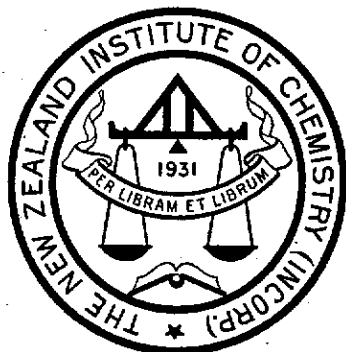


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RUAKURA ANIMAL RESEARCH STATION

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CHROMIUM



THE only workable source of the element chromium is chromite, a compound of chromium, iron and oxygen mined in Russia, Africa and Turkey. Chromium is known everywhere as the plating on taps, hardware and motor fittings, but it has other and more important applications. Alloyed with steel, for example, it imparts superior strength and surface hardness, and it is from chromium that stainless steel derives its resistance to corrosion. As well as being the source of chromium, crude chromite ore is used to make heat-resisting firebricks and cements for the construction of furnaces. Chromium derives its name from the Greek "χρῶμα", meaning colour, because its compounds are almost always coloured. Known as chrome pigments, some of these—the chromates of lead, zinc and barium for example—are used extensively for colouring paints, linoleum, rubber and ceramics. Chromium sulphate is important in tanning, and potassium dichromate in the dyeing of wool, silk and leather. Other chromium compounds are used in photography and in the manufacture of safety matches. I.C.I. makes a complete range of chrome pigments for the paint, linoleum and rubber industries, besides employing chromium compounds as catalysts in the manufacture of aviation petrol and methanol, an industrial alcohol.



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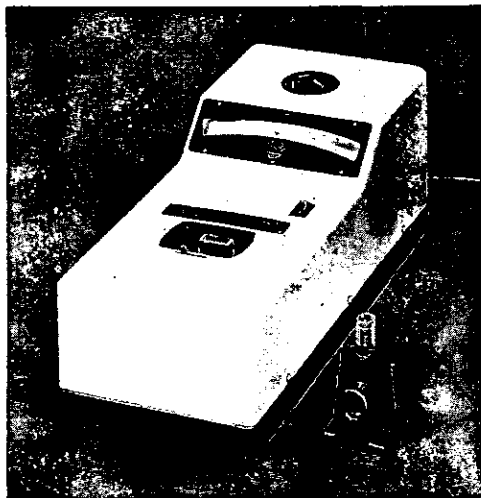
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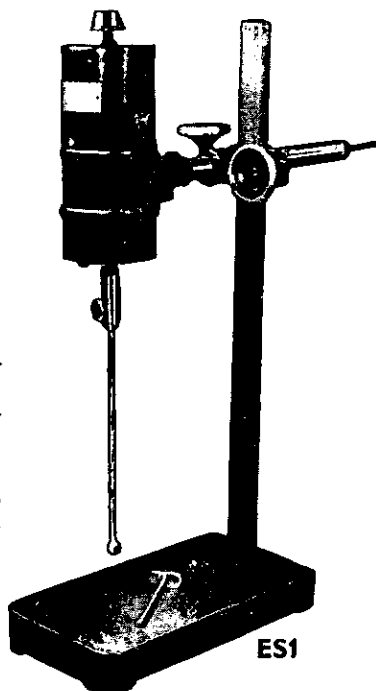
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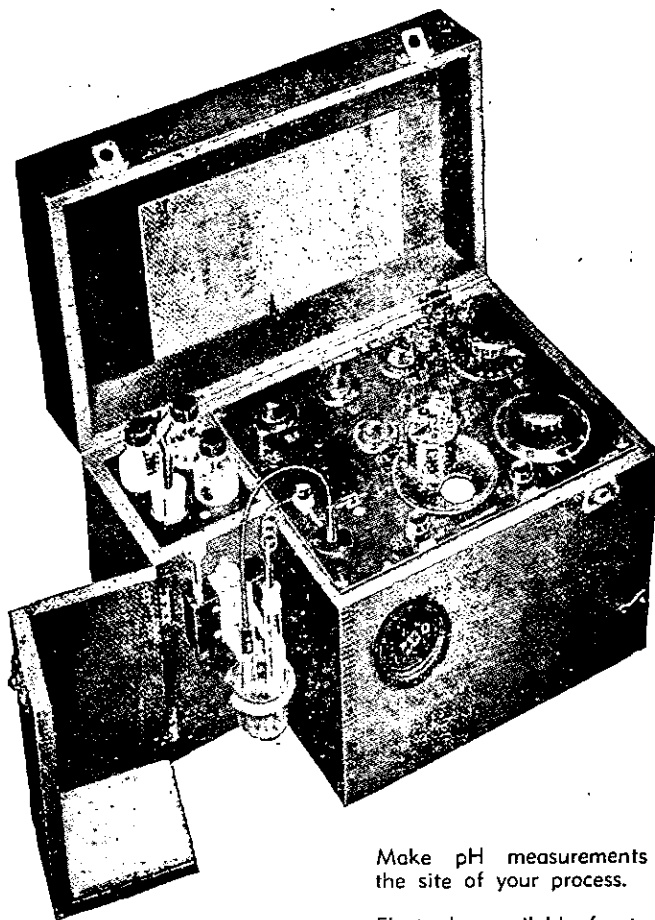
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**THE WORK OF THE BIOCHEMICAL SECTION,
RUAKURA ANIMAL RESEARCH STATION**

