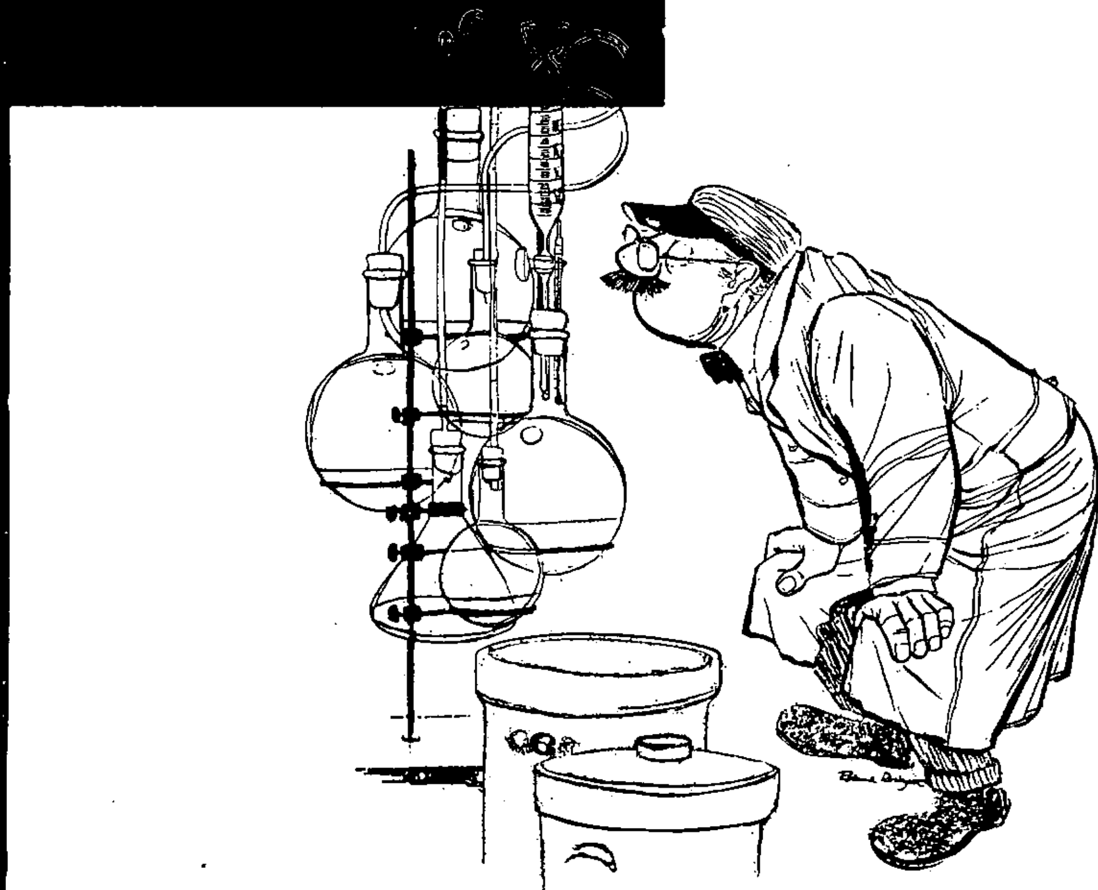
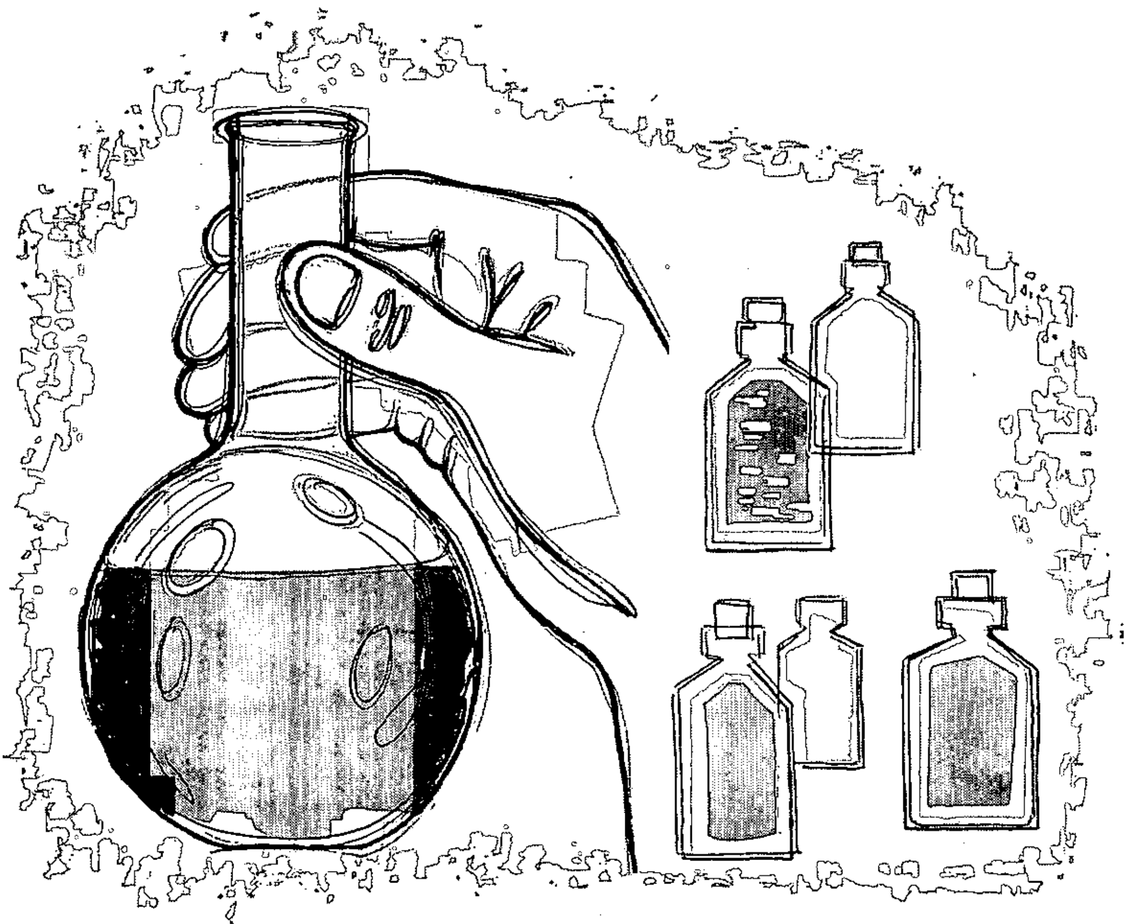
CHEMISTRY IN NEW ZEALAND

JOURNAL OF
THE NEW ZEALAND
INSTITUTE
OF CHEMISTRY



Vol. 32, No. 6, December 1968



In every BDH laboratory chemical you'll find a very special ingredient. It's impossible to purchase, yet we give it to you free. It's known as quality.
It leads to reliability. Look for it in the seven thousand-odd BDH laboratory chemicals. They never fail.

BDH BRITISH DRUG HOUSES (NEW ZEALAND) LTD.,
C.P.O. BOX 151, AUCKLAND.

BDH Laboratory Chemicals available through:–

National Dairy Association of N.Z., Auckland and Wellington.
Scientific & Laboratory Equipment N.Z. Ltd., Auckland.
Townson & Mercer (N.Z.) Ltd., Auckland, Christchurch and Wellington.
Geo. Wilton & Co. Ltd., Auckland and Wellington.
Kempthorne Prosser & Co. N.Z. Drug Co. Ltd., Dunedin.

20540

CHEMISTRY IN NEW ZEALAND

Journal of
The New Zealand
Institute of Chemistry

Vol. 32, No. 6, December, 1968

Published bi-monthly by the New Zealand Institute of Chemistry Inc. (P.O. Box 250, Wellington)

Contents

Page

181 Alcohol—The Problem Drug, *by C. R. Henwood, B.Sc.(Hons.) (Wales), A.N.Z.I.C., Toxicology Section, Chemistry Division, D.S.I.R., Petone.*

188 Letter to the Editor.

189 The Replication of Bacteriophage Lambda DNA, *by B. J. Carter, Department of Biochemistry, Medical School, University of Otago, Dunedin.*

195 Technical Topic — Pens for Potentiometric Recorders, *by J. R. L. Walker, B.Sc., Ph.D.(Leeds), A.N.Z.I.C. and R. J. Brook, Cawthron Institute, Nelson.*

196 Industrial Research and Development in Australia, *by W. I. Whitton, M.Sc., Ph.D., F.R.A.C.I., I.C.I.A.N.Z. Ltd., Victoria, Australia.*

200 Institute Prize Winners, 1968.

202 Conference Programme 1969.

202 Memorandum on the Formation of Specialists Groups.

203 Chemical Essay Prize Regulations.

204 Institute and Branch Officers, 1968-1969.

207 Branch Notes.

209 Book Reviews.

Editor: Miss J. Mattingley, B.Sc., A.N.Z.I.C.
P.O. Box 250, Wellington.

Advertising Manager:
D. Howard, M.Sc., A.N.Z.I.C.
P.O. Box 250, Wellington.

The Institute and Council are not responsible for individual opinions of any kind expressed in any article, editorial, review or report in this publication.

Printed by David F. Jones Ltd., 108 Tory Street, Wellington.

COVER
Distilling the Christmas Spirit? See page 181.
(With acknowledgement to the unknown artist).

Distribution. The Registrar:
D. J. Hogan, B.Sc., A.N.Z.I.C.
P.O. Box 1926, Christchurch.

Honorary General Secretary:
Dr. E. Harvey, M.Sc., Ph.D., F.N.Z.I.C.
P.O. Box 250, Wellington.

Employment Officer:
E. S. Borthwick, M.Sc., A.R.I.C., A.N.Z.I.C.
P.O. Box 2091, Wellington.

The Journal of the N.Z. Institute of Chemistry has an audit circulation Certificate of New Zealand Advertisers.

NEW

Gallenkamp

PEEL* models

* Probability envelopes of electron location

help your students to

understand

chemistry through a

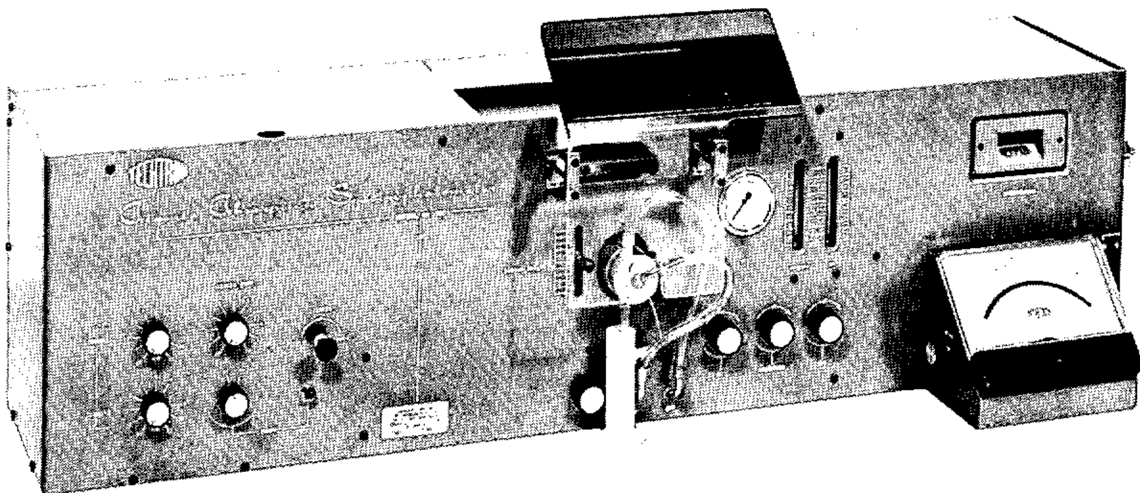
MOLECULAR ORBITAL approach

Gallenkamp

A. GALLENKAMP & CO. LTD.
P.O. Box 290, Technico House,
Christopher Street, London, E.C.2

Our appointed distributors in New Zealand are:—

GEO. W. WILTON & CO. LTD.
Box 9071, Newmarket, Auckland
Box 367, Wellington



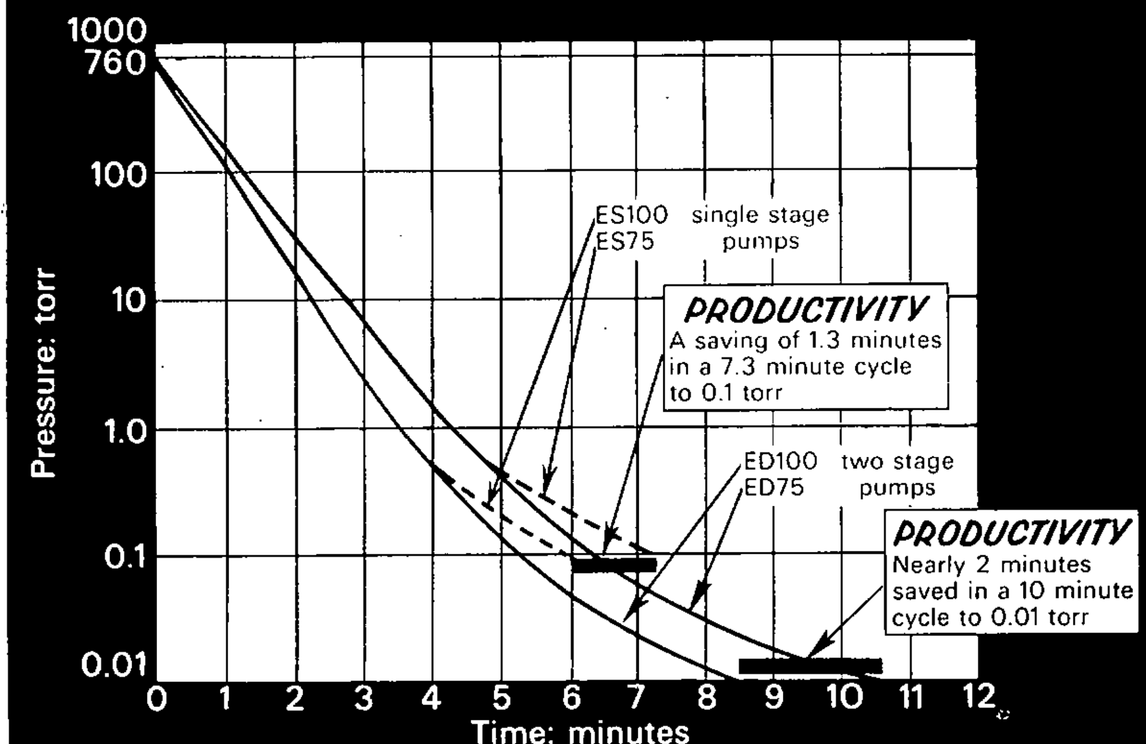
THE TECHTRON AA-100 ATOMIC ABSORPTION SPECTROPHOTOMETER IS COMPACT, VERSATILE AND FAST!

