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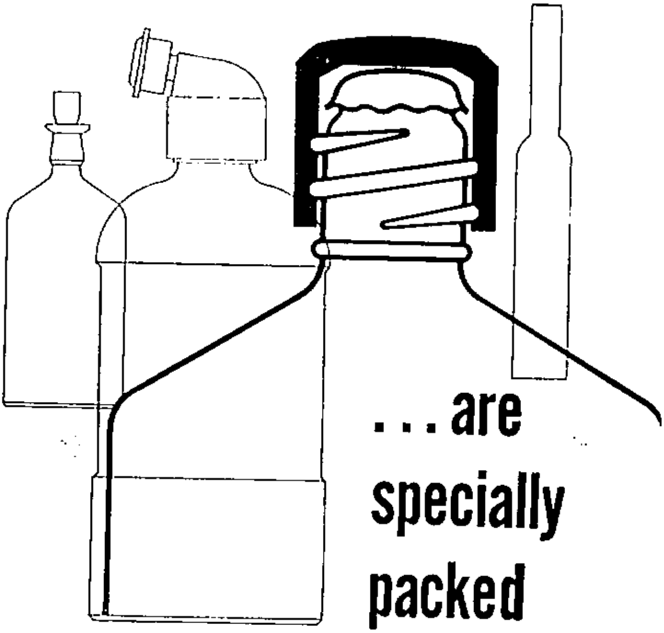
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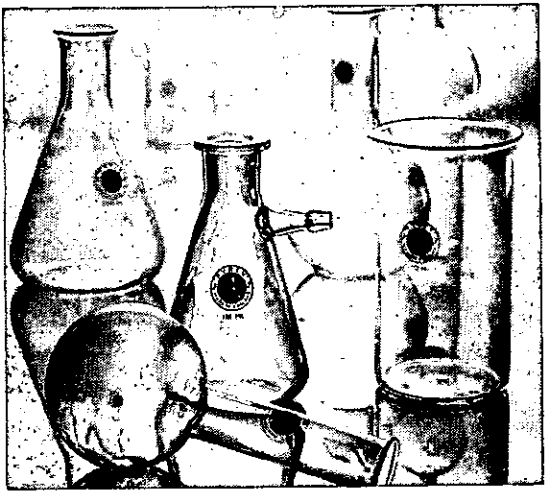

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LOOKING BOTH WAYS

In the twenty-fifth year of publication of this journal a new Editorial Committee take over the responsibility for its production. Their first task is to look back to the origin of the *Journal,* to consider its development, and rather apprehensively to peer forward to wonder what they can make of it. Like most past Committees, they start quite innocent of experience, unless one counts a period when the Editor served on the Committee during the third year of publication. Of one thing the new Committee are certain—they start with a more sure foundation than any previous Editorial Committee, for their predecessors have each moulded and reinforced the structure.

During its twenty-five years, the *Journal* has undergone several changes of style and policy. The first Editorial foresaw its development into a vehicle for publication of research papers, but courageous efforts by Mr O. H. Keys in this direction received little support from New Zealand's chemists. From Volume 4, for eight years, most of them fraught with difficulties due to the War, Dr H. N. Parton provided a newsletter type of journal which in the absence of annual conferences maintained an invaluable cohesive force between the Branches. Subsequently, under the managements of Mr S. G. Brooker, Mr G. M. Wallace, and Dr W. A. McGillivray, the present system of review articles together with Institute news has been developed.

The new Committee propose no sweeping changes. The function of the *Journal* as a record of Institute affairs will continue with the publication of Council minutes, notices, conference business, presidential addresses, etc. It is intended to record and discuss major advances in chemical research and development occurring in New Zealand, or likely to affect directly New Zealand's economy and culture. Wider issues of scientific organization, as far as these concern our members, must be considered in these pages. Book reviews will be continued and if possible comments on new types of apparatus will be essayed. Our pages will be open to correspondence where the subject requires direct presentation to members —but we hope intending correspondents will first consider whether the issue which concerns them is not better directed to the Council or to their Branch committee. If any common thread binds these diverse units it will be a sort of parochialism, a preoccupation with indigenous chemistry. Work relevant to agricultural and industrial problems within New Zealand will be preferred to reviews of wider scope which are likely to be covered in journals of less restricted circulation. Our biochemists like to know the chemical problems in establishing an aluminium industry in this country; our industrial chemists are interested in the role of selenium in animal health; and both want to know the trend of chemical research in our postgraduate schools. In short, the Editorial concept of the major function of this journal is to tell Institute members what their fellow members are doing, why they are doing it, and how they are doing it.

Writing a manifesto is easy; acting upon it, even upon such a mild one as this, is much more difficult. Whether or not it should be acted upon, indeed, lies not with its promulgators but with Institute members, for the Editor and his associates are but servants of the Institute. And so we revert to a theme that has been stressed in the inaugural fanfares of all previous Editorial Committees, and which was summarized in the opening lines of the first issue of this journal in 1936: "This is the first issue of a journal whose fate lies wholly in the hands of the chemists of our Dominion."

DR G. M. MOIR, author of the main article in this issue, has since his appointment as Dairy Chemist at the Wallaceville Laboratory in 1931 played a leading part in developing laboratory work to assist the Instructional and Grading Services of the Dairy Division of the Department of Agriculture. After military service overseas in 1918-19 Dr Moir graduated M.Sc. (1st class Hons) in 1922 at Otago University, holding a Senior Scholarship and later the Smeaton Research Scholarship. He taught at King Edward Technical College, Dunedin, then went to the National Institute for Research in Dairying, Shinfield, England, and in 1925 received the first award of the Pedler Scholarship of the Royal Institute of Chemistry to investigate milk proteins. He gained the degree of Ph.D. from the University of Reading in 1930. Apart from his chemical repute George Moir is well known to trampers and mountaineers as the author of *Moir's Guide Book* to Western Otago, first published in 1925 and now in its third edition.

THE BIOCHEMISTRY OF CHEESE

G. M. MOIR

Wallaceville Dairy Laboratory.

(Adapted from the address delivered as Chairman of the New Zealand Section of the Royal Institute of Chemistry at the Combined Conference in Dunedin, August, 1959.)

A discourse on the biochemistry of cheese in this country must refer primarily to Cheddar cheese, for in New Zealand about 100,000 tons of Cheddar are made each year, compared with less than 200 tons of blue vein, and only a few tons of some other varieties, for which there is a limited market. Throughout Europe and Asia many hundreds of different kinds of cheese have been made from time immemorial and there are still a few places where a merchant may be able to offer a choice of fifty or a hundred different varieties. In general, cheese can be subdivided into two main types, soft and hard; the soft type usually has less fat and more moisture so that it matures more quickly, perhaps within two or three weeks; the hard type has always been made as a means of storing food for use later, so that a low moisture content is essential.

Most preserved foods are biologically static, and the objective of food manufacture is usually to destroy bacteria and enzymes which might later cause spoilage. Cheese is almost the only manufactured food which is organically alive, for a series of biological changes occur in it, during a short period for soft cheese, or over a much longer period for hard cheese. The aim in cheese-making is to establish the correct bacteriological flora to produce these changes and to control it, first during manufacture and then during ripening. The resulting physico-chemical structure of the cheese plays a major part in this process, and further control is achieved by maintaining the correct temperature and humidity during ripening.

Because cheese is made from milk, which is a biological fluid, it contains, besides its major chemical constituents, important biological components such as vitamins, enzymes and bacteria. Although some of the enzyme activity and many of the bacteria are destroyed by a rather mild flash pasteurization at about 65°C, the remainder become concentrated in the cheese and play a small part in the ripening. The chief part of the process, however, is due to bacteria and enzymes added during manufacture, mainly to bring about chemical and physical changes in the casein of the milk.