**N. T. Clare, Chief Biochemist,
Ruakura Animal Research Station, Hamilton**

For nearly forty years almost all the chemical work of the Department of Agriculture was carried out by the Chemistry Section in Wellington controlled first by Mr. B. C. Aston and later by Mr. R. E. R. Grimmett. As animal research work of a chemical nature increased, chemists were stationed at Wallaceville, Ruakura and Lincoln College. All these units were included in the Animal Research Division formed in 1939, with the exception of a number of soil chemists who were placed under the Fields Division. With the development of the policy of placing chemists and chemical laboratories where they could be integrated with the field aspects of animal and pasture studies, the Chief Agricultural Chemist and his staff were transferred to Ruakura Animal Research Station in 1945. In 1946 when Mr. Grimmett was appointed Superintendent of the newly established Rukuhia Soil Fertility Research Station some of the chemists whose chief interests were in soil and plant problems accompanied him, those concerned with animal diseases and nutrition remaining in the Biochemical Section of Ruakura Animal Research Station. Until the projected new laboratories are built at both Stations, these two groups of chemists continue to occupy the war time munitions factory at Dey St., Hamilton. Both these chemical sections may claim a lineal descent from the Chemistry Section which pioneered much valuable agricultural research in New Zealand.

Much of the chemical work at Ruakura is conducted in close collaboration with the agricultural research officers and veterinarians, the chemists providing analytical services and devising

methods for obtaining the information required by the field workers. Other projects, particularly those in photosensitization diseases and other toxic conditions, are carried out almost entirely by chemists. The work of the laboratory over recent years can be conveniently divided into six main groups:—

1. Nutrition Chemistry.
2. Milk composition studies.
3. Blood analysis.
4. Facial Eczema and photosensitivity diseases investigations.
5. Estimation of sex hormones in urine of ewes.
6. Various toxicological studies.

Nutrition Chemistry

(a) Measurement of intake by grazing animals and digestibility determination.

In work on the nutritional value of animal feed stuffs it is almost always necessary to know how much the animal eats and how much it can digest. In Europe and America where a great deal of the productive feeding has been carried out with confined animals on concentrates and conserved fodders it is comparatively easy to obtain this information by weighing what goes in at one end of the animals and what comes out at the other. In New Zealand, where virtually all production depends on the grazing of pasture, and where even conserved feeds are fed outdoors, the difficulty of measuring the intake of grass by the grazing cow or sheep, and the digestibility of that grass, has been a stumbling block in animal nutrition work. The development and application of techniques for this purposes have been foremost in the work of the nutrition team.

Since the faeces voided by the animal represents mainly the indigestible matter of the feed, the weight of grass eaten can be calculated from the weight of faeces voided and the digestibility of the grass. Assessment of these two factors without recourse to collection of all the faeces is the essential problem of measuring the intake of the grazing animal.

A suitable procedure for measuring *faeces output* has been worked out by Lancaster, Coup and Percival (1, 2). A cardboard capsule containing 10g of chromium sesquioxide is dosed twice daily to each cow (at milking times) and a sample of dung is taken directly from the cow at the same time. Since the chromic oxide is quite insoluble in the digestive tract and is therefore

excreted unchanged the concentration in the faeces samples indicates the "dilution" of the oxide with feed residues, and the weight of faeces dry matter voided (F) can thus be calculated from the

relationship $F = \frac{20}{c} \times \frac{100}{1}$ where c = the weight of chromic

oxide in 100g. dried faeces. (In practice the ash content of the sample is also determined and the estimate expressed on an organic matter basis, since contamination of pasture with soil, which contributes little nutritional energy, is variable and sometimes considerable).