Here at last is a spectrophotometer that is easy to operate and fast enough to determine most elements in a matter of seconds! The AA-100 is compact too — now smaller laboratories can have the advantages of atomic absorption spectroscopy at low cost.
An interesting application of atomic absorption spectroscopy is the analysis of sump oil from locomotives and heavy machinery. This determines the amount of metal deposit so that the engine wear can be assessed without stripping down.
The AA-100 gives fast, routine, accurate metal analysis every time — invaluable in every medical, scientific, industrial and agricultural field. Spare lamps are always available for the AA-100 and similar instruments.
Literature available . . . contact us now for further details.
Represented and Serviced by GEO. W. WILTON & CO. LTD.,
Auckland, Ph: 360-467, 77 Carlton Gore Road, P.O. Box 9071.
Wellington, Ph: 697-099, 410 Hutt Road, P.O. Box 367.

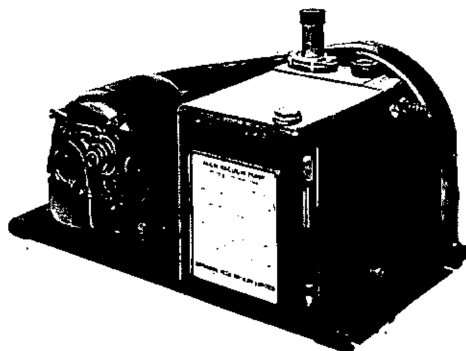
GEO. W. WILTON & CO. LTD.

20896

EDWARDS ROTARY VACUUM PUMP DISPLACEMENTS UPRATED 20% *-at no extra cost!*



11 of Edwards rotary pumps now have 15-20% higher pumping speeds than the corresponding models they replace—without significant changes in dimensions. You get shorter pump down times and sharply and increased productivity—the ES/ED100 series, subject of the above graph, is typical of all the uprated pumps. And the new models are as quiet as ever. You'll need a guide to these uprated pumps; we have one ready—a summary that highlights the new performance figures at a glance. Ask for Publication No. 03824.



Sole N.Z. Distributors: **GEO. W. WILTON & CO. LTD.**

P.O. Box 367 WELLINGTON P.O. Box 9071, Newmarket AUCKLAND

ALCOHOL — THE PROBLEM DRUG

C. R. Henwood, B.Sc.(Hons.) (Wales), A.N.Z.I.C.
Toxicology Section, Chemistry Division, D.S.I.R., Petone

"To me, oh friends, it appears right that man should drink; for as oil is to the flame, so wine refreshes the soul, mitigates sorrow and inspires gaiety".

SOCRATES.

"Our people have become what they never were before, cruel and inhuman. These accursed spirituous liquors which to the shame of our Government are to be so easily had and in such quantities drunk, have changed the very nature of our people, and will if continued to be drunk, destroy the very race".

CADOGAN. "The Roots of Evil".

WHATEVER one's opinion is about the use or abuse of alcohol, it must be the oldest poison cultivated by man. Its discoverer like many other great men must remain unknown, for early writings from all parts of the world mention alcohol in one form or another. Noah was found by his sons in an intoxicated state. Sealed wine jugs are found in the tombs of Egyptian Kings. The "Blue Monument" in the Louvre—the oldest monument of human culture dating back to 6000 BC—has an inscription mentioning beer as a drink offering.

The first technological advances in the manufacture of alcohol were made in the twelfth century A.D., though the earliest name linked with the distillation of alcohol from wine is that of Arnaldus de Villa Nova, a Latin Alchemist. Its preparation widened the scope of pharmacists for it enabled them to extract many natural products and minerals and to study reactions in solution. The redistillation of the impure 60 percent *aqua ardens* (burning water) yielded the much stronger *aqua vitae* (water of life) and in the fourteenth century redistillation with quick lime yielded 100 percent alcohol.

There is little doubt that alcohol is of great benefit to man, yet it has always presented social and moral problems. The toxicologist finds it an important factor in many of his cases. A knowledge of its behaviour in the physiological processes of the body is essential for his true understanding of its importance in a case. The following is an account of these processes and a review of methods available for the analyses of alcohol in body fluids.

Absorption

All mucous surfaces of the body are capable of absorbing alcohol. It is sometimes injected in the region of nerve tissues to relieve severe pain or used as an analgesic and anaesthetic by intravenous injection, but the most common method of entry into the body is oral. Once in the stomach it is absorbed at a rapid rate due to its small molecular size. This small molecule can diffuse immediately through the mucous membrane.

Absorption from the stomach depends upon a variety of factors including the amount of alcohol ingested, the amount of diluting material (food) present in the stomach, and the length of time it is in the stomach.

Absorption from the upper part of the small intestine occurs even more rapidly than from the stomach.

It is well known that alcohol ingested with or after a meal has a less toxic effect than when taken at other times. This is due not only to the diluting effect of food or its slower passage into the small intestine but also to the coating of the stomach wall with less permeable materials, particularly fatty foods

and oils. Work has shown that other non-fat foods do this as well. Tuovinen[1] showed that a large helping of mashed potatoes is an excellent deterrent to alcohol absorption. (It has also been shown that alcoholics absorb at least as rapidly as occasional drinkers[2].)

Distribution

Once in the blood stream, alcohol diffuses into the water of other tissues and an equilibrium is set up between blood and tissue alcohol. The rate of attainment of this equilibrium depends upon absorption from the stomach and may take up to an hour from the time of the last ingestion of alcohol. On reaching this equilibrium the alcohol concentration in one part of the body can be calculated from the concentration elsewhere. Taking the whole blood concentration as unity the following figures have been quoted[3] for other tissues:

Whole blood	1
Urine	1.2 - 1.4 (depending upon S.G.)
Plasma or serum	1.10 - 1.2
Brain or Liver	0.85 - 0.9
Kidney	0.83

Metabolism and Elimination

As early as 1899 Atwater and Benedict[4] showed that ethanol is quickly destroyed in the body and is mainly converted to carbon dioxide. Other early workers showed that the intermediate steps in this oxidation involve acetaldehyde and acetic acid.

It now appears that two enzymes are responsible for the conversion of ethanol to acetic acid, both requiring diphosphopyridine nucleotide (D.P.N.), which is slowly released from a complex with nicotinamide adenine dinucleotide.

Alcohol dehydrogenase catalyses the first reaction, while acetaldehyde dehydrogenase catalyses the second almost irreversible reaction. See below (a).
The amounts of acetaldehyde usually detected in blood rarely exceed 1 milligram per 100 millilitres, even with large doses of ingested alcohol. However the pharmacological effect of acetaldehyde is seen when the drug disulfiram, tetra ethyl thiuram disulfide, is used. This drug, under the trade name Antabuse(R) is used to create a repulsing attitude towards alcohol. During its action blood acetaldehyde levels reached are several times higher than those obtained with equal doses of ethanol given alone, causing palpitations, vomiting and even collapse. This increase is not the consequence of a higher rate of formation of acetaldehyde but the blocking of its oxidation.

Although most of the alcohol is oxidised to carbon dioxide, a minor metabolic pathway also exists—that of conjugation with glucuronic acid. It has been shown that up to 2% of alcohol given to rabbits is excreted in this way.

Alcohol metabolism can be outlined as below (b).

$$CH_3CH_2OH + DPN^+ \rightleftharpoons CH_3CHO + DPNH + H^+$$

$$CH_3CHO + H_2O + DPN^+ \longrightarrow CH_3COOH + DPNH + H^+$$

(a)

$$CH_3CH_2OH \xrightarrow{\text{not less than } 98\%} CH_3CHO \longrightarrow CH_3COOH \longrightarrow CO_2$$

$$CH_3CH_2OH \xrightarrow{\simeq 2\%} C_2H_5OC_6H_9O_6 + \text{unchanged ethanol}$$

(b)

Alcohol, Disease and Other Drugs

Alcohol acts as a central nervous system depressant and initially affects the brain and the higher centres dealing with emotions, co-ordination, memory, etc. The apparent stimulant effect occurs when the lower centres are no longer controlled in the usual way by the higher centres and inhibitions are removed. Much work has gone into studying ways of increasing the rate of its metabolism so as to decrease its effect. Balogh et al[5] found that as a result of administering fructose the metabolism of alcohol in man accelerated up to 11 percent during the first 45 minutes. Honey caused an increase of up to 39 percent. The resultant lowering of the blood alcohol level showed wide variations. Tygstrup et al[6] concluded that the most important factor in this fructose effect seems to be the formation of glyceraldehyde from fructose. Glyceraldehyde is normally dehydrogenated to a glycerate; however, in the presence of alcohol, it is presumed to be reduced to glycerol with alcohol dehydrogenase and DPNH, resulting in the formation of DPN+. A limiting step in the dehydrogenation of ethanol to acetaldehyde is the slow release of DPN+ from the complex with nicotinamide adenine dinucleotide but this step is circumvented when glyceraldehyde is present, thus accelerating the normal oxidation metabolism of ethanol.

Persons suffering from epilepsy or those who have sustained head injury are more susceptible to the effects of alcohol than others. They are more likely to become extremely intoxicated by relatively small doses of alcohol and to become more sensitive to further medication. Lieber et al[7] attempted to see if alcohol can produce fattv liver in man and rats despite an adequate diet. Their results incriminate alcohol as the direct etiologic factor in the pathogenesis of the alcoholic fatty liver independent of nutritional deficiencies.

According to Polson and Tattersall[8], the first time the theory of "potentiation" or "synergism" between barbiturates and alcohol was enunciated seems to have been during the inquest into the accidental death of a woman who had taken 3 or 4 capsules of sodium amytal and a small amount of alcohol—a gin and ginger ale as an aperitif. Some confusion seems to exist in the literature about this effect due mainly to the fact that "potentiation" and "synergism" are not strictly defined and have different meanings in different disciplines. It is safer to speak of the additive effects of alcohol and other drugs. In 1934 a report by Carriere et al[9] stated that ethanol antagonised the hypnotic effect and reduced the toxicity of phenobarbitone, yet subsequent investigators have failed to confirm this result. Working with mice and rats Olszycka[10] found that ethanol potentiated the hypnotic effect of butobarbitone and Dille and Ahliquist[11] showed that it produced the same effect with pentobarbitone in rabbits. Jetter and McLean[12] and Ramsay and Haag[13] came to the conclusion that ethanol increased the toxicity of barbiturates while Fern and Hodges[14] decided that amylobarbitone and ethanol were simply additive in effect and could produce no evidence to show that ethanol potentiates the acute toxicity or anaesthetic effect of the barbiturate.

Tests of 3 antihistamines with ethanol on mental and motor performances showed no appreciable potentiation of alcohol by the drugs. Diphenhydramine was potentiated by ethanol in two of the tests carried out. Muller et al[15] showed that mephanoxalone (Trepidone), a drug similar to meprobamate, failed to show a significantly greater decrement in psychophysiological test performance than alcohol does alone. They seem to think this casts doubt on the validity of the work on meprobamate which shows a potentiation effect between this drug and alcohol.

A paper given bv Carpenter and Varley to the International Conference on Alcohol and Road Traffic in 1962[16] ably summarizes the difficulty of evaluating tests involving the combined action of drugs. An important point made is that of considering the dose-

response function of a drug, a factor not mentioned in many of the papers covering combined actions. For example, if the response to each drug under test is an accelerating function of dose then equally potent doses of each together may give a response larger than otherwise expected. This would be interpreted by the pharmacologist as potentiation when strictly it is additive. This and other points show the difficulty of evaluating such work. However, all things considered, one important point emerges. There is litle doubt about the danger in the practice of taking alcohol with quick-acting barbiturates, or for that matter any other depressants—notably morphine.

Alcohol and the Law

Recent changes in the Transport Act have highlighted the importance of alcohol as a drug and statistics show that it plays an important part in road accidents. Fig. 1 shows the correlation between alcohol in the blood stream and risk of accident[17]. Note from the graph that at very low alcohol concentrations the risk of accident is statistically slightly lower than that at zero concentration, probably due to an easing of tension, yet the risk rises rapidly after this and at 80 milligrams percent the risk is nearly double.

