliva or the stability of the calcium salts in the teeth themselves.
Undoubtedly certain familiar characteristics such as the prognathism of the Royal House of Hapsburg, have a hereditary factor concerned in transmission, so also are certain types of teeth, as reported by Moody and Montgomery (1934).

There is much conflicting evidence regarding the beneficial effect of oral hygiene in preventing dental caries.

Certain peoples, who take more care in cleansing their teeth (e.g. the Indians) suffer far less from caries than those who are not so particular (e.g. the Chinese). Yet, on the other hand, the inhabitants of Tristan da Cunha, who never use a toothbrush, are practically immune from caries. Again, the English born rating does not give as much care to the cleanliness of his teeth as the Australian born and yet suffers far less from caries.

The salient features a pearing in the foregoing discussion of the literature on the relationship of diet to dental caries, are as follows:

(1) The primitive races possessed teeth less affected by dental caries when compared with the modern races, and amongst the primitive races the more luxurious the diet the greater the incidence of caries, whereas the poorer classes living on coarse uncooked food had a relative immunity to dental caries.

(2) An increase in the incidence of caries has been observed since the addition of sugar to the diet of the inhabitants of Tristan da Cunha.

(3) The children of the above islanders are weaned very late in life when compared with modern standards of civilization, and have teeth relatively free from caries.

(4) No definite proof is available that any one of the vitamins have a caries preventative property, although there is some evidence that vitamin (B), which is always present in the diet of the Indian worker and rarely in that of the Chinese workers in the Malay States has this property as there is a considerable difference in the incidence of dental caries between these two races.

(5) Vitamin (D) is abundantly supplied to the inhabitants of Australia owing to the greater number of hours of sunshine, yet the teeth of the English are far less affected by dental caries although fewer hours of sunshine are available.

(6) Vitamin (C) and (D) are essential for the development of the teeth, but there is no evidence to prove that either have the property of preventing dental caries.
(7) The African tribe with a high daily intake of calcium have teeth far less affected by caries than those whose diet is of a low daily intake.

(8) The females of this latter tribe have teeth less affected by caries than the males, as additional calcium is always available for their diet.

(9) Despite some evidence to the contrary an increase in the calcium intake throughout infancy and adolescence of the Australian born, especially during the developmental period of the teeth is suggested to develop teeth with a greater resistance to caries.

(10) There appears to be some evidence that an immunity to dental caries is passed on by the parents and this is to be ascribed to the physical factors and dietetic habits, rather than to genetic influences.

(11) There is overwhelming evidence that a high carbohydrate intake has a bearing on the incidence of dental caries.

(12) The influence of oral hygiene on the incidence of caries is a debatable point, but obviously certain races owing to their diet and the perfection of their occlusion have less need for mechanical cleansing of their teeth than to others.
SUMMARY

A survey of the incidence of caries of the ratings serving in the Royal Australian Navy has been made, and the diet investigated.

The difference in the incidence of caries between the Australian and English born has been analysed statistically and found to be significant.

The investigation using the molar teeth as an index was divided into three age groups (i) 14 years, (ii) 16 years and (iii) 20 years. We find that at 14 years of age the Australian born has 61 per cent of his first and second molars involved whereas the English born has 18 per cent; at 18 years of age the percentage has increased to 76 per cent, compared with 35 per cent, and at twenty years of age 91 per cent, as compared to 41 per cent.

A comparison using the total number of carious teeth also showed a significant difference, the percentages being 40 and 20.

There is evidence of a transmission of resistance to dental caries, the Australian born of English parents having teeth less susceptible than the Australian born of Australian parentage. The manner of the transmission is almost certainly indirect.

There appears to be some evidence that the lack of calcium in the drinking water is associated with the incidence of caries but no significance can be attached to this relationship.

An association between the serum-calcium level and the incidence of caries appears to be indicated but again no significance can be attached. There appears to be no changes in the blood induced by Dental Caries.
The diet allowed to ratings in the Royal Australian Navy possibly has sufficient calcium for normal metabolism if the full allowances are consumed, and the other factors of utilization are present. It is however at the lower level of maintenance requirements and leaves no margin for the probable demands of an active period of growth. Moreover, it contains an excess of acidic radicles and this may possibly be a factor causing the greater incidence of caries found in Australian born ratings.

Certain races have an immunity to dental caries whilst on a natural diet of a high calcium content, and these people are able to consume an appreciable amount of Carbohydrate and acid forming foodstuffs yet do not suffer from Dental Caries to the same extent as those without a natural or inborn resistance.

The Australian born naval rating consumes more fermentable carbohydrates, especially between meals, than the English born rating in the Royal Australian Navy.

An abundant supply of calcium prenatally and up to middle age would possibly result in the normal calcification of the Dentine through the action of the pulp provided a due proportion of Phosphorus, Vitamin C and D are available, and result in a lessened incidence of active caries in the Australian community.
CONCLUSIONS.