A method of determining *digestibility* from analysis of the faeces only has been worked out by Mr. R. J. Lancaster (3). Working with data from sheep digestibility trials he found that irrespective of the nitrogen content of the grass, the amount of nitrogen excreted per 100g. of grass organic matter eaten was relatively constant ($0.83 \pm .10g$). From this value the amount of faeces organic matter produced from 100g. of grass is:

$\frac{0.83}{x} \times \frac{100}{1}$ where x is the concentration of nitrogen found

in 100g. faeces organic matter. The percentage of digestible organic

matter is then given as $100 \left\{ 1 - \frac{.83}{x} \right\}$.

For the calculation of the digestibility of grass by cows the relationship is less simple, since the nitrogen content of the faeces per 100g. grass eaten is dependent on the nitrogen content of the grass (4). This would introduce the necessity of a pasture nitrogen determination, with its attendant sampling difficulties. (Chemists cannot accurately imitate the selective grazing behaviour of the cow!) However from an analysis of a series of 22 trials conducted at Ruakura, Dr. A. H. Carter has established a statistical relationship between the nitrogen concentration and the "intake factor." This "intake factor" is the inverse of the indigestibility and is the value by which the weight of faeces voided is multiplied in calculating the intake.

Although the faeces nitrogen concentration is used in slightly different ways for the two species, the fundamental basis of the relationship appears to be the same in each case. The nitrogen in the types of pasture grazed in New Zealand is highly digestible, so that most of the excreted nitrogen is of metabolic origin—it has been absorbed and excreted again in intestinal secretions, or

is the indigestible nitrogenous component of the micro-organisms which play a large role in ruminant digestion. The amount of this metabolic nitrogen is relatively constant over a wide range of nutritional levels; its concentration in the faeces therefore gives a measure of the degree to which it is diluted with indigestible feed residues.

The essential requirements for a method of intake measurement applicable to grazing animals are that it must be independent of pasture analysis, must not involve quantitative collection of faeces and must interfere as little as possible with the normal management of a milking herd. It was established quite early in the work that chromium sesquioxide is excreted sufficiently quantitatively to serve as reference substance. Because the method is based on the collection of small samples of faeces twice a day a great deal of the subsequent work in developing and testing the method has been the study of the adequacy of such samples in representing the daily excretion of faeces. The fluctuations in marker concentrations from day to day, from morning to evening, and from defaecation to defaecation have all been examined (1).

These experiments have revealed considerable fluctuation, but by bulking the twice-daily samples over a fortnight a mean concentration is obtained which gives a sufficiently accurate measure of faeces output.

Similarly investigation of methods of bulking have been necessary—since the output of faeces is the value to be determined, the ideal method of combining aliquots from each day's faeces is obviously impossible. Although the most convenient procedure, bulking of 5g. portions of the dried faeces from each grab sample, gives a bias towards underestimation of faeces output this bias is sufficiently consistent for allowance to be made for it.

The error in the whole procedure for the intake measurement of individual cows, combining errors arising from both faeces output and digestibility determinations, has been assessed as ± 15 per cent. While this may appear considerable to those accustomed to purely chemical techniques the method provides a more exact measure of intake than has hitherto been possible with individual cows in a grazing herd. In the Ruakura Nutrition Section, under the direction of Dr. L. R. Wallace, such intake measurements are used, in conjunction with milk and butterfat yields and bodyweight changes, for the calculation of the efficiency of butterfat production per acre by grass-fed cows and the study of factors

such as breed, type and management which may influence this efficiency.

The scale of operations involved is illustrated by the following figures. Throughout the 1952-53 milking season the individual intake, over 14 day periods, of 64 cows has been measured, while additional short term experiments have increased the number of animals to over 100 at times. This work alone has involved the preparation in the laboratory of over 30,000 10g. capsules of chromic oxide and 1500 analyses for chromium, nitrogen and ash. Altogether about 7 cwt. of chromic oxide is required annually.

The chromium analyses are made by a procedure worked out by Coup and Lancaster (5), modified recently by Christian and Coup. The chromic oxide in the faeces ash is oxidised to dichromate by bromate in a phosphoric-sulphuric mixture, with manganese as catalyst. The dichromate is reduced by excess arsenite and the back titration is carried out with permanganate.

The use of another substance, Monastral Blue (copper phthalocyanine) for measuring faeces output originated at Ruakura. Monastral Blue has certain advantages over chromium sesquioxide, in particular the more rapid estimation which involves only a copper determination on the digest made for the Kjeldahl nitrogen, but until recently the amount of Monastral Blue available has not been sufficient for extensive use.

One disadvantage of Monastral Blue is that the natural copper content of the faeces gives a "base line" which because of its irregularity is difficult to allow for in assessing the marker recovery.