A conservative estimate puts the proportion of fatal, single car accidents caused mainly by alcohol at 65 percent. A paper presented by Haddon[18] presents a very thorough and disturbing picture of the connection between alcohol and traffic accidents. At the D.S.I.R. during 1967, the Toxicology Section handled 210 blood samples for the Police Department, taken from drivers charged with driving while under the influence of drink or drugs. On analysis 129 samples were found to contain more than 200 milligrams of alcohol per 100 millilitres of blood, 63 were between 150 and 200 milligrams percent and 16 between 100 and 150 milligrams percent; 2 contained less than 100. In the Amendment to the Traffic Act[19], if the blood alcohol figure is above 100 milli-

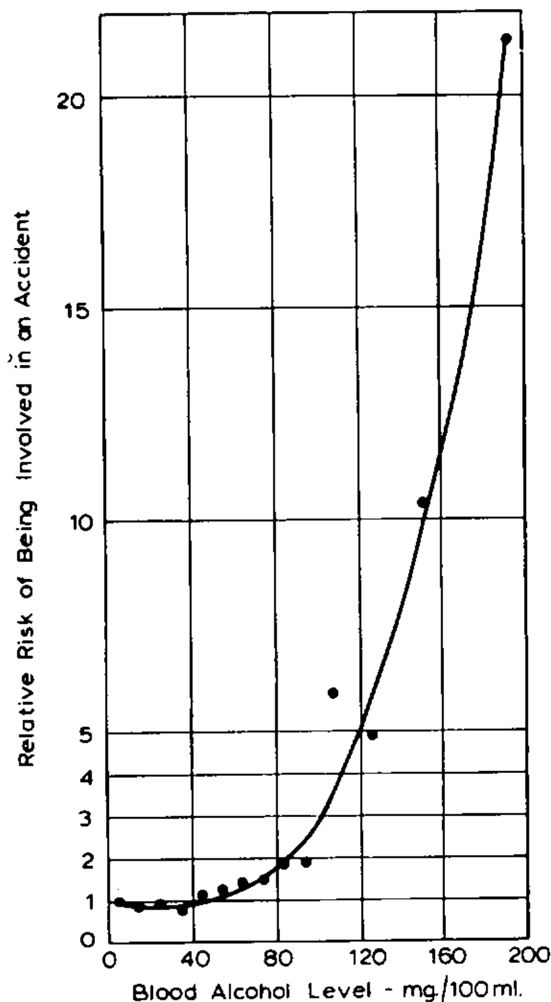


FIGURE 1

GRAPH OF DRIVER'S ACCIDENT RISK AGAINST BLOOD ALCOHOL LEVEL

grams per 100 millilitres it is presumed that the driver is incapable of having proper control of a motor vehicle.

Methods for Determining Alcohol

Interest in the methods for determining alcohol in body tissue, especially blood, has been highlighted by recent legislation concerning alcohol and driving. New Zealand is the latest in a succession of countries to adopt such legislation.

The history of alcohol determination in the form we know it today began in 1865 with the development by M. A. Bechamp[20] of a method involving chromic acid oxidation. He oxidised alcohol to acetic acid by means of potassium dichromate and sulphuric acid. The amount of acetic acid was determined by neutralization and weighing the sodium acetate after crystallization. Various modifications were made until finally in 1896 Nicloux[21] produced the first really quantitative method for small amounts of alcohol using chromic acid. The basic Nicloux method is most widely practiced today as the modification of Kozelka and Hine[22]. In this the alcohol is steam distilled from the sample directly into an oxidising mixture. Unless many sets of apparatus are used, it means only one sample is analysed at a time and many successive distillations must be carried out.

In 1918 Widmark began to modify the Nicloux method and by 1922[23] he had developed a method in which distillation and oxidation steps are carried out simultaneously in the same vessel. Using a cup suspended from the stopper of an Erlenmeyer flask, he placed the ground sample over the oxidizing mixture of potassium dichromate and sulphuric acid. The flask was heated to bring the sample to dryness and under the desiccating action of the sulphuric acid the alcohol was absorbed and oxidised. Titration of the unused dichromate using liberated iodine and thiosulphate gave a measure of the alcohol absorbed. The most convenient development of this method came from Nickolls[24] and is one which finds wide use in forensic laboratories for the determination of blood alcohol. In the Nickolls method, one millilitre of blood is placed in a petrie dish and stands over a known amount of dichromate-sulphuric acid mixture in a sealed vessel. The vessels stand overnight at 60°C for complete reaction between absorbed alcohol and dichromate. Titration is again with thiosulphate. The method is convenient and accurate.

The desire for a specific method for alcohol arises since the body produces other volatile substances capable of oxidation (acetone, acetaldehyde, etc.). Although many specific chemical methods have been proposed, including iodine pentoxide, the iodoform reaction, ethyl iodide and many others, they all include either a complexity of apparatus or a lack of specificity in the presence of ketones. By far the best of the specific methods is that of gas chromatography. Aldehydes, ketones and alcohols can all be differentiated and with a little care the method can be made quantitative to a high degree of accuracy. The best of the quantitative methods involves the use of internal standards. Work by Stone[25] and Curry[26] using n-propanol as the internal standard has led to the method finding general use for alcohol determinations in blood and urine. The blood is diluted 1:1 with a propanol solution of known strength and the relative peak heights for ethanol and propanol are found by integration. The response factor for propanol compared to ethanol is determined by using a mixture of the alcohol solutions of known concentration. This factor when applied to the ratio of the peak heights from the injected blood dilution gives a reading of ethanol per 100 millilitres of blood. The use of the internal standard eliminates the need for accurate injection at the microlitre level.

Of more recent times, the analysis of breath alcohol has commanded great attention since enforcement of laws concerning

alcohol and driving often involves the use of a simple breath testing device used as a screening test.

The alveoli of the lungs constitute a large surface area over which the blood is separated from the air by a membrane of single cells. Diffusion of volatiles through this membrane takes place and a consideration of Henry's Law makes possible the determination of the concentration of alcohol in air which is in equilibrium with a known blood alcohol concentration. Theoretically, the determination of a blood alcohol concentration via the breath from the lungs would give a truer picture of the effect of this alcohol on the brain than would analysis of venous blood direct. This is because arterial blood is in equilibrium with deep lung air.

Experience of breath analysis has been limited in New Zealand but recently at Chemistry Division, D.S.I.R., Wellington, a series of experiments using various types of breath analysis instruments has been carried out. These instruments can be divided into two classes:

(a) those measuring accurately the alcohol content of the breath and expressing the result in terms of blood alcohol concentration;

(b) those intended as screening devices to show whether the blood alcohol content is above or below a level indicated.

In a typical experiment, a group of twenty males and females were asked to drink at their own rate over a fixed time, the consumption being noted. At the end of the session a blood sample was taken and after allowing at least twenty minutes for residual alcohol in the saliva of the mouth to disappear, they were tested with various breath analysis devices.

The results of these experiments show that the instruments intended as screening devices are successful in this role. They are simple in construction being tubes containing potassium dichromate crystals uniformly packed with silica gel soaked in sulphuric acid. The amount of breath sample passed through the tube is controlled in one of two ways. Either the subject blows through the tube to fill a bag of fixed volume or a separate balloon is filled and the air passed through the tube for a fixed time. One tube employing this second alternative uses a precision pump to pull a fixed volume through the tube from a previously filled balloon. The time interval mentioned earlier between the last drink and testing is most important, since the result of a breath analysis is of the order of 0.10 percent alcohol, while any residual liquor in the mouth may be up to 40 percent alcohol and it needs only traces of such liquor to give falsely high results. Work by Grosskopfe[27] in Germany has shown that traces of alcohol disappear from the mouth within twenty minutes of the last drink.

Use of a more sophisticated breath analyser intended to give an accurate assessment of blood alcohol concentration proved disappointing. Although when calibrated with air samples from above alcohol-water solutions the instrument was found to be accurate, samples from human subjects failed to correlate with the results from direct venous blood analysis. The reason for this lies in the inability to obtain a sample of breath which is in true equilibrium with the blood in the lungs. Work being done at Aldermaston[28] seems to support this view that the inadequacy of breath samples reduces the use of such instruments to screening work only, and this can be done by much simpler devices.

Laboratory tests of all the instruments using air from above alcohol-water solutions has shown that their reproducibility is good and their accuracy is within the limits expected of them.

In summary one can say that methods now exist for fast, accurate analysis of blood or other body tissue for alcohol, and screening devices can safely be used on breath samples for legal purposes in deciding whether a blood sample should be demanded.

I think there is little doubt that if alcohol had been recently discovered by a research chemist its use would be stringently controlled. But because we have learned to live with it, it occupies a special place in the drug field and poses many social and moral problems. Scientists from many disciplines must now work at a fuller understanding of its chemical, psychological and physiological effects on man in order to contain the problem within reasonable bounds.

References

1. Tuovinen, Scandinav. Arch. f. Physiol., 1930, *60*, 1-134.
2. Newman, Acute Alcoholic Intoxication: Critical Review, Standford, Calif., Stanford Univ. Press, 1941, pp. 8-10.
3. Muehlberger, J.A.M.A. 1958, *167*, 15, 1842-1845.
4. Attwater and Benedict, U.S. Dept. Agric. Bull. 1899, No. 69.
5. Balogh et al., Rev. Med., 1964, *10*, 49.
6. Tygstrup et al., J. Clin. Invest., 1965, *44*, 817.
7. Lieber et al., J. Clin. Invest., 1965, *44*, 1009.
8. Polson and Tattersall, Clinical Toxicology, 1959. Eng. Univ. Press, London.
9. Carriere et al., Soc. Biol. Paris., 1934, *116*, 188.
10. Olszycka, Acad. Sci. Paris., 1935, *201*, 796.
11. Dille and Ahliquist, J. Pharmacol., 1937, *61*, 385.
12. Jetter and MacLean, Arch. Path., 1943, *36*, 112.
13. Ramsey and Haag, J. Pharmacol., 1946, *88*, 313.
14. Fern and Hodges, J. Pharmacol., 1953, *5*, 1041.
15. Muller et al., Diseases Nervous System, 1964, *25*, 373.
16. Alcohol and Road Traffic: Conf. Proc., B.M.A., 1963, London.
17. Road Safety Legislation 1965-6, White Paper, H.M. Stationery Office, 1965, London.
18. Alcohol and Road Traffic: Conf. Proc., B.M.A., 1963, London.
19. Transport Amendment Act. 1966.
20. Bechamp, Compte. Rend. Acad. Sci., Paris, 1865, *61*, 374.
21. Lansberg, Z. Physiol. Chem., 1904, *41*, 505.
22. Kozelka and Hine, Ind. Eng. Chem. Anal. Ed., 1941, *13*, 905.
23. Widmark, Biochem. Z., 1922, *13*, 473.
24. Nickolls, Analyst, 1960, *85*, 840.
25. Stone, N.Z. Journal Sci., 1965, *8*, 190-191.
26. Curry, Analyst, 1966, *91*, 742.
27. Grosskopfe, Alcohol and Road Traffic: Conf. Proc., BMA, 1963, London.
28. Stone, 1968, private communication.

IUPAC SECRETARIAT

The International Union of Pure & Applied Chemistry has recently established a new Secretariat office at Oxford (U.K.) with permanent staff. Its function is to deal with the day-to-day business and administration of IUPAC. Preparations for future meetings of the Council, the Bureau and the Executive Committee will be made through this office. In order to increase the efficiency and the speed of their deliberations, the Secretariat will provide appropriate clerical assistance to the six Divisions and some forty scientific Commissions of the Union.

The responsibility for running the Secretariat is in the hands of a new post, the Executive Secretary (Dr. M. Williams), who will report to the Secretary General (Dr. R. Morf) and the Treasurer (Prof. John C. Bailar, Jr.). Dr. Williams will have the help of an Assistant Secretary, Mr. R. J. M. Ratcliffe.

All correspondence for IUPAC should henceforth, in the first instance, be addressed to:

IUPAC Secretariat, 2-3, Pound Way,
Cowley Centre, Oxford, England.
(Tel.: Oxford 70125).

LETTER TO THE EDITOR

Dear Madam,

At the 1968 Conference of the N.Z. Institute of Chemistry, during the session on Liaison between Government, Industry and Tertiary Education, many delegates from industry spoke of the difficulty in finding out the research topics that are being carried out in the Universities. I would like to bring to their attention, "Science Record", an annual publication of the Otago University Science Students' Association. As well as containing articles of general interest to New Zealand scientists, this journal contains the only published record of research notes from Science Departments in New Zealand Universities.

For those interested, copies may be obtained by writing to P.O. Box 56, Dunedin, for 50c per copy. Yours faithfully,

A. C. Herd,
Editor Science Record 1968.

Science Record, Volume 18, August 1968, contains fourteen articles covering a wide range of topics, and a section 'Science Survey' devoted to scientific papers of the Routeburn Valley area. The particular value of this issue is the section headed 'Research Notes'; university staff and students and their research topics for each N.Z. University are listed in their appropriate sciences.

Science Record is a nicely produced publication containing just the sort of information which members at Conference were saying was not available. Members, here it is!

Editor.

DISPOSABLE PLASTIC TEST-TUBE

In this laboratory we are considering the question of having a special type of disposable plastic test-tube manufactured in New Zealand to use for assays and for scintillation counting with a Nuclear Chicago gamma counter. It is hoped thereby to reduce the cost and to avoid the difficulties of importing.

The specifications are:

- — outside diameter, 13-15 mm;
- — length, 100-125 mm;
- — volume, 8-16 ml;
- — material, any suitable plastic;
- — rim, outside diameter at least 16 mm;
- — caps, plastic, liquid-proof, push-in, or possibly push-on.

These specifications are not rigid and we would consider any tubes of similar design. As far as we know, such a test-tube is not being made in New Zealand.

If you could use such a test-tube and would like to collaborate in getting it produced locally with a view to cutting the cost, please get in touch with

Dr. A. C. Arcus,
Biochemist,
Medical Unit,
The Princess Margaret Hospital,
Private Bag,
Christchurch

stating specifications (including opacity) and likely annual consumption. This enquiry is tentative only and no obligation is incurred by your replying.

THE REPLICATION OF BACTERIOPHAGE LAMBDA DNA*

B. J. Carter
Department of Biochemistry, Medical School, University of Otago, Dunedin, New Zealand

I AM studying the replication of the DNA of the bacterial virus (bacteriophage) lambda. An understanding of the mechanism of this event is important since DNA contains the genetic information of living organisms; therefore the replication process is central to the problem of passing genetic information from generation to generation. The bacteriophage system has the great advantage that it is relatively simple, yet contains many of the problems found in higher life forms.

