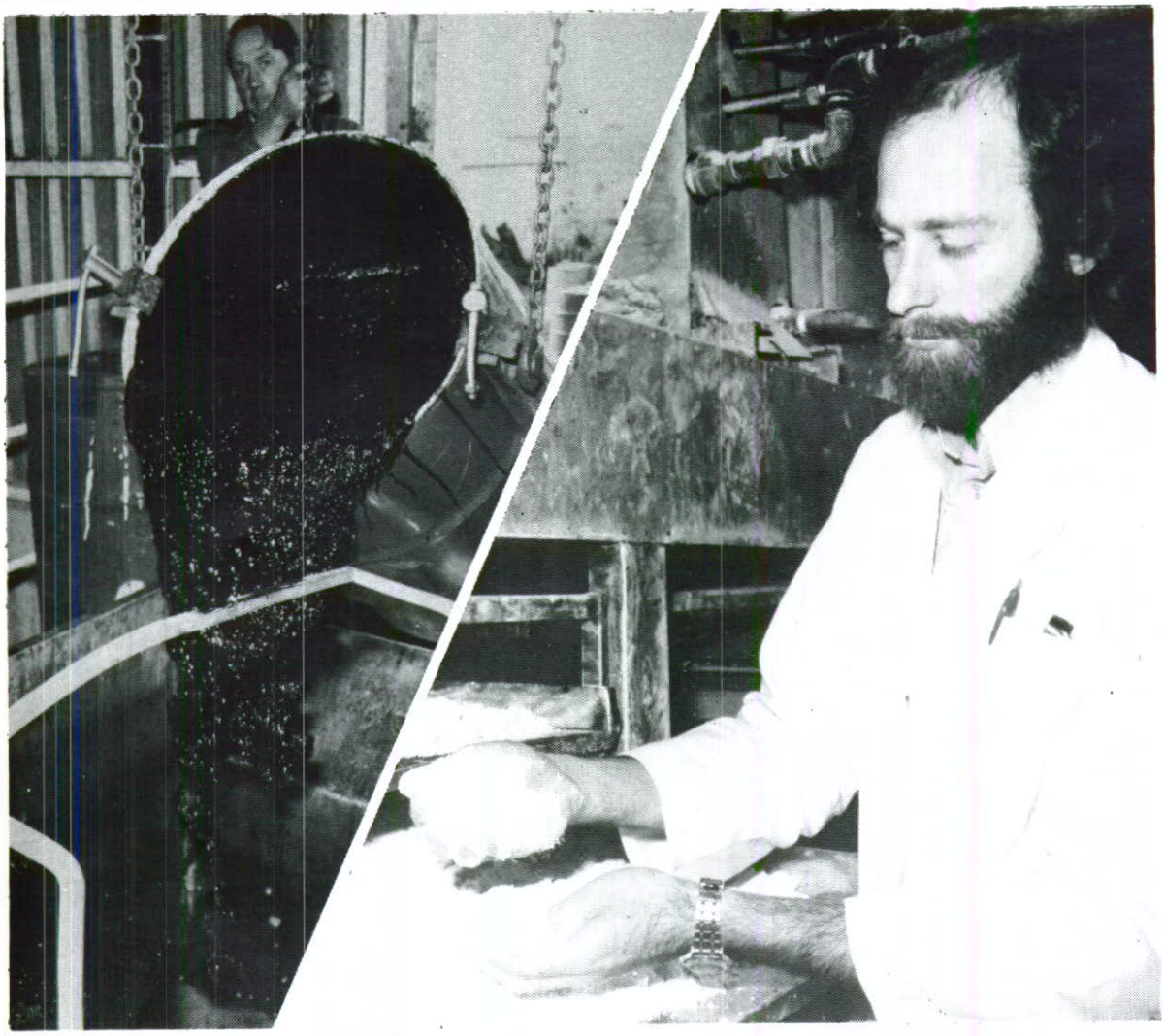
ISSN 0110-5566

chemistry in new zealand



The Light in the Firefly

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NUMBER 3
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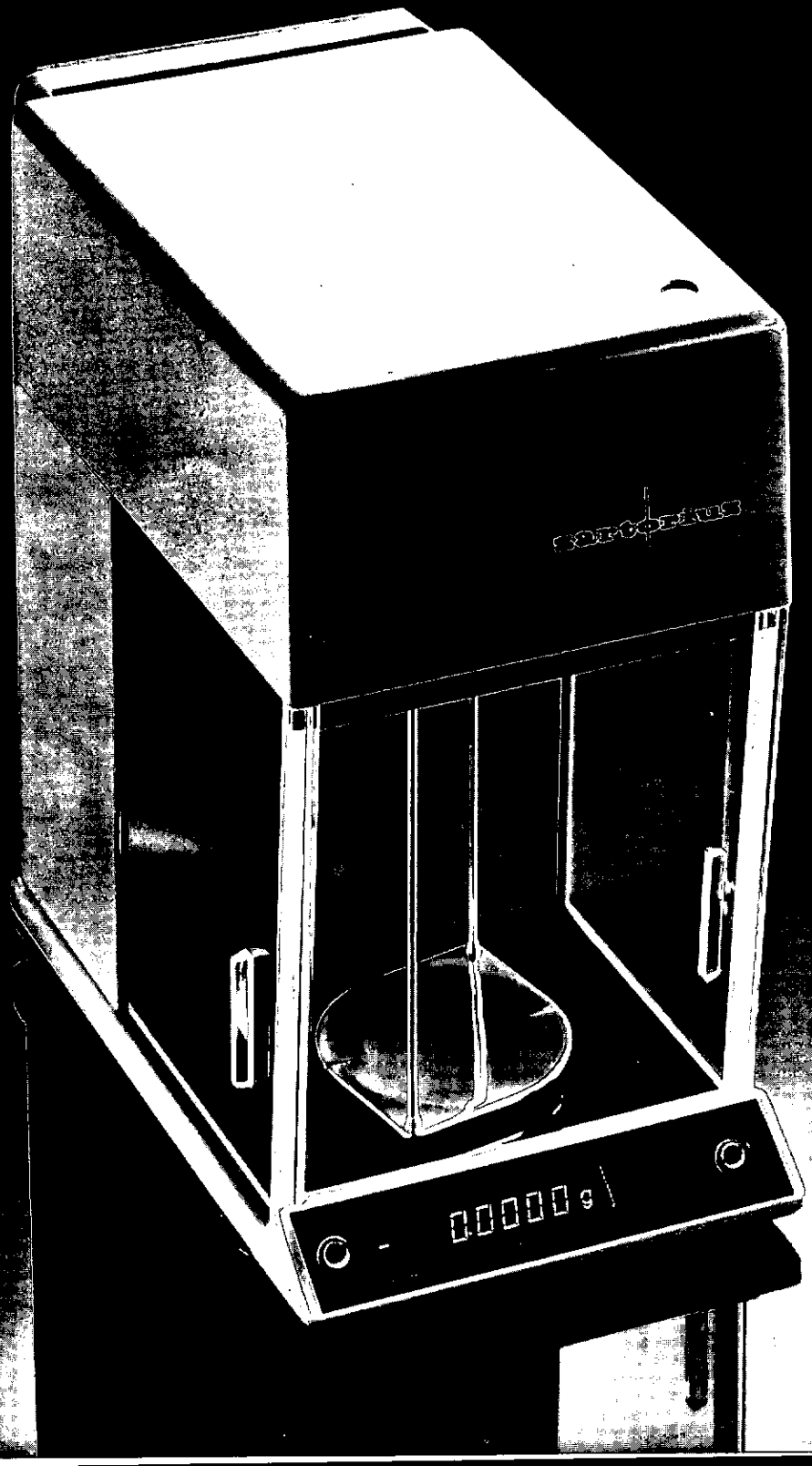

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NOVEMBER 1978
VOLUME 42
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Journal of the New Zealand Institute of Chemistry

Printed by P.N. Printing Co. Ltd.
Palmerston North

ANZA AUDITED CIRCULATION
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N.Z.I.C. PRIZE WINNERS

1978 ICI Prize Winner

Dr Graeme Russell (Applied Biochemistry Division, DSIR) has been awarded the ICI Prize of the NZ Institute of Chemistry for his work on the chemistry of plant-insect interactions. Dr Russell in collaboration with his entomological colleagues has been on the forefront of developments in this field which has led to the growing realisation that many natural products are of prime importance in relation to ecology. They are important in the defence of the plant against predators, provide the chemical signals of pheromonal interactions, contribute towards disease resistance and so on.

The work in N.Z. began from the observation that many native plants have few insect predators recorded from them, in particular some species of the Podocarpaceae obviously had a chemical barrier to insect predation. In the case of *Dacrydium intermedium* a number of ecdysteroids were isolated from the leaves and bark in high yield and accounted for the deterrency of this species towards insects. The major compound was ecdysterone an insect hormone which initiates the moulting cycle. At super-critical doses these compounds derange insect development and their occurrence in the plant at such concentrations must present the insect attempting to eat the leaves, with a considerable biochemical problem. The work on the isolation of the ecdysteroids led on to studies of their metabolism in the insects in order to understand the de-activation mechanisms which operate in the normal course of events.

The unique feature of this natural product chemistry lies in its contribution to the new and growing science of chemical ecology which attempts to understand the role of the so-called secondary compounds. It is also apparent from the very nature of this work that a great deal of credit is due to the many colleagues who have collaborated in the various research projects.

Easterfield Prize Winner

Dr R.E. Mitchell
Plant Diseases Division
DSIR, Auckland

Chemical Essay Prize Winner

Mr C.J. Nokes
Department of Chemistry
University of Canterbury

Industrial Chemistry Prize — see page 111

Prize Winning Chemical Essay

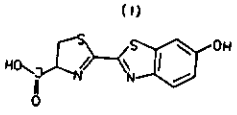
THE CHEMISTRY OF FIREFLY BIOLUMINESCENCE

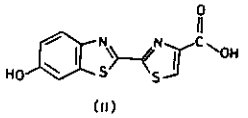
C. J. Nokes

As early as the mid 1880's it was demonstrated, by Dubois, that luminescence from living organisms required three chemical species. The phenomenon involved oxidation, by molecular oxygen, of a low molecular weight substrate he called *Luciferin* and the reaction was catalysed by an enzyme he labelled *Luciferase*. Organisms from a number of phylla show bioluminescence with the vast majority of these being marine creatures. The luminescent organs of these creatures may be put to uses ranging from recognition and mating in the case of the firefly: to hunting, exemplified by the searchlights of deep-sea fish whose red emission goes unnoticed by the blue-green sensitive eyes of their abyssal prey. The most studied firefly is *Photinus Pyralis* and most of the following will be concerned with this American species.

Although previous work had allowed isolation and partial characterization of firefly luciferin by the late fifties, it was not until 1961 that McCapra and co-workers [1] deduced the structure to be (I). The compound was unique in that it was the only known naturally occuring benzothiazole derivative. Chemical tests, degraduation, UV and IR spectra carried out by the group pointed to (I) being the correct structure although their initial molecular weight determinations gave a molecular formula of $C_{13}H_{12}N_2O_3S_2$. This disagreement was settled when it was found that oxidation of luciferin yielded a compound, dehydroluciferin (II), previously isolated from firefly lanterns. Further work on some analogues of this compound gave a molecular formula for luciferin corresponding to that of (I). Confirmation of the structure came with total synthesis followed by UV and IR tests showing the synthetic product was identical to luciferin.

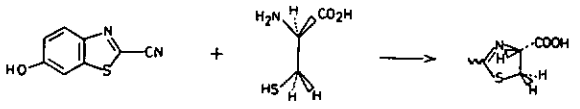
(I)





(II)

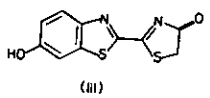
A point of interest arose from the last step of the synthesis which required the condensation of 2-cyano-6-hydrobenzothiazole with optically active cysteine (Scheme I). although both L(+) and D(−) isomers were chemically identical, only the latter would produce bioluminescence. (Later results were to show that although L(+) was enzymatically inactive, it was chemiluminescent.)



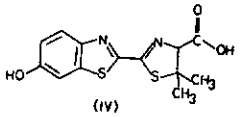
2-cyano-6-hydrobenzothiazole *D(-) Cysteine* *D(-) Luciferin*

SCHEME I. *Final step of luciferin synthesis.*

With the substrate structure clearly determined it was now possible for progress in mechanistic elucidation. A certain knowledge of the reaction was late in coming: the hypothesis that oxyluciferin (III) was the product of the light emitting reaction not being confirmed until 1972 by Suzuki *et al.*, [2]. Early in the bioluminescent studies dehydroluciferin, because it possessed many of the properties of the product of the light reaction, had been looked on as possibly being the reaction product. However, by the time Seliger and McElroy wrote their review in 1965 [3] it seemed unlikely that this was the case. Although it was an oxidation product of luciferin, was found in firefly lanterns and was chemically like the bioluminescent reaction's product in some respects, studies had shown it to be oxidized in a reaction that emitted no light.

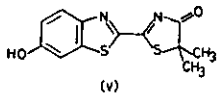


(III)

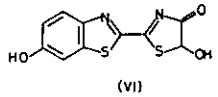


(IV)

In 1967 White and colleagues [4] proposed a mechanism and product structure for the reaction based on other chemiluminescent reaction mechanisms which the group considered bore a close relationship to the luciferin reaction. Attempts to isolate the product failed and it was thought the product was too unstable under the reaction conditions to allow isolation. To overcome this problem a more stable analogue of luciferin was sought out, whose emission spectrum was identical to luciferin's. The 5,5 dialkyl substituted analogue (IV) was used, and spent reaction mixtures from this compound possessed fluorescent spectra identical to those of solutions of compound (V): the product expected if their scheme were correct.



(V)



(VI)

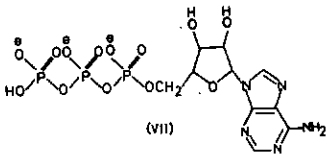
Chromatographic studies of the bioluminescent and synthetic reactions the following year by Plant *et al.* [5] suggesting the three stage breakdown of the immediate reaction product, supported the notion that the product which was of importance in mechanistic determination, was too unstable to isolate. Suzuki and co-workers [2], on investigating the work of Plant *et al.* with NMR, mass spectroscopic and IR techniques, concluded that the product postulated for the synthetic reaction (III) had, under the conditions of synthesis, been further oxidized to (VI). Success in obtaining oxyluciferin came as a result of carrying out the final step in the synthetic reaction under nitrogen at 0° C to eliminate further oxidation. TLC of chemiluminescent

reaction mixtures allowed separation of a product which possessed a UV spectrum identical to that of oxyluciferin. Further product characterization was achieved by immediate acetylation of the reaction product (for stabilization) allowing isolation of a compound which was shown to be oxyluciferin diacetate by mass spectroscopic and UV analysis. Acetylation of the *in-vivo* bioluminescent reaction residue also resulted in the presence of oxyluciferin diacetate.

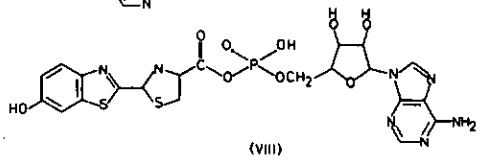
Closely bound to the product identification studies was work on the reaction mechanism. The bioluminescent reaction of the firefly requires not only luciferin, luciferase and oxygen, but also the biologically important compound adenosine-5'-triphosphate (ATP) (VII) and magnesium or divalent manganese ions. The oxidation step of the reaction that results in light emission is preceded by the equilibrium:-

$$\text{Luciferin} + \text{ATP} + \text{Luciferase} \overset{Mg^{2+}}{\rightleftharpoons} \text{E-LH}_2\text{-AMP} + \text{PP}$$

where PP is inorganic pyrophosphate and E-LH_2-AMP is the enzyme bound luciferyl adenylate (AMP = adenosine-5'-monophosphate (VIII).



(VII)



(VIII)

The second step in the reaction is the oxidation of LH_2-AMP of the complex to give the excited state which subsequently emits a photon:-

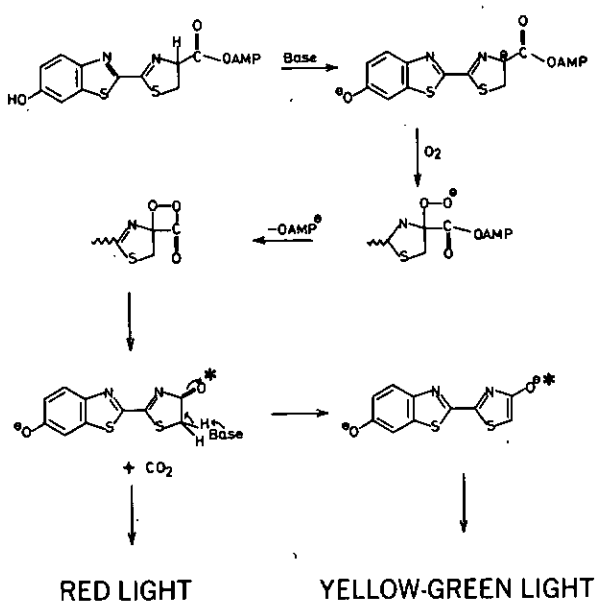
$$\text{E-LH}_2\text{-AMP} + O_2 \rightarrow \text{Products} + CO_2 + \text{AMP} + h\nu$$

Both steps are catalysed by luciferase, the first being about ten times slower than the oxidation. The reaction is severely inhibited by the formation of a dehydroluciferyl adenylate complex (L-AMP) with the enzyme [6]. This complex possesses a dissociation constant of about 5×10^{-10} with the result that the side reaction producing dehydroluciferin will effectively remove the enzyme from the light emitting system. It is found that after initiation of the luminescent reaction there is a rapid increase in the light intensity followed by a rapid decrease which tails off to a very slow decay. The slow decay is a manifestation of the ability of pyrophosphate to break up the complex of the enzyme with the inhibitor and so release the enzyme for catalysis of the light emitting reaction.

$$\text{E-L-AMP} + \text{PP} \rightarrow \text{L} + \text{E-ATP}$$

Once the isolation of luciferase and luciferin synthesis became a reality, LH_2-AMP could be synthesised and the reaction carried out from the second step. Much work has been done in this way, but beside the bioluminescent reaction information on detail of the mechanism has been sought through the chemiluminescent reaction of luciferin and its derivatives. Mechanistic interpretation through the chemiluminescent reaction is considered valid because of the match between the emission spectra of the two reactions and between the fluorescent spectra of the spent reaction mixtures.

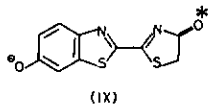
From studies of the bioluminescent system in the fifties and early sixties a pH dependence of the emission wavelength was known that had to be accounted for by any mechanism proposed. In conditions of high basicity a very



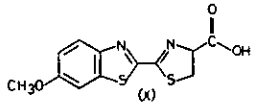
SCHEME II. *Mechanism of White et al.*

high quantum yield (1 quantum/molecule of luciferin) was obtained and the emission was yellow-green. However, with decrease in pH came a decrease in quantum yield and the emission maximum shifted to red.

In 1962 Seliger and McElroy [7] were the first to study the oxidation of synthetic LH_2-AMP in the presence of base without luciferase, and it was this system that White and co-workers [4] based their mechanism on in their paper of 1967. This paper laid the basis of mechanism, most of which is generally accepted today (Scheme II). The electronically excited state of the anion (IX) was suggested as the emitter of the observed red 6 bio-luminescence under slightly acidic conditions. Insupport of such a mechanism it was found that LH_2-AMP easily racimizes in basic anaerobic solutions and also, that the reaction was slowed by deuterium substitution at the chiral centre: both indications of deprotonation at the C-4 position. Evidence for the ionization of the phenol group came from two sources. Moretn *et al.* [8] from potentiometric and spectrophotometric evidence showed that in the pH range from 4 to 11.5 there was a single ionisation in LH_2-AMP solutions corresponding to the ionisation of the phenol group. The pKa for the phenolate of LH_2-AMP was estimated to be about 8.7 from changes in the absorption spectrum with pH. The highly fluorescent form in aqueous solutions of lucierin is $^{-}0\text{-LH}_2$ but if the compound is placed in a medium with no proton acceptors only weak fluorescence is observed. Secondly, White *et al* [9] found that the luciferin derivative (X) would yield neither green nor red chemiluminescence, only faint blue or orange, depending on the base concentration. This they attributed to there being no possibility of phenol ionisation.

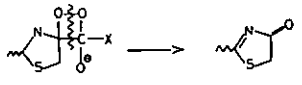


(IX)



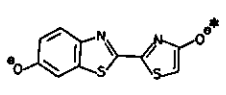
(X)

Lastly, light emission was enhanced by X being a good leaving group, as such groups reduced the possibility of decomposition of the ketodioxetane (Scheme III).

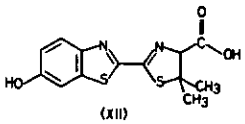


SCHEME III. *Decomposition of the ketodioxetane where X is a poor leaving group. (No light emission results from such a decomposition.)*

Although evidence was scarce at the time, as a more basic pH was required for the yellow-green emission, the dianionic species (XI) was postulated by White and colleagues as the emitter at this wavelength (Scheme II).



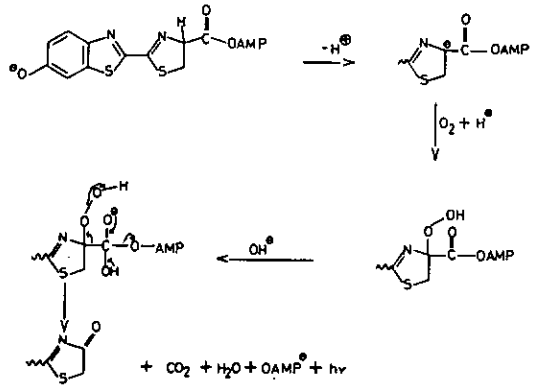
(XI)



(XII)

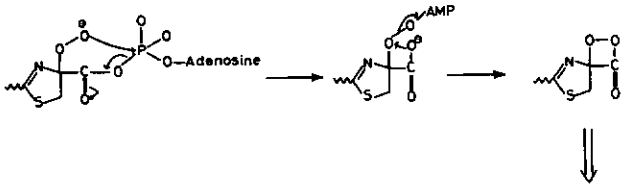
Further work by this group in 1969 [9] with luciferin derivatives supported this postulate. By use of the non-enolisable compound (XII) in which the keto form of the excited species could not convert to the enol form with subsequent loss of a proton, it was found only red chemiluminescence could be obtained irrespective of base concentration. By 1971 more evidence had been collected to support the mechanism [10]. Work on the thermal decomposition of 3,3,4 trimethyl-1,2-dioxetane had revealed an excited carbonyl singlet state was formed during the reaction that decayed by photon emission [11] as was predicted in the decomposition of the dioxetane in the luciferin reaction other chemiluminescent and bioluminescent reactions had been found to go via the dioxetane intermediate so except for one experimental result, which will be discussed later, the dioxetane path seemed well corroborated. The need for further extraction of a proton from the substrate to give the yellow-green emission was borne out by the fact that in derivatives where no proton was present at the C-5 carbon only red emission could be obtained.

Although this considerable weight of evidence had been built up in support of most steps in this mechanism, the previous year DeLuca and Dempsey [12] had run experiments the results of which, if reproducible, ruled out the ringed intermediate of Scheme II. This mechanism necessitated the inclusion of one atom from molecular oxygen in the end product carbon dioxide molecule. Studies involving ^{18}O labelling from $^{18}O_2$ were done, but no significant amounts of the heavy isotope could be found in the CO_2. Furthermore, in conjunction with these studies were ones done using ^{18}O labelled H_2) which showed take up of ^{18}O into the CO_2. In explanation of these results DeLuca and Dempsey proposed the mechanism shown in Scheme IV.