In some experiments on the rate of passage of faeces both chromium sesquioxide and Monastral Blue have been used together. Unexpectedly low recoveries of copper encountered in these experiments were eventually traced to interference by chromium which appears to give insoluble copper chromates. A method involving an initial extraction of the copper with acetic and nitric acids has been devised for the determination of copper in presence of chromium (5).

An alternative method for measuring digestibility is the "chromogen" determination devised by a group of American workers. In this method the concentration of faeces pigments derived from plant pigments is correlated with digestibility. Fundamentally the method appears to depend on the fact that the degradation of chlorophyll by the ruminant leaves intact the porphyrin ring,

which gives a strong absorption conveniently measured at $406m\mu$. Although a variety of chlorophyll derivatives occur in the faeces, the absorption curves of these pigments and of the plant pigments show an isosbestic point at $406m\mu$, hence the optical density at this wavelength of 100g. of grass in a given volume of acetone is the same as that of an equal volume of acetone extract of the amount of faeces derived from 100g. of that grass. Studies so far indicate that this method is more sensitive for New Zealand pastures than the nitrogen method, but the more cumbersome chemical determination and the necessity to work with raw faeces are disadvantages. (Estimation of chromogen on dried faeces has not proved satisfactory). Investigations by Mr. R. J. Lancaster and Miss M. P. Bartrum are now in progress on the chemistry of the chromogen method in the hope of increasing its speed and flexibility.

The claim that the Ellis, Matrone and Maynard method for estimating "lignin" (6) yields a fraction which is totally indigestible and hence of use as an internal marker for calculating digestibility, has been examined by Miss M. P. Bartrum (7) for New Zealand pastures.

Inconsistent analytical results led to an examination of the method of determination, and the main source of error was shown to be slight variation in the conditions of digestion with 72 per cent sulphuric acid, the recommended temperature ($20^{\circ}\text{C}.$) being apparently the minimum temperature for complete hydrolysis of cellulose in 2 hours. Digestion at $38^{\circ}\text{C}.$ was adopted as a standard procedure, since this temperature gave the lowest values for lignin.

On applying this method to samples of feed and faeces from twelve digestibility trials with sheep and cattle Miss Bartrum obtained digestibility figures for lignin ranging from -17 to $+30$ per cent, nearly half being in the range 0 to $+10$ per cent. It was concluded that lignin estimated by this method did not yield a product satisfactory for use as an internal marker.

(b) Studies on nutritive value of special purpose feeds.

From time to time studies on the nutritive value of special purpose pastures, based on chemical composition and digestibility trials, have been carried out. The nutritive characteristics of pampas grass (*Cortaderia selloana*) as indicated by digestible organic matter and digestible protein was examined by Mr. Coup (8). No difference in nutritive value was found between different strains of this plant and the fertility level of the soil did not show any consistent influence on the nutritive value. Severe frosting how-

ever appeared to reduce the nutritive value. While removal of the seed head during growth did not improve the value of the plant as a fodder, the stage of growth at which the pampas was fed was shown to be important. Pampas cut every three months had the best nutritive characteristics, but this would not be an economic method of management, while material cut only once a year showed a marked reduction in digestible constituents. The system of feeding pampas twice a year, when grass is short in winter and summer, was recommended. Comparing pampas with other fodders likely to be used at these times led to the conclusion that it was of about the same nutritive value as an average-quality pasture hay.

In similar studies on *Paspalum dilatatum* Coup and Dunlop (9) found that young paspalum had a nutritive value comparable to summer-grown mixed dairy pasture, that paspalum of intermediate maturity was comparable to good silage, and that mature paspalum had the nutritive characteristic of hay.

In six trials with autumn saved pasture Coup, Percival and Lancaster (10) showed that the autumn flush of pasture, preserved *in situ* for feeding in the late winter and early spring, retained a high feeding value almost as good as high quality spring pasture.

From this account it is apparent that the chemists in the nutrition field at Ruakura have so far largely been engaged in development of techniques applicable to New Zealand conditions of pasture grazing. Further technique studies, such as the examination of the best methods of assessing the feeding value of pasture and of expressing this in a standard form, and investigation of the influence of season on the nutritional value, in terms of production, of the constituents of pasture will call for the collaboration of the chemists as these problems become more accurately defined by data now being collected by the nutrition team. While some of these problems may be answered in terms of the amount and digestibility of pasture available, it is possible that others will involve qualitative investigation of the composition of pasture at different stages of growth, a rich field for the biochemist when he knows what effects he is to look for.

