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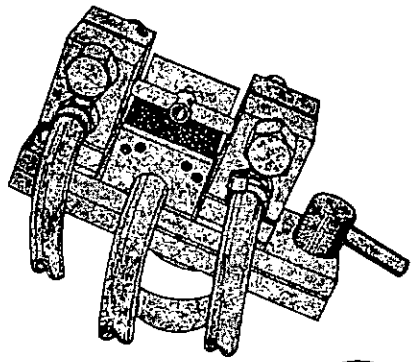

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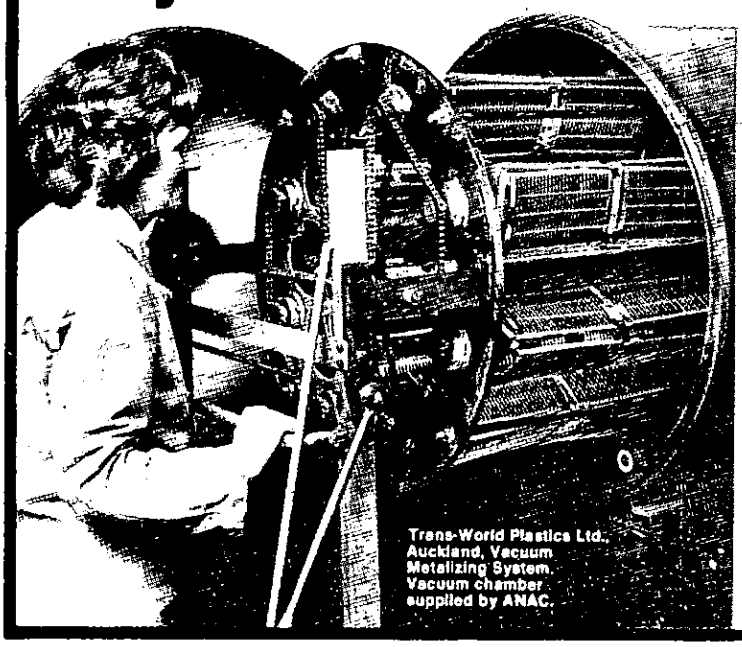

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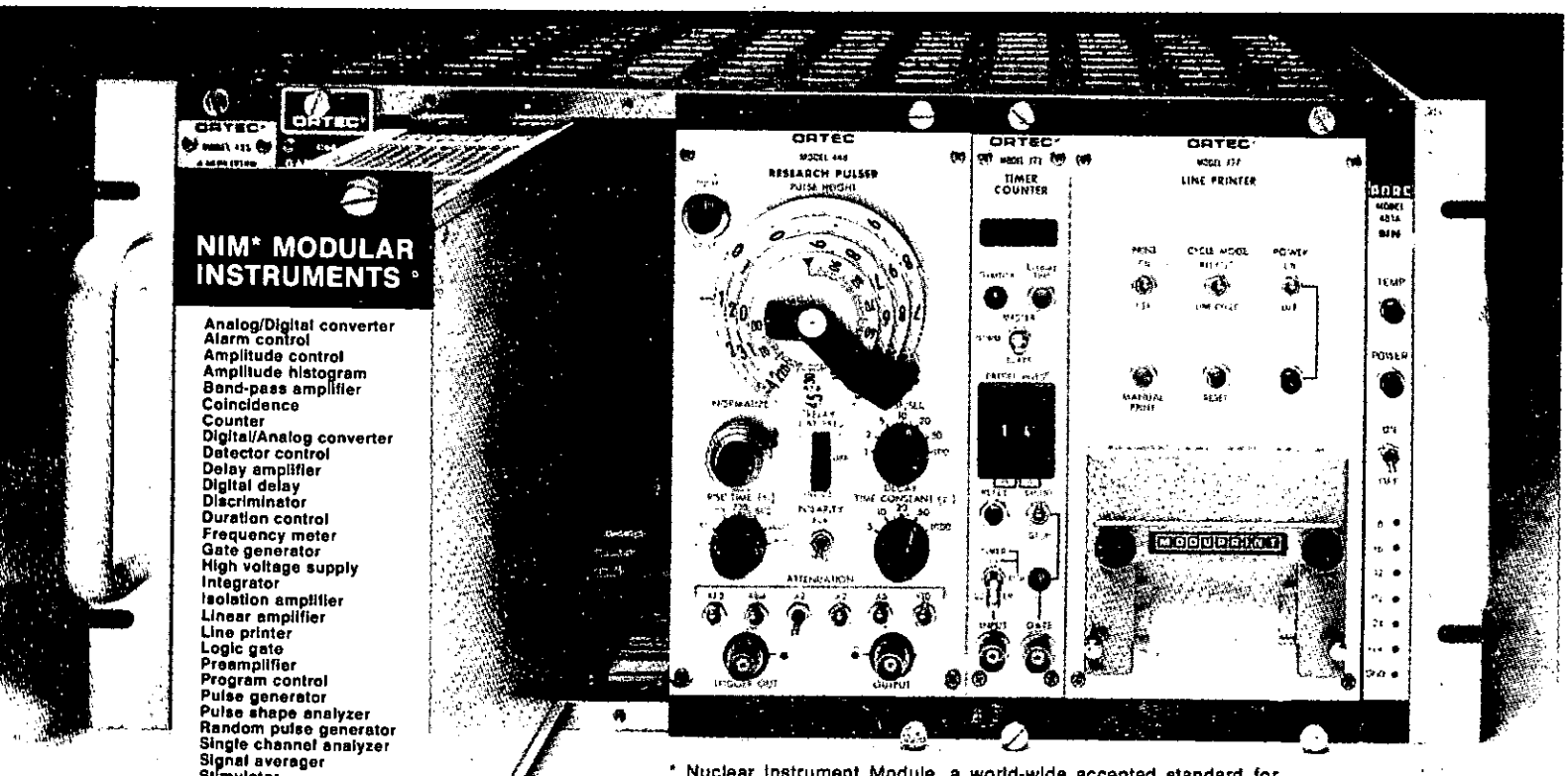

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FROM THE PRESIDENT OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

Chemists in New Zealand have cause to be grateful to Professor Corbett and his team, for without their enthusiasm, perseverance, and hard slogging the I.U.P.A.C. Symposium could not have become a reality.

It is good for us to entertain visitors, not only because they enable us to see ourselves through other eyes. We are a staid nation, self-critical, self-effacing, sometimes in need of reassurance by assessment against outside standards.

We bid our overseas guests doubly welcome, first for the stimulation their presence will bring, and secondly because they will provide a reason for us to demonstrate our best. One might suggest that theirs will be a catalytic effect but catalysts remain unchanged. Rather, I hope that both visitors and hosts will find their outlook, ideas and interests the richer, long after the Symposium has faded in the memory.

In this issue *"Chemistry in New Zealand"* has endeavoured to present an overall picture of New Zealand's recent and current chemical activities. Sober reviews cannot hope to recapture all the ambitions, struggles and triumphs that have marked our chemical progress. To solve these our visitors will need to talk with our chemists and biochemists, to visit their laboratories and institutions.

If this review assists in indicating the scope of our activities, in providing the stimulus to seek further, then it will have achieved the Institute's wish to aid and encourage the success of the 10th I.U.P.A.C. Symposium.

JOHN POLLARD,
President.

THE NEW ZEALAND INSTITUTE OF CHEMISTRY 1955-1976

The New Zealand Institute of Chemistry was founded in 1930 and the history of its first 25 years is recorded in the Silver Jubilee issue of its *Journal*, November, 1955. As copies of that issue of the *Journal* are now few, it will probably be unknown to I.U.P.A.C. visitors, and indeed to many present N.Z.I.C. members. In that issue W. G. Hughson wrote, "Prior to 1930 matters pertaining to the status of chemists in New Zealand were in the hands of local societies attached as a rule to the University Colleges, or operating as sections of the Philosophical or Royal Society of New Zealand . . . On November 7th, 1930, representatives from the four Centres met in Wellington under the chairmanship of Emeritus Professor W. P. Evans and resolved—That a New Zealand Institute of Chemistry be formed." By the end of the first 25 years there were about 500 members. Since then membership has increased to approximately 1300, and the Auckland Branch alone now has a total membership nearly equalling the 1955 New Zealand total.

The most important feature of the period 1955-1976 has been the significant change in membership structure and rules for admission. Increasing emphasis has been placed on "professionalism" as a requirement for corporate membership; at the same time provision has been made for admission of newly-qualified graduates as Graduate Members, who require to complete four years' post-graduate experience before becoming Members (previously designated Associates).

During the 1960's a significant development in chemical education was the establishment of formal, work-based courses in Technical Institutes leading to the New Zealand Certificate in Science (Chemistry). This practically-oriented qualification has proved very popular, and a large number of N.Z.C.S. holders is emerging from the technical education system. These people represent a new factor in the chemical employment scene and the N.Z.I.C. has recently moved to recognize these N.Z.C.S. holders.

On qualification N.Z.C.S. they may become Technician Members, and after at least four years approved experience and attaining at least 25 years of age, they may transfer to the Associate Member grade. As with the transport from Graduate Member to Member, the quality of the experience gained over the four year period is carefully scrutinised. These moves to broaden the basis of membership while increasing the requirements for professional membership and practical experience parallel changes which have taken place in other chemical institutes, notably the Royal Institute of Chemistry.

The other significant change has been the creation of a number of specialist groups, e.g. geochemistry, electrochemistry, polymer chemistry, chemical education, etc., informally organised and only loosely tied to the Institute structure. Their main function is to organise specialist symposia at the Institute's Annual Conference or at other times. Because of the small scattered numbers other group activities have so far been mainly confined to the distribution of newsletters. These special interest groups will play an increasingly important part in Institute activities, and it is easy to envisage an increasing number of one or two day single topic symposia which will supplement, or in some years replace, the traditional Annual Conference. The size of the Annual Conference has steadily increased to a record attendance of 400 at the 1974 Conference in Auckland.

The Institute takes an active part in Chemical Education particularly at secondary school level; the formation of a Chemical Education Group in 1975 was the logical outcome of this interest. All Branches arrange special lectures, tours and competitions for secondary school pupils, and all offer prizes to outstanding university and technical institute scholars. The Institute is also deeply involved in devising and continual revising syllabuses for N.Z.C.S. courses.

Institute members, and the Council, have always taken an active interest in the affairs of the Royal Society, the senior scientific body in this country. Co-operation with the R.S.N.Z. is likely to increase as chemists become more involved in "fringe" issues such as those concerning the environment.

The Institute has always been controlled by a Council comprising President, two Vice-Presidents, General Secretary and a representative from each of the Branches. (Auckland, Wellington, Christchurch and Dunedin were the original four; Waikato and Manawatu were added later.) The Editor became a member of Council in recognition of the importance the Institute has always attached to its publications. The Branches are responsible for activities in their own geographical areas and arrange regular meetings for their members.

The period under review has been one of steady growth towards larger membership and greater diversity of activities. However, despite increasing administrative demands, the membership is still not large enough to sustain a full-time secretariat; the Institute relies heavily on the essentially voluntary work of members, although an important step towards a full-time secretariat was taken in 1975 with the appointment of a part-time Administrative Secretary.

We look forward with confidence, believing that the Institute will continue as a significant voice in the New Zealand scientific community. Doubtless the next twenty years may see changes no less significant than those of the last two decades.

W. E. HARVEY, Hon. Gen. Sec., N.Z.I.C.
D. J. HOGAN, Registrar, N.Z.I.C.

NOTE: INFORMATION ON AUTHORS WILL BE FOUND ON THE TITLES PAGE.

THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY, IUPAC

by A. Rafter

This year the Organic Chemistry Division of IUPAC is holding its 10th Natural Products Symposium in Dunedin. This is a most important occasion for the chemists of New Zealand and an opportunity for us to look briefly at the organisation of IUPAC and the part New Zealand chemists are playing, and could further contribute to the profession of chemistry in the international sphere.

The organisation of IUPAC is shown in the accompanying chart. The current President is Dr. R. W. Cairns, the Executive Director of the American Chemical Society and a distinguished industrial chemist. The Past-President is Sir Harold Thompson, Professor of Physical Chemistry, Oxford University; among the Past-Presidents of the Organic Chemistry Division are the present Secretary-General, Professor G. Ourisson of France, and Sir Derek Barton, F.R.S., Nobel Laureate. Sir Derek is at present an Elected Member of the Bureau of IUPAC and will be the Symposium President at Dunedin. Another visitor to Dunedin will be Lord Todd who was President of IUPAC in 1963-65. Lord Todd in his Presidential Report to the IUPAC Conference in 1965 set out clearly what, in his views were the functions of IUPAC:

(1) To promote the study and application of chemistry internationally by bringing together chemists of all types from different countries, to facilitate exchange of information and to promote meetings, symposia and conferences where chemical topics can be discussed.

(2) To seek international agreement on issues of importance to chemistry, e.g., nomenclature, constants, analytical methods, etc., and to provide a source of authoritative advice to other international organisations concerned with standards.

(3) To provide advice and assistance to developing countries in matters relating to the training of chemists.

Today, the stated objectives of IUPAC have changed very little from the guidance given to it by Lord Todd 11 years ago. They are: (1) to investigate and make recommendations for action on chemical matters of international importance that need regulation, standardisation, or codification; (2) to co-operate with other international organisations that deal with topics of a chemical nature; (3) to promote continuing co-operation among the chemists of the member countries; and (4) to contribute to the advancement of chemistry in all its aspects.

The membership of IUPAC presently comprises 44 countries, each represented by a national organisation. In New Zealand the National Adhering Organisation is the Royal Society. The National Committee for Chemistry (of the Royal Society) is responsible for corresponding with IUPAC, for co-ordinating New Zealand activities in relation to IUPAC and for functioning as the Sectional Committee for Chemistry. The committee comprises four members appointed by the Royal Society, four members appointed by the New Zealand Institute of Chemistry, the International Secretary of the Royal Society and the Committee Secretary.

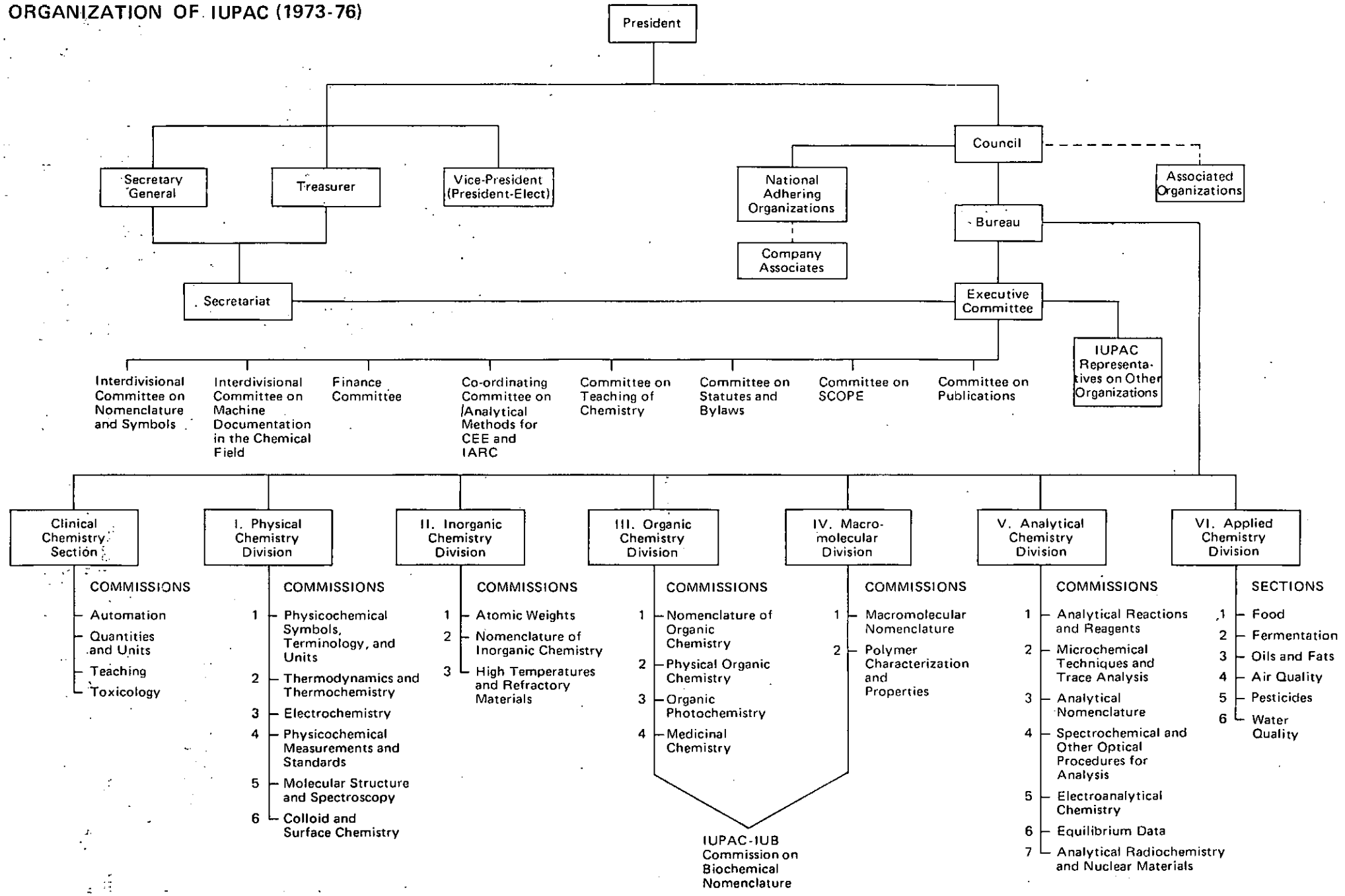
The work of IUPAC is mainly done in the Commissions and Committees shown on the organisation chart. Some scientists, because of their world standing in the work of a Commission, are invited to join as Titular Members. The more common way is by selection as a National Representative —and through one's scientific contribution — to be chosen for Titular Membership. New Zealanders can play an important part in the work of IUPAC which offers to younger scientists willing to give of their expertise the opportunity to meet and work with colleagues in other parts of the world.