CASEIN

Cheese-making and ripening are closely associated with the chemical properties of casein, the protein precipitated from milk at its iso-electric point pH 4.6. Despite the many improved methods of investigation now available, the *precise* structure of casein remains to be established. Casein used to be considered homogeneous, but since 1925 contrary evidence has been submitted by several workers. This evidence is based on the fact that, when iso-electric casein is re-dissolved in reagents such as dilute hydrochloric acid or caustic soda, and the solvent partially neutralized, a number of fractions precipitate as neutralization proceeds. These fractions differ in both physical and chemical properties. It appears to the writer that the fractionation really depends on chemical changes brought about at the time of re-solution. The reagents used are capable of opening weak linkages in what is a very delicate structure. Physico-chemical methods may cause similar disruption. This may be a conservative opinion but very little is known about the molecular structure or even the molecular weight of casein. Estimates vary from 100,000 to several hundred thousand. Oddments of the order of a thousand or two could be displaced by very mild reagents or even chiselled off without being noticed.

In several respects casein differs from other proteins. It is a phospho-protein of the amorphous type, not as highly organized as the globular type. The phosphoric acid is joined by an ester bond to the hydroxyl groups of the amino-acid serine (β-hydroxy-α-amino-propionic acid). Casein has the very important property of being able to combine with calcium, a property which is believed to be dependent on the phosphoric acid linkages, and in milk, casein is also complexed with calcium phosphate. Another outstanding property of casein is its reaction with rennet, which is used to curdle the milk in the cheese vat, whereby *casein* is changed into *para*-casein, thus:

Ca caseinate (complexed with $CaHPO_4$) + rennet ⟶
Ca *para*-caseinate (complexed with $CaHPO_4$)
+ a water soluble nitrogenous fragment

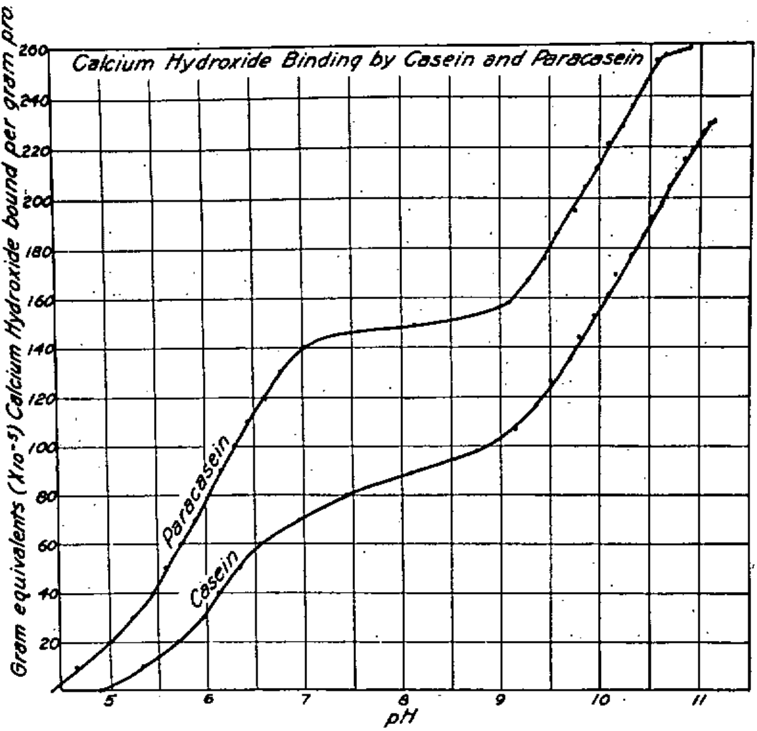

Fig. 1: In this graph the ordinates are gram-equivalents (x 10 ^{5}) of calcium hydroxide bound, per gram of protein. The gap between the curves is considerably greater than similar curves for caustic soda. At pH 6.6, at which the rennet coagulation takes place, the amount of Ca combined with para-casein is almost twice what is combined with casein. The marked flattening near pH 8 is believed to indicate that Ca is combined with phosphoric acid bonds opened up in para-casein by rennet action. (A phosphoric acid curve has a similar flattening about pH 8.)

Rennet is the common name for the enzyme rennin, associated with pepsin in the stomach, rennin predominating in the very young animal, particularly the calf. These two enzymes differ in important respects, rennin coagulating milk best at pH 5.4 to 6.6, while pepsin needs a lower pH of 2.0, besides having other properties undesirable for cheese-making. The function of rennin is mainly coagulation, with only limited proteolytic power, but pepsin is almost the opposite. Crystalline rennin has a molecular weight of about 40,000 and 1 part is capable of coagulating about 10 to 15 million parts of milk. Coagulation takes place in two stages, the first of which is a cleavage of the casein. The evidence given by its temperature coefficient indicates that this is a typical enzyme reaction. For instance, a milk which completes Stage I in 8 minutes at 37°C needs about 130 min. at 0°C. At this stage a tiny fragment, perhaps less than 1%, is split off the protein.

The second stage occurs only in the presence of calcium ions which are essential to precipitate the clot, and does not proceed at temperatures much below 15°C. During Stage I there appears to be some unfolding of the peptide cross-linkages so as to expose acidic groups with base-binding capacity, and as a result the protein in Stage II combines very rapidly with calcium ions and forms the well-known clot. Very small additions of calcium to milk, equivalent to N/5,000, have been found to accelerate Stage II. Despite physical differences in the properties of casein and *para*-casein there is almost no chemical difference between them, except in the increased base-binding capacity of the latter. This is illustrated in Fig. 1.

MANUFACTURING SUMMARY

The actual Cheddar cheese-making process in the factory occupies about 6 to 7 hours in the vat; followed by 16 to 18 hours in the press; then 2-3 weeks in the factory curing room; and further cool storage of between 4 and 12 months to mature. At all stages the chemical nature of the product is being altered by different biological agents, enzymes and bacteria of different kinds. In a short visit to a factory only a small part of the process can be seen, but it is possible to illustrate the more important early stages with a film.*

VAT OPERATIONS

During the filling of the vat with milk the starter bacteria have been growing for about 20 to 30 minutes. Rennet is then added at the rate of 3 oz per 100 gallons of milk, stirring is stopped, and in 30 to 35 minutes the curd is firm enough for cutting, an operation requiring skill to ensure uniformity. The curd is cut in three planes, yielding ⅜ in. cubes, so as to expose a much greater area of curd surface and thereby speed drainage.

After five minutes, agitators are gently placed in the vat and steam heat applied slowly to the vat jacket. If stirring is too vigorous, the fragile curd is shattered, or if heating is too fast, the skin round the curd becomes "case-hardened" and traps the mois-

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*At this point in his address, Dr Moir showed a sound film of cheese-making operations. This film was compiled by the Australian Dairy Research Laboratory, Melbourne, and lent by J. B. McEwan & Co.

ture. During this "cooking process" of about two hours, the curd behaves as a gel, shrinking under the combined influence of steady acidity development and temperature rise. Whey gradually separates and the cheese-maker measures the progress of the changes at regular intervals by titration of the whey with N/10 NaOH to phenolphthalein, as first used by Lloyd nearly 70 years ago. The skin round the cube appears to set up a Donnan membrane equilibrium, that controls the separation of the soluble constituents from the curd, particularly the calcium and phosphate ions. About 2½ hours after rennetting, the whey is run off and the curd left in the vat where it is vigorously stirred to encourage loss of whey, after which it is gathered along the sides of the vat with a central drain. The curd quickly mats together and after 10 minutes it is cut into blocks and the "cheddaring" process begins. Every 15 minutes these blocks are turned to square them off and to allow whey to escape, while acidity continues to develop and the pressure helps to expel the whey. After about two hours the blocks are cut up into long fingers which are stirred to release more whey. About half an hour later salt is applied and the curd thoroughly mixed so that the salt is absorbed and more whey lost. After 15 to 30 minutes the salted curd is gathered into the cheese hoops, and put into the press in which it remains overnight. Next morning the resulting 80 lb cheese are taken into the curing room and stored there for at least a fortnight at a temperature of 55 to 60°F. and relative humidity of about 75 to 80%. The storage conditions should bring about a continued slight loss of moisture which ensures a firm tight rind. The resulting shrinkage maintains considerable internal pressure that helps to prevent cracks opening up, in which mould can grow and cause damage.