Milk Composition Studies

In studies by Mr. D. M. Smith on pig nutrition it has been essential to consider both the quantity and the nutritional quality of the milk supplied by the sows to the litters. Samples of milk are

obtained each week during the 8 week lactation with the sow milking machine devised by Smith, Whittlestone and Allen (11). These samples are analysed by Mrs. D. R. Perrin for fat, protein, lactose, total solids and ash, and the gross energy calculated from the composition by applying the appropriate factor for each component. From this work more reliable information has been obtained on the chemical composition of sow's milk and on the changes which occur during lactation than was hitherto available. Variation of the mineral constituents has also been studied. The results of these composition studies are embodied in a paper recently prepared for publication (12). Lactational trends include (a) a rise in fat and total solids over the first three weeks, followed by a fall over the remaining period; (b) a fall in protein for the first two weeks, followed by a steady rise; (c) a fall in lactose from the third week onwards; (d) a general rise in ash constituents throughout the lactation. Examination of day to day variations has shown that fat values may change considerably, but non-fat components are relatively constant. In practice therefore, the analyses are made on composite samples prepared from three milkings in each week. Variations in composition of the milk during the process of milking were found to involve chiefly an erratic fat content in the early part of the lactation.

Analyses of sow colostrum have similarly provided data on the rapid composition changes, particularly in protein and lactose, during the first 2-3 days. The total ash and particularly calcium and phosphorus are high in colostrum and decrease as the milk flow becomes established in contrast to the gradual increase in these mineral constituents in the ash of the colostrum of the dairy cow.

Since the initial purpose of these analyses—the estimation of calorific value of the milk of individual sows—required a large number of complete analyses a less laborious procedure was sought. Examination of the analytical results from the first 34 lactations showed that, for a given stage of the lactation, the lactose and ash content of the milk of different sows is remarkably constant. By taking mean values for these constituents for each week of lactation and calculating protein by difference it is possible to estimate the energy content of the milk from an analysis for fat and total solids only (Dawn R. Perrin, 13). This labour-saving method gave very close agreement with results obtained by complete analysis—in a comparison over 11 different dietary levels involving nearly 70 lactations the extreme difference between the group mean values obtained by the two methods was 1.2 per cent of the gross energy. This is well within the errors involved in assessments of milk yield, growth rate, etc.

Special modifications of methods devised originally for analysis of cow's milk have been necessary in this work to suit the particular characteristics of sow's milk and for colostrum.

A number of studies of the detailed composition of cow's milk at various stages of lactation and during the milking process are being carried out by Mrs. Perrin in connection with investigations on the hormonal control of milk let-down undertaken by the milk secretion group under Mr. Whittlestone, and with Mr. Hancock's experiments in which lactation has been artificially induced and maintained by hormone administration.

Blood Analysis

One of the long term studies at Ruakura involves a comparison of good and poor rearing upon the life time performance of dairy cows. Groups fed on a high and even level of nutrition by the use of modern techniques of farm management are compared with groups whose level of intakes is subjected to the seasonal fluctuations experienced in set-stocked management. Data being collected in this experiment include the blood status of each animal in respect to calcium, phosphorus, magnesium, blood sugar and acetone bodies. Determinations are made by Mr. R. R. White every month and weekly around the calving period. These constituents have been chosen for special study because they are associated with metabolic disorders such as grass staggers and milk fever. Results covering the productive life of the animals with which the experiment started are now being examined statistically. Information on the normal level of these blood constituents at various ages and at various seasons should emerge from this study. The most obvious trend apparent in these results is a tendency for the cows which have been consistently on a poor plane of nutrition to have a lower serum magnesium than those which have been well reared.

To extend the range of blood studies in connection with the metabolic disorders of cows, Mr. R. R. White is undertaking determinations of ionized calcium and ionized magnesium in the blood serum of affected animals.

Facial Eczema and Diseases involving Photosensitivity

Before describing the work in progress on facial eczema some explanation of the nature of photosensitization in animals is per-

inent, since this is a spectacular, although by no means the most important lesion, in facial eczema.

When certain substances which are activated by light are introduced into the skin tissues of animals a dramatic sensitivity of the skin to sunlight results, with sequelæ which include reddening, itching, swelling and eventually necrosis and scab formation. Photochemical oxidation of specific amino acids in the membrane of the skin cells, leading to a release of inflammation producing substances, is considered to be responsible for these reactions.

Photodynamic agents active *in vivo* vary widely in their nature and origin and for convenience a classification of diseases involving photosensitization may be based on the origin of the photodynamic agent or the process by which it reaches the skin (Clare 14). Most photosensitivity diseases in animals fall within two types. In Primary Photosensitivity the photodynamic agent is a plant pigment not usually encountered in the animal's diet and not efficiently excreted or detoxicated by the liver; in Hepatogenous Photosensitivity the agent is the chlorophyll breakdown product phylloerythrin. This pigment is normally absorbed from the digestive tract of ruminants and is excreted in the bile. Only when the excretory function of the liver is impaired does phylloerythrin accumulate in the blood and reach the skin.

