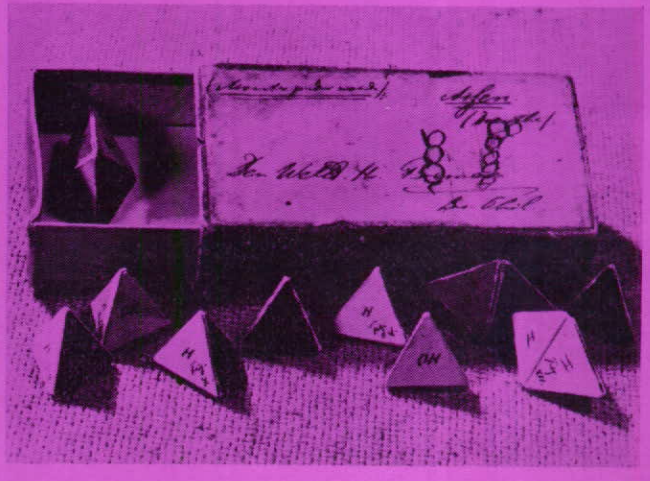
chemistry in new zealand



june 1973

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Journal of the New Zealand Institute of Chemistry

Cover
Ten models of asymmetrical molecules, prepared by J. H. van 't Hoff in 1875. (Photograph: "Rijksmuseum voor Geschiedenis der Natuurwetenschappen", Leiden.) By courtesy Philips Research.

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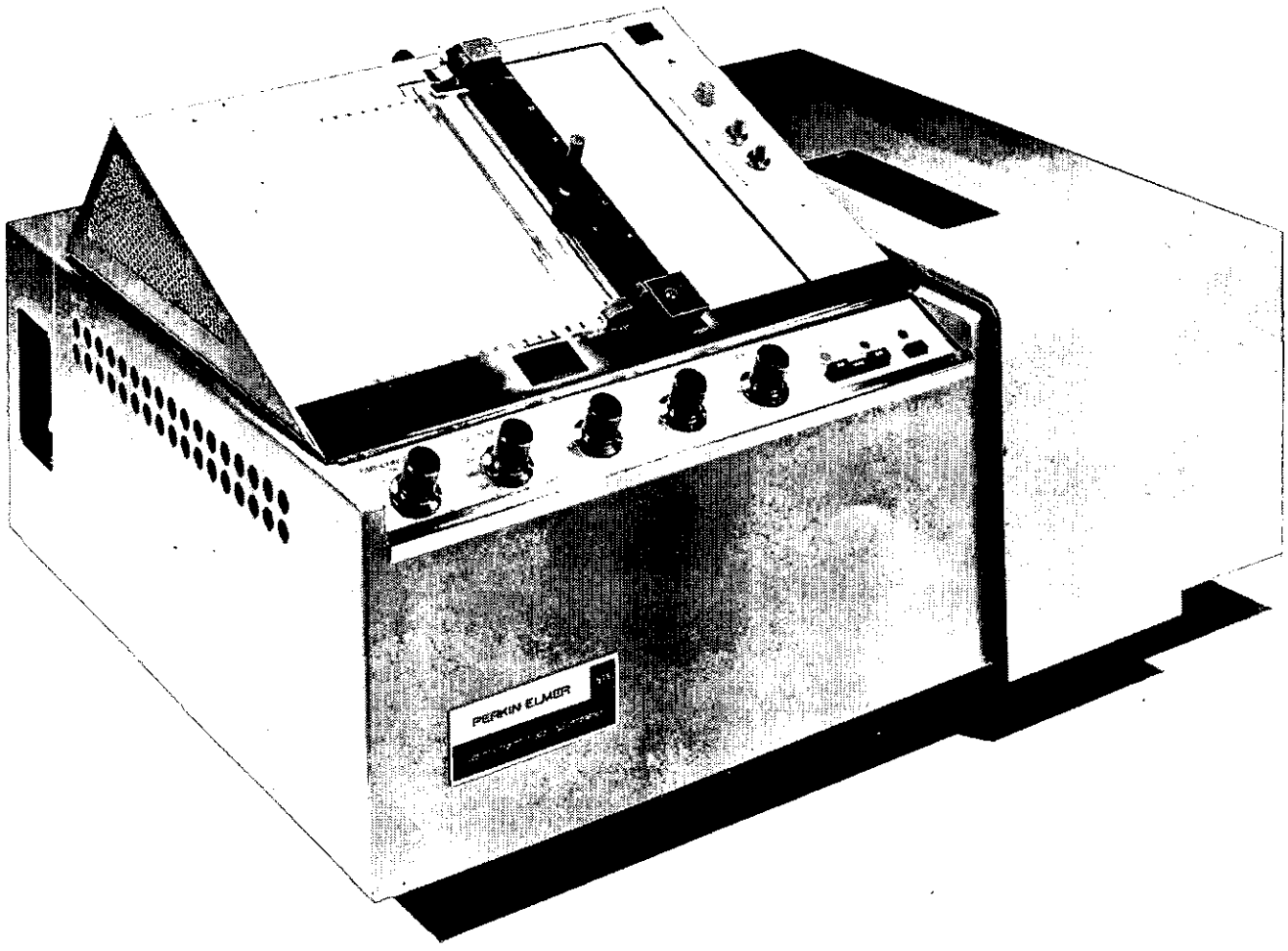

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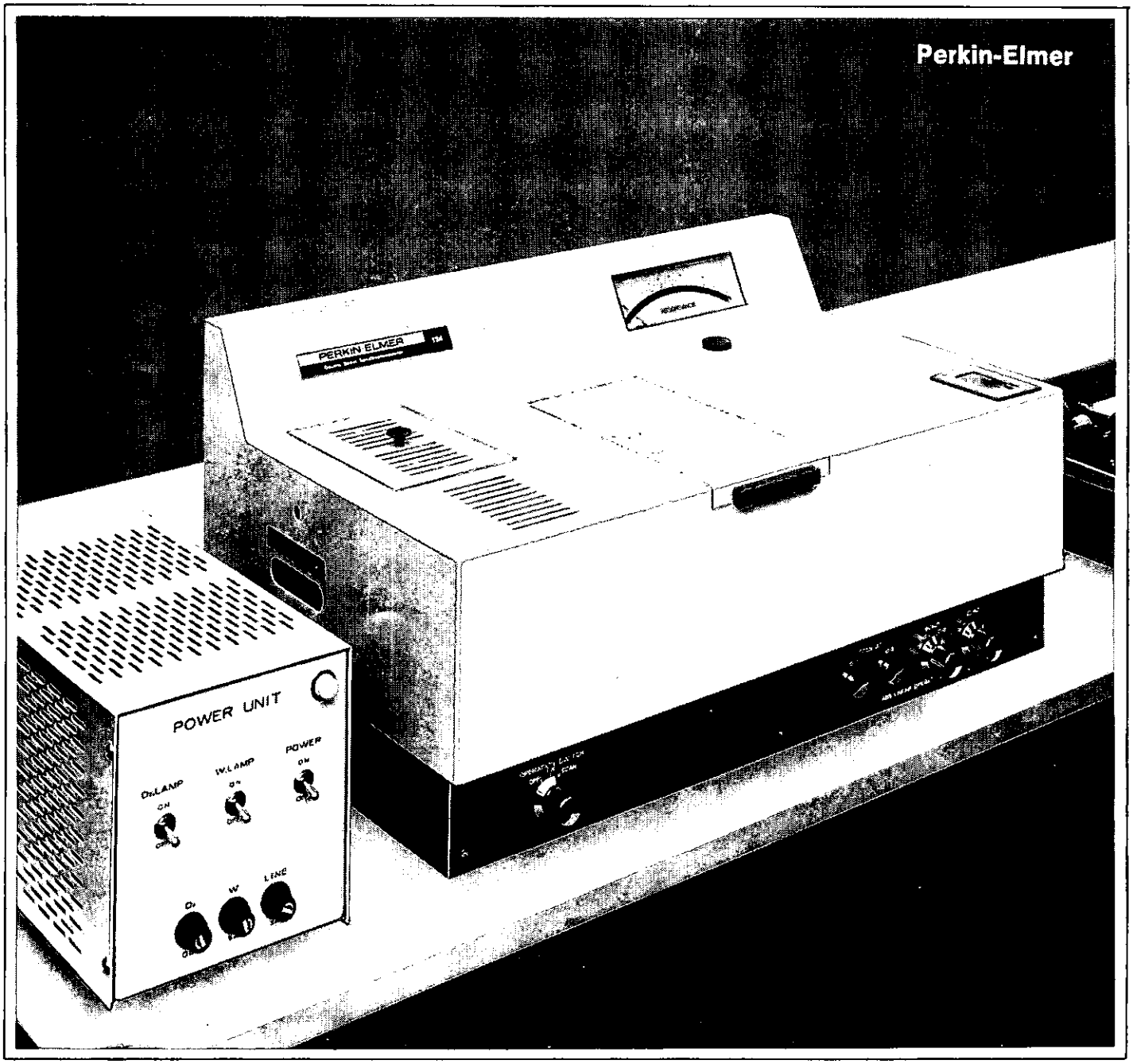

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From the President

Since the first students gained their New Zealand Certificates in Science (Chemistry) in 1963, 308 Certificates have been awarded, sixty in 1973. The number of students qualifying annually has increased regularly since 1963, and if the present trend continues, and I expect it to accelerate, at least 1000 certificates could be awarded during the next decade. The large majority of these certificate holders enter industry and government science where they practise as chemists. Although I do not have accurate figures to support my contention, at least a third of University graduates in chemistry enter the teaching profession, while a substantial percentage of the remainder do not practice as chemists. All members will have noticed the increasing tendency of employers to advertise for chemists and to specify as the qualification sought the possession of the New Zealand Certificate in Science. I suggest that by 1983 it could be possible for a substantial percentage of those calling themselves chemists in New Zealand industry and government science to be certificate rather than degree holders.

What is the Institute going to do about this new generation of Polytechnic trained chemists? It may choose to ignore them but industry and government science will not.

In his forward looking Presidential address to the Institute in 1971 Dr. W. A. McGillivray[1] drew attention to this problem and offered possible solutions. The problem was not as obvious then as it is now. By the end of 1970 there were only 196 certificate holders. The past two years has seen the number increased by 112. Whilst the number of students majoring in chemistry in the Universities has risen very slowly during the past five years, the number choosing chemistry at the Polytechnic is increasing rapidly.

I firmly believe that a place must be found under the umbrella of the Institute for all who call themselves chemists and have supporting qualifications. Dr. McGillivray has already suggested a new all-embracing category of membership, a probationary grade through which all new graduates and certificate holders would have to pass, and suggested the grade of Licentiate for this category. He envisaged that "the Licentiate could be assessed for a minimum period of four years as for Graduate Membership at the present time. At that stage, the majority would become Associates, but others might remain Licentiates for longer—and perhaps indefinitely."

Since the Institute has agreed that the present grade of Associate should be changed to Member there is the possibility of an alternative use for this title. It could replace the title Licentiate suggested for the probationary grade and would be rather more appropriate.

The idea of an all-embracing probationary grade is a good one, but problems could arise in defining standards for promotion to Membership and most of the certificate holders could find themselves indefinitely confined to the probationary grade if Dr. McGillivray's proposal is accepted.

As an alternative, all degree and certificate holders could be elected to local Membership, a category without voting rights, for a probationary period of four years. After assessment the degree holder would normally proceed to the rank of Member of the N.Z.I.C., while the majority of the certificate holders would become Associates of the N.Z.I.C., a grade with appropriate rights. In certain cases certificate holders could qualify for election as Members.

A further alternative which Institute members might find more attractive, is to introduce two new grades for certificate holders. The present three grades of Graduate (non-voting), Member and Fellow are very suitable for degree holders. The probationary grade of Technician could correspond for certificate holders with that of Graduate member for degree holders. It may be desirable to make the probationary period for Technician somewhat longer than the four years required of a Graduate member. After assessment, a Technician member of the N.Z.I.C. would proceed to the grade of Associate of the N.Z.I.C., a grade with appropriate voting rights. The grade of Associate would be complementary to that of Member. Some Associates could in appropriate cases qualify for election to the Fellowship.

It could be argued that Local Membership is already open to certificate holders. To relegate them permanently to this status is in practical terms to banish them from the Institute. A way must be found to incorporate this new breed of chemists, in a meaningful manner, into the Institute. If they are to have a status that will preserve their interest and self-respect they must have voting rights. The Institute will be completely out of touch with the mood of the new generation if it believes that it can offer it anything less than full participation in Institute affairs. It is a generation which will have been represented, with voting rights, on the executive bodies of Technical Institutes and Universities. I can see no compelling reason why a certificate holder who has spent four probationary years as a Technician member of the Institute and met the requirements for election to Associateship should not have voting rights.

The acceptance of certificate holders into full membership would be a radical new departure and could require many consequential changes in the structure of the Institute. For example, it might be necessary to restructure the Council so that it included a proportion of representatives elected by and from the Fellowship, the Membership and the Associateship.

The aim of this Editorial is to stimulate discussion. The grades that we should have and what they will signify must be discussed and thrashed out at all levels of the Institute. A solution must be found to this important problem.

R. E. CORBETT
President

[1] W. A. McGillivray, *Chemistry in New Zealand*, 1972, Vol. 36, No. 5, 138.