At the present time New Zealand has two Titular Members on two Commissions of IUPAC (Dr. W. H. Melhuish on Commission V.4 and Dr. T. A. Rafter on Commission V.7) and National Representatives on 6 Commissions (on Commission 1.2, Professor J. W. Williamson; Commission 1.3, Professor J. W. Tomlinson; Commission VI. 1.1, Mr. I. R. C. McDonald; Commission VI. 3.1, Mr. S. G. Brooker; Commission VI. 3.2, Dr. F. B. Shorland; and on the Committee on Teaching of Chemistry Mr. T. R. Hitchings.)

The principal source of IUPAC'S operating expenses are from annual subscriptions based on the chemical activity of a country. New Zealand is listed as Category B.1, and pays an annual subscription of $1,500. Another source of income is from Company Associates. More than 150 industrial firms have already joined the scheme thereby indicating their appreciation of the value of IUPAC's work. New Zealand has at present one Company Associate, Ivon Watkins-Dow Limited, and it is hoped that more interest can be generated in IUPAC affairs by those New Zealand companies which are chemically orientated.

The holding of the 10th IUPAC Natural Products Symposium at Otago University this August offers the opportunity for many of our younger scientists to meet and to discuss their scientific problems with some of the world's most eminent organic chemists. I am sure this will be a most stimulating experience, and a source of great satisfaction for Professor R. E. Corbett and the members of local sub-committees who have worked so strenuously to make this symposium—both for visiting and local scientists—a most memorable occasion for the chemical profession in New Zealand.

ORGANIZATION OF IUPAC (1973-76)



CHEMISTRY IN NEW ZEALAND: CURRENT AND FUTURE TRENDS

by L. F. Phillips

The phrase "chemistry in New Zealand" covers an extremely wide range of activities by some very diverse organisations and individuals. Nevertheless, the trends one finds in industry, research associations, government departments and universities have a great deal in common, because the various organisations must all respond to the same set of external circumstances. Trends in chemistry in New Zealand, like trends in science everywhere, are largely governed by a compromise between the current demands of the economy and the long-term need to solve what are seen as the big problems of the era. For most people the big problems just now are energy, the environment, and the potential shortage of resources, including food. (Alternatively, these problems might be summarised as an over-supply of people). The demands of our economy are simply that we must obtain more for the export of agricultural produce, relative to what we spend on the importation of manufactured goods and energy. The type of compromise that is reached depends on the nature of the organisation which is being considered. Industry, at one extreme, gives most weight to the demands of the economy; universities, at the other, pay more attention to the big problems. Pure research, undertaken with no end in view but an increase in knowledge, is also carried on to a limited extent, is almost independent of the factors responsible for trends such as we are considering, and is tolerated mainly because of its valuable teaching role. The big swing away from pure, basic research that accompanied the economic recession in the U.S.A., and which will certainly be reversed in the next five or ten years, had no counterpart here because most of our science was already very much applied. In the long term it is reasonable to suppose that the balance of research in New Zealand will not alter radically. Our economic circumstances could change for the better because of a worldwide shift in the relative values of food, mineral resources and manufactured goods; but barring some unpredictable, innovative breakthrough, equivalent to the first decision by a Swiss to begin selling cuckoo clocks, our chemistry will continue to be virtually all applied and will be applied almost exclusively to local problems relating to agriculture.

For the New Zealand chemical industry the major event in recent years has been the production of our own natural gas, with its implications for potential petrochemical industries and in relation to the energy crisis. At least three commercial firms —B.P. Chemicals, Ivon Watkins-Dow and I.C.I. — are interested in the petrochemical possibilities which are being investigated by an inter-Departmental group. The most likely initial development is the conversion of methane from Maui gas to methanol for use as fuel. The technology appears to be under control and the economics to be favourable, which would leave only political decisions to be made. (While on the subject of political decisions we may note that the use of natural gas instead of electricity for low-grade heating will have to be encouraged by a suitable price structure). Other possible uses of Maui gas include nitrogen fixation, the function which is at present performed *in situ* by clover, and production of liquid fuels by reforming low molecular weight hydrocarbons. The opposite type of process, hydrogenation and cracking of coal to produce liquid fuel, is a very long-term possibility as a means of reducing our dependence on imported petroleum, as is the resumption of the exploitation of coal as a source of what have come to be regarded as petrochemicals. In contrast, the production of calcium carbide as a source of acetylene could have been undertaken with advantage ten years ago, on the basis of the work of the late Dr. Hagyard at Canterbury University. However, as oil becomes more expensive the main use of coal must continue to be as a simple fuel. More efficient combustion systems have been developed, including fluidised bed combustion, which reduces the pollution problems associated with the burning of high-sulphur coal. Still on the subject of minerals, we may note that the fertilizer industry is beginning to make some of its superphosphate with sulphuric acid derived from local sulphur. Excess acid-producing capacity could lead to production of other chemicals based on sulphuric acid. The phosphate rock needed for superphosphate production will still have to be imported; fortunately, world supplies appear to be more than adequate for the foreseeable future. Our main mineral export will probably continue to be ironsand; vanadium is a possibility for the future but the deposits occur in a National Park. The country's capacity for further large-scale electrochemical industry is very limited but small-scale production of chemicals like hypochlorites is a possibility in plants where electricity is generated from excess steam. Further developments are likely in the production of exportable chemicals from natural products, including pinenes and terpineol from turpentine, cholesterol (used in liquid-crystal digital displays and as a precursor for vitamin D_3, and potentially useful as a precursor for birth-control hormones) from lanolin, and cholic acid, dehydrocholic acid, and bovine serum albumin as cattle by-products.

Rather than attempt to cover all of the research associations with an interest in chemistry in a limited space, we confine attention to two major ones. The Wool Research Organisation at Lincoln is typical in many ways. It exists to carry out research on problems in wool utilisation, and chem-

istry is one facet, albeit a major one, of a multidisciplinary approach. The work ranges from testing carpet wear, by rubbing real shoes on actual carpets, to topics as basic as protein photochemistry or the mechanism of wool growth. New developments that are under way include antistatic fibres, flameproof textiles, textiles whose dyeing character has been modified for special effects, ion-exchange fibres, and polymer-modified fibres. In recent years the emphasis of the laboratory has moved further away from basic research towards closer links with the textile-processing industry, with more feedback from industry, to a building up of strength in textile technology, to the development of useful research findings "in-house" at the pilot plant level, and to a change from discipline-oriented groups to mission-oriented groups. Associated with these trends has been increasing concern with the cost-effectiveness of basic scientific research, especially in relation to the high cost of modern instrumentation. Several approaches have been made to this problem, one being to send a staff member to work in another laboratory where suitable expertise or equipment is available, another to purchase time on outside equipment such as computers or electron microscopes, and a third to collaborate with other laboratories working on different aspects of a single problem such as flameproofing. Obvious extensions would be to award research contracts for specified investigations to be carried out in other laboratories, and to provide research fellowships for university students to work in particular fields. The long-term trend is towards still stronger links with industry in its day-to-day practice, and with other laboratories which can share project interests, equipment and exchanges of staff. The organisation will continue to employ chemists and chemical engineers and will continue to require them to be versatile enough to contribute much more than just chemistry.

The Dairy Research Institute at Palmerston North resembles the Wool Research Organisation in having very close contact with the day-to-day operation of the parent industry and in tending more and more towards collaborative efforts with other organisations, such as universities and D.S.I.R. divisions, which possess special skills or equipment. The channelling of the dairy industry's problems to other interested groups is seen as preferable to the continued growth that would be necessary if the Institute were to tackle every new technical problem itself. The current problems of the dairy industry stem mainly from the need to change from a relatively simple task, that of supplying large quantities of butter and cheese to the British market, to the more difficult task of making an increasing range of specialized products, many very sophisticated and demanding a high degree of technical skill in their manufacture and quality control. In the long term this means that the standard processes for making traditional products such as butter, cheese, milk powder and casein will, to a large extent, give way to more chemically-oriented processes such as fat fractionation, ultrafiltration, or electrodialysis, by which milk can be separated into its basic components before being reassembled, often with other, non-dairy ingredients, into the final product that the customer requires. At present the standard operations in the dairy industry require good technicians who have some background in science. The new developments are likely to require the employment of more science graduates at all levels up to Ph.D., and a significant proportion of them will be chemists or chemical engineers.

An important trend for the research associations as a group is a likely increase in the number of such associations. At an intermediate stage, industry is likely to make greater use of scientific consultants and independent commercial laboratories, whose numbers are also likely to increase. A major factor here is the setting up of the TELARC council, which gives a stamp of approval to the consultants and laboratories whose work it considers satisfactory.

The Chemistry Division of D.S.I.R. endeavours to maintain a fairly constant balance between pure and applied research, on the grounds that a solid background in basic research is needed if people are to take a fundamental approach to new problems in everyday activities like forensic chemistry, water quality, or industrial development work. Applied research is relatively more conspicuous because many of the present projects take people away from the laboratory bench into the field or to industry, and because of the increasing importance of co-operative projects with non-government research organisations. Another factor is that new graduates joining the Division are much more interested in environmental, social and economic problems than those who graduated, say, ten years ago.

Chemistry Division's choice of projects is affected by the state of the economy in several ways. One is that the emphasis on export industries leads to an enhanced interest in projects which are designed to add value to raw materials such as seed oils, beach sands or peat wax, or in projects aimed at overcoming barriers to export produce that might be due, for example, to the presence of mercury in frozen fish, or pesticide residues in crops. (Problems of this last type are sometimes more a consequence of politics and the high sensitivity of particular analytical techniques rather than a real need for concern—mercury at natural abundance levels in fish is a case in point.)

Through the National Research Advisory Council, Government is able to channel money for science into certain specific areas, which affects not only the choice of projects but also the type of graduates who are in demand — environment, energy and metallurgy, for example, are favoured fields at present.

Drugs and pharmaceuticals, both licit and illicit are a current source of much work for Chemistry Division, and the involvement gets larger each year. Energy and petrochemicals will continue to be major topics of interest. The long-term extent and timing of work on energy will depend on when nuclear power stations are installed in New Zealand. A major organisational change that is likely to occur in the next few years is the splitting of the large Chemistry Division (approaching 300 staff) into two Divisions, one of which will deal mainly with chemical engineering and process development. Reorganisation into a larger number of mission-oriented groups is not likely to occur in the foreseeable future. The most important reason for retaining the present structure is the ability to cover a wide range of problems and areas of activity with a finite number of staff; there is also a shortage of senior multi-disciplinary people to run project-oriented groups. A new development is that chemists are increasingly being hired by other Government Departments, such as the Ministry of Works and Development or the Health Department, so that they grow up with their Department's own particular problems and enable better communication with Chemistry Division. Maintenance of communication between specialists in different areas of science and engineering is seen as a major problem for the future.

In recent years chemists in the universities have shown increased awareness of the possibilities for finding academically-respectable research projects that are related to the country's economic needs. This admirable trend will undoubtedly continue, aided by co-operative efforts with industry and research associations and by the availability of Mineral Resources and Lottery Distribution Committee grants. The huge cost of major items of research equipment and the personal dedication that is required to get the most from such equipment must lead to an increased tendency for people to travel to other centres for intensive periods of data collection, as already happens for example with X-ray crystallography, and to work in co-operative groups rather than as isolated individuals.

The difficulty that highly-qualified graduates have at present in obtaining positions commensurate with their qualifications is likely to diminish during the next ten years, partly as a result of improvement in the western world's economic situation, and partly as the result of a gradual adjustment of supply to demand in the job market. Meanwhile, the degree courses taken by most undergraduates are being tailored more to the current demand for people with a good grounding in basic techniques and broad versatility, as opposed to narrow specialization and a deep understanding of theoretical matters. At Canterbury, for example, the introduction of the 'points' system has led to a more than twofold increase in the number of available options in degree courses and a three-fold decrease in the size of the minimum examinable unit. For the small number of top Honours graduates, on the other hand, more specialization and deeper understanding is required if they are to compete successfully with similar people from other places, so the difference in outlook and training between Honours and Pass graduates is likely to increase further.

In the long term the innate conservatism of university institutions and the strength of the links that university chemists maintain with overseas workers in their own fields are likely to ensure that only relatively minor changes occur in the shape and emphasis of university chemistry. Exciting new developments are more likely to occur in the borderline areas between chemistry and other disciplines such as biology or geology, or in new inter-combinations such as chemistry and operational research, chemistry and computer science, or even chemistry and politics—'the art of the possible' is a description that could be applied to either.

One of the least salubrious of Dante's infernal circles is reserved for those whose earthly lives were spent devising titles for articles to be written by other people. Another circle, not far away, contains the damned souls of all who agreed to write such articles. Nearby is the circle containing weather forecasters, fortune tellers, economic planners, and lynx-eyed spotters of current and future trends. In writing this article I have taken advice from a number of lynx-eyed spotters (see acknowledgements) and have borrowed a technique from the weather forecasters, namely that of producing several different kinds of forecast — local and large scale, short and long term — in order to improve the chance of being proved correct in at least some respects.

Acknowledgements

This article could not have been written without the generous assistance of a number of people, some of whom will find their helpful comments appearing almost verbatim. I particularly must thank Mr. D. J. Hogan, Dr. W. S. Simpson, Professor A. G. Williamson, Dr. J. Rogers, Dr. L. K. Creamer, Dr. W. A. McGillivray, Dr. I. K. Walker and Dr. A. J. Ellis.

CHEMISTRY AND BIOCHEMISTRY IN NEW ZEALAND AGRICULTURE

by D. E. Wright

Since the silver jubilee issue of the *Journal of the New Zealand Institute of Chemistry* in 1955 which described many of the activities of chemists in agricultural research in this country and forecast their role, there have been many significant changes. Research teams of agriculturalists, biologists and chemists have increasingly been used to solve problems requiring a multi-disciplinary approach; greater numbers of biochemistry graduates have been employed; new separating and analytical equipment with sensitivity and precision undreamed in the 1940's has been developed; automated analytical equipment has become commonplace; and computers now record, process and report data.

In this country chemical and biochemical research in agriculture has largely been done in government research stations, in agro-industry supported institutes, or in Massey University and Lincoln College. While it has been a feature that generally research and teaching have hitherto not been highly integrated, in recent years a greater effort has been made to locate research laboratories on or near universities and to award research contracts to university staff and students. In a country with both a small population and small pool of expertise, but an abundance of problems many unique to this country, it is important that our most valuable resource — people — should be used most effectively. Who would not agree that research scientists are more creative with contact with eager students, or teachers more stimulating with a reduced teaching load and greater access to the facilities with which government research stations are so well endowed?

New Zealand chemists and biochemists have made notable contributions to this country's agriculture, particularly in providing the basic information necessary to understand and resolve problems. Rather than survey their activities I will present only a few examples, my familiarity with such work and its relevance to New Zealand agriculture being the major reasons for inclusion.

Despite the glamour associated with spectacular discoveries — the "breakthroughs" of the popular press — undoubtedly the most valuable work by chemists has been in analytical chemistry. A research station without a laboratory equipped to provide routine analysis of samples such as soil, meat, plants, milk, blood, etc. would hardly merit its title. Central to all soil-plant-animal research is an understanding of how these systems interact and how minerals and organic materials flow through them. To provide this data has been the role of the analyst. Two noteworthy contributions have originated in this country in the last 20 years.

In 1958, the late J. E. Allan published the first analytical method using atomic absorption spectroscopy. Using an instrument he built himself, he developed a method for analysing Mg and discussed the factors influencing reproducibility, accuracy and sensitivity by this new method the theory of which had been proposed by A. Walsh in Australia. It was Allan who appreciated the potential of this new idea, and subsequently he described methods for the analysis of Fe, Mn, Ni, Co, Cu and Zn, proposed the use of nitrous oxide-acetylene flames, air-hydrogen flames and the use of atomic absorption spectroscopy at wave lengths below 200 nm.