(a) Facial Eczema

Facial eczema belongs to the second of these types, phylloerythrin being demonstrated as the photodynamic agent at an early stage in the investigation (15). The derangement of liver function is accompanied by characteristic morphological changes in the liver which include a mottled appearance due to fibrosis and development of necrotic areas. In many sheep which have shown none of the external symptoms seen in acute cases quite severe liver lesions are found on post mortem examination, such damage having probably developed slowly enough to allow the liver to maintain its function by production of new tissue. The search for the cause of this liver damage is the immediate object of the work in progress at Ruakura. When sufficient is known of the toxin to permit reasonably accurate estimation, the conditions which control its concentration in the plant can be studied. With that information, measures to control the disease can be placed on a more secure foundation.

The general hypothesis which has been followed throughout the facial eczema work is that the liver damage is produced by a toxin elaborated under certain seasonal and climatic conditions in

pasture which is normally quite safe. The disease occurs in both sheep and cattle in the autumn months chiefly in the Waikato, Hawkes Bay and Gisborne districts, the incidence varying from year to year and reaching epidemic proportions with considerable economic loss in some seasons. The climatic conditions leading to outbreaks are still not clearly defined, but in general severe outbreaks have been associated with an autumn flush of pasture which occurs when rapid growth is stimulated by warm rain following a spell of dry weather.

The dependence of the disease on such factors has added to the difficulty of securing toxic pasture for isolation of the hepatotoxin. Until recently lambs were the smallest animals which could be used for test purposes, so that a large quantity of grass was necessary for extraction work. Since the toxin may have disappeared from the grass by the time clinical cases are seen in the field the collection of toxic pasture is still further complicated. At the Manutuke station at Gisborne grass is mown and dried daily throughout the critical months. Periodically sheep, grazing paddocks from which this grass is cut, are slaughtered for liver examinations and new sheep are introduced. If lesions are found in any sheep the grass collected while they were grazing the area should contain the toxin, and this can be checked by feeding the dried grass to other sheep. In this way dried grass of low toxicity was obtained in several years, but this material was of little use for extraction experiments.

In 1951 a comparatively small sample of more toxic grass was collected. In view of the immense advantage of a smaller test animal for the work, and with experience of the use of the guinea pig for work at Ruakura on other liver damaging toxins as a guide, feeding tests with guinea pigs were carried out at both Wallaceville and Ruakura. The results established the guinea pig as a test animal for the facial eczema toxin (16). This advance means that about 50 experiments can now be done with the amount of dried grass (100 lbs) which previously would have been necessary for one experiment using sheep. Since the grass available is still comparatively low in toxicity and the liver lesions take some time to develop it is necessary in each experiment to continue the feeding over at least four weeks, a guinea pig of 150g. consuming about 400g. in this time, and at least twice as much grass is required in extraction experiments.

With a small test animal available work on the extraction of the toxin proceeded, and in the first experiments carried out by Mr. E. P. White it was found that continuous extraction with

either acetone or ether will extract the toxin. Subsequent fractionation of these extracts has so far not been successful, as loss of toxicity occurs during concentration of the extracts under quite mild conditions. It must be remembered that there is no knowledge of the type of compound with which we are dealing to guide the course of fractionation. The only evidence at present for the presence of the toxin in any fraction is the lesions in the guinea pig's liver after the animal has eaten the extract, incorporated into non-toxic grass meal, for a month. Progress is necessarily slow. In the meantime, however, small scale fractionation of the extracts is being continued to accumulate information for later stages of the work, and it is possible that this work may in itself enlarge our knowledge of the minor constituents of pasture grasses.

The tediousness of the present guinea pig liver test has stimulated the search for a more rapid small scale test for the toxin. Dr. D. D. Perrin is conducting a series of liver function tests and other biochemical observations on guinea pigs fed the toxic grass or extracts. Increased blood amino acid nitrogen has been observed in some affected guinea pigs, but this occurs too late in the disease to reduce the period of the test. Preliminary observations carried out with the collaboration of Dr. Lyttleton at the Plant Chemistry Laboratory on the electrophoresis of serum proteins showed changes in albumin and β globulin fractions in a guinea pig showing typical liver damage. If such changes can be detected in animals fed for shorter times they could provide the basis for a quicker test. Liver function tests depending on the rate of elimination of dyes—bromsulphthalein and rose bengal—have been adapted for use with guinea pigs and will be tested as affected animals become available. Liver tissue slice techniques are also being explored for this purpose.