STARTER BACTERIA

Continual efforts are made to improve the bacteriological quality of milk. The bacterial population varies somewhat, being of course greater in warm weather. It is considerably reduced by pasteurization, which also eliminates part of the enzyme activity. The manufacture of Cheddar cheese depends on the development of acidity by the growth of bacteria in the cheese vat. Historically, this was achieved by adding some of the previous day's whey to the milk. Yesterday's crop of bacteria were used to START the fermentation in the right direction, hence the name "starter". The results were often erratic, for yesterday's troubles due to bacterial contaminants were also repeated.

About 60 to 70 years ago, two cheese-makers, Lloyd in the West of England and Campbell in the West of Scotland, made the first scientific studies which revealed that the essential starter bacteria used in Cheddar cheese-making are strains of lactic streptococci—commonly known as *Streptococcus lactis* and *Streptococcus cremoris*. These bacteria form slightly oval cells, occurring either singly, in pairs, or as short chains. They are characterized by the rapid development of acidity in the milk and curd, this being their major function in cheese-making.

The lactic streptococci are closely related to the rod-shaped organisms known as lacto-bacilli that develop later in the cheese. Collectively, these two groups are known as the Lactic Acid Bacteria, which are fundamentally plant-dwelling saprophytes. The Lactic Acid Bacteria are anaerobes and facultative aerobes, that is, they can all grow in the absence of oxygen, but can also grow, with varying ease, in the presence of oxygen. These bacteria have the important property that they are devoid of cytochromes and usually of catalase also, so they generally obtain their energy for growth by fermentation rather than by aerobic oxidation. The bacteria may be further divided into two classes according to the products of their fermentation of sugar. The fermentation may result in the production of nearly 99% of lactic acid, when the bacteria are known as *homo-fermentative.* Alternatively, the products may contain only about 50% lactic acid, together with a mixture of other acids, alcohols, etc., and especially carbon dioxide, when the bacteria are known as *hetero*-fermentative. The commonly used starter streptococci are *homo*-fermentative, although *hetero*-fermentative streptococci known as betacocci may occur as contaminants. Some of the lacto-bacilli are *homo*-fermentative, whilst others are *hetero*-fermentative. This is an important distinction because gas-formation is one cause of the slitty texture defect in Cheddar cheese.

Even when pure cultures of lactic streptococci are used for cheese-making they can be erratic. About 25 years ago the reason for this was discovered in New Zealand by Dr H. R. Whitehead, who found that failures in acid development are due to the starter bacterio being attacked by a virus called bacteriophage. This has a most devastating effect, a virtual atomic bomb to the streptococci. Because the phage is distributed by the whey, it is much more difficult to keep it out of the starter than to exclude common bacterial contaminants.

BACTERIAL DEVELOPMENT

As already mentioned, throughout the making and curing operations the object is to restrain the growth of the undesirable bacteria and stimulate those which help to improve the cheese. Various types are needed and if sufficient are not available the flavour may be disappointing. However useful pasteurization of the milk may be, it also has the effect of reducing the variety of bacteria in the cheese, and the enzymes too. The result is that the cheese takes longer to develop an attractive, mature flavour.

Temperature can play an important part in encouraging the good types, the starter bacteria, while at the same time discouraging the bad types, derived from unclean utensils, soil, dirty water, etc. In the diagram (Fig. 2) can be seen how the desirable types are growing faster than the undesirable, while the latter are checked when the temperature rises high enough, and are further checked by the increasing acidity, and again by salting, and finally by curing conditions, including cool temperature.

Figure 3 shows that the bacterial population in cheese is not static. In the young cheese there are immense numbers of lactic streptococci, but these soon begin to decline, and within a fortnight other types begin to appear in considerable numbers. These are the lactobacilli which are usually so scarce in the original milk that they cannot be detected without a preliminary enrichment process.

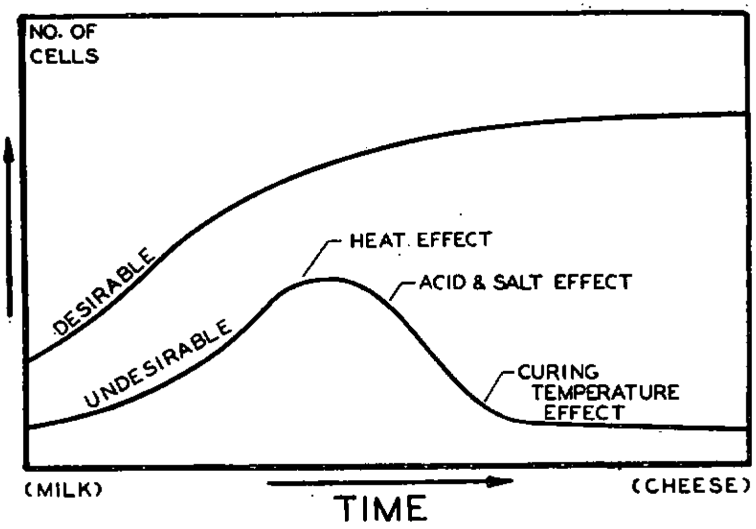

Fig. 2: Operations in the cheese vat stimulate the growth of the desirable starter bacteria, while undesirable types derived from soil, manure, unclean utensils, etc., are checked at various stages.

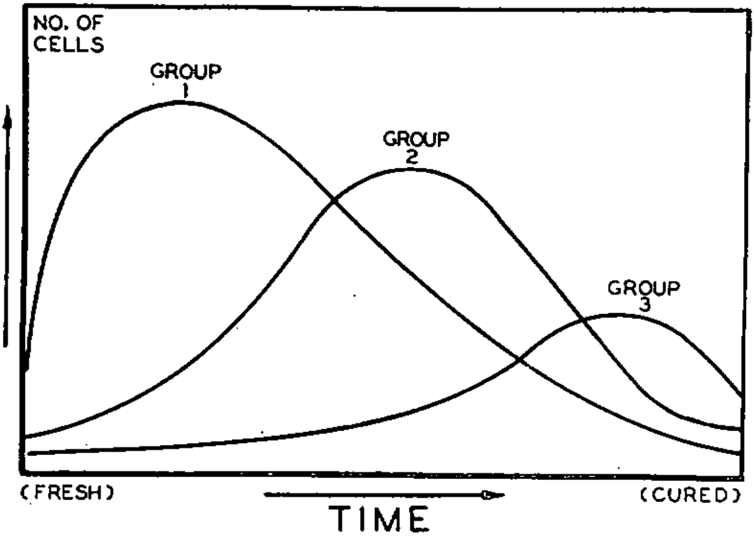

Fig. 3: As cheese ripens, the starter bacteria (group 1) which predominate at first, gradually decline in numbers, and are succeeded by lactobacilli (group 2), and then by another group.

Within a month the lactobacilli increase to very large numbers, finding a favourable environment at the pH, salt content, and almost anaerobic conditions within the cheese. The numbers begin to decline slowly and when the cheese has been maturing for 8 to 10 months, depending on the temperature, other types, chiefly micrococci, may have increased in number slightly.

When a fault develops at the vat stage—*e.g.*, failure of starter to develop acid—the curd retains too much whey. The operations in the vat are thus delayed, more mechanical stirring is needed, and the cheese-maker has recourse to adding extra salt to try to get rid of the surplus moisture. If the resulting cheese finishes up with too much salt, the growth of salt-tolerant staphylococci may be stimulated in preference to other desirable micrococci.

COUNTING BACTERIA

Only very approximate estimates can be obtained of the numbers of bacteria in cheese, mainly because they are not uniformly distributed but grow in colonies in fixed locations. Investigations carried out recently by one of my assistants, C. G. Rammell, have shown that nearly all the bacterial colonies grow on the junctions of what were the curd particles in the cheese vat.

The location where the curd has joined together is made evident by photomicrographs and along these joins or seams the colonies grow. A gram of cheese may have about 1,600 colonies, and each colony may contain up to 300,000 bacteria, but there is a very wide variation, so that there is a possibility of the estimate varying from 15 million to at least 400 million per gram.

