Owing to recent revelations with regard to tinned food in America much unrest has naturally prevailed, and the desire to ensure the provision of pure food has very greatly increased. The latest figures have shown that in 1906 the total meat produce exported from the United States will amount to £39,210,000, of which Great Britain takes no less than 90 per cent.¹

During the war in South Africa, rather more than half of the whole amount of tinned food supplied to the troops came from the United States.

In the army at home, during peace time, comparatively very little tinned foods are used, but a certain amount of tinned provisions are sold in the canteens, a considerable proportion of which are consumed by women and children. It is during campaigns and in our Colonies, particularly South Africa, that for various reasons the need for tinned provisions to supplement fresh food is essential.

At the close of the late war in South Africa large quantities of tinned provisions were condemned as unfit for issue, and, undoubtedly, very rightly. Unfortunately, in tinned foods, there can never be any certainty that the animals from which the meat was obtained were healthy,² and hence the necessity that the manufacture of these goods should be controlled, and that the premises should always be open to inspection.

From my own observations in South Africa the deterioration of what was really a small part of the enormous quantities necessary to such a large campaign was almost entirely due to exposure to climate, sun and rain, combined with a too lengthened period of keeping before issue. This was unavoidable. It was impossible to keep tinned foods in such quantities under efficient cover in the open veldt, and even in large towns the difficulties were great.

In 1903 several cases of ptomaine poisoning occurred among the troops stationed at Pretoria, all in about one week, and we traced them conclusively to certain tinned hams. On this being reported, the General Officer Commanding at once ordered a Board on all

¹ Daily Telegraph, June 23rd, 1906.
² Osterag.
The Inspection of Tinned Foods

the tinned provisions that were in the Command. To ensure no unnecessary loss to the Government—I advised that at least 10 per cent. of the whole stock should be examined and opened, and it is fairly certain that if 10 per cent. are found bad there is no doubt about the remainder, which can be safely condemned. This, at least, was our experience. It involves considerable labour, and at the Board in question we found it absolutely necessary to condemn about 330,000 tins, some of which were so putrid as to be practically unapproachable on opening; others were more dangerous in being only slightly deteriorated and therefore more liable to be consumed unawares. No further cases of ptomaine poisoning followed, and as the tins condemned were all tins which had survived the war, and were mostly over three years old, the probability is strong that the meat in the first instance was not the offender. The tinned rations issued to the troops in the field were, from the great demand, never kept for any great time, and hence, actually in the field, there were few complaints of deterioration of rations or disease resulting therefrom.

The importance of careful and complete inspections of these supplies to the Army cannot be over-estimated. The danger to the consumer of deteriorated food is a very real one, and is very frequently not detected until a case of ptomaine or metallic poisoning draws attention to its presence. The cause is then sought for, the supply discontinued or destroyed when traced, and the danger ceases. All this means time, and possibly a considerable loss to the Government. To obviate this, frequent inspections, at least every six months, of the whole supply of tinned food should be insisted upon, and large supplies, except in the case of war supplies, should never be maintained. The danger of large supplies, although unavoidable, was well shown during the late war in South Africa, when it was found necessary to condemn in the last year of the war many thousands of tins. This was in a great part due to the immense supplies which were necessary to such a large campaign. In many cases, owing to want of space, necessity of concentrating the stores, and economy of labour, tinned provisions were arranged in high stacks. As more supplies arrived they were added to the existing stacks. As issues were made the tins were taken generally from the top, so that those at the bottom, in some cases, remained until the end of the war, and some of those, at least, which came under my notice and were condemned as unfit for food, came under this category.

Now the question will arise how long, under different conditions, is it safe to store tins of food before issue?
From a considerable practical experience when analyst during the late war, I am of opinion that no meat stacked in the open, exposed to changes of temperature, heat of the sun and effects of rain in warm climates, should ever be kept for more than one year. When under suitable cover, perhaps for two years, but never more, and in all cases should be inspected at intervals. The reason of this is not so much in the meat itself as in the tin. During transit, knocking about in lading and unlading ships, in trains and carriage by road, the paint on the tins becomes cracked or knocked off. If the tin is now exposed to damp, especially damp with heat, rusting rapidly follows, attacking more especially those portions of the tins which are dented or scratched, and very soon a hole results. This hole in the tin is frequently very minute, but sufficient to allow the entrance of micro-organisms, fermentation and putrescence of the contents rapidly following. It has been shown that on long keeping a certain change, of the nature of adipocere, not understood, sometimes takes place in the meat itself, which is another argument against long keeping.

The custom of surrounding tins with paper labels in war-time should be discouraged, as, when wet, from water soaking through the boxes in which they are packed, the paper becomes sodden, retains the moisture and in some cases ferments, increasing the danger to the tins themselves. For the above reasons, tins should be invariably painted, with as thick a coat as possible: unpainted tins should not be accepted.

In stacking tins in the open some arrangement must be made to allow a free circulation of air around each tin. This can be carried out by placing the tins in rows, with a small interval between each on a raised platform. Over the first layer some wire netting or slabs of wood should be placed, and on this again the succeeding layers alternating with the wire netting or wood. Stacks should never be so large that the lower layers are not issued within a reasonable time, and they should be numbered for regulated issue.