THAT:

(1) The clinically striking and persistent difference in the incidence of caries between the English and Australian-born ratings in the R.A.N. is statistically significant.

(2) Of the causes of the difference, emphasis must be placed on:
   (a) Changes in dietetic habits and dietary composition.
   (b) The Ca-content of the R.A.N. dietary leaves little margin for safety.
   (c) The acid radical preponderance is a possible factor of instability.
   (d) The insufficiency of the margin of safety may be accentuated at periods of active growth.
   (e) Deficiencies in the early developmental stages affect the later incidence and severity of caries.
   (f) Parental influence and a reduced margin of safety probably operate indirectly and not genetically.
The appended photographs, reduced thirteen one-hundredths of an inch, of models of mouths having an immunity to Dental Caries, appears to demonstrate the theory that the broad square arch with a flat but capacious palate is conductive to or causal of such a condition.

The photographs are arranged according to the development of the arch, and it will be noticed that there is a change from the square or English type to the triangular type which predominates in the Australian born.

Nos. 1 and 2 are the models of the arches of two English born ratings who arrived in Australia at 8 and 12 years of age respectively. The first being 23 years of age and the second 18 years. Both arches are square and broad and a capacious palate is in evidence. The other models are of Australian born ratings from the various States of the Commonwealth, with the exception of Queensland as so far no rating from that part has had an immunity to caries, whereas there is one of a Tasmanian born youth which is most surprising as the teeth of the Islanders are the most susceptible to caries.

The Australians from whom the models were taken have Australian born parents but English grandparents, with the exception of the Victorian whose paternal grandfather was Dutch, the other forebears being Australian born.
APPENDIX "B".

Method used for estimating the Calcium content of foodstuffs.
A sample of food to be analysed is carefully weighed in a platinum dish, the weight of the dish having been previously ascertained; during the weighing procedure all moisture was excluded by using a precision balance in an airtight cabinet. After the weight of the dish and sample is found, the dish is removed with tongs and placed in a desiccator and then removed to a muffled furnace until only a white ash remains. The ash is dissolved in dilute HCl (1 - 4) and transferred to a beaker or evaporating dish. Evaporate to dryness and heat on a water bath for 1 hour to render any silica insoluble. The residue is then moistened with 4 to 10 c.c. of strong Hydrochloric acid and 50 c.c. water added, then heated for a few minutes on a water bath and filtered, using a hardened filter paper and then thoroughly washed. Ferric Chloride Solution is then added, more than sufficient to combine with the Phosphoric Acid. Dilute the filtrate and washings to 200 c.c., add a few drops of Methyl Orange Indicator and make slightly alkaline with dilute Ammonium Hydroxide (1 - 4). Add dilute Hydrochloric Acid (1 - 4) until solution is slightly acid. Add 10 c.c. of a 2.5 per cent. Oxalic Acid Solution. Boil the mixture and add, with constant stirring, 15 c.c. of a saturated solution Ammonium Oxalate. Continue to heat until the precipitate becomes granular. Cool - add, with constant stirring, 8 c.c. of a 20 per cent. Sodium Acetate Solution and allow to stand for 12 hours. Filter and wash with hot water until free from Chlorides.