Many trace element deficiencies have been recognised in New Zealand, the most recent of these being selenium deficiency. Initial progress in mapping low selenium areas and in identifying low selenium status in animals was hampered by inadequate methods for measuring this element.

Following the finding by the late F. B. Cousins that the fluorescence of an organic selenium compound would provide a sensitive method to measure selenium, Watkinson reported at the 1959 New Zealand Institute of Chemistry Conference that the benzopiazselenoles formed by reacting selenous acid with o-phenylenediamines could be used to measure selenium fluorimetrically. The present Association of Official Analytical Chemists method for analysing selenium in plant material is a modification of that of Watkinson and permits the selective measurement of nanogram quantities of selenium. Recently the technique has been adapted by Watkinson for use on the Technicon Autoanalyser. While selenium deficiency in livestock is most accurately assessed by measuring animal responses to selenium treatment, analytical data has been of great value in aiding diagnosis of the various manifestations of low selenium status. This interest more recently has extended into human nutrition since New Zealanders have unusually low blood selenium levels.

New Zealand has presented unusual challenge to chemists and biochemists since it has many unique plants and ecosystems. As a consequence, some important agricultural problems in this country are either not encountered or are of only minor significance elsewhere.

Two such problems in animal production were described in 1955 by Butler, Cousins and Melville as challenges for the future—"What are the chemical agencies producing bloat and facial eczema in stock?" Happily we now have anwers to this question and control measures for farmers.

Facial eczema in cattle and sheep is characterised by photo-sensitivity and liver damage. These are the consequences of ingesting pasture contam-

inated with heavy growth of spores of *Pithomyces chartarum*. In 1958 the toxin sporidesmin was isolated by Synge and White and its structure determined. While this represented a most significant achievement in the study of this mycotoxicosis, other important contributions were the development of the "beaker" test by Perrin which provided a simple method to identify toxic pasture; the development of chemical assays, the description of the chemical pathology of facial eczema, the demonstration that toxicity could be reduced by diet, and recently the discovery that high doses of zinc will protect animals against the toxin. The biochemistry of the toxin is not understood, although some information on the effect of sporidesmin on mitochondrial metabolism has been reported. However, its *in vivo* action as an inflammatory agent and the protective effect of zinc ions remain as a challenge to biochemists.

The other major cattle disorder - bloat - is a consequence of the reliance of this country on legumes to biologically fix nitrogen for plant growth. Pastures which contain a high proportion of clovers or lucerne can become "bloaty" during periods of lush growth. Mangan in 1959 reported that the soluble plant protein from clover was the major foaming agent in the rumen and described the influence of chemical and physical factors on foam stability and strength.

The sporadic nature of the disease has prompted detailed investigations of other likely factors including plant carbohydrates and lipids, cow salivary proteins, rumen micro-organisms and protein precipitating agents such as tannins.

Control of the disease on farms has been achieved using mineral and vegetable oils or non-ionic detergents. The development and testing of anti-bloat methods has involved several New Zealand scientists and has provided farmers with reliable methods to control the disorder. Chemical control by these means hopefully will not be the long term solution and research is being directed towards testing non-bloating legumes containing tannins, and the breeding of cattle less susceptible to the disorder. While considerable chemical and biochemical work will be necessary to identify the factors involved in making "bloat-safe" plants and cattle, such plants are already being studied by the Department of Scientific and Industrial Research, and cows differing in bloat susceptibility are being bred at Ruakura Animal Research Station.

While New Zealand is favoured with an equable climate, its topography, its soils of varying fertility, and its distance from traditional markets have presented problems. Essentially this country has developed a "low cost" agriculture and has relied on a grassland system of animal production and efficient use of farm manpower to produce relatively cheap agricultural exports.

Soil research has played a basic role in identifying areas of low fertility and in defining the necessary fertiliser inputs to improve and maintain productivity. Chemists have been responsible for the detailed analysis of hundreds of types of soils, have provided data on major and minor element compositions and general chemical properties of soils, and have provided an analytical soil-testing service to assist farmers. In collaboration with horticulturists, agronomists and animal scientists, chemists and biochemists have identified many trace mineral deficiencies such as those involving inadequate Co, B, Cu, Mn, Fe, Mo, and Se; surveys have enabled mineral deficient areas in New Zealand to be mapped.

The fixation of nutrients by soils in New Zealand has been described as the most important single scientific problem facing our agriculture. Particularly important is phosphate fixation which, after water, is often the first limiting factor in plant growth. Many New Zealand chemists have been involved, not only in using an empirical approach to solving this problem but also in providing data on the chemistry of phosphate fixation.

While the immediate supply of phosphate is not threatened, increasing costs of this resource have stimulated much discussion and research on how phosphate requirements can best be assessed and its efficient use maximised. While phosphate use as a fertiliser has been the major reason for undertaking phosphorus research, phosphate pollution of river and lake water in this country is demanding an increased knowledge of the sources of this phosphate. Syers has calculated that phosphate from human effluent may be 3-4 times greater than that from fertiliser application. However good data from extensive chemical surveys seem to be lacking to support or refute this estimate.

Increasingly our overseas customers, some traditional, others new, insist on quality products. It has been the responsibility of various industry-supported institutes (Meat Industry Research Institute of New Zealand, Dairy Research Institute, Wool Research Organisation, etc.) to research the processing needs of their industries. The chemists and biochemists in these Institutes have played an important role in ensuring that New Zealand exports do meet the customer's requirements.

An interesting example where research into basic biochemistry has provided knowledge applicable to an industrial process is work on meat tenderness, a long-term activity at the Meat Industry Research Institute. Biochemists have studied many aspects of muscle biochemistry, including protein structure and the factors influencing the contraction and the relaxation of muscle proteins.

From this work it has been found that relatively low temperatures (below 7 deg. C) stimulate the shortening of muscles by up to 40 percent. This affect has been called "cold shock" and has an extremely adverse effect on subsequent meat tenderness.The practical importance of these studies relates directly to lamb carcasses which become tough when rapidly frozen soon after death. To overcome "cold shock" a conditioning and aging process has been devised, and all lamb carcasses sent to North America are processed in this manner to preserve natural tenderness.

More recently further processing improvements have been made; one of these involves the use of electrical stimulation of carcasses. This hastens muscle glycolysis and induces an early onset of rigor. While still in the experimental stage, this method is likely to become a process in the New Zealand meat industry.

In any brief review of this nature there are forgotten men and women. They are, for example, the chemists and the biochemists who provide the agricultural industries with chemicals and with the quality control so necessary in food producing industries. They are the chemists and biochemists who provided the details of cheese making which enabled the Dairy Research Institute to automate cheese manufacture and develop the "Cheesemaster" continuous cheese makers installed in many countries. They are the chemists producing fertilisers, weedicides, pesticides, detergents, antiseptics, antibiotics and hormones.

Some of the unsolved problems of 21 years ago have now been solved, others resist a solution and new problems have appeared.

We need better techniques for assessing soil fertility, for identifying nutrient deficiency in plants and for diagnosing animal diseases. Reproduction —the basic function of farm animals needs specific hormone assays and biochemical explanations for infertility. Animals resistant to diseases need to be identified and a biochemical basis for resistance determined. Plant diseases caused by insects or micro-organisms cannot always be controlled by chemical means, and future plant production may need to use biochemists to complement genetic selection with molecular engineering. It may be possible to reduce fertiliser needs by breeding productive grasses which are less demanding on nutrient supply, or to modify cereals to fix their own nitrogen. The technologist and the chemist will need to produce new foods to satisfy new markets as our traditional economic ties loosen. These problems, and our society's increasing insistence on clean air and water, on pleasing landscapes, and on uncontaminated food presents a formidable challenge to New Zealand chemists and biochemists in the last quarter of the 20th century.

CHEMISTRY, BIOCHEMISTRY AND CHEMICAL ENGINEERING IN DSIR

by I. K. Walker and G. W. Butler

The major event influencing chemistry in DSIR over the past 20 years was the Royal Commission of Enquiry into the State Services in New Zealand, which reported in 1962. This Commission recommended appointment of a Minister of Science with broad responsibilities, and replacement of the old Council of Scientific and Industrial Research with a National Research Advisory Council, also with broad interests. Together with a probe into whether research in the various departments of State should be amalgamated into a single agency, this has stimulated a much closer co-ordination in the practice of chemistry (*inter alia*) in the various departments than had existed prior to 1962. Moreover, the introduction of a Science Budget (in 1970) by the National Research Advisory Council has created a much closer interest in the ultimate purposes and applications of the chemical research carried out by government departments. The National Research Advisory Council includes members from outside the purely scientific field, and is thus better placed to consider applications of science than was the older Council of Scientific and Industrial Research. Further impetus was given by the National Development Conference in 1968 and its succeeding short-lived Council.

Under the domination of these events two major aspects have characterised the practice of chemistry, chemical engineering and biochemistry in DSIR over the 20 year period. First has been the steady growth of DSIR, which has meant that total staff numbers have more than doubled over a 20-year period. Equivalent growth has also taken place in the Research Associations. Chemists have been proportionately represented in these figures. The second aspect has been the greatly increased tendency for government-employed chemists to meet with workers in other fields of endeavour — other scientific disciplines such as mathematics and biology, but more importantly with engineers, farmers, industrialists, and educators. These meetings have taken place in a wide range of organisations, seminars and conferences, ranging from the Boards of Management of the various Research Associations to technical seminars and such forums as the Steel Investigating Company. These developments are well illustrated by the Pollution Research Conference held at Wairakei in 1973 where for the first time many DSIR scientists met some of the engineers in local government who are responsible for treating sewage, disposing of garbage, and the supply of pure water. Although these last three activities all represent multi-million dol-

lar industries, there had been little co-ordinated research in New Zealand to increase their efficiency.

Within DSIR major groups of chemists are located in Chemistry Division, Applied Biochemistry Division (into which has been amalgamated the Food Research Laboratory), Soil Bureau, Institute of Nuclear Sciences and Plant Diseases Division. Other Divisions employ smaller groups of chemists. In addition, a strong group of biochemists is working at Applied Biochemistry Division, and a chemical engineering group in Chemistry Division.

The small size and remote location of New Zealand generates in its chemists a feeling of isolation and loneliness, even in this jet age. Consequently, New Zealand scientists are avid readers of overseas journals and watch closely the scientific trends current in other countries. The development of chemistry over the last 20 years in this country therefore closely parallels its progress world-wide.

However, certain fields of work which are important to the country's economy or peculiar to its geography or geology pervade the New Zealand practice of chemistry and give it a characteristic flavour. One such field is the chemistry of geothermal systems and the chemical and chemical engineering problems associated with their exploitation as power sources. This work has helped establish a 150 MW base-load station which has supplied over 16 percent of the power generated in the North Island over the past decade. Fundamental geochemical investigations of geothermal discharges (both liquid and gas) have developed chemical indicators for predicting sub-surface temperatures. Experimental investigations have elucidated chemical equilibria in geothermal systems by determining solubilities of minerals and gases, equilibrium constants of weak acids and bases, and partial molal volumes of ions, all in water up to 250 deg. C. These investigations have led to a new understanding of the origin of chemical constituents in thermal waters and of how their concentrations are controlled by the different equilibria. Studies of corrosion problems associated with power generation have also been important, particularly in the wet steam drawn from the Wairakei field.

High hydrogen sulphide concentrations and the accompanying hydrogen embrittlement of some steels have required extensive work in selection of materials for turbines. Current development of a new field at Broadlands has provided new impetus to this work.

The extensive native flora of New Zealand has traditionally provided our organic chemists with a wide field in the study of extractives. Work in this area terminated in DSIR about 1965 with a thorough study of Kauri gum. The establishment of large commercial exotic forests (particularly of *pinus radiata*) has led to detailed chemical investigations related to the major logging and pulping industries now in existence. Work involving aspects of commercial utilization and of chemical taxonomy has been done on the composition and chemistry of turpentine, tall oil and bark. The problem of yellowing of untreated or varnished pine surfaces and of paper made from pine pulp has received close study, and a partial solution has been found.

An examination of the properties and activities of timber preservatives led to development of a method for preserving canvas which is now used by New Zealand Railways in the manufacture of tarpaulins with a long life.

A striking feature of chemistry over the past 20 years has been the upsurge of interest in inorganic chemistry. Fundamental work (particularly on transition elements) has also attracted New Zealand chemists, and in DSIR has been particularly applied to biological and agricultural fields of major economic importance. For example, studies of the availability of micro and macro inorganic nutrients in soils, exploitation of indigenous resources for use as fertilizers, and the physicochemical and metal fixing properties of crystalline and amorphous clay minerals in soils.

Another area of economic importance has been the chemistry of steel production from the extensive ironsand deposits in the North Island. Major DSIR efforts were involved in the exploration and pilot-scale processing which culminated in the formation of New Zealand Steel Ltd. This work is continuing, to improve ironsand reduction and smelting technology, to recover vanadium and titanium from waste steelmaking slag, and to recover scrap metal for recycling in steel plants.

Study of materials is exemplified by work on concrete and cement, the reactivity of siliceous admixtures, the use of stable calcium silicate hydrates as binders in pumice concrete, mechanisms of formation of manufactured lightweight aggregate, and the use of fly ash from a coal burning power station at Meremere as a cementitious material.

Problems of corrosion, which always arise in the use of metals, have been many and varied over the past 20 years. This work has frequently revealed principles of importance to metallurgical engineering or to New Zealand trade practices. The proliferation of high-rise buildings in New Zealand cities gave rise to previously unnoticed corrosion of copper water pipes. Study of this resulted in recommendations being made to the plumbing industry and to the operators of water treatment plants. The utilization of natural gas from the Taranaki fields gave rise to corrosion problems in the purification plant and in pipelines serving the North Island.

In a country with so long a shore-line, marine corrosion is important; work has been devoted to this field, to produce new coatings, particularly inorganic ones, which may prove to give effective protection.

The recognition that research in chemical processing can contribute significantly to the manufacturing industries has led to marked increases in

staff numbers and facilities for pilot-plant research in the chemical engineering fields. The basis of a national facility for pilot-scale testing of chemical processes is now established in DSIR, and its development will continue over the coming years. In common with other nations, New Zealand is putting considerable scientific effort into the treatment of industrial effluents. DSIR has developed a full sized prototype plant for effluent control of woolscour liquors. The process reduces the level of suspended solids in the effluent and recovers the valuable grease fraction from scour bowl liquor. Commercial development based on this project is being undertaken.

The possibilities of exploiting local resources are constantly under review. For example, DSIR has recently investigated the technical feasibility of establishing a ferro-silicon industry in Southland using the widespread local reserves of high-grade quartz gravel, lignite, and timber as raw materials. The possibility of manufacturing rayon quality pulp from locally available timber has also been demonstrated. Continual review of studies such as these are essential in the face of rapidly changing national and world economies.

Back in the laboratory the face of chemistry in New Zealand, as elsewhere, has been drastically changed over the past 20 years by the advent of large instruments, and the resultant decline of "wet chemistry" analytical procedures. Funding the purchase of large instruments in a small country is often a problem, and it has occasionally been found necessary to purchase a single instrument of a class (e.g., NMR) for installation as a national facility until such time as the work load will clearly demonstrate the need for others like it. The total effects of large scale instrumentation in our chemical laboratories are incalculable; but when large numbers of samples are to be processed, or when rapid action is necessary, the availability of rapid analytical procedures is invaluable. For example, an accidental spillage of an agricultural chemical from an unlabelled drum a few years ago necessitated the immediate evacuation of several city blocks in Auckland. By using a gas chromatograph-mass spectrometer in Wellington the offending chemical was completely characterised within five hours of the spill so that appropriate decontamination procedures could be recommended. Without the availability of this equipment identification of the compounds involved would have taken a matter of weeks.

By the middle fifties small but effective groups of biochemists were working in three centres in DSIR. At Plant Chemistry Division studies were made of various metabolic processes in pasture plants, with the aim of increasing the production of herbage of higher nutritive value for grazing animals. An ultracentrifuge was built at the Dominion Physical Laboratory and used to fractionate leaf proteins, aided by Tiselius electrophoresis. The biochemistry of ruminant digestion was also studied, with particular emphasis on the cause of frothy bloat in cattle. Biochemists at Plant Diseases Division studied hormonal regulation of plant growth, the composition of plant tissues as affected by nitrogen and phosphorus nutrition, the mechanism of infection of plant tissues by virus and the mode of multiplication of virus protein. Fats Research Laboratory expanded their programme on lipid chemistry to studies of lipid biosynthesis. The Institute of Nuclear Sciences was of great assistance to all these groups in the development of radio-isotope and stable-isotope tracer techniques.