SCHEME IV. *mechanism of DeLuca and Dempsey.*

White and colleagues raised a number of objections to this possibility. Firstly, when t-butoxide was used as a base in the chemiluminescent reaction red luminescence was observed, despite the fact that cleavage of the butyl-oxygen bond as was required in the final step of this new scheme, was impossible. Secondly, under the conditions of the reaction the hydroperoxide group would be largely ionised. In defence of their mechanism, White *et al.* suggested the possibility that ^{18}O incorporated in the CO_2 could have been exchanged with the oxygens of water. In the eventuality that in carefully controlled experiments the heavy isotope was



SCHEME V. *Modification of the mechanism of White et al.*

indeed found not to be incorporated in the CO_2, they proposed a modification to their mechanism (Scheme V).

The validity of these isotopic experiemnts is still in question today. In 1975 White *et al.*[18] conducted labelling experiments to test their mechanism and with careful handling and carrying out all steps of the reaction under vacuum, they found a 66% incorporation of the heavy isotope in the CO_2. Furthermore, when only the acidification of the system (to decompose the carbonate formed from the CO_2 and the base) was conducted under vacuum, it was found 62% of the ^{18}O present in the CO_2 was "washed out". They concluded that the low incorporation reported by DeLuca and Dempsey was the result of handling such small amounts of CO_2 and that blank runs done to make correction for isotope exchange with the solvent were of no advantage because bubbling CO_2 through solutions was not the same as the gas being produced a molecule at a time in solution. The following year DeLuca and co-workers[14] repeated their experiments claiming the same results they had previously obtained: ^{18}O incorporation from $H_2{}^{18}O$ but not from $^{18}O_2$. Recently, Johnson *et al.*[15] reported labelling experiments supporting White's mechanism. Their acuum system results obtained a 75% incorporation of the heavy isotope in CO_2, and discovered that exchange of ^{18}O between CO_2 and H_2O could mean that as little as 28% of initially incorporated ^{18}O was finally detected in the CO_2.

Study of luciferin chemiluminescence has allowed probing of the substrate role in the bioluminescent system. To further our knowledge of the bioluminescent reaction much time has been spent in the study of luciferase. Firefly lanterns may glow in colours intermediate to the yellow-green of the dianion and red of the monoanion, depending on species and in some cases sex. Studies of a large number of species show the luciferin structure is the same in all cases and this points to the enzyme being the colour controlling factor. A number of factors can influence the emission wavelength of the boiluminescent reaction. Reversible shifts to the red, in the case of *P.Pyralis,* can be obtained by:–

(i) Decreasing the pH of the system.
(ii) Increasing the temperature of the system.
(iii) Carrying out the reaction of urea at normal pH.
(iv) Addition of small amounts of Zn^{2+}, Cd^{2+} or Hg^{2+} ions.

Information about the enzyme, it was hoped, would explain these observations.

Conclusions from the earlier studies to determine the molecular weight of the enzyme were that the active enzyme was an entity with a molecular weight of 100,000, comprising of two subunits [16]. However, more recent results from binding studies of dehydroluciferin to the enzyme indicated only one molecule of dehydroluciferyl adenylate was bound to each 100,000 molecular weight unit of the enzyme, suggesting asymmetry in the system. By 1974, enough evidence had been accumulated to allow McElroy and colleagues[17] to conclude that only one of the subunits in the 100,000 molecular weight aggregate was active. Both binding sites of luciferin, both of ATP and the Mg-ATP binding site are on this subunit, the differences between subunits appearing to be very small. The strong tendency for the enzyme to aggregate was considered to be the reason for the original incorrect determination of the molecular weight.

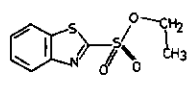
By titrating the sulphydryl (-SH) groups of the protein (enzyme) with p-mercuribenzoate (PMB) and measuring the

resulting loss of activity, DeLuca and co-workers [18] found that six to seven such functional groups existed in each molecule. In many bio-organic systems it is found that only a small fraction of the -SH groups present in the molecule are vital to its activity. To investigate this possibility in the case of luciferase an experiment was run which made use of the potent inhibiting abilities of dehydroluciferin. Study of the L-AMP/enzyme showed that the inhibitor covered only two -SH sites. By titrating the remaining sites with PMB so the protein was totally inactive and then removing the L-AMP inhibitor with co-enzyme A, almost all of the enzymatic activity could be restored to the complex: evidence that only these two -SH groups were required for activity. Investigations with dithiol inhibitors point to the two groups being arranged as a dithiol, and the long time required for dehydroluciferin to effect complete inhibition also suggests that the dithiol is "buried" within the enzyme, making interaction difficult. Low concentrations of Zn^{2+} and Cd^{2+} ions were also found to inhibit activity, but as this inhibition was accompanied by a red shift in the emission, it was thought the ions were affecting the enzyme in a way different from that of the other inhibitors. Radioactive labelling of the enzyme's active sites with (1-^{14}C) N-ethylmaleimide by Travis and McElroy [16], followed by digestion of the enzyme and degradation of the radioactive fragments to obtain the amino acid sequence around the active sites, also gave an indication that the sites covered by L-AMP and the active sites of luciferase are the same.

In an attempt to explain the yellow-green and red emitting species of bioluminescence, which they considered to be the same as those in the chemiluminescent reaction, White and Branchini[19] set out to study the results of modifying the enzyme. In the bioluminescent system the enzyme has to fulfil the role that the base plays in chemiluminescence. They therefore postulated that two basic sites on the binding enzyme were responsible for the dual ionization of the luciferin substrate. If the second of these two sites could be blocked, then only one deprotonation should occur and only the red emission should be observed. The effects of low pH and heavy metal ions on *P. Pyralis* emission, they believed, resulted from such blockage.

Attempts to modify the enzyme with large groups resulted in total inhibition, but by the use of ethyl-2-benzothiazolesulphonate (XIII), the small ethyl group could be bonded to the basic group of the enzyme (UV spectra indicated no sulphonation of the basic groups). If the enzyme was exposed to (XIII) for less than 30 seconds inhibition was reversible, but with longer incubation periods the inhibition became irreversible and a shift in emission maximum from yellow-green (560nm) to red (610nm) was observed. Reduction of the inhibition in the presence of luciferin showed the inhibitor was in competition for the same site as luciferin and therefore, that the colour change was not the result of conformational changes induced by the inhibitor binding at a different part of the protein (Conformational effects on the emission will be returned to later). They concluded from the studies that the site responsible for the second deprotonation had indeed been blocked, and consequently the system could not produce the species required for the yellow-green emission.

Apart from the four environmental factors already mentioned, there is one other factor, a structural one, which results in a red shift. Until the mid-sixties it was thought the reaction was ATP specific. About this time however, an ATP isomer and later, an LH_2-AMP analogue [23] (the structure of the modified adenosine group is given below XIV), where found that when used in the reaction yielded



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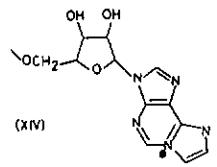

(XIV)

light, albeit at a markedly lower intensity. When the LH^2-AMP analogue, LH^2-ξ AMP, was used in the reaction, only red emission was obtained which was independent of pH. Distortion of the complex by the new structure therefore, seems to result in an inability of the proton abstracting group of the protein in interact with the substrate C-5 hydrogens, thus prohibiting the second ionization required for the yellow-green emission. A similar conclusion was reached by McElroy and co-workers [21] from studies done on the emission from the reaction using the ATP isomer (3 iso-ATP).

changes, brought about by the presence of heavy metal ions etc show the existence of two different emitting species, these two excited states alone, are not sufficient to explain the variations in emission spectrum with a single peak, not composed of a superpositioning of a red and a yellow-green emission, as is obtained in solutions of intermediate pH, for instance, but having an FWHM value and shape similar to that of a single red or yellow-green emitter.

It would appear that the observation of bioluminescence is dependent upon the interaction of substrate with particular groups of the enzyme and that the equilibrium distance between luciferin and these groups the perturbation of the complex's energy levels which in turn govern the colour observed. Seliger *et al.* [8] in 1969 put forward three further explanations for the bioluminescent emission being luciferase dependent.

(i) the environment of the site at which luciferin is bound to luciferase.
(ii) the orientation of charged groups on the enzyme relative to the bound excited product molecule.
(iii) the excited product and the adenylate group being separately bound to the enzyme, so that different luciferase molecules may allow different degrees of interaction between these two entities.

At present detailed information on the structure of the complex is not available to support or refute any of these proposals.

Lastly, a look will be taken at the enzyme's tendency to undergo conformational change during the reaction. Luciferase is one of the most hydrophobic proteins in the literature and the class of prteins to which it belongs has an unusually high affinity for compounds like ATP. It is thought an ability for the protein to "fold" around this molecule to the exclusion of water is the basis of this affinity. Two different types of study have shown that large conformational changes are undergone by the enzyme during the reaction.

Such "folding" can be detected by measurement of the ratios of tritium-hydrogen exhange in the enzyme. Exchange of hydrogen with tritiated water is almost negligible with those hydrogens bonded to carbon atoms but almost complete for hydrogens bonded to other atoms, such as oxygen and nitrogen. The ability of this second class of hydrogen to exchange is governed by the inreraction of solvent with the hydrogens and hence, by the hydrogen's environment. Measurements of the number of hydrogens exchanged by the enzyme alone, and in the presence of substrates, shows that in the latter case fewer hydrogens are in a situation where they can interact with water to allow exchange. This has been interpreted as a significant change in the protein structure to allow it to "fold" around the substrate, and it is estimated that 39% of the protein becomes inaccessible to water.

Further evidence to support the notion of large conformational rearrangement was supplied by DeLuca and McElroy [22] in 1974. Their time resolved studies of emission intensity using oscilloscope traces indicated a 25 msec lag before light emission, followed by a slow rise (0.3 sec to maximum intensity). Traces obtained from a system using synthetic LH_2-AMP and the enzyme showed the same delay sequence as the luciferin, ATP/Mg^{2+} and enzyme system, indicating the delay occurred after the initial formation of the enzyme-luciferadenylate complex. However, if

the luciferin, ATP/Mg^{2+} and luciferase were allowed to equilibrate in an oxygen-free environment, then on mixing with an oxygenated buffer solution, light emission was rapid. The inference from this experiement was that the process causing the dealy takes place in the equilibrating mixture and was therefore not evident when the oxygen was added to the solution. From the last experiment of the series, concerned with the effect of temperature on the system, came the information that a large negative entropy was associated with the slow rise, and an activation entropy for the initial lag was essentially zero, possibly resulting from the cancellation of two opposite effects.

The conclusion DeLuca and McElroy drew from these studies was that these slow steps were the result of conformational changes connected with the LH_2-AMP binding to the enzyme. The first occurs before deprotonation so that the specific proton acceptor of the enzyme is in the correct orientation with respect to the substrate so as to allow ionization. The 0.3 second rise, they think, corresponds to a conformational change after proton abstraction, but before the reaction with oxygen.

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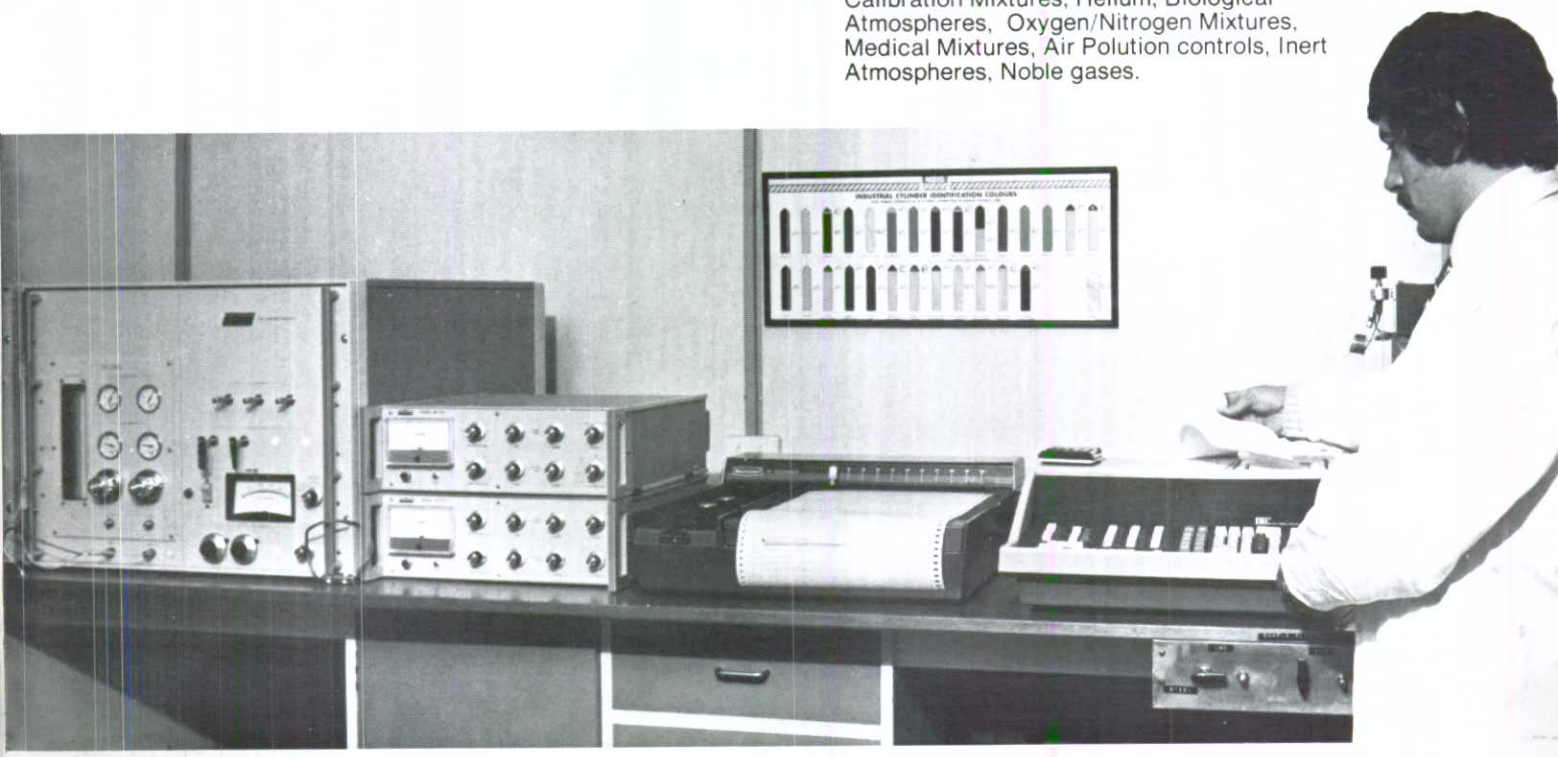

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CADMIUM IN THE ENVIRONMENT
by Pauline D. Noonan

Cadmium is toxic to many organisms. It is known, for example, to inhibit human renal function, increase the loss of calcium and compete with essential zinc ions for sites within certain protein complexes. Because of recent reports of the devastating effects of cadmium; for example the outbreak of Itai-Itai disease in Japan, and its long biological half-life it has been recommended that release of Cd to the environment be controlled. This review concentrates on the environmental cycling and accumulation of Cd as illustrated in Figure 1.

SOURCES

Natural

The earths crust contains approximately 0.15 to 0.20 mg kg^{-1} of which approximately 1500 to 2000 Mg is released each year into the environment by weathering. This amounts to 20% of that discharged by industry.

Cadmium is usually found associated with zinc in nature but also occurs as the sulfide in the rare mineral, greenockite.

Anthropogenic

Production of Cd in the western world has recently averaged 10,000 to 14,300 Mg/yr. Large quantities are released to the atmosphere for example from refining ores mostly Cu and Zn, heating scrap steel which is coated with Cd and the burning of plastics which were produced using cadmium catalysts.

Industrial countries are the major consumers, the principal uses being electroplating (35%), pigments such as yellow CdS (23%), stabilizers for polyvinyl chloride (16%) and Ni-Cd Batteries (13%).

Cadmium Concentrations in the Environment

Atmosphere

The Cd concentration in relatively unpolluted air above the Atlantic Ocean varies from 0.003 to 0.62 ng m^{-3}. However concentrations as high as 5 ng m^{-3} have been reported above rural sites rising to 50 ng m^{-3} above urban sites. In the vicinity of Pb smelting complexes ambient air concentrations of 600 ng m^{-3} and 800 ng m^{-3} have been reported.

Soils

Cadmium levels in uncontaminated soils range from 0.4 to 1.0 mg kg^{-1} while levels as high as 100 mg kg^{-1} occur for soils subjected to airborne or waterborne Cd. In the vicinity of a zinc smelter levels of 1700 mg kg^{-1} have been reported. The levels decrease with distance from smelters (Table 1).

Surface soils near roads show elevated levels of Cd arising from lubricating oils and car tyres (which contain 20-90 mg kg^{-1} rubber). Levels of 0.94 to 0.24 mg kg^{-1} in soils 8 to 32m from a road have been reported as well as levels as high as 1.82 mg kg^{-1}.

In 1975 the University of Canterbury first provided courses leading to a Certificate in Liberal Studies. The purpose of the Liberal Studies programme is to bring into the University mature students who have had some experience of non-academic life and who wish to illuminate that experience by academic study. The course offers options to the students at the same time as it ensures that any group of options will have coherence. The studies are related fairly directly to contemporary life not in order to provide professional qualification but in order to enlarge the area of informed understanding. To bring older and younger students together some classes for the course are taken from regular first-year teaching programmes. Others are specially offered by volunteers from the University teaching staff and these classes are intended to give students of Liberal Studies a sense of themselves as a group.

The Chemistry Department has offered a course for two years which deals with the chemistry of the world around us, and in particular how matter can be transformed in relation to man's practical requirements for new substances and materials. There is discussion on available raw materials, how they are changed into desired end products, and the way that new chemical processes are devised to keep pace with changes in demand and in the availability of raw materials. Topics are selected from:

> The chemical elements, basic chemistry, principles, extraction, availability, chemistry in agriculture, medicine, the home, the environment, pollution and its control and chemistry in industrial and other processes.

The students are assessed by three essays, many of which are of a high class. The following review 'Cadmium in the Environment' by Pauline Noonan, is an example. The course lecturers believe that the quality of this review is such that it warranted publication, and that the review would be of value to members of the NZIC.

J. E. Fergusson

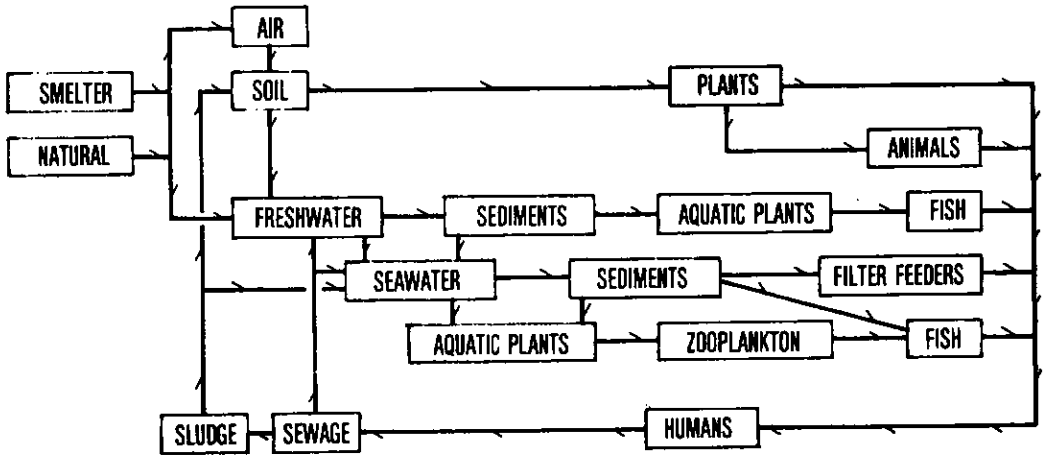

Figure 1. The cycling of cadmium through the environment.

Rock phosphates contain large amounts of Cd (31 to 90 mg kg^{-1}) and therefore superphosphate applied to a soil is a source of Cd, normally in a form readily available to plants. The application of 4.5 mg/ha of superphosphate with a Cd concentration of 38-48 mg kg^{-1} over 30 to 40 years increased the IM HCl extractable Cd five-fold.

Table 1. Cadmium Levels in Relation to Smelters.

Type of Smelter	Distance from Smelter km	Depth of sample	Cd mg kg^{-1}
Pb	5.3	0.2 cm	18
	1.1	0.2 cm	140
Cu-Zn	2.0	–	29
	43.0	–	1.6
Pb	0.4	Litter Layer	128.5
	2.0	Litter Layer	20.6

Sewage Sludge

Eighty percent of Cadmium can be removed from wastewater. The sludge containing this Cd when applied to land is potentially toxic, depending on the concentration, availability, mode of incorporation into the soil, soil moisture, cation exchange capacity, temperature, pH and crop susceptibility.

Cd levels in sewage sludge have been reported in the range of 5 to 2,000 mg kg^{-1}, but for application to arable land the concentration should not exceed 15 mg kg^{-1}. Soils that had been treated with dried sludge for 35 years showed a total concentration of 70.5 mg kg^{-1} at 0-30 cm depth.

Table 2. Distribution of Cadmium in Three Species of Vegetation in relation to Distance from Cadmium Source.

Source of pollution	Average distance of sites from smelter (km)	Plant species	Cadmium mg kg^{-1}
Zn - Pb	2.3	Mosses	10.0 - 200.0
Smelting	7.4	Mosses	2.0 - 9.9
Complex	9.8	Mosses	1.0 - 1.9
	11.3	Mosses	0.6 - 0.9
	11.7	Mosses	0.3 - 0.5
	12.5	Mosses	0.1 - 0.2
	13.2	Mosses	0
Pb smelter	0.4	Grass	9,500.0
	5.4	Grass	17.0
Pb smelter	0.4	Oak Roots	46.0
	2.0	Oak Roots	3.7

Vegetation

Plant uptake of cadmium generally ranges from 0.4 to 7% of that available and is dependent on the pH, organic matter, competing cations and plant species. Uptake by rice increased with an increase in soil redox potential, and decrease in pH. Increased uptake under low pH soil conditions will be due to the Cd^{2+} species dominating (below pH 7).

Plants differ in their ability to take up Cd, their tolerance and the distribution within a plant. Only 12 to 18% of Cd in cereal plant tops was translocated to the grain, which had a lower Cd content than any other part of the plant. Thus cereal breakfast foods grown on soils with a history of superphosphate application showed a low Cd content (0.012 to 0.036 mg kg^{-1}).

Levels of Cd in vegetation vary with distance from the source of pollution (Table 2). In a relatively unpolluted forest ecosystem, litter samples accounting for 13% of the total forest organic matter (excluding soil organic matter) contained an average of 34% of the total Cd in all the organic matter, while lateral roots which constituted 11% of the living forest ecosystem contained 28% of the Cd.

Freshwater

Cadmium levels in normal freshwater are usually around 1 mg m^{-3} while background levels, in unpolluted soft water lakes, are 0.1 to 0.5 mg m^{-3}.

Long range transport of polluted air has resulted in increased concentrations in lakes of Southern Norway compared with the north. Levels in snow from Greenland have risen from 0.03 to 0.6 mg m^{-3} in 3000 years and lake levels have risen to 10 mg m^{-3} due in part to urban and rural runoff.

High pH levels can effectively remove most of the metal from solution as insoluble cadmium hydroxide and therefore Cd was not detected in the Qishon River, Israel.

Freshwater Sediments. Agricultural runoff, domestic sewage and industrial effluent are the main sources of Cd occurring in sediments and levels ranging from 0 to 123 mg kg^{-1} have been reported. Concentrations in the sediment are found to decline with depth from 4.6 mg kg^{-1} at 0.5 cm to 0.7 mg kg^{-1} at deeper than 50 cm.