THE CASE OF

PROFESSOR VENIAMIN G. LEVICH

Professor V. G. Levich is a prominent Russian physical chemist, well known for his leading contributions to electrochemistry and quantum chemistry. His book on *Physico-Chemical Hydrodynamics (1962)* is a classic in its field, and his recent work on mass transport and the theory of electron transfer processes is widely applied by engineers and electrochemists. Professor Levich is Vice-President of the International Society of Electrochemistry and a member of many scientific boards and councils. Until recently he held a chair of mathematical physics at Moscow University, and was a Corresponding Member of the USSR Academy of Sciences. His research work was conducted in the Institute of Electrochemistry, Moscow where he was Head of the Department of Theoretical Electrochemistry. He is well known to New Zealand scientists in his special field through his books and published papers, which are widely quoted and respected.

In May 1972 news leaked out that Professor Levich had applied for his "Characteristik" (certificate of integrity) which is needed before an emigration permit can be obtained. It was his intention to settle in Israel where suitable employment had already been offered. The Soviet authorities refused to issue the "Characteristik", and application for emigration was refused. Worse still, Professor Levich was dismissed without warning from his chair at Moscow University and he was demoted to a minor position at the Institute of Electrochemistry. He was denied the right to give lectures and attend conferences, and his papers were not accepted for publication in Russian journals. His name was dropped from a number of scientific councils and other bodies, and he was severely restricted in his research activity. Meanwhile his two sons were also refused emigration permits; one was dismissed from his job as an engineer and the other has suffered restrictions in his work as a theoretical physicist.

It is clear that the plight of Professor Levich is part of the general problem affecting many people who are prevented from leaving the Soviet Union. In some cases the Soviet authorities have demanded large payments before Jews and other persons are granted exit permits. But it appears that in Professor Levich's case he has become a virtual prisoner in his own country against his own wishes, and that some of his colleagues have been implicated in the actions taken against him.

Professor Levich's prominent position as an international authority in his field has drawn the attention of the scientific community to his harsh treatment. There has been a wave of sympathy and concern from many quarters. In USA resolutions have been passed on behalf of Professor Levich by the National Academy of Sciences, the American Chemical Society and the American Physical Society. In Britain a group headed by Sir Frederick Dainton and Professor D. H. R. Barton (Nobel Laureate) organised a petition to the Soviet Government carrying the names of over 3,000 scientists, including some New Zealanders. Their views were published in *Nature* and other journals; many circulars and letters have been distributed to scientists throughout the world.

The International Society of Electrochemistry found itself in a difficult position because Professor Levich had been invited to be the guest lecturer at a major conference on Electrochemistry at Stockholm in August 1972. The President, Dr. Hans Gerischer, was under strong pressure to allow a formal resolution of protest at the treatment of Professor Levich to be voted on, but he wisely pointed out that the Society's sole object was "to contribute to and promote research and studies in the field of electrochemistry". He ruled that a purely scientific society cannot take action on political, moral or personal matters, and so the conference delegates held a separate, unofficial meeting at which their concern was expressed. At this meeting a recorded statement from Professor Levich was heard, in which he stressed the plight of Soviet scientists who have been denied the basic rights of employment and travel; he appealed to the international scientific community to try to persuade the Soviet authorities to change their policy.

In New Zealand chemists are represented by the Institute of Chemistry which is both a scientific and a professional body. The Rules quite clearly go beyond the promotion of the science of chemistry and include as objectives the following:

"Rule 3.2 To raise the status and to advance the interests of the profession of chemistry and of those engaged therein.

Rule 3.12 To take any other lawful steps to promote the progress of chemistry and the welfare of those engaged in its study and practice."

The Code of Ethics further states that

"A member shall act in a spirit of personal helpfulness and fraternity toward other members of his profession."

In the light of these statements of our objects, the Institute felt it should take a stand on principle, even though there is little chance of directly helping Professor Levich. At its meeting on 2 November 1972, Council resolved:

"*That* the New Zealand Institute of Chemistry reaffirms its view that all scientists should be free to practise their profession without political restriction or persecution; *and that* scientists should be accorded their full rights and freedoms, including the rights of international travel and emigration; *and that* the reported treatment of Professor V. G. Levich of the Institute of Electrochemistry, USSR Academy of Sciences, Moscow, is of concern to the members of the N.Z.I.C., who wish to put on record their strong disapproval of the actions of the Soviet authorities."

The stand taken by Council has been conveyed to the Minister of Foreign Affairs, the Royal Society of New Zealand, and the Soviet Embassy.

In November, 1972, the then Minister of Foreign Affairs, Sir Keith Holyoake, confirmed that the Soviet Union has applied pressure on many of its citizens in order to prevent them from emigrating to other countries. According to the Minister, the treatment of Professor Levich would be "a direct breach of Article 13 of the Universal Declaration of Human Rights, which says that everyone has the right to leave any country including his own." Sir Keith Holyoake has told Council that his concern on these matters was brought to the attention of two senior USSR officials who visited New Zealand in November 1972.

It is still not clear what the final outcome of the Levich affair will be, but it is hoped that governments and other authorities will learn to respect the basic human rights and apply them with justice and generosity when dealing with scientists and all other persons.

G. A. Wright

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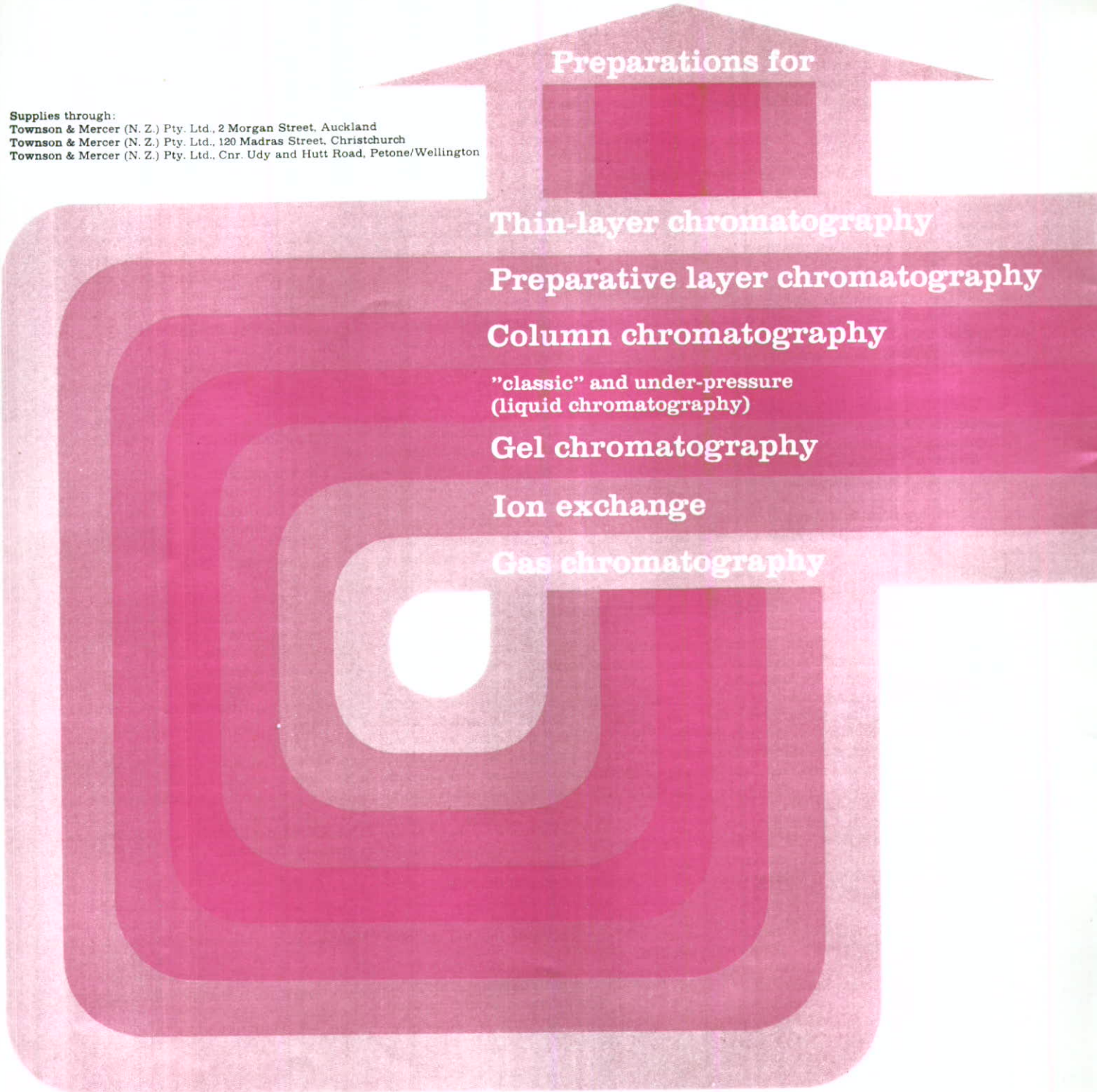

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Interdisciplinary Chemistry

A Challenge to the Universities

by J. F. Young

The University of Waikato was recently advertising internationally for an inorganic chemist 'specialising in some aspect of organometallic chemistry.' I find this a disturbing item because it indicates that the chance to create a new approach to chemistry in a new university is not being used to advantage. Organometallic chemistry is already flourishing in several other chemistry departments in the country so why is it necessary to extend an already well-subscribed area?

If this were symptomatic of the general attitude it would be even more disturbing, but fortunately articles in a recent issue suggest otherwise[1, 2]. I have found organometallic chemistry is an extremely interesting subject and it could be argued that it is as good an area as any for training graduates in experimental chemistry. However, it is questionable whether the established areas of chemistry are necessarily the best means of training future graduates. Without wholly turning our back on present endeavours we must seek to broaden the educational experience in chemistry to maintain its national importance in the future.

Classification of Research

I shall attempt to discuss what seem to be some of the more important aspects in the light of my own personal experiences. In this context I wish to avoid the use of pure and applied science (or chemistry) since these words have acquired unfortunate emotive associations. Instead I prefer to adopt the terms used by Professor Dainton.[3] "Basic science" is defined as research and training with no specific applications in sight. "Strategic science" embraces the general scientific effort needed as a foundation for "tactical science," which is the application and development of science for specific needs.

Department of Civil Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois, U.S.A., 61801

Basic chemistry is carried out primarily, but not exclusively, by the universities. Government laboratories are concerned with both strategic and tactical chemistry while most industrial laboratories in New Zealand are primarily concerned with tactical chemistry. I wish to centre my discussion around the differences between basic and strategic chemistry, since I would expect that Ph.D. and M.Sc. graduates in research positions would be mostly employed in strategic chemistry. Moreover, strategic and tactical chemistry are much more closely related and a training for strategic chemistry at the undergraduate level would equip a B.Sc. graduate for employment in both strategic and tactical science.

There is a considerable difference between strategic chemistry and most basic chemistry being done in chemistry departments. This statement is not to be construed as a belittlement of university research, since the problems studied may be equally or more difficult. But the terms of reference are quite different. The academician can generally define and control his system fairly closely to deal with pure well-characterised compounds in homogenous systems under controlled experimental conditions. The strategic chemist may frequently have to work with impure materials, perhaps of variable composition, complex phase systems, and experimental conditions that cannot be so precisely controlled. He may be involved with phenomena and techniques barely touched upon in his formal training: surface phenomena, high temperature and pressure chemistry, diffusion reactions, polymer chemistry, etc.

Interdisciplinary Research

The solving of practical problems rarely involves chemistry alone since the effects on other properties must be considered. Indeed the application of chemistry may well be to produce desirable physical and engineering properties, biological reactions, etc. Therefore it would seem desirable to provide students with the opportunity to become involved in

interdisciplinary problems, and to foster an interdisciplinary outlook.

Such an outlook is becoming increasingly common in British and American universities, and the University of Illinois is probably a good example in this respect. Thus, it is possible for a chemist like myself to be a member of the civil engineering faculty. I am not in a unique position since there are several other faculty members who have been trained in other disciplines. Within the College of Engineering there are probably another three or four chemists in various branches of engineering. Joint appointments between different departments are quite common within the University, e.g., chemistry and physics, civil engineering and ceramics, metallurgy and physics, etc. Such appointments give strong encouragement to interdisciplinary work, cutting across normal departmental boundaries. Further encouragement is given in research support by such formal arrangements as the Materials Research Laboratory which brings together physicists, chemists, metallurgists and ceramicists under long term Federal support. Recently an environmental programme extending over several years investigating the state of lead is being sponsored by the National Science Foundation, and it brings together many different disciplines and may eventually transform to a permanent Environmental Institute.

New Zealand universities have been slow in recognising this need. Unless rapid changes have been made in the last two or three years biochemistry is probably the only organised interdisciplinary area. Yet interdisciplinary research is already the hallmark of the New Zealand scene. I have classified strategic chemical research in New Zealand broadly into three separate interdisciplinary categories:

1. Food science — utilisation of natural products, pesticides, fertilizers, protein chemistry and food products, soil science.
2. Materials science — concrete technology, wood technology, metallurgy and corrosion, ceramics, paints and coatings.
3. Environmental science — air and water pollution, food additives, pesticide residues, geochemistry.

These classifications are very broad and one could make further divisions if so desired, but the diversity of each category is linked by a unifying central theme, e.g., 1) chemistry and nutrition, 2) chemistry and engineering properties, 3) chemistry and the environment. It is significant also that a subject can be easily placed in more than one category, e.g., pesticides in food science and environmental science, soil science in materials science and food science, etc.

Curricula Changes

It is therefore desirable to introduce chemistry students to strategic science by offering basic courses in these areas. Instruction in materials science, science of food production and environmental science should be taught to science majors in general and would, I am sure, prove highly popular with students.