DNA consists of two polydeoxyribonucleotide chains arranged in a right-hand, double-helical structure. Each chain of the helix consists of an alternating phosphate-deoxyribose backbone. To each deoxyribose is attached one or other of the four nitrogenous bases; the pyrimidines thymine and cytosine, and the purines adenine and guanine. The two chains (strands) of the double helix are held together by hydrogen bonding between pairs of complementary bases, thymine with adenine, or cytosine with guanine.

Replication of DNA occurs semiconservatively by a fork type of mechanism (Fig. 1). The two strands of the parental helix unwind and on each is built a new daughter strand by addition of complementary nucleotides. This replication involves at least one enzyme, DNA polymerase.

Some species of DNA have been shown to exist in circular forms, e.g. the chromosome of *Escherichia coli* and it is believed that these molecules also replicate by a fork type mechanism[1]. This is illustrated in Fig. 2. Replication is believed to begin at a particular point 0 (the origin) and proceed round the circle in the direction shown. This process results in the formation of two circular daughter DNA molecules.

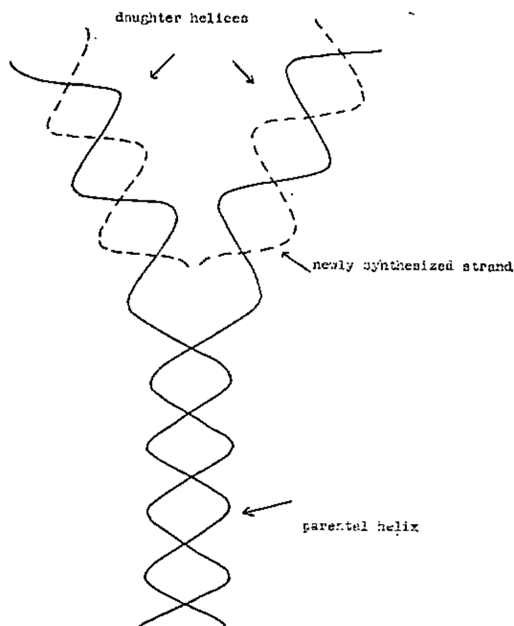


Fig. 1 The Fork mechanism for replication of double helical DNA.

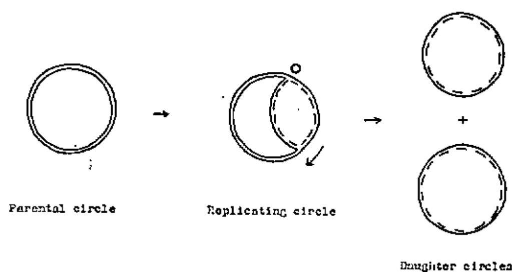


Fig. 2 Replication of circular DNA by a Fork mechanism. Note, in this figure and figure 3, two strands of the DNA molecule are represented by two lines. Helical turns are not shown for simplicity.

*This paper was awarded the Institute Prize in the Students' Papers Session at the N.Z.I.C. Conference 1968.

The λ phage used in the work reported here is the virulent mutant λ b2b5 which consists of a polygonal head and a long, flexible tail, both of which are made of protein. Tightly coiled up inside the head is the phage chromosome, a single, linear DNA molecule of molecular weight 25.4 x 10^6 daltons. This DNA has a unique and important feature; the ends of the molecule are single stranded over a short region (Fig. 3a) and furthermore, these single strand regions are complementary to each other.

Phage λ multiplies in its bacterial host *E. coli*. The phage tail is attached to the bacterial cell wall and the λ DNA is then injected into the host. After a latent period of 45 minutes the bacteria lyse and up to 200 new progeny phage are released. Thus, during the latent period the λ DNA chromosome must have replicated to produce at least 200 copies of itself, each of which was then packaged into a protein head, attached to a protein tail and released as an intact phage particle.

To investigate the sequence of events involved in the replication of λ DNA, radioisotope pulse-chase experiments have been performed and followed by analysis of the DNA in the ultracentrifuge.

A pulse-chase experiment is quite simple in principle. Bacteria grown in liquid culture are infected with phage. At a particular time after infection an isotopically labelled precursor of DNA, usually [^{3}H]-thymidine, is added. This precursor will be incorporated into DNA which is replicating at that time providing the *pulse* of isotope. A short while after addition of isotope, usually 2 minutes, a several thousandfold excess of unlabelled thymidine is added to dilute out the isotope and prevent further incorporation of it into DNA. At subsequent intervals samples can be taken to determine what has happened to the DNA which was replicating, and therefore had incorporated isotope, during the period of the pulse, i.e. the pulse is *chased*.

The DNA is extracted by treating the infected cells with detergent, e.g. sodium dodecyl sulphate or sodium lauroyl sarcosinate, and the proteolytic enzyme pronase. This is followed by deproteinization with phenol and then dialysis. The DNA can now be analysed by sedimentation in the ultracentrifuge since the rate of sedimentation depends, among other things, upon size and conformation of the molecule.

The DNA is sedimented through a preformed linear concentration gradient of sucrose increasing from 5% sucrose at the top of the tube to 20% at the bottom. After centrifuging for several hours at speeds up to 35,000 rev/min. the various DNA species which are present form bands at positions down the tube depending upon their rates of sedimentation. The gradient is fractionated by piercing a hole in the bottom of the

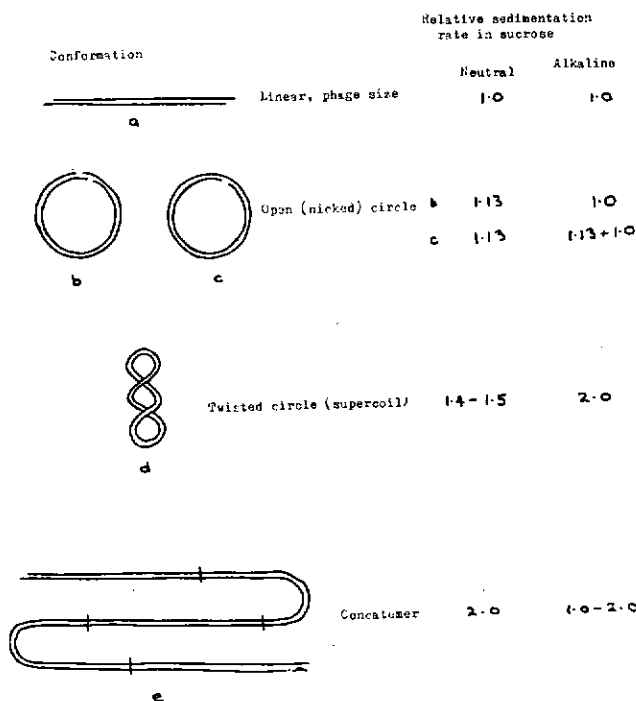


Fig. 3 Conformations of λ-DNA and relative sedimentation rates in neutral and alkaline sucrose. Note that the rates for linear phage size DNA in neutral and alkaline sucrose are not identical. In neutral sucrose the rate refers to that for a double strand molecule while that in alkali refers to a single strand.

tube and collecting drops. The radioisotope content of each fraction is then determined in a liquid scintillation spectrometer.

The sucrose gradients are at pH 7.0 (neutral sucrose) or pH 12.0 (alkaline sucrose). At pH 7.0 DNA retains its native, double-strand structure but at pH 12.0 the interstrand hydrogen bonding is ruptured and the strands of the double helix usually separate.

Phage λ DNA can exist in several conformations each of which has a characteristic sedimentation rate in neutral and alkaline sucrose. These conformations are illustrated in Fig. 3.

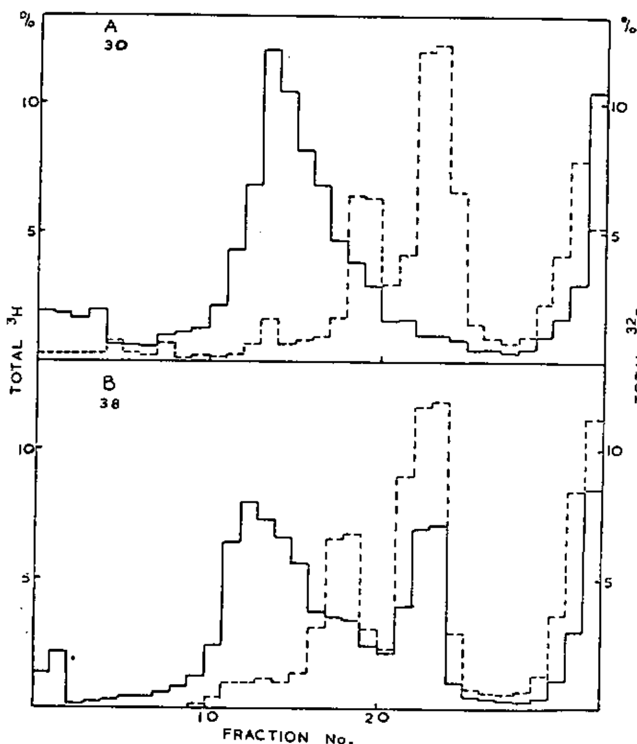


Fig. 4 Sedimentation of "late" pulse labelled DNA in a neutral sucrose gradients. A λ-infected culture was pulsed at 28 minutes after infection with ^{3}H-thymidine for 2 min. DNA was isolated at A) 30 min. and B) 38 min. after infection. Sedimentation in this and succeeding figures is from right to left. Solid line, ^{3}H (pulse); broken line ^{32}P (parental).

Firstly, as mentioned above, the λ DNA isolated from intact phage is a linear duplex. This is referred to as *linear* or *phage* size DNA. Under appropriate conditions (heated to 75°C and then cooled slowly) the single strand ends of phage DNA join up by complementary hydrogen bonding to yield an *open* or *nicked* circle. This circular molecule, which has one single strand break (or "nick") (Fig. 3b) in each phosphodiester chain, sediments in neutral sucrose 1.13 times faster than phage size DNA. The nicks can be repaired using the enzyme polynucleotide ligase. If only one nick is repaired (Fig. 3c), then in alkali one single linear strand and one single circular strand are produced. The single circular strand sediments 1.13 times as fast as the single linear strand.

A third configuration in which λ DNA may exist is the twisted circle or *supercoil* (Fig.

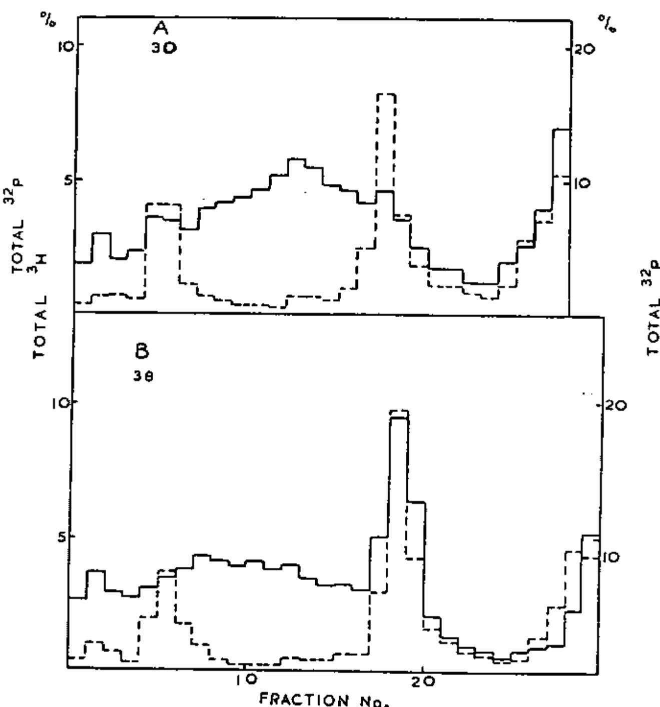


Fig. 5 Sedimentation of "late" pulse labelled DNA in alkaline sucrose gradients. The samples are from the late pulse-chase experiment (Fig. 4). A) 30 min. B) 38 min. after infection. Solid line, ^{3}H (pulse); broken line, ^{32}P (parental).

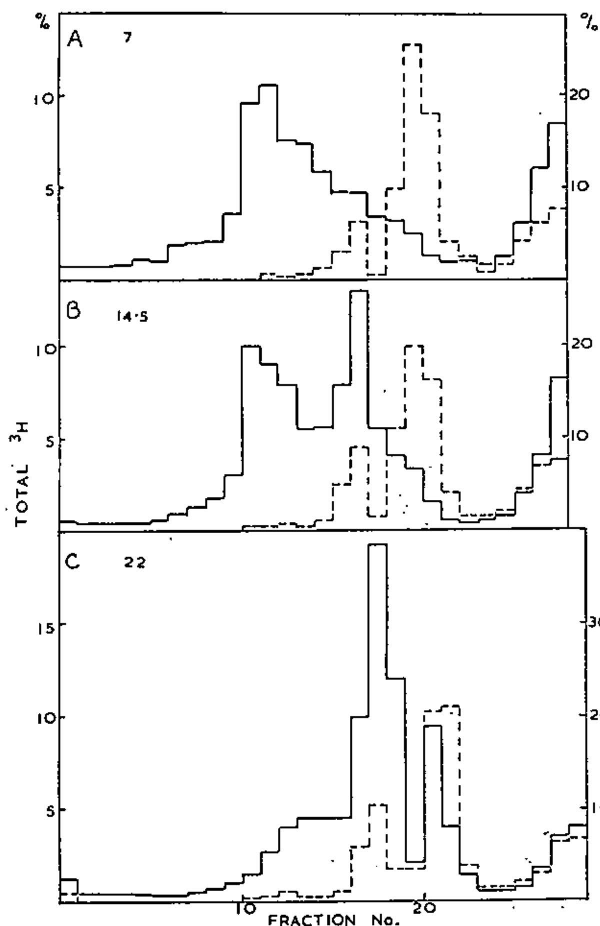


Fig. 6 Sedimentation of "early" pulse labelled DNA in neutral sucrose. A λ-infected culture was pulsed at 5 min. after infection for 2 min. DNA was isolated at A) 7 min. B) 14.5 min. C) 22 min. after infection. Solid line, ^{3}H (pulse); broken line, ^{32}P (parental).