A second approach which if successful would greatly facilitate the isolation of the toxin is the attempt to control conditions of pasture growth with the object of producing toxic grass, and preferably grass of high toxicity, at will. Dr. Perrin has set up frames in which soil and air temperature and supply of moisture can be controlled, and in which guinea pigs can be grazed. Once again the usefulness of the small test animal is apparent, since such experiments would not have been practicable on the scale necessary to supply grass for sheep.

In a recent paper (17) important conclusions which can already be drawn from these advances in the facial eczema work were summarized as follows:

"1. Facial eczema is not a simple deficiency disease.

2. Facial eczema is due to a toxic substance present in the pasture sample. This has of course been postulated for many years but this is probably the first time that the fact has been demonstrated experimentally.

3. Because of its solubility in organic solvents the facial eczema toxin is not protein in nature. It may be concluded therefore that facial eczema is not caused by the direct action on the animal of a virus or a micro-organism.

4. Because the liver damage can be produced in the guinea pig, which is a rodent, it is clear that facial eczema liver damage is not peculiar to ruminants.

It might be added that no significant amount of the fluorescent alkaloid, perlorline, has been detected in this dried grass."

(b) Millet Poisoning

In the course of the work on facial eczema other toxic conditions in which liver damage is associated with photosensitivity have been studied. Chief among these is poisoning by broom corn millet (*Panicum miliaceum*). This plant is not normally used as a stock feed in New Zealand, but was grown by a farmer a few years ago at Gisborne and produced a severe outbreak of what appeared to be facial eczema. Although detailed observations revealed marked differences between *Panicum* poisoning and facial eczema, isolation of the *Panicum* toxin was attempted since experience gained in the one disease could contribute useful information for work on the other. Unlike the facial eczema pasture *P. miliaceum* is highly toxic at almost all stages of growth. At an early stage it was shown that the full syndrome—including liver damage with bilirubinæmia and photosensitization—could be produced in guinea pigs. The van den Bergh reaction for bilirubin in blood taken by heart puncture is used as the criterion of toxicity, and positive results of feeding tests have been obtained in as short a period as three days, although usually feeding periods up to 14 days are necessary. An extensive series of experiments carried out first by Mr. D. S. Letham and subsequently by Mr. J. W. Ronaldson have shown that most organic solvents do not readily extract the toxin, which persists in the plant residue even after prolonged boiling or treatment with 1 per cent hydrochloric acid. Positive results have been

obtained by repeated extraction with large volumes of cold water, but either the solubility in water is low or two factors are present, since the plant residue after five such extractions is still toxic. Methanol extracts which for feeding purposes had been mixed with methanol-extracted dried grass meal have also proved toxic; but no positive results have been obtained when such extracts were incorporated into unextracted grass meal. It has been found that "reconstituted millet", that is, methanol extract incorporated back into the plant residue, is as toxic as the original millet, whereas the residue alone is not toxic even when fed at three times the usual dose rate. While interpretation of these results is at present uncertain, they do demonstrate the stability of the toxin under the conditions of manipulation. The greatest degree of concentration of the toxin so far obtained has been achieved by prior extraction of the plant material with ether and acetone, followed by continuous extraction with hot methanol and removal of inactive insoluble material. In this way an extract containing 8g. dry matter is obtained from 100g. of dried millet.

Biochemical studies on the guinea pigs poisoned by *Panicum miliaceum* are being carried out by Dr. Perrin. In the severer stage of the intoxication, when bilirubinæmia is detectable, there is an elevation of blood amino acid nitrogen, while the blood alkaline phosphatase is normal. These results suggest that the biliary obstruction, which would be expected to increase the alkaline phosphatase, is preceded by damage to the liver tissue.

When bromsulphthalein or rose bengal is injected into the blood stream of millet poisoned guinea pigs the removal of these dyes by the liver is slower than for normal animals. As such retarded elimination has been observed prior to the development of bilirubinæmia these tests of liver function may prove useful where the production of bilirubinæmia is doubtful.

(c) Photosensitization by chlorophyll derivatives in dried *Panicum miliaceum*

In early attempts to isolate the *Panicum* hepatotoxin the writer found that alcoholic or ether extracts of dried millet produced photosensitivity in rats, a single feeding of the extracts being enough to make rats photosensitive next day. Although the full syndrome, involving liver damage and jaundice, could not be reproduced in rats after prolonged administration of the extracts, there were reasons to assume that this photosensitivity was due to derangement of the phyloerythrin excretory mechanism of the liver. An alternative possibility, that the ability of the rat liver to excrete phyloerythrin or other chlorophyll derivatives was

insufficient for the high level of chlorophyll in these extracts, appeared untenable because neither similar extracts of other dried grasses nor high doses of freshly prepared chlorophyll produced these effects.