During the sixties this effort grew, with expansion of biochemical studies into other sections of DSIR. Various aspects of crop biochemistry were studied at DSIR (Lincoln), the Wheat Research Institute and the newly-created Plant Physiology Division. Plant Chemistry Division continued to study pasture plants and ruminant digestion, including structural carbohydrates, minerals and non-protein-nitrogenous compounds, plant phenolics, plant proteins, and nutritional biochemistry. At Plant Diseases Division the discovery of an important plant growth regulator (kinetin) was especially significant, and the modes of phosphate assimilation in plants were studied. The Auckland group demonstrated that unusual purine bases could inhibit virus replication in plants after incorporation into viral RNA. Other biochemists worked on the hydrogenation of fats in the rumen and on unusual fatty acids, and interests were extended to the potential nutritive value of wool protein hydrolysates. Studies of soil organic matter and soil enzymes were commenced at Soil Bureau.

Biochemistry is now firmly established as a component of many multi-disciplinary team efforts aimed at solving a wide range of mission-oriented problems. Approximately 45 scientists with interests in biochemistry or biological chemistry are currently employed in DSIR. Although the major effort is concerned with understanding and manipulating agricultural ecosystems, increasing attention is given to the biochemistry of processing biological products.

Accompanying this growth of chemical research activities in DSIR has been an equal growth in the Research Associations. There are now 11 of these autonomous organisations, funded jointly by industry and by Government, and managed by independent executive councils. Chemistry, chemical engineering and biochemistry form a large part of the research activities of all these laboratories, and a majority of the Directors have been drawn from these three disciplines. More than half of these Research Associations have been formed during the 20 year period now under review — Meat, Wool, Coal, Building, Concrete, and Logging Research.

CHEMISTRY AND BIOCHEMISTRY IN THE UNIVERSITIES 1956-76

by P. B. D. de la Mare

"For the advancement of knowledge and the dissemination and maintenance thereof by teaching and research there shall be . . . a University . . ."

(University of Auckland Act, 1961)

Introduction

In 1955, Parton[1] reviewed the development of New Zealand University Chemistry Departments from 1930 onwards. Many of his general comments remain true; his hopes for the future have surely been realised in part. The present article is written from the point of view of a New Zealander who returned from the United Kingdom after an absence of 21 years; and of one who has more detailed knowledge of Auckland University than of other institutions.

General University Structure

The years succeeding 1955 have seen the Colleges of the University of New Zealand become separate Universities, with finance determined by government allocation through the University Grants Committee. This body also coordinates some co-operative activities of the universities, and provides through its curriculum committee that the degrees awarded by the universities do not become too diverse. New universities have been set up at Hamilton (Waikato University) and at Palmerston North (Massey University), both now with flourishing Science Faculties. Science Departments have on the whole been given good new buildings, adequately equipped, with satisfactory technical facilities; and have been adequately though not unduly generously financed for undergraduate and postgraduate teaching. Staffing is at an adequate level, just sufficient to allow effective original research to be engaged in or supervised by most of the teaching staff. The larger science Departments are multiprofessorial; their Heads have heavy administrative duties, and some universities have provided mechanisms which enable Headships to change more easily than was possible in the past.

The formal organisation for the teaching of chemistry and biochemistry differs considerably among the universities. Departments of Chemistry of a traditional kind operate at Auckland, Waikato, Victoria, Canterbury, and Otago; and of Biochemistry at Auckland, Victoria, and Otago. Massey has a single Department of Chemistry, Biochemistry and Biophysics; Canterbury collaborates with Lincoln College through their Departments of Chemistry and Biochemistry respectively to provide an Honours course in Biochemistry. Auckland also has a flourishing Department of Cell Biology. Some teaching of specialised aspects of chemistry occurs in other faculties, as for example in the Engineering Schools at Auckland and at Canterbury; in the Medical Schools at Auckland and at Otago; at Lincoln College in Soil Science; at Massey in Food Technology and in Soil Science; and at Otago in Home Science.

Entry, and undergraduate courses

First-year University courses in the basic sciences are at "intermediate", rather than at the higher level more common for English Universities; and the minimum qualification for matriculation is at a correspondingly low level, no specialised choice of school subjects being required. It is common, of course, for students attempting University subjects such as chemistry to have reached a much higher standard than this at school, and there is provision even for direct entry into the second year of the B.Sc. courses. The vast majority of first-year students, however, enter the large first-year courses, and some of these students are not adequately prepared even for work at this level. Despite this, the success rate has been encouragingly good, partly because the system of bursaries and scholarships, available to all without a means test, has rewarded good performance.

A B.Sc. degree taken over three or more years can include varying amounts of chemistry, and the course structures have tended to become more diverse, so that students have a more flexible choice of areas of study, with greater possibility of interdisciplinary combinations. Even within chemistry departments a good deal of the teaching cuts across the conventional divisions of the subject; study of more than one subject at third-year level is common, thus providing a diversity of ways of achieving equivalent training. At Auckland, where the Departments of Biochemistry and Cell Biology start their courses at the third-year level, students often combine one of these with chemistry. The similar combination of third-year courses in chemistry and in geology provides a basis for geochemistry, which at Victoria is taught in the Chemistry Department. At Waikato, biochemistry is taught as a second and third-year course within the Chemistry Department, whereas at Massey, biochemistry starts in the first year and is required for all those majoring in chemistry. At Victoria and at Otago, courses in biochemistry start in the second year.

Industrial, applied, and analytical chemistry are likewise provided in a variety of ways. Most Chemistry Departments feel that analysis is so much an

[1] H. N. Parton, *J.N.Z. Inst. Chem.*, 1955, pp. 41-45.

integral part of all chemistry that it best forms a major component of the normal practical courses. These in many cases contribute a substantial proportion to the grades for the courses, and must be passed if the courses are to be credited to the degree. Auckland and Canterbury make provision for specialised industrial needs through the courses in their Engineering Schools, whilst Victoria provides a course in Industrial Chemistry, and Canterbury one in Chemical Process Technology, within their respective Chemistry Departments. Otago makes a feature of applied chemistry in the second, third-year and Honours courses in Chemistry. Radiochemistry is specially featured in the course at Auckland where particularly good facilities have been provided, and also at Waikato and at Victoria.

The departments concerned in undergraduate teaching towards the B.Sc. degree contribute also, in varying ways and extents, to the courses for degrees in other faculties, including those of Medicine, Agriculture, Pharmacy and Engineering.

Further Study: Honours courses

A substantial proportion of B.Sc. graduates leave the University for employment. Rather more than half, however, proceed to further study, some in a new field and some in training for teaching. Essential for the development of the basic sciences, however, is the group going forward to an Honours degree. Such degrees can in general be awarded with Honours once only and must have a substantial content of work for written examinations covering all the main branches of the subject studied. An M.Sc. degree generally has associated with it a substantial thesis based on training in research. Auckland retains an Honours system based on this type of M.Sc. degree, which in Chemistry can be completed within one calendar year or can be extended over a longer period; a consistent new enrolment for M.Sc. in Chemistry of between 20 and 30 students per year points to its popularity and success. Waikato provides for the submission of a dissertation rather than of a thesis; Massey and Victoria now run a B.Sc. (Honours) degree in parallel with one leading to an M.Sc. with Honours. Canterbury and Otago use the B.Sc. (Honours) degree; their M.Sc. degree can be awarded with (or without) Distinction. Possibilities of cross-crediting between faculties have been provided where these have been seen to fill an academic need. The standards attained by Honours graduates are high; and in the writer's opinion are a particularly good guide to a candidate's capability because of the attention given to the process of assessment.

The Ph.D. and D.Sc. Degrees

Admission to the Ph.D. degree normally requires prior attainment of Honours standard. It is awarded by research only, on the basis of a substantial thesis. Study as a full-time student is usually required, except for academic staff of the University or in other special circumstances. Internal and external, including overseas and oral, examiners are used, and the standards required and achieved are at a level which reflects very highly to the credit not only of the candidates but also of the universities' supervisors.

Support towards work for this degree comes from Post-graduate Scholarships awarded by the University Grants Committee to a large proportion but not all of First-class Honours Graduates; from various types of temporary staff appointments; by secondment from some Government Departments; and from a few external grants for the support of special projects. An encouraging feature which has persisted has been the steady flow of students whose wish to continue to study at this level has been motivated more by a genuine enthusiasm for the work done than by the mere wish to obtain a higher qualification.

The degree of D.Sc. is normally awarded for substantial original published work of special excellence, submitted a number of years after first graduation. The University of Auckland has awarded ten D.Sc. degrees since 1962, six of them in Chemistry.

Research

The funding of university research in New Zealand derives in a major way from allocations by each University to individual departments. Some grants for special equipment are provided directly to individual or group applicants by the University Grants Committee. The universities supply also some specialised research services, some of which are centralised and some are shared. Notable are the computer services, served by Burroughs computers located in the main centres, the micro-analytical service provided by Otago University, and high-resolution mass-spectrometry provided by Massey University. Some joint projects are supported by government departments; by local authorities, Research Associations, and related bodies; and by industry. Biochemistry and Cell Biology also receive substantial support from the Medical Research Council.

Research is carried out by members of staff with the help of a limited number of research technicians, by Honours (particularly by M.Sc.) students, and by Ph.D. students. The very few post-doctoral appointments also make a contribution to the research effort. University Chemistry departments have always been very conscious that the primary function of their research must be towards the training of students in research methods, and towards providing graduates from among whom can be derived scientists who can contribute widely to areas important in the development of New Zealand. This has inevitably led to a dispersal of effort over a wide field. Auckland, for example, divides its research expenditure roughly

equally between sections very loosely described as organic, inorganic, physical, crystallography, radiochemistry, and physical organic. Quite diverse interests are to be found within each group, and each group attracts a satisfactory proportion of research students, but the development of any single theme is limited by the availability of manpower and technical resources.

Among the themes to which New Zealand Chemistry departments have made notable contributions are: the organic chemistry of New Zealand natural products, springing in large part from the inspiration of T. H. Easterfield at Victoria and of L. H. Briggs in Auckland (currently Otago and Auckland are the most active contributors in this field); physical-organic chemistry and its application to organic reaction mechanisms, developed early in New Zealand through the original contributions of P. W. Robertson at Victoria, F. G. Soper at Otago, and J. Packer at Canterbury (most departments of chemistry maintain an active current interest in this area of study); the contributions to physical chemistry of R. A. Robinson and H. N. Parton, who played a major part in the inspiration which maintains research in this area under widespread active study. The application of modern physical chemistry made practicable by sophisticated instrumentation has enabled studies of structure and of reactions to be developed extensively at most of the university centres.

New Zealand chemists have made major contributions over the past twenty years in the renaissance of inorganic chemistry, with Auckland, Victoria, Canterbury, and now Waikato in the forefront of work in this area. F. J. Llewellyn pioneered at Auckland the use of X-ray crystallography for the study of the structures of organic and inorganic molecules, and the extension of this work to compounds of biological importance has been a major recent trend at Auckland, Canterbury, and Massey. Norman Edson became in 1949 the first Professor of Biochemistry in the Otago Medical School; his work on metabolic processes derived from his studies at Cambridge under Krebs, and he remained a leader in biochemical education in New Zealand until his retirement in 1967, by which time biochemistry was fully established as a subject in its own right, under active study in most of the universities.

Applied research, involving special projects often supported by industry, government departments, or local authorities, plays a small but important part in the work of most university chemistry departments. It has proved to be most effective at the Ph.D. level. This type of work is featured even more prominently in the Departments of Chemical Engineering. The University of Auckland has recently set up an administrative section (The University of Auckland Research Services) to coordinate this area of activity in terms of the general principles which require the University to provide at all times for open enquiry, publication of scientific information, and general dissemination of knowledge for the benefit of all.

Refresher leave; overseas contacts; and overseas students

Provision is made for refresher leave (roughly one year in seven for senior university staff). The obligations involved in taking such leave, including financial necessities, have tended recently to encourage some members of staff to spend part or all of their leave in New Zealand.

Overseas contacts are maintained also through the many short-, medium-, and long-term visitors who are welcomed to departments throughout New Zealand; the University Grants Committee, the Universities themselves, and the New Zealand Institute of Chemistry and other professional bodies make valued contributions towards the support of such visits, which add considerably to the international character of university work.

Contribution to overseas contracts comes also from the small but significant influx of students from overseas. Entry is provided for at entrance or at any appropriate higher level, through the *ad eundem statum* regulations. Adjustment to a new university situation is not always easy, and students from other university systems often take extra time so that they can do themselves full justice. Most overseas students of recent years have been successful in completing the courses which they have undertaken. Countries represented in 1975 at the post-graduate level in the Auckland Chemistry Department include students from Australia, Canada, England, Fiji, Hong Kong, Malaysia, Singapore, and Thailand.

The Universities in the service of the community

The New Zealand community has been far-sighted in defining the aims of its universities in the terms quoted at the head of this article. It has every reason to be proud of the ways in which the Universities work towards these aims; and no better examples could be chosen, so the writer believes, than from those departments to which the attention of this article is turned. Thus for exemplification of the advancement of knowledge and the dissemination and maintenance thereof by teaching, one has only to turn to the output of graduates and survey the varied areas to which they contribute. Study of the current list of members of the New Zealand Institute of Chemistry provides only part, albeit an important one, of the picture. A different but equally instructive indication is given by a survey recently carried out relating to the Auckland Chemistry Department. In Table I we give the information available to us, classifying (a) the present known occupations of M.Sc., and Ph.D. graduates in Chemistry from Auckland over the period 1960-1969; (b) the first occupation after

graduation of the B.Sc., M.Sc., and Ph.D. graduates in Chemistry in 1975.

TABLE 1

Employment of Auckland University Graduates in Chemistry

Type of employment	1950-1969 Graduates; Occupations as known in 1970† M.Sc.	Ph.D.	1975 Graduates First occupation[2] B.Sc.*	M.Sc.	Ph.D.
Overseas:					
Further study	11	—	2	2	3
University teaching	—	22	—	—	—
Other employment	9	18	1	—	1
In New Zealand:					
Further study	—	—	33	5	—
University teaching	—	18	—	—	1
Technical-Institute teaching	3	2	—	—	—
Schoolteaching	17	—	5	2	—
Other employment in education	3	1	1	—	—
Government	3	7	1	4	1
Research Association	2	6	—	—	—
Local Authority	1	—	—	1	—
Hospital Board	3	1	1	—	—
Industry	18	2	7	2	—
Self-employed	—	1	—	—	—
Changed field	6	2	2	—	—
Not known	22	4	5‡	2‡	—
Total	98	84	58	18	6

*Includes those with Chemistry and other subjects at third-year level.
†Information where possible up-dated since that time.
‡Includes those still seeking or not available for employment at that date.
[2] The writer thanks Mr C. W. Pascoe, University of Auckland Careers and Appointments Office, for this information.

I conclude from this Table that our graduates, along with those of other departments and universities, contribute fully to a wide range of activities valuable to the community. Indeed, the study of chemistry, as of any proper university subject, forms the basis for a liberal education, rather than of a restrictive technical training. As a result, New Zealand graduates are well received, and usually do very well indeed, when they go overseas for employment or for further training.

The contribution of Chemistry, Biochemistry, and Cell Biology Departments to the advancement of knowledge by research can be illustrated in various ways. For example, from among their current members of staff, one has been elected to Fellowship of the Royal Society, and some twelve to the Fellowship of the Royal Society of New Zealand. Likewise these Departments do much to help to sustain New Zealand's reputation for scholarly work through their output of published papers, reviews, and books. The publication list for the Chemistry Department at Auckland, for example, has for a number of years averaged well over 60 per annum, mostly in international journals of high quality.

New Zealand must always remember that in order for her to be treated as an equal among the technologically developed nations, and hence to be able to expect to share in the advances possible through overseas technology, international recognition that we can make a fair contribution to the international pool of knowledge is needed. It is to the credit of university staff in the past that they have conceived their educational function to have a long-term basis, providing for graduates able to give a lifetime of service rather than to serve the needs of the moment. The maintenance of standards requires that the climate of opinion should encourage this far-sighted approach. Let us hope that the community will continue to provide such encouragement, as sometimes it seems to do more through its deeds than through its words.

The writer thanks his colleagues for comments and information. It is hoped that no errors have crept in; the opinions expressed are personal, and the examples are based on the writer's restricted personal knowledge.

NATURAL PRODUCT RESEARCH IN NEW ZEALAND

by R. C. Cambie

Introduction

Natural products research, especially that of the endemic flora has for many years been a fruitful avenue for research in the universities and government research establishments of New Zealand. Facilities for this work are in general very good, although some universities suffer from the disadvantage that their research funds are very meagre by comparison with overseas' standards. Nevertheless, New Zealand has an enviable reputation for the calibre of its natural products research, and with up-to-date publications on its flora and with comprehensive phytochemical surveys and registers available, New Zealand is particularly well favoured for such study.