The danger of consuming deteriorating food is, I think, not sufficiently recognised, and the habit of leaving exposed the contents of opened tins is only too common among the families of soldiers, and has led to many cases of ptomaine poisoning. When Sanitary Officer of Cape Colony many cases among the women and children came under my notice from this cause alone, although the tins and their contents were originally sound.

The foods which are to be considered the most dangerous are those containing much moisture, such as tinned milk, salmon,
lobster, and mixtures of meat and vegetables. The more acid food, such as fruit, jams and vegetables, are more liable to take up metals from the tins.

Certain kinds of tinned food do not keep so well as others. It was found during the war that corned-mutton, on the whole, kept better than beef. The simpler the preparation the better it with­stands effects of climate and heat. For instance, corned or bully-beef was far superior to mixed preparation of meat and vegetables. The latter did not, as a rule, keep well, owing to the vegetable acids, which eventually attacked and corroded the interior of the tins, and also absorbed certain amounts of metal from the interior. Tinned hams and bacon, likewise, did not keep well.

Most of us are called upon to examine supplies of tinned food, either as members of Boards or to give expert evidence, and the points which demand attention are as follows:—

(1) The Age of the Supplies.—Many makers mark their tins with the date, and this is now generally insisted upon. In many cases the date marked, e.g., 31.5.05, will be found stamped at either end; in some, on the label, which is liable to be torn off, and therefore insufficient. A general idea of the age of the tins can sometimes be arrived at by mere inspection. The longest period that contractors can be expected to guarantee their tinned foods under favourable conditions, should be taken at two years, not longer; but in the case of mixed meat and vegetables, six to twelve months should be the limit in hot climates.

During the war I frequently had samples of the emergency rations sent for an opinion as to their suitability for issue, and it was found on examination in thirteen different samples that they were quite unfit, having become mouldy, the cocoa being of the two portions most frequently deteriorated. This was due entirely to prolonged storage or exposure, and to the band of tin, which is soldered around the two portions, becoming partially detached.

(2) The External Condition of the Tins.—During the preparation of tinned foods the cooked meat is placed in the tin, which is then subjected to steam at a temperature of about 125° C., or sterilised by submersion in boiling brine, and then immediately sealed up, after the steam has escaped. Thus a partial vacuum is formed which gives to the end of the tin a slight concave appearance. In a good tin of meat the concave ends are generally present, whereas in a tin in which the contents have undergone fermentation, the ends are likely to be bulged outwards owing to the presence of gases, the products of fermentation.
A word of warning must be given with regard to this appearance of bulging. I have frequently had tins sent to me condemned as unfit, owing to apparent bulging caused by external pressure, the tins being dented, but on opening these the contents were shewn to be quite sound.

As a rule during the canning process, two holes are made in one end of the tin to allow the steam to escape before the final soldering. The tins, therefore, should be carefully inspected as to any evidence of re-soldering, or the presence of a third or more soldered holes, which frequently may be found at the margin or rim of the tin or even below the paper label. This points to the tin having been punctured to remove any gases due to commencing putrefaction, and then again being re-soldered up, by dishonest makers. Tins which are greatly dented or crushed should be treated with suspicion, for a minute opening may be found in the depression, from which the gases have escaped, and no bulging results, but the contents may be found to be either putrefied or mummified. In the latter case, on shaking the tin the rattling of the contents makes this apparent.

Dented tins should always be issued early, if otherwise fit. Tins which show much rust make it probable that they are old, or have been subjected to rough usage. Frequently tins in wooden cases which have laid in holds of ships show much rust, due to soakage from sea-water. Rusting is very often followed by perforation.

(3) The Condition of the Interior of the Tins.—On opening certain tins of preserved food, and especially tins of marmalade, rhubarb, tomato soup, some vegetables and mixtures of meat and vegetables, it will be noticed that the interior presents a blackened appearance in a more or less degree. This is due to the action of the vegetable acids on the tin-plating, and in extreme cases may lead to actual corrosion of the surface and solution of the metals. If the blackening is slight it is, as a rule, of no great importance, provided no fermentation, evinced by minute gas bubbles, of the contents is present.

During the War in South Africa, samples of marmalade were sent to the Army Medical Services Laboratory from the Director of Supplies for report. On opening the tins, the contents were seen to be in a state of fermentation, the interiors quite black and corroded in places by the action of the acids that were present. On analysis of the juice, both by the Government Analyst at Cape Town and myself at Pretoria, very heavy traces of tin and iron were found, showing the danger to health which may result from
such a condition. Luckily, in my experience, the salts of lead were of very rare occurrence, and when present were probably due to solder accidentally gaining access to the tin.

Leach has shown, in a series of analyses carried out in the author's laboratory, "that a wide range of variation exists in the amount of tin dissolved by various fruit juices."