CHEMICAL CHANGES IN THE VAT

The curd resulting from the vat operations was called "mono-calcium para-caseinate" by Van Slyke and Bosworth who investigated its properties during the period 1900-1910. They found that this protein material, which is not strictly a definite compound, dissolved readily in a warm (120°F) 5% solution of common salt, and the maximum solubility of over 90% was reached at about 12 to 15 hours after rennetting. Solubility in brine declined to about 85% in 24 hours and after a week became about 50%. Chemically, cheese has the following approximate percentage composition: Water 35, protein 25.2, fat 34, salt 1.8, mineral matter 4. More important are brine strength about 4.5; a ratio of moisture to solids-not-fat of about 1.1 to 1.2; and a final pH of about 4.8 to 5.0.

Cheddar cheese must have a strong tight rind, the main purpose of which is to exclude the air, so that conditions within the cheese are practically anaerobic. Coupled with this, the bacterial growth within the cheese must maintain strongly reducing conditions, to prevent any oxidative deterioration of the fat. This can be demonstrated by making cheese with methylene blue added, as we did first at Wallaceville in 1930.

This then is the material in which a further series of biochemical changes occur during ripening or maturing. The brine-soluble "mono-calcium para-caseinate" was believed by Van Slyke to be the basic material which the enzymes and bacteria break down to caseoses, peptones, polypeptides and flavour substances present in mature cheese. The final pH of about 5 is favourable to the proteolytic activity of rennet, which is certainly the most powerful enzyme left in the cheese, and it continues to chip off large bits of varying size, which are further broken down by other enzymes and the bacteria. It is the protein much more than the fat which is undergoing change during ripening.

GAS PRODUCTION

Throughout the ripening period the bacteria that are growing steadily are also producing chemical changes in the body and flavour of the cheese. One important feature is the formation and loss of carbon dioxide, in later stages chiefly by de-carboxylation of acidic groupings. The amount produced varies with the dominant type of bacteria. For example, during the manufacture of Swiss cheese, the propionic acid bacteria are encouraged partly by a higher cooking temperature, and they are able to ferment lactates to yield propionic and acetic acid and carbon dioxide. The gas accumulates in large holes or "eyes" which are a characteristic feature of Swiss cheese.

In Cheddar cheese, gas can be formed quite early by some of the lactic streptococci, or by undesirable organisms such as the gas-forming coliforms, or later by some strains of the lactobacilli. The first sign of gas in Cheddar cheese often becomes evident about a fortnight after manufacture, at the same time as the lactobacilli increase to large numbers. As the gas escapes, it usually produces a series of tiny slits, an undesirable feature known as "open texture".

Certain strains of lactobacilli have valuable inhibitory properties, other than their ability to produce relatively high concentrations of lactic acid. These inhibitory properties appear to be derived from the production of hydrogen peroxide or of substances giving the peroxide reaction; in small concentrations peroxides are effective against many common types of bacteria including staphylococci, streptococci, coliforms, and clostridia. The inhibitory action is greatly influenced by temperature and is exerted only in the presence of *living* cells of lactobacilli, as the peroxide rapidly decomposes in their absence. It is exerted even when the sensitive bacteria, such as staphylococci, are catalase producers, and also under relatively anaerobic conditions.

FLAVOUR

Of more importance is the influence of lactobacilli upon the development of flavour. Many workers consider that these bacteria are the principal agents in the development of cheese flavour. Different strains vary considerably in their effects, and as a result different cheese out of the same vat can vary appreciably in flavour, and that may be further modified by the growth of other types such as micrococci. The changes produced in the cheese are mainly proteolytic rather than lipolytic, but, if some strains of fat-splitting bacteria develop, they may give the mature cheese that more pronounced peppery flavour, probably derived from the lower fatty acids. Other off-flavours may be produced by such types as the coliform bacteria, which are derived from soil and manure, and are very common contaminants of milk. These break down tryptophane to indole and skatole.

During the last fifty years there has been a great deal of investigation to try to characterize the flavour-producing substances. Within the last ten years some progress has been made by means of new assay techniques and especially by chromatography, but the flavours of individual amino-acids, peptides, or fatty acids, either singly or in complex mixture, give no taste resembling typical cheese flavour. The "Component Balance" theory now receives considerable support. This states that the flavour does not depend on any one compound, but originates from a variety of substances broken down from protein, fat, and lactose; when these substances are collectively present in a certain balance we have typical cheese flavour, and certain components in this balance are more important than others. For comparison, an example of basic flavour is acetic acid in pickles and sauces, or alcohol in wines and spirits. The basic flavour is modified by minute traces of a variety of substances.

Despite considerable variations in the manufacturing details and bacterial population, it is surprising how little variation there may be in Cheddar cheese flavour at the age of 4 to 6 months. An experienced judge can predict, at the age of a month or less, what the storage quality of the cheese will be. That is, he can usually say whether the cheese at the age of 6 months is likely to be improving or deteriorating during subsequent storage.

DEFECTS

Mould penetration in Cheddar cheese has often caused serious loss. An export cheese weighs 80 lb and it must be turned daily during the first fortnight in the factory curing room, in order to ensure uniform drying out of both ends, the crowns. Rough handling at this stage can damage the tender rind and cause cracks to develop. Two cheese are boxed into a crate giving a gross weight of nearly 180 lb which gets rough handling at all stages of transit to the British market. Cracks originate mainly at the corners and spread inwards, usually following a pattern which appears to be developed during pressing operations, when the cheese is not yet homogeneous.

In some types of cheese, mould is a desirable feature—*e.g.*, in Stilton or in blue vein, which are soft-bodied cheese that are bored with wires and inoculated with the mould *Penicillium roqueforti* in order to develop the desired piquant flavour. As the *mould* enzymes are very much more powerful than those present in *bacteria,* they quickly break down the protein to ammoniacal compounds, which raise the pH and create a favourable medium for a variety of bacteria to grow. Moulds also attack the fats more vigorously, so in Cheddar cheese there is often local deterioration associated with mould growth. To check this, careful attention must be given to many details of handling the cheese at all stages.

Another serious defect in recent years has been the frequent occurrence of isolated black spots in cheese. At Wallaceville, for over 20 years, we have been detecting and eliminating trace metals in dairy produce; in butter 2 p.p.m. of iron is excessive, the limit for copper being even less, 0.2 p.p.m. So we were very quickly able to show that these black spots in cheese were essentially copper sulphide derived from tiny fragments of brass. This metal along with traces of iron was being worn off certain types of new machinery used for stirring the curd in the vats.

For several years another problem that has caused a great deal of concern is *tallowy discoloration,* also called *white streaks* in England. This appears as narrow bands on either side of cracks which extend in irregular fashion throughout the cheese. The normal pale yellow carotene colour adjacent to the cracks is bleached, and the fat develops an unpleasant tallowy flavour. The cracks extend to the rind, allowing oxygen to diffuse in and help the oxidation. Rough handling produces more cracks and damage of this kind.

A great deal of research work has been done upon this problem, principally by the Dairy Research Institute at Palmerston North, which has collaborated with the Agriculture Department's Dairy Instructors in an extensive series of manufacturing trials in recent years.

WALLACEVILLE INVESTIGATIONS

When we began to study tallowy discoloration at Wallaceville about five years ago, an outstanding difference was soon found between the amounts of the trace metals, copper and iron, in the tallowy and adjacent normal portions of the same cheese. Copper is well known to be a powerful catalyst of fat-oxidation. My assistant, F. Bishop, was therefore greatly surprised to find that the copper content in seams of tallowy cheese is distinctly lower than in the normal. Another surprise was that the iron content of the tallowy is consistently a little higher than in the normal. In Table 1 are typical results, as parts of metal per million of sample.

TABLE 1

Brand	*Copper* *Normal*	*Copper* *Tallowy*	*Iron* *Normal*	*Iron* *Tallowy*
R-Ki	0.5	0.3	3.3	3.9
W-Na	0.6	0.2	1.9	2.3
H-Vle	0.7	0.4	1.9	2.8
O.D.	0.3	0.15	2.1	3.4
W-Ke	0.6	0.2	5.4	7.1

After lengthy investigation, Mr Bishop discovered that the distribution of metals, especially iron, could be altered during the salting operations. As previously mentioned, cheese curd is soluble in 5% brine, so this revived our interest in the salting and pressing, especially as some of the typical cracks which become tallowy are believed to develop during pressing operations. The copper story is more obscure, but Mr Bishop believes that some migration takes place.