Despite its small size New Zealand constitutes one of the distinct botanical regions of the world. According to geological evidence the land mass of New Zealand has existed for approximately 60-70 million years. From the similarity, indeed the identity of some plants of the flora of New Zealand and the southern part of Chile together with evidence from the paleobotany of Antarctica, it would appear that New Zealand was in past geological times connected through Antarctica to South America but not to Australia. During a long period of separation from other land masses evolutionary processes have produced in New Zealand a unique fauna and flora. The diversity of plant species has been accentuated by the variety

of geographical features which range from plains to high snow-capped mountains and from arid regions to those of exceptionally heavy rainfall. Although the number of indigenous higher plants in New Zealand is small, about 1750, approximately three quarters of these are endemic; almost half are relatively small plants which are only found in alpine regions. Even the small outlying islands of New Zealand have endemic species not found on the main islands. Before the arrival of European settlers to New Zealand approximately 80 percent of the area was covered by native bush, but today most of this has been destroyed except for that preserved in national parks.

In many countries there has been a tendency to investigate firstly those plants which, according to folk-lore, have medicinal value. This has not been the case in New Zealand since little medicinal use was made of plants by the indigenous Maoris. The general absence of a native pharmacopoeia before the arrival of Europeans to New Zealand was due in part to the religion of the Maoris; many of the so-called "Maori cures" of today emanate from the post-European period when the early settlers attempted to find substitutes for their European herbal remedies. In the early Maori religion, led by the tohunga or priest, illness was believed to be caused by evil spirits or to be punishment by the gods for sins committed: sick people were admonished to accept this form of punishment without recourse to herbal remedies. According to Captain Cook (who landed in New Zealand in 1769) the Maoris did use medicinal vapour baths and herbal linaments for external injury, but there was no evidence of the use of plant extracts for internal complaints. Valuable summaries of the medicinal plants of New Zealand which have been published by Brooker and Cooper reveal a number of species which could be profitably examined for their active principles.

Only a relatively small number of New Zealand plants have been examined, but they have yielded a diverse range of extractives including essential oils, alkaloids, colouring matters, dyestuffs, steroids, tannins, etc., some of which have potential economic value to the country. In keeping with the characteristic flora of temperate regions, that of New Zealand is not particularly rich in alkaloid-bearing plants. There is one unusual feature, however, in that practically all the essential oils of the large timber trees (species of *Agathis, Podocarpus, Dacrydium, Phyllocladus)* contain diterpenes which are rarely found in the essential oils of plants of other genera. Since the heartwoods of these trees are also a rich source of oxygenated diterpenoids it is not surprising that New Zealand is noted for its work on diterpenoid compounds.

It is because of its unique flora, its long history of natural products research, and in recognition of the international reputation achieved by New Zealand workers in this field that New Zealand has been chosen as the venue for the 10th IUPAC Symposium on the Chemistry of Natural Products.

The Universities

Natural products research is carried out in the Chemistry Departments of all six universities of New Zealand. Courses on the biosynthesis of natural products are offered in some at the M.Sc. level, but in general natural products are not given prominence in undergraduate teaching. Most universities are reasonably well equipped with a range of modern instruments, e.g. i.r., u.v., n.m.r., gas chromatographs, etc. which are necessary for the modern study of natural products. However, advances overseas especially in other Pacific areas make it essential for the upgrading of equipment to continue if New Zealand is to hold its place as a significant contributor in the field.

In the past a wide range of natural products has been investigated at the University of Auckland, but in more recent times efforts have been concentrated on the utilization of natural products, especially of diterpenoids, for various purposes, e.g. for chemotaxonomic purposes, for use as optically active relays in synthesis, for the production of perfumes, and for the examination of unusual reactions. Essential oils, fungal constituents, anthraquinones, triterpenoids, and steroids are also the subject of current research, while steroid biochemistry is one of the main lines of work in the Biochemistry Department. Significant contributions have been made by the X-ray crystallographic group of this University in solving the structures of certain natural products.

The University of Waikato is the newest of the New Zealand universities and thus has no long-standing association with natural products. However, a lecturer whose specific research interest is in natural products was recently appointed to the staff of the Chemistry Department. Current research includes work on steroids, the identification of metabolic intermediates in the germination of seeds, pollen and spores, and the identification of naturally occurring fungicides.

Most research in natural products at Massey University is in the biochemical area. Current studies include peptide-protein work, the chemistry of pasture polysaccharides, carbohydrate and amino acid interactions, the endogenous metabolism of plants, the complexing of divalent cations with plant constituents, and an investigation of the lipid metabolism of photosynthetic tissues of pasture plants with special reference to the biosynthesis of fatty acids. Attention is also focussed on the metabolism of alcohol in the human body, on fungal products (e.g. dothistromin, a fungal metabolite from *Dothistroma pini* which is responsible for needle blight in *Pinus radiata*), and on the use of high resolution mass spectrometry and X-ray crystallography for the study of a variety of natural products problems.

The major lines of research at Victoria University, Wellington are concerned with carbohydrates and the synthesis of natural products. Current interests include novel reactions of monosaccharides, e.g. glycosylation utilizing the specific inter-

action between the sulphur atom of thioglycosides and metal ions, and the synthesis of indole derivatives which might be of value in the immunological prevention of facial eczema of sheep. Also studied is the synthesis and reactions of terpenoid compounds especially caranes and substituted cyclohexanes related to the antibiotic fumagillin, and the application of gas chromatography — mass spectrometry to the identification and characterisation of compounds of biological interest. Biochemical studies include work on hydrolytic enzymes from New Zealand invertebrates.

The Chemistry Department of the University of Canterbury, Christchurch, is well known for its research on steroids and monoterpenes, especially the rearrangements undergone by these compounds. Current interests include investigations of the carbohydrates of pines, diterpenoid rearrangements, model studies in terpene biosynthesis, photochemical transformations of natural products, and marine natural products. The X-ray structure of organic molecules, and mass-spectrometric and ^{13}C n.m.r. studies of natural products are also undertaken.

Plant science is studied at Lincoln College which is also located in Christchurch.

The major natural products work carried out in the University of Otago is concerned with the isolation, characterisation and structure elucidation of extractives of native plants and lichens, especially with triterpenoids from lichens and with diterpenoids from indigenous conifers. Constituents of essential oils are also of long standing interest, while the chemistry of polysaccharide systems, especially those of New Zealand woods and tussock grasses, is also studied. Synthetic studies are aimed at the commercial utilization of New Zealand natural products wherein attempts are made to convert some of New Zealand's unique natural products into steroids and perfumes.

The pharmacology of native plants is examined in the Pharmacology Department of the University of Otago. However, although the New Zealand flora is rich in unique species, few native plants have been tested for medicinal properties.

Government Institutions

A number of Government-financed research establishments carry out research on natural products. The major institutions are administered by the Department of Scientific and Industrial Research and research policy is aimed at combining basic chemical research with the investigation of problems of economic importance. The Chemistry Division, Wellington, is the largest chemical laboratory in New Zealand permitting considerable staff specialisation. A continuing interest is the study of extractives of native and exotic timbers to evaluate their commercial possibilities.

Considerable effort has been expended with problems which might assist New Zealand's economy. For example, an investigation was carried out in the 1960's on the methods of isolation of manool, a bicyclic diterpenoid from the heartwood of *Dacrydium biforme*. Manool can be converted to acetal derivatives which have the typical odour of ambergris, a highly prized material in perfumery. In another study a mean essential oil composition of New Zealand *Pinus radiata* forests was established resulting in a chemically defined production of sulphate turpentine during woodpulping operations in this country. The turpentine has an unusually high proportion of β-pinene which makes it of greater commercial value than other turpentines.

Recent investigations include the isolation of the steroidal alkaloid solasodine from native New Zealand *Solanum* species and its use for the production of steroid drugs. Current investigations include a reassessment of lanolin constituents from wool wax, extractives from South Island lignites, flavour, perfume and animal pheromone chemistry, wood polyphenol chemistry (particularly of lignin and lignin-carbohydrate bonding), tannin structure and biosynthesis, and cannabinoid research. The taxonomy and phylogeny of New Zealand plants such as *Sophora*, mistletoe and liverworts is being established by separating and identifying the flavonoid constituents. Extensive work on the seed fats from indigenous monocotyledons constitutes a continuing study in this laboratory.

The Applied Biochemistry Division, Palmerston North, has a number of chemists engaged in basic natural products work. Current interests include structural and biogenetic relationships of flavonoids and other plant phenolics of biological interest, insect moulting hormones, alkaloids of indigenous species, plant polysaccharides and phytoalexins, and the isolation and identification of trace fatty acid constituents from meat fat, milk fat, and other fats of animal, plant and marine origin. Flavour studies on lamb and mutton are also carried out.

The Ruakura Animal Research Station, Hamilton, has a long association with the investigation of alkaloids and other toxic principles from endemic and introduced species. One of their major and continuing investigations has been on sporidesmin, the toxic principle of *Pithomyces chartarum* the fungus which causes facial eczema in sheep. Current work includes the investigation of constituents of other fungal species, of pheromone compounds, and phytoecdysones of ferns.

Natural products research carried out at the Plant Diseases Division, Auckland, includes work on the chemistry of growth regulators, especially cytokinins, auxins, and inhibitors. Other studies are concerned with flavour components of New Zealand fruits, the chemistry of toxins produced by plant pathogens, and with analytical techniques for biologically important compounds derived from natural sources.

The New Zealand Forest Research Institute, Rotorua, has recently appointed a number of young research workers with a natural products background

and an increasing concentration on natural products research can be expected. Current interests include the wood and bark extractives of New Zealand beeches (*Nothofagus* species), the resin acid constituents of indigenous trees, and lignin and carbohydrate studies.

Industrial Firms

Little research on the chemistry of natural products is carried out by industrial firms in New Zealand. However, New Zealand Pharmaceuticals Ltd. have recently developed a process for the extraction and purification of bile acids from animal gall, which may herald an increased interest in natural products by New Zealand firms. Ivon Watkins Dow, in conjunction with Syntex, Mexico, have expended considerable effort in attempts to promote an industry based on the alkaloid solasodine extracted from N.Z. *Solanum* species. They, like New Zealand Forest Products Limited, have also been concerned with turpentine and tall oil studies.

In conclusion, natural products in New Zealand can be said to be in a healthy and developing state. However, the death in early 1975 of Professor L. H. Briggs struck a sad blow to the subject, since for a period of more than forty years Briggs had done more than any other New Zealander to promote the investigation of natural products in New Zealand.

CHEMISTRY IN THE RESEARCH ASSOCIATIONS

by W. A. McGillivray

Research Associations, which like their counterparts in Great Britain and elsewhere are financed and controlled jointly by the industries they serve and the Government (through the Department of Scientific and Industrial Research), have come to occupy an important place on the New Zealand scientific scene. The first Research Association was established almost 50 years ago, and since then Associations have been set up to service most of New Zealand's major industries and a number of smaller industries. The various Research Associations differ considerably in size and to some extent in management and financing, but all were established with the objective of providing centralized research and development facilities for their particular industries which were individually too small to provide their own scientific backing.

New Zealand is primarily an agricultural country, and the Research Associations are thus mainly concerned with scientific aspects of the production and processing of agricultural products. The problems facing many primary industries are largely chemical in nature, hence chemists tended to predominate, at least amongst the early appointees to most Research Associations. The range of work was wide and varied, covering all of the traditional sections of chemistry, including more recently biochemistry and chemical engineering. Furthermore, the nature of much of the work in Research Associations has called for a considerable degree of versatility, particularly where staffs have been relatively small. As a result chemists quickly branched out not only into the broad ramifications of applied chemistry and technology but into other disciplines such as microbiology and engineering. This paper is therefore concerned not so much with chemical achievements in the Research Associations, but rather it is an attempt to outline the work that has been done by chemists in their own and other fields into which they have diversified in the Research Associations. Because of the very different natures of the industries served by the Research Associations, and hence the differences in their fields of work, this is best illustrated by a few specific examples.

New Zealand Dairy Research Institute

The New Zealand Dairy Research Institute is one of the oldest and is the largest of the Research Associations; the work of chemists within this Association well illustrates some of the points made in the introduction. Almost all of the staff in earlier years were chemists, and even today a high proportion have at least a chemical background. The composition of milk, particularly milkfat, and factors affecting this and the rheology of butter were obvious topics for the organic and the physical chemist, and the step from these to various aspects of the technology of milk processing was a simple and logical one. Less to be expected was the very detailed investigation carried out by other chemists into microbiological aspects of cheesemaking, leading to the development of single strain starters and the characterization of their homologous phages, an investigation which has been continued to the present day, mainly by chemists, with spectacular success.

Initially much of the work of the Institute was of a fairly applied nature; a major contribution of the

earlier chemists was in convincing a somewhat reluctant industry of the value of a scientific approach to their problems, and that the scientist could make a significant contribution to what were then regarded as the arts of butter and cheese-making. With the increasing sophistication of the dairy industry and the rapid expansion which has taken place in the Institute over the past 10-15 years it has been possible to extend some of these areas of chemical work to include more fundamental as well as applied investigations. Such areas include fat chemistry, protein chemistry, flavour chemistry, bacterial biochemistry and viral genetics. Most major projects at the Institute are now multi-disciplinary, but chemists have continued to make significant contributions to such diverse topics as the mechanization of Cheddar cheese-making, the elimination of bitterness in cheese, automation and computerisation of evaporation and spray-drying, fractionation of milkfat, isolation and utilisation of whey proteins, the modification of casein and other protein products for functional end uses, and the development of milk powders for specialized uses, particularly in recombination.

Wool Research Organization of New Zealand

Wool is a product with many natural advantages, but like most natural products is subject to increasing pressure from synthetics and other alternatives. The Wool Research Organization works closely with wool producers and processors to help capitalize on the natural advantages of wool, and to overcome any of its disadvantages.

A major success has been the development of a comprehensive scouring system which is now being operated in about half the New Zealand scours, with more being converted. This system is based on the rationalization of the handling of scouring liquors, and has numerous advantages over conventional scouring. Another interesting development is a patented catalyst system for depositing polymers based on methacrylates and styrene inside wool fibres, with the primary objective of increasing the bulk and stiffness of the fibres to make them more suitable for use in carpets.

Other investigations include flame-proofing of wool, prevention of tendering of wool by light (a detailed study which involves a considerable amount of basic protein and photochemistry), the treatment of wool to prevent the development of static electricity on carpets under conditions of low humidity, the elucidation of factors which lead to the yellowing of wool and methods for removing this discolouration by bleaching. Detailed investigations are also being carried out into aspects of the biosynthesis of wool. Recent work has sought to identify the enzymic basis of control of wool growth, and the unusual biological process of keratinization.

Meat Industry Research Institute of New Zealand

When this Institute was established in 1956 concern was developing in the meat industry over complaints from the United Kingdom of toughness in New Zealand frozen lamb. Investigations of this problem led to extensive basic chemical and biochemical work relating tenderness to the state of muscle contraction and the traditional method of hanging and freezing meat. This long-term study represented virtually the development of a new branch of meat science—the relationship between muscular contraction, meat tenderness and cold. It greatly influenced the course of meat research in other centres, and finally found recognition in new international standards for meat handling.

Work continues on the mechanism of cold shortening; investigations are being made into the structure of myosin, including the identification of low molecular weight sub-units which are part of the myosin heads and essential to their biological function, the electron microscope is being used to study the assembly of myosin molecules into the thick filaments of muscle; the mechanism of the accelerated rigor mortis induced by electrical stimulation is being studied; work on very highly stretched single beef fibres has re-kindled interest in the "gap filaments" of the sarcomere. This type of chemical work has developed over a period during which muscle chemistry and biochemistry has moved from simple studies of impure proteins to a sophisticated appreciation of muscle structure and function, and significant contributions have been made to both muscle biology and to meat science.

New Zealand Fertilizer Manufacturers Research Association

The utter dependence of New Zealand primary industries on high quality fertilizer is well recognized, so it was logical that one of the early Research Associations should service the needs of fertilizer manufacturers. From its inception the Institute has concentrated on methods of overcoming the problems associated with the processing of Christmas Island phosphate for superphosphate manufacture. The development of this type of phosphate, in place of the much more highly priced Nauru rock, has resulted in significant savings in overseas exchange; in 1974, and again in 1975, these more than paid for the cost of research at the Institute since its inception.

Like a number of other Research Associations this Institute may be described as a "go to whoa" organization, in which an attempt is made to achieve a close understanding and co-operation between all concerned from the production of the raw materials, through their processing and distribution, to the final use of the end product. While the current programme emphasizes the chemistry of superphosphate manufacture, a considerable amount of other chemical work relating to new and modified types of fertilizer is also being carried out. Another important area of in-

vestigation relates to the effect of fertilizer manufacture and use on the environment. Typical studies include measurement of dust and other process effluents, recovery of residues from these effluents, and pot trial studies of fertilizer nutrient movement in soils and uptake by pasture plants. Considerable emphasis is also placed on research which will effect manufacturing efficiency, since it is well-recognized that the holding of fertilizer production costs would contribute significantly to the stability of overall farming costs.