Freshwater fauna. Uptake of Cd by freshwater snails exposed to 1.3 mg kg^{-1} over 24 hrs was 0.55 mg kg^{-1} hr^{-1} while the rate of elimination over the next 24 hrs was 0.23

mg kg^{-1} hr^{-1}. Oysters containing concentrations of 1.0 mg kg^{-1}, many times greater than ambient water, have been reported.

Freshwater vertebrates. Both low levels of Cd (less than 1 mg kg^{-1}) and high levels (more than 20 mg kg^{-1}) have been found in freshwater fish. It has been demonstrated by the use of ^{109}Cd that the bulk of Cd was rapidly eliminated, while 1% was retained in rainbow trout.

Estuarine

Anaerobic salt marsh muds accumulate cadmium as CdS or as a co-precipate with FeS which leads to significant removal of Cd from contaminated seawater provided amounts do not exceed 15 mg m^{-2} yr^{-1}.

Amounts accumulated in sediments can be large and an increase from the preculture level of 0.04 mg kg^{-1} to 12 mg kg^{-1} was found in Port Phillip Bay, Australia. Remobilization of Cd from the sediment can be produced by a reduction in cation exchange or by solubilization of Cd as aqueous complexes. Hence Cd in sediments flushed from the estuary will redissolve in the water at the mouth.

Estuarine Invertebrates. The degree of pollution in an estuary can affect the levels found in organisms. The levels found in *Crassosrea gigas* are given in Table 3. Concentrations can vary with species, as shown by the *Mytilus edulis* which accumulated 6.1 to 83 mg kg^{-1} (dry wt) while the oyster *Ostreidae sp* accumulated 35 to 174 mg kg^{-1}. Values ranging from 0.3 mg kg^{-1} (dry wt) to 52.5 mg kg^{-1} of cadmium have been found in a gastropod *Melagraphia aethiops* in the Avon-Heathcote estuary of Christchurch, New Zealand.

Table 3. Levels of Cadmium in Crassosrea gigas.

Location and Year		Cadmium mg kg^{-1} (dry wt)
Knysna Estuary S. Africa	1975	3.7
Colne River U.K.	1971	4.0
Helford River U.K.	1972	2.0
Poole Harbour U.K.	1971	27.0
Conway River U.K.	1971	3.0
Menai Straits U.K.	1973	6.0
Hinkley Power Stn. U.K.	1972	40.0
Hinkley Power Stn. U.K.	1973	27.0
Langebaan Lagoon S. Africa	1974	9.0
Derwent Estuary (Tasmania)	1972	46.0 - 175.0
Tamar Estuary (Tasmania)	1972	9.0 - 84.0

The concentration of Cd in organisms is also found to be a function of their diet (Table 4).

Seawater

Based on the reported value of 0.032 mg m^{-3} as the dissolved concentration of Cd in the ocean and a volume of $1.4 \times 10^{8} m^{3}$ the oceans contain about 45×10^{6} Mg Cd. Increased levels found in coastal water (Table 5) and sounds are probably due to runoff. Cd found in surface water near dense populations and in the vicinity of chemical plants

Table 4. Cadmium concentrations in organisms from Severn Estuary and Bristol Channel.

Organisms	Cadmium levels mg kg^{-1} (dry wt)	% Crustacean in diet
Sea Snail	16.8	100
Poor Cod (*Trisopterus sp*)	8.5	80
Sand Gobi (*Gobius sp*)	3.2	10

Table 5. Levels of dissolved Cadmium in coastal waters.

Location	Cadmium mg m^{-3}
Liverpool Bay	0.27
Bristol Channel	1.38
Firth of Clyde	0.50
Eastern Irish Sea (near shore)	0.46
English Channel	0.06
Cardigan Bay	1.11
Tasman Bay	0.11
Monterey Bay, California	0.08
West Caribbean Sea	0.19
East Caribbean Sea	0.25

ranged from 2.0 to 2.9 mg m^{-3}. The 19,000 factories concentrated in a few densely populated areas in Hong Kong have led to a 180-fold increase in Cd in coastal waters (i.e. to 50 mg m^{-3}).

Seawater Sediment. It has been estimated that through geological history no more than 2×10^{17} Mg of igneous rock can have weathered in all. Thus the total Cd released by weathering would be of the order of 4×10^{10} Mg, and therefore only 0.1% of Cd released should remain in solution in the oceans. The concentration of Cd found in sediments ranged from 0.2 to 2.2 mg kg^{-1} (dry wt). Sewage entering the ocean environment is simultaneously diluted and oxidized, causing solubilization of the metals which increases their retention time in the water column and ensures a very high dilution. The 1% of insoluble CdS particles which fall to the bottom around the sewage pipe enter an anaerobic zone from which there is no remobilization because of the presence of large amounts of organic matter.

Sea Flora. The highest accumulation of heavy metals in aquatic food chains is commonly found in unicellular plants. Where uptake is primarily by absorption and is therefore a function of surface area rather than biomass, smaller cells will show higher concentrations. Plants with acid polysaccharide cell walls such as brown algae absorb metals much faster than those whose cell walls are composed of other membrane materials. Cadmium is readily accumulated by phytoplankton sometimes reaching concentration factors as high as 10^{6}. Higher concentrations occur in plankton from nearshore areas.

The levels of Cd found in seaweeds show considerable variation and may be higher than levels in the surrounding waters. *Fucus vesiculosus*, the most widely studied seaweed, shows concentrations which vary from 0.7 to 19.5 mg kg^{-1} (dry wt).

The dominant factor governing the concentration of Cd in marine brown algae is apparently the dissolved concentration in seawater because brown seaweeds (e.g. *Fucus vesiculosus*) cannot regulate their uptake.

Sea Fauna. Cadmium is concentrated to varying degrees by invertebrates, depending on species and Cd levels in their surroundings (Table 6). Euphrasids, for example, have been shown to reduce the concentration from food (Microplankton 2.1 mg kg^{-1} (dry wt)) to whole animal (0.7 mg kg^{-1} (dry wt)) although there is an accumulation in the faeces (9.6 mg kg^{-1} (dry wt)). Oysters can accumulate Cd which has been shown by the species *Ostrea edulis* which contained 53.7 mg kg^{-1} (dry wt) while the algae (*Ulva lactuca*) and the sediments in the area contained 1.4 to 3.3 and 2 to 12 mg kg^{-1} (dry wt) respectively. Adult oysters

(*Crassostrea virginica*) reared in seawater containing 5 mg m^{-3} Cd accumulated up to 10.7 mg kg^{-1} in 40 weeks. Accumulation of Cd can occur differentially in organs of invertebrates and it has been found that scallop stomachs have a unique ability to accumulate Cd.

Organisms are often able to restrict transfer of pollutants and pathogens to their offspring. The American oyster (*Crassostrea virginica*) with a body burden of 28 mg kg^{-1} (dry wt) can reduce the Cd level in its eggs to less than 1.6 mg kg^{-1} and a euphrasid was able to reduce a body burden of 0.7 mg kg^{-1} to 0.3 mg kg^{-1} (dry wt) in the eggs. Cd in the seal's (*Phoca vitulina*) foetal tissue was also almost undetectable.

Table 6. Levels of Cadmium in Mytilus edulis.

Location	Levels Cd mg kg^{-1} (dry wt)	
	Mean	Range
Mediterranean Sea (North West)	1.9	0.4 - 5.9
South West Spain and Portugal	2.7	-
California	5.0	3.0 - 7.0
New Zealand	<10	-
Derwent Estuary, Tasmania	35	-
Irish Sea, U.K.	5.1	-
Bristol Channel	18.0	4.0 - 60.0
Clyde Sea, Scotland	2.2	2.0 - 2.7
North Sea, U.K.	1.0	-
North Sea, The Netherlands	1.8	-
North Sea, Norway	3.0	-

Seawater Vertebrates. Reports suggest that most vertebrates do not show levels of Cd markedly higher than their food. This suggests that there is no important food chain effect, since high concentrations would be found in predatory and aged fish. Levels found reflect the concentrations in food, for example, the Arctic Cod was found to have a concentration of 0.6 mg kg^{-1} which could be accounted for by consumption of a diet of 20% copepods containing 2.8 mg kg^{-1} of cadmium.

As with invertebrates, vertebrates differentially accumulate Cd in various tissues (Table 7). A range of 0.001 to 0.024 mg kg^{-1} (wet wt) has been found in the edible muscle tissue of commercial fish from N.Z. waters. Higher levels found in the gurnard may be due to ingestion of sediment during feeding, although it has been reported that the livers of benthic fishes inhabiting areas with metal enriched bottom sediments, influenced by the outfall of domestic waste, have somewhat lower concentrations of Cd.

Terrestrial Animals

Cadmium can accumulate in herbivores and 10 to 15 fold increases in concentration are found. These increases are greater than those found for other elements, such as Pb or Zn. Both the liver and kidney accumulate quantities of Cd, and domestic animals when fed normal amounts of Cd (less than 0.4 mg Cd kg^{-1}), showed concentrations of 2 to 4 mg Cd kg^{-1} in the liver and kidneys. The small intestines and spleen can also accumulate Cd.

Humans.

Humans are exposed to more sources of Cd today than a century ago and Cd levels in human kidneys have risen from 15.1 mg kg^{-1} (dry wt) to 57.1 mg kg^{-1} for non-smokers. Settled floor dusts in houses have led to Cd levels of 219 μg m^{-2} while rugs contained 44 μg m^{-2} which is probably due to the rubber backing which contains 3000 mg kg^{-1} Cd. Tobacco smoking may also be an important contributor as one cigarette generally contains 1 μg Cd mostly in the form of CdO. Thus 10 to 20 cigarettes per day adds 1 to 4 μg to the body burden, which means that a smoker takes in as much Cd in smoke as a non-smoker does in food and water. This situation is reflected in the levels found in the cortex of the kidney which showed a concentration of 11 mg kg^{-1} (wet wt) in non-smokers and 24 mg kg^{-1} (wet wt) in smokers of the same age.

Corrosion of zinc-galvanised pipe constitutes a significant source of Cd in drinking water, with the maximum concentration of Cd detected in drinking water being 8.6 mg m^{-3}.

Average Cd intake via a normal diet in western countries is about 10 to 80 μg/day of which 6% is accumulated and most of the rest excreted in faeces. Reported levels of Cd in some foods are shown in Table 8.

Table 8. Levels of Cadmium in some foods.

Food type	Cadmium mg kg^{-1}
Liver of shellfish, Japan	420.0
Assorted Canned Vegetables	0.01 - 0.18
Fresh Fruit	0.01 - 0.08
Rice and Wheat (non polluted areas)	0.05
Rice (polluted areas)	0.05 - 1.0
Some seafoods	10.0 - 100.0 (wet wt)

The biological half-life of a more mobile fraction of Cd is 2.5 days while a slower component has a half-life of 15 to 20 years. The maximum tolerable intake is 60 to 70 μg day^{-1}, however as much as 180 to 390 mg kg^{-1} may be consumed in polluted areas, leading to a total body burden of 10 - 60 mg at age 50.

Table 7. Mean Cadmium Concentrations (mg kg^{-1} (wet wt)) in various organs of several species of seafish and mammals.

Species	Liver	Kidney	Muscle	Gonads	Collection Site
Common Seal (*Phoca vitulina*)	0.2 - 1.1	0.1 - 1.9	0.73	-	Coast East Anglia & West Scotland
Cod	-	-	0.003 - 0.012	-	Coastal area Southern Norway
Whiting	-	-	0.002 - 0.029	-	Coastal area Southern Norway
Herring	-	-	0.004 - 0.033	-	Coastal area Southern Norway
Black Marlin	9.2		0.9	-	Coastal area Southern Norway
Gurnard	4.23	0.12	-	0.14	East Coast of New Zealand
Hapuku	12.15	5.35	-	0.17	North Island
Kahawai	0.40	2.27	-	0.08	North Island
King-Fish	4.63	0.30	-	-	North Island
Moki	1.73	0.50	-	0.12	North Island
Schnapper	1.10	0.71	-	0.11	North Island
Tarakihi	14.70	1.67	-	0.14	North Island
Trevally	1.05	0.85	-	0.23	North Island

CONCLUSIONS

Anthropogenic release of Cd is high relative to natural release and the outbreak of Itai-Itai disease shows that Cd can be concentrated in many local environments with disastrous results. Fortunately Cd is concentrated in many non-edible organs of species used as human food and also is reduced in progeny (e.g. wheat) so that humans do not take in as much Cd as they might.

Cd is released into the air largely by smelting activities and onto the soil by the application of superphosphate and sludge. The Cd which gets into water is greatly concentrated by flora. However in higher animals a mechanism of Cd elimination appears to limit high body concentrations except in some organs.

Our knowledge on the cycling of Cd in the environment is still in a state of flux. However, the amount of work reported has increased in the last few years and thus some of the unknown factors are beginning to be resolved.

The majority of the sources used in compiling this review come from the Journal of Water Pollution Control Federation (1975 to 1977). Copies of the bibliography may be obtained from the author at a cost of 50c.

CHEMICAL PROCESSES IN NEW ZEALAND

Edited by J. E. Packer and published by N.Z.I.C. 469 pp. Paper. Price $9.50 ($8.50 to N.Z.I.C. members) + $1.00 p. and p. from the Auckland Branch.

Although chemical processes have been taught in our schools for some time, there has been little information available to teachers apart from Industry's publicity handouts. This book fills that gap, which exists in every New Zealand chemistry teachers' reference library.

This book was written as a result of an approach made by a teacher to Dr Packer at an Auckland Science Teachers Association meeting in 1975. Many chemically based industries were approached and each article was written as a joint effort between a professional chemist and a teacher. This was thought desirable for the production of articles of an appropriate standard for senior pupils. Consequently over one hundred people have contributed something to this book.

I had no idea of the large range of chemical processes that are used industrially in New Zealand until I read this book. It covers: Chemistry in agriculture, herbicides and nutrients; the pulp and paper industry; the dairy industry and dairy products; meat and wool industries, fellmongery and leather; the chemistry of baking, beer, wine and spirits; processing natural gas; water treatment; polymers and coatings; glass and ceramics; production of metals; sugar refining, soaps and cosmetics; and an assortment of other processes.

Most of the articles are detailed but easy to read. For example, the series of articles on the Kraft Pulp and Paper industry include details of the chemical processes, flow diagrams, pollution control, recycling of chemicals, quality control, by-products, etc. Because of the size of the book and the complexity of some of the chemistry I would have some doubts about letting all my students loose with it. However, it is an excellent resource book for classroom teachers who could make their own decisions about which articles to use at which level. Capable form six and seven students should find little difficulty with it.

Dr Packer has done a good job of editing what must have been a tremendous volume of material and I would recommend this book as excellent value for money for teachers of form five science and senior chemistry as well as others interested in chemical processes in New Zealand.

B. E. Hasall
Feilding Agricultural High School.

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CANCER AND CHEMICAL CARCINOGENS IN NEW ZEALAND

WILLIAM A. DENNY, BRUCE F. CAIN and LYNNETTE R. FERGUSON,
Cancer Research Laboratory,
Auckland Division, Cancer Society of NZ (Inc.),
P. O. Box 1724, Auckland.

While cancer is often considered a disease of the elderly, this viewpoint is misleading. Certainly disease incidence does climb with increasing age (Fig.1), but in this country cancer is the leading cause of death before age forty, barring fatalities resulting from accidents [1] (Table I). In industrial states generally, a male child at birth has approximately a one in four chance of developing cancer during his lifetime [2], and a one in five chance of eventually dying from this disease [3]. In New Zealand, the current death rate from cancer is one in 5.2 [1], with the disease taking an especially heavy toll among people in their most productive years (Fig.2.).

Calculation of economic cost to the community is difficult, but all who have attempted the exercise agree that in developed countries a significant proportion of resources is directed to the care and treatment of cancer sufferers [4]. Adding to this the costs of lost production, a recent American estimate[5] placed the annual costs to that country in excess of $15,000,000,000.

MAJOR CAUSES

By examining differences in cancer incidence between the families of migrants and those of the population from which they stemmed, an estimate of the effects of varying life styles, as opposed to purely genetic and racial differences, can be gauged. Similarly, changes in incidence with geographic location, local customs, occupation, etc., can also be scrutinized. It has been concluded from a large number of these studies that between 80 and 90% of human cancer incidence results from contact with exogenous factors [6-9]. There is also a formidable body of evidence suggesting that most of these factors are chemical in nature [8-9]. Such studies provide a new perspective to the problem; in the majority of cases **the disease should be considered preventable** [9]. In contrast to this evidence that cancer is largely dependent on environmental factors and is theoretically preventable, our present knowledge of the pathology of old age suggests that the majority of the other diseases of later life can only be retarded [10].

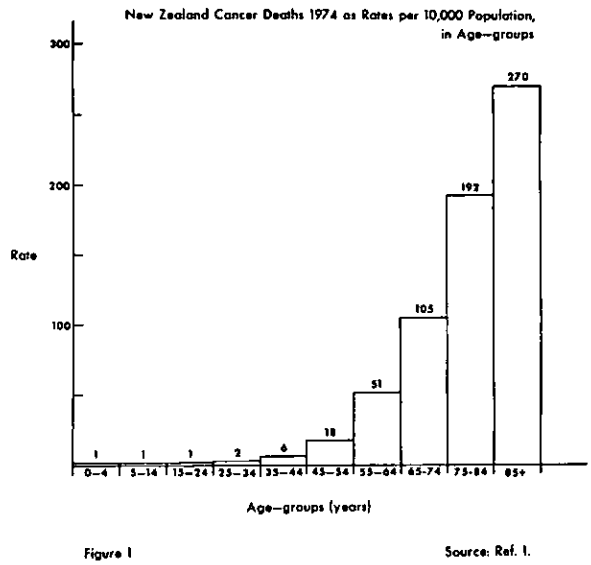

Figure 1 Source: Ref. 1.

DETECTION OF CARCINOGENS

Acceptance of the premise that the majority of human cancer incidence results from exposure to exogenous chemicals makes the detection of such agents of paramount importance, as a necessary first step towards their control. There are three broad methods available.

(1) Epidemiology. The only unequivocal evidence of human carcinogenicity of specific chemicals is that obtained from epidemiologic studies of exposed human populations. However, it is often difficult to obtain sufficiently large matched populations which respectively have, and have not, been exposed to a particular chemical. The statistical significance of differences in cancer incidence between two groups is a complex function of background frequency of the tumour type, change in incidence, and the time of study involved. As a guide, for a less common type of cancer providing 50 cases a year in a population, an annual rate of increase of 26% a year would be necessary in order for it to be recognized as statistically significant at the 1% level in a five-year study [11]. For rare types of cancer, such as cancer of the eye, a population of 7-10 million would be needed to yield 50 such cases a year. Thus the epidemiologic detection of carcinogenic chemicals has been confined to compounds encountered occupationally, where the increase in incidence can be very high, and been conducted in countries with large populations available for study. For most of the chemicals in our environment, it may be impossible to ever obtain satisfactory evidence of carcinogenicity in man.

(2) Animal Screening. Animals provide much more homogeneous and controllable populations. Nevertheless, animal screening systems have their own particular drawbacks. For example, doses of drugs which provide equivalent responses in different animal species appear related to the relative surface area of these different animals, and not to their relative weights. Thus drug doses for the most commonly employed animal, the mouse, must be on average 7 times greater on a weight basis (mg/Kg) than doses used to gain the same response in humans. In mice, which have a 2-year lifespan, we must try to gauge what might happen in a human population when there is the opportunity of an exposure time 10 to 20 times longer. Additionally, for economic reasons, relatively small groups of animals (say, 50 of either sex) are used, and for statistical significance the change in cancer incidence must be greater than approximately 10% [12]. These three factors; species difference in equivalent drug dose, marked differences in exposure time, and necessary high response level demand that relatively massive doses of chemicals be employed in animal studies. Most animal carcinogenicity screening tests employ a top dose level which is close to the maximum which will be tolerated, and a further group receives half this dose. While use of high levels is necessary, some hesitation in accepting the results of such studies is inevitable. High doses can, for example, overwhelm detoxification mechanisms which may act satisfactorily at lower levels.

Despite criticisms, compounds known carcinogenic in man all prove carcinogenic in animals, albeit at higher dose levels. Nothing is known of the reverse proposition, whether all compounds carcinogenic in animals are also carcinogenic in man. Evidence for the latter point can never be ethically obtained (See Table II).

While deceptively simple, animal screening tests for carcinogenicity are time-consuming and extremely expensive. The painstaking safeguards and pathological examinations necessary require an average of 40 months work and $100,000 – $150,000 (1975 costs) per chemical examined [12]. At the present world screening rate it would take centuries to examine all the chemicals already released into the biosphere, let alone keep up-to-date.

As previously stated, for statistical significance in animal studies the absolute cancer incidence must be above 10%. Between the limits of 100% and 10% incidence, dose-response relationships can be derived from animal

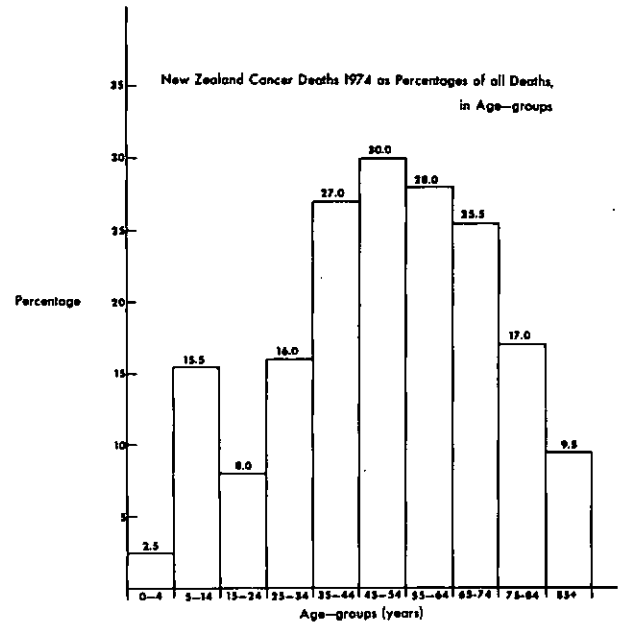

Figure 2 Source: Ref. 1.

experiments. To extend these relationships to lower percentage incidences more in line with human levels would require an exponential increase in the numbers of animals involved. The massive costs associated with such 'mega-mouse' experiments provides a considerable deterrent to their ever being undertaken. Yet such experiments demand serious consideration, since demonstration of a linear relationship between dose and incidence means that any exposure to a carcinogen is associated with some incidence, and therefore some risk; i.e. there would be no 'safe' level of exposure to a carcinogen. Unfortunately, classical methods of toxicology cannot help to settle this question; initial carcinogenic events take place at an unseeable molecular level.

Quantitation of human risk from the results of animal screening tests is not possible at present. In the absence of any evidence to the contrary, current opinion is that it would be extremely unwise to assume that 'safe threshold levels' exist for chemical carcinogens. This is the explicit basis of the famous 1958 Delaney Amendment to the US Food, Drug and Cosmetic Act, a law which imposes a zero tolerance level in food for any compound which has been shown to cause cancer in animals.

Table I. Leading Causes of Death in NZ, 1974.