More recently, further light has been shed on the problem by my assistant, C. G. Rammell. His investigations have been based on evidence he has collected that tallowy discoloration in cheese is similar, biochemically, to certain oxidative changes occurring in food and other natural products. Such changes are often accelerated by specific systems, particularly haematin systems, which are widespread in nature. This evidence led Mr Rammell to arrange to have some cheese made from milk to which was added a small amount of cow's blood, which is a concentrated source of haematin. In a relatively short time this cheese developed, in suitable cracks, the typical tallowy flavour and discoloration. To explain this shortly, we have the observed facts that during salting the blood cells are partially haemolysed, and during pressing the brine solution of haematin gathers in lenticular pockets in the cheese. Rough handling later causes these to link up with cracks in the rind through which oxygen enters. The haematin which is concentrated in those cracks with the higher iron content stimulates the oxidation of the carotene and the butter fat and so causes the tallowy discoloration. A brief report on this work has since appeared in *Nature, 184*: 1295-6 (1959).

It is appropriate to conclude this account of biochemical changes occurring during cheese-making with that brief outline of some important work which has been done at the Wallaceville Dairy Laboratory.

ON LIBRARY RESOURCES

> *"In our technological age books and periodicals are the major channel through which progress is made known and further progress is rendered possible. No civilization, no community, no institution, can in the middle of the twentieth century afford to shut itself off from sources of information, least of all a country which around the turn of the century attracted world wide attention because of its progressive character."*

These statements are made in the preface to *New Zealand Library Resources,* Dr A. D. Osborn's report of his survey made in 1959 for the New Zealand Library Association under the auspices of the Carnegie Corporation of New York. To librarians and scientific workers these statements are in the nature of axioms. The importance and value of the Osborn Report lie in its revelation of the extent to which these axioms have been neglected by the community and responsible authorities, its exposure of the deficiencies of our library resources, and its general proposals to correct these deficiencies. The report makes a starting point for progress in the next 25 years in libraries for scholarship and research just as the Munn-Barr Survey of 1934 instituted much needed development in public library organization.

For the university libraries the extent of these deficiencies is indicated by Dr Osborn's references to periodicals. He states, "Each of the university libraries now receives between one and two thousand currently. The minimum number each should take is 10,000 though the desirable minimum is really 20,000." Lest these numbers appear unrealistic, compare them with the statement, elsewhere in the report, that over 50,000 periodicals are published for the sciences alone. The figures quoted are presumably present needs, but the report stresses the expansion which must occur. "Every year 15,000 new titles come into existence, so far-reaching is contemporary reliance on periodical literature throughout the world. These incipient titles in considerable numbers must constantly be taken into account along with the older titles that are not already in the country." It is possible that in the past the sciences have fared better than other faculties in the collection of journals; but anyone who scans current publishers' lists must be impressed, and even appalled, by the increase in serial publications dealing with specialized subjects, and the multiplication of journals within these subjects, in the last few years.

The inadequacy of present grants is aggravated by the increase in subscriptions for most journals, exemplified in the report by the 25 per cent. increase, between 1958 and 1959, for journals taken by the Engineering School Library at Auckland.

The general conclusion from reading Dr Osborn's chapter on University Libraries, that they are approaching adequacy for undergraduate needs, but are most inadequate for advanced teaching and research, is an indictment against a country struggling with problems in staffing both its universities and its research institutions.

In discussion of special libraries, most of which are in Government institutions, the report indicates that the present situation is somewhat better than in the universities but points to the need for considerable expansion and re-organization. Although the D.S.I.R. library system is named as "the outstanding special-library development in the past 30 years", its expenditure of £8,000 in 1959 for periodical subscriptions is "far too small an amount in view of the high cost of scientific publications and their tremendous proliferation. There are in the world today well over 50,000 current scientific periodicals and £8,000 can buy only a small fraction of them. . . . Considering this figure of 50,000 periodicals for the science subjects, one feels that many of these must be comparatively minor bulletins and reports. It would be interesting to know how many of these are devoted primarily to original research papers. Because of this problem of definition, or discrimination, Dr Osborn has probably been misled, on page 40 of the report, through differences between librarians in providing the information from which the New Zealand Library Association compiled their *Special Libraries and Collections* directory (1959). For example, comparison of the number of current periodicals attributed to Wallaceville Animal Research Station (700) with that quoted for the Ruakura Station (290) gives a false picture of the relative strengths of these two libraries in research periodicals.

Among the 31 items which the report recommends for inclusion in a programme for the future, four of immediate interest to chemists are the proposals for systematic acquisition of current books, standard works and periodicals, and completion of periodical sets. In reference to these points the role of the proposed National Library is discussed. Arguments against a scientific collection within the National Library include the need for having scientific literature in reasonably close proximity to the scientists themselves, and the danger of weakening other research libraries, especially those of the universities. Osborn concludes that "New Zealand needs a strong National Library as well as strong university and research libraries generally. For the good of the country money should be forthcoming for both."

Whatever mechanism is adopted to secure a greater coverage of the world's scientific periodicals, there can be no disagreement among chemists that a greater range is needed. There is nothing so frustrating as to find an abstract reference to a method of analysis or a reagent which one wants to use immediately and then find that the original paper is in a journal not taken by any New Zealand library. So also with back issues—a synthesis described in full only in 1890 can be essential to prove the structure of a compound isolated in 1960. Usually the result is the continuation of an inefficient procedure; too often a worthwhile idea is not followed up at all. The lack of wide library resources is part of that isolation of which New Zealand chemists are keenly conscious, and which contributes towards our inability to retain first-class scientists.

In particular there is a serious lack of foreign language journals taken in our libraries. The old argument that few New Zealand chemists are familiar with foreign languages was never a very strong one, as the more technical aspects of most papers in chemistry can often be understood with comparatively meagre language resources, and the argument has been greatly weakened by the post-war immigration from Europe. Ready availability of a paper containing essential information is a potent stimulus to surmounting the language barrier.

In assessing the completeness of library periodical resources Dr Osborn quotes the result of a test to determine how many titles are in the country, and in how many cases there is a complete set. He concludes that, of the titles listed in eight standard works, 39 per cent. are not available at all, 37 per cent. are represented by incomplete sets, and only 24 per cent. are available in one or more complete sets. Analysis of results of this test according to subjects indicates that sciences have fared comparatively well, since the corresponding figures for science subjects are 4, 50 and 46 per cent., and for chemistry, 6, 35 and 59 per cent.; but it is likely that such results are very misleading as they were obtained by taking for each science only the first 20 titles listed in Brown's *Scientific Serials*. Dr Osborn makes the specific recommendation that the Book Resources Committee (which has already compiled a list of works which should be in some library for the benefit of all) should ensure "that at least one copy of each new periodical of importance is brought into the country."

This problem of prompt access to the world's published advances in science has often enough been discussed among us. It was in fact the subject of an Editorial of this *Journal* in September, 1938, when the possible solution was seen in the microfilm service. Such services have never achieved the popularity then predicted. The Osborn report considers that photocopying should largely replace interloans, and indeed looks ahead further to the supplying of television facsimile; but the value of such inter-library services depends upon there being available in New Zealand at least one complete file of all worthwhile scientific periodicals.

Here is a project of such importance to the future of chemical teaching and research in this country that the Institute should take a lead in its furtherance. There is a need for preparation of a list of chemical journals, not now available, which should be taken by at least one library in the country; for an indication of the extent to which incomplete sets should be built up; and for consideration of the places where these special journals should be held. As the Osborn report indicates, librarians have already taken valuable initiative along these lines, but there are certain facets that only the scientists, who use the journals and know their relative merits, can determine—in particular the selection of journals not already available. Finally, the influence of the Institute must be added to that of the Library Association and of other scientific bodies to ensure that the Government provides for a greatly increased range of scientific literature within this country. Neglect today can have serious effects tomorrow on our cultural and material resources.