New Zealand Leather & Shoe Research Association

The tanning industry was one of the first to be established in New Zealand, and until recently was principally concerned with supplying leather to local manufacturers, mainly for manufacture of footwear. Hides and skins excess to local tanner requirements were exported in an untanned preserved condition. Recently established tanneries have been expanded, and large new units built in order to process a greater proportion of the hides and skins in New Zealand. The tanning industry has great potential, and the current research programme of this Institute has been geared to assist in the expansion which is currently taking place.

This Institute was one of the first Research Associations established. Over the years it has investigated all the chemical processes involved in the manufacture of all types of leathers, and the adoption of many of the results of this work by the tanning industry has led to an improvement in the quality of New Zealand leathers. Typical examples of its work include the elimination of a serious defect due to calcium phosphate deposits in cured calf skins by the incorporation of boric acid in the curing salt, the control of bacterial proliferation which resulted in defects such as hairslip and red and purple stains by the incorporation of boric acid and naphthalene in the curing salt, and the production of pickled pelts of more uniform shelf life by standardization of the preservation treatment and the use of a fungicide.

New Zealand Pottery and Ceramics Research Association

This is an example of a Research Association servicing an industry based on a non-agricultural raw material. Over the years its chemical work has extended into many aspects of clay chemistry and the technology of pottery and ceramics.

In the clay field attention has been devoted to the problems of characterizing amorphous materials. Normal mineralogical techniques cannot detect these, and chemical dissolution methods have therefore been developed for the determination of the extractable iron oxides, alumina and silica contained in ceramic bodies. A correlation has been shown to exist between the moisture content of clay dried to a controlled humidity, and its extractable (or amorphous) material content for a wide range of kaolinitic and halloysitic clay samples. The practical result of this work has been to provide an additional tool for the ranking of clays in accord with their physical properties. High temperature chemistry related to ceramic materials has included a detailed investigation of cristobalite, a form of silica often found in fired clay bodies. Studies have also been made of the effect of kiln atmosphere on the chemistry of firing reactions.

Investigations into the chemistry of clay article forming have included studies of the complex chemical properties of clay slips. The long-term objective of this work is to control plastic whiteware clay properties by appropriate chemical control of the slip.

A particular characteristic of the work of this Institute, partly because of its small size and because of the nature of the physical and inorganic chemistry problems involved, has been its close association with appropriate university departments, and its efforts, through scholarships and other means, to encourage greater emphasis on solid state chemistry and ceramic research generally.

New Zealand Coal Research Association

Coal is an important source of energy in New Zealand, and the recent energy situation is stimulating more detailed investigation of this natural resource. Much of the chemical work of the Coal Research Association relates to the routine examination of geological, prospecting and industrial samples, particularly core samples from the Huntly area which will supply the projected thermal power stations.

Research is devoted generally to a better understanding of the properties of New Zealand coals, especially those of our unique sub-bituminous type, the greatest distinguishing feature of which is their remarkably high reactivity. Another current study is concerned with the various forms of sulphur in coal.

Building Research Association of New Zealand

This is one of the newer Research Associations whose function is to foster and participate in the search for new building materials and methods, and to create a better understanding of those already in use. Chemical research mainly involves the investigation of the properties, durability and compatibility of building materials. Many of these projects cover more than one scientific discipline, and work in chemistry is combined with research in other disciplines to produce information of use to the building industry.

Current work includes exposure testing of paints and other surface coatings on roofs, timber, and timber products, coated metal roofing tiles,

joint sealants, particle boards, and ultraviolet degradation of PVC; methods of overcoming the inhibition of the cement hydration reaction by timber extractives; testing of durability of materials for special purposes such as freezing works' floors; studies on corrosion of various metals in different environments; and methods of fire protection, such as the use of fire-retardant paints.

Conclusion

The above necessarily very sketchy account outlines some of the work in which chemists employed in a number of New Zealand Research Associations are, or have been, engaged. No mention has been made of the very considerable amount of time which staff of Research Associations must spend in liaison work with their industries, nor of the extent to which such staff may be able to influence the course of chemical work within the individual units of their respective industries. The Research Associations were established at times when the individual units were too small to carry out their own research and development work, but this situation is rapidly changing, and with it comes a changing role for Research Association chemists — an opportunity to work more closely with their counterparts, to see their research findings more quickly and probably more effectively put into practice, and an opportunity to concentrate on longer-term more basic investigations, rather than a series of ad hoc projects. No mention has been made of another very important area of responsibility for Research Association chemists; this is in forming a liaison link between their industry and other chemists, particularly in DSIR Divisions and university departments. With the increasing complexity of industrial chemistry, it is important that developing industries should have access to the latest knowledge and the most sophisticated equipment. This link is being effectively provided through Research Association chemists who continue to be extremely broad-ranging in their outlooks and interests.

BIOCHEMISTRY IN NEW ZEALAND: CURRENT AND FUTURE TRENDS

by R. D. Batt

Introduction

The role and extent of biochemistry as part of the total spectrum of New Zealand science can now be described and identified, at least in general terms. This has not always been so. Although biochemistry in Europe and North America was a well established discipline before 1920, the science began to develop in New Zealand only after the Second World War. However, even from the earliest days in the development of the country, the work of chemists was partly biochemical in nature and was supported financially for the benefits which could be obtained by applying the skills of chemists to solving problems in biological fields.

The reasons for this major and continuing orientation of the work of chemists in New Zealand is understandable when it is realised that the major resources of the country are biological raw materials.

There have been times when this dependence of the country on the products of agriculture and forestry may have been reduced, but never more than minimally, for example during the gold rush days of the mid-19th century, and in more recent years, from ironsands exports and aluminium smelting.

Biological materials: the major national resources

The extent to which the economy of New Zealand is dependent on biological raw materials can be estimated with some approximations. Over 90 percent of the total overseas earnings from the country are derived from biological macromolecules, proteins and polysaccharides, and from lipids. Approximately 45 percent of these earnings come from protein exports. The reason for this level of economic dependence on biological raw materials is only, in part, related to the relative paucity of other large natural resources. Of particular significance is the high degree of efficiency with which New Zealand can produce biolo- exploitation would have to compete for manpower gical raw materials. Even if the country had large natural resources of other types, efficiency of their and economic returns with the agricultural and forestry industries. The productivity per labour-unit in agriculture for the period 1960-62 in 29 different countries is recorded in an FAO publication *The State of Food and Agriculture 1968.* With a scale on which the gross agricultural output per labour unit averaged over 29 countries is taken as 100, New Zealand has the highest rating of all, as shown in the following extract from the complete list:

New Zealand	770
Australia	640
U.S.A.	510
Canada	340
U.K.	210
Denmark	180
Netherlands	160
France	130
South Africa	40
Japan	25

Scientific employment related to the nature of the economy

A prime reason for employing scientists and providing appropriate facilities has always been related to the need for the country to maintain not only the high level of production of biological materials but also the remarkable levels of efficiency. The extent to which chemists have been employed in "biological" research institutes and industries was clearly illustrated in the figures given by Andrews and Brooker in the Silver Jubilee issue of the *Journal of the New Zealand Institute of Chemistry* (November, 1955).

In 1937, of 66 chemists employed in research institutes and industries in New Zealand, 52 or nearly 80 percent were in positions related to primary production. Figures for subsequent years are summarised below:

	1947	1950	1954
Number of chemists	119	135	180
Employed in "primary" industries	73	76	105
Percentage of the total	61	56	58

In recent years it has become more difficult to identify the proportion of the chemists and biochemists employed to support and promote the production in New Zealand of biological raw materials but it is likely to be well in excess of 50 percent.

Growth of Biochemistry in New Zealand

Although so many chemists were employed on biochemical work, biochemistry as a well-defined separate discipline from chemistry, did not begin to develop in this country until after 1940. Biochemistry was introduced as a B.Sc. unit at the University of Otago and masterate courses became available when the independent Department of Biochemistry was established in that university in 1949. The Agricultural Colleges had included biochemistry as part of their curricula for a number of years and the first Department of Biochemistry in a New Zealand university institution could rightly have been that of Agricultural Biochemistry at Massey Agricultural College, headed by Dr. C. R. Barnicoat from 1944 until 1959.

The rapid growth in biochemistry as a discipline in New Zealand universities is reflected in the present situation with six well-established departments employing approximately sixty permanent academic staff members, including six professors. The major Government research institution for biochemical work is the Applied Biochemistry Division, at Palmerston North, employing approximately 45 permanent scientific officers in a total staff of about 100. All other Government and special research institutions which employ scientists on biochemical work would add another estimated 45 scientific officers.

It is difficult to estimate the numbers of biochemists employed in industry but it is certainly a number which is increasing rapidly and would represent a significant proportion of the total number of scientists employed on biochemical work in New Zealand.

Although reference has been made to the main areas in which biochemists are employed, the increasing demand for biochemical techniques in medical research groups in New Zealand is noteworthy. Clinical biochemistry as an aspect of modern medicine has led to the development of many laboratories both as private clinical services and in general hospitals. Although such laboratories can meet some of the requirements for medical research groups, especially in the major hospitals, the complexity of many of the funded investigations requires specially-trained biochemists to work full-time within the research groups. The extent and growth of medical research funding can be gauged from Medical Research Council reference publications. Trends which will almost certainly impinge on the nature and training policies in New Zealand biochemistry have been proposed as recommendations in the recently-published special MRC report *Medical Research in New Zealand*.

Current Biochemical research

A high proportion of New Zealand scientists work on biochemical problems of special significance to New Zealand. To cover them all would be impractical and of little interest, providing essentially a catalogue. Selecting topics presents problems; the choice of the following examples carries no implication of relative merits, either in the relevance or quality of studies not mentioned.

(a) Ruminant metabolism

Much of the work of biochemists at the Applied Biochemistry Division and elsewhere in New Zealand is related either directly or indirectly to ruminant metabolism. In New Zealand there are over 60 million sheep, 3 million dairy cattle and nearly 6 million beef stock. The nature and quality of the plants on which these animals feed and grow are subjects of major importance to New Zealand scientists. The early recognition of a need to concentrate research efforts on animal nutrition has led to some of the most important developments in the

history of New Zealand science. To cite just a few: the development of new grasses to suit particular growth and soil conditions, the recognition of cobalt-deficiencies in soils in certain areas, the introduction and extensive use of phosphate fertilisers, and more recently the controls developed to offset the effects on production of conditions such as bloat.

To continue to maintain and make progress in an area such as ruminant metabolism, research effort has to be directed to basic as well as to more applied studies. For example, it is likely that advances in our knowledge of basic cell biology may well be of considerable significance in New Zealand agriculture. In advancing our understanding of the processes for fixing nitrogen by symbiotic and free-living nitrogen fixing organisms, there is the possibility of using biological fixation to a maximium and offsetting an existing concern to reduce energy imputs in all phases of the agricultural industries. To help achieve such objectives has, in part, been the justification for centering the research efforts of a relatively large group of biochemists on studies of legume-nodule development, including investigations on biological membranes, protein synthesis and transport of amino acids.

Similarly, to make maximum use of photosynthetic processes, new knowledge is being obtained and studies promoted in basic cell biology to give new techniques in plant breeding.

A major programme during the next few years is to concentrate research on ruminant product quality. It is now recognised that improvements in the quality of herbage for ruminants may be negated if meat from the animals produced is too fat, or has flavours undesirable to potential export customers. Investigations on both mutton flavours and over-fat deposition in export lambs have become major biochemical studies for New Zealand scientists.

(b) Protein Chemistry and Biochemistry

Although a high proportion of New Zealand export earnings are derived from proteins, the establishment of protein research programmes and the training of protein scientists in the universities are relatively recent developments.

For many years, it has been stressed that the country needs to diversify its economy and the obvious resources from which new products and industries might develop are, clearly, biological raw materials.

Fine protein industries have been discussed frequently as potentially of economic value to New Zealand including, for example, an insulin industry which some estimates suggest may be worth nearly 20 million dollars a year in overseas earnings.

To develop protein industries the country will need well-trained scientific manpower, and recognition of this has led to university involvement not only in training protein chemists and biochemists, but also in establishing large research programmes covering most areas from new methods of isolating and purifying proteins through to the determination of primary and tertiary structures of pure proteins.

It will probably take many years to develop viable protein industries, but for a country in which first-class animal protein is the source of one of its major pollution problems, as effluent from the freezing works, the logic and indeed the responsibility to ensure that such protein ceases to be a waste product is clear.

Future trends

"The ultimate object of biochemistry is a description of vital phenomena in the language of chemistry and physics." This statement was made in 1956, by Profesor N. L. Edson, the first Professor of Biochemistry appointed in New Zealand at the University of Otago. An important and most productive feature of modern biochemistry has been the application of the sophisticated techniques of chemistry and physics to biochemical studies, and these applications must surely be extended. The potential for the techniques of NMR, ESR, high-resolution mass-spectrometry and the use of lasers are well documented already, and the impact from interaction of disciplines will undoubtedly be a feature of biochemistry in the future.

CHEMISTRY AND THE TEACHING PROFESSION

by T. C. Ralfe

For two decades the teaching profession has been experiencing the twin pressures of rapidly rising rolls and curriculum changes adapting to emerging socio-economic conditions. In what way have teachers of science, and of chemistry in particular, been affected?

Writing of his impressions in 1955, P. O. Veale[1] commented that advances take too long to get into schools, and that syllabuses for science seemed to be based on the requirements of university inorganic chemistry although, even then, few of the total number of students would go on to university studies. Some people would say that this is a fair comment today. But the vision of Veale went deeper. In describing how chemistry had progressed too much to be taken casually as a single undivided subject in post primary schools, he proposed for those seeking a "general education" new courses related to the world of reality—matters which most affect the daily lives of ordinary men and women. For those aiming at a university career he foresaw well-equipped school laboratories enabling an inorganic chemistry course to be academic, modern and industrial. The way to satisfy the growing need in industry of technicians and laboratory aids would be through the development of courses at technological institutes. These are now matters of fact. It is interesting to trace events which have influenced developments.

The period following the Second World War was marked by a high and increasing birth rate until 1961 when the level dropped.[2] In the two decades we are considering, the yearly increase in the secondary school population was compounded by a longer time spent at school.[3]

In this same period secondary schools faced the problem of a teacher shortage which had its origins in the very low birth rate of the 1930's, but later in the inadequate provision of post-primary teacher bursaries. The persistent shortages caused friction within and outside the schools and handicapped the secondary service in meeting all the demands created by the expanding school population.[4] In 1955 the pattern of science education, established after the Thomas Report of 1944, included a compulsory core of General Science for the first two years and then as an option to chemistry and other specialist sciences for the School Certificate Examination. The increasing numbers entering the sixth form inevitably brought together in chemistry classes students with alternative backgrounds. The problems this difference posed led to claims by some teachers that it was an almost impossible task for students from General Science to attain the level expected in University Entrance Chemistry.[5] However, the trend continued with more and more students opting for General Science and then taking chemistry in the sixth form with a marked degree of success.

The length and content of the chemistry syllabuses in the sixth and seventh forms were widely criticised. Each year examiners seemed to find some aspects of topics not previously assessed and teachers steadily added these to an already full programme. The unrest among chemistry teachers in the early 1960's encouraged some to examine developments in the United States. There, in the late 50's, the Government fearing that the existing standards of science education would gravely affect industrial progress, had financed major developmental programmes in high school science led by some of the foremost scientists of the day. The resulting chemistry projects, CHEM Study and CBA, provided new approaches and teaching materials emphasising the development of abilities expected of young chemists, rather than the necessity to cover a given body of knowledge. These were welcomed in New Zealand and tried in a number of schools from 1963.

A concurrent development had been efforts to improve the teaching of science in Forms 1 and 2 and to look at fresh approaches to science courses in Forms 3 and 4 to revive interest among students. This acitivity eventually led in 1967 to the introduction of a new Forms 1-4 Science Syllabus which reflected many of the ideas and approaches encouraged by the trial of CHEM Study material, the parallel developments in physics and biology, and other materials developed in Britain. The most important features were the statements of aims and objectives, the arrangement of content to reflect these objectives, and explanatory notes about the depth of treatment or methods of approach.

This was the first New Zealand secondary syllabus to break with the practice of stating a syllabus mainly as a list of content, and to make explicit the concepts and principles, the cognitive skills and the attitudes expected to be developed. A new School Certificate subject called Science was introduced to follow on and as a replacement to the old General Science. This, too, was a departure from the practice of preparing a fifth form syllabus to meet specific background requirements of a Form 6 course.

During these developments the decision was taken to revise the University Entrance and Scholarship prescriptions assuming only a background of the School Certificate General Science rather than adopt or adapt the programme which had been on trial. The chemistry prescription introduced in 1967 presented the content under six headings which identified the major ideas and structure of the discipline — states of matter,

structure of matter, chemical periodicity, organic chemistry, patterns and principles of chemical change, important types of reactions — together with a set of explanatory notes indicating depth of treatment. The content prescribed to develop these areas represented a considerable reduction and provided teachers with a great deal of freedom to determine the sequence and manner of presentation. Here the extensive teacher guides which acompanied the CHEM Study approach and the materials produced in England by the Nuffield Chemistry Project had great influence.