	Age–Groups (years)								
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	over 80
1.	Neonatal & Congenital 650	Accidents 331	Accidents 318	Accidents 182	Circulatory 498	Circulatory 1259	Circulatory 2730	circulatory 3827	Circulatory 4140
2.	Respiratory 222	Cancer 45	Cancer 58	Cancer 117	Cancer 345	Cancer 780	Cancer 1413	Cancer 1419	Respiratory 879
3.	Accident 198	Circulatory 21	Circulatory 43	Circulatory 111	Accidents 141	Accidents 163	Respiratory 311	Respiratory 558	Cancer 783
4.	Infective 52	Respiratory 19	Respiratory 18	Respiratory 23	respiratory 58	Respiratory 154	Accidents 173	Accidents 205	Accident 364
5.	Cancer 49	Nervous System 19	Nervous System 18	Nervous System 14	Digestive 51	Digestive 94	Digestive 134	Digestive 176	Digestive 169

Source: Ref. 1

(3) Mutagenicity Tests. Over the last few years, many ingenious in vitro tests have been devised which allow ready detection of mutagenesis, following chemical damage to the DNA of particular organisms. There is much evidence [13] that somatic mutation is the primary event by which chemicals transform normal cells into cells capable of malignant growth, and thus that mutagenic chemicals have the capability to be carcinogens also. The most widely employed and studied mutagenicity tests employ genetically-selected bacterial Salmonella strains developed by Ames [14]. These in vitro tests are simple, rapid and inexpensive, lacking the major disadvantages of the epidemiologic and animal screening methods. With the recognition [15] that most chemical carcinogens are metabolized in vivo to electrophilic 'ultimate carcinogens', inclusion of activation systems in the bacterial mutagenicity test have made them good predictors of carcinogenicity. Thus, studies of animal carcinogens in different laboratories show that between 75 and 90% of such compounds are mutagenic [14]. All of the chemicals known to be human carcinogens from epidemiologic studies are active in mutagenicity assays. Conversely, chemicals first found to be mutagens have on later testing been shown to be animal carcinogens [14]. Although the correspondence is not perfect, it is now reasonable to suggest that a compound active as a mutagen has a high probability of proving to be an animal carcinogen. (See Table II).

The development of these rapid and inexpensive tests is of great significance; it will provide a method for testing the many thousands of new chemicals which enter the commercial market throughout the world each year. The mutagenicity tests also provide extremely flexible research tools. Little is known about the possible interactions of two or more weakly carcinogenic compounds; whether these together provide a greater than additive, synergistic effect or whether they will antagonize one another. Also, chemicals tested in carcinogenicity assays are usually as pure as possible, in the interests of scientific rigour, whereas commercial samples of the same chemical may not have the same degree of purity, and the impurities present may have effects of their own. Nor do studies with pure substances relate to shelf samples after prolonged or inadequate storage, after oxidation and photolysis in air and sunlight, or after metabolic conversion in a plant or animal. Use of mutagenicity assays allows rapid monitoring of all these possible interactions.

It must be remembered that, to induce cancer, carcinogens must be ingested or in some way make contact with susceptible target cells in the body. Thus the possible routes of administration such as food, air and water supplies are prime areas for which mutagenic test assays should be developed. Such research is being actively pursued by one of the authors (LRF).

EFFECTIVE EXHANGE OF INFORMATION

The impetus provided by mutagenicity assays has made both the animal screening and epidemiologic studies more cost effective by concentrating on suspect chemicals. The expanded research effort, together with the preselection of chemicals by mutagenicity tests before beginning expensive animal studies, has lead to an increased rate of detection of chemicals which show carcinogenic effects in animals. The continual reporting of such results in the press is leading to the popular opinion that, by giving sufficiently large doses to a range of animals, scientists will ultimately show that any chemical is an animal carcinogen. **This dangerously misleading idea is just not correct.** Examination of random selections of chemicals demonstrates that mutagenic potential is a relatively rare property; only 1-2% of such selections prove positive [14]. In the expectation that this small percentage is a reflection of the numbers of carcinogens in these random samples, the prospect of detecting, limiting and eventually replacing carcinogens in our environment appears feasible. A logical, economical three-tier approach to the detection of such chemicals would be:

screen employing mutagenicity tests

↓ positives

examine in animal screening systems

↓ positives

examine human populations exposed to high levels of chemical for epidemiological evidence of increased cancer incidence

Figure 3

With more rapid progress, the chances of needless duplication of scientific effort has also increased. Only by effective communication and collaboration with international groups can this be avoided. The International Agency for Research on Cancer (IARC) was founded on such collaboration and publishes reports, which have been evaluated by experts from many countries. Cross communication between the many laboratories involved in mutagenicity screening also furnishes reams of reports. Within this torrent of information lies the means of categorising various chemicals and deciding what precautions in labelling, transport, handling, use and disposal should be taken. While computer technology assists those interested, such as this laboratory, in keeping up with the information there is a formidable problem of communication within NZ. How many chemists are aware of the carcinogenic or mutagenic potential of all the intermediates and products in their immediate responsibility?

Employers and manufacturers must also face the legal problems attendant on unwitting exposure of their workforce or customers to carcinogens. The recent $40,000,000 settlement to asbestos workers in the US courts provides emphasis to this problem.

LEGISLATION

Faced with the evidence that cancer is a largely preventable disease if the causative agents can be removed from the environment, and that the means for the rapid and inexpensive detection of such chemical agents is now available, legislation to control exposure to chemical carcinogens is being strengthened in many countries. Many problems associated with carcinogenic chemicals are considered in poison and hazardous substances legislation, where toxic, corrosive, inflammable, explosive and other short-term dangers are regulated. However, there is now recognition that the insidious, long-term effects of exposure to low levels of chemical carcinogens requires special consideration. Although no two countries consider carcinogens in identical fashion, most current international discussion centres on a three-tier system embracing the features of Fig. 3 [16]. The descending tiers of this figure reflect increasing degrees of surety that the chemical considered is a human carcinogen. For example, the

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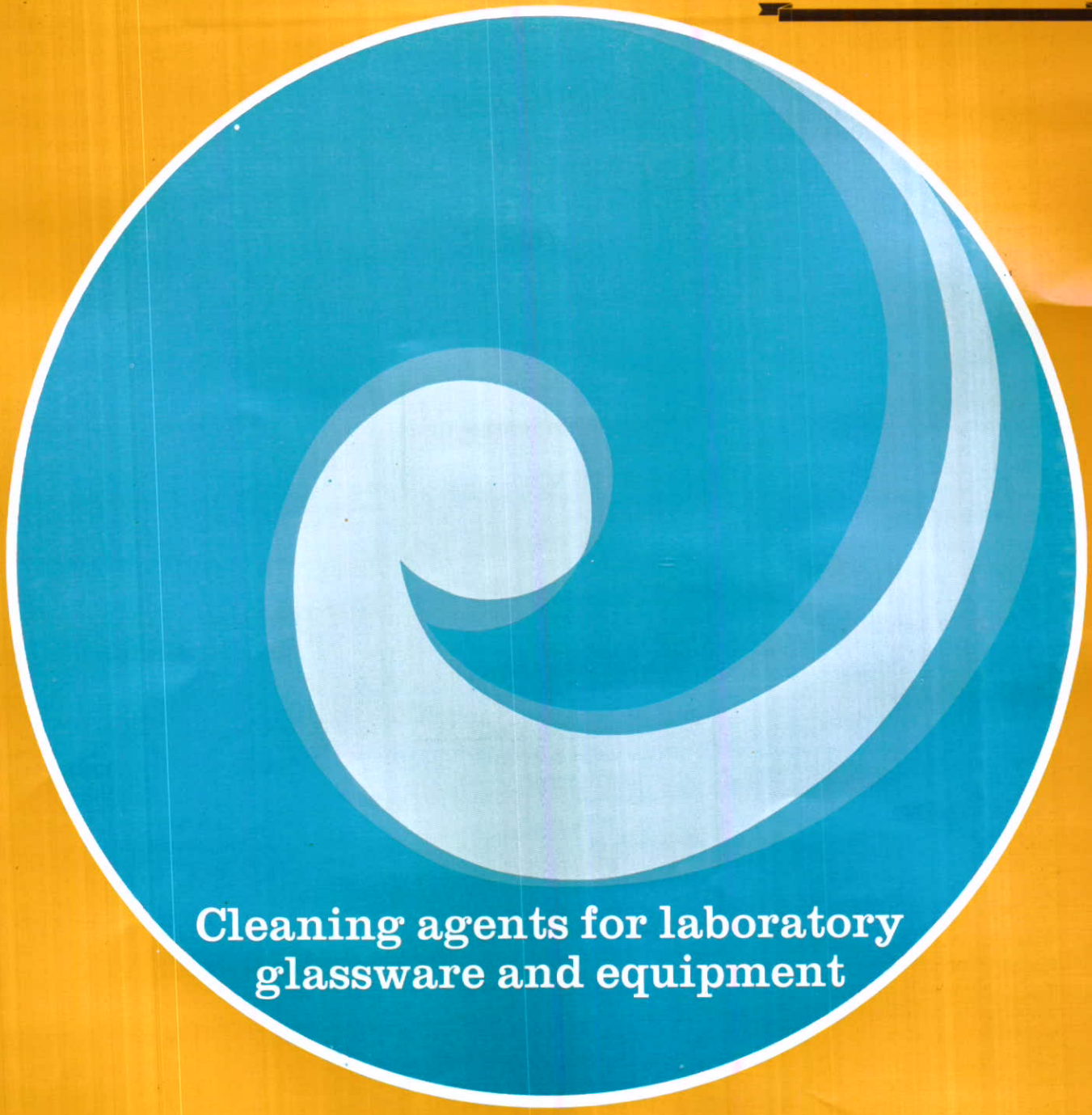

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Table II Classification of Chemicals According to Carcinogenic and Mutagenic Potential[a].

Category I (Human Carcinogens)	Category II (Animal Carcinogens)	Category III (Mutagens, in Ames test)
benzidine and salts	benzidine and salts	benzidine and salts
2-naphthylamine	2-naphthylamine	2-naphthylamine
4-aminobiphenyl	4-aminobiphenyl	4-aminobiphenyl
auramine	auramine	*b*
magenta	magenta	magenta
bix chloromethylether	bis chloromethylether	bis chloromethylether
2-propiolactone	2-propiolactone	2-propiolactone
vinyl chloride	vinyl chloride	vinyl chloride
benzene	benzene	benzene
aflatoxin B_1	aflatoxin B_1	aflatoxin B_1
stilbestrol	stilbestrol	*b*
arsenic and salts	arsenic and salts	*c*
nickel and salts	nickel and salts	*c*
chromium and salts	chromium and salts	*c*
cadmium salts	cadmium salts	*c*
asbestos (some forms)[d]	asbestos (some forms)[d]	*d, e*
(3,4-benzpyrene)[f]	many polycyclic hydrocarbons	many polycyclic hydrocarbons
(3,3'-dimethoxybenzidine)[f]	3,3'-dimethoxybenzidine	3,3'-dimethoxybenzidine
(3,3'-dichlorobenzidine)[f]	3,3'-dichlorobenzidine	3,3'-dichlorobenzidine
(4-nitrobiphenyl)[f]	4-nitrobiphenyl	4-nitrobiphenyl
(N-nitrosodimethylamine)[f]	*many N-nitrosocompounds*	*most N-nitrosocompounds*
(chloramphenicol)[f]	chloramphenicol	chloramphenicol
	dibromochloropropane	dibromochloropropane
	ethyleneimine	ethyleneimine
	benzyl chloride	benzyl chloride
	ethylene dibromide	ethylene dibromide
	2-acetylaminofluorene	2-acetylaminofluorene
	1,3-propanesultone	1,3-propanesultone
	2,4-diaminotoluene[g]	2,4-diaminotoluene
	p-phenylenediamine[g]	*p*-phenylenediamine
	2-nitro-*p*-phenylenediamine[g]	2-nitro-*p*-phenylenediamine
	4-nitro-*o*-phenylenediamine[g]	4-nitro-*o*-phenylenediamine
	4-amino-2-nitrophenol[g]	4-amino-2-nitrophenol
	beryllium and salts	beryllium and salts
	saccharin	saccharin
	metronidazole	metronidazole
	niridazole	niridazole
	proflavine	proflavine
	DDT	*h*
	polychlorinated biphenyls	*b*
	phenobarbital sodium	*b*
	thiourea	*b*
	thioacetamide	*b*
	safrole	*b*
	hexamethylphosphoramide	*h*
	p-dioxane	*h*
	trichloroethylene	*h*
	chloroform	*h*
	diazomethane	*h*
	dimethyl sulphate	*h*
		acriflavine
		sodium azide

a The Table is not a comprehensive list; although it is believed that all the proven human carcinogens are included, the number of compounds possessing animal carcinogenicity or mutagenic properties runs into at least many hundreds.

b These compounds were negative in the Ames test; data for other types of mutagenicity tests not available.

c No data for the Ames test; compounds show positive in a DNA synthesis test, Ref. 18.

d Especially crocidolite, chrysotile and amosite.

e Negative in Ames test, but cause chromosomal changes in mammalian cells, Ref. 20.

f Not proven as a human carcinogen, but suggestive epidemiological evidence available.

g Common constituents of hair dyes, see Ref. 19.

h No data available.

NZIC Bulletin

No. 18 **10 December 1978**

Edited by Dr L. K. Creamer, N.Z. Dairy Research Institute, Private Bag, Palmerston North.

FINAL ISSUE

This is the final issue of the NZIC Bulletin. From February next year the material that has appeared in the bulletin: branch notes, meeting notices, etc. will again appear in our journal, **Chemistry in New Zealand.** The editor for the journal will be Stan Brooker, to whom all editorial correspondence shall be directed (c/o Tricom, Box 9512, Auckland) from now on.

SPECIAL GENERAL MEETING

At the request of the 1978 Annual General Meeting of the NZIC, I hereby give notice that a Special General Meeting of the Institute will be held in the 5th Floor Seminar Room, Department of Chemistry, University of Auckland, on Tuesday, 23 January, 1979 (during the ANZAAS Congress), at 1.30 p.m.

BUSINESS

To discuss "The Role of the N.Z.I.C. and Society", an article published in *Chemistry in New Zealand* 41 (August) 1978 and any other matters members wish to raise.

J. G. Fletcher, General Secretary.

STAN BROOKER – NZIC EDITOR 1979/80

NZIC stalwart Stan Brooker was elected Editor of the Journal for 1979/80 at a special meeting of Council held during the 1978 Mini-Conference in August. He will take over from Dr Lawrie Creamer whose term expires at the end of 1978 and who did not offer himself for re-election. The Institute is very grateful to Lawrie for his magnificent effort in editing and producing two major publications – the Bulletin and the Journal.

His successor is no newcomer to editorship having previously been Editor of the Journal and Consultant Editor for Food Technology in New Zealand for 15 years.

INDUSTRIAL CHEMISTRY GROUP TO BE FORMED

The 1978 Annual General Meeting resolved to recommend the establishment of an Industrial Chemistry Group within the Institute.

Members who would like to join the group (no extra fees payable) should write to the General Secretary, Box 1926, Christchurch. An election of officers of the Group will be held at the General Meeting to be held at the ANZAAS meeting in January 1979.

ANZAAS – Chemistry Section

Monday 22

11.00
Presidential Address: Dr A. J. Ellis, Chemistry Division, D.S.I.R. "Chemistry 1984: design or evolution".

2.00-5.30
Intersectional Symposium: Toxic Elements in the Environment – I. Featured Speaker: Professor D. Bryce-Smith "Environmental heavy metals and their role in disorders of personality, intellect, behaviour and learning ability in children."

Tuesday 23

9.00-10.00
Plenary lecture: Professor J. P. Collman "Synthetic Analogues of the Hemoproteins".

10.00-12.30
Concurrent sessions of contributed papers:
I Co-ordination and Metal-organic Chemistry
II Organic Chemistry
III Electrochemistry & Physical Chemistry.

1.30-2.30
NZIC Extraordinary General Meeting.

Evening
Section wine and cheese function.

Wednesday 24

9.00-10.00
Plenary lecture: Professor D. Bryce-Smith lecture on organic photochemistry.

10.00-12.30
Concurrent sessions of contributed papers:
I Co-ordination and Metal-organic Chemistry
II Organic Chemistry
III Electrochemistry.

11.00-12.30
Poster session I.

Afternoon
Clean Air Society of Australia and New Zealand special meeting with Professor D. Bryce-Smith followed by branch AGM.

Thursday 25

9.00-10.00
Intersectional Symposium: Toxic Elements in the Environment – II. Featured speaker: Professor H. Bloom "Mercury and Cadmium in the marine environment". (This symposium continues until 1.00 p.m.)

10.00-12.30
Concurrent sessions of contributed papers:
I Applied and Industrial Chemistry
II Electrochemistry
III Radiation Chemistry.

2.00-3.00
Interdisciplinary lecture: Dr G. A. Sklovsky "So what's new? – Information for chemists in New Zealand and Australia in 1979".

Friday 26

9.00-10.00
Plenary lecture: Mr D. F. Sangster "Radiation in Science and Industry".

10.00-12.30
Concurrent sessions of contributed papers:
I Applied and Industrial Chemistry
II Radiation Chemistry.

11.00-12.30
Poster Session II.

BRANCH NEWS

AUCKLAND

Branch news:

The annual student lecture (for students at A.T.I. and Auckland University) was given by **Dr Ashley Wilson** of New zealand Forest Products on 20 September. Dr Wilson's topic was "How to Succeed in Business by Really Trying".

On the 25 September a group travelled to Warkworth for a guided tour over the satellite earth station.

The branch organised a two-day Chromatography Symposium on the 11th and 12th October at the Secondary Teacher's College. This included lectures, times of discussion and comparing systems, and various trade displays.

Mr N. G. Thom was the speaker at a meeting on 16th October when the subject was "Two Decades of Air Pollution Control". In his illustrated address Mr Thom surveyed the developments that have occurred in emission testing and pollution monitoring and reviewed some of the potential problems that urban areas such as Auckland may be facing.

At this meeting initial discussions were held concerning the formation of an industrial chemistry specialist group within the N.Z.I.C.

The final meeting of the year will be the Branch AGM on 16 November. This meeting will include an address from **Dr R. E. Parker,** Secretary and Registrar of the Royal Institute of Chemistry, London.

A large number of orders for copies of the Chemical Processes Publication have been received and a second edition has been ordered.

The programme for the Chemistry Section of the ANZAAS Congress to be held in Auckland in January 1979 has been finalised. Over 50 papers are to be presented either in oral or poster form.

MANAWATU

Branch Meeting:

At the Branch AGM on 16 October, committee members elected were: Chairman: **Dr Andrew M. Brodie,** Secretary: **Dr David R. Husbands,** Treasurer: **Dr Ken R. Whittle,** committee: **Dr Graeme G. Midwinter, Dr Rex S. Humphrey, Dr Geoff A. Lane** and **Dr David A. D. Parry,** Branch Editor: **Dr Cecil B. Johnson. Dr Lawrie K. Creamer** is also a member of the committee (ex officio, past-chairman) and he has been elected Branch Delegate.

The branch subscription for members was increased to $5, with a refund of $2 if the account is paid by 31 August. In future, accounts will be sent and subscriptions collected by a centralised system based at Christchurch.

Congratulations were extended to **Dr Wayne B. Sanderson** on his election to Fellowship of the Institute, **Dr Graeme B. Russell** on being awarded the I.C.I. Prize for excellence in research and **Dr Richard P. Garland** on being awarded the ICI-TVL Industrial Chemistry Prize.

The Chairman's Address was given by **Dr Lawrie K. Creamer** on "Protein Breakdown During Cheese Ripening". Dr Creamer described the stages in cheesemaking and different rates of hydrolytic degradation of casein components during ripening. The latter was illustrated by electrophoretic patterns of proteins and their polypeptide breakdown products in various cheeses. The application of this protein fragmentation to a bitterness problem in some cheeses, that is related to the formation of specified peptides, was discussed.

Massey University:

Dr V. F. Larsen (Biotechnology Department) was recently awarded a research contract from the N.Z. Energy Research and Development Committee to investigate fermentation technology for ethanol production.

The International Conference on Fibrous Proteins: Scientific, Industrial and Medical Aspects will be held at the University during 12-16 February 1979. Reviews on selected areas of fibrous protein research will be given by scientists from Great Britain, United States, West Germany, Australia and New Zealand. For further details, contact the organising secretary, **Dr David A. D. Parry** (department of Chemistry, Biochemistry and Biophysics).

Dr David R. Husbands recently returned from overseas leave in the School of Biochemical and Physiological Sciences at Southampton University, England. Dr Husbands worked with **Prof. T. G. Taylor** and **Dr P.G. Burstyn** on the effects of feeding diets containing high levels of fat or fibre on blood pressure in rabbits. He investigated changes in the blood chemistry of rabbits whose blood pressure increased when their diet contained a large proportion of energy in the form of fat and decreased when fed on a low fat high carbohydrate diet. Work in this area will continue.

Recent publications from the Department of Chemistry, Biochemistry and Biophysics include: R. R. Brooks and C. C. Radford, Nickel Accumulation by European Species of the Genus Alyssum, Proc. Roy. Soc. (London) Section B, **200** 217 (1978), M. J. Hardman, J. H. Coates and H. Gutfreund, Pressure Relaxation of the Equilibrium of the Pig heart Lactate Dehydrogenase System, Biochem. J., **171** 215 (1978), F. Malaisse, J. Gregoire, R. R. Brooks, R. S. Morrison, and R. D. Reeves, **Aeolanthus biformifolius:** A Hyperaccumulator of Copper from Zaire, Science, **199** 887 (1978). W. S. Hancock, C. A. Bishop, R. L. Prestidge, D. R. K. Harding and M. T. W. Hearn, High-Pressure Liquid Chromatography pf Peptides and Proteins II. The Use of Phosphoric Acid in the Analysis of Underivatised Peptides by Reversed-Phase High-Pressure Liquid Chromatography, J. Chrom. **153** 391 (1978). W. S. Hancock, C. A. Bishop, R. L. Prestidge, D. R. K. Harding and M. T. W. Hearn, Reversed-Phase, High-Pressure Liquid Chromatography of Peptides and Proteins with Ion-Pairing Reagents, Science **200** 1168 (1978). W. D. Hancock, C. A. Bishop, R. L. Presidge and M. T. W. Hearn, The Use of High Pressure Liquid Chromatography (hplc) for Peptide Mapping of Proteins IV, Anal. Biochem. **89** 203 (1978). D. A. D. Parry, Fibrinogen: A Preliminary Analysis of the Amino Acid Sequences of the Portions of the , and chains Postulated to Form the Interdomainal Link Between Globular Regions of the Molecule, J. Mol. Biol. **120** 545 (1978) and D. A. D. Parry and A. S. Craig, Collagen Fibrils and Elastic Fibres in Rat-Tail Tendon: An Electron Microscopic Investigation, Biopolymers **17** 843 (1978).

D.S.I.R. – Plant Physiology Division:

Dr P. Grattan Roughan is on leave at the University of California. He will be spending six month periods with **Prof. B. J. Mudd** in the Department of Biochemistry at Riverside, **Prof. H. Beevers** in the Department of Biochemistry at Santa Cruz and **Prof. J. M. Lyons** in the Department of Vegetable Crops at Davis.

Some recent publications from the Division include: C. R. Slack and P. G. Roughan, Rapid Temerpature Induced Changes in the Fatty Acid Composition of Certain Lipids in Developing Linseed and Soya-Bean Cotyledons, Biochem. J. **170** 437 (1978). C. R. Slack, P. G. Roughan and N. Balasingham, Labelling of Glycerolipids in the Cotyledons of Developing Oilseeds by [1-^{14}C] Acetate and [2-^{3}H] Glycerol, Biochem. J. **170** 421 (1978) and P. G. Roughan, R. Holland and C. R. Slack, Generation of Phospholipid Artefacts During Extraction pf Developing Soybean Cotyledons With Methanolic Solvents, Lipids **13** 497 (1978).