I.U.P.A.C. SYMPOSIUM :"THE CHEMISTRY OF NATURAL PRODUCTS"

Under the auspices of the Section of Organic Chemistry of the International Union of Pure and Applied Chemistry, a Symposium on "The Chemistry of Natural Products" is being organized by the Australian Academy of Science. Meetings will be held at Melbourne, Canberra, and Sydney during the period August 15 to 25, 1960. In Melbourne there will be an address by the past President, Professor A. Stoll, at the opening ceremony, and a special lecture by Dr J. R. Price on "Australian Natural Product Research." The Symposium President, Professor Sir Alexander Todd, will deliver his presidential address in Canberra, and the closing ceremony at Sydney is in the hands of Sir Robert Robinson. The Symposium lecturers are Professors R. B. Woodward, R. Kuhn and F. Sorm, and Dr H. W. Thompson. Section lecturers include Professors C. Djerassi, H. Brockmann, T. R. Govindachari, D. H. R. Barton, E. Lederer and N. A. Sorensen, Dr A. McL. Mathieson and Dr J. W. Cornforth.

Institute members who are known to be attending the Symposium are Professor Briggs and Dr Cambie from Auckland and Dr White of Ruakura.

As a result of this Symposium being held in Australia, chemists in New Zealand will have an opportunity of meeting and hearing a number of distinguished visitors in the next few months. Arrangements have been made by the universities and the Institute for six of these visitors to travel to this country and to deliver lectures to Branches. They are:

> Professor A. J. Birch, F.R.S., of Manchester University and previously of Sydney, who has recently been engaged on studies in biosynthesis, particularly of mould products.
>
> Professor C. Djerassi, now at Stanford University, California, but earlier at Wayne University, Detroit and Syntex, S.A., Mexico. Subjects on which he has made contributions include triterpenes, steroids, alkaloids, antibiotics and optical rotatory dispersion.
>
> Professor A. W. Johnson, Nottingham University, who has made contributions to a wide field of organic chemistry, including work on Vitamin B12.
>
> Professor E. Lederer, Professor of Biochemistry at the Sorbonne and Directeur des Recherches, Institut de Biologie Physico-Chimique, Paris. Although most widely known as author, together with Dr M. Lederer, of a book on chromatography, he has published papers in many fields including lipid chemistry.
>
> Professor F. Sorm, Department of Natural Products, Institute of Chemistry, Czechoslovak Academy of Science, Prague. Professor Sorm's contributions include research on alkaloids, steroids, triterpenes and sesquiterpene lactones.
>
> Dr H. W. Thompson, O.B.E., F.R.S., from the Physical Chemistry Laboratory, Oxford, is well known for his work in the field of infra-red spectography.

The President of the Symposium, Professor Sir Alexander Todd, F.R.S., who is Chairman of the U.K. Advisory Council on Scientific Policy, will also be travelling in New Zealand under the auspices of the Nuffield Foundation, of which he is a trustee. Two other chemists attending the Symposium who are likely to be in New Zealand are Dr P. R. Enslin, from the Chemical Research Laboratories, Pretoria, South Africa; and Professor N. A. Sorensen, from Trondheim, Norway.

OBITUARY

FRANK ANTON DENZ

1909 - 1960

Frank Anton Denz died on May 15, 1960, after an illness of some months.

Denz was educated at the Whangarei and Palmerston North Boys' High Schools and in 1927 entered the Chemistry Laboratory of the Department of Agriculture, Wellington. He studied part-time at Victoria University College and graduated B.Sc. in 1931. In this year he was awarded a Sir George Grey Scholarship. Denz then took six months off work to study full-time for the M.Sc. degree which he took with first-class honours in Chemistry in 1932, and was awarded a Jacob Joseph Scholarship. In 1934 he went to England to study medicine at University College Hospital Medical School. In 1941 he graduated M.B., B.S.(London) and then joined the Royal Army Medical Corps. After service in North Africa, Italy and Germany he returned to University College where in 1947 he obtained an M.D. in Pathology and Bacteriology.

Denz worked with the Toxicology Research Unit of the Medical Research Council of Great Britain until 1952 when he returned to this country to become Director of the newly established Toxicology Research Department of the Medical Research Council of New Zealand. He was elected an Associate of the Institute in 1955. In April, 1959, he was appointed Associate Professor of Chemical Pathology in the University of Otago Medical School.

Denz's scientific work was concerned chiefly with the biochemical effects of toxic agents. His first work in this field was an investigation of the biochemical and pathological changes produced by beryllium poisoning. With his colleagues, Barnes and Aldridge, he then embarked on a comprehensive study of the effects of certain organophosphorus compounds. They showed that the toxic effects could be related to their anticholinesterase activity. With J. M. Barnes he was the author of a comprehensive and critical review of experimental methods used in determining chronic toxicity, a review which is widely cited by workers in this field. In New Zealand he initiated work on the metabolism of some phenolic antioxidants. He retained his interest in work to the end as is shown by the fact that his last published paper on the toxic effects of Ngaio was written during his illness.

He was a member of a number of official committees in England concerned with the problems of industrial toxicology, a member of the Fact Finding Committee on Facial Eczema, and also N.Z. representative on the Joint FAO/WHO Expert Committee on Food Additives.

At the time of his death, Denz was the commanding officer of the Otago University Medical Corps with the rank of Lieutenant-Colonel.

As a young man he was keenly interested in tramping and mountaineering, activities in which he remained interested. An old colleague who worked with Denz from 1927 to 1933 says, "He was a lively character, full of enthusiasm, intolerant of fools, and ever ready to provoke argument whatever the topic of discussion". Those of us who knew him only more recently could say that he retained these characteristics to the end.

He is survived by his wife and four children.

NINTH NEW ZEALAND SCIENCE CONGRESS

Wellington, May 12-17, 1960

This year the usual Institute of Chemistry Conference will not be held. Instead the Institute combined with the Royal Society and other professional bodies in the organization of the Ninth New Zealand Science Congress. The 1960 Conference Committee of the Wellington Branch was responsible for the programme for Section B (Chemistry).

The policy of participation in the Science Congresses as an Institute function has never been greatly favoured by Institute members. There is undoubtedly much to be gained from such Congresses in that they bring together scientific workers from all disciplines, giving opportunity for specialists to widen their horizons and to see how their work may influence, and be influenced by, the advances in seemingly quite unrelated fields. Perhaps the Professor of Chemistry who said in Wellington that he intended to go to any Section other than the Chemistry Section had the right idea. It is possible that the greatest value to chemists at a Science Congress can come from a programme which deals with broad issues, with borderline aspects of various subjects and with problems involving the integration of many fields of research. The Institute's Conference Committee may have had such principles in mind in its original programme suggestions, before it heeded comments that more detailed chemistry was required.

In general members found the Congress a stimulating experience and the matter and presentation of most papers was of high standard. One of the objects of the Congress, "to acquaint the public of New Zealand with developments in science" was achieved in the public lectures, which were well reported in the daily papers in most centres. The Congress organizers can be congratulated on handling nearly 1,000 delegates, divided into 16 Sections, and meeting over six days, with so few inconveniences.

There has, however, been much criticism of some aspects of the general organization of the Congress. Most of the faults appear to have arisen from failure to ensure that the programme booklet was distributed to members before the Congress. The essential advantage of such a booklet is that it informs members of the scope of the papers and allows them to decide in advance which Sections they will attend on any particular day. Delay of issue of the booklet until the opening morning considerably reduces its usefulness. Some speakers did not know until the first morning on which day they were to deliver their paper; surely this information should have been sent to them when it was known that the booklet would be late. The writer found one annoyed chairman, five minutes before the first afternoon session, uncertain as to which room his session was in, and which half of the session he was to chair. Even worse, it appears that the person set down to chair the other half of that session did not know that he had been given this duty and was not at the Congress.

Before the Institute again relinquishes its annual Conference to join with other organizations in a Science Congress, the functions of such Congresses, and how these functions determine the organization, need close consideration.