On a more specialised level one would like to see consideration of courses covering such topics as industrial chemistry, polymers and adhesives, protein chemistry, etc. A general aim in all existing and future courses should be to illustrate principles of basic chemistry using examples of strategic chemistry where possible. This approach might well improve the learning process since students better relate to topics when they are placed in a proper perspective.

Interdisciplinary instruction has been slow to emerge in the United States as discrete curricula. Although interdisciplinary research is flourishing at the University of Illinois, no formal curricula exist. However, an option in bioengineering has recently been established and the environmental engineering programme in Civil Engineering has an interdisciplinary foundation. There is less need for formal programmes, however, since curricula in the United States allow the individual student a high degree of flexibility in choosing a programme to suit his own interests or to explore attractive areas of study. A greater flexibility will probably be needed in New Zealand curricula to encourage the interdisciplinary approach. Thus, in order to capitalise on broadened curricula at the undergraduate level it would be desirable to give students an opportunity, say at the master's level, to pursue their interests in a more specialised way. There is a danger of spreading the teaching effort too thin, but a happy balance should be sought.

New Directions in University Research

If changes in the emphasis of chemistry teaching are sought, as I feel they should be, then some redirection of the research effort should also be sought to fully capitalise on change. In recent years there have been suggestions that the universities should get more relevant. Since the universities rely on public support these opinions must be heeded, although I remain strongly convinced that the fundamental nature of the university should not be substantially modified. One of the problems facing American universities today stems from their historic role of being all things for all people. Besides providing traditional university education they have also served as colleges of technology, agriculture, etc. In the call for relevance, the latter roles are threatening to diminish the general university education.

It is, however, possible to institute research programmes in strategic chemistry without sacrificing the tenets of university education. There are plenty of extremely interesting areas that involve legitimate and interesting problems in chemistry. The science of ceramics, inorganic structural cements, utilisation and modification of proteins, flavour chemistry, degradation of pesticides and herbicides, develop-

ment of fertilisers, wood chemistry, metallic corrosion, mineral extraction, are all examples of areas of strategic chemistry which could be usefully studied at the university level. Indeed some progress has already been made in this direction; for example, research in ceramics at Victoria and corrosion chemistry at Auckland.

To provide this diversity, the universities will need to expand their faculties with personnel who have gained experience in strategic research. One possible way would be to seek joint appointments with staff from government research laboratories. This approach has already been tried with success and could be further extended. Cooperation with government laboratories in research should be expanded and perhaps also extended to instruction in the form of specialised laboratory workshops and seminars. Policies of this nature would seem desirable because faculties in New Zealand lack the opportunity to maintain links within strategic chemistry through consulting or research contracts with industry.

But it is also desirable to have several full-time faculty members in strategic chemistry to devote their talents to instruction and training in the classroom and laboratory. Hopefully, joint appointments with other departments would be considered for such individuals because New Zealand research will be increasingly hampered by the individualistic attitudes of disciplines which still seem to be prevalent.

Conclusions

The foregoing paragraphs are to be taken not as arguments for a rejection of current research but rather for additions to complement present research interests. Thus organometallic chemistry is still a viable and exciting area of research capable of illustrating the basic principles of chemistry and the scientific method. Organometallic chemistry has contributed to strategic chemistry and one can envisage a situation where a chemist trained in organometallic chemistry might find new solutions to problems of strategic chemistry.

What we must guard against in the future development of chemistry in the universities is the danger of perpetuating the particular character of a chemistry department. It is necessary to encourage specialisation at the graduate level so that students can explore a research problem in depth. But specialisation must not come too early and must not be allowed to obscure the wider view of chemistry. We must aim to provide a diversity in chemical education which produces students who can clearly see chemistry's potential in solving the country's problems and who are eager to use the whole spectrum of their basic chemical knowledge. The more broadly based chemical education becomes, the more valuable our graduates will be to the broadly based research requirements of New Zealand.

REFERENCES

1 L. F. Phillips, *Chemistry in New Zealand* (1972), *36*, 73.
2 A. J. Ellis, *Chemistry in New Zealand* (1972), *36*, 79.
3 Sir F. Dainton, quoted in *Chemistry in Britain* (1972), p.83.

100 YEARS AGO

SCIENCE LECTURES

FOR THE PEOPLE

It is the great weakness of Science in this country that its professors are rather a mass of incoherent units than an organised body eager to influence others and themselves enjoying the privileges of such influence.

Each one is apt to work too much by himself, and while he often exhibits the most rare skill in discovering truth, he too frequently leaves to others less able than he the task of bringing his labours before the world at large.

Now, while the man of science complains with much justice that his pursuits have not been recognised by the rulers of our country, he ought not to forget that it is likewise his duty to help others, in doing which he will help himself. Whatever be the faults of our rulers, they are eminently sensitive to public opinion; men of science, therefore, have only to prove to the people that they are a useful class in order to have their services recognised. It is really absurd to suppose that one of the most intelligent and useful bodies of men in this country could not obtain their just demands if they set themselves earnestly and unitedly to the task. They have hitherto tried to prove to our rulers that the promotion of science will benefit the country, but have met with only indifferent success; let them supplement their endeavours by convincing our rulers that to promote it will be for their own benefit, and they are sure to succeed. Success, in fine, will not be attained by a policy of isolation, but by leavening the whole mass of the community with the love of science, and when this is done science will rise to its just place in the councils of the nation.

From Nature, 4, 81, June, 1871.

N.Z. INSTITUTE OF CHEMISTRY CONFERENCE

Christchurch 20 - 24 August 1973

Conference Programme . . .

An outline of the Institute Conference to be held in Christchurch is as follows:

Monday, August 20th

Teachers' group meeting and specialist group meetings will be held throughout the day. The specialist group A.G.Ms will be held in the evening.

Student papers will be presented in the afternoon.

Tuesday, August 21st

Registration.

Conference opening at 10.30 a.m. by the Hon. C. J. Moyle, Minister of Science.

The Packer Memorial Lecture will be given at 11 a.m.

Symposium 1, Wool (chaired by Dr. W. S. Simpson) will be held in the afternoon.

A Meat Buffet at 5.45 p.m. will be followed at 8.15 p.m. by the Guest Lecture.

Wednesday, August 22nd

Symposium 2, Timber (chaired by Dr. A. F. Wilson) will be held in the morning.

Symposium 3, Pastoral Food Products (chaired by Dr. W. A. McGillivray) will be held in the afternoon.

The Presidential address by Professor R. E. Corbett will be presented in the evening, followed by supper.

Thursday, August 23rd

Symposium 4, Minerals (chaired by Dr. A. J. Ellis) will be held in the morning.

The Institute A.G.M. will be held at 4.30 p.m. and the Conference Dinner in the evening.

Friday, August 24th

Visits to be arranged if interest demands.

N Z I C

Notice of Annual General Meeting

UNIVERSITY OF CANTERBURY

Thursday, 23rd August, 1973

4.30 p.m.

Properties of Actinidin*

by M. J. Boland, B.Sc. (Hons.)

The mechanism by which enzymes are able to catalyse reactions at rates far in excess of those of any man-made catalysts has been one of the main topics of interest in biochemistry for many years. In 1800 the Academy of the first French Republic offered a prize of a kilo of gold for a satisfactory answer to the question: "What is the difference between "ferments" and the materials they are fermenting?" Since then enzymes have been isolated, crystallised, sequenced, and most recently had their three dimensional structure determined. These structural studies have indicated the mechanism of enzyme substrate interaction but fail to account quantitatively for the great catalytic power of these molecules. As Knowles and Gutfreund[1] point out: "Making a model of a horse from photographs does not tell you how fast it can run". The explanation of the dynamic properties of enzyme catalysed reactions can only come from kinetic studies.

Probably the simplest enzyme reactions are those of hydrolytic enzymes as they in effect involve only one substrate, and hydrolytic enzymes such as the proteases will often catalyse the hydrolysis of simple model substrates such as esters or amides of amino acids or their derivatives. These model substrates have advantages over natural substrates, such as higher solubility, fewer problems in orientation in the active site of the enzyme, and they can be designed in order to observe different parts of the reaction; for example, p-nitrophenol esters can be used to observe the release of the alcoholic product of hydrolytic esterase reaction by spectrophotometric observation.

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Special Abbreviations Used: Z-lys.pNp:NαCBZ lysine p-nitrophenyl ester.

* This paper won the Students' Prize, NZIC Conference 1972.

Proteolytic activity was first observed in chinese gooseberries by Arcus in 1959[2], and since then nothing was published on it until 1970 when McDowall[3] reported a purification of the enzyme and some of its properties. Our work on this enzyme was begun in 1971 without our awareness of this publication so we consequently developed our own method of purification of the enzyme.

As proteolytic enzymes undergo autolysis, and the active site thiol group is sensitive to air oxidation, the unripe fruit is extracted into EDTA-sodium tetrathionate solution.[4] The tetrathionate forms a sulphenyl thiosoulphate derivative of the thiol group thus protecting it from oxidation, and also temporarily inactivating the proteolytic activity. The enzyme is precipitated from ammonium sulphate solution and subsequently chromatographed on a DEAE cellulose column, on which the active fraction travelled as a single slow moving band. This fraction behaved as a single protein of molecular weight 26000 in the ultracentrifuge. This value disagrees with the value reported by McDowall[3] but he has communicated to us that this result is incorrect as the enzyme exhibits anomalous behaviour on gel filtration. Enzyme from this preparation has also been crystallised and X-ray photographs indicate homogeneity to a 0.25 nm resolution[5]. If however, the enzyme is rechromatographed on a 1.5m DEAE-cellulose column, two proteins are resolved, only one of which is active (Fig. 1). The slower running protein is active enzyme and probably represents fully active enzyme, having a k_{cat} or turnover number of 29 sec^{-1}. The faster running protein may be a form of the enzyme with an oxidised thiol group as this would have the same charge as the sulphenylthiosulphate derivative and also virtually the same molecular weight, but the SO_3^{--} group would be buried in the active site and hence less able to bind to DEAE groups.

For activity studies the enzyme is reactivated by either dithioerythritol or mercaptoethanol which regenerates the active thiol group. The steady state

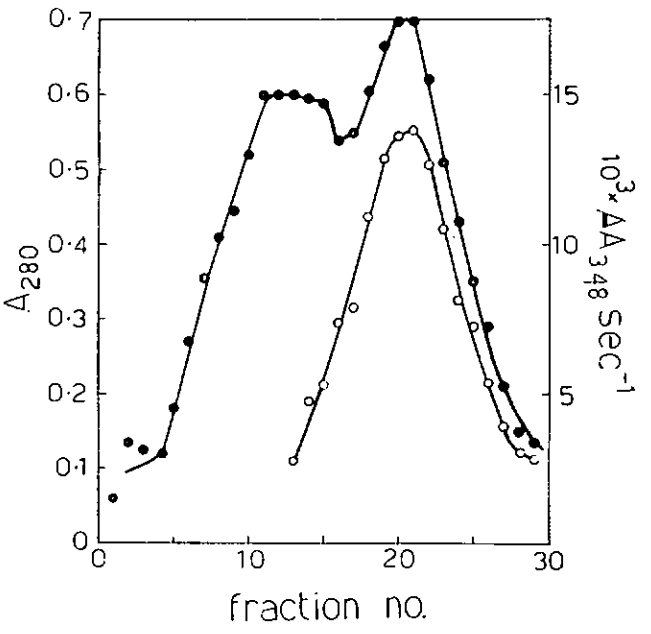

Fig. 1: Elution profile for enzyme from 1.5 M DEAE cellulose column.

Dots: Protein concentration as indicated by absorbance at 280 nm.

Open Circles: Enzyme activity (assayed using Z lys pNp at 348 nm). Fractions were 10 ml. Fraction numbering was taken from the first tube to show any absorbance at 280 nm.

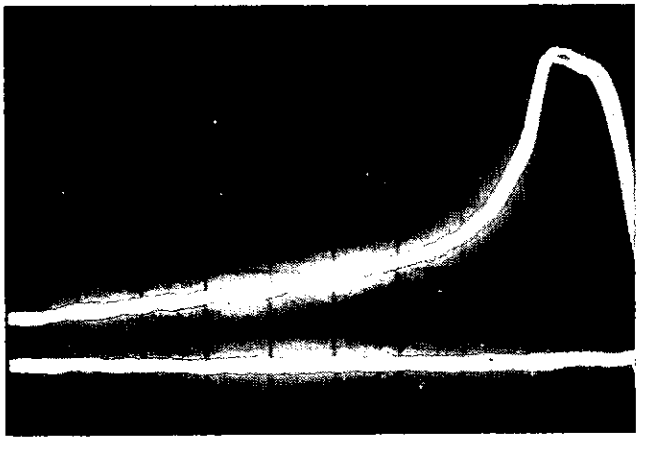

Fig. 2: A typical oscilloscope trace for the burst experiment.

The photograph in fact represents three experimental traces superimposed. The experimental line begins at the lowest point on the trace, and shows the rapid burst for the first 15 ms, followed by the beginning of the slow phase.

Enzyme about 10^{-4}M, Substrate 5 x 10^{-6}M.
Vertical Scale 0.01 A per division.
Horizontal Scale 5 ms per division.
(Time constant 0.1 ms, backoff ca. 0.4).

TABLE 1

Kinetic constants for the hydrolysis of z-lys-pNP catalysed by actinidin, papain and ficin.

	actinidin[a]	papain[b]	fici n[c]
k_{cat}, sec^{-1}	29 ± 2	44.5 ± 1.8	32.4 ± 4.5
K_m, μM	22 ± 2	1.71 ± 0.25	2.7 ± 0.2

a. In pH 6.0 phosphate buffer, using rechromatographed enzymes.
b. At pH 6.2 (ref. 13).
c. At pH 6.6 (ref. 14).