Further assistance was provided by a Curriculum Development Bulletin,[6] prepared by experienced teachers at a residential in-service course, and by several teacher refresher courses.

It can be safely said that teachers welcomed the guidance given by the identification of major chemical principles and concepts that students were expected to master, and also the reduced range of content to be covered. This enthusiasm was reflected in support materials prepared to help less experienced teachers with the chemistry sections of the science syllabus in Forms 1 to 5.[7] From an early stage teachers were encouraged to aim at developing theoretical concepts, models and explanations for a range of observed physical phenomena. It can be said that concept development was the hallmark of science teaching which emerged during the late 60's and early 70's. As chemistry is a discipline built on theoretical concepts to explain behaviour of matter, it lent itself to this approach. The inclusion of much abstract formal thinking soon proved to be at odds with the researched findings about the development of students' thinking processes. For a large number of secondary students the chemistry section of the Forms 1-4 science course became an unpalatable chore. It has been reported elsewhere[8] how the Form 1-4 Science course became effectively condensed to two years because of the failure to provide the necessary training for Forms 1 and 2 teachers and the financial support for equipment and facilities in intermediate and primary schools.

The difficulties did have the effect of encouraging teachers at all levels to examine more closely theories about how children learn and develop the skills that are carried forward into their life outside and beyond the school. This proved to be a matter of concern across the whole school curriculum. Today a national curriculum can be recognised emerging as distinct from a set of syllabuses. Each subject area is being developed on the basis of a common pattern involving the statement of objectives in terms of intended changes in students' cognitive and affective behaviour, the drafting of learning resources designed to achieve these objectives, the trial and appraisal of these materials in schools, and then the revision in light of the trials prior to publication and dissemination.

Chemistry in the sixth and seventh forms has moved in this direction since 1975 when the prescriptions were rewritten in the same basic format (after wide consultation with teachers), but with the addition of a clear statement of aims as an introduction.[9] Material resources are in the final stages of preparation for publication.

In the senior secondary school chemistry programmes can be seen to have moved from a period in the 1950's dominated by the acquisition of knowledge about an increasing range of topics, to an emphasis on chemical principles, concepts and theories in the 1960's; and now there is emerging an identifiable concern for the development of cognitive and affective behavioural changes in students. Whether a study of chemistry is an effective vehicle for such development will remain a matter for debate and research.

The picture in the middle years of secondary school is less clear. Reaction against the emphasis placed on concept development is widespread and the concern for the development in students of those skills and attributes which will help them live in harmony with others and fit them to undertake vocational training on leaving school is strong. Another function of a science education today is to develop students to a level where they can make intelligent and informed judgements and participate in reasoned discussions concerning matters where science impinges on society.

A revision of the Forms 1-4 Science Syllabus will begin shortly.

After 5 years of debate about revisions at the fifth form level three new subjects are being tried in 40 schools during 1976-77. The three subjects, Biological Science, Physical Science, and Alternative Science are based on two sets of modules which provide scope for differing abilities and aspirations of students, and opportunity for schools to develop courses most appropriate to the needs of particular students.[10] In each module there is a statement of objectives which indicate the behaviour students can be expected to exhibit with regard to content knowledge, cognitive and physical skills, and attitudes. The degree of emphasis on these objectives in the teaching programme and their assessment is a decision for schools and teachers to make. This is seen as an important stage in the use of internal assessment for certification purposes.

In the evaluation of these trials evidence will be gathered about the adequacy of such a flexible approach in providing students with the background, study skills and attitudes necessary for continuing studies in chemistry and other sciences, as well as those continuing in other directions.

The past twenty years have witnessed a shift in school chemistry programmes from providing an encyclopedic knowledge of chemistry topics to an emphasis on equipping students with skills nec-

essary to study and work effectively, and to enjoy to a greater degree the world about them. Will chemists in the years ahead continue to listen to the lessons provided by the actions of ordinary men and women, and adapt chemical education at the school level to satisfy the needs of all?

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THE TRAINING OF TECHNICIANS IN CHEMISTRY AND BIOCHEMISTRY

by H. Offenberger

The recognition that there was room for the training of technicians, that is to say of sub-professionals whose task is to assist professionals in their work, goes back to the war years. Initially the attention of the Department of Education was focussed on apprentices and other young workers who were in need of technical education. The technical high schools of the day were secondary schools for non-academic children ,and their evening classes provided vocational training of a limited range. Dr. Beeby, then Director of Education, gave some indications in the early 1940's that he had plans for the establishment of a system of senior technical education divorced from the technical high schools.

The introduction of trade training was the first step (Apprenticeship Act 1948) and with it came compulsory attendance at a technical school in the day-time. Without the acceptance by employers of "day-release" there would not have been enough teaching load in the schools to allow seperate institutions to be formed with at least a nucleus of full-time teaching staff.

Technician Training:

The development of formalized training for engineering technicians came next. There was a shortage of engineers, and the senior technical classes preparing students for the membership examinations of the various British Institutions increased both in number and rolls; but the suggestion of the Department of Education to train engineers outside the university was strongly opposed by the Institution of Engineers—so strongly that a stale-mate resulted. This was ultimately resolved by deciding that the higher technical training of professional engineers should be the function of the universities only, while the sub-professional technical labour force should receive its schooling in the technical colleges. Thus, toward the end of 1954 the "Controlling Authority for the New Zealand Certificates in Engineering" was established and the teaching of its courses began in 1955.

These were structured as five year courses commencing at about School Certificate level. Cross credits were allowed for success in the public secondary school examinations. The first two years of the course included mathematics, physics, chemistry, mechanics, technical drawing and English, while the last three years contained more and more special technical subjects depending on the branch of engineering in which the students were employed.

The courses were conceived as consisting of part-time study for a minimum of 6-8 hours per week concurrent with suitable work experience.

Science Technicians

Technician training was in the air from the late 1940's onward. The war had its effect. Industrialisation was increasing, and with it the requirement for quality control, product development and trouble shooting demanded the skills of professional scientists. Much of the work in science, however, was done in government departments and some in the universities.

Most of the training for science technicians was "in house", and then only in large establishments such as at Wallaceville Animal Research Station. This gave technicians some internally recognised qualification while making them more useful to the scientists they were to assist. In the private sector the turnover of technicians was high. Without the opportunity to acquire qualifications there were no certain career expectations, and boys who had just left school stayed for short periods only. True, some qualifications could be obtained, but

tuition, if available at all, was haphazard. Many a technician qualified by having failed B.Sc., or possibly passed the odd unit toward a degree.

The New Zealand Association of Scientific Workers, now the New Zealand Association of Scientists, was concerned about the status of science technicians and as a result of a survey in 1953 drew the conclusion that . . . "Science technicians are a class of scientific workers deserving greater attention . . ." ". . . more attention is urgently required for the institution of qualifying examinations in different branches of science"[1].

Their concern for the status of science technicians led them to introduce a category "technician member" in an effort to lend their organisation's support until the technician membership became strong enough to enable technicians to form their own New Zealand Institute of Science Technicians.

The Role of the New Zealand Institute of Chemistry

The New Zealand Institute of Chemistry had conducted examinations for a Laboratory Assistants' Certificate. However this was not entirely successful, particularly as tuition was not readily available, nor, as can be said now, did it aim at a high enough level. In 1957 a representative group of industrial chemists in Auckland had meetings which culminated in the recommendation that a National Certificate for Technicians in Chemistry be established.

This was conveyed to the Director of Education by the Board of Governors of Seddon Memorial Technical College. A similar demand came from the Council of the New Zealand Institute of Chemistry (NZIC). The Director of Education called together a conference of interested parties on 8th August, 1957. The original proposals agreed to at that meeting were later found not to be satisfactory by Council of the NZIC. Its counter proposals differed considerably. Notably, it required 12 hours of tuition time per week compared with 8 hours per week in the original proposal; and it restricted block-course tuition to students who had to be catered for by correspondence only, while the original scheme made 3 weeks attendance at block courses for laboratory work mandatory for all students in their final year.

It is noteworthy that employers should have agreed so readily to give daytime release on full pay to their technician trainees.

A meeting of representatives of interested organisations in May, 1959, agreed to a scheme similar to that already operating for the New Zealand Certificates in Engineering. An estimate of the demand was that 50 students per annum would enrol.

The Technicians Certification Authority

"Controlling Authority" set up in 1954 suffered from two shortcomings. Firstly, it was not a statutory body, secondly, its activity was confined to engineering when the above mentioned negotiations took place.

These defects were removed by the passing of the Technicians' Certification Act 1958, which set up the Technicians' Certification Authority (TCA) with power to prescribe courses, conduct examinations and to award certificates and diplomas. The former Controlling Authority became its Executive Committee for Engineering and Draughting. The Executive Committee for Science, newly formed, was ready to go ahead with the design of the course structure and syllabuses for the New Zealand Certificate in Science (Chemistry) and other options of the NZCS.

The Course in Chemistry: From Fixed to Flexible Structure

To begin with the course structure was fixed and in line with other New Zealand Certificates. Exemptions from subjects of the first year were given for a 50 percent minimum pass in the corresponding School Certificate subject and for subjects of year two for similar University Entrance passes. Conditions for exemptions were changed from time to time to meet new circumstances, particularly in secondary school qualifications. English has remained the exception. There is no exemption from the subject English as laid down by the TCA.

TABLE 1
The NZCS (Chemistry) Out-Line of Course Structure

Year I	Chemistry I	Mathematics I	Physics I Eng.
Year II	Chemistry II	Mathematics II	Physics II
Year III**	Chemistry III*	Lab. Mathematics*	Lab. Crafts
Year IV	Chemistry IV	Instrumentation	
Year V	Chemistry V*		

*Externally examined by TCA
**An Intermediate Certificate is awarded after the completion of Year III.

For a number of years the course in chemistry remained so fixed. As more subjects were introduced into the NZCS course the course structure was freed up and more choices became available. However, the essential unity of the course was not disturbed unduly by this development.

The strength of the NZCS (Chemistry), and its usefulness lies in its relative generality. The TCA has always resisted pressures from special interest groups when they wanted to introduce options into the NZCS (Chemistry) specific to their own narrow needs.

The subject Chemistry III has changed in character. It now has to serve a number of purposes:

(i) Reorientation of students with school chemistry from academic to technician work.
(ii) Provide in its practical work training in skills of immediate use to employers.
(iii) Provide an introduction to Chemistry IV and V.
(iv) Serve as a terminal subject in chemistry for other Science Certificate options.
(v) Serve as a pre-requisite for Biochemistry I.

To meet these needs the course was revised once with Chemistry III as the key subject. The second revision came as a response to demands for the introduction of instrumental methods at an earlier stage, and for a change in emphasis towards applications. The new course structure is seen to be more flexible. It is sufficient to show years III, IV and V of the course. Chemistry IV now contains most of the fundamental chemistry, Chemistry V emphasises applications.

TABLE 2
The NZCS (Chemistry) New Structure[2]

Subjects of Stages III, IV and V: No subject may be presented for examination until any prerequisites stipulated have been passed. Subjects marked * include a practical laboratory or field requirement.

Stage III

SUBJECTS	PREREQUISITES
*Chemistry III, and TWO of	*Chemistry II
either *Biology III	*Biology II & *Chemistry II
or *Medical Biology	*Biology II
Mathematics III	Mathematics II
*Physics IIIA	*Physics II
Elements of Statistics	*Mathematics I
*Laboratory Technology	
*Geology I	
*Elementary Metallurgy	*Chemistry I

Stage IV

*Chemistry IVA, *Chemistry IVB, *Chemistry IVC	*Chemistry III, Mathematics II
and ONE of	
*Biochemistry I	*Chemistry III
*Microbiology I	
*Instrumentation	*Physics II
*General Forestry	Mathematics II
Applied Statistics I	Elements of Statistics
Mathematics IV	Mathematics III
Numerical Methods	

Stage V (1976)

*Chemistry VA, *VB, *VC, *VD	*Chemistry IVA, *IVB

(1977)

Either	
*Chemistry VA (Physical Chemistry), *Chemistry VB (Organic Chemistry), *Chemistry VC (Inorganic Chemistry) and ONE of: *Chemistry VD (I) (Analytical Chemistry), *Chemistry VD (II) (Industrial Chemistry)	Chemistry *IVA, *IVB, *IVC
Or	
*Biochemistry II and Two *Chemistry V papers other than *Chemistry VB	*Biochemistry I; Chemistry *IVA, *IVB, *IVC

Biochemistry

There is no NZCS (Biochemistry) as such. Biochemistry was first introduced into the NZCS (Biology) course.

There were two stages, Biochemistry I and Biochemistry II (at years IV and V). Students frequently studied Microbiology and Biochemistry for their final two years.

Only Chemistry II (or U.E. Chemistry) was a prerequisite initially, but as students lacked sufficient background in organic chemistry Chemistry III has become a prerequisite after the first revision of that subject. With the freeing up of the regulations Biochemistry I was often taken by students in conjunction with Chemistry IV. The revised NZCS (Chemistry) course permits students to take Chemistry IV and Biochemistry I in Year IV, and apart from the organic chemistry paper they make take any other two of the Chemistry V papers with Biochemistry II (one theory paper, one practical examination) in the final year.

Biochemistry I is a necessary prerequisite for students in hospital pathology laboratories who are studying toward a NZCS (paramedical). In the fifth year of that course they take Medical Laboratory Practice II, with a paper in Clinical Biochemistry and a practical examination. Chemistry, Biochemistry and Clinical Biochemistry are practically oriented, and nowadays this means that technicians need extensive training in the use of instrumental techniques. The Technical Institutes where these subjects are taught are therefore equipped with spectrophotometers (U.V. visible, and I.R., atomic absorption), gas chromatographs and other commonly used instruments.

The Biochemistry I and II syllabuses have undergone revision and will take their new shape with some alterations in content. But it is probably fair to state that the principal changes are in attitude. When the syllabus was first devised many biochemists were "synthetic", that is to say, they were originally trained as organic chemists whose work was in a biochemical environment. Recognition of biochemistry as a discipline in its own right has produced a new breed of biochemists whose interests lie in the applicability of their subject to biology and medicine, as well as to the chemistry of natural products. The emphasis has shifted to a more physiological content.

Teaching and Output

The prediction that 50 recruits per annum would embark on chemistry courses has proved to be an under-estimate as shown in Tables 3 and 4.

A Survey of New Zealand Certificate Holders

Many of the data cited in this paper stem from a survey carried out by the author when as 1970-71 J. R. McKenzie fellow he was attached to the New Zealand Council for Educational Research. The findings are based on the replies to an extensive questionnaire by New Zealand Certificate holders (80 percent return) then in the country, supplemented by interviews with them and their employers. A book *A Survey of New Zealand Certificate Holders* is to be published by the NZCER shortly.

TABLE 3

Numbers* Sitting Examinations in Chemistry, Biochemistry and Clinical Biochemistry in the Period 1961-1974 (3)

Year	Chemistry III	Chemistry IV	Chemistry V	Biochemistry I	Biochemistry II	Medical Laboratory Practice I**	Medical Laboratory Practice II***
1974	378	109	73	221	55	104	90
1973	470	84	71	200	58	110	74
1972	447	92	71	173	50	87	46
1971	356	85	67	127	53	50	
1970	270	83	54	85	50	50	
1969	214	68	64	92	25		
1968	205	72	45	71	21		
1967	174	64	36	49	20		
1966	141	40	34	51	11		
1965	105	39	28	43	9		
1964	76	41	21	29			
1963	61	24	9				
1962	60	11					
1961	26						

*Mean numbers are given where more than one paper needs to be attempted.

**This subject contains microbiology and haematology; with Biochemistry I.

***4 papers, including a written paper in Clinical Biochemistry, and one third of a practical paper.

The Rating of the NZCS (Chemistry) Course

New Zealand Certificate holders were asked to rate the content and level of their courses in relation to the job they were holding. The questions were with respect to the theory and practical portions of the major subjects, mathematics, and the obligatory TCA English.

TABLE 5

Relevance of the Content and Level of the Theory and Practical Parts of Major Subjects, Mathematics and English to the Job Held by Certificate Holders (4)

	NZCS (Chemistry)				All New Zealand Certificates			
	Theo.	Prac.	Math.	Eng.	Theo.	Prac.	Math.	Eng.
CONTENT	%	%	%	%	%	%	%	%
Highly relevant	41	51	34	12	51	35	35	24
Of some relevance	55	37	54	47	43	53	54	51
Not relevant	4	12	12	40	6	12	11	25
	100	100	100	100	100	100	100	100
LEVEL	%	%	%	%	%	%	%	%
Too low	17	22	24	27	16	27	15	21
About right	66	67	69	69	69	65	64	73
Too High	17	11	7	4	15	8	21	6
	100	100	100	100	100	100	100	100
Mean number	N = 113				N = 1545			

Both the theoretical and practical content in chemistry seem to meet the needs of Certificate holders in their jobs. If the TCA intended to give a practical bias to its courses it has succeeded, even better in chemistry than overall. But if TCA English is not an unequivocal success, then it is even less so for those with a NZCS (Chemistry).