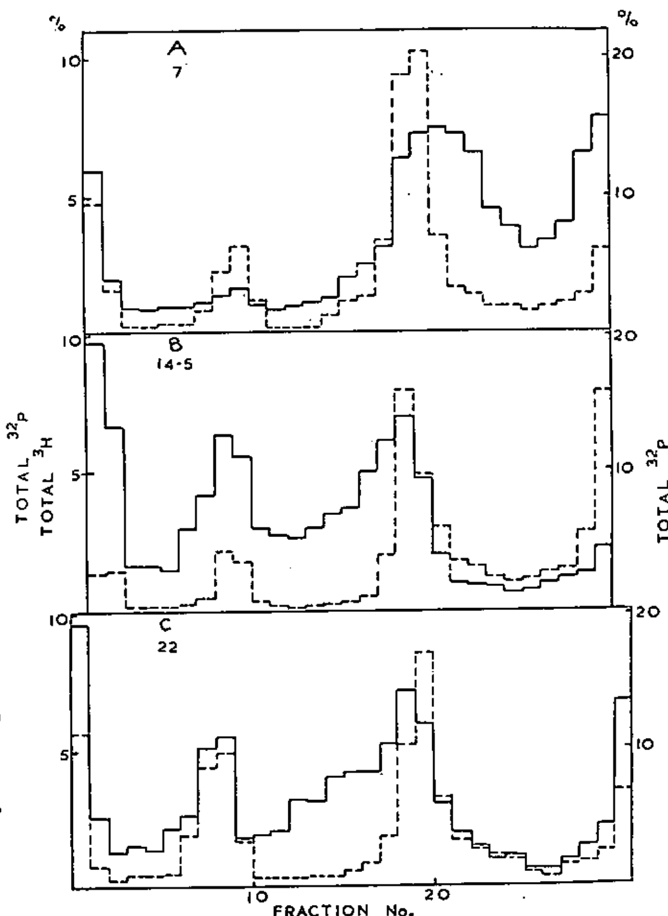


Fig. 7 Sedimentation of "early" pulse labelled DNA in alkaline sucrose. The samples are from the early pulse-chase experiment (Fig. 6). A) 7 min. B) 14.5 min. C) 22 min. after infection. Solid line, ^{3}H (pulse); broken line, ^{32}P (parental).

3d). This is a circular form which has no single strand breaks and which contains tertiary twists as well as those of the double helix. Introduction of one single strand break into the supercoil causes conversion to an open circle and loss of the tertiary twists. The supercoil sediments 1.5 times faster than phage size DNA in neutral sucrose. In alkali the rate increases to 2.0 because, although the interstrand hydrogen bonding is destroyed, the strands cannot separate and so the structure collapses into a more compact, faster sedimenting form. Some or all of the parental, infecting phage DNA is converted to supercoils in the bacterial host[2,3].

Smith and Skalka[4] first showed that DNA pulse-labelled in the middle of the latent period, i.e. 22 minutes after infection, appears in yet another configuration the *concatemer,* which in neutral sucrose sediments 2.0 times as fast as phage size DNA, but in alkali yields a broad band sedimenting from 1.0 to 2.0 times as fast. Other properties of this form, notably its sensitivity to

breakage by shear, together with further work we have done[5], indicate that the concatemer is a long, linear polymer of λ DNA of molecular weight up to 200 x 10^6 daltons, i.e. 7 or 8 times the length of phage DNA. Pulse chase experiments showed that the concatemers are subsequently broken into phage size DNA. Since these experiments were all performed at only one time after infection it is important to know whether this is the sequence of events at all times.

I have done a series of pulse-chase experiments at both later and earlier times after infection. In these experiments the infecting λ phage DNA is labelled with radioactive phosphorus (^{32}P) so that the fate of this DNA as well as that of the newly replicated, progeny DNA can be observed. The phage infected cultures were pulsed at various times with [^{3}H]-thymidine.

In one experiment a λ-infected culture was pulsed at 28 minutes after infection, for 2 minutes. DNA was isolated at 30 and 38 minutes after infection and analysed on neutral (Fig. 4) and alkaline (Fig. 5) sucrose gradients. The neutral sucrose gradients (Figs. 4A and 4B) show that the parental [^{32}P]-λDNA is in two peaks. The slower sedimenting peak is phage size DNA and the faster peak consists of supercoils. Initially, at the end of the pulse (Fig. 4A) the [^{3}H]-labelled DNA sediments up to 2.0 times as fast as phage size. This is the concatemer DNA. Eight minutes later (Fig. 4B) an appreciable amount of the concatemer DNA has been converted to phage size DNA.

Fig. 5 shows the alkaline sucrose gradient analysis of the same DNA preparations as in Fig. 4. The supercoil peak of the parental [^{32}P]-λDNA now shows the expected increase in sedimentation rate. Also the [^{3}H]-pulse labelled DNA shows in alkali the expected broad peak sedimenting 1.0-2.0 times as fast as phage size DNA. Hence, at later stages the events occurring are the same as those reported by Smith and Skalka, i.e. concatemers are apparently direct precursors of phage size DNA.

A similar pulse-chase experiment is shown in Figs. 6 and 7 but here the [^{3}H]-pulse was from 5 to 7 minutes after infection and DNA was isolated at 7, 14.5 and 22 minutes after infection. In all cases (Fig. 6) the parental [^{32}P]-λDNA is in two peaks corresponding to phage size and supercoil DNA, and in alkaline sucrose (Fig. 7) the supercoils show the expected increase in sedimentation rate. The [^{3}H]-pulse labelled DNA again sediments 2.0 times as fast as phage size DNA in neutral sucrose (Fig. 6A), but in alkali (Fig. 7A) it sediments more slowly than phage size DNA. Thus it appears that this pulsed DNA is not of the concatemer type. Furthermore, it is not phage size DNA, but supercoil DNA which accumulates in the chase period (Fig. 6B and 6C). The alkaline gradients of the later samples (Fig. 7B and 7C) also show pulse label accumulating in supercoils. There is also, in alkali (Fig. 7B and 7C) some heterogeneous pulse labelled DNA and supercoils. The nature of this material is unknown at present.

It is clear that at early times after infection the replication events occurring are quite different from those at later times. This then suggests that there may be a switchover from an "early" to a "late" mode of replication. That such a switchover occurs seems certain because pulse chase experiments performed at intermediate times showed sedimentation profiles which consist of a mixture of those seen early and late. The nature of the switchover is under investigation.

What is the conformation of the early pulse labelled λ DNA? I believe that this DNA is a replicating circular form. The major reason for this is the alkaline sedimentation profile of this DNA (Fig. 7A) which is just that expected of a pulse-labelled replicating circle of the type illustrated in Fig. 2. Also, the product of early replication is a supercoil, i.e. a circular form.

The most direct way of characterising this DNA is by direct visual observation in the

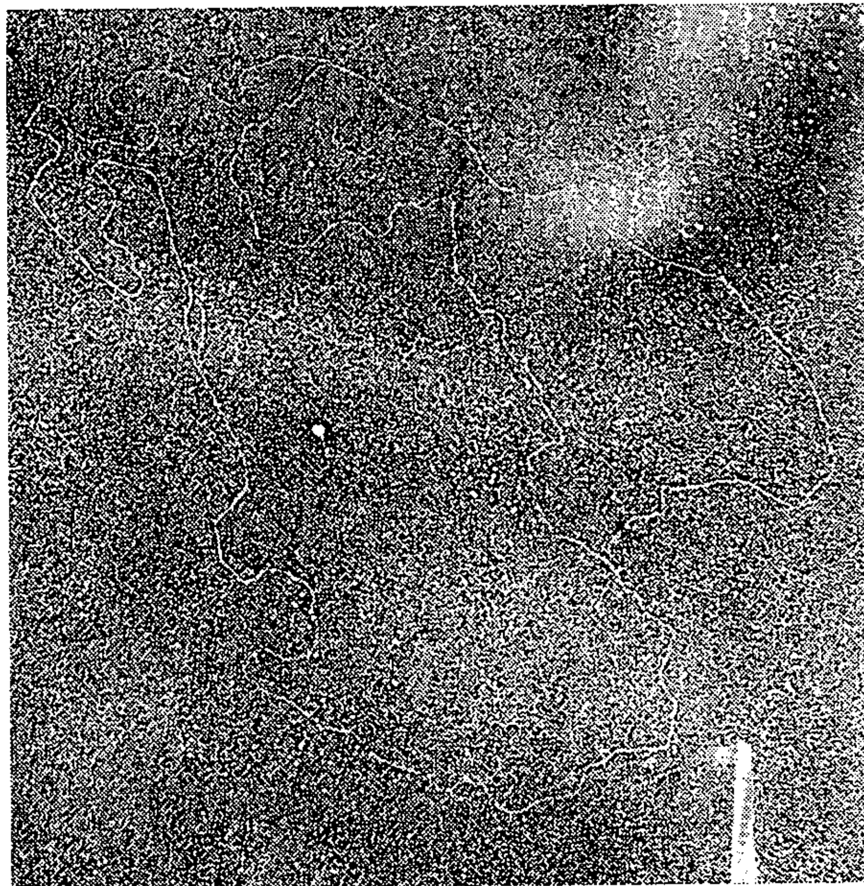


Fig. 8 Electron microscopy of λ DNA. A replicating circle of λ DNA present in a preparation made 6 minutes after infection. The DNA was spread on a carbon-coated grid and shadowed with platinum.

electron microscope. Pulse-labelled DNA is first separated from contaminating bacterial DNA[5] and then spread on a protein film, picked up on a carbon-coated grid and shadowed with platinum. The result of some preliminary work with Mr. K. Williamson is shown in Fig. 8. This is a circular replicating molecule of λ DNA which was present in a preparation made 6 minutes after infection and is just the structure predicted above for the early replicating DNA.

Further sedimentation and electron microscope studies are in progress and are planned in order to elucidate more fully the structure and subsequent fate of λ replicating DNA.

References

1. J. Cairns. Cold Spring Harbour Symp. Quant. Biol., *28*, 43 (1963).
2. V. C. Bode and A. D. Kaiser. J. Mol. Biol., *14*, 399 (1965).
3. E. T. Young and R. L. Sinsheimer. J. Mol. Biol., *10*, 562 (1964).
4. M. G. Smith and A. Skalka. J. Gen. Physiol., *49*, 127 (1966).
5. B. J. Carter and M. G. Smith. Biochem. Biophys. Acta. (1968) *166*, 735.

Acknowledgements

I would like to thank Mr. K. Williamson of Plant Chemistry Division, D.S.I.R., Palmerston North, for the electron microscopy. Also, I wish to thank my supervisor Dr. M. G. Smith for much helpful advice and criticism.

TECHNICAL TOPICS . . .

PENS FOR POTENTIOMETRIC RECORDERS

J. R. L. Walker and R. J. Brook

(Cawthron Institute, Nelson)

MANY of the newer forms of sophisticated chemical gadgetry, such as recording U.V. and I.R. spectrophotometers, gas chromatographs and so on, require some sort of recording instrument. These recording devices can sometimes provide a powerful source of frustration. The pens in the writing systems of these recorders are apt to fail in their duty at a critical moment and there can be few things more annoying than to find half a GLC trace lost because the recorder pen has failed. Here at the Cawthron Institute we have modified the pen systems on our Varian G-41 and Heathkit EUW-20A recorders in order to overcome these troubles.

Potentiometric recorders used for GLC need a pen system capable of fast writing speeds during peak excursions (best done by a gravity feed pen), yet the pen must not flood whilst a slow running base line is being recorded (a task better suited to a capillary feed pen). The drying time of the ink and the surface of the chart paper also play a part in this problem. Our GLC apparatus is coupled to a Varian G-41 recorder originally equipped with a gravity feed pen which was prone to flood or clog depending on chart speed and the type of ink used. After a certain amount of trial and error we achieved a satisfactory solution to our problem by mounting an inexpensive stencil pen ("Standardgraph" or similar) on the recorder pen carriage with modelling clay ("Plasticine"*) or other means. These stencil pens offer several advantages: (a) they are equipped with a built-in cleaning wire so that the pen is readily cleared before each run, (b) they are available in a range of nib thicknesses, (c) their low cost (about 50c) makes it possible to have a separate pen for each colour recording ink.

The Heathkit EUW-20AE is an inexpensive laboratory recorder that is designed to use a cartridge refill type fountain pen and this has been reasonably satisfactory. However in the authors' experience the substitution of a low-cost, fine-point, felt-nib pen ("ELF" brand) has proved to be more convenient and offers the advantages of ready change of colour and less danger of smudging of the trace.

Finally we have investigated the question of locally available substitutes for the special grade "Ever-sharp" ball pens used in the Unicam SP200 and SP800 recording spectrophotometers. Our research showed that the "Scripto" refill could be modified for this purpose and was available for less than a quarter of the cost of the special refills. More recently we have fitted a "Variant" wet ink pen assembly (Unicam Part No. 790118) to these instruments and find it most satisfactory. This system using a readily available Rotring "Variant" drawing pen makes it very easy to change pen colours—a great advantage when recording multiple traces on the same recorder chart. The "Variant" pen also works well on potentiometric recorders.

*A.R. Grade, naturally!!

CONCERN about the economic situation of this country recently led to the setting up of the National Development Council.

It could well be of value, and certainly of much interest, to briefly look at economic trends in other countries which have recently faced similar situations. Dr. Whitton of ICIANZ reports here on Industrial Research and Development in Australia; Dr. Borren will report in the next issue of the Journal on recent developments in Holland.

INDUSTRIAL RESEARCH AND DEVELOPMENT IN AUSTRALIA

by W. I. Whitton, M.Sc., Ph.D., F.R.A.C.I.

I.C.I.A.N.Z. Ltd., Victoria, Australia

RECENTLY, the Australian Industrial Research Group sent a questionnaire to 600 manufacturing companies to collect information about their I R & D activities.

The A.I.R.G. is a group of industrial research and development managers who meet in Sydney and Melbourne to discuss matters concerning I R & D management and the role of I R & D in the Australian economy.