BRANCH NEWS AND NOTES

AUCKLAND BRANCH

The April meeting of the Branch was addressed by Dr R. O. Farrelly, M.Sc., M.B., Ch.B., of the Auckland Hospital, who spoke on the subject "The Biochemistry of Mental Disorder."

At the April meeting the Chairman of the Branch, Professor H. Bloom, was congratulated on his recent appointment as Professor of Chemistry at the University of Hobart, Tasmania. Professor Bloom, who leaves New Zealand in September to take up his new position, will continue as Branch Chairman until the annual general meeting of the Branch, which will be chaired by Professor A. L. Odell.

C. J. Masters, formerly Chemist to Dr L. Brown, Auckland, has been appointed to the position of Lecturer in Biochemistry at the University of Queensland, Australia

WAIKATO BRANCH

At the March meeting Dr A. Taylor spoke on some recent developments in chemical research on facial eczema, dealing chiefly with observations of abnormal constituents in the sterol fraction of sera from animals affected with the disease. Dr Taylor is one of the three Facial Eczema Research Fellows now working at Ruakura Animal Research Station.

The April meeting was addressed by John Watkinson on methods for determination of selenium, especially procedures which he has developed for use on agricultural materials.

F. E. Mason, a foundation member of the Institute, organizer of the first Conference, and Branch Chairman in 1954, recently underwent a serious abdominal operation in the Waikato Hospital. It is pleasing to report that he is now making a good recovery.

Dr E. P. White will attend the I.U.P.A.C. Symposium on the Chemistry of Natural Products to be held during August at Melbourne, Canberra, and Sydney.

MANAWATU BRANCH

Dr A. T. Johns, Director of the Plant Chemistry Division, D.S.I.R., has just left on a four months' overseas tour. His itinerary begins with the U.S.A. where he has been sponsored by a Rockefeller grant, then he will be attending the International Grassland Conference at Reading. Dr Johns is returning to New Zealand via the Continent and Russia.

Thanks to the kindness of Glaxo Laboratories (N.Z.) Ltd., the Manawatu Branch was able to meet Sir Harry Jephcott, who gave an illustrated talk on the activities of D.S.I.R. in the United Kingdom.

The Branch welcomes two biochemists to the staff of the Plant Chemistry Division; Dr G. Petersen who is interested in nucleic acids in plants, and P. J. Peterson who will be studying problems associated with selenium in plants.

Dr J. R. L. Walker has accepted an appointment as Biochemist at the Cawthron Institute; there he will be working on biochemical problems associated with trace elements in plants. R. C. Lawrence (Biochemistry Department, Massey Agricultural College) will be the new Branch secretary.

CANTERBURY BRANCH

Dr J. E. Ferguson, a graduate of the University of Canterbury, has returned to take up an appointment as Lecturer in Chemistry. After graduating with First Class Honours in Chemistry in 1957, he travelled to England under a Sims Empire Scholarship and a post-graduate fellowship. He completed his Ph.D. degree at University College, London.

At the first meeting of the Canterbury Junior Chemical Society, Professor J. Packer was elected as Patron of the Society. The meeting was addressed by L. Wilkinson on "Paper Chromatography".

The April meeting of the Branch was addressed by a distinguished graduate of the Chemistry Department of Canterbury University, Dr R. M. Barrer, F.R.S., now Professor of Chemistry at Imperial College, University of London. The subject of his address was "Structure and Sorption In Porous Crystals."

This year's Chairman's Address achieved the unusual distinction of editorial comment in the daily press, Mr Pollard's plea for the establishment of a Ministry of Fuel and Power being echoed by the editor of the Christchurch *Press*.

A further group of lectures in the "Chemistry in Action" series was completed recently. The speakers and subjects this year were:

A. W. Mackney: "Chemistry and the Magic of Wood."
J. Vaughan: "Phlogiston and Fire-air."
Dr W. A. McGillivray: "Sheep, Cows and Chemists."

These lectures were again enthusiastically received by large audiences.

OTAGO BRANCH

The Branch Chairman, A. H. Lewin, is a member of the Otago-Southland Trade Delegation which is at present visiting Australia.

Dr F. Fastier of the Department of Medicine in the Otago University Medical School has been appointed Associate Professor in Pharmacology.

C. Beath, a former member of this Branch, is returning from Malaya to take up his new appointment as Principal of the Dunedin Teachers' College.

At the April meeting of the Branch, the N.Z.I.C. Prize was presented to R. Kershaw and M. McIntyre (absent), and the Inglis Memorial Prize was presented to Miss M. Kershaw. Dr J. Rogers addressed the meeting briefly about "Some Canadian Ore-dressing Problems" and showed a film dealing with the International Nickel Company's operations in Sudbury.

On March 30 Professor R. M. Barrer, F.R.S., visited Dunedin. The Branch held a dinner in his honour at the Savoy Restaurant and this pleasant function was followed by an address by Professor Barrer on "Porosity and Structure in Molecular Sieve Crystals." Members were most gratified to have the opportunity of hearing one who has contributed so much to this important field of study.

BOOKS RECEIVED

SCIENTIFIC RUSSIAN, by G. E. Condoyannis. Published by John Wiley & Sons, Inc., New York, 1959. 225 p. Price, 3.50 dollars.

THIS is a companion volume to *Scientific French* and *Scientific German* published in 1957. It is intended as a first text in Russian to be used almost from the beginning in conjunction with unsimplified technical and scientific reading matter and with a dictionary.

FUELS AND LUBRICANTS, by M. Popovich and C. Hering. Published by John Wiley and Sons, Inc., New York, 1959. 312 pages. Price 8.50 dollars.

A valuable consolidation of the vast amount of information currently available on the subject of fuels and lubricants. The text deals with conventional fuels through to rocket propellents and nuclear fuels.

BOOK REVIEWS

PROCEEDINGS OF THE FOURTH INTERNATIONAL CONGRESS OF BIOCHEMISTRY, VIENNA, SEPTEMBER, 1958. Published in fifteen volumes by the Pergamon Press Ltd., London, 1959.

Volumes to hand: *VOLUME 7, BIOCHEMISTRY OF VIRUSES,* edited by E. Broda and W. Frisch-Niggemeyer. 255 pages. Price 63s. *VOLUME 14, TRANSACTIONS OF THE PLENARY SESSIONS,* edited by W. Auerswald and O. Hoeffmann-Ostenhof. 299 pages. Price 75s.

The publication of conference and congress proceedings as rapidly as possible after the papers have been presented is an important contribution to the problem of keeping up with current trends in the various sciences. Considering the very large volume of material to be handled, Pergamon Press is to be congratulated on the speed with which they have produced this set, and on the technical excellence of the volumes.

Biochemistry of Viruses, like the other volumes devoted to the separate symposia, is a specialized publication covering the papers presented in this symposium and an indication of the discussion which followed them. While of particular interest to virologists and biochemists working in this field, many of the papers will have a more general appeal, for few chemists can fail to be intrigued by the fascinating developments in the studies on viruses. *Transactions of the Plenary Sessions* will, however, be of wider interest since, in presenting the summarizing reports on all the symposia as well as the speeches and lectures given at the plenary sessions, it aims to give a good cross-section of the typical problems and essential trends in biochemistry at the present time.

In the reviewer's opinion, however, the value of these and other conference proceedings is seriously limited by the publication of individual papers and reviews in a number of different languages in the same volume. There seems no need whatever for this complication. Since, in this case, most papers are in English, it is to be assumed that the volumes will be purchased only by those fluent in this language—so why not translate all contributions into this common medium?

A LABORATORY MANUAL OF CHEMICAL PATHOLOGY, by F. T. G. Prunty, R. R. McSwiney, and Joyce B. Hawkins. Published by Pergamon Press, London, 1959. 259 pages. Price, 35s.

This manual, which describes the methods used in the Department of Chemical Pathology of St. Thomas's Hospital Medical School, London, will be a useful addition to the library of most hospital laboratories. The format and printing are of a high standard, and only a very few errors have eluded the vigilance of the proof-readers.

In order to keep the size of the book within reasonable limits, no interpretations of results are given. It might, however, have been helpful if to each item were added the normal and pathological ranges of the substance under analysis, with some indication of the magnitude of the analytical error involved; this would not have added appreciably to the size of the book.