Applied Biochemistry Division:

A symposium, organised by **Dr Rex Gallagher** and chaired by **Dr Cam S. W. Reid,** on "Mycotoxins: The World Scene and New Zealand" was recently held at Massey University. The principal speaker, **Prof. Benjamin J. Wilson** of Vanderbilt University, Nashville, Tennessee, U.S.A., spoke on chemically related potent lung toxins produced by moldy sweet potatoes and the ornamental plant **perilla frutescens.** Researchers from various government departments presented papers on their aspects of mycotoxin research and surveillance in New Zealand. The symposium concluded with a general discussion of mycotoxin problems.

Recent publications from this department include: D. R. Body and R. P. Hansen, The Occurrence of C13 to C31 Branched-Chain Fatty Acids in the Faeces of Sheep Fed Ryegrass, and of C12 to C34 Normal Acids in Both the Faeces and the Ryegrass, J. Sci. Food Agric. **29** 107 (1978), R. P. Hansen and Z. Czochanska, Fatty Acid Composition of the Subcutaneous Fats of Lamb Fed 71% Barley Grain, and a Comparison with those of Lambs Grazed on Pasture, or Fed Higher Levels of Barley Grain, N.Z. J. Sci. **21** 85 (1978), R. T. Gallagher, R. G. Keogh, G. C. M. Latch and C. S. W. Reid, The Role of Fungal Tremorgens in Ryegrass Staggers, N.Z. J. Agr. Res. **20** 431 (1977), R. T. Gallagher and G. C. M. Latch, Production of the Tremorgenic Mycotoxins Verruculogen and Fumitremorgin B by **Penicillium piscarium** Westling, Appl. Environ. Microbiol. **33** 730 (1977). L. P. Ruiz Jr., Alkaloid Analysis of "Sweet" Lupin Seed by GLC, N.Z. J. Agr. Res. **21** 241 (1978), R. M. Greenwood and N. O. Bathurst, Effect of Rhizobial Strain and Host on the Amino Acid Patterns in Legume Root Nodules, N.Z. J. Sci. **21**, 107 (1978) and A. R. Cashmore, M. K. Broadhurst and R. E. Gray, Cell-Free Synthesis of Leaf Protein: Identification of an Apparent Precursor of the Small Subunit of Ribulose-1, 5-Biphosphate Carboxylase, Proc. Natl., Acad. Sci. U.S.A. **75** 655 (1978).

contributed by
Dr Cecil B. Johnson.

WELLINGTON

Branch News:

The branch A.G.M. in October resulted in the following officers for 1979. Chairman: **Dr J. D. B. Fatherstone (C.I.T.); Secretary: Dr D. Bibby** (D.S.I.R.); Treasurer: **Dr D. Buisson** (Industrial Processes Division, D.S.I.R.); Council Delegate and Branch Editor: **Dr B. Halton** (V.U.W.). The A.G.M. was followed by the annual Mellor Lecture given this year by **Professor R. J. Ferrier** (Victoria University) on "A Carbohydrate Chemist Looks at Inorganic

Chemistry". This well presented lecture illustrated the dependence of carbohydrate chemistry on the interaction of both macromolecules and simple compounds with inorganic species.

V.U.W.:

Drs David Weatherburn and **Jim Johnston** have returned from profitable leaves at Leeds University and U.K.A.E.A. (Harwell), respectively.

C.I.T.:

Dr J. D. Featherstone (Pharmacy School, C.I.T.) and **Mr D. G. Nelson** (Chemistry Department, V.U.W.) recently spent two weeks in Australia primarily at Chemical Physics section of C.S.I.R.O. in Melbourne, using the technique of high resolution lattice imaging to study several dental enamel samples and related synthetic apatites. The visit was funded largely by Medical Research Council. Dr Featherstone gave lectures in Melbourne and Adelaide on various aspects of the chemistry of dental decay. **Dr D. R. Gowley** (University of Nebraska) is currently on sabbatical leave in the School. His experience in the relationship of clinical pharmacy to the basic sciences has stimulated much discussion within the School.

Wellington Polytechnic:

Mr Ross Fletcher of Chemistry Division has been awarded a Wellington Polytechnic Diploma in Applied Science. The Diploma Course involves two years part-time study of a work based problem at post New Zealand Certificate level. Mr Fletcher's course culminated in the presentation of a thesis entitled: "Some Studies of the High temperature Chemistry of Cement Clinker Forming Reactions", the essential results of which are to be published in *Thermochimica Acta*.

D.S.I.R., Chemistry Division:

Dr G. Leary (Group Leader, Food, Natural Products and Information Sections) returned early in November from eighteen months spent at the Swedish Forest Products Research Laboratory in Stockholm. **Dr G. Gainsford** is spending two months working in the X-ray Crystallographic Section at the Australian National University in Canberra, and **Mr A. Mahon**, (Geothermal Section at Wairakei) is visiting Indonesia for a month as part of a regular series of visits. **Dr D. J. Hannah**, formerly of the Chemistry Department at Otago University, has recently joined the Fodd Section and **Miss J. L. Hendry**, a graduate of the University of Aberdeen, who has also completed a course in Forensic Science at the University of Strathclyde, will be joining the forensic section for six months from the beginning of November.

OTAGO

Chemistry Department:

Dr K. Grime has resigned his position to take up an appointment at the University of Denver, Colorado.

Professor C. Knobler and his wife **Dr C. Knobler**, Chemistry Department U.C.L.A. gave a seminar in the department during their visit.

Professor D. Buckingham had a memorable experience in a Moscow hospital when he took ill after his lecture there. It prevented him from giving his plenary lecture at the International Conference in Co-ordination Chemistry in Prague.

Nutrition Department:

Mr Peter Chappell, Cereal Development Manager of Cropper-N.R.M. Auckland, visited the Faculty of Home Science and presented a seminar on starch products and a lecture on the milling of cereal grains.

contributed by
S. G. Gray

OBITUARY

HERBERT LESLIE LONGBOTTOM, C.B.E. (1964), B.Sc. (Melbourne), F.N.Z.I.C., (1967), Honorary Fellow (1973).

He was born on 3 October 1895 and following graduation worked as a pharmaceutical chemist before proceeding to Britain on munitions work at Gretna Green and later at Avonmouth in the 1914-18 war. Returning to Australia he was appointed as chemist with the Forest Products Division of C.S.I.R.O., and joined Michaelis, Hallenstein and Company Pty in 1921 coming to Dunedin to Glendermid Limited in 1930 and was Managing Director from 1939 until his retirement in 1968.

Mr Longbottom was also a director of the Holding Company Associated Leathers Ltd of Melbourne; of Coulls Somerville Wilkie Ltd., Otakou Fisheries Ltd, and Davis Gelatine (N.Z.) Ltd. He was the Governor-General's appointee on the New Zealand University Grants Committee for several years. His interests were wide ranging. He was the first president of the Otago division of the New Zealand Institute of Management of which he was an honorary fellow. He was a past president of the Otago-Southland Manufacturers Association, a member of the Dunedin Chamber of Commerce, of the New Zealand Tanners Association and an executive member of the Otago Employers Association.

He was an industrialist who combined early process experience with management and administration and behind such experience was a sound chemical background. His warm personality endeared him to a wide circle of friends, and the recognition of his services to industry and education by the awards in 1964 and 1973, gave great satisfaction to all.

He is survived by his wife, a daughter and a son.

contributed by
Dr F. G. Soper

NEW FORMAT FOR CHEMISTRY IN NEW ZEALAND

The NZIC Council at its August meeting gave Publications Committee (Chairman Dr A. Brodie) authority to bring forward recommendations for a new format for the Official Journal of the Institute – Chemistry in New Zealand.

The Committee has sought Council's guidance on the future of the Journal and had asked for the views of branches. Although there is considerable satisfaction among branches, with the present format of six bulletins and three Journals per annum – the branch delegates accepted that there are good reasons for combining the two in an extended Journal which would appear bimonthly – especially if there was no extra cost to members. The Auckland delegate (Dr L. Eyres) submitted the basis of a proposal from Trade and Industrial Communications Ltd which looked very attractive. The Committee was asked to bring forward final recommendations to the November Council meeting.

The proposal is that (inter alia) the Journal will be published six times per year, be of 56 pages and have a scientific and Institute section which will be under the control of the N.Z.I.C. Editor. The remainder of the editorial and advertising will be the publishers responsibility. The Institute will probably resolve at the November Council meeting to enter into a two year agreement which will protect the rights of the Institute and its members. Under the editorship of Mr Stan Brooker the Journal should be the number one publication serving the Institute and the Chemical Industry in New Zealand.

MR BOB SCHOENFELD TO VISIT NEW ZEALAND

Mr Bob Schoenfeld, managing Editor of the Royal Australian Chemical Institute will be visiting New Zealand from 3-17 February 1979. He has been accredited "Overseas Visitor" status by the Council of the Institute. Dr Jim Coxon is co-ordinating the visit.

REPORT ON AUGUST NZIC COUNCIL MEETING

The President, Dr Graham A. Wright (Auckland), presided over his last Council Meeting on Sunday 20 August.

This meeting was in many ways the climax to a year which had seen the tempo of Institute activities take a quantum jump. It witnessed a record number of resolutions (38), among which were the following:

1. The Institute would financially support the Chemical Education Group's publication **"Chem NZ"**. The Group intends to publish this 16-page pooklet thrice yearly.
2. The Institute would join the organisation **"Common Concern"** an amateur group which notifies subscribers of Parliamentary events – especially bills, their essential contents and progress through the House. The main reason for joining is so that any pending legislation which affects members or chemistry can be watched.
3. An improved tax advice document will be arranged for the current tax year.
4. Council congratulated the Auckland Branch on the publishing of **"Chemical Processes in New Zealand"** a magnificent book which should be in **every** members personal library.
5. Council decided to ask Publications Committee to bring forward recommendations on having the Journal and Bulletin published commercially with a minimum of six issues per year. (See separate notice).
6. Council asked Professor A. Williamson (Chairman of the Energy and National Resources Committee) to make a public statement on "Goals and Guidelines" isssued by the Ministry of Energy (this has since been issued and has received wide interest. Copies available from the General Secretary).
7. Council asked Mr A. C. Kennet (Chairman, Hazardous Chemicals Committee) to seek corresponding members from branches. Council noted that both Mr Kennet and Mr R. Hopgood had been attending meetings which are considering standard for labelling of Hazardous Goods and Containerisation of Hazardous Goods.
8. The Institute has at last got a temporary home in which to assemble its activities. Council appointed a committee to be chaired by Dr R. F. C. Claridge to guide the collection which will be catalogued by Mrs Wignall (Administrative Secretary). (Any members with old records should post these to Box 1926, Christchurch).
9. A new committee of Council is titled "Public Affairs" consisting of the President and the two Vice-Presidents. This committee will issue statements of Public Interest on behalf od the Institute. Professor A. D. Campbell (1st Vice-president) has since made a statement on the Commission for the Environment's Audit of the new Fertiliser works at Runcimans (South Auckland). (Generally this statement was critical of the Audit – copies available from the General Secretary.)
10. The Scale of Professional Fees will be updated by the committee consisting of Professor A. D. Campbell, Dr P. Bailey and the General Secretary.
11. Dr A. J. Ellis (2nd Vice-President) was asked to co-ordinate the Institute's Golden Jubilee celebrations in 1981. (Suggestions for these celebrations are solicited from members).
12. Council resolved to appoint a working party to investigate the employment rights of NZIC members in research Associations.

The following members were elected:

Fellows: J. M. Coxon, K. E. Richards, W. T. Robinson.

Members: F. W. Grayson, R. Nath, R. R. Sherlock, M. Wagenvoort, J. L. Wakeman, J. M. Waring, O. A. Young.

Graduate Members: B. L. Balshaw, D. R. Campbell, J. A. Christie, P. K. Johnstone, M. J. Mitchell, D. W. Scott, P. J. Steel, F. S. Wong.

Associate Members: J. C. Parnell, K. S. Thom.

Technician Members: R. C. Pizer, C. J. Temple.

QUESTIONNAIRE RETURNS

Although many members did not receive NZIC Bulletin No. 16 until after the questionnaire return date, 48 replies, including a number of letters with detailed comment, were returned. 18 replies were received from Wellington Branch Members and 13 from Auckland. The Bulletin has been popular because of its content and regular publication, however it will be discontinued in 1979 with the commercial publication of 6 issues *per annum* of "Chemistry in New Zealand". Many members appear satisfied with the content of "Chemistry in New Zealand" but a preference (63% of the returns) was indicated for short, general review type articles rather than specialised, high level research material. Almost all of the articles published in the last two years received an "interest vote" although the two most popular were clearly "High Pressure Liquid Chromatography", R. I. Adams, **41** (1977) 96 and "1977 N.Z.I.C. Salary Survey", **42** (1978) 26. The Publications Committee thanks all those who replied to the questionnaire. All the comments will be passed on to the new N.Z.I.C. Editor.

A. M. Brodie,
Chairman,
Publications
Committee

CENTRALISED SUBSCRIPTION COLLECTION SERVICE

The NZIC Council decided to introduce a centralised subscription collection service to branches, beginning next year. The administrative secretary will send out standard subscription notices in April 1979. Members should remit their subscriptions directly to Box 1926, Christchurch. Branches will continue to receive their annual grants from Council (currently $150 p.a.), and the Branch fees (which vary among Branches). The purpose of the change is to relieve branch treasurers and to aid the cash flow to branches and the Institute.

Occupational Safety and Health Administration (OSHA) of the US Federal Government has recently proposed sweeping new controls on carcinogenic chemicals.

Category I compounds are 'confirmed carcinogens'. These are known human carcinogens, together with those compounds shown to be carcinogenic in two or more mammalian species of animals. Continued use of such compounds will be allowed to continue with 'best available technology' employed to prevent worker contact, and with stringent monitoring of levels at all times. Such substances will be banned entirely if suitable substitutes can be found.

Category II compounds will be the bulk of the compounds for which animal data is available. There is a lesser degree of certainty about potential human hazard for this group, and less stringent controls will be applied. Manufacture or use would require suitable protective measures and continual monitoring of exposure levels; minimum exposure levels may be set. Worker records could form valuable input for epidemiologic studies. Every effort should be made to discover alternative non-carcinogenic chemicals which will serve the same uses.

Category III compounds are those for which the test data is not definitive enough to warrant their inclusion in the above categories. This will include compounds positive in bacterial or other mutagenicity tests, and the guidelines are clearly worded on the expectation that later animal studies may promote these compounds into the higher categories. Measures must be taken to minimize contact with such compounds until further testing clarifies their status.

Future test data on any compound which results in its classification or reclassification into the above categories will automatically trigger the appropriate set of controls, which will then have to be applied by all people using the material.

THE NZ SITUATION

In this country, responsibility for the control of carcinogens as they affect human health lies with the Health Department. Adequate existing legislation is in place to cover the control of known carcinogens in the air and water, and in food, drugs, insecticides and other user end-products, under sections of the Health Act (1956), the Water and Soil Conservation Act (1967), the Clean Air Act (1972) and the Food and Drug regulations (1973). Control of household and industrial carcinogens will be covered in the pending Toxic Substances legislation, which will replace the Poisons Act (196) and the Poisons Regulations (1964). The only legislative control of a named carcinogen to date is the proposed Asbestos Regulations, although the existing Factories Act makes a general provision for worker protection against 'injurious substances'. The Industrial Chemicals commitee of the Health Department is currently looking at the whole question of industrial carcinogens [17]. It has been stated [17] that past experience has shown that industry in NZ does, to a considerable extent, control itself in this matter, and the recent voluntary removal of vinyl chloride as a propellant for aerosol cans was cited as an example.

It is the viewpoint of the authors that, if control of carcinogenic chemicals in NZ is to be effective, a source of accurate, comprehensive and up-to-date information is needed for this country. Legislation that requires regulation of carcinogenic substances on a name-by-name basis would be an endless task, as the US has discovered, since the scope and effectiveness of carcinogenicity testing is continually expanding. Legislation that relies, as do the new OSHA regulations, on the triggering of automatic controls on a compound when evidence of risk is shown, suggests that an authoritative and up-to-date list of such substances should be available in NZ. This information should be collated by experts in the field from the vast flow of international data presently being produced. Reliance on industry to police itself requires additionally that this information be not just available to, but impressed upon, all those in industry (and elsewhere) who handle chemicals or supervise others doing so.

Voluntary control or OSHA-type regulations both require the maintenance of a central register of all chemicals imported into NZ or manufactured locally. How can users be informed of the hazardous properties of the material they are handling when their posession of it is known only to themselves. the manufacturer and the importer? Although the Customs Department presently possesses lists of all chemicals filed by importers, these do not appear to be collated. There is a clear need for all imported chemicals to be checked against a central register, for if they fall into one of the categories described the least that should be done is that potential users be informed of the long-term hazards of the material.

In summary, if one accepts the considerable scientific evidence that:–

i most human cancer is caused by exogenous factors
ii these factors are primarily chemical in nature, with removal of them implying an eventual drastic reduction in cancer incidence
iii only 1-2% of all chemicals are probably carcinogenic, and inexpensive tests are now available to detect these, then it is imperative that all reasonable steps be taken to ensure that human contact with all such materials be minimized.

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Health Statistics Centre, Department of Health.

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Special General Meeting

There will be a Special General Meeting of the NZIC on Tuesday, January 23, 1979 at 1.30 pm in the 5th floor seminar room, Department of Chemistry, University of Auckland.

J.G. Fletcher
General Secretary

OBITUARY : DR GEORGE MORRISON MOIR

Dr Moir joined the Department of Agriculture as Dairy Chemist in 1931 after a brilliant career as a scholar. He attended Otago Boys' High School from 1911 to 1916 and was awarded a university national scholarship. After serving overseas with the New Zealand Expeditionary Force in the First World War, Dr Moir studied at Otago University, where he graduated B.Sc. in 1921 with highest marks in New Zealand for Chemistry. He gained his M.Sc. degree with first class honours in chemistry in 1922 and was Otago University's Smeaton Research Scholar in 1923.

In 1924 he was elected an Associate of the Institute of Chemistry (London) and from 1924 to 1927 was a member of the staff of King Edward Technical College, Dunedin.

Dr Moir was a Pedler Research Scholar in 1927 and in 1930 gained his Ph.D at Reading University, England, where he did research on the chemical composition of milk. Before returning to New Zealand to take up his appointment with the Department of Agriculture, Dr Moir visited several leading research institutions in the United Kingdom and Europe.

In the course of his 31 years as Dairy Chemist, Dr Moir built up the Wallaceville Dairy Laboratory to a most effective and internationally recognized unit. This was later to become the National Dairy Laboratory at Ruakura. Dr Moir played a leading role in the development of analytical methods suitable to New Zealand conditions. His particular fields were caseins, starters, sediments and dairy factory water supplies.

A distinguished mountaineer and tramper, he published guide books to Fiordland and South Westland which have been revised and reprinted over the years, and are still in use.

DIRECTOR FOR NEW DSIR DIVISION

Mr Thomas Marshall, deputy director of the DSIR Chemistry Division, Lower Hutt, has been appointed Director of the department's Industrial Processing Division which officially came into operation on 1 April.

Born in England in 1923 Mr Marshall came to New Zealand as an infant. After service in the Pacific theatre with the RNZAF from 1943 to 1945 he went on to the University of Otago. There he gained the degrees of B. E. in mining in 1947; B. E. in metallurgy, 1948; B.Sc. in geology, 1948; and diploma of the Otago School of Mines, 1949. A Fellow of the New Zealand Institute of Chemistry, Mr Marshall is also an associate of the Institute of Mining Engineers. In 1948 he joined the DSIR as a metallurgist and he has been with the department's Chemistry Division ever since.

Mr Marshall has been responsible for the research and management of the division's meteorological, chemistry engineering, mineral processing, geo-chemistry, geothermal studies, work in cement and concrete, and physical chemistry. His work on localised mineral and energy resources led to the early establishment of New Zealand's ironsands, and resulting steel industries.

The Industrial Processing Division will provide a national pilot-scale production facility where new processes and products can be fully developed to the stage at which industry can take over and start commercial production. Technical staff from industry will work alongside divisional staff at all stages of development.

Research on pollution control and the efficient use and conservation of the country's energy resources will be major features of the development work, which will emphasise the processing of local agricultural, forestry, mineral, and energy raw materials.

The division will work in close co-operation with industry, the universities, and research associations to ensure that the latest processing technology is available to manufacturers after it has been thoroughly tested and adapted to local conditions.

Tenders have been let for laboratories to house IPD, and work has started on clearing the site alongside the Chemistry Division laboratories at Gracefield, Lower Hutt.

This is the first new division to be formed within DSIR for a number of years, and it continues the Chemistry Division tradition (inherited from the Dominion Laboratory) of recognising a need for specialised research and developing the work until it can sustain a new organisation. In the past, this foresight has led on to the formation of several of the 12 agricultural and industrial research associations.

METRICATED ENGINEERING DESIGN DATA

The Chemical Engineering Group of the New Zealand Institution of Engineers have sponsored a continuing project to publish a series of S.I. Data Items to summarise physical data and information in S.I. units for engineering design. The data will include physical and thermodynamic properties, design data and cost correlations, with particular emphasis on New Zealand materials and production. The publications so far available are:

SIDI No. 1002 – (1976): "Conversion Factors for Engineering Units"

This publication lists conversion factors to the international system of units (S.I.) from other units of interest to chemical engineers, for about 900 units, both alphabetically from Abampere to Zentener, and as classified quantities, from Acceleration to Work. A concise guide to the S.I. system and values for a selection of physical constants are included.

This particular booklet is now in its third revised printing (52 pages).

SIDI No. 5001 – (1975): "Costs of Process Equipment in New Zealand"

A guide for budget estimating purposes this booklet assembles New Zealand cost data for a wide range of process equipment in a number of categories.

Obviously costs are continually changing with inflation but past costs may be brought up to date with appropriate cost index factors. A section of this booklet is devoted to an account of the Ministry of Works construction cost index and its labour, plant and materials component price indices (76 pages).

SIDI No. 2041 – (1976): "Pump Characteristics"

This publication is a guide to the selection of pumps for industrial and laboratory use. The performance of many kinds of pumps is summarised in 13 clauses with the name of local manufacturers and New Zealand agents included where appropriate. Typical characteristic curves are plotted for a wide selection of pumps available in New Zealand (100 pages).

SIDI No. 1012 – (1977): "Hygrothermal Properties of the Air-Stream System"

This data item is concerned with the hygrothermal properties of mixtures of water vapour and air at 100 KPa total pressure. Tabulation of thermophysical data (density, kinematic viscosity, thermal conductivity, Prandtl number, humid heat and saturated humidity) are given with Grosvenor, Mollier, humidity difference and humidity potential coefficient charts, with a guide to their use (36 pages).

The costs for the Data Items are $5 each (with the exception of SIDI 5001 at $2.50). Handling and postage is extra; 50 cents within New Zealand or by surface overseas, and $ airmail overseas. Cheques and drafts should be made payable to the Chemical Engineering Group.

All publications and further information can be obtained from Mr I. A. Gilmour, Chemical Engineering Dept., University of Canterbury, Christchurch, New Zealand.

CHEMISTRY — IRANIAN STYLE

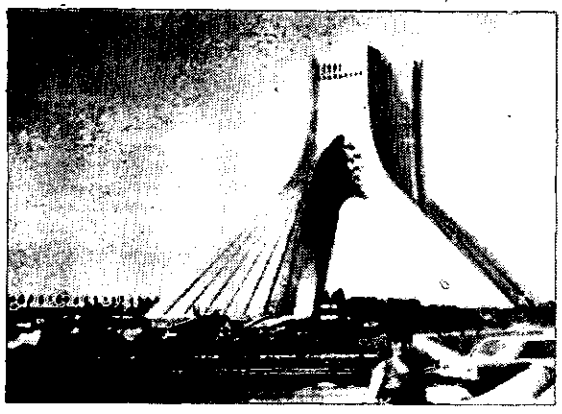
K.J.D. MacKenzie
Chemistry Division
DSIR, Gracefield

Saturday morning – the start of the normal Iranian working week. Arrived at work 7am. Taxi driver tried to rip me off – wanted 100 rials ($1.45) instead of the normal 20 (28c). Refused to pay, and walked off after heated discussion. Going to be a hot day – temperature in the 30's already. Water supply in lab failed over weekend, and no gas delivered. Most of staff very late again due to traffic jams...