132 survey forms were returned fully or partly completed. 12 of them were almost bare of useful answers. 8 of the remainder indicated R & D expenditure of $5,000 p.a. or less. These 20 were disregarded as being of insufficient significance.

112 survey returns were subjected to analysis. Of these, some gave no indication of their industry. Others considered R & D expenditure as confidential but stated numbers and categories of persons engaged in R & D. It has been possible to estimate their probable expenditure by comparison with returns showing reasonable areas of similarity. They would not add more than 2 or 3 percent to the survey total.

Outline Data on Present Expenditure

(a) Total "in house" I R & D for 112 firms (including the estimates for those not stating the exact amounts)	$30,437,585
(b) Research contracted from other firms	1,032,300
Total (a and b)	$31,469,885

I R & D Staff

Professional:	Doctor's degree	120	
	Master's degree	146	
	Honours Bachelor or more than one Bachelor degree	317	
	Bachelor's degree	704	
	Diplomates	712	
	Total professional	1,999	persons
Non Professional:	Technician class	2,164	
	Others	496	
		2,660	
	Total all categories in I R & D	4,659	persons

Distribution of Expenditure by Products

Some indication of this distribution is given in Table I. In compiling this data, due respect has been given to the smaller numerical groups by combining totals to obscure and keep confidential details of their returns.

TABLE 1

Distribution of Expenditure by Products

	No. of companies responding	In house $	Purchased $
Ferrous & Non Ferrous Metals	8	6,931,000	445,300
Electronic & Light Electrical	11	5,565,000	15,000
Chemicals	15	5,398,202	56,354
Engineering, Machinery & Automotive	24	3,759,853	98,000
Food	7	2,479,600	50,000
Paint & Coatings, Fats and Detergents, Matches	7	2,351,000	180,000
Glass, Rubber, Plastics, Paper	9	2,359,000	15,000
Pharmaceuticals	9	482,500	43,000
Materials of Construction	6	234,000	104,000
Textiles	5	184,430	20,000
Utilities & some unspecified	5	208,000	5,400
Remaining unspecified	6	485,000	250
TOTALS	112	$30,437,585	1,032,300
		1,032,300	
		$31,469,885	

N.B. All figures stated above should be considered as minima, since they are the summation of figures supplied only by those companies which answered the questionnaire. It is not correct to conclude that any group spends no more than the sums stated nor that the order in which the groups appear would remain unaltered in the event a 100% survey could be conducted.

Range of Expenditure

10 companies spent 1 to 3 million dollars, in-house, annually.
36 spend $100,000 to $1,000,000.
26 spend $50,000 to $100,000.
40 spend $5,000 to $50,000.

I. R. & D. Expenditure as a Percentage of Sales

95 companies provided data permitting of this line of analysis. The data was assembled into groups according to the percentage of Sales (Range) indicated.

Group

A	10	companies	spend	over	3%	of Sales on	I. R. & D.
B	8	,,	,,	,,	2.1 - 3%	,,	,,
C	24	,,	,,	,,	1.1 - 2%	,,	,,
D	19	,,	,,	,,	0.6 - 1%	,,	,,
E	34	,,	,,	,,	0 - 0.5%	,,	,,

Sources of Technology

A. *For New Processes*

% of Capital Expenditure based on Overseas Technology	No. of companies responding	% of companies
0 - 10	26	20
10 - 25	21	16
25 - 50	24	19
50 - 75	21	16
75 - 100	37	29
	129	100

B. *For Improvement of Existing Processes*

% of Capital Expenditure based on Overseas Technology	No. of companies responding	% of companies
0 - 10	44	34
10 - 25	30	23
25 - 50	24	19
50 - 75	20	15.5
75 - 100	11	8.5
	129	100.0

Relationship to Gross National Production

Whereas the data establishes that 112 companies from a representative cross-section of Industry are currently spending about $31,470,000 a year on I. R. & D., it is pointed out that this does not include all companies having I. R. & D. activity. In the circumstances, it is considered reasonable to assume a total figure of at least $35,000,000 p.a.

Relating this figure to the G.N.P. for the September quarter 1967, $5,842 million (or $23,300 million per annum) one arrives at a minimum figure of 0.15% of G.N.P. for expenditure on I. R. & D. in Australia.

Comment

Although it is known that a number of companies doing I. R. & D. did not return the questionnaire, it is thought that a figure of $35m. p.a. is probably not too far from the real total.

On this basis, Australia's expenditure, which is 0.15% of G.N.P., is low compared with other industrialised countries, only being ahead of countries such as Spain and Greece (see Table 2).

TABLE 2

I. R. & D. as % G.N.P.

Country	%	Country	%
United States	2.2	France	0.8
United Kingdom	1.5	Canada	0.44
Sweden	1.0	Australia	0.15
Germany	1.0	Spain	0.05
Japan	0.9	Greece	0.03

It is interesting that in the more industrialised countries, 60% to 70% of all R. & D. done is done in industry; U.S. 67%, U.K. 67%, Japan 65%, whereas in Australia only about 25% of all research is done in industry, and Canada also a lower %, approximately 41%.

Another important factor is that in some other countries government financial support to I. R. & D. is high, being approximately 50% in U.S., 30% in U.K., 40% in France and 30% in Norway. In Australia the support by government is still very small. The new I. R. & D. Grants Act will help, but it appears that it has had little impact so far.

According to the survey just completed, there are only 120 I. R. & D. staff with Dr's degrees. Even with a high growth rate in I. R. & D. in Australia, it appears that industry will only absorb 20 to 30 Ph.D. graduates a year. This is a serious matter with the large number of post-graduate students now at local and overseas universities.

QUALITY CONTROL CHEMIST

Merck Sharp & Dohme (New Zealand) Limited, pharmaceutical manufacturers, wish to retain a graduate chemist to supervise Quality Control in their Lower Hutt factory.

The position entails supervision of manufacturing processes and analysis of finished products to ensure conformity with the Company's standards.

Initial training will be undertaken in Australia and the successful applicant may spend considerable time in Sydney during the next two years.

An attractive salary will be negotiated and applicants are asked to indicate desired salary range in their application.

Please address all correspondence to the Managing Director, Merck Sharp & Dohme (New Zealand) Limited, P.O. Box 30-342, Lower Hutt, marked "confidential".

INSTITUTE PRIZE-WINNERS 1968

Dr. R. C. Lawrence
(I.C.I. Prize)

THE PRODUCTION OF CHEDDAR CHEESE

One of the least understood aspects of cheese ripening is the way in which the distinctive flavour of Cheddar cheese develops. In particular the chemical identity of the compounds responsible for this flavour has proved remarkably elusive.

There was considerable evidence, prior to the present studies, that milk fat was the source of characteristic Cheddar flavour. Our investigations have shown that the small quantities (100-200 ppm) of esterified $C_6 - C_{14}$ β-keto acids present in milk fat, which on hydrolysis yield the highly flavourful $C_5 - C_{13}$ methyl ketones, are the most likely precursors. These ketones are considered to be responsible for the more pungent flavour of "Blue" cheeses, i.e. cheese inoculated with spores of the fungus *Penicillium roqueforti.*

It seemed reasonable at the time (1963), since very little was then known about which of the many different types of microorganisms present in Cheddar cheese might be responsible for flavour formation, to assume that Cheddar flavour might be a more dilute form of Blue cheese flavour and that fungal spores might be implicated. A study of the metabolism of triglycerides and fatty acids by spores of *Penicillium roqueforti* was therefore undertaken. The formation of methyl ketones was shown to be markedly stimulated by the same specific sugar and amino acids that promoted the rapid germination of the spores, indicating that common reactions were involved.

Highly interesting as this work proved to be, trials being carried out concurrently with cheeses made under strictly controlled conditions showed with increasing certainty that the microorganisms responsible for the basic flavour in Cheddar cheese are not fungi but the "starters", i.e. strains of lactic streptococci added to the milk to produce the acid needed in cheesemaking. Equally important, the two major flavour defects in Cheddar cheese, i.e. bitterness and fruitiness, result from the use of specific strains of starter. The economic implications of these findings may prove important since it is now considered possible to make cheese without off-flavours by the careful choice of certain strains of starter. Cheese with increasing intensity of flavour can be produced to order by the use of increased starter concentrations and higher ripening temperatures.

Identification of the lactic streptococci as the organisms responsible for flavour production has provided the stimulus for the current investigation on their biochemical characteristics, in particular with respect to their lipolytic and proteolytic activities. It is hoped that these studies will eventually provide the material that will allow the identification of the individual compounds that are responsible for Cheddar cheese flavour.

D. A. Hills
(Morcom, Green Edwards Prize)

AN INDUSTRIAL CONTRIBUTION

My work on various aspects of rubber technology has covered heat transfer, microbiological degradation of pipe joint rings, and test methods relating to the kinetics of the vulcanization reaction. While seemingly unconnected topics, they fall I believe, into a common category, i.e., areas where published work available to industry is "classical" or "commercial", but seldom practical.

Regarding heat transfer, I can best explain my work by quoting from the first paragraph of the publication—'To the rubber technologist who occasionally becomes involved in a heat transfer problem, most reference books present a formidable series of equations, the use of which requires, or appears to require, a reasonable mastery of mathematics. Under these circumstances it is common (and wise) practice not to attempt to solve the problem, but to fall back on arbitrary rules-of-thumb or tables, the significance of which may not be well understood, or pure guesswork. In this paper, it is hoped to present a basic approach to heat transfer calculations or reference tables as these are applied in the rubber industry, and to promote a better understanding of these matters.' The acceptance of this publication as a "standard reference" by major concerns has justified the effort.

The microbiological degradation of natural rubber pipe joint rings has been the subject of much controversy. A Dutch microbiologist concerned with water reticulation reported that natural rubber is susceptible to attack. A member of a natural rubber research organisation reported that the rubber itself was not the problem, that "correct" compounding was the answer. In view of the conflict, microbiologists, ring manufacturers and end users, each excusing their lack of knowledge of the other two fields, generally "stuck their heads in the sand". My independent research in this country has been published, and appears to have stimulated the "other sides". Many standard tests exist for the practical assessment of "cure kinetics", but few people using them appear to understand their significance, or be able to modify them to suit their laboratory conditions and equipment. Most of my published work has stemmed from basic research into the test methods and their interpretation. The results have enabled unrelated instruments to be compared, both by myself and workers in other countries.

The purposes involved in conducting "private research" for publication, I would rate in the following order:

(1) To prove that industrial chemists can, by the use of a little of their leisure time, add to the knowledge of their fellow technologists, without disclosing any "industrial secrets".

(2) To illustrate the need for education, even if self-imposed, for the industrial chemist, who, in the absence of suitable courses in this country, must extract "practical" knowledge from either "classical" textbooks or "commercial" brochures.

(3) To show that New Zealand technologists can conduct work of benefit to their particular field, and have this work accepted overseas.

CONFERENCE 1969

General Theme of Conference: Chemistry and the N.Z. Economy. Three broad topics have been picked which will be treated fully but in a general way. These should be of interest to all chemists and should provoke discussion among both specialists and non-specialists.

Meetings of "Groups" on the Monday preceding Conference: A memorandum from the President concerning the formation of specialist groups in the Institute is to be found below.

An invitation is extended to anyone who wants to arrange a group meeting or who would be interested in a group meeting to write to the Conference Secretary (Dr. P. K. Grant, Chemistry Dept., Otago University). The Conference Committee will arrange facilities both for inaugural meetings and for the presentation of papers at this meeting. Group organisers are likely to be asked by the Conference Committee to take responsibility for the scientific programmes of such inaugural meetings.

	Monday 25th August	Tuesday 26th August	Wednesday 27th August	Thursday 28th August	Friday 29th August
a.m.	Council Meeting. Inaugural Meetings of Groups	Protein Symposium 1. Meat 2. Dairy 3. Plant	Fibres Symposium 1. Introductory 2. Wool	1. Economic future of N.Z. Science based industries 2. A.G.M.	Symposium: Chemical Based Industries in N.Z. 1. Biochemical 2. Chemical. Close of Conference.
p.m.	and Scientific Sessions organised by Groups. Opening of Conference. Presidential Address.	1. Food Proteins A general lecture by a guest speaker. 2. N.Z.'s contribution to world protein. Free.	3. Vegetable fibres 4. Synthetic fibres. Dinner.	Lecture visits 1. Industrial, at McSkimmings 2. Biological, at Medical School 3. Academic. Public Lecture.	

MEMORANDUM ON THE FORMATION OF SPECIALIST GROUPS

The N.Z.I.C. membership is large and includes many kinds of chemists, some of whom are sufficiently specialised to be out of touch with the interests of some other NZIC members. There is a natural tendency for specialists with similar interests to group together for periodic discussion and exchange of information, and the NZIC Council should encourage this. After all, the Institute exists for the good of its membership, and Council should sponsor healthy development of any well-defined minority group, as well as expecting loyalty to the Institute from all such groups.

It is suggested that at the 1969 Conference opportunity be provided on the Monday for an inaugural meeting of any group and any number of groups of chemists who believe they have common interests. From such a meeting might come a resolution to form a group which agrees to hold special meetings among its members — for example an annual meeting immediately preceding the Institute conference. A development beyond a loose grouping could be a formal Section of the NZIC. A group of chemists could apply to Council for recognition as a Section, and Council might make its decision on a number of grounds, such as the size of the proposed group and the importance attached to formal communication between group members. There is no doubt that on most grounds biochemists and geochemists would automatically be granted Section status. On the other hand, Council might reject a proposal for an alicylic chemistry Section in favour of a wider organic chemistry Section. With granting of Section status could go formal aid to Section secretaries, such as the provision of addressograph plates and stationery.

The detailed working of any such scheme would require careful discussion by Council. It is important, however, that encouragement and sponsorship of useful groups within the Institute be agreed upon without delay. If we wait much longer, we could well see the irreversible fragmentation of the Institute.