TABLE 2

Second order rate constants for the actinidin-catalyzed hydrolysis of N-CBZ-amino acid p-nitrophenyl esters*.

Amino acid	10^{-4} Rate Constant M^{-1} sec^{-1}
lysine	11.9
tryptophan	1.4
alanine	1.3
tyrosine	0.6
leucine	0.6
glycine	0.2

* In pH 6.0 phosphate buffer, 20% CH_3CN-water, at 17°.

TABLE 3

K_i values for competitive inhibitors of the hydrolysis of Z-lys-pNP (50 μM) at pH 6.0.

Inhibitor	K_i, mM
N-acetyl-L-arginine	110
N-benzoyl-L-arginine	24
N-benzoyl-L-arginine ethyl ester	40

kinetics of the enzyme were examined and showed a great similarity to ficin and papain, the two analogous plant proteases that have been examined in detail. The best substrate we have found is Zlys pNp and the properties of the enzyme with this substrate indicate that k_{cat}, the turnover number, is very similar to that of ficin and papain, but K_m is an order of magnitude higher (Table 1). Specificity was examined using a series of Z-amino acid p-nitrophenyl esters, with the enzyme showing a marked preference for lysine (Table 2). Thus it can be inferred that the enzyme has some kind of binding site for a basic side chain. Studies using a series of arginine inhibitors show that an Nα benzoyl group confers better binding than an acetyl group (Table 3). The Ki values shown represent true dissociation constants and as such indicate the free energy of binding. In the case of papain the binding enhancement due to an aromatic group in the penultimate position from the active site is far more pronounced. The better binding of the free acid over the ester may indicate the presence of a cationic group at the active site. A full report on this work has been published.[6]

The involvement of a thiol group in the active site is shown by the loss of activity in the presence of mercuric ions, iodacetate, N-ethyl maleiimide, and tetrathionate, in the latter case being reactivated by thiol reducing agents. Consequently the mechanism is likely to involve a thioacyl-enzyme intermediate.

$$E + S \underset{}{\overset{K_s}{\rightleftharpoons}} ES \overset{k_2}{\rightarrow} \underset{+\,P_1}{EP_2} \overset{k_3}{\rightarrow} E + P_2$$

This type of mechanism has been well established for ficin and papain, the only plant proteases which have been studied in detail. The mechanism involves reversible binding of the substrate in the active site of the enzyme, shown by K_s. The active thiol group then gives nucleophilic attack on the carbonyl carbon atom, and a tetrahedral intermediate may be involved, which subsequently breaks down releasing the free alcoholic or amino function, and leaves an enzyme thioester of the acyl function of the substrate. This step, shown by k_2, is the acylation step. The thioester is then attacked by water, shown by k_3, the deacylation step, to give free enzyme and a free acyl function.

Recently it has been demonstrated that the ficin and papain have a more complicated mechanism, apparent in their hydrolysis of Zlys pNp[7].

$$E + S \overset{K_s}{\rightleftharpoons} ES \overset{k_2}{\rightarrow} \underset{P_2}{E^*} \overset{k_3}{\rightarrow} \underset{P_2}{E} \overset{P_1\ k_4}{\rightarrow} \underset{+\,P_1}{EP_2} \overset{k_5}{\rightarrow} E + P_2$$

In order to investigate the mechanism of actinidin catalysed hydrolysis of this substrate we examined the reaction in the stopped flow spectrophotometer (Durrum-Gibson D110). This instrument can rapidly mix enzyme and substrate solutions and follow optical density changes from 2 ms after mixing. We examined actinidin using a large amount of enzyme and a small amount of substrate. In this system the sequential formation of intermediates can be observed, as we are in effect putting a pulse of substrate through the reaction pathway. This is one of the most powerful techniques available to the kineticist, and as Gutfreund pointed out: "The algebra of steady state kinetics is no substitute for the direct observation of the formation and decomposition of intermediates"[8].

When actinidin is examined under these conditions a "burst" of p-nitrophenolate ion is observed to about 80% of the total reaction followed by a much slower step (Fig. 2). Bursts of this type are seen when a product is released before a rate limiting step, and are concurrent and equal in size to the build up of the corresponding intermediate just before the rate limiting step. From this it can be concluded that the slow step occurs after the acylation step, k_2, which is the step in which the p-nitrophenol is produced. It is not however, the deacylation step, k_3, because if that were the case the burst would be expected to go to 100% of the reaction instead of only 80%. This is supported by the fact that nucleophiles such as L-tryptophanamide do not enhance the overall rate of the reaction, but they are known to greatly increase deacylation rates[9]. It is, therefore, necessary to include another reaction step in between acylation and deacylation, which is the rate limiting step and must control the release of the p-nitrophenol from the active site of the enzyme into the solution.

$$E + S \overset{K_s}{\rightleftharpoons} ES \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} \underset{}{E^*} \overset{P_1\ k_3}{\rightarrow} EP_2 \overset{k_4}{\rightarrow} E + P_2$$

This qualification is necessary to explain why the burst size is only 80% of the reaction, as an equilibrium situation must exist about the k_2 step to explain this result, and since $[P_1]$ would be very small, a second order k_{-2} step is not feasible. Therefore, EP_1P_2 represents the thioacyl enzyme with the nitrophenolate ion bound to the enzyme at the active site. This binding is not covalent as this would prevent ionisation of the nitrophenol, and from the slow rate of release of the P_1 it is believed that a change of conformation of the enzyme is involved.

Theoretical parameters for the behaviour of the system have been derived for both steady state ($S > E$) and burst ($E > S$) conditions.

$$K_m = \frac{K_s k\alpha}{k_2 + k\alpha}$$

$$k_{cat} = \frac{k_2 k_3}{k_2 + k\alpha}$$

$$K_b \left(\frac{\text{burst size}}{\text{total O.D. change}}\right) \simeq \frac{1}{\left(\frac{K_m}{[E]} + 1\right)\left(\frac{k\alpha}{k_2} + 1\right)}$$

$$k\phi \text{ (rate constant for burst phase)} \simeq \frac{k_2[E]}{K_s + [E]} + k\alpha$$

$(k\alpha = k_{-2} + k_3)$

The approximations of the two burst phase equations are valid only if $[E] > K_m$.

K_b is obtained from the observed burst size and the known initial substrate concentration, and $k\phi$ is the slope of a semilogarithmic plot of the burst phase. Unfortunately the method is very error prone as the low substrate concentration requires high sensitivity, and only part of the burst is seen due to the 2ms dead time of the instrument. In an effort to overcome this the experiment can be repeated at various enzyme concentrations and the results plotted according to:

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$$\frac{1}{K_b} = \frac{1}{E} \cdot K_m\left(\frac{k_\alpha}{k_2} + 1\right) + \frac{k_\alpha}{k_2} + 1$$

This line is predicted by

$$\frac{\text{slope}}{\text{intercept}} = K_m$$

which is well known.

No such plot is feasible, unfortunately, for k_ϕ and so the value can only be roughly determined. Present results indicate that at pH 7.0 k_3 is 33 sec^{-1}, and k_2 is of the order of 700 sec^{-1}, which is considerably higher than rates normally measurable by stopped flow, and is only known because we are measuring a known proportion of it.

Since steps like k_3, which is probably a conformational change, have now been identified in three plant proteolytic enzymes, it is possible that conformational changes may play a role in catalysis (c.f. Lumry's rack hypothesis[10]), and it is possible that conformational changes occur in other enzymic processes but have not been detected as they are not rate limiting. It is therefore to be hoped that investigations of this type of change may provide some insight into the mechanism of enzyme catalysis.

REFERENCES

1. J. R. Knowles and H. Gutfreund, *Essays in Biochemistry*, (1967), *3*, 25.
2. A. C. Arcus, *Biochim. Biophys. Acta*, (1959), *33*, 242.
3. M. A. McDowall, *Eur. J. Biochem.*, (1970), *14*, 214.
4. P. T. Englund, T. P. King, L. L. Craig and A. Walti, *Biochemistry*, (1968), *7*, 163.
5. E. N. Baker, *J. Mol. Biol.* In press.
6. M. J. Boland and M. J. Hardman, *F.E.B.S. Lett.*, In press.
7. M. R. Hollaway and M. J. Hardman, *Eur. J. Biochem.*, In press.
8. H. Gutfreund, *Ann. Rev. Biochem.*, (1971), *40*, 315.
9. A. L. Fink and M. L. Bender, *Biochemistry*, (1969), *8*, 5109.
10. R. Lumry and R. Biltonen — in *"Structure and Stability of Biological Macromolecules"* p.65 Ed. S. N. Timasheff and G. D. Fasman (Marcel Dekker N.Y. 1969).

THE CHEMIST AS A POET

(An address to the Student Chemical Society, University of Auckland)

T. A. Tumey

It is my belief that the same imaginative element causes progress both in the arts and in the sciences and that the only difference is in the perceptive media. The chemist brings his imagination to the rather specialised area of atoms and molecules while the poet operates over much more general areas.

In the thirteenth century before clocks were widespread the time was kept by an hourly trumpet note sounded on the walls of Cracow city in Poland. In 1241 there was a Mongol invasion of Poland. The Mongols bypassed Cracow but shot the trumpeter — with an abrupt ending to his playing. I composed a poem on this event:

THE TRUMPETER

In olden times,
Before the clock,
A trumpet blew,
Upon the hour,
In Cracow's
High walled city.

A young man,
Born within the walls,
Could set his heart,
From early years,
To make his life,
A trumpeter.

At dawn he rose,
And donned his clothes,
To pace his hourly role,
As proud he blew,
His trumpet new,
Upon the city walls.

But far away,
On Asian plains,
The Mongol hordes,
Were massing,
With eyes,
Upon the walls,
Of distant,
Cracow city.

Then came a day,
When horsemen wild,
Did reach the city wall,
An arrow true,
Flew on the hour,
The music broke,
And time stood still,
The trumpeter was dead.

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It is not a particularly good poem but it illustrates rather nicely the theme I wish to develop. That is the way in which real events are transformed by the poetic imagination. We can imagine a young boy aspiring to be a trumpeter. We can imagine the Mongols massing for invasion. We had the fact that the trumpet marked the hour and we know the trumpeter was shot. All these things are combined in the poem.

A richer and much more sustained illustration of this sort of thing has been provided by John Livingston Lowes in his book *'The Road to Xanadu'* which is subtitled *'The Ways of the Imagination'*. In this book he traces the sources of imagery used by Coleridge in the writing of his poems *'The Ancient Mariner'* and *'Kubla Khan'*.

I think the creative element in chemistry is no less interesting than that in poetry. John Read in his book *'Humour and Humanism in Chemistry'* recounts the discovery of the benzene ring by Kekule—

"Meanwhile, August Kekule, a young Privatdozent at Heidelberg had been brooding over the problem of molecular structure, and the fundamental idea of the quadravalency of carbon and the linking of carbon atoms came to him with dramatic suddenness as he sat one night in a reverie on top of a London bus. A few years later, in 1865, as he dozed by his fireside at Ghent, a dramatic vision of a snake seizing hold of its own tail revealed to him in a flash the further secret of the benzene ring. He is reported to have said 'Let us learn to dream gentlemen, then perhaps we shall find the truth'. It seems to me that the transformation made by the chemist in this discovery is little different from that made by a poet in writing poetry. I believe the imagination to operate in the same way in both science and literature, but the perceptive area in science is much more specialised.

The philosophy of science

Karl Popper in his book *'The Logic of Scientific Discovery'* refers to science as a game without end. I believe that the relation of the philosophy of science to actual science bears about the same relation as do the rules of a game to actual play. Another statement of Popper is quite relevant. 'And although I believe in the history of science it is always the theory and not the experiment, always the idea and not the observation, which opens up the way to new knowledge, I also believe that it is always the experiment which saves us following a path that leads to nowhere, which helps us out of the rut, and which challenges us to find a new way.'

Always the idea and not the experiment —in finding these we use creative processes no less different from the poet. If we go back to our earlier analogy with a game it is almost as if science is played with ideas and theories but is regulated by the rules of observation and experiment.

How then are ideas created in science?

There seem to be at least three mechanisms operating in this area and because one is player one operates these mechanisms unconsciously without analysing them—

(1) a breaking of existing patterns. (2) the creation of new patterns by analogy. (3) the creation of new patterns by plausible reasoning.

Let me illustrate the breaking of an existing pattern by the discovery of α particle recoil. This is an account by Rutherford, "One day Geiger came to me and said 'Don't you think that young Marsden whom I am training in radioactive methods, ought to begin a small research?" Now I had thought that too, so I said "Why not let him see if any α particles can be scattered through a large angle?" I may tell you in confidence that I did not believe they would be. Then I remember three days later Geiger coming to me in great excitement and saying, 'We have been able to get some of the α particles coming backwards'. It was the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15 inch shell at a piece of tissue paper and it came back and hit you."

This discovery represented a break in an established patern. Particles or shells had never been known to completely rebound to their sources so that this was something completely new and lead to the postulation of the nuclear atom.

I don't think anything quite as dramatic has ever happened in poetry. We have had changes in tradition such as

those from poetry with rhyming verse to poetry with free verse and verbal rhythm and we can compare

"The curfew tolls the knell of parting day,
The lowing herd winds slowly oer the lea,
The ploughman homeward winds his weary way,
And leaves the world to darkness and to me"

with the free verse of Eliot

"Time present and time past,
Are both perhaps present in time future,
And time future contained in time past,
If all time is eternally present,
All time is unredeemable."