Thus might run a typical entry in my diary for an average life in Iran is seldom boring and free from incident. Indeed, after spending almost two years in Tehran setting up a high temperature materials laboratory for the Materials and Energy Research Centre of Aryamehr University, we have found life back in New Zealand rather flat and uneventful. But at least free from traffic jams.

Our first introduction to the Iranian way of doing things came with our arrival at Tehran airport at 1.30 in the morning (planes seem to arrive and depart from here at ungodly hours of the morning). A stern-faced, heavily-armed but youthful guard demands entrance visas. "Sorry – we don't have visas, since the Research Centre said the necessary paper work would be handled at this end after our arrival". "So you intend to stay and work then?" This was much more serious. A lengthy debate follows, and we are shunted off to an office to see a Higher Official. The children, aged 5 and 2, wake up and start to grizzle. In desperation the Official stamps our passports with a visa good for 2 days only (this was Thursday, the first day of the weekend).

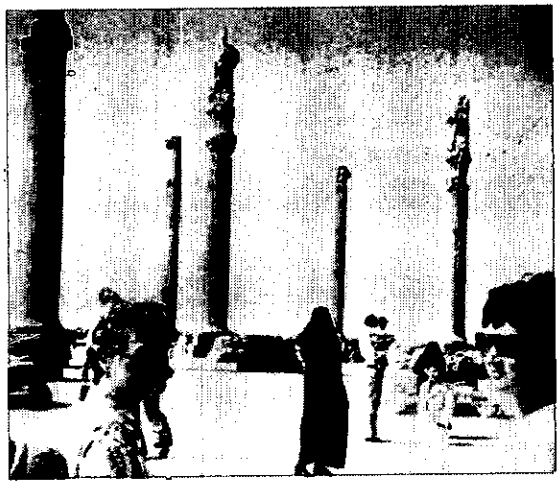
Shock number two comes when we find there is nobody to meet us. To make matters worse, we haven't been told what hotel we are booked in at. I approach a sleepy individual in a booth marked "Tourist Information" to enquire about hotels, and am gruffly told to try the Hotel Casablanca. Our taxi driver looks aghast on hearing this. Surely not the Casablanca sir? I can take you to a much nicer hotel". One look at the Hotel Casablanca and I take up our driver's offer to find us a nicer hotel. Finally we check in at the Miami Hotel, where I find we were originally booked anyway. Of the hundreds of hotels in Tehran, we have stumbled across the one we were meant to be staying in. But after an eight-hour flight from Bangkok and almost three hours of formalities, we are past caring. With mumbled thanks and a hefty tip to the driver, we stumble off to bed.



Shahyad Square – the symbol of modern Iran. This archway houses a museum illustrating the achievements of the country over the last 25 centuries and was erected to commemorate the 50th anniversary of the present (Pahlavi) Dynasty.

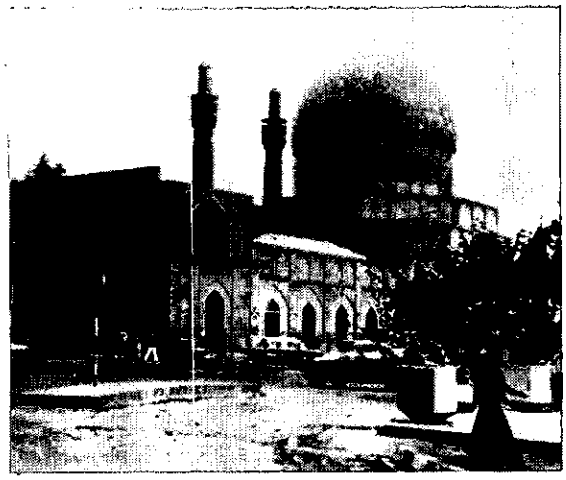
Entrance to a Bazaar – the symbol of old Iran, and the centre of trade and commerce in every city, town and village in Iran.

The next few weeks were occupied with finding a not-too-expensive apartment (only $650 per month), furnishing it with not-too-expensive furniture; applying for work permits and residence permits, buying and registering a car and opening a bank account. Life in Iran, even for a Farsi-speaking Iranian, seems to be conducted on the principle that everything, even the simplest operation, has to be complicated and as difficult as possible. Withdrawing or depositing money from a bank can take up to an hour, depending on the prevailing mood of the teller (strangely, it seemed harder to deposit money than to withdraw it). Posting a parcel was a full morning's work, which could only be done at one Post Office deep in the South of the city. Needless to say, trying to clear items through Customs or enquire about a missing parcel involved even more immense amounts of paper work which could take several days of commuting from one office to another, and to which a satisfactory conclusion could never be guaranteed. It therefore came as no surprise that our work permits and residence permits took more than six months to be issued, and involved countless trips to the Ministry of Aliens by the Personnel Officer from the Research Centre. This job was considered too tricky to be carried out by foreigners on their own behalf, for which we were devoutly thankful. It eventually transpired that the slow step in the process was the granting of security clearance by the Secret Police (SAVAK); nevertheless, the Centre was heavily fined by the Ministry of Aliens for not having obtained our permits within the statutory 90 days.



The ruins of Perepolis, the ancient royal city of Darius and the seat of the Archamenian Dynasty, are visited by foreign tourists and native Iranians alike.

Most of the work involved in setting up the new Research Group was characterized by a similar heavy-handed bureaucracy, which was made more difficult by the fact that not even the Iranians really understood the rules, which in any case were continually being changed. I was allocated an empty room on the third floor of a new apartment building for an office, but for several weeks had no furniture. The first item to be supplied was a large framed portrait of the Shah, which was clearly considered the most important embellishment, and was in fact mandatory in every Government office. My laboratory was in the garage underneath the same building (the Centre was not situated on the main University Campus, but was housed temporarily in three large apartment buildings in the north of the city. This turned out to be a blessing, as it meant we were unaffected by student riots which from time to time broke every window on the main Campus, causing its frequent closure). After installing partitions and air conditioning in the garage, and sealing up as many cracks as possible, we were ready to install the x-ray equipment, which had stood in its crates on the footpath outside for several months, awaiting a final resting place. The Iranian staff, including the Director, threw themselves into the task of unpacking the equipment with their usual exuberance and in no time at all had reduced the crates to rubble, which was ultimately tossed over the fence, back into the street. Having done the easiest and most enjoyable part, it was left to me to arrange for installation and to provide power and water, all of which was easier said than done. French and English installation engineers had to be summoned and their travel arrangements, visas and accommodation organised, but the more difficult part was the provision of utilities to the lab. The wiring in Iranian apartment buildings is of very light capacity, never more than 10 amps per apartment, so we had to arrange a direct heavy-duty line from the sub-station. Again, the paper work and red tape was immense, but eventually some months later we got our 900 amp three-phase cable, only to find that our engineering department had quite overlooked the need for a switchboard to handle all this power. Another long wait, then finally a lovely new switchboard arrived. Our joy soon turned to dismay when it was found to be too big to go through any door, but this problem was quickly solved in direct Iranian fashion by knocking down part of the front wall of the building. Another problem was soon encountered with the recirculating cooling water system for the x-ray, which in summer heated up until the thermal cut-out switch was actuated. This problem was solved with the help of the mobile ice-vendors, who in summer ply Tehran's streets with large blocks of ice for sale, strapped across the rear seats of their motorcycles. One of these blocks, purchased early in the morning and dumped into the recirculating tank kept the system at a reasonable operating temperature most of the day. Later we became more sophisticated and bought a water chiller system, but the ice kept us operating throughout the first summer.



The blue-domed mosque with its twin minarets is the focal point of the religious life of every town and village.

Baking bread the traditional way. The unleavened dough is rolled out and flung on to the clay walls of the circular charcoal-heated oven pit to cook. The resulting product, called nan, is delicious.

Similar snags were encountered in the purchase and installation of all our major equipment, and because there was no shortage of funds for capital items, we had plenty of major equipment to install. Our electron microprobe analyser was dropped in Customs and damage conservatively estimated at $110,000 was done to the column, but the real headache came in trying to recover this money from Bimeh Iran, the Government insurance company with whom we had no option but to insure. It took us well over a year to get a cheque for $70,000 out of them in settlement of this claim. Keeping such sophisticated equipment running was another headache, and our scanning Auger spectrometer was constantly being put out of action by the most alarming fluctuations in the mains voltage, which had a tendency to zoom from its normal summertime value of about 180 volts to about 320 volts, as somebody down the street switched something off. The solid state circuitry in our furnace controllers didn't take too kindly to this sort of treatment either, and our electronics servicing department, headed by an inscrutable, bearded, BBC-trained Englishman, was constantly rectifying the ravages of our unpredictable electricity supply. In the

height of the summer, when the demand for power to run air-conditioners was at its maximum the supply frequently petered out altogether, and daily four-hour power cuts became a fact of life. Despite promises from the Ministry of Power that consumers would be notified well in advance of the cuts, the times at which they occurred usually bore no relationship to the advertised times, making summertime experimental work virtually impossible.

A street scene in a northern Tehran suburb, backed by the foothills of the mighty Elborz mountain range.

Despite these annoyances, it soon became clear that we were going to get a good deal of work out of our newly-formed group. Apart from a leavening of more experienced foreign scientists, the backbone of the scientific and technical staff were locally-trained Iranians, mostly B.Sc graduates from Aryamehr and other Iranian universities (until recently, the Iranian tertiary educational system did not allow for higher degrees to be taken, so all postgraduates had to be trained abroad). The new Iranian graduates were a keen lot, determined to make their mark on the scientific community, and eager to make full use of their new equipment. Initially, a series of small research projects had to be devised largely for training purposes, as the original staff had been recruited from a wide variety of disciplines, with apparently little regard for the research interests of the Centre. Eventually this diversity of disciplines began to pay off, as people began to tackle problems in their own way, but it made the six-monthly task of assessing their progress something of a nightmare. How do you compare the productivity of a theoretical physicist (one page of equations) with a prototype solar panel or a sun-tracking device produced by a metallurgist or an engineer? Long agonising meetings were held amongst the Division Leaders at assessment time, and my life was spent sitting on interminable committees. The Iranians have a passion for Committees, but seldom take notes, and frequently find themselves debating an issue which was decided at a previous meeting (and probably coming to a different conclusion the second time around). I developed a habit of nodding sagely at all that was going on, while all the time quitely dozing. This resulted in my infrequent comments giving the impression of being carefully weighed, and consequently being treated with more respect than they probably deserved.

Winter comes to Tehran. Our street, with our apartment building in the foreground, remained like this for more than six weeks and the last traces of ice took almost 10 weeks to disappear from the gutters and footpaths.

Towards the end of my stint, the direction of the research effort began to turn from fundamental and rather rarified investigations to the much more practical task of assisting local materials and energy-based industries, which was to my mind a much more sensible role for a Research Centre in a developing country, and one which I had actively advocated ever since my arrival. However, the drumming-up of industrial customers introduced me to another facet of industrial life which I had been unaware — the world of Iranian big business. My days were now spent in High Level Conferences with directors of companies and Government Ministers, drinking endless cups of tea and listening only semi-intelligently to long discussions in Farsi (the Persian language). Frequently my thoughts would stray wistfully to my group of workers back in the lab, busily getting on with the jobs for which we were now negotiating contract rates. Although we knew we were working in the Country's interests, the industrial contracts proved to be rather a headache; our clients tended to demand all manner of additional and usually irrelevant tests, and invariably showed extreme reluctance to pay the agreed fees for our services, once they had received their report.

If my arrival in Iran had perhaps been less than auspicious, this was well and truly compensated for by the farewell I was given, marked by the customary round of farewell afternoon teas at which large quantities of sticky cakes and fruit are consumed and many emotional farewell speeches are made. Taking me completely by surprise, my own research group had conspired together to present me with several very beautiful artifacts, and at the moment of my final departure from the Centre, my secretary (always an emotional girl) emerged red-eyed from the toilet where she had been blubbering most of the afternoon, and presented me with a carnation. Then, dazed and filled with strange mixture of relief and sadness, I was on my way to the airport (was it my imagination, or were the guards really more friendly this time?).

Now, several months later, the memories are starting to fade, but sometimes, sitting in my office eating my sandwiches, I can almost smell the pungent aroma of a lunchtime chelokebab, or driving in the quiet orderliness of Wellington's traffic, I sometimes fancy I can hear the persistant and furious honking of an orange taxicab.

WHAT IS AN INDUSTRIAL CHEMIST? A SORT OF AUTOBIOGRAPHY

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Silverstream

"I suppose you'd better get a job" growled my father, after I'd spent four undistinguished years at high school, and seemed to have no clear idea of what to do next. (Vocational guidance was practically unknown, in or out of schools). "I think there might be a job in the laboratory at Davis Gelatine – you're interested in science aren't you?"

Well I was, so I soon found myself being interviewed by the chief chemist, a very forceful woman of about 25, which was old to my 17 summers, and soon afterwards I learnt the art of washing glassware. "You'd better go and enrol at University" she said a few days later. Heavens! What's a university?

My home town had one, but never having been in contact with people who had been there my impressions were of dark brown studies above stone-pillared cloisters, where one lived a life alternating between intense study and debauchery. Alas for the reality – riding the bike 10 or 20 miles almost every day of the week, between the glue works, the classrooms and my home, with heavy oiled cloth garments for the wet, and a carrier laden with books all the time.

Time has fortunately dimmed the memory of those days, but some impressions remain. Who could forget the barn which was the Stage I laboratory, badly lit night and day, hardly heated at all, with a huge fiendish H^2S

The Author - not-so-recently

apparatus in what was supposed to be a fume cupboard which occupied most of one and of the laboratory? (Always the far end from my few square feet of bench space, of course). Then there were the lectures from Professor McLeod – yes, the actual inventor of the McLeod Gauge, although it seemed hard to believe it as he droned on, inaudible beyond the front row, and incomprehensible to all except the genius members of the group. Another thing I remember from those days was the fact that in *practical* classes not too much reliance was placed on the accuracy or reality of numerical results, which contrasted strangely with what was expected of me in my earning hours.

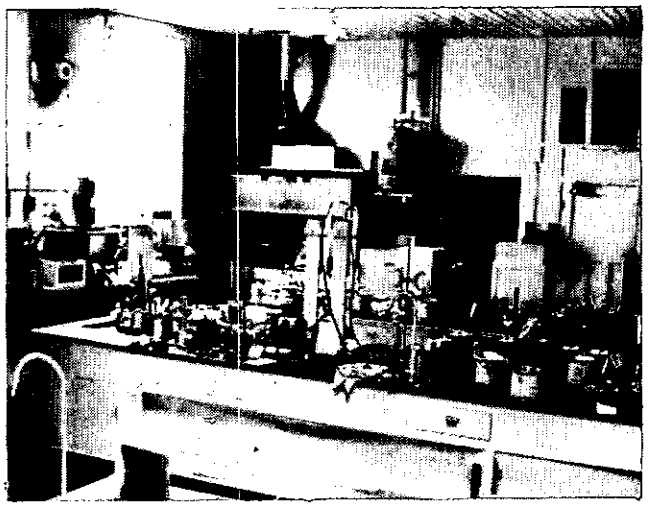
The war of 1939 found me quite unprepared for either it or a career, but thanks to the *phoney* period I was able to get the absolute minimum qualifications that the professor of chemistry could grant, on the understanding that I went into industry and didn't bother the academic world any more! About this time compulsory military service arrived, and since the Territorials had convinced me of the undesirability of army life, I started preliminary moves towards the Air Force. The need of the Australian munitions industry for chemists saved me and several dozen other N.Z. graduates from military service, and off we went into the unknown world of TNT, lead azide and similar deceptively simple chemical compounds.

More fortunate than most, I had experienced life in a real laboratory, where results had to be correct and had to be useful in progressing the manufacture of a real product.

"What did you do during the war, daddy?" A pen more fluent than mine could write a book about it, starting with one of the first days in an enormous laboratory with yards of glass partitions – they broke easily in the explosive accidents – when we met Bob X, who had preceded us from Wellington by a week or so. "What's the work Bob? What will we be doing? How will we learn about it?" "Well", he said, "I've spent the entire time so far getting these labels off these bottles." Needless to say Bob went on to do more useful work, as we all did. Some went on to the dizzy heights of managing a section of an explosives factory, some were honoured by mercifully short-term appointments as *Chemist in Charge of Visitors,* others like your humble servant tried to analyse, measure and test every conceivable material the government bought, or wanted to buy, as well as the finished products of the explosive factories. At the place I spent most time, the most unusual thing I ever did was getting the nursing sister in charge of the mini-hospital on the site to use her X-ray machine to X-ray the TNT from the famous 25-pounder shells. The best thing was meeting the laboratory assistant who became my wife.

Wars eventually end, and so does the war work, and with the help of Jim Nash (son of the Prime Minister,

Vacuum Oil in the 1950's



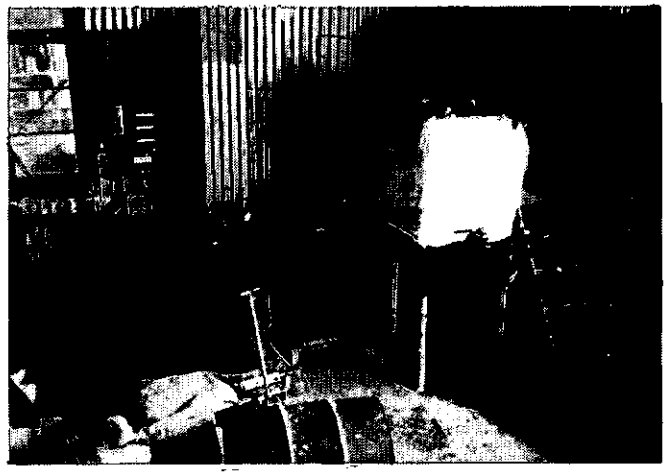
Vacuum Oil about 1960

and a long-time member of our Institute) I got an appointment in the Vacuum Oil Co. in Wellington. Can anyone not working at that time believe that I got £8 ($16) per week? I can hardly believe it myself. No-one at Vacuum was too sure of what they wanted several chemicals for, but they wanted to be ready for the post-war boom. One of the duties was visiting most of the major ports in N.Z. when tankers brought petrol and diesel from mysterious places. One local official was convinced that the Russians were supplying us when the American-speaking mate informed him that the cargo came from Georgia. The real fun started when enough petrol had become mixed with the diesel to make it dangerous – or at least dangerous according to our Dangerous Goods Regulations. Lots of toll calls to the chief chemist in Wellington, lots of diplomacy pacifying the ship's officers who had allowed this horrible thing to happen, lots of sympathy for the local superintendents who desperately wanted the diesel, contaminated or not. I have retained the ability to do Pensky-Martens flash points half asleep in a cupboard (set aside as a laboratory) at 3 o'clock in the morning, to this day.

What else did oil company chemists do? They did research of course, as well as quality control tests on oil, greases, emulsions, solutions or whatever else the company was making at that time. Where is this research published, you ask? Nowhere, is the usual reply. Often we didn't think it was research, just a bit of investigation work which the company wouldn't want revealed anyway. Sometimes it did get published but not by the author. In those *olden days* we did a lot of work on sheep branding fluids, with sheep, scouring baths and the whole works. The few published formulae were in our opinion very bad, and when I told this to a C.S.I.R.O. man in Geelong whilst on holiday there, he naturally asked about our work. In my innocence I revealed details of our latest formula to him, and of course was rather upset to find them published later in a glossy C.S.I.R.O. booklet. Still perhaps this doesn't happen nowadays?

Other types of *publication* are for internal use. Many score sales reps must have suffered under our attempts to teach them the rudiments of petroleum chemistry, and many others must have struggled through technical bulletins which we produced to help them and our customers know more about our products. They seemed elementary to us, but now, and again a question from an intelligent but non-scientific colleague showed how difficult it is to communicate in a two-page bulletin.

Change is inevitable, and after too many years in the laboratory I was asked, with of course no possibility of refusal, if I would like to go into Head Office. Having chemists in the sales force meant that, since no-one in a branch office could control them, they had to be controlled from Head Office. We all know that chemists are particularly uncontrollable even in laboratories and manufacturing plants, so how much control one had over chemists whose basic job was selling and trouble-shooting and who were hundreds of miles away, I will not dwell on. Life in a big mid-city office has its drawbacks unless one has a particularly sedentary disposition, so after only two years of this I allowed myself to be seduced back to factory life, this time to an offshoot of a self-made man's main enterprise.



A do-it-yourself bitumen melter — **Premier Products Waikanae**

His factory had two main disadvantages – it was 30 miles from home, and its main products were paint and agricultural chemicals, neither of which I knew very much about. To those suppliers of raw materials, fellow members of O.C.C.A., and chemists at the D.S.I.R. I now apologise for the overt and covert picking of their brains that I did at that time.

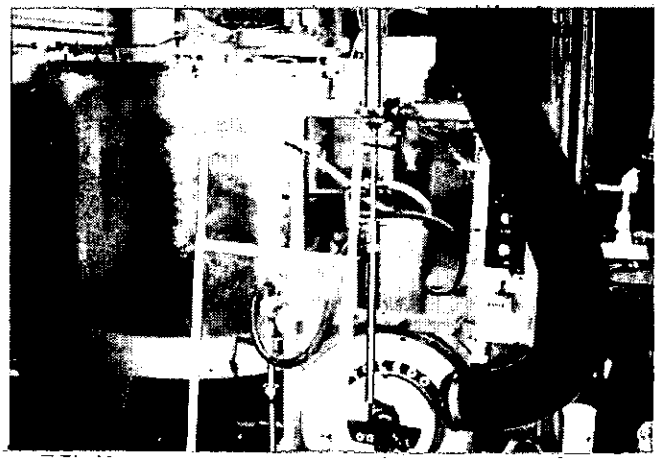
Once again to publications – why don't industrial chemists write more? Most of my information to help restore this factory's products to a reasonable standard, apart from the verbal advice belatedly acknowledged above, came from books, pamphlets. and manufacturer's bulletins, but nearly all written overseas. One reason must be lack of time – the work work

work syndrome is a part of most industrial chemist's makeup, leaving very little time for writing and thinking. Do employers expect this, or do chemists inflict this on themselves? A writer in Chemtech some years ago pointed out that plant chemists have only one problem – get the product out at the speed, the quality and the cost that will make a profit for the firm. Perhaps the size of most companies in this country means that the one, two or three chemists can do little else. When a firm has three chemists on production it probably has an R and D division as well, so once again the true industrial (industrious?) chemist misses out on the opportunity to do research, or to write and publish his everyday experiences. Secrecy is given as an excuse, and is true for many cases, but with the mobility of staff in this country not many companies have secrets for long. However, even though I was factory manager, chief chemist, personnel manager and everything else, I managed to write *What Every Painter Should Know About PVC* (Pigment Volume Concentration), which I hope was useful, which I believe needed saying, and which any other paint chemist could have written with much less cerebral perspiration than I did.

After a year or two of the delights of being able to look out my window at sheep grazing in the fields opposite, with a distant vista of Kapiti in the background, our lords and masters decided that paint was not their game (their name had **vaccine** in it after all) and I had the unhappy experience of doing away with the staff, the stock, the sheep and the machines. Fortunately redundancy was only a word in the dictionary at that time, and since I was all right Jack I could only hope that the staff were. I wonder if the aging non-European member of the staff who I put off about a month before the rest were told, so that he could have a fair go at the few local jobs, has forgiven me?