"Eleven samples of canned blueberries were examined by Worcester in 1894, showing an amount of tin in solution (calculated as SnO₂) varying from 0.0066 to 0.27 grammes per can of 615 cc. capacity." So that the danger is undoubtedly a real one, although cases of tin poisoning are very rare. The effects of small quantities of tin on the human system are not definitely known or agreed upon, but if continued, or in any quantity, the results are liable to be injurious. With lead it is otherwise, and the least trace is sufficient to condemn the food. Traces of lead are chiefly to be found in tinned fruits and vegetables.

It has been shown by Leach, that in general the amount of tin dissolved in tinned foods in three months was the maximum amount, and that practically afterwards no further solution took place, and also that the amount of tin dissolved varies proportionately with the strength of the acid present. This interesting conclusion shows the importance of an analytical examination of samples of all supplies, before being passed as suitable for issue to troops in the field.

Zinc salts are sometimes found in tinned foods, and are generally due to a solution of ZnCl₂ having been used in the soldering. In some few cases I found zinc salts in tins of jam in South Africa, but only in mere traces.

(4) The Condition of the Contents.—Decomposition can take place by incomplete sterilisation or by incomplete sealing of the tin. In tins which have gone bad, as before stated, the ends are usually bulged, due to accumulation of the gases of decomposition. These gases are chiefly hydrogen, carbon dioxide and hydrogen sulphide. A test is to open the tins in doubtful cases by means of a puncture under water, when any gases present will bubble out. In some cases a little gas will escape from tins containing perfectly sound meat, being due to retained air in the interstices of the meat, owing to incomplete exhaustion during the process of sterilisation, but which, being sterile, is of no real consequence and amounts to, as a rule, only about 1 cc. or so.

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1 "Annual Report Massachusetts State Board of Health," 1899.
2 "Food Inspection and Analysis," Leach.
Doremus\(^1\) collects the gases from the tins, by means of an adjustable clamp, provided with a perforating steel needle passing through a rubber stopper. The gases are collected into a sphygmometer by a tube, both being filled with mercury. The gases can then be analysed in the usual manner. The amount of gas from a tin varies from 50 to 80 cc. Much bulged tins give a dull sound on percussion and a crackling on pressure.

Prescott and Underwood, quoted by Leach, adopt the following method:—When the swelling is not apparent the tins are boiled for one hour, which causes, by expansion, the ends of all to swell, they are then cooled and set aside for eight hours, when the sound ones will return to their former condition. The unsound ones will remain bulged, as the convexity is due to the presence of gases. This is a useful test and worthy of trial.

Viry calls attention to the fact that putrefaction may take place in tinned meats without the formation of gas, but so far I have not been able to confirm this.

The most reliable test, of course, is to open the tins, when any doubt is at once dispelled. If, as one frequently sees, there is any trace of mould shown by the presence of patches of blue (or yellow) (penicillium, aspergillus, mucor) the tins must be condemned, sterilisation not being efficient. Moulds are more often seen in the case of jams and jellies, and occasionally in sterilised milk. They impart an unpleasant taste to the food and are liable to cause diarrhoea.

Decomposition of meat is easily recognised when advanced, the smell of decomposed tinned meat being most sickening. A most important test of the presence of putrefaction is the liquefaction, even at a low temperature, and discoloration of the gelatine, which in sound meat should be firm, and this should always be examined. Decomposing meat has an alkaline reaction, due to the formation of ammonia.

Eber's test for the decomposition of meat is useful, but is not absolutely reliable, owing to the presence of trimethylamine, in, for instance, mutton and most pickled foods.

The test is performed as follows:—A small quantity of the reagent, which consists of one part sulphuric ether, one part pure HCl. and three parts ethylic alcohol, is placed in a test tube or other suitable vessel. The material to be examined is smeared on to the end of a glass rod, which is dipped below the surface of the re-

\(^1\) Journal American Chemical Society, 19, 1897.
agent but is not allowed to touch the side. If ammonia be present a cloudiness appears or fumes may be given off.

The colour of decomposing meat is generally in shades of green or grey, and is well known.

The rancidity of butter is detected by smell and taste, being due to the decomposition of butyrin, caproin and caprin into their fatty acids, and needs no further notice.

As before stated, in making inspections of supplies of tinned provisions, at least 10 per cent. should be opened and examined.

The danger of issuing bulged tins is not great, as the condition is so well known and would at once be detected. In all cases of doubt, samples should be sent to an analyst, and in sending these, care should be taken that they are a fair and sufficient sample of the whole, for it must be remembered that the analyst reports merely on the sample sent for examination, but his responsibility is very great.

As an example, I had a sample of marmalade once sent for analysis, consisting of a few tins which showed no deterioration; as there was some doubt, I asked for a further sample of two cases from the same consignment and found that every tin in these particular cases was bad. The original sample was evidently not a fair one, and if the first report had been final, the whole consignment would have been passed as fit for issue.

This paper lays claim to no originality, being merely the outcome of practical experience gained during the War in South Africa, when the quantities of tinned provisions supplied to troops in the field exceeded all past records. Considering the enormous supplies, the difficulties of transport and storage (the latter being under the most difficult conditions), the immunity which the troops undoubtedly enjoyed from any disease traceable to deteriorated food is remarkable, and any fear that they suffered in this respect can be confidently set aside.