And we might foresee a future in syllabic poetry composed by computer in which phonetic sounds were fed in to produce verse with rhythm but without meaning, for example
Icky sapwook billy tock,
Oodle zing ray toddle kop.
which sounds nice but is meaningless.

The other way in which we can make progress is by comparison. The Mendeleeff table is an excellent example. Comparison of known elements lead to gaps in series which were subsequently filled. The periodic table was the idea that was followed by new experiment.

Let us describe the situation in Mendeleeff's own words.

"Before the promulgation of the periodic law the chemical elements were mere fragments, incidental facts in nature, there was no special reason to expect the discovery of new elements, and the new ones which were discovered from time to time appeared to be possessed of quite novel properties. The law of periodicity first enabled us to perceive undiscovered elements at a distance which formerly was inaccessible to chemical vision, and long ere they were discovered new elements appeared before our eyes possessed of a number of well defined properties."

This then was discovery by comparison, and the periodic table may still be used in the same way.

In poetry poets often make unconscious comparisons with others. Professor Musgrove ha shown how much of Eliot's imagery has been unconsciously derived from Whitman. I have sometimes detected the same thing in my own writing. Thus I wrote about a boarding house, Eden Lodge,

"Sordid cats which roam through gloomy rooms,
Search for the smell of half cooked steak."

which is an echo of Eliot

"The evening mist it settles down,
With smell of steak in passage ways."

So that unconsciously analogy is often made by writers of poetry, while a deliberate comparison is made in the parody.

Finally, we can create ideas by plausible reasoning. This is a little harder to illustrate and I shall take a very simpe example. A student working on molybdenum riboflavin complexes showed me a solution of riboflavin. I remarked that I had grown clover seeds on filter paper with and without a molybdenum salt, but the noteworthy point was that the seeds with molybdenum had developed yellow colours around them very similar to the riboflavin yellow. We reasoned plausibly that this might perhaps be riboflavin since the colours were similar. This then was the idea. It could be followed through by experiment and is a good simple example of plausible reasoning leading to a new experimental position.

In a similar way poets will look to the future possibilities of mankind. Thus after the last moonlanding I wrote a poem with the final stanza

"Who first will find,
Love on that orb,
And so produce,
The first moon child."

This of course refers to an obvious future possibility.

I would not wish to push the comparison between the poet and scientist too far. I do hope however that I have shown that the creative processes are similar, but are exercised in different media. To conclude here is one of my better poems:

MOVEMENT

There was movement on the waters,
As the sun's rays mixed with motion,
And the movement of the clouds,
Caused further aberrations.
There was movement on the land,
In the trees, the plants and flowers,
As the forces of all nature,
Met the living bowers.

Came the living creatures,
To survive, to play and mate,
But it was movement always movement,
That was determining their fate.
The irradescent butterfly,
At length did find a mate,
And the motion of their play,
Was a high ecstatic state.

There was movement in the fields,
And the unison of song,
Was a strong determining factor,
For survival of the race,
Builders moved in unison,
And the rhythm of their trowels,
Would bring comfort in the winter,
When nature came to growl.

But it was movement always movement,
Far outside of human ken,
The fairies joined in dancing,
With the supernatural beings,
Of the caverns and the woodlands,
With their gently flowing streams,
And nothing stopped the motion,
Which was natures way of being.

But the beauty of all movement,
Was its comprehensive way,
For while the clouds were changing,
The butterflies still played,
And men pursued their labours,
While the fairies had their day,
But it was the total movement,
That was the natural way.

As day gave way to darkness,
The night became most still,
What were the waves now saying,
To the butterfles at rest,
While the dreams of men were mingling,
With pasts beyond recall,
Where the child now comes to manhood,
Found three fairies in the falls.

What the waves were saying,
Was no mystery at all,
All creatures when the day is gone,
Can rest until recall,
Back to movement, movement,
Movement for the things of everyday,
Survival, recreation,
And the furtherance of life.

AWARD FOR BP CUTTING OILS FILM

In London recently Princess Anne presented the Society of Film and Television Arts award for the Best Specialised Film of 1972 to Lawrence Crabb, director of the BP film 'Cutting Oils and Fluids".

This is the third consecutive year in which a BP film has won the British equivalent of a Hollywood Oscar against world-wide competition. Two other BP films, "The Dawn of Motoring" and "The Tide of Traffic" were also nominated for an award.

"Cuting Oils and Fluids" examines the composition and qualities of the various types of water-based fluids and neat cutting oils. It explains their function, the importance of selecting the right one for the job and the benefits derived from good housekeeping and hygiene.

Although primarily intended to inform management, production engineers and students of the important role played by cutting fluids in the machine shop, the imaginative treatment and unusual techniques used in the film, including infra-red and polarised light photography, make it of fascinating interest to wider audiences.

The film is available from the film libraries at BP offices in Wellington (tel: 59-899), Auckland (tel: 33-159) and Christchurch (tel: 64-699).

Twenty-Five Years of Research For Chemical Industry

by J. Rogers

The New Zealand Fertiliser Manufacturers' Research Association was born early in 1947 when the four New Zealand superphosphate manufacturers, the Challenge Phosphate Co. Ltd., Dominion Fertiliser Co. Ltd., Kempthorne Prosser and Co. Ltd. and the New Zealand Farmers' Fertilizer Co. Ltd., formed an incorporated research association under the sponsorship of the Department of Scientific and Industrial Research. It was a marriage between the industry and the government in the interests of extended fertiliser research, with each of the partners at that time contributing approximately half the cost. Between 1954 and 1964, the East Coast Farmers' Fertilizer Co. Ltd., Kiwi Fertilizer Co. Ltd., Bay of Plenty Co-op. Fertilizer Co. Ltd., Southland Co-operative Phosphate Co. Ltd. and Northland Fertilizer Co. Ltd., were formed and became members of the N.Z.F.M.R.A.

Increased Use

Since 1947 the amounts of superphosphate and mixed fertiliser delivered annually by the industry and used have increased from about 600,000 tonnes to the record of 2,041,000 tonnes (2,009,000 tons) in 1972. Although this is only a small percentage of total world fertiliser production, it is by far the highest use of phosphorus and sulphur fertiliser in the world per head of population — 12 bags for every New Zealander. Superphosphate production began in Dunedin shortly after 1881 when Kempthorne Prosser and Co's N.Z. Drug Company began manufacturing sulphuric acid at Burnside. The company won a prize of £1,500 from the New Zealand Government for this achievement.

New Zealand Fertiliser Manufacturers' Research Association, Auckland.

At a present cost of about 2 cents a kilogram, or between 40 and 50 cents per ewe equivalent, fertiliser is, and has been, a key factor in the growth of stock numbers in New Zealand from about 55 million ewe equivalents in 1947 to the present 100 million. As a result of the increasing efficiency of our farmers, whose numbers have decreased from about 90,000 in 1947 to approximately 60,000, overseas earnings from agricultural products have risen from about $300 million in 1947 to $1,186 million in 1972.

The above facts not only underline the importance of fertilisers in New Zealand farming, but also emphasise the foresight of the fertiliser industry's leaders in establishing, in conjunction with government, a co-operative research organisation which was unique amongst the world's fertiliser industries, until 1970 when South Africa's fertiliser companies took steps along similar lines.

The Beginning

The Association's first Director of Research, Dr. M. M. Burns (now Sir Malcolm Burns, K.B.E.) initiated soil and fertiliser studies at the Otara Fertiliser Research Station in 1950. Prior to his appointment as Principal of Lincoln College in 1953, Dr. Burns had added a glasshouse to the laboratories fitted out in the buildings which, with the adjoining land, were purchased by D.S.I.R. from the Dilworth Trust at the end of 1949. In 1952, Dr. Burns wrote:

"We do not normally think of sulphur as a major plant nutrient, yet pastures and crops contain about as much sulphur as phosphate. So far no deficiency of sulphur has been found in this country, but might not this be due to the fact that most of our manufactured phosphate fertilisers contain appreciable amounts of calcium sulphate?"

With increased stocking rates, lack of sulphur has indeed been found to limit pasture production on some soils in both the North and South Islands and this deficiency is corrected by using sulphur-fortified superphosphate. Many other soils are now known to become sulphur deficient rapidly unless regularly topdressed with superphosphate.

Development

Between 1953 and 1965 under the direction of Dr. Brian W. Doak, previously of Plant Chemistry Laboratory, Grasslands Division, the research projects at Otara were extended to include an increasing proportion dealing with the manufacture of fertiliser, particularly the processing of phosphate rocks other than that from Nauru. By that time, aerial topdressing had developed into a major industry — an economic way to increase production on hill country — appreciably increasing demand for fertiliser. Problems associated with corrosion of aircraft by fertiliser mixtures were studied at Otara, and from 1968-70 research was funded at the University of Auckland's School of Engineering to develop an improved spreader.

Also investigated were ways of mixing herbicides and insecticides (such as 2, 4-D and DDT) with superphosphate fertilisers to give optimum product quality combined with effective control in pastures of weeds and grass grub and the porina caterpillar. Studies were made of the chemical stability of DDT in superphosphate and soils, the penetration and loss of DDT in various soil types, and "wet" mixing of DDT in superphosphate for more efficient manufacture, and granulation of the product to minimise contamination of pastures and the animals grazing them. Methods were developed for testing the physical properties of fertiliser granules. Much of this work benefited from a close association through F.M.R.A. of the engineers and scientists responsible for the manufacture of these products with the agricultural experts who advised farmers on their use.

Exchange of Ideas

This bringing together of fertiliser makers and research and extension workers, together with scientists working in associated fields, has developed in large measure through the N.Z.F.M.R.A. Technical Conferences, the first of which was organised by Dr. Doak at Otara in 1957. At the 13th Technical Conference, held in November 1971, 150 delegates from the fertiliser industry, the F.M.R.A., government departments, universities and other organisations serving the industry and farmers discussed the results of research at Otara and elsewhere.

There is a ready exchange of ideas at these conferences, many of which are put to work in the industry for the ultimate benefit of the farming community. Usually there are contributors from Australia or further afield. The papers and the discussions are printed and distributed within the industry and associated organisations.

Major Expansions

From a modest beginning of $12,000, or 2 cents per tonne of fertiliser manufactured, F.M.R.A.'s annual budget has grown to $183,000 (9 cents per tonne). Sixty percent of this sum (which has increased from $35,000 in 1966) is currently provided by the industry. Broadly speaking $120,000 is spent on more efficient ways of manufacturing fertiliser, and $60,000 on improving the efficiency of fertiliser use. On many facets of the latter subject, D.S.I.R. and the Department of Agriculture have larger research programmes with which the work at Otara dovetails.

Beginning in 1966, new laboratories and offices in the J.K. Dixon Memorial Wing at Otara were built and equipped with the finest equipment available. Scientific staff has been recruited in New Zealand and from overseas, adding wide research experience from the U.K., North America, Japan, Africa and Australia, to the "know-how" about the New Zealand industry and agricultural research practice of senior staff appointed earlier. A new building suitable for large scale as well as laboratory experiments was added in 1969.

Current Priority

These human and material resources are now concentrated on Christmas Island phosphate research, as since 1965 the annual usage of phosphate rock from that source for superphosphate manufacture has risen in New Zealand from nil to over 300,000 tonnes. As Christmas Island phosphate is now cheaper than Nauru rock, it is to farmers' advantage that ways be found to use more of it. This work has brought closer links with the British Phosphate Commissioners and the Christmas Island Phosphate Commission.

Looking Ahead

Research on the effects of growth of the fertiliser industry's manufacturing operations and the increasing quantities of its product used by farmers on an environment enjoyed by all New Zealanders is likely to require more than the present 10 percent of F.M.R.A.'s effort in this field. Work on this began in 1955 when a report was made on atmospheric pollution in the Otahuhu-Onehunga area.

Fluorine compounds are now recovered from effluent and used to treat water supplies, thus saving overseas funds. This is an example of the industry's diversification into chemical manufacture, a potential growth area in which research may contribute significantly.

Constant efforts are made by visits to manufacturers, university and government research laboratories in this country and overseas to ensure that the industry is informed of significant developments and has access to them.

Faith in research is an attitude of mind. New Zealand's oldest and largest chemical manufacturing industry's continuing co-operative support of research in its own field is sound backing for the $26 million spent by the fertiliser companies on land, buildings and plant since 1962 to improve their efficiency. The fertiliser industry provides a key input for farmers' production which is by many times the greatest contribution in absolute terms to the NDC export targets. It took 74 years for output to exceed 1 million tonnes, but only another 17 years to exceed 2 million (achieved in 1972). A reasonable guess is that the 3 million tonne barrier will be passed or challenged by 1980.

International Conferences . . .

INTERNATIONAL SOLVENT EXTRACTION CONFERENCE

LYON

8th-14th SEPTEMBER 1974

The next International Solvent Extraction Conference will be held in Lyon, France from the 8th-14th September 1974 and will be sponsored by the Society of Chemical Industry in association with the Societe de Chimie Industrielle, the Institution of Chemical Engineers and the European Federation of Chemical Engineering. All the major aspects of Solvent Extraction will be discussed and papers from intending delegates are invited under the following headings:

(a) FUNDAMENTAL CONTRIBUTIONS

Chemistry of solvent extraction system including rate and equilibrium data.

Physical characteristics of droplet systems.
Mass transfer characteristics of droplet systems.

(b) APPLIED CONTRIBUTIONS

Solvent extraction processes including operational, control and economic aspects.