Break the point of the filter with a stirring rod and wash the precipitate into a beaker with hot water. Add 10 c.c. dilute Sulphuric Acid (1 - 1), heat nearly to boiling Titrate with 0.1 N Pot. Permang. Finally add the filter to the solution and complete the titration.
APPENDIX "C"
<table>
<thead>
<tr>
<th>Day and Date</th>
<th>Breakfast</th>
<th>Dinner</th>
<th>Tea</th>
<th>Supper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>Coffee (1 oz) Scrambled Eggs (1 per) and Toast</td>
<td>Roast Pork (9 oz) Apple Sauce Green per diem Roast (1 lb) Baked Bread Potatoes (1/2 lb) Butter Plum Pudding (1 lb) and Sauce</td>
<td>Cold Roast Beef (7 ozs)</td>
<td>Beef (7 ozs) Salads Tinned Fruit and Custard (1 tin to 4 men)</td>
</tr>
<tr>
<td>Monday</td>
<td>Grilled Steak (7 ozs) and Tomatoes (2 ozs)</td>
<td>Roast Beef (7 ozs) Brand Yorkshire Pudding Butter Baked Pumpkin (1/2 lb) Jam (1 oz) Baked Potatoes per diem (1/2 lb) Apricots and Custard (5 ozs)</td>
<td>Frys and Bacon</td>
<td>Rice Pudding</td>
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<tr>
<td>Tuesday</td>
<td>Fried Eggs (2 per and Bacon (3 ozs)</td>
<td>Steak and Kidney (7 ozs) Pie Cabbage (1 lb) Baked Potatoes (1/2 lb) Apricots and Custard (5 ozs)</td>
<td>Cold Roast Beef (7 ozs)</td>
<td>Beef (7 ozs) Salads Macaroni Pudding (2 ozs)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Mutton Chops (1 per) and Mash (1/2 lb)</td>
<td>Sea Supp. Corned Rinds (7 ozs) Trifle (1/6 per)</td>
<td>Rissoles (6 oz) Sausage Potatoes, Currant Fritter</td>
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<tr>
<td>Thursday</td>
<td>Sausages (2 per) and Mash (1/2 lb)</td>
<td>Roast Veal (9 ozs) Seasoning, Cabbage (1/2 lb) Baked Potatoes (1/2 lb) Ginger Satement and Sauce (1/2 lb)</td>
<td>Sausages and Mash (2 per &amp; 1 lb) Apple Dumplings &amp; Custard</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>Fried Fish &amp; Chips (1 lb per)</td>
<td>Roast Mutton (9 ozs) Mint Sauce, Cabbage, Baked Potatoes (1 lb)</td>
<td>Steak and Egg (7 ozs) (1 per) Tapioca Custard (2 ozs)</td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>Mixed Grill, 1 Sausage 1 Bacon Rasher 1 Sheep's Kidney</td>
<td>Cold Roast Beef</td>
<td>Pork Chop (1 per) and Mash (1/2 lb) Peaches &amp; Custard (2 ozs)</td>
<td></td>
</tr>
</tbody>
</table>

Milk - 1/8 pint per. The above scale is the allowance for one man.
<table>
<thead>
<tr>
<th>Day and Date</th>
<th>Breakfast</th>
<th>Dinner</th>
<th>Tea</th>
<th>Supper</th>
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<tbody>
<tr>
<td>Monday</td>
<td>Porridge</td>
<td>Gravy Soup</td>
<td>Heat or Fish</td>
<td>Soup Eggs &amp; Chips</td>
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<tr>
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<td>Fried Pork Sausages</td>
<td>Roast Beef</td>
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<td>Potatoes, Cabbage,</td>
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<td>Currant Roll &amp; Sauce</td>
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<td>Tuesday</td>
<td>Rolls</td>
<td>Vegetable Soup</td>
<td>Jam or Marmalade</td>
<td>Steak and Chips</td>
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<td></td>
<td>Bacon &amp; Tomatoes</td>
<td>Beef Pie, Potatoes,</td>
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<td></td>
<td></td>
<td>Cauliflower</td>
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<td>Macaroni Pudding</td>
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<td>Wednesday(a) Boiled Eggs</td>
<td>Tomato Soup, Roast</td>
<td>Coconut Soup</td>
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<td>Fish Cakes</td>
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<tr>
<td></td>
<td>(b) Fried Eggs</td>
<td>Shoulder of Mutton</td>
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<td></td>
<td></td>
<td>Mint Sauce, Roast</td>
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<td>Potatoes, Turnips</td>
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<td>Fruit and Custard</td>
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<td>Thursday</td>
<td>Cold Ham</td>
<td>PEa Soup, Fried</td>
<td>Jam or Marmalade</td>
<td>Mutton Chops &amp; Potatoes</td>
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<td>Steak and Onions</td>
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<td>Potatoes, Cabbage</td>
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<td>Custard Tart</td>
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<td>Friday (a) Fried Eggs</td>
<td>Gravy Soup, Roast</td>
<td>Syrup</td>
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<td>(b) Boiled Eggs</td>
<td>Pork and Apple</td>
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<td></td>
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<td>Sauce, Potatoes</td>
<td>Potatoes</td>
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<td>Leronips, Marmalade</td>
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<td></td>
<td></td>
<td>Roll</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>Liver and Bacon</td>
<td>Vegetable Soup</td>
<td>Jam or Marmalade, Cheese</td>
<td>Pickles</td>
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<td></td>
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<td>Hashed Beef, Potatoes,</td>
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<td></td>
<td></td>
<td>Haricot Beans</td>
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<tr>
<td></td>
<td></td>
<td>Black Currant and</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Apple Pie, Custard</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Sauce</td>
<td></td>
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<tr>
<td>Sunday</td>
<td>Rolls</td>
<td>Tomato Soup, Roast</td>
<td>Cake</td>
<td>Cold Rounds of</td>
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<tr>
<td></td>
<td>Bacon and Eggs</td>
<td>Veal and Stuffing</td>
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<td>Beef, Beetroot</td>
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<tr>
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<td>Roast Potatoes, Green</td>
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<td>&amp; Onion Salad</td>
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<tr>
<td></td>
<td></td>
<td>Peas, Fruit and</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Custard</td>
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