TVL laboratory in the 1960's

And so back to yet another laboratory, which I found even less equipped for its tasks than the almost empty room which passed for a laboratory at the paint factory. True, it had a spectrophotometer, but the balance was the two pan type with a box of round, square and triangular weights – chemists over 50 will know what I mean – and the pH meter needed at least three hands to operate it, and a Tarzan to carry it around. The formula sheets were only one step removed from a device which worked with rubber bands and perspex covers, to display the card of choice to the lucky worker. Fortunately Mr Xerox started selling his useful gadget shortly afterwards, bringing us up to date with a rush, and the general manager was very receptive to the idea of modernising the lab. gear.



***Not an elephant — sheep dip manufacture* — TVL**

Did we do research in this laboratory? No – we had a Research Director, but he was not in charge of us, which was just as well because he was highly qualified in virology and interested only in that. Our research had to be disguised as Technical Service, Product Development, or anything except research. The usual inhibitions against publication applied, and most of our writing was for the benefit of our staff or our customers.

The *vaccine* in our name had now been recognised as an anomaly, and other projects were allowed and even encouraged. I worked on making sutures from the guts of animals, pine oil from turpentine, soya bean oil and meal from the great New Zealand soil and rain and sun, protein-absorbing resins from cellulose, and what to do with detergents, alkalies and bacteriocides in all kinds of combinations. Some years, with a sympathetic general manager, I worked nearly full time on these problems but sad to say in other eras I had to fit them in as best I could whilst working on the only problem that a plant chemist has – as the man said in Chemtech.

Soya bean trials in 1967

My life seems to run in decades, so after about a decade of this it was suggested that I should run most of the non-biological production units of the company. What could I say? Had I chosen to stay with job satisfaction, chemical technology and easy paper work, I would probably have been much happier, but like most fools I rushed into the world of weeping women, union secretaries, procurement problems, personnel managers, accountants and all those who affect a production manager. No wonder angels fear to tread!

There were technical problems to be solved, and I believe that the production manager of a chemical plant should be qualified in chemistry, at least in a technology not too far removed, but as usual the real problems were people problems. Convincing one's superiors that more and better qualified people were needed, and one's staff that they could work better, cleaner and safer, was always the major part of the job. Whether I succeeded at this task or not is a question which presumably only one's superiors can answer, and since reorganisations take place at frequent intervals I'm not too sure that they can. Suffice to say that with a complete change of ownership of the firm, the years ahead of me before they pay me to stay away have been sharply reduced, and I can look forward to yet another episode in the saga of an industrial chemist. What will it be?

Some who were not a problem – TVL

My philosphy for the future can perhaps be expressed by some words from comic opera:

If life's a boon
Then so it must befall
That death's too soon
When ere he call . . .
For idleness is chief mistress
Of vices all.

INDUSTRIAL CHEMISTRY PRIZE

The award of the New Zealand Institute of Chemistry Industrial Chemistry Prize to Dr R. P. Garland was based on his contribution to the establishment of a $1,000,000 Organic Chemical Processing Unit to extract pure bile acids from animal bile, a by-product from New Zealand's slaughterhouse industry.

New Zealand Pharmaceuticals Limited was formed in 1971 as a result of the National Development Conference, with the aim of producing fine chemicals and pharmaceuticals from the by-products and wastes of the New Zealand freezing industry. After investigation the processing of animal bile was chosen as the initial project. As a first step, overseas gall processors were approached for assistance in forming a joint venture company to process the New Zealand gall supply. However, when there was no interest in processing beyond the crude product stage it was decided to undertake the complete development in New Zealand.

Process Development

The bench-scale investigations were carried out in collaboration with the Biotechnology Department at Massey University. Dr Garland joined the project in November 1971 at a stage when production of a crude cholic acid product and a crude deoxycholic acid product had been achieved.

However, the economic success of the project depended on the efficient purifications of these crude products. Crude cholic acid and crude deoxycholic acid are heavily contaminated with fatty acids and bile pigments and purification by simple crystallization was inadequate. Moreover until the development of a quantitative assay for both cholic and deoxycholic acid, little progress could be made.

The development of several different purification techniques were necessary to obtain bile acids of the necessary purity. In addition the retention and treatment of crystallization liquors to recover the cholic and deoxycholic acids present was vital for the economic viability of the process.

Pilot Plant Testing

The successful bench process was first translated into a pilot plant process in 1973. Working alongside engineering and production personnel Dr Garland was physically involved in all aspects of the testing process and the gathering of design data for the fullscale processing unit. As a result of the pilot plant testing the process was improved in several ways.

Commissioning of Processing Unit

With the successful completion of the pilot plant trials in August 1973, the project progressed to the design of the full-scale unit. Installation was complete in November 1974, plant commissioning begun, and full-scale production was achieved in May 1975.

Quality and Process Control

The transformation of the bench process into an efficient smooth-running factory operation, incorporating a series of simple unit operations, required the establishment of many quality control and process control procedures. The most important of these was the development of a quantitative assay for cholic and deoxycholic acids using gas liquid chromotography initially before superseding this with high pressure liquid chromotography.

Cover photo: a) concentrated gall being loaded into the crude processing area of the plant; b) pure deoxycholic acid just prior to being ground and packed.

THE 1978 NZIC SALARY SURVEY

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Gracefield, Lower Hutt

There were 687 returns of which three were late and 14 rejected. Of these 14 forms six did not include a salary and one was from a retired person. Another six had very low salaries and so were assumed to be from part-time workers. One university return that showed a salary of $217,569 was thought to be an error, so rather than bias the university results it was not included. However, if this was a genuine salary the authors would be delighted to hear from the person concerned. The return rate of 57.3 percent was disappointing after a rate of 78.7 percent last year.

A large amount of checking and correcting of forms had to be done before they were processed. All employment groups with set salary scales who received the 8.8 percent and 7 percent salary increases had their salaries checked against the old and new salary scales and, where recognised, were corrected to the new scale (as at August 1978).

One conclusion from the 1977 Survey was that essential figures were not recorded and might explain the unaccounted variability in the industrial group. Government jobs are thought to have the advantage of job security and an extremely good superannuation fund, while industrial positions have allowances, some non-taxable, in addition to their salaries and chances for paid overtime. The 1978 Survey form was therefore designed to extract information in these areas.

The value of superannuation to members in the private sector was considered and reference made to the Superannuation Board. In non-government schemes, it seemed that an employee receives the employers' contribution upon his/her resignation. No such reimbursement is paid to government employees, and this led to the qualifying statement about superannuation in the 1978 form. The form was previewed by several industrial members but no comment was made on this allowance. However, several returns with comments attached, pointed out the above misconception, emphasizing that a bias could result. The only practical solution has been followed therefore: All superannuation figures were removed from the returns.

The analyses were calculated using GENSTAT (1). A regression model was fitted, as in previous years, to the salary *and* salary plus allowances data. No improvement in the variance accounted for by the regression model was seen with the inclusion of the allowances. With the extra major function category of "research and teaching" any comparison between University and other employment groups is not strictly valid. Of the 128 university returns, 108 were in this category against three returns from other employment groups. Similarly, industry is not comparable with any of the teaching groups as the two have quite distinct major function categories.

Central and Local Government, Research Associations and Hospitals are employment groups that have major function categories that are common to those of Industry. Local Government and Hospital samples are considered too small to make meaningful comparisons. The only significant differences (t-test) found between the three remaining groups show that industry salaries without allowances are less than those for Central Government and Research Associations. However, there are no significant differences when salaries *plus* allowances are compared. There are no observable qualification group differences this year. Because of the misleading nature of the t-test tables, these have not been presented (see 5-8 in the 1977 Survey). They are available on request from the authors.

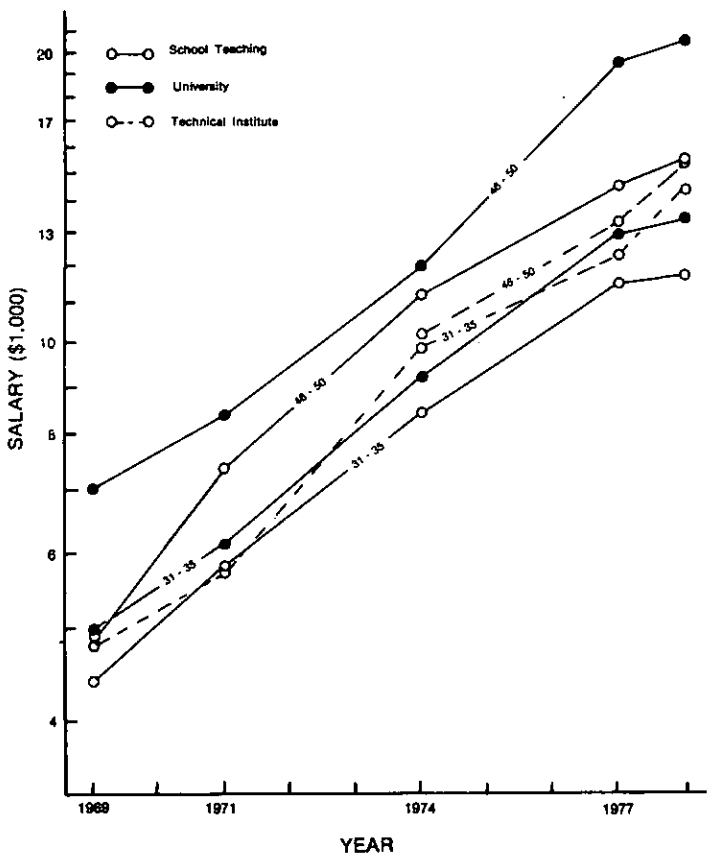
Some comments on the new features in this survey are now made. The *administrative* and *sales and service* categories within the industrial group received considerable taxable and non-taxable allowances and appear to be the best paid. Other categories such as *technical services* and *analysis and testing* receive lower salaries and the few allowances, e.g. telephone or car, often are related to the fact that the person is on call, so that it is questionable whether they are beneficial. With the allowances added, the range of Industry salaries is doubled to over $42,000. Table A shows the distribution of allowances. Future Surveys should extend and clarify these points.

Analyses of the overtime returns also proved informative. Only two people in the whole survey had guaranteed overtime. A mere 19 worked paid overtime; eight of these were in the industrial group. In some cases, this overtime was not related to the normal job: one unsolicited comment read *paid overtime involves doing jobs that union members refuse to do (basically only a form of getting extra money during the busy season).*

The unpaid overtime results are presented in Table B. Many returns indicated that this section was not applicable and so were classified as not working overtime. This table provides an enlightening summary of individual feelings on this subject, and undoubtedly poses the question of what is considered as overtime.

The 1978 survey provides some data appropriate to the industrial members of the Institute. Setting aside the lack of superannuation figures, the following general conclusions, about the Industry group can be made:

1. Members do not receive significant amounts of paid overtime.
2. Unpaid overtime hours, as seen by members, are greater in other employment groups. Viz., around 30 percent of University members work more than 50 hours/week.



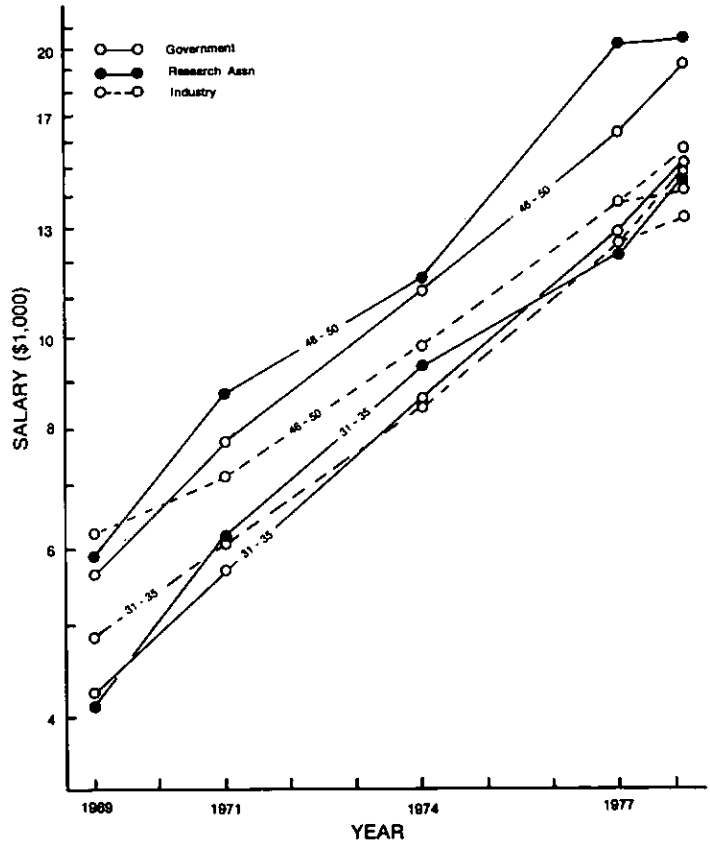


TABLE A. The Mean Median, Minimum and Maximum Salaries for each Employment Group.

Employment Group		Number	Mean	Median	Minimum	Maximum
School teaching	S	44	13505	12777	9044	21500
	S + A		13793	13101	9044	21500
Teachers college	S, S + A	2	15356	15356	13684	17027
University	S	131	16750	15999	6523	31000
	S + A		16865	16033	6823	33100
Technical Inst.	S	22	15657	16002	11185	18679
	S + A		15677	16002	11317	18769
Industry	S	219	13858	13000	7800	30000
	S + A		15230	14034	7800	50991
Central Govt.	S	147	16680	16635	7786	28973
	S + A		16687	16635	7786	29013
Local Govt.	S	14	13427	13035	8831	18742
	S + A		13718	13268	8922	18742
Research Assn	S	45	16506	16062	8066	26003
	S + A		16638	16062	8066	26003
Self-employed	S	8	16438	15500	10800	24500
	S + A		22233	17000	15000	42000
Hospital services	S	18	13660	14209	8221	20007
	S + A		13690	14209	8221	20007
Student	S, S + A	13	2944	3125	120	4264
Other	S	7	16198	15000	10000	22286
	S + A		16831	16276	10300	23105

a. S, Salary, S + A Salary + All Allowances.
b. Where Mean different from Median, distribution is skewed. When Mean *K* median, more than 50% of sample are below mean.

TABLE C. Distribution of allowances over the employment groups (missing groups do not receive allowances).

	Allowance	School Teaching	University	Technical Institute	Industry	Central Government	Local Government	Research Association	Self-Employed	Hospital Services	Other	
Taxable	Car	1	0	1	1	0	0	0	1	0	0	No.
		130	-	10	1800	-	-	-	1080	-	-	Mean
		-	-	-	-	-	-	-	-	-	-	Min.
		-	-	-	-	-	-	-	-	-	-	Max.
	Telephone	0	0	0	3	0	0	0	0	0	0	No.
		-	-	-	43	-	-	-	-	-	-	Mean
		-	-	-	40	-	-	-	-	-	-	Min.
		-	-	-	50	-	-	-	-	-	-	Max.
	House	0	2	0	3	0	0	0	0	0	0	No.
		-	1700	-	1347	-	-	-	-	-	-	Mean
		-	600	-	500	-	-	-	-	-	-	Min.
		-	2800	-	2500	-	-	-	-	-	-	Max.
	Guaranteed Overtime	0	0	0	2	0	0	0	0	0	0	No.
		-	-	-	725	-	-	-	-	-	-	Mean
		-	-	-	50	-	-	-	-	-	-	Min.
		-	-	-	1400	-	-	-	-	-	-	Max.
	Insurance	1	0	0	3	0	0	0	0	0	0	No.
		720	-	-	87	-	-	-	-	-	-	Mean
		-	-	-	80	-	-	-	-	-	-	Min.
		-	-	-	100	-	-	-	-	-	-	Max.
	Allowances	1	1	0	3	0	1	0	0	1	0	No.
		1200	300	-	238	-	31	-	-	220	-	Mean
		-	-	-	143	-	-	-	-	-	-	Min.
		-	-	-	300	-	-	-	-	-	-	Max.
	Bonuses	0	1	0	34	0	5	0	2	0	0	No.
		-	450	-	1418	-	82	-	4250	-	-	Mean
		-	-	-	102	-	50	-	2000	-	-	Min.
		-	-	-	20000	-	100	-	6500	-	-	Max.
	Other	0	2	0	3	0	0	1	2	0	0	No.
		-	713	-	708	-	-	1300	8710	-	-	Mean
		-	425	-	200	-	-	-	2420	-	-	Min.
		-	1000	-	1225	-	-	-	15000	-	-	Max.
Non-Taxable	Car	1	3	0	111	1	3	4	2	1	3	No.
		120	1100	-	1547	250	733	503	1150	25	1140	Mean
		-	300	-	100	-	500	50	900	-	300	Min.
		-	2000	-	4150	-	1000	1000	1400	-	2000	Max.
	Telephone	4	2	1	85	6	4	0	4	2	2	No.
		102	102	90	150	87	99	-	147	53	153	Mean
		75	63	-	35	40	60	-	80	40	150	Min.
		132	141	-	1000	120	120	-	288	66	156	Max.
	House	7	0	0	10	0	1	1	0	0	0	No.
		1187	-	-	669	-	1000	1040	-	-	-	Mean
		400	-	-	52	-	-	-	-	-	-	Min.
		2000	-	-	1100	-	-	-	-	-	-	Max.
	Insurance	2	0	1	43	0	0	4	3	0	0	No.
		564	-	340	108	-	-	163	220	-	-	Mean
		200	-	-	12	-	-	50	40	-	-	Min.
		927	-	-	600	-	-	400	400	-	-	Max.
	Allowances	3	10	0	68	1	1	3	2	0	2	No.
		206	300	-	416	250	31	70	650	-	350	Mean
		17	22	-	25	-	-	49	300	-	200	Min.
		300	1500	-	2500	-	-	100	1000	-	500	Max.
	Bonuses	0	0	0	6	0	0	0	1	0	0	No.
		-	-	-	1367	-	-	-	3080	-	-	Mean
		-	-	-	200	-	-	-	-	-	-	Min.
		-	-	-	4500	-	-	-	-	-	-	Max.
	Other	2	3	0	21	2	0	4	0	0	0	No.
		13	166	-	257	65	-	186	-	-	-	Mean
		11	50	-	30	50	-	49	-	-	-	Min.
		15	299	-	1000	80	-	596	-	-	-	Max.

TABLE B. Percentage unpaid overtime worked.

Time hours/week	Total	School Teaching	University	Industry	Central Govt.	Research Assns.
NIL	43.4	45.5	35.1	31.1	66.0	46.7
1 - 3	14.3	4.5	1.5	24.2	15.0	15.6
4 - 6	12.4	9.1	16.8	15.1	7.5	11.1
7 - 9	8.8	6.8	9.9	11.9	4.1	11.1
10 - 14	9.1	13.6	13.7	8.2	3.4	6.7
15 +	10.3	15.9	18.3	9.1	3.4	6.7
Unspecified	1.6	4.5	4.7	0.4	0.6	2.2

3. Allowances are significant largely in the "administrative and *sales and service* categories. They are generally non-taxable. A high proportion of members acknowledge the non-taxable allowance of a car (51 percent) and telephone (39 percent).
4. Reference to the figures 1 and 2 showing salary movement over the last 9 years indicates that allowances tend to reduce the differences between Industry and Government remunerations.

A point has been reached where the form of the survey needs to be reappraised. What is required? Is it only a tool for industrial members during their salary reviews? If so, is the current format adequate? How can such things as job satisfaction, levels of responsibility, and superannuation be qualified. How are non-taxable allowances equated to salary? What are realistic figures to place on items such as cars? What downgrading of these should be made if they benefit the employer, e.g. telephone paid so that the employee is on call 24 hours a day? Dr M. Kingsford (C/- Chemistry Division, DSIR, Private Bag, Petone) has agreed to act as co-ordinator and responses on the subject should be made to him.

REFERENCES:

1. "GENSTAT" programme suite; Contributors: N. G. Alvery et al, Statistics Department, Rothamsted Experimental Station, Harpenden, Herts, England.
2. 1977 N.Z.I.C. Salary Survey; *Chem in N.Z.* **42,** 26 (1978).
3. 1969 Salary Survey; *J.N.Z.I.C.* **33,** 181 (1969); 34, 13 (1970).
4. 1971 Salary Survey; *Chem in N.Z.* **35,** 82 (1971);
5. 1974 Salary Survey; *Chem in N.Z.* **39,** 61 (1975).

BOOK REVIEWS

Biological and Biomedical Applications of Isoelectric Focusing. Edited by Nicholas Catsimpoolas and James Drysdale. Plenum Press. New York and London, 1977. Pp 351. ca$40

This book is one of a series on Biological Seperations and deals with certain biological applications of isoelectric focusing (IEF). While the possibility of seperating proteins and other ampholytes on the basis of their isoelectric points has long been recognised it is only within the last ten years that it has been made practicable by the availability of low molecular weight synthetic ampholytes capable of forming a smooth stable pH gradient. The method has good resolving ability and, as the range of applications covered in this book illustrates, is widely useful in biochemistry. The various chapters comprehensively review the application of isoelectric focusing to salive, cerebospinal fluid, urine, hemoglobins, muscle proteins, immunoglobulins, nuclear non-histone proteins, membrane components, seed proteins, microbial proteins, and plasma proteins. The book will appeal primarily to specialists in these fields. While the range of biological applications covered is wide, it is not exhaustive, since interesting and important applications such as the IEF of hormones and cells are not covered. The emphasis of the book is on results rather than methodology, so it will not meet the needs of those wishing to learn the techniques of IEF. Each chapter features an extensive bibliography, the book is generally well illustrated and there is a good subject index. Although few individuals are likely to purchase this book it would be a worthwhile addition to a library and should prove to be of value to specialists in the areas of biochemistry that it covers.

J. Livesey

Contemporary Quantum Chemistry. An Introduction. J. Goodisman. Plenum Press, New York and London, 1977. pp 376. $39.00.

By way of justification for another introductory text on quantum chemistry the author states that, of the existing texts, "none fit his ideas of what subjects should be discussed and in what way". We are therefore lead to expect a rather different treatment from that of the existing texts, and the title would suggest that recent advances would be given prominence. However, the topics covered (harmonic oscillators, diatomic rotors, hydrogen and hydrogenlike atoms, multielectron atoms, molecular orbital and valence bond theory) have all been covered in a similar way in other texts. The difference between this and other books on these subjects is largely one of emphasis. Thus, relatively little space (36 pages) is devoted to the molecular orbital theory of polyatomic molecules — the area of quantum chemistry in which most progress has been made in recent years. This is perhaps the least satisfactory chapter in the book, the treatment of some topics being rather superficial. For example, the statement "delocalization generally occurs when symmetry is involved" seems to imply that delocalization is a physical consequence of the presence of symmetry elements. Topics such as this are much more satisfactorily treated in older texts.

The chapters on the quantum mechanics of oscillators, rotors and atoms are much more satisfactory, the treatment being clear and the mathematical presentation not too demanding. There are also two good chapters on symmetry and time dependence. Overall, the text would probably be more suitable for a course on the fundamentals of spectroscopy rather than for one on valence theory. Each chapter concludes with a number of problems which should provide a good test of the students' understanding of the main text.