Contactor performance characteristics.

New contacting devices.

Design criteria for equipment and processes.

Further information may be obtained from the Honorary Secretary, *Dr. A. Naylor, British Nuclear Fuels Limited, Windscale and Calder Works, Seascale, Cumberland, CA20 1PG, United Kingdom.*

The 4th International Conference on Thermal Analysis is being held in Budapest, Hungary, from 8th-13th July 1974. Copies of the 1st Circular are held by Dr. R. J. Furkert, Soil Bureau, D.S.I.R. Private Bag, Lower Hutt.

Philosophy of a Laboratory Supply House

by John G. Heron

I feel certain that most chemists and scientists whether in research, industry education or what have you, tend to take their laboratory supply house very much for granted. This is possibly true of any trade or profession; even the research chemist carries on quietly unnoticed until such time as he has achieved some worthwhile breakthrough. Unfortunately very little which could be called spectacular happens in the field of laboratory supplies, except perhaps when one or the other of us has a fire — as occurred with my company some time in the 1940s. When I arrived in Auckland in 1950 I would occasionally still hear reference to the day of Wilton's fire when traffic in Queen Street was stopped by a pall of acrid yellow smoke. Naturally this is not the type of advertising that any laboratory supply house wants. I was therefore very glad when I was given the opportunity to talk to a group of members of the N.Z.I.C. at a symposium on laboratory supplies recently held in Auckland. I was specifically requested to talk on guidance in purchasing laboratory supplies, and I have approached the subject from the point of view that if I could convey a little of our philosophy to our clients and establish some degree of understanding of our mutual problems the amount of guidance really required was minimal.

The relationship between the laboratory supply house and its clients is very well summed up by the slogan of one well known and long established supply house "Service to Science". The essential function of a laboratory supply house, as its name conveys, is to carry stocks of laboratory equipment, chemicals and glassware in sufficient breadth and depth to keep a very wide range of laboratories operating. To the uninitiated this may appear to be a relatively simple task of deciding what should be carried in stock, locating a suitable source, estimating what quantities one should carry, and then simply carrying these in boxes and cartons on shelves until they are actually required. This may very well have been the situation when Rutherford was a boy. Indeed in 1889, when he first gained a scholarship to the University of New Zealand, Wellington, he may have stood in Manners Street peering into the side window of a chemist's shop owned by George Wilton, a man who had the foresight to see that there was a demand for scientific equipment. As a small sideline to handling his pills and potions he imported a meagre range of glassware and laboratory apparatus, thus becoming possibly the first laboratory supply house in New Zealand. The selection of laboratory equipment available in those days was obviously very limited when compared with the incredibly wide range available today. Nonetheless, they probably had their own difficulties in those days, and the chemist or scientist probably had just as many frustrations in trying to purchase the equipment or materials that he needed to perform his job.

As each new branch of science and chemistry emerged, and as each new developing industry in New Zealand discovered that it needed science to control its processes or improve its products, so the demand for more and more complex equipment or more specialised types of equipment was created. In the early 1900s there were possibly four or five companies in the laboratory supply trade, each one endeavouring to keep abreast of the ever increasing demand, and probably competing for what small volume of business there was. These companies established the pattern of providing the service to science which is very evident today but on a much more sophisticated plane.

Today there are possibly some thirty odd companies in New Zealand engaged one way or another in supplying laboratories with their requirements. Some of these companies are very highly specialised in one particular aspect or another, and as such probably serve a very useful purpose in their particular field. Howeevr, there are still only four or five companies which can correctly claim that they are laboratory supply houses insofar as they are carrying a comprehensive range of laboratory apparatus, glassware and laboratory chemicals to provide the type of service which laboratories demand. A typical laboratory supply house endeavouring to give a good, all-round, comprehensive service may carry upwards of six thousand lines of laboratory apparatus and chemicals in stock, and during the course of a year may possibly deal with more than two

Manager, Auckland Branch, Geo. W. Wilton and Co. Ltd.

This paper was part of an Auckland Branch Symposium on Laboratory Supplies.

hundred different overseas companies in purchasing this stock. This may give you some idea of the complexity of this business today. Despite this apparently wide range of stock being held in New Zealand, by overseas standards it represents only a fraction of the many brands and variations of apparatus that are currently available. One has only to look through the massive overseas catalogues or technical journals to realise there are many items not normally available from New Zealand stockists. This obviously causes many frustrations to chemists and scientists when they find that particular items of their choice are just not available from stock, and they are told by a supply house that their requirements will have to be indented with a possible delay of three to four months. It must be appreciated that the capital investment in carrying the wide range of stocks currently available is extremely high, and whilst many supply houses would be delighted to carry bigger and better stocks, they like any other business, are limited by the amount of capital available.

The constantly changing needs of laboratories, the introduction of new methods and techniques and the constant introduction of new lines by overseas manufacturers makes stock holding and stock selection a somewhat hazardous undertaking. The laboratory supply house endeavours to keep in close touch with developing techniques, and by studying the demands and feedback from customers tries to see that he is carrying the stocks which will be required. Despite this effort, the average supply house ends up holding a considerable number of items for which there is no demand because equipment has become obsolete or techniques have changed. The laboratory supply industry has changed drastically even over the past five to ten years. Each branch of science and industry now appears to have developed their own highly specialised range of apparatus and equipment, and the ordinary simple basic items of the laboratory have expanded into a multitude of types and varieties making comprehensive stock holding almost impossible. Despite the fact that the laboratory supplier realises he has to accept a fair proportion of the bad with the good, the demand must be sufficient to justify him putting capital into stock.

Here in New Zealand we face a number of problems, some of which stem from the rather small total market, other resulting from the fact that we are many thousands of miles away from the major sources of supply. Despite the small size of our country we are reasonably well developed, both economically and industrially, and we are becoming more and more scientifically oriented. Every country which manufactures scientific equipment or instruments looks to New Zealand as being a potential market. This has two opposing effects. From the point of view of the chemist or scientist, it is good because he has a selection o fequipment virtually on a global basis. New Zealand may be rather unique in this respect, as many of the larger overseas countries which have their own laboratory apparatus manufacturing industries limit importation of foreign goods with the effect that the scientist has only a narrow choice. If we look around the New Zealand stockists, it is possible to find scientific equipment from practically every country in the world, either available ex stock or on indent. The opposing effect of this wide availability of goods gives some concern to the laboratory suppliers, because it tends to oversaturate a relatively small market with too large a variety of goods; if a supplier surveys the market with a view to putting in stocks of a specific item, he is likely to find that the share of the market which he could expect to obtain would be too small to justify him putting in reasonable quantities.

Making stocks available is only one of the services which a laboratory supply house provides, albeit an important one and probably that by which a laboratory supply house is judged. We must also look at some of the other aspects. Generally speaking, a laboratory supply house in New Zealand limits stocks to those items which turn over with reasonable frequency — for example, standard ranges of laboratory apparatus and glassware, the more commonly used laboratory reagents, possibly some of the middle range instruments such as microscopes, centrifuges, lower priced spectrophotometers and so on. The more specialised apparatus, sophisticated instruments or rare chemicals stocks are not available. They must be indented when required. The service which a laboratory supply house provides in this respect is firstly to be able to provide the knowledge of what is available overseas with detailed specifications and estimates of prices, secondly to know how to bring requirements into the country as efficiently and economically as possible, and lastly to install and provide after-sales service in the case of instrumentation. Again this may sound a relatively simple undertaking, but if we analyse each function, we can see some of the problems involved — particularly if we relate this to the extremely wide range of instrumentation which is available today and likely to be available tomorrow.

Instrumentation is becoming more and more sophisticated and complex to the extent that many supply houses are now employing science graduates to handle sales promotion and after-sales service. Many overseas companies insist that their New Zealand agent provides technically qualified staff capable of absorbing training in their specific products. This becomes very necessary when we look at such items as gas chromatographs, mass spectrometers, scintillation counters and similar instruments. The supply house is thus providing the customer with a consultant-type service — providing a man capable of discussing the customer's problems on equal terms and giving technical advice.

When it comes to the actual importation of requirements the efficient supply house again provides the expertise to import as smoothly, efficiently and economically as possible, being fully conversant

with all the requirements and capable of avoiding the many pitfalls and difficulties in obtaining goods from overseas.

The correct installation of an instrument and its after-sales service both during warranty and post-warranty periods are of a vital concern to the customer. The laboratory supply house is very conscious of its responsibility in this respect. Most supply houses that are engaged in selling scientific instruments employ a number of well-qualified service engineers. In many instances these service engineers are provided with overseas training and they are usually also well equipped with full service data and manuals provided by the instrument manufacturers.

All these services cost money and it is quite obvious that if there is no limit to the cost the type of service provided could be superb. Unfortunately there is usually an economic limit, as the amount of money that can be spent on providing service is proportional to the amount of profit which can be made.

The word profit is usually spoken of in whispers and indeed many people still regard profit as being a rather dirty word. However in these enlightened days we all admit that profit, like sex, does indeed exist and can be talked about at least qualitatively if not quantitatively. As already stated, for a supply house to provide a goo dservice they must operate profitably. It does not necessarily follow that a highly profitable organisation is necessarily going to provide the best service, but as service is one of the recognised elemnts of a very competitive type of trade, most supply houses are striving hard to provide the best service they can for the most reasonable price.

If we examine the situation carefully we find that there is a delicate balance between price, profit and service provided. The competitive nature of the laboratory supply trade tends to keep the price structure reasonable and at the same time the laboratory supply houses are endeavouring to provide the best service they can. Consequently the profit margin is pegged at a very reasonable level. This competitive element in the laboratory supply trade should provide the users with some assurance that they are obtaining value for the money they spend, presupposing of course, that laboratory supply houses are run efficiently. Again the competitive element controls this, as the inefficient supply house would very soon cease to exist.

The selection of equipment is largely dictated by the money available and the specification or limits of accuracy required in the instrument. It is worth nctng at this point that the laboratory supply trade does not adopt what is commonly referred to as hard sell tactics. This type of salesmanship definitely does not work on our line of business. The laboratory supply house has to establish and maintain confidence with its clientele and also has a responsibility to stand behind the good name of their principals and to back up any guarantees and warranties which their principals provide.

Summary — we are an ethical, service-oriented trade trying hard to provide the all-round type of service needed to maintain the smooth running of chemists' own operations. Good liaison, co-operation and communication between supply house and users must result in happy relationships. Keep the feedback going — feel free to tell supply houses how they may improve their service.

CONTROVERSY ABOUT CRYSTAL STRUCTURES QUICKLY RESOLVED

Molecules and crystals, the atoms in which are in asymmetrical arrangement, have interesting optical, electromechanical and chemical properties. The asymmetry makes two structures possible, each of which is the mirror image of the other. To understand these properties it is important to determine which of the two mirror-image structures is responsible for any particular property observed. Hitherto, the process of determination was based mainly on a special method of X-ray analysis, namely, anomalous X-ray scatter. This made classification of the asymmetrical structures possible.

When the Japanese researcher J. Tanaka argued on the basis of a theoretical analysis at a recent congress that the long accepted classification showed an error in calculation and that all structures ought therefore to be replaced by their mirror images, the experts experienced a sense of shock.

This prompted intensive experimental and theoretical study of the problem. Using a new analysis technique based on the reflection of low-energy ions against an asymmetrical crystal, researchers of Philips Research Laboratories, Eindhoven, were able to prove that Tanaka's assertion was incorrect and that the existing classification could be upheld. About the same time, workers at the State University, Utrecht, detected an error in Tanaka's calculations.

The ion reflection technique is based on the fact that, on being reflected against a crystal surface, ions lose a certain fraction of their energy. The magnitude of this fraction is characteristic for the mass of the atoms with which the ions have collided. Two workers at the Philips Laboratory mentioned, H. H. Brongersma and P. M. Mul, first showed this technique to be usable for selective investigation of the outermost atomic layer. To this end they applied a monolayer of bromine atoms to a silicon crystal. The energy of the reflected ions proved that only collisions with bromine atoms, and not with silicon atoms, were involved. They then applied the method in determining the structure of a zinc sulphide crystal, a well-known example of the asymmetrical structures concerned. Such a crystal comprises alternate layers of zinc and sulphur. The distances between a given atomic layer and its two neighbours are unequal, in consequence of which there therefore allowed a clear distinction to is asymmetry. There are two opposing end faces, the one consisting entirely of the light sulphur atoms and the other of the heavy zinc atoms. Ion reflection be made between these end faces.

BRANCH NEWS

Auckland

Thirty-one members attended a combined meeting with the Chemistry Department, University of Auckland, to hear Professor R. Belcher (University of Birmingham) on 27 April. His address entitled "New Methods for the Determination of Traces", outlined developments on the following:

new reagents and reactions,
charge transfer reactions,
candoluminescence,
molecular emission cavity analysis,
enzymatic reactions,
G.L.C. of chelates,
mass spectroscopy of chelates.

Fifteen graduands in chemistry and bio-chemistry were the guests at a luncheon meeting on 9 May, addressed by the Hon. C. J. Moyle, Minister of Science. The Minister took this opportunity of stating Government policy on co-operation between universities, government scientific departments and industry.

The all day Food Chemistry Symposium organised jointly by the Branch and the Institute of Food Technology held on 9 May, was an outstanding success. Papers were presented by Assoc. Prof. R. Wrolstead (Department of Food Science and Technology, Oregon State University), Mr. J. Fraser (Department of Health), Mr. O. H. Keys (Government Analyst), Mr. G. W. Tunnicliffe (U.E.B. Industries), Mr. M. Reeves (Massey University), Dr. D. Heatherbell (Plant Diseases Division D.S.I.R.), and Dr. J. M. Park (Ruakura Agricultural Research Centre).