J. VAUGHAN,
President.

THE CHEMICAL ESSAY PRIZE REGULATIONS

1. The New Zealand Institute of Chemistry shall offer annually a prize for an essay or review on a chemical topic.
2. The prize shall be open to anyone who has not attained the age of 25 years before April 30th in the year of the contest, whether a member of the Institute or not.

   (Note: Entries from students will be welcomed.)
3. The entry shall be not longer than 5,000 words.
4. The entry shall be in a form suitable for publication, and the Institute shall have the right to publish the winning entry.
5. Applications, in completed form, must be received by the General Secretary, P.O. Box 250, Wellington, not later than 30th April in the year of the contest.
6. The entries shall be judged by a Committee of examiners set up by Council for the purpose. The President of the Institute and the Editor of the Journal shall be ex-officio members of this Committee.
7. The award shall be made by the Council after consideration of the report of the Committee of examiners, and the presentation of the prize shall be made, whenever possible, at the annual conference of the Institute.
8. No award shall be made if, in the opinion of the Committee of examiners, there is no entry of a sufficiently high standard of merit.
9. The value of the prize shall be such sum as the Council may from time to time determine, and the prize shall be spent on books or instruments to the satisfaction of the Council.

   (Note: The value of the prize is at present $50.)

INSTITUTE OFFICERS — 1968-1969

PRESIDENT

J. Vaughan was born in South Wales in 1920 and graduated from the University of Wales in 1941. He spent some time in the Armament Research Department of the British Ministry of Supply, and in the London pharmaceutical firm of Crookes Laboratories Ltd. before joining the staff of University College, Swansea, in 1947. He came to Canterbury in 1949 and was made Professor of Chemistry in 1963. Since becoming a university teacher his research interests have been consistently in organic reaction mechanisms and he has about seventy publications in this general field. He is head of the chemistry department at Canterbury and Pro-Rector of the University. He served for six years on the Management Committee of the Leather and Shoe Research Association and is at present on the Council of the Pottery and Ceramics Research Association. He was chairman of the Canterbury Branch Committee which inaugurated the highly successful "Chemistry in Action" series and maintains a very active interest in this and the Junior Chemical Society.

FIRST VICE-PRESIDENT Dr. T. A. Rafter.

SECOND VICE-PRESIDENT Dr. W. A. McGillivray.

BRANCH OFFICERS

Waikato

Chairman: Mr. J. E. Allan.

Hon. Secretary/Treasurer: M. P. Lester.

Committee: R. A. Hall, A. Peters, Dr. E. P. White, Dr. D. E. Wright.

Branch Editor: F. S. Pickering.

Mr. J. E. Allan

Auckland

Chairman: Professor P. B. D. de la Mare.
Secretary: Dr. D. J. McLennan.
Treasurer: Mr. H. A. Raethel.
Committee Members: Mr. J. K. Johannesson, Mr. A. S. Morton, Dr. D. F. Nelson (Council Delegate), Dr. J. Rogers, Dr. M. J. Taylor (Branch Editor), Dr. A. F. Wilson.

Professor P. B. D. de la Mare, M.Sc.(N.Z.), D.Sc.(Lond.), F.R.I.C., F.N.Z.I.C., was born in Hamilton, New Zealand, and was educated at Hamilton High School (1933-37) and at Victoria University College (1938-41). From 1942 to 1945 he was employed by the New Zealand Department of Agriculture, first in the Chemistry Section in Wellington and later at Ruakura Animal Research Station. Between 1946 and 1948 he studied for the Ph.D. Degree at University College, London, where he was appointed to the staff in 1948. In 1960 he became Professor of Chemistry and Head of the Chemistry Department of Bedford College (University of London), and in November 1967 returned to the University of Auckland as Head of the Chemistry Department. He is the co-author of several books, and has published numerous scientific papers, mainly in the Journal of the Chemical Society, in the field of organic reaction mechanisms. He has been a Member of the Council of The Chemical Society (London) and has served on several of its subcommittees. He has acted as the Royal Institute of Chemistry's Assessor in Organic Chemistry for the Higher National Certificate in Chemistry and as External Examiner in Chemistry for the University of Khartoum.

Manawatu

Chairman: Dr. R. R. Brooks.

Secretary: Dr. L. K. Creamer.

Treasurer: Dr. G. B. Russell.

Committee: Mr. E. C. Jessop, Dr. R. C. Lawrence, Dr. E. Moustafa, Dr. P. J. Peterson, Dr. E. L. Richards.

Council Delegate: Dr. R. R. Brooks.

Branch Editor: Dr. L. K. Creamer.

Dr. R. R. Brooks is Reader in Chemistry at the Department of Chemistry and Biochemistry, Massey University, Palmerston North.

He was born and educated in Bristol, England, and gained a B.Sc.(Hons.) in Chemistry from Bristol University in 1952. After working as an industrial chemist until 1956, he emigrated to South Africa. Following further industrial experience, he was appointed lecturer at the University of Capetown in 1958 where he gained a Ph.D. in Geochemistry in 1960. He joined the staff of Massey Agricultural College in 1960 where his main research interest has been in analytical geochemistry and bio-geochemistry. He has recently returned from a year's leave spent in the Geology Department of U.C.L.A., California.

Dr. R. R. Brooks

Wellington

Chairman: Dr. D. Suuring.

Hon. Secretary: Dr. J. F. Young.

Hon. Treasurer: Dr. R. J. Furkert.

Committee: Dr. A. F. M. Barton, Mr. G. F. Browne, Mr. C. L. H. Stonyer, Professor J. W. Tomlinson.

Branch Editor: Dr. A. F. M. Barton.

Past Chairman: Dr. I. R. C. McDonald.

Delegate to Council: Dr. P. K. Foster.

Hon. Auditor: Mr. F. J. T. Grigg.

Dora Suuring graduated from the University of Amsterdam in 1940 as Doca. Chem. She worked as a teacher and as an industrial chemist (paints and baking powders) before her activities in the Dutch Underground Movement led to her being put in Concentration Camp at Barneveld. When the camp was shifted to Germany she escaped and renewed her underground activities. She came to New Zealand in 1948, began teaching again and is now Head of the Science Department, Tawa College.

She became an Associate in 1954 and helped to establish the Wellington Junior Chemistry Group. She has been its convener for four years, and is especially interested in modernising the teaching of chemistry in secondary schools. She has taken part in the organising and running of several refresher courses for teachers.

Canterbury

Chairman: M. S. J. Hogan.

Hon. Secretary: Dr. J. M. Coxon.

Hon. Treasurer: Mr. G. M. Keeley.

Committee: Mr. J. A. Berry, Dr. M. P. Hartshorn, Dr. M. H. C. Munro, Dr. W. S. Simpson.

Delegate: Dr. J. M. Coxon.

Branch Editor: Mr. S. J. Hogan.

Chairman of the Canterbury branch for the coming year will be the Registrar, Mr. D. J. Hogan. Born and educated in Canterbury he graduated B.Sc. from Canterbury University College in 1949. After dabbling briefly with industrial chemistry he joined the Christchurch Branch of the then Dominion Laboratory. In 1952 he studied Dairy Chemistry and Dairy Bacteriology at Massey College and then worked for a year as bacteriologist at Dominion Laboratory, Wellington. In 1954 he returned to Chemistry Division, D.S.I.R., Christchurch, where he works in the fields of toxicology and water supplies while retaining an interest in food chemistry and bacteriology.

He was secretary of the Canterbury Branch from 1955 to 1966 and was appointed Registrar in 1959. He has been closely associated with the "Chemistry in Action" series and with the Canterbury Junior Chemical Society.

D. J. Hogan

Otago

Chairman: Professor J. R. Robinson, Physiology Department, University of Otago.

Secretary: Dr. R. M. Carr, Chemistry Department, University of Otago.

Treasurer: Dr. G. W. Emerson, Biochemistry Department, University of Otago.

Delegate: Dr. J. C. Dacre, Toxicology Research Unit, University of Otago.

Committee: Dr. M. R. Grimmett (Editor), Mr. M. R. Anderson, Mr. R. H. McKeown, Mr. R. McNaught.

Auditor: Mr. T. A. Thompson.

Professor J. R. Robinson, Ph.D., M.D., Sc.D. (Cambridge), F.N.Z.I.C., F.R.S.N.Z., F.R.A.C.P., was born in the English Lake District, took first class honours in the Natural Sciences Tripos at Cambridge in Physics, Chemistry and Physiology (Part I, 1934) and Biochemistry (Part II, 1935). He worked under Professor E. K. Rideal in the Department of Colloid Science at Cambridge on the anomalous viscosity of suspensions of tobacco mosaic virus for his Ph.D. degree (1938), and then later qualified in medicine at the London Hospital Medical College. He did clinical work at the London Hospital, served in the R.A.M.C. in the United Kingdom, France and Belgium, and finished his "military" career in charge of the Biochemistry Department of the Central Military Pathological Laboratory (at Poona!). He returned from the Army to Cambridge to become a Fellow and Medical Tutor at Emmanuel College and an Assistant Director of Research in the Department of Experimental Medicine under Professor R. A. McCance, FRS. He came to New Zealand temporarily on sabbatical leave in 1954 (to meet his in-laws) and then permanently in 1957 to become Associate Professor in the Department of Physiology, where he was left to hold the Chair when Professor A. K. McIntyre departed to Monash University in 1961. Since 1947 he has been working on transport of water and accumulation of alkali metal cations by living cells with particular reference to the functions of water and electrolytes in the body and their handling by the kidney. He was elected a Fellow of the N.Z. Institute of Chemistry in 1963, Fellow of the Royal Society of New Zealand and of the Royal Australasian College of Physicians in 1964, gained a Sc.D. at Cambridge in 1965, and has served on the New Zealand Medical Research Council since 1961.

BRANCH NOTES

Wellington

Soil Bureau

K. S. Birrell was recently awarded the degree of D.Sc. from the University of Otago.

Dr. J. K. Martin, who has spent the last two years at the Exobiology Section, National Aeronautics and Space Administration, Moffett Field, California, has now resigned to take up a position with the Division of Soils, C.S.I.R.O., Adelaide.

Mr. P. L. Searle recently returned after spending eight months with the Division of Soils, C.S.I.R.O., Adelaide.

Chemistry Division

Dr. A. J. Ellis is spending 2 to 3 months in Chile, where he is directing geothermal field work in the Northern Provinces.

Mr. C. Liu, a chemist from Taiwan, is spending 6 months at the Chemistry Division studying Geothermal Development.

Mr. I. R. C. McDonald, past Chairman of the Wellington Branch, N.Z.I.C., has been globe-trotting for 3 months, visiting laboratories working on wood chemistry and allied fields.

Mr. R. J. Weston leaves shortly for Linacre College, Oxford, where he is to work with Dr. T. G. Halsall on triterpenes.

Institute of Nuclear Sciences

Dr. H. C. Sutton recently attended the 4th Radiation Chemistry Conference organised by the Australian Institute of Nuclear Science and Engineering. During the Conference, which was held at the Australian Atomic Energy Commission's Research Establishment, Lucas Heights, near Sydney, Dr. Sutton chaired a Session and gave a lecture on his studies of peroxy radicals.

Victoria University

Dr. E. A. Barnsley of St. Thomas' Hospital Medical School, University of London, has taken up the position of Senior Lecturer in Biochemistry. His research interests include the formation and metabolism of S-alkyl cysteines in animals, and the metabolism, genetics and control by the host of intra-cellular symbionts of insects.

Dr. G. R. and Mrs. J. R. Burns, both graduates of Victoria University, will shortly return to Wellington from England. Dr. Burns, who has been a Post-Doctoral Fellow in Spectroscopy with Professor I. Mills at the University of Reading has been appointed to a Lectureship in Chemistry.

Dr. Emerson F. Heald of Thiel College, Greenville, Pennsylvania, is working with Professor J. F. Duncan for a year on the kinetics of iron oxide-titanium dioxide reactions. Mrs. Joan S. Heald is a Temporary Junior Lecturer in the Chemistry Department during this time.

Dr. R. A. Matheson will be leaving Victoria University early in 1969 to take up a Senior Lectureship in the Chemistry Department, University of Otago.

Dr. D. N. Sitharama Rao, of Mysore, India, previousy at the All India Institute of Medical Sciences in New Delhi, has arrived to take up a Post-Doctoral Fellowship and work with Professor J. F. Duncan. He is accompanied by his wife and son.

The Chemistry Department recently took delivery of a Hitachi Perkin-Elmer R20 N.M.R. Spectrometer, the first of this model to be installed in Australasia. This machine, purchased on a U.G.C. research fund award, features a thermostatted permanent magnet and will be used for a variety of research studies including kinetics of aryl substituted cyclopropene rearrangements, identification of photochemical reaction products, conformational isomerism in cyclic secondary amine complexes and general structural determination.

Industry

Mr. G. J. Gordon, formerly Chief Chemist with the Guardian Cement Company, Westport, has taken up a position with the South Australian Portland Cement Company.

Mr. E. S. Borthwick has been appointed Technical Manager for Shell Oil N.Z. Ltd.

Teaching

Dr. Dora Suuring has been appointed as one of two New Zealand teachers on the National Subject Panel of the International Educational Association.

. . . and from Nelson

Mr. A. R. Thawley, Hopkins-Cotterell Research Fellow, leaves Nelson in October to take up an appointment as Research Assistant in the Department of Chemistry, University of Glasgow, where he will be applying gas chromatography/mass spectrometry techniques to the investigation of steroidal drugs and their metabolites.

Dr. J. R. L. Walker visited Australia in the last two weeks of October in order to present a review paper on "Phytochemical Studies on N.Z. Hop Varieties" to the Institute of Brewing (A.N.Z. Section) meeting in Sydney. Dr. Walker's trip has been sponsored by the Brewer's Association of N.Z.