While it is evidently the practice at St. Thomas's to determine proteins by the Kjeldahl method, this is a relatively laborious and time-consuming procedure; colorimetric methods, such as the biuret method or Lowry's method, are very commonly used in clinical pathology practice, and are not significantly less accurate.

Determination of sodium and potassium is disposed of in a page and a half, without any detailed instructions for preparation of standards and samples; this is in contrast to the very full detail given for other analyses. Yet analysis of blood electrolytes is a very important part of the functions of a hospital laboratory, and is performed routinely in most of them.

While the instructions for preparation of standard solutions are in general most helpful and accurate, in one case they might be difficult to follow (p. 220). This refers to preparation of a standard phenol solution, by weighing out 100 mg of "pure dry phenol". This is not readily achievable; the usual procedure is to dissolve an excess of moist phenol in water, to determine the phenol content of the solution by titration, and to dilute accordingly. —R.T.

HETEROCYCLIC CHEMISTRY, by A. R. Katritzky and J. M. Lagowski. Methuen & Co. Ltd., London, 1960. 274 pages. Price 21s.

This little book is a masterpiece of condensed writing, and as such is difficult reading, each line requiring one's full concentration. It is designed partly for the advanced undergraduate, presenting a comprehensive and up-to-date sketch of synthetic methods and reactions in the heterocylic field, from the electronic viewpoint.

References, naturally. are used sparingly, and refer one to key papers and reviews of the late 1950's.

Nomenclature used is largely based on that of *Chemical Abstracts*. The book contains over 2,000 clearly set out structural formulae, which are referred to in the text and can be located without much trouble.

The authors have produced a valuable friend to have on one's desk. One of the problems in reading current literature and abstracts is to be able to locate quickly the ring structure and formula of the newer compounds. Textbooks seem doomed to be inadequate and out-of-date. This book gives one ready reference to ring structures and to representatives of most classes of natural products, right up-to-date.

The reviewer has not found any errors in references in the index, in cross-references in the text, or in references from the text to structural formulae; this is rather surprising in a book so complex in structure as this one. One does not expect the detail of the two major works on heterocyclic chemistry and does not get the descriptive account of the older classics. More on infra-red, ultra-violet and other physical aspects would have been welcomed, as the last chapter adds little, but after all, this is good value for a guinea, and perhaps we can expect in the future work including the authors' infra-red studies. —E.P.W.

SYNTHESES OF HETEROCYCLIC COMPOUNDS, Vols. 1 and 2, by A. L. Mndzhoian. Chapman & Hall, London, 1959. 48s. Consultants Bureau Inc. N.Y., $6.00. (Translated from the Russian by A. E. Stubbs).

Volumes 1 (71 pages) and 2 (84 pages) of this series, bound together in the present volume, deal exclusively with the practical preparation of compounds containing the furan ring.

In layout and presentation it follows closely the style of the well-known *Organic Syntheses* series, and there is very little duplication of compounds already catered for by *Organic Syntheses*. The practical directions draw heavily on the work of the author's group, published mostly in the *Proceedings* of the Academy of Sciences of the Armenian S.S.R., while at the same time references to the world literature up to the end of 1954 are covered.

It is the type of work to be expected in a library covering organic chemistry, but is of limited interest to most chemists, apart from specialists in furan chemistry. —E.P.W.

AN INTRODUCTION TO THE ORGANIC CHEMISTRY OF HIGH POLYMERS, by Carl S. Marvel. Published by John Wiley & Sons, New York, 1959. 79 pages.

The author of this monograph is Research Professor of Organic Chemistry, University of Illinois, and member of both the Advisory Board for the *Journal of Polymer Science* and the U.S. National Research Council Materials Advisory Board. He has adapted a series of lectures given by him in 1956 to produce a concise and systemic account of high polymer chemistry useful as a general introduction to this subject. From definition of the types of polymers and their characterization, he proceeds with chapters outlining the processes of formation, linkage structure and essential properties of the main types. There is adequate use of structural formulae, and over 80 references to key papers are listed. Although the emphasis is on the more basic aspects of polymer synthesis, frequent references are made to the uses of these polymers and to properties which determine these applications. —N.T.C.

CHEMICAL TITLES. A new chemical literature index, published by the American Chemical Society.

Chemical Titles is an automatically-produced bibliography of about 3,000 articles from the principal scientific journals published throughout the world, with foreign-language titles translated into English. About 100 Russian journals are included in its scope. The indexing of these titles has been made possible by the use of an "electronic editor"—an IBM 704 electronic data processing system which sorts out the key or important words in the title and indexes them under relevant headings with cross-reference to author, publication and date.

Chemical Titles consists of two sections, a "Keyword-in-Context Index" and a Bibliography. In the former the processing system slices out sixty letters from the full title of the article and determines which words are significant clues to the contents. These keywords are then posiioned in the centre column of the index so that they can be easily scanned by eye. A column on the right carries a coded reference to the Bibliography, where the full title with authors and journal reference is listed in alphabetical sequence by author. The coded reference is derived from the first four letters of the author's name, his initials, the year of publication and the first letters of three main words in the title. To give an illustration, the highly unlikely paper "Absorption of alcohol from wine and whisky" by A. T. Totaller in the *Journal of Organoleptic Chemistry* would be listed as follows:

ALCOHOL FROM WINE AND WHISKY. ABSORPTION OF TOTAAT-60-AAW for the keyword "whisky". Lines rearranged to place "wine" and "alcohol" in the keyword column would appear elsewhere in the keyword index. These three lines would have the same coded reference to the Bibliography, where full title and reference would appear.

Apart from the great saving of labour in the preparation of such an index, the use of the electronic editor makes is possible to place the index in the hands of chemists within a few weeks of the publication of the papers indexed. *Chemical Titles* was first issued in April of this year and is to appear twice a month.

There is no need to comment further on the great usefulness to chemists of this new venture in publication. One can only hope that it will be possible to carry it a step further, by some method of prediction, to include in the Bibliography a coded reference to the abstract of each paper which will subsequently appear in *Chemical Abstracts.*

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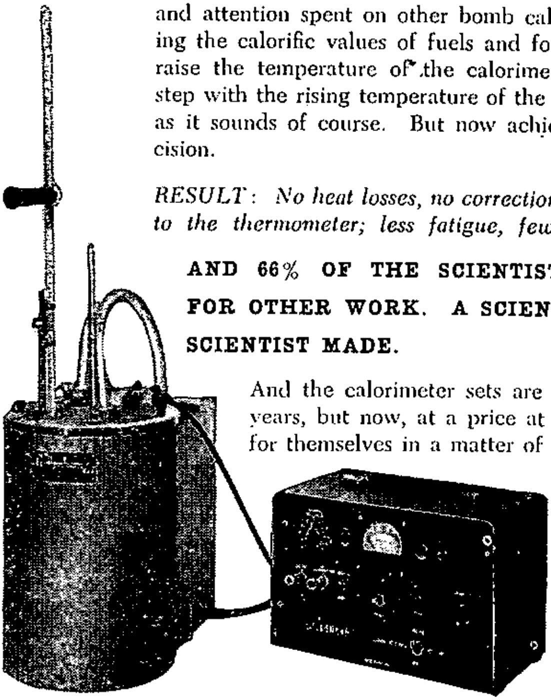

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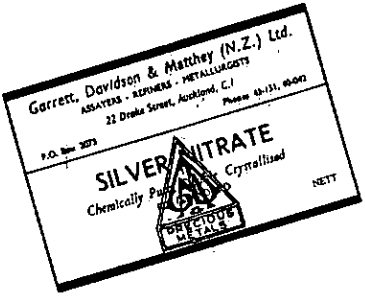
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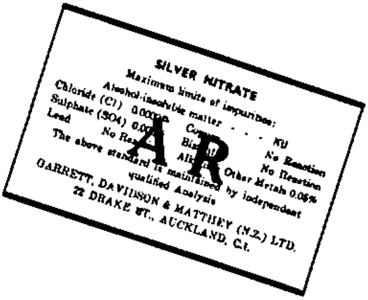
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