The "Management Course for Chemists" has had excellent support and has now commenced at the Auckland Technical Institute.

Professor L. Hepler visited the Chemistry Department, University of Auckland, giving a warmly received address on "Some Informal History and Unconventional Applications of Thermodynamics".

Personal

Mr. M. L. Allen, Senior Lecturer in Chemical Engineering, addressed an N.Z.I.E. symposium on S1 units on 8 May.

Dr. Chris Reed has been awarded an Associate Professorship at University of California. His researches are in the field of inorganic synthesis.

Dr. H. C. Holland was recently honoured with a D.Sc. by the University of Canterbury for his services to the leather industry.

Several members of this Branch gave evidence to the Public Enquiry into the "Parnell Fumes" civil emergency.

Manawatu

Over sixty people attended the April meeting of the branch to hear Professor R. Belcher, Professor of Analytical Chemistry at the University of Birmingham, speaking on "Myths and Legends in Analytical Chemistry". Professor Belcher, B.Sc., Ph.D., D.Sc., who is one of the outstanding analytical chemists of today was in New Zealand as a British Council Visitor.

Massey University

Professor Belcher spent a day in the Department of Chemistry, Biochemistry and Biophysics and spoke on "The Application of Chelate Compounds in Analytical Chemistry".

Dr. M. G. Rumsby, Lecturer in Biochemistry, University of York visited the department.

Professor G. N. Malcolm gave the Annual Chemistry in Action Lecture in Christchurch. His address was entitled "Macromolecules in Physical Chemistry and in Molecular Biology".

D.S.I.R., Applied Biochemistry Division

Dr. R. W. Bailey has left to spend 12 months as a visiting professor at the University of Trier-Kaiserslautern in West Germany. He will be studying basic mechanisms of cell wall formation in plants and aspects of wood wastes and seaweed utilisation.

Dairy Research Institute

K. N. Pearce, Fundamental Protein Section, has obtained a Ph.D. from Massey University with a thesis entitled "Electrolyte Systems Relating to Milk".

Dr. N. J. Walter is to spend a year at the National Institute for Research in Dairying, Reading University, doing work on flavour components of milk products using combined Gas Liquid Chromatography and Mass Spectrometry.

Dairy Industry Graduate Trainees at the Institute this year are Mr. J. J. M. Lubeck (Dairy Board), Mr. P. A. Munro (Ministry of Agriculture and Fisheries — Dairy Division), Mr. K. E. Russell (Dairy Division), Mr. B. L. S. Sutherland (Dairy Division), Mr. J. I. Sutherland (Dairy Board) and Mr. N. W. Walker (Kiwi Co-op Dairy Co.).

Mr. A. K. R. McDowell, Head of Analytical Chemistry, in the Applied Division, retires from the Institute on May 25th having been on the staff since 1933.

Mr. K. R. Marshall has been invited to a conference on waste disposal, to be held in Denmark and organised by the International Dairy Federation.

Other

Mr. B. E. Hassall has moved from Palmerston North Boys' High School to Head of Chemistry at Fielding Agricultural High School.

Wellington

Soil Bureau—D.S.I.R.

Mr. P. L. Searle has returned to the Analysis Section of Soil Bureau from the U.K. where he spent thirteen months as holder of a Queen Elizabeth II Study Award. His chief interest was in automated methods of soil analysis and he divided his time between the Tropical Soils Analysis Unit, University of Reading and the Macaulay Institute for Soils Research, Aberdeen.

Dr. W. B. Healy is spending May and June visiting research organisations in Europe and in the U.S.A. where he is presenting a paper "Ingested soil as a source of elements to grazing animals" at the 2nd International Symposium on Trace Element Metabolism in Animals in Madison. His interests overseas relate to this topic and to the effects of soil biology on soil fertility.

Chemistry Division

In April, Dr. Kayser of the Chemistry Department of Victoria University delivered an entertaining lecture entitled "The mouse as test tube".

Mr. T. E. J. Scahill visited Australia for two weeks in March in order to attend the Instron Users' Course in Melbourne.

Mr. E. Cairns who recently gained his B.Sc. (Hons.) degree in Chemistry from Victoria University has joined the Toxicology Section.

Institute of Nuclear Sciences

Dr. T. A. Rafter left in April to spend two months at the Federal University of Bahia in Brazil. He is assisting with a UNESCO project to strengthen teaching and research in the basic sciences.

Dr. J. R. Hulston visited Australia in February to attend the second conference of the Australia and New Zealand Society for Mass Spectrometry, and to lecture on his work on the use of stable isotopes in estimating underground temperatures in geothermal areas. He was re-elected as the New Zealand representative on ANZSMS, and he is currently attempting to form a New Zealand section of this Society.

Dr. G. L. Lyon visited Antarctica in December in attempt to sample geothermal gases from Mt. Erebus and Mt. Melbourne.

Dr. A. W. Fairhall gave a lecture to the Institute on his present studies relating to the accumulation of carbon dioxide in the oceans.

Dr. B. J. O'Brien lectured to the Wellington Branch of the Royal Society on fall-out levels and other sources of radiation exposure.

A recent appointment to the staff is Dr. B. J. Barry who has recently gained his Ph.D. degree at Waikato, and who will assist Mr. W. J. McCabe in industrial work with radioactive isotopes.

Otago

Secondary School Lecture Series

The Otago Branch is this year making a determined bid to interest local sixth and seventh formers in chemistry, and as part of this effort the following three lectures have been arranged:—

May 25, Professor G. Petersen, Head of the Department of Biochemistry at the University of Otago, delivered a lecture entitled "Living Molecules". This is to be followed on July 13, by a lecture on "Chemistry and the Moon" by Dr. B. Peake of the Chemistry Department of Otago University, and finally on August 3 Dr. R. Cunninghame of the Chemistry Department will discuss "The Artist's Palette — Colour in Inorganic Chemistry". All lectures will be held in the Old Chemistry Lecture Theatre at 8 p.m.

Chemistry Department

Professor A. D. Campbell left for Australia on 9th May for a brief visit to analytical chemistry laboratories and to attend the Second Australian Symposum on Analytical Chemistry held in Sydney in the third week of May. The Symposium was organised by the Analytical Division of the Royal Australian Chemical Institute.

Computer Facilities

The new Burrough's B6712 Computer has now been installed at the Computer Centre of the University.

Visitors

Professor R. Belcher of the University of Birmingham visited Dunedin early in May and gave two lectures. The first of these, entitled "Myths and Legends in Analytical Chemistry" was accompanied by a demonstration and attracted a good attendance of branch members. The second lecture "New Methods of Trace Analysis", was also well attended.

Another visitor to Dunedin was Dr. I. Furzer of the Chemical Engineering Department of Sydney University. Dr. Furzer inspected the Applied Chemistry Laboratories in the Chemistry Department of the University, and also gave a very well attended lecture on the cyclic operation of distillation and gas absorption columns.

Canterbury

On May 9-11th a seminar was organised by the Chemistry Department on the subject of "Chemicals in the Environment". The seminar covered chemical, technological and legal aspects of air and water pollution.

From June 11th to July 23rd the branch is replacing the regular meetings with a series of refresher courses for chemistry graduates of some years standing. In the courses a survey of developments over the past 15 years, in a selection of topics, will be given on Monday evenings. The subjects being covered are:

transition metal chemistry, separation techniques, quantum chemistry, polymers, spectroscopic techniques, molecular biology, photochemistry.

BOOK REVIEWS

"Safety in chemical laboratories and in the use of chemicals"—Imperial College of Science and Technology, London. 3rd Edition, 1971: 46 pp.; $0.40.

This source, at this price, promotes itself.

Safety handbooks of this size are necessarily pared and related to local anxieties, but the coverage of the usual lore is good. Somewhat greater proportion than usual is given both to pressurised gases and vacuum practices. It is indexed adequately and the few references are up-to-date and well chosen.

It is well enough set out, with a discursive approach, without tabulation of data. This tends to give a slightly "rambled" impression, but the subject matter itself is of course very rambling, added to which the booklet is probably begotten by Committee. It has (elsewhere) three siblings — on radiation, electrical and biological hazards. Filled with information for the knowledgeable, it does not attempt any simplifying insights, such as might be advisable for the mental freeze-ups of emergencies or the ignorance of fledgling students or technicians.

For any laboratory, satisfactory coverage of its own peculiar range of hazards can only be fully treated by its own staff. This booklet covers most situations and to anyone concerned with such matters it must be welcomed as a sound example and asset.

A.H.H.

Copies of this booklet are available singly or in bulk from the Registrar, 40 cents per copy.

"Modern Analytical Methods by D. Betteridge and H. E. Hallam.

The Chemical Society, Monographs for Teachers No. 21. 1972 227 pages $4.

"Modern Analytical Methods' is a further publication in the now well established series of Monographs for Teachers, but unlike its predecessors this monograph runs to 227 pages. In the preface the authors state 'The subject is so wide ranging that each chapter might warrant an individual monograph'. After reading through this book (monograph is hardly the correct word) I am inclined to agree, but we must not forget the original aim and purpose of the series. In this context the book is fairly successful for it presents in a concise, readable manner a comprehensive current account of many aspects of a subject which has undergone a tremendous transformation in recent years. Today analytical chemistry enters into most sciences, and in fact our everyday life has become dependant on the results of analyses. It is significant that the Chemical Society should recognise this development as worthy of a monograph to bring teachers and their students up to date.

In the introduction the authors briefly set out the scope of analytical chemistry and stress the importance of knowing the significance of a result once it is obtained. The first few chapters are concerned with methods of separation and also contain an excellent chapter on solution equilibria presented in a form which requires no more than a knowledge of elementary algebra. The remainder of the book contains chapters on the various analytical methods such as titrimetry, electrochemical nuclear, X-ray and spectroscopic methods. Some may question the inclusion of titrimetry as a modern analytical method but this chapter fully justifies its inclusion. To compensate for the brief treatment which is necessary in order to condense such a wide range of topics into a single monograph, the authors give references to numerous texts, reviews and original papers which may be consclted by the reader interested in further detail and information. Although the book does not contain practical procedures, the discussion is well illustrated with typical examples.

Several of the texts listed by the authors under general references are much more comprehensive and useful for teaching puposes, but I do consider this to be a valuable addition to the series of monographs for teachers.

I trust that in the future other monographs will complete areas where there are discrepancies in the present book.

A. D. Campbell.

RIC Monographs for Teachers

Copies of Monograph 20 *"Silicon Chemistry and its Applications"*, $3.00 and Monograph 21 *"Modern Analytical Chemistry,* $4.00, are available from the Registrar, P.O. Box 1926, Christchurch.

The Registrar holds the complete range of RIC Monographs for Teachers.

A review of *Silicon Chemistry and its Applications* will appear in the next issue.

NEW ELECTIONS

The following were elected to Fellowship on May 10, 1973:—

FLETCHER, John Gavin, M.Sc. (Auck.), Auckland Technical Institute (Course Supervisor and Tutor in Chemistry).

HARTLEY, Gilbert Spencer, D.Sc. (London), 57 Aurora Terrace, Hamilton (Retired).

HOPGOOD, Raymond Henry, B.Sc., Fletcher Holdings Ltd., Auckland (Associate Director).

MARKHAM, Kenneth Ronald, M.Sc. (Well.), Ph.D. (Melbourne), Chemistry Division, Gracefield (Scientist).

PORTER, Lawrence James, M.Sc., Ph.D. (Well.), Chemistry Division, Gracefield (Scientist).

The following were elected as Members:—

BARTON, John Patric, M.Sc., Ph.D. (Auck.), Dept. of Psychiatry, Medical School, Auckland University (Post-Doctoral Fellow).

GRETNEY, John Robert, B.Sc. (Hons.), Ph.D. (Centuar.), Christchurch Technical Institute (Tutor).

DENNY, William Alexander, M.Sc., Ph.D. (Auck.), Auckland Cancer Research Laboratory (Senior Organic Chemist).

EDMONDS, Neil Raymond, M.Sc. (Auck.), Polymers (N.Z.), Pty. Ltd., Auckland (Industrial Chemist).

GARDNER, Frank, A.R.I.C. Fletcher Chemicals Ltd., Auckland (Works Chemist).

HARDING, David Roger Kay, B.Sc. (Hons.) (Cantuar.), Ph.D. (West Ontario), Dept. of Chemistry, Massey University (Post Doctoral Fellow).

JOHNSON, James Howard, M.Sc. (Well.), Chemistry Dept., Victoria University, Wellington (Junior Lecturer).

MAISTER, Selwyn Gerald, M.Sc. (Cantuar.), D.Phil. (Oxon.), Christchurch Technical Institute (Tutor).

NORTHOVER, Miss Jennifer Dean, B.Sc., Technical Laboratory, H.M. Stationery Office, London (Examiner).

REYNOLDS, Christopher Paul, M.Sc. (Well.), Secondary Division, Teachers College, Christchurch (Student).

SHARP, Frances Vera, B.Sc. (Hons.) (Lond.), A.R.I.C., T. J. Sprott & Associates, Auckland (Analytical Chemist).

SUTTON, Maxwell McLaughlan, B.Sc. (Hons.), Ph.D. (Leeds), Ruakura Soil Research Station Hamilton (Scientist).

TUCKER, Lois Elizabeth, B.Sc. (Hons.) (Cantuar.), Ph.D. Zoology Dept., University of Canterbury (Lecturer).