Canterbury

Dr. A. Fischer, Reader in Chemistry, University of Canterbury, leaves early in 1969 to become Professor of Organic Chemistry at the University of Victoria, British Colombia, Canada. Dr. Fischer was appointed Assistant Lecturer in the Canterbury University Chemistry Department in 1955 and was promoted to Reader in 1966. He was a Research Fellow at California Institute of Technology in 1960/61 and held a Nuffield Fellowship at University of Sussex in 1966/67. He was Conference Secretary for the N.Z.I.C. Conference in Christchurch in 1956 and Chairman of the Canterbury branch in 1964.

Dr. G. A. Rodley and Dr. G. J. Wright have been promoted to Senior Lecturers in Chemistry at the University of Canterbury.

Mr. A. A. Evans has left the Department of Chemical Engineering, University of Canterbury, to take up an appointment as Chemical Engineer with the N.Z. Dairy Research Institute, Palmerston North.

Professor A. M. Kennedy, Head of the Department of Chemical Engineering, University of Canterbury, returned recently from an Erskine Fellowship study tour of Britain, United States, Canada and Japan. On his return he commented on the way chemical engineers in in universities in these countries were becoming increasingly involved in biochemical research and gave as examples the study of the flow of red blood cells in veins, the artificial kidney, and artificial lungs. He also said that New Zealand should consider a chemical process for producing salt from sea water before further developing solar salt works.

Otago

Recent overseas visitors to the Chemistry Department, Otago University, included Professor R. P. Bell, F.R.S. (University of Stirling) who lectured on "The halogenation of olefins" and "The special position of hydrogen in chemistry", Professor R. W. Raphael, F.R.S. (Regius Professor of Chemistry at Glasgow University) who lectured on "The structure of isoclovene", Professor H. W. F. Taylor (Aberdeen University) who spoke on "The chemistry of cements", and Professor M. W. Lister (Toronto University).

Professor R. L. Scott (University of California, Los Angeles) is spending his sabbatical leave in the Chemistry Department as Visiting Mellor Professor of Chemistry. His primary research interests are related to the study of non-electrolyte solutions.

Dr. W. Hanger, formerly manager of McSkimmings Industries' Benhar factory, is now a member of A. M. Anderson and Associates, Management and Technical consultants.

The second of the two sixth form lectures for 1968, delivered by Dr. M. R. Grimmett with the aid of demonstrations by Dr. R. A. J. Smith, dealt with techniques of separation and purification used by organic chemists. In excess of 200 sixth-form students attended. Dr. Smith, a recent Ph.D. graduate of Otago University, will relinquish his post of Junior Lecturer in November to take up a post-doctoral fellowship at Dartmouth College, New Hampshire, U.S.A.

Mr. R. B. Withers, recently of W. Gregg and Co. Ltd., Dunedin, has accepted a position as Lecturer in Applied Chemistry at Otago University.

We record with regret the death of Dr. A. D. G. Blanc, A.N.Z.I.C., of Wanaka.

Dr. J. Dacre, a member of the WHO Expert Committee on Pesticides in Food, will spend December in Geneva, London. The Committee will be meeting to set tolerance levels of various pesticides, a matter of great importance to New Zealand.

BOOK REVIEWS

"Elemental Sulphur" — Chemistry and Physics. Edited by B. Meyer. Interscience Publishers, New York, 1965. 390pp. Price £6 15s.

This book arose out of discussions held at a Symposium on Elemental Sulphur in Berkeley, California in July 1964. It is not a collection of the papers presented (which often vary from very good to poor) but it is a volume of articles written by invited authors. The objective was to produce an extensive, authoritative review on elemental sulphur and in the view of the reviewer this has been achieved.

The reader is left with the impression that no physical technique has been left untouched in an endeavour to find out more on the physical and chemical properties of elemental sulphur. Chapters on the vibrational, electronic and mass spectra, as well as electron spin resonance and X-ray diffraction methods are a few among the total of eighteen.

The second chapter on the structure of the allotropes of solid sulphur is a useful critical statement. It gives detailed structural data on the allotropes, supported by excellent diagrams. The advent of far infrared instruments together with the Raman technique has meant that the vibrational spectra of elemental sulphur has been studied in more detail. Yet it is clear from Chapter 12 that considerably more work is required. The production of atomic sulphur by photochemical methods opens up a new field of sulphur reaction chemistry which is discussed in Chapter 14. New synthetic routes as well as interesting theoretical results on the conservation of the total spin of the reacting species are outlined. When one thinks of sulphur, one almost automatically thinks of S_8 rings. Such a limitation will be quickly dispelled by the reading of Chapter 16, where other ring systems are described.

In selecting a few chapters for comment the reviewer is obviously influenced by his own interests. However, other chapters such as on phase transitions, mechanical properties, high pressure behaviour and electrical properties to cite a few, contain useful information and references to the literature for people interested in these different aspects of elemental sulphur.

The book will clear away a few misconceptions concerning sulphur, as for example the report in the literature of up to sixteen different allotropes in addition to the well established ones. It is pleasing to have a lot of the "mystery" of elemental sulphur removed and clarified and on this point alone the book is a worthwhile acquisition for both academic and applied chemical libraries and chemists who are interested in elemental sulphur.

J. E. FERGUSSON.

Progress in Inorganic Chemistry. Volume 8. Edited by F. A. Cotton. Pp. 488. New York: Interscience 1967. Price $15.95.

There are seven reviews in the latest volume; these are: Chemical Applications of Mössbauer Spectroscopy, by R. H. Herber; The Clathrate Hydrates, by G. A. Jeffrey and R. K. McMullan; Eight-Coordination Chemistry, by S. J. Lippard; Complexes Containing the Nitrate Ion, by C. C. Addison and D. Sutton; The Chemistry of Bivalent Tin, by J. D. Donaldson; Intervalence Transfer Absorption, Part 1, Qualitative Considerations, by G. C. Allen and N. S. Hush; Part 2, Theoretical Considerations, by N. S. Hush.

Like the previous volumes in the series, this volume contains authoritative reviews over a fairly wide range of inorganic chemistry and lives up to the stated aims of the editor '. . . some experts will give expository and interpretive treatments of their special subjects to enable inorganic chemists to keep in touch with progress over the entire field.' Most inorganic chemists will find interest in the present book (the reviewer found three of the chapters of particular interest to him). There is perhaps less emphasis on the transition metal elements than in some of the earlier volumes. The titles of the reviews are largely self-explanatory although something should be said about the last two.

Compounds containing an element (or two elements) in different oxidation states often show very intense colours which do not appear to be simply related to the colours of either of the individual ions. A well known example is Prussian Blue, $KFe(II)Fe(III)(CN)_6.H_2O$. It is proposed that the light absorption resulting from the transfer of an electron from a lower to a higher oxidation state be called ***intervalence-transfer absorption.*** The qualitative aspects are discussed in Part 1 and the quantitative aspects in Part 2.

This volume will join its well used predecessors on library bookshelves but, due to the price, it is unlikely to appear on many private bookshelves. One wonders if the publishers could produce cheaper editions (paperbound) for personal use.

R. G. Cunninghame.

A Valency Primer by J. C. Speakman 1968. Published by Edward Arnold Ltd. 112 pages. Price 25/- (Paperback edition 12/6).

This book replaces Dr. Speakman's famous book Introduction to the Electronic Theory of Valency. Apart from its last chapter, the text is completely new. The treatment of elementary ideas is much more concise, and more emphasis is placed on the molecular concept and on the measurable properties of molecules.

The contents include elementary electronic interpretations of valency, the measurement of molecular properties, a wave mechanical interpretation of valency, a discussion of the hydrogen bond and other forces, and the bond concept of molecules. There is a section on related problems at the end of the book.

Primarily, this book is intended for use at 6A level in schools and in first-year classes at University. To keep the mathematics at a reasonable level, the treatment of wave mechanics is descriptive only. Teachers requiring background reading for themselves and their students would find this book useful, as it provides a sound basis upon which the concept of the molecule may be developed.

R. E. M. Hodge.

Organic Chemistry (2nd Edition) 1967 by B. J. Stokes. Published by Edward Arnold Ltd. 495 pages. Price NZ$3.

The first edition of Organic Chemistry appeared in 1961 and its popularity necessitated reprints in 1963 and 1964. The aim was to provide a course for G.C.E. Advanced and Scholarship level students.

This edition has been extensively re-written to include up-to-date subject matter and to bring that part of Chapter I dealing with atomic structure and bonding more into line with current educational and scientific thinking. A greater use of electronic explanations for various reactions has been made and a whole chapter has been devoted to mechanisms.

The content of the book is more than sufficient for the revised 6A chemistry prescription and would be a useful reference text for 6B teachers and students. Its presentation prevents organic chemistry from seeming a catalogue of facts, and, in addition to providing a training in critical thinking, successfully shows the significance of the subject in an industrial society.

In addition to the usual chapters on aliphatic and aromatic hydrocarbons and their main derivatives ,there are excellent sections on such topics as stereochemistry, the use of Grignard reagents in synthesis, and compounds with more than one functional group. Suitable experiments are included at relevant points, but others would be necessary for a complete course. At the end of each chapter there are summaries of technical terms used, suggestions for further reading, and a number of questions, including problems. There are three pages of miscellaneous questions at the end of the book, together with the answers to the numerical questions found throughout.

For teachers about to replace or supplement out-dated sixth form organic texts, this book deserves serious consideration; graduate students of teachers colleges would find the book particularly useful. The price compares very favourably with other less suitable texts.

R. E. M. Hodge.

We're growing

60-61

62-63

64-65

66-67

...grow with us

IWD'S growth over the past seven years has been tremendous—as a result we now have unparalleled need for qualified personnel. We have openings for graduates in research, quality control, development, process control, marketing, sales and advisory services. Programmes range from weed and pest control to veterinary products, from detergents to fumigants. If you're a science graduate this is what the IWD group of companies has to offer: * Employment in a position of status. * A position of satisfactory work content—on programmes where there are problems to solve and something to really get to grips with. * Work with distinguished colleagues * The opportunity to continue academic study. * Good prospects for the future. * A satisfactory remuneration during the induction period—as well as later. *If you're interested drop us a line. The address is The Secretary, Ivon Watkins-Dow Ltd., Box 144, New Plymouth.*

THE IVON WATKINS-DOW GROUP OF COMPANIES

W5621

Space probe . . .
Instrumentation . . . packing,
cushioning . . . shockproof,
shatterproof . . . Shell.
Plastics, 'Epikote' resins,
'Cariflex' rubbers . . .
chemicals for a modern age . . .
by Shell. Chemicals for industry
. . . by Shell. Production,
research, marketing . . . by Shell.
Behind the advances of
science and industry . . . Shell.
Now, and in the future.

For further inform
Shell Oil New Ze

In New Zealand Industry Shell Chemicals

145.8

If you have a laboratory . . . whether it's small or large . . . research or industrial . . . whatever the size or type, the N.D.A. can be of assistance to you.

We stock a comprehensive range of analytical and laboratory reagents, technical and industrial chemicals, scientific apparatus and laboratory equipment.

CONSULT the N.D.A. in regard to your particular requirements, we will be pleased to quote you on an ex-stock or indent basis.

The National Dairy Association of N.Z. Ltd.

Thorndon Quay
Wellington
P.O. Box 28

Beach Road
Auckland
P.O. Box 1001

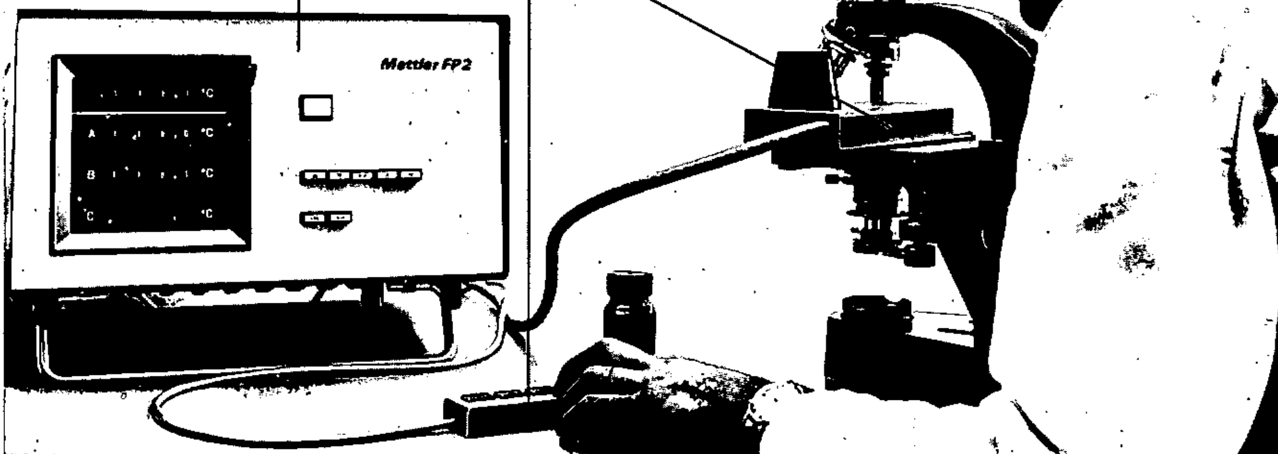
Mettler makes microthermal investigations without disturbance possible.

The researcher

retains first, by simply pressing a button, the temperature at the moment, where characteristic changes occur to the micro sample during the heating process. All routine manipulations, such as control of the temperature, thermometer reading and recording of the results are eliminated.

The Mettler FP2

consists of three elements: Micro hot stage, electronic control unit and push button station for the fixation of the temperature values. The following features guarantee that one can rely on the analytical data supplied by the METTLER FP2.



The temperature field of uniform pattern of the micro hot stage is heating up the sample regularly. Fully automatic temperature control allows three heating rates. The exact measuring of the sample temperature is guaranteed by a platinum resistance thermometer, embedded in the heating plate and in direct contact with the sample. Thanks to digital result storage, three independent temperature values can by stored with an accuracy of 0.1 °C.

WATSON VICTOR LTD.

Head Office: 4 Adelaide Road, Wellington.

Branches: Auckland, Christchurch and Dunedin.

Printed by David F. Jones Ltd.