G. A. Bowmaker

Metal Toxicity in Mammals. 1. Physiologic and Chemical Basis for Metal Toxicity. T. D. Luckey andB. Venugopal, Plenum Press, New York-London, 1977, pp238, ca $33.00

This book, the first of two volumes on metal toxicity in mammals, covers the principles of chemical toxicity. A wide range of literature sources are reviewed up to 1975 with a few references to 1976 work. The introduction discusses the meaning of toxicity followed by a brief, but not very valuable, statement on analytical techniques. Modes of intake of toxins and their absorption are then reviewed, this being a useful and clearly written chapter. The toxic and physiocochemical properties of the metals are covered and is a useful summary for non-chemists. A whole chapter is devoted to carcinogenicity and teratogenicity, and finally a summary of the toxic effects of each metal is discussed in relation to their position in the periodic table. Useful features of the book are a glossary and periodic tables are the elements where the different biological activities of the metal atoms are summarised. The treatment can best be considered as an introduction to the subject and could be usefully read by chemists and biologists not very familiar with the field. However, there are cheaper, and smaller, books available. Whether libraries can afford introductory texts is a matter for individual libraries to decide, but it could be that the second volume, which appears from the authors' comments to be more detailed and specific should perhaps be viewed first.

J. E. Fergusson

MYCOTOXINS

"Mycotoxins: The World Scene and New Zealand" was the subject of a symposium organised by Applied Biochemistry Division, DSIR and held at Massey University on 19 September. The symposium was co-ordinated by Dr Rex T. Gallagher and chaired by Dr Cam S. W. Reid of the Division.

Professor Benjamin Wilson of the Center in Toxicology, Department of Biochemistry, School of Medicine, Vanderbilt University, Nashville, Tennessee, USA, a world authority on mycotoxins, was the principal speaker. He discussed his recent work on toxins produced by mold-infected sweet potatoes and by the ornamental plant *Perilla frutescens*. These chemically related compounds (furanoterpenoids) are potent cattle and rat lung toxins and they may also affect human health.

Papers presented by various New Zealand researchers started with discussions on surveillance aspects for mycotoxins in various foods (Mr Jim Fraser, Department of Health, Wellington) and analysis of the toxins, in particular the aflatoxins (Dr Don W. Stanton, Chemistry Division, DSIR, Auckland). Studies on the effect of pasture fungi on the health of animals (Dr Gary C. M. Latch, Plant Diseases Division, DSIR, Palmerston North) and the aetiology of disorders in animals grazing on grass-dominant pastures (Mr Reg G. Keogh, Grasslands Division, DSIR, Palmerston North) emphasised problems associated with attempts to work out the effects of complex microbial populations as found on farmland grass. The discovery of conditions under which toxin-producing fungi will either grow and produce sufficient toxic materials or remain dormant may lead to the establishment of effective preventive measures (Dr Peter J. Brook, Plant Diseases Division, DSIR, Auckland). A haemorrhagic syndrome observed in piggeries in South Canterbury that may be induced by feed-stuff mycotoxins (Mr Bob C. Gumbrell, Lincoln Animal Diagnostic Laboratory) and natural and induced mycotoxicoses in sheep and cattle (Dr Peter H. Mortimer, Ministry of Agriculture and Fisheries, Ruakura) were discussed.

The formal part of the symposium ended with review papers by Dr Gallagher and Professor Wilson. A general discussion then ensued on the incidence of mycotoxins in New Zealand and directions that mycotoxin research may take.

Dr Cecil B. Johnson
Branch Editor,
Manawatu

Carl Wilhelm Scheele

a sad tale if ever there was one

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BOOK REVIEWS

Lipid Metabolism in Mammals. Volumes 1 and 2. Ed. G. Fred Snyder. Plennum Press, New York – London 1977. Pp 402 (1) and 390 (2). Price $51 each.

The editor's purpose in assembling the reviews contained in these two volumes was to provide a single reference source based on a comparitive organ approach to lipid metabollism in mammals. This comparison is however, preceded by an introductory chapter.

Emphasis is placed on the synthetic and degradative pathways and their control in liver, gastrointenstinal tissue, the various components of blood, adipose tissue, brain, cardiac muscle, lung, kidney, gonads, mammary glands, the eye, skeletal muscle, skin, bone, teeth, cancer cells, the harderian gland, cultured cells and cell membranes. Many of the authors have included discussions on changes in lipid composition and metabolism in diseased tissues.

All the reviews are provided with excellent bibliographies. Reviews containing extensive literature references are frequently deficient in textural material but not one of these in the present two volumes suffers from this deficiency.

Each volume has an index, which, although not prolific, is nonetheless sufficient.

My general conclusion is therefore that "Lipid Metabolism in Mammals" constitutes not only a valuable reference source but may also be extremely useful to the researcher when planning new work.

It is my impression that the editor succeeded admirably in the task he set himself and that the two volumes are an excellent research aid in any institute concerned with the biochemistry of lipids.

The price of $51 (N.Z.) does not appear excessive for the value obtained.

T. Gerson

Food from Waste
Eds., G. G. Birch, K. H. Parker & J. T. Worgan
Applied Science, London, 1976.

This book contains twenty papers from a symposium held at the National College of Food Technology, University of Reading U. K. There is a good balance of papers from industry and university with a range of topics discussed.

The papers fall into three main groups; firstly the recovery of under- utilized or waste materials such as dairy wastes, meat, poultry and fish processing plant effluent and potato starch mill liquors, secondly the production of SCP (single cell protein) or their metabolites from carbohydrate wastes and thirdly the philosophical considerations of the whole 'food from waste' concept; including nutritional and toxicological evaluation of novel products, and socio economic considerations. On very valuable point about this book is the inclusion of the discussion period after each paper which enables the reader to share the comments and queries of the distinguished audience at this meeting. As one might expect there is much concern expressed both as to the safety of the use of novel microorganisms for food/feed production and regarding the enormous barrier erected by regulatory authorities regarding food safety and the stifling effect this has on the food from waste concept. I think it can be safely said that the opinions expressed in this book indicate the concern of the scientific community with mans inefficient utilization of food resources and emphasize that by the judicious use of some of the microscopic forms of life, enormous quantities of waste (mainly carbohydrate) may be turned into valuable feed protein. The general theme of the papers appears to be that direct human food production by fermentation of waste materials is unlikely but that this material could function as valuable feedstuff.

Recycling of waste utilization would appear to offer little scope for private enterprise so that government incentives and controls may be expected. This book certainly offers a stimulating 'pot pourri' of topics all relevant to the food technologist and environmentalist involved in the problems of feeding the world in the coming decades, and as such is to be highly recommended.

J. L. Short

Structured Questions in A Level Chemistry
byJ.R.L.SwainandJ.S.Clarke,Hodder & Stoughton, London, 1977; 122pp., £1.75

The last ten years have seen the publication of many books and booklets of multiple-choice questions in Chemistry. The British books among these, published largely by Harrap, Arnold and Hodder & Stoughton, have provided New zealand school teachers with useful sources of questions, O-level being approximately suited to Form 5 and Form 6, and A-level to Form 7.

This book presents itself as a reaction to "the semi-myth that exists that various mental abilities can be tested using only objective items". The authors define a structure question as consisting of two parts: (a) the presentation of material, which may take the form of a graph, table, diagram, passage, etc.; and (b) a series of short questions built around the material. The questions often become progressively more difficult through the series, although this is not a prerequisite. Each question in the series does not depend to a large extent on previous questions. Structured questions are intended to reflect the teaching situation: the teacher poses a problem and guides the pupils to the answer by using a series of shorter problems. The authors provide (as a condensation of Bloom's taxonomy of cognitive objectives) a classification of each question as testing knowledge, comprehension, or higher processes. The book consists of a hundred short (one or two page) tests, each being a "structured question" as described above. The questions tend to be of a detailed and specific type, requiring the student to apply known principles to the solution of particular problems, rather than to simplify regurgitate learned information (hence the low weighting, 16%, given to "knowledge" type questions). Because of this specifiity the book does not give a complete coverage of the Form 7 syllabus. However, the spread of tests (39 on General, Physical and Theoretical Chemistry, 31 on Inorganic Chemistry, and 30 on Organic Chemistry) means that questions related to most parts of the syllabus can be found. The level of difficulty of the questions ranges from average Bursary level to quite taxing Scholarship level.

This book provides a useful resource for any teacher of Form 7 or Stage I Chemistry, and in particular for the teacher looking for a text to provide supplementary problems for Scholarship candidates.

J. S. DeCourcy

Reactivity of Solids.
Edited by J. Woods, O. Lindqvist, C. Hegglesson and N-G Vannenberg, Plennum Press, N.Y., 1977, 810pp, Price $71.40

This volume contains all of the papers presented at the 8th International Symposium on the Reactivity of Solids, 1976. The 112 contributed papers were given in six sections, each section headed by a plenary lecture. Well over half the contributions were devoted to Reactions at Surfaces and Interfaces, and to the influence of Structural Defects on the Reactivity of Solids. More than one quarter of the contributions were comcerned with Solid State Reactions of Industrial Importance and with New Developments in Experimental Techniques. The remainder covered Solid State Reactions in Organic Materials and Reactions in Vitreous Solids.

For the most part each plenary lecturer did a good job in surveying his area. These plenary lectures form the best value in the book. The other papers appear to have been rigorously restricted to a length which makes them little more than notes. It is understandable why this restriction was necessary but the overall value of the book is considerably reduced in consequence. Naturally, the quality of these contributions varies over a wide range from excellent to mediocre.

The book is produced directly from typescript and the presentation is somewhat uneven on this account.

The worker in this field will need to have occasional access to this book.

A. G. Freeman.

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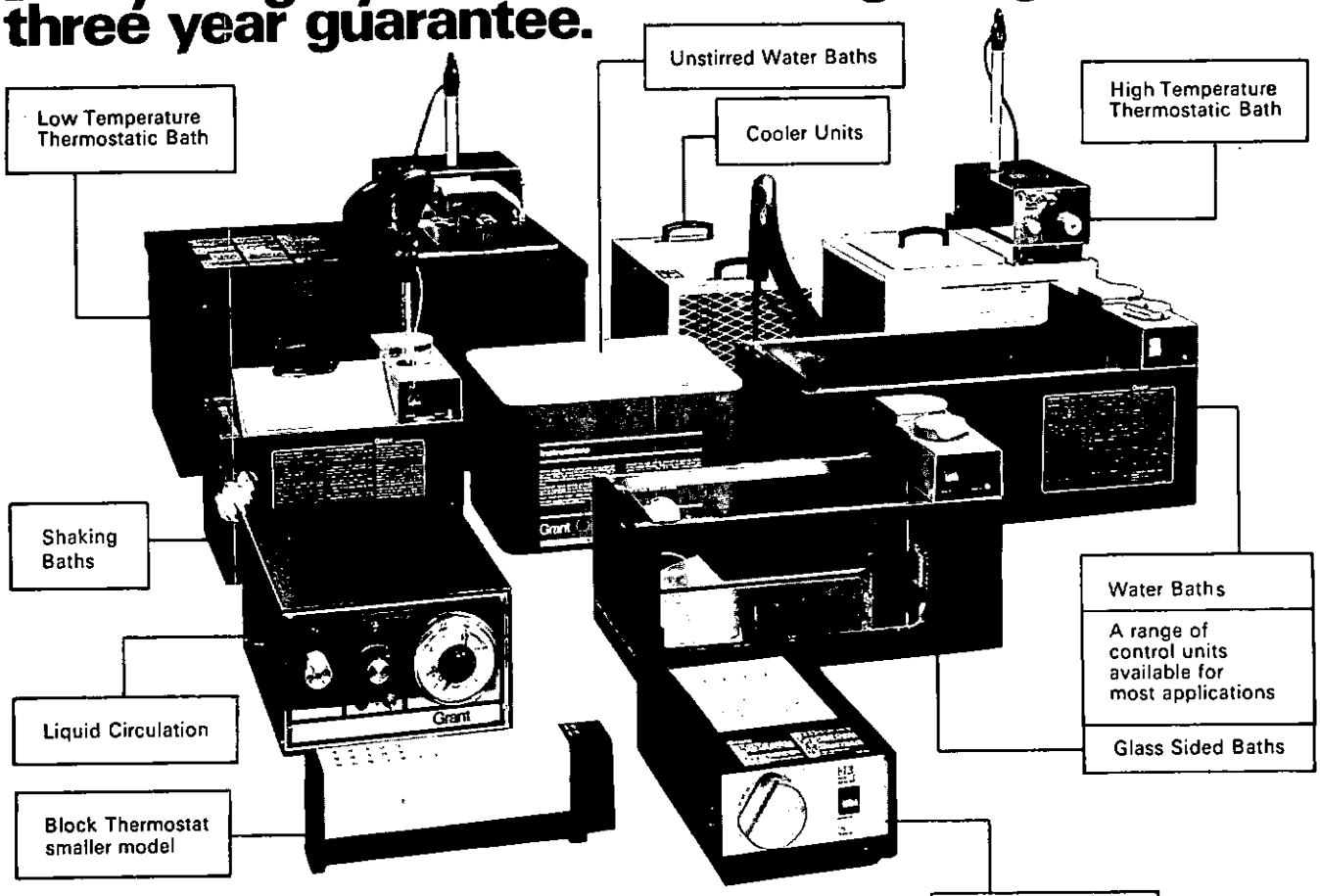

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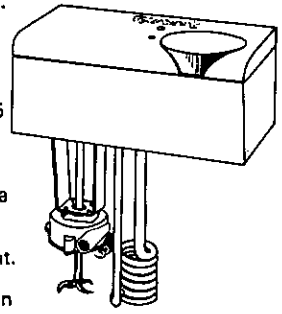

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Crystal Field Effects in Metals and Alloys. A. Furner (Editor). Plenum Press, New York-London 1977, pp 365, ca $45.00.

This book is a collection of papers presented to the Proceedings of the Second International Conference on Crystal Field Effects in Metals and Alloys, Zurich 1976. Consequently the book is highly specialised and probably would only be considered for purchase by specialists in the field or libraries. Topics covered in the 58 papers include spin waves, magnetic effects, electron spin resonance, physical properties of metals and alloys and the Jahn-Teller effect and the majority of papers deal with the lanthanides. Except for the invited papers the contributions are brief, 3 to 4 pages of typescript, and therefore can only be considered a summary of the full research. It is clear that there is some doubt concerning the usefulness of the crystal field model for the description of metals and alloys especially as the crystal field applies to local effects rather than the complete metallic lattice. However, the field of study is an important one with numerous applications including permanent magnets, hydrogen storage, insulators and conductors. While the majority of us need to wait for a more introductory text the specialists in the field will welcome the collection of papers, if not the price.

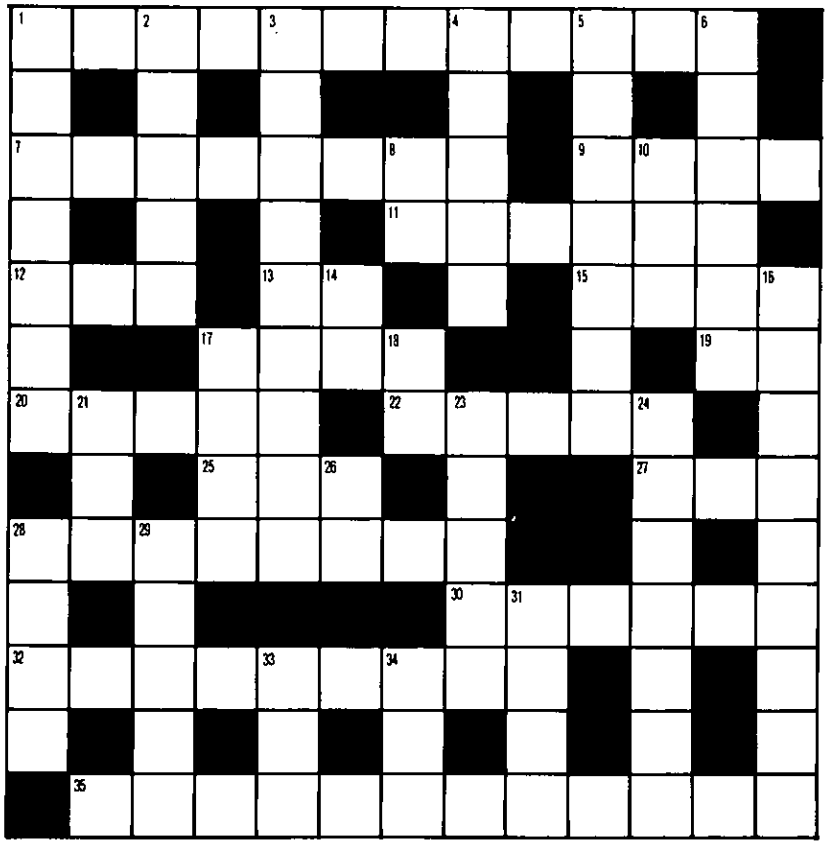
J. E. Fergusson

Characterization of Solutes in Nonaqueous Solvents. G. Mamantov (Editor), Plenum Press, New York-London 1978, pp325.

Contributions to a Symposium on Spectroscopic and Electrochemical Characterization of Solute Species in Nonaqueous Solvent, San Francisco 1976 make up the contents of this book, the format being the original typescript of the papers. The solvent areas covered are organic, covalent inorganic and molten salts. The book includes fifteen papers and outside the field of nonaqueous solvents covers a diverse range of topics such as ligand substitution reactions, alkali metal ions in organic solvents, spectroscopic (nmr, esr, ir, ur-vis) methods, electrochemical techniques, acid-base and redox chemistry. For this reason only a few people will find the whole book of interest, but it is clearly a book of value in most chemical or chemical engineering libraries. A feature of a number of the papers is the joint use of spectroscopic and electrochemical techniques for studying various problems and especially in characterising the various chemical species produced such as rhodium and iridium diimine complexes and the chalcogen species in chloroaluminate melts.

J. E. Fergusson

CHEMICAL CROSSWORD – By Mike



CLUES

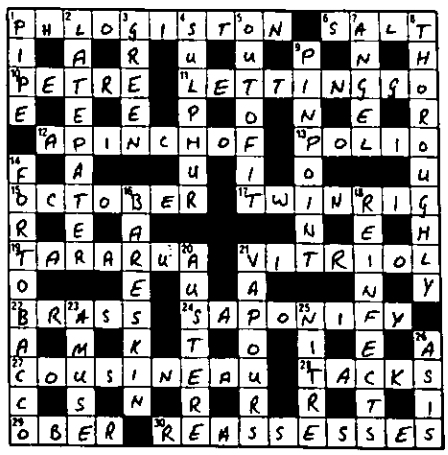
Across

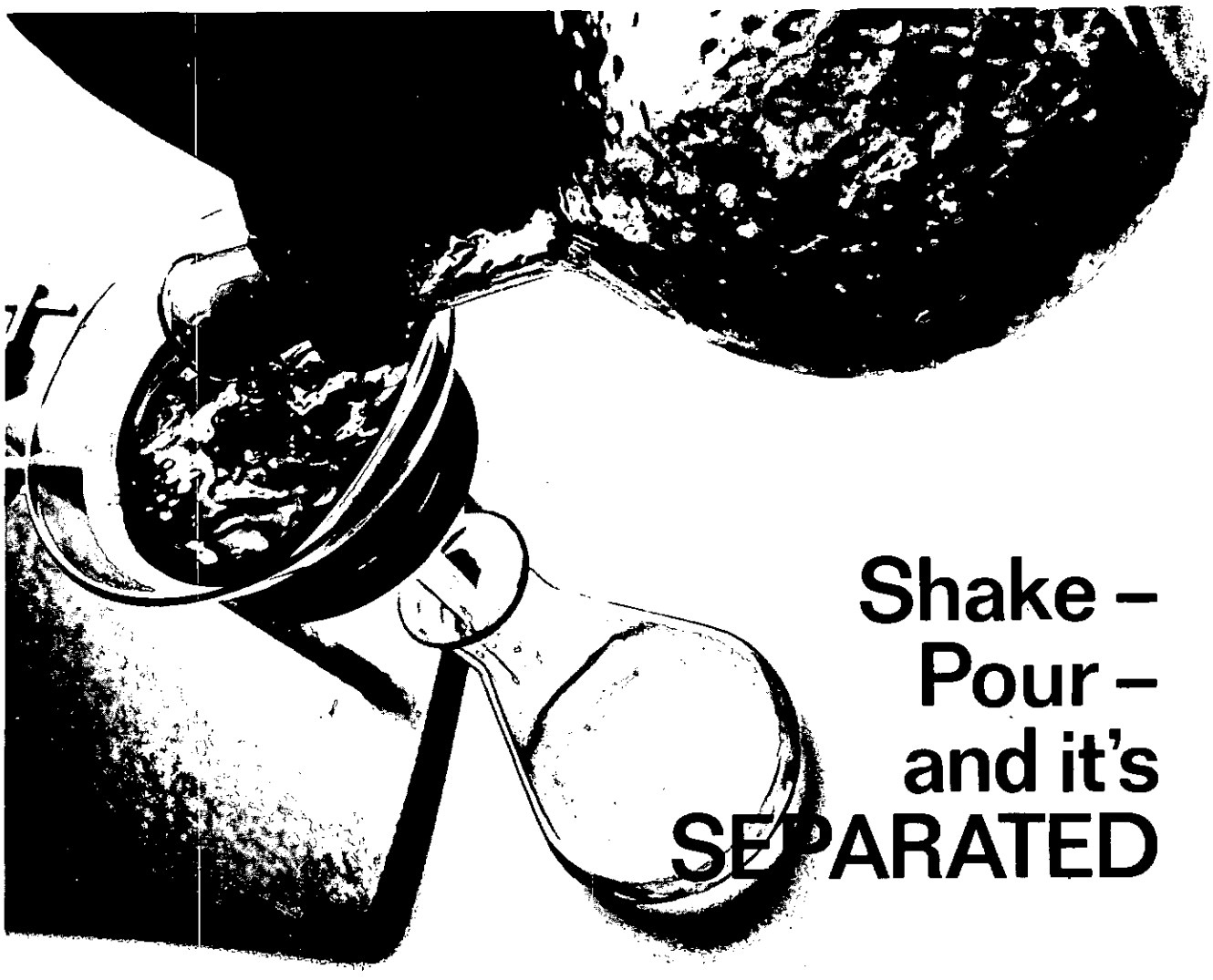
1 Type of 35, often like 2, 11 but less direct (12).
7 Stunted, to a point, perhaps due to lack of trying (8).
9 Wordless crossword puzzle? (4)
11 See 2 dn.
12 Plant growth factor (3).
13 Five cents worth of metal? (2).
15 Original home of need (4).
17 Weighty type of 35 (4).
19 Loop? (2).
20 Type of 35, usually of 22, 10 variety (5).
22, 10 Type of 35, converse of 2, 11 (5, 3).
25 It hasn't been this cold for ages! (3).
27 The lot (3).
28 See 5 dn.
30 Electronic feeler (6).
32 See 1 dn.
35 Of which 17, 20, 22 ac and 1, 2, 5 dn are varieties!! (12).

Down

1, 32, 5, 28 ac, 3 Sophisticated version of 5 (7, 9, 7, 8, 9).
2, 11 ac Far-out type of 35? (5, 6).
3 See 5 dn.
4 Spanish port (5).
5, 28 ac, 3 Type of 35 (7, 8, 9).
6 Came out in the wash? (6).
8 Unit of energy (2).
10 See 22 ac.
14 Bob to be 18 on his head (2).
16 Usual amount in solution (9).
17 In a sentence without a comma in it, this is usually important adjective.
18 Element of elements of 14 (2).
21 Small amino acid is palindromic (3).
23 Walking because it's not running (2, 3).
24 If it's in a glass ignore it and give it a value of nowt (6, 1).
26 Al's mate (2).
28 Often found in the sort of infamy the ancients used to put about (4).
29 Comprehension of a gripping nature (5).
31 Small rodent is confused; losing nothing it becomes other creatures (4).
33 Has a cavity in it, containing fluid (3).
34 Sounds like an alternative for a row (3).

Answer to the last Crossword





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