WHITTLE, Kenneth Rodney, M.Sc., Ph.D. (Auck.), Palmerston North Technical Institute (Tutor).

The following Graduates were elected as Members:—

BOYD, Graeme Stewart, M.Sc. (Cantuar.), I.C.I. N.Z. Ltd., Lower Hutt (Production Supervisor).

NIELSON, Jeppe Sondergaard, M.Sc. (Massey), Ministry of Works Laboratory, Hamilton (Chemist).

PEARCE, Philip David, B.Sc., Applied Biochemistry Division D.S.I.R., Palmerston North (Scientist).

The following were elected as Graduate Members:—

BEDFORD, Keith Richard, M.Sc. (Auck.), Chemistry Dept., Auckland University (Ph.D. Student).

CHEW, Chee Kong, B.Sc., Chemistry Dept., University of Canterbury (M.Sc. Student).

CONSTABLE, John Reginald, B.Sc., Trimol Laboratories Ltd., Auckland (Chemist).

DAROUX, Mark Louis, M.Sc., Chemistry Dept., Auckland University (Research Student).

EDGAR, John Stanley, B.Sc.Tech. (Hons.) (N.S.W.), Wool Research Organisation, Lincoln (Asst. Scientist).

FLYNN, Randyl Gregory Albert, B.Sc., Chemistry Dept., Auckland University (M.Sc. Student).

MACKAY, Ian Murray, B.Sc., Dip.Food Tech., Cadbury Fry Hudson Ltd., Auckland (Chemist).

MACKIE, Keith Lawrence, B.Sc. (Hons.) (Massey), Chemistry Dept., Massey University, Palmerston North (Student).

MORCOM, Anthony Thomas, B.Sc., Chemistry Dept., Auckland University (M.Sc. Student).

WALKER, Leon William, B.Sc. Lactose Co., of N.Z. Ltd., Edendale (Chemist).

WOD, Chee Pan, B.Sc., Southdown Freezing Co. Ltd., Auckland. (Industrial Chemist).

The deaths of the following members were noted with regret: Pai Wah Cheng, T. J. McKee, F. Morgan.

The following resignations were accepted: I. D. Beall, A. N. Wilson.

The following were granted remission of further subscriptions: D. A. Dick, G. S. Hartley, E. W. Hullett, G. M. Richardson, W. F. Rolt, Mrs. R. M. Swanwick.

The following were deleted from the List of Members: P. C. Betts, B. N. Blackett, W. E. Brown, D. R. Castaing, D. G. S. Clark, A. D. Collins, D. F. Cook, Mrs. M. J. Davies, R. W. Hay, M. F. Hornblow, Mrs. L. Kampjes, T. Ronson, M. D. W. Robins, Mrs. P. M. Shanks, R. L. Sinclair, W. K. Thomas, Mrs. P. A. Wilson, B. J. Wilkins.

IUPAC INFORMATION

The information on XXVII IUPAC Conference (Munich, 21-31 August 1973) and XXIV IUPAC Congress (Hamburg, 2-7 September 1973) has been brought up-to-date in this issue of *Information Bulletin*. A list of official delegates (as available at the time of going to press) of the National Adhering Organisations and Associated Organisations to the Conference and the agenda for the Council meetings are included.

Nomenclature of several specific subjects has been taken up for the preparation of IUPAC recommendations by the Commissions on Macromolecular and Organic Nomenclature at their last meetings, e.g. stereochemical nomenclature of polymers, nomenclature and symbolism of inorganic polymers, nomenclature of natural products, etc. Salient features of recent meetings of the following IUPAC bodies are reported: Commission on Macromolecular Nomenclature (Knokke-Zoute, 4-9 June 1972); Commission on Food Additives and Commission on Food Contaminants (Kungalv, 23-25 August 1972); Commission on Nomenclature of Organic Chemistry Villefranche-sur-Mer, 4-10 September 1972); Section on Oils and Fats (Chester, 6-7 September 1972); Macromolecular Division Working Party on Structure and Mechanical Properties of Commercial Polymers (Lyon, 7 September 1972); Commission on Molecular Structure and Spectroscopy (Wroclaw, 17 September 1972); Applied Chemistry Division Committee (Le Bischenberg, Strasbourg, 20-21 September 1972); Commission on High Temperatures and Refractories (Paris, 11-12 October 1972); Interdivisional Committee on Machine Documentation in the Chemical Field (Paris, 15-16 October 1972); Commission on Physicochemical Symbols, Terminology, and Units (Paris, 17-18 October 1972); Macromolecular Division Working Party on Molecular Characterisation of Commercial Polymers (Brussels, 17 November 1972); Commission on Analytical Nomenclature (London, 22 November 1972); Macromolecular Division Working Party on Structure and Mechanical Properties of Commercial Polymers (Frankfurt/Main,2 6-27 February 1973).

Details of sixteen forthcoming Symposia sponsored by IUPAC are provided for the benefit of intending participants; brief accounts of two Symposia held towards the end of 1972 are also included.

In view of the active collaboration which IUPAC has with other international organisations, the recent activities of WHO, SCOPE, ICSU Abstracting Board and ISO of relevance to chemistry are mentioned.

The May 1973 issue of the Bulletin also includes a list of IUPAC Publications issued during 1972 and sources of their availability. Calendars of forthcoming IUPAC-sponsored meetings and non-IUPAC meetings are included as usual.

Extracts from Minutes of Council Meeting

Future Conferences: 1974 Auckland
1975 Waikato
1976 Dunedin, in conjunction with the IUPAC Natural Products Congress.

Overseas Visitors: To this year's Conference, Professor F. W. Gibson, Research School of Medicine, Australian National University.

In July-August, Professor J. L. Wain, Commonwealth Prestige Fellow.

Manpower Survey: Dr. Foster asked branches to state clearly how closely they had followed last year's memo, and to report to Dr. Foster.

TCA and Syllabus: The NZIC Committee have completed a syllabus revision for Chemistry III, IV, and V, and this has been forwarded to the TCA. Work is proceeding on recommendations for a 3-year Certificate. The TCA has appointed an ad hoc committee with Professor A. Odell as Chairman to carry out a chemistry syllabus review. The NZIC report will be the starting point for this review.

Strong dissatisfaction with the revised Biochemistry II syllabus was reported, and it was resolved that Council should express its concern to the TCA and suggest that TCA consult with Professor J. B. Petersen on this.

Testing Laboratories Registration Council: Mr. R. H. Hopgood F.N.Z.I.C. has been appointed to the TELARC. It was resolved that Council suggest to TELARC that it should be a requirement for a registered laboratory to have at least one professionally qualified person as a full-time staff member.

Standards Association of N.Z.: Dr. P. K. Foster has been appointed by the Minister to SANZ Council, replacing Mr. W. A. Joiner who did not wish to be reappointed. It was resolved that Council write to the Director of SANZ requesting urgency in the production of NZS6503 Metrication, because this standard is urgently needed by teachers and others.

Grades of Membership: The President tabled a draft of his journal editorial on this matter; submissions from the Auckland Branch and Mr. W. Freitag, and from the membership committee members were also received. It is clear that there are many different points of view regarding the place of technicians in the Institute. The President requested full discussions at Branch meetings so that delegates could report back to the August Council meeting. It is hoped that the President's editorial in the Journal will promote vigorous correspondence in the Journal.

N.Z. GEOCHEMICAL

GROUP SYMPOSIUM

The Geochemical Group held a symposium at the Cawthron Institute, Nelson, from the 14th to 16th May. It was preceded by an excursion to Dun Mt. and was followed by a two-day excursion to the Takaka region. The meeting was attended by about 95 delegates including some from Australia and U.S.A. Overseas scientists included Dr. J. R. Richards, mass spectroscopist in the Geophysics and Geochemistry Department of A.N.U., Dr. D. J. Swaine, environmentologist in C.S.I.R.O., Sydney, and Dr. Brian Mason of the Smithsonian Institute, Washington D.C. Thirty papers on a variety of topics included ore deposition, petrochemistry of mafic and ultramafic rocks, geochemical prospecting, analytical techniques, isotopes, low temperature metamorphism and hydrothermal alteration were presented.

In his annual report, retiring chairman Dr. A. Wodzicki noted a membership of 143, the usefulness and popularity of the newsletter ably edited by Mr. S. H. Wilson, and the success of the biennial symposia which are now well established.

Officers for 1973-75 were elected as follows:

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

Secretary-Treasurer: Dr. R. W. Henley, Geology Department, University of Otago.

Editor: Mr. S. H. Wilson, York Bay, Eastbourne.

Committee: Dr. A. Reay, Mr. J. O. Sinton, Dr. R. Goguel and Dr. P. Blattner.

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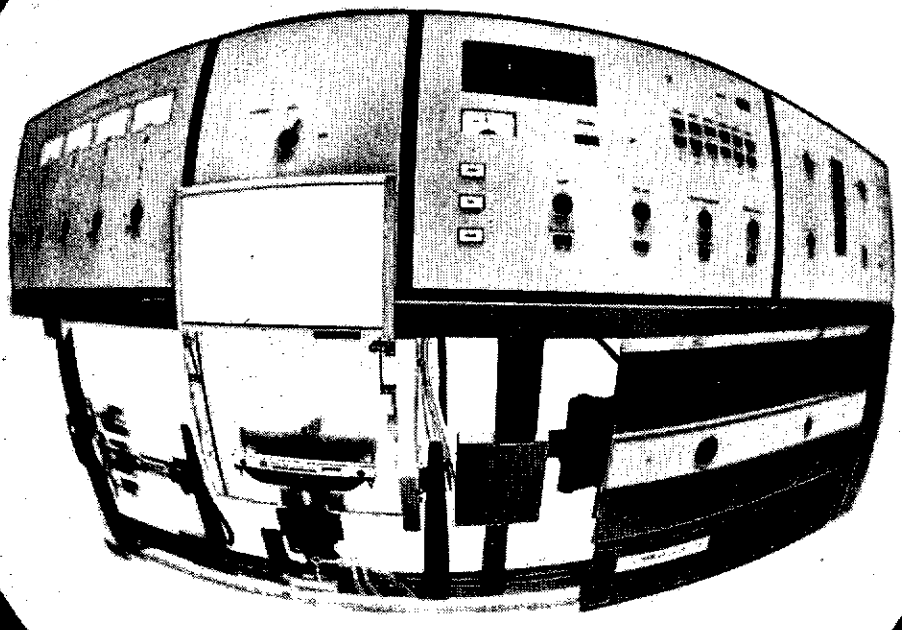
AA—6



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Duties: to be responsible to the Senior Waterworks Chemist for supervision of water treatment at filter stations and quality control of public water supplies within a region; to control the regional laboratories and staff engaged on the chemical, bacteriological examination of water samples and of miscellaneous materials connected with the water industry; to carry out such other duties as may be required.

Candidates should possess a First or Second Class Honours degree in Chemistry, or equivalent, plus three years' post-graduate experience, OR, ANZIC or ARIC, plus one year's appropriate post-qualification experience.

Salary scale equal to about $NZ6,000-$NZ9,500 by eight annual increments. (Comparative scale in N.Z. would be about $8,000-$13,500.) When fixing commencing salary, one increment granted for each completed year of relevant experience in excess of entry requirements.

Gratuity of 25% payable on total earnings on completion of agreement.

Appointment on agreement for 2½ years in the first instance.

Low income tax, free family passages, paid leave, subsidised accommodation, free medical attention.

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A graduate is needed for one of our Upper Hutt laboratories. Applicants must have had some experience in manufacturing, and will be engaged initially in laboratory work associated with our wide range of chemical and biological products.

Responsibilities will increase rapidly as he becomes familiar with our business. Supervision, technical service and product development will become part of the job and the continuing growth, expansion and diversification of our company assures a worthwhile future for the right man.

Interviews can be arranged in any major city.

Please address replies or enquiries to . . .

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CAWTHRON INSTITUTE
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A permanent position will be available in November in the Chemical Services Section (10 staff) which offers a wide range of analytical and consultant services to industry and agriculture.

The position would suit a hardworking, versatile chemist interested in applying knowledge and experience to a variety of organic and inorganic analytical problems.

Applicants should have a B.Sc. Hons or M.Sc. degree with preferably some years of experience in an analytical laboratory and some experience in the supervision of staff.

The Institute offers pleasant working conditions in a modern well equipped laboratory. Instrumentation includes G.C., U.V., I.R. and A.A.

Salary will be commensurate with qualifications and experience.

Applications giving details of experience, qualifications and names of at least 2 referees should be in the hands of . . .

The Director
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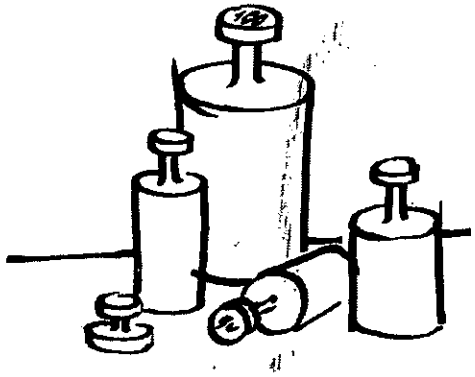

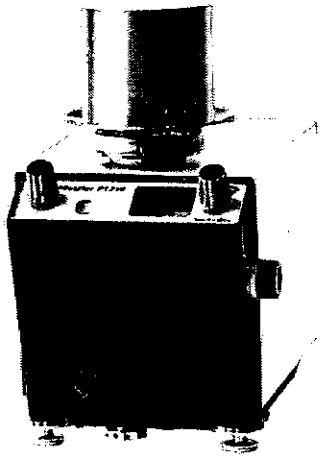

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