TABLE 4

New Zealand Certificates in Science Awarded in the Period 1963-1974 (3)

Year	Chemistry	Biology	Paramedical	*Other	All
1974	60	74	93	25	252
1973	51	56	52	27	186
1972	58	48	32	16	154
1971	54	50		19	123
1970	38	34		26	98
1969	37	21		28	86
1968	32	19		10	61
1967	30	18		11	59
1966	26	10		7	43
1965	15	5		8	28
1964	12				12
1963	5				5
TOTAL	418	335	177	177	1,107

*Includes Physics, Metallurgy, Geology, Forestry.

Employment, Movement and Utilisation

Holders of a New Zealand Certificate in Chemistry were employed predominantly by private enterprise, both at the start of their training (registration), at the end of their training (certification), and subsequently. In this they differ from other New Zealand Certificate holders where the State appears in the role of donor, and semi-public organisations such as local bodies, NZBC, together with private employers act as acceptors, both before and after certification.

TABLE 6

Employers of New Zealand Certificate Holders (4)

	NZCS CHEMISTRY			ALL NEW ZEALAND CERTIFICATES		
	At Regist.	At Certif.	After Certif.	At Regist.	At Certif.	After Certif.
EMPLOYER	%	%	%	%	%	%
State	35	24	23	54	46	37
Semi public	13	16	17	14	18	20
Private	52	60	60	31	36	43
	100	100	100	100	100	100
TOTAL	N = 117			N = 1582		

Replies from New Zealand Certificate holders in chemistry to a question to list one or two activities which they regarded as predominant in their jobs show the following major pattern:

TABLE 7

Job Content, Restricted to One or Two Predominant Activities by Holders of a NZCS (Chemistry) (4)

ACTIVITIES:	
Quality Control	39%
Research Projects	37%
Product Development	26%
Production Control	18%
Management	8%
Maintenance	6%
Field Work	6%
Technical Sales	4%
Teaching	4%

Routine Work

An estimate of the time spent by New Zealand Certificate holders on routine work and on new problems can be seen in the next tables:

TABLE 8

Percentage of Time Spent on Regular Job Element (4)

Percentage of Time	NZCS (Chemistry) %	All New Zealand Certificates %
0-25	18	24
26-50	41	36
51-75	31	32
76-100	10	8
TOTAL N = 114	100	N = 1527 100

TABLE 9

Frequency of New Problems Encountered (4)

New Problems	NZCS (Chemistry) %	All New Zealand Certificates %
Not usually encountered	7	5
Generally similar to previous problems	37	53
As a rule of markedly different character	56	42
TOTAL N = 114	100	N = 1547 100

Obviously chemistry technicians are faced with some routine work, but unlike the general run of New Zealand Certificate holders they meet more new situations. This corroborates the information in Table 7 above.

Job Satisfaction

Job involvement and the degree to which people are fully extended by their work are indicative of job satisfaction. Only the shortest indication can be given here in the form of summary tables:

TABLE 10

Percentage of Time Spent Regularly on Tasks Regarded as Highly Absorbing (4)

Percentage of Time	NZCS (Chemistry)	All New Zealand Certificates
0-25	33	31
26-50	37	35
51-75	17	26
76-100	13	3
TOTAL N = 114	100	N = 1550 100

The reaction of New Zealand Certificate holders to the work they are doing relative to the training they have received can be gauged from Table II. The feeling of working below the proper level is not conducive to job satisfaction; interviews corroborate the view that working above the proper level, while sometimes imposing strain, is usually regarded as a pleasurable experience.

TABLE 11
Level of Work (4)

Worker	NZCS (Chemistry) %	All New Zealand Certificates %
Below the proper level	31	41
At the proper level	56	50
Above the proper level	13	9
TOTAL N = 113	100	N = 1533 100

Cross Credits with University Courses

A New Zealand Certificate holder in science who has passed his examinations with some merit is offered cross-credits which amount to approximately one third of a B.Sc. course (including Chemistry I). Some have taken advantage of the scheme and have graduated B.Sc. and often have gone on with further studies. A few have taken University Chemistry at Stage III in order to qualify for ANZIC. However, there is no race to get into university, partly because the cross-credits are not as generous as for people who qualify for a New Zealand Certificate in Engineering or Architecture, who when accepted are credited with 2 years of the 4 year courses leading to the B.E. or B.Arch. degrees.

On the other hand, university successes in science subjects are given full credit up to Year III of the NZCS course; e.g. a pass in university Stage I Chemistry exempts from TCA Chemistry III. There are more university subjects that fit the pattern of the science courses than the other courses run by the TCA, therefore more science students are able to switch from degree to certificate courses than any other. About 19 percent of all New Zealand Certificate holders have had prior university experience. However, 33 percent of those with NZCS had attempted degrees and in particular, 41 percent of those who hold a NZCS (Chemistry) had done so.

Diplomas

The demand for extending the NZCS course to Diploma level comes from successful New Zealand Certificate holders who like their chosen career, feel they would like to extend themselves further, but are unwilling to take a university degree. They seek to prove themselves by tackling a scientific problem rather than pass further examinations. The co-operation of employers, willing to find a work-based problem of sufficient depth, and technical institute staff to supervise the diploma studies are necessary. The first such Diploma was awarded to a student at Wellington Polytechnic in 1965.

When the TCA showed willingness to develop post-New Zealand Certificate diplomas, the Minister of Education placed an embargo on such activities until the Advisory Council for Education Educational Planning produced a report.

For a few diploma work is a worthwhile personal development, not to be judged on utilitarian

grounds only. The TCA is now preparing regulations for such a National Diploma.

Literature used:
(1) *N.Z. Science Review*, (1953).
(2) TCA Handbooks.
(3) TCA Annual Reports.
(4) Unpublished research data; Correspondence, and papers produced by the Department of Education.

DSIR'S HALF CENTURY

by J. G. Gregory

Some chemists claim that the most important part of DSIR was founded 11 years ago, a claim made with equal fervour by certain geologists. The fact is that the Colonial Museum and Laboratory from which both Chemistry Division and the Geological Survey of DSIR have developed was founded in 1865. The Department of Scientific and Industrial Research itself was established 50 years ago, in October 1926, and the chemical and geological services were brought together under its administration. At this time the work of the Dominion Laboratory, as it was then called, was beginning to expand rapidly, and to meet this growth in its first 10 years as part of DSIR the laboratory had to use ingeniously adapted accommodation in a strange variety of buildings, including a stable. (Of course, some might consider this a most auspicious place to start.)

Overseas Visitors

Overseas visitors at the IUPAC conference who were not already aware of Chemistry Division's work will become familiar with it, particularly that on natural products. They will also hear something of the work of other Divisions of DSIR (of which there are twenty-one); for example Applied Biochemistry Division and Soil Bureau, and of the Research Associations it helps to support and may wonder if there is any field of research that does not involve DSIR.

In truth, there is hardly a research activity in the science budget classification in which DSIR scientists are not active. For many of its staff this is an added attraction about the Department, for it brings an occasional dash of the unexpected to an otherwise constrained routine, and demands versatility and breadth of interest as well as specialisation.

The Department is proud of its achievements and has published a commemorative history of its development, written by Dr. J. D. Atkinson, a member of its staff for over 40 years. In addition a short film showing something of the range of its activities has been issued, and a travelling exhibit of its work will be on tour from July onwards. The exhibit will be in Wellington at the time the IUPAC conference is on, and will have reached Christchurch on its way south by mid September. This year's volume of *DSIR Research* has been expanded to give a complete review of the Department. Most of the Divisions are staging open days at particular times of the year, but will also be pleased to arrange to have scientists visit their laboratories at other times of mutual convenience.

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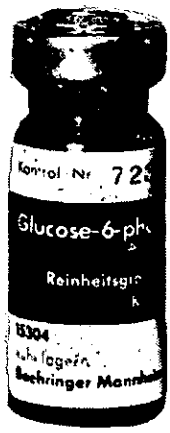

For the solution of a variety of considerably complex questions, many analytical methods are employed by the biochemist. An almost classical method of analytical biochemistry came into existence from biochemistry itself, viz. the enzymatic analysis.

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enzymology

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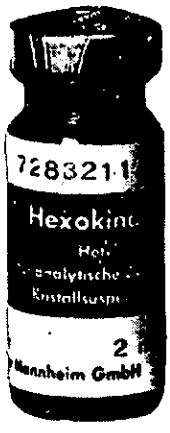
food analysis

The first knowledge of biochemical processes, of the role enzymes play in them and the first experiences with enzymatic analytical methods were gained with foods. Analyses with the aid of enzymes have many advantages in food analysis: enzymatic methods are fast, safe and reproducible. The measurement of enzyme activities as a criterion of the condition of foods is supplemented more and more by enzymatic analysis of the components of foods.



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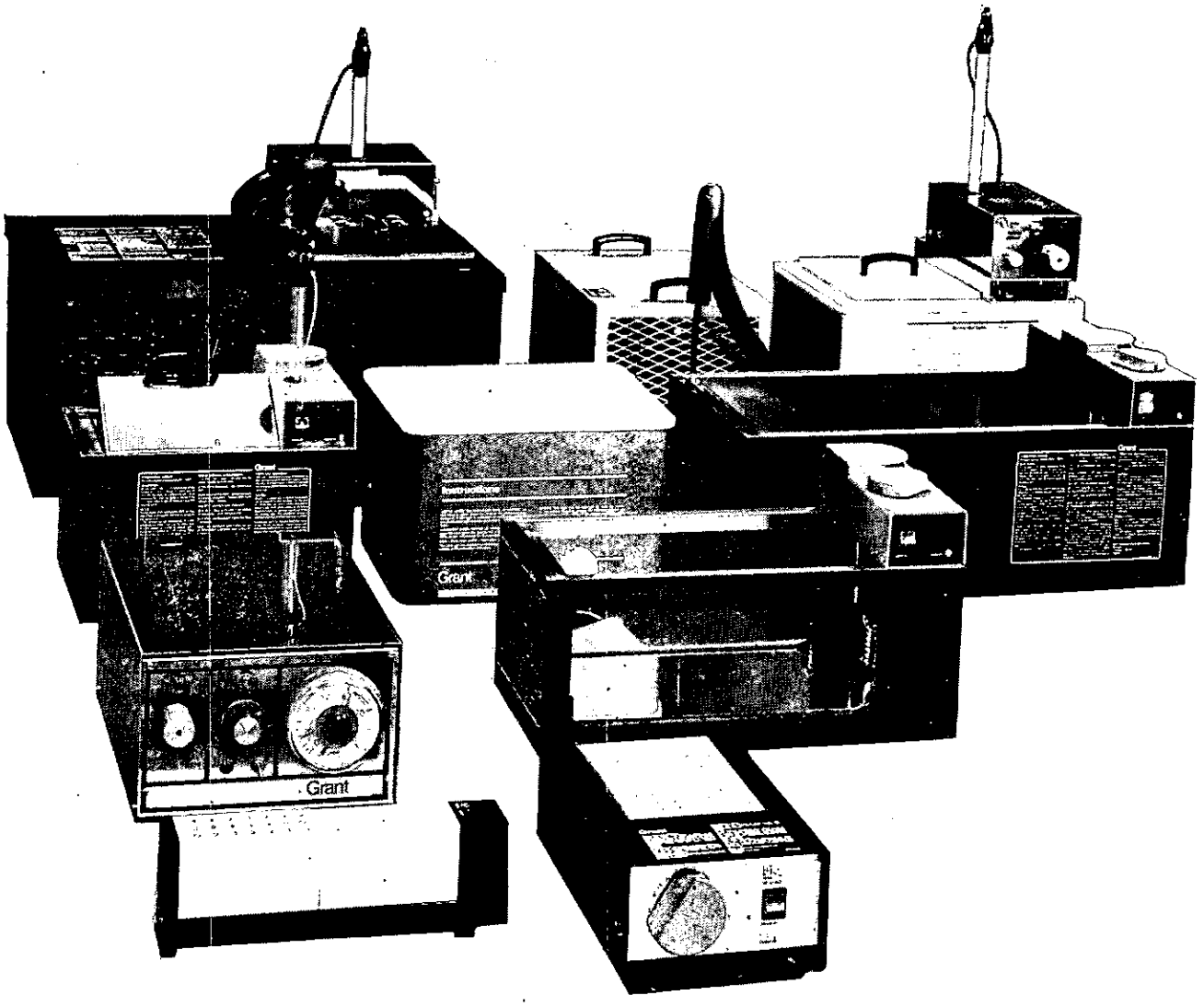

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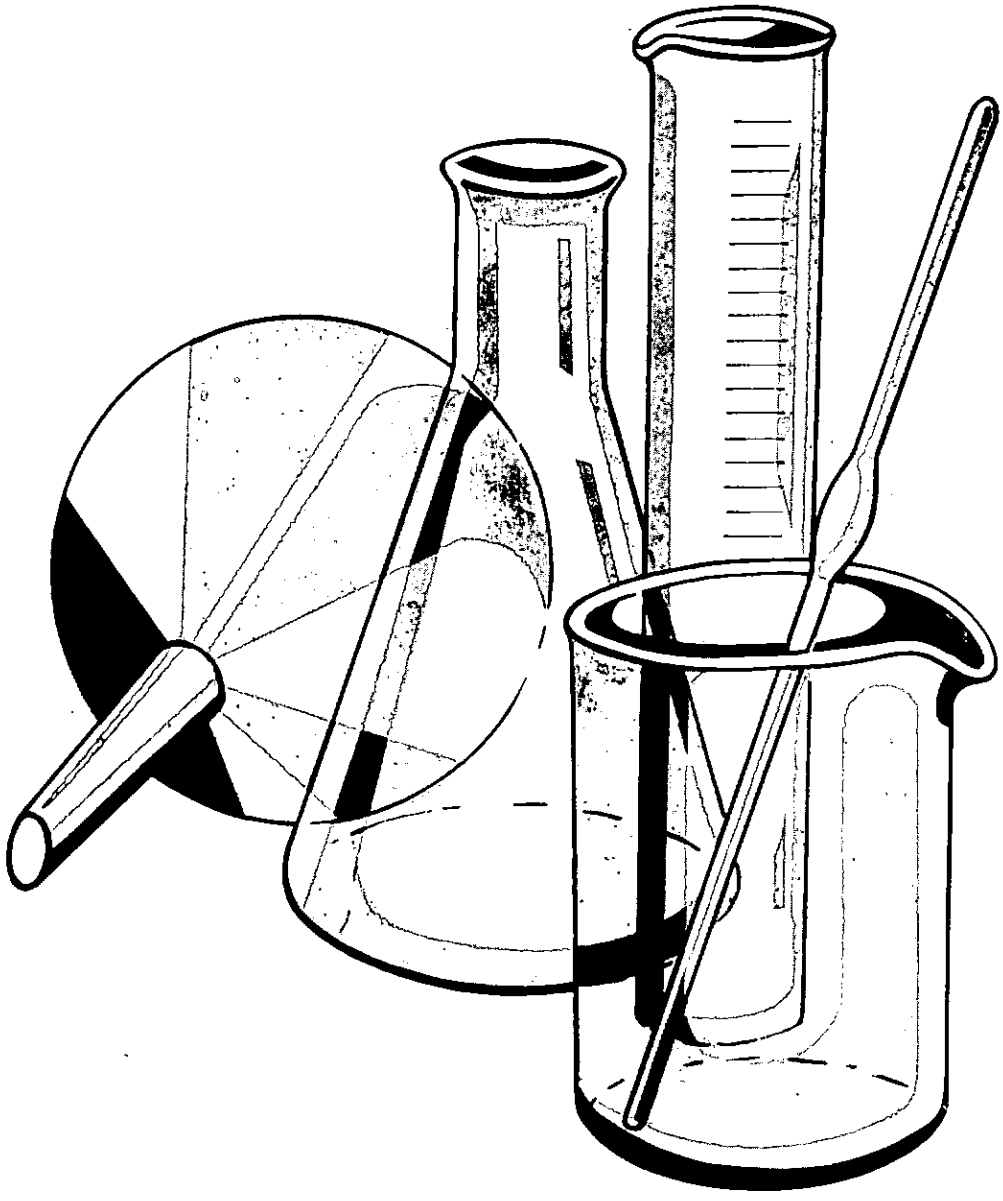

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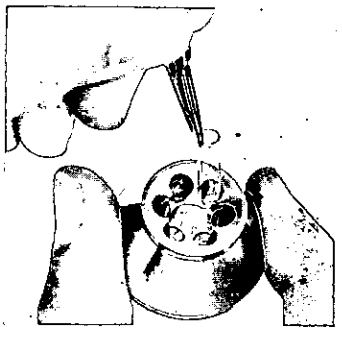

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