However as fractionation of these extracts proceeded it became evident that the active fractions were always those containing the bulk of the chlorophyll derivatives. An experiment in which the extracts were inactivated when the pigments were converted to copper derivatives, a form in which they would not be expected to cause photosensitization, strengthened the conviction that this photosensitivity in rats was not associated with the principle which causes the liver damage in sheep and guinea pigs but was a Primary Photosensitivity due to a photodynamic agent in the dried millet.

A chlorophyll derivative which produced photosensitivity on oral administration was isolated from the extracts by Mr. D. S. Letham using chromatography on alumina (18). This pigment, purpurin 18, was later found to be an artefact produced during a stage in the fractionation which involved treatment with alkali. Milder processes for the fractionation were therefore introduced and a system of chromatography on filter paper from ether solution led to the resolution of the pigment extracts (previously freed of other substances by partition between ether and aqueous hydrochloric acid) into five components. By the use of a large number of filter paper squares about 20-100 mg. of each of these pigments was prepared for feeding experiments and chemical identification. Two of these were shown by spectrophotometric and melting point comparisons with authentic material to be phæophorbide a and pyrophæophorbide a; two others, which are probably artefacts formed during manipulation, were tentatively identified as monomethyl chlorin e₆ and monomethyl chlorin g.

It has since been found that these pigments are not present in the green millet, and that the conditions of drying were probably responsible for their formation from chlorophyll—samples of rye grass and clover dried in the same coke drier also contained the photosensitizing pigments.

This work has emphasized the difference in the processes of degradation and metabolism of chlorophyll by ruminants and small animals. Both the phæophorbides identified are formed in considerable amounts during the digestion of green feed by sheep whereas in grass-fed rats there appears to be little removal of the phytol chain from the chlorophyll molecule. An interesting obser-

vation during this work was that rats could be made extremely photosensitive if dried sheep's faeces were added to their diet.

This work appears to be the first demonstration that chlorophyll derivatives or other pigments with the porphyrin structure administered orally can produce photosensitization without a prior disturbance of liver function such as occurs in facial eczema. Guinea pigs were also affected by the pigments isolated from millet but were not so susceptible.

A moral to this story is that care should be taken to ensure the absence of chlorophyll derivatives from extracts of plants suspected of containing photodynamic agents if small animals are used for test purposes.

Estimation of Sex Hormones in Urine of Ewes.

In studies being carried out by Mrs. E. G. Bassett on infertility in ewes information was required on the amount and nature of oestrogens and androgens excreted in the urine of ewes during the oestrus cycle and during pregnancy. The very low level of these substances in sheep urine makes it necessary to extract and concentrate the oestrogens in several litres of urine before a biological assay with mice can be made. Techniques for this purpose have been explored by Messrs. E. P. White and O. K. Sewell. Their first concentrates from urine of pregnant ewes killed the mice used in oestrogen assays. The toxic substance was identified as *p*-cresol which was shown to constitute almost the entire volatile phenolic fraction in sheep urine, whereas, in the urine of other species several simple phenols are usually present. By introducing a steam distillation step into the concentration procedure the *p*-cresol was removed and the concentrates rendered safe for assay without loss of oestrogenic activity (White, Sewell and Bassett 19).

Oestrogenic activity was detected in the urine of pregnant ewes only during the last few weeks of pregnancy, but androgens were found from the beginning of the third month. The amounts of hormones excreted in 24 hours varied considerably from ewe to ewe. The highest level of oestrogen activity was equivalent to 6 micrograms of oestrone, and the highest level of androgen activity equivalent to 156 micrograms of androsterone. Urinary excretion of oestrogens was fairly constant during the breeding season, the level being equivalent to 1-2 micrograms in 24 hours (20).

The very low level of oestrogens present in the urine makes determination of their nature by conventional methods a colossal undertaking. Some information was obtained by subjecting a large volume of pregnant ewe urine to fractionation procedures

which should separate oestrone, oestriol and oestradiol. All three fractions were active. Small amounts of unconjugated oestrogens were also detected in the urine.

Following reports from English workers that oestrogenic potency had been found not only in subterranean clover but also in mixed pasture during early spring, extracts of pasture at Ruakura were made by Mr. E. P. White at weekly intervals in the spring of 1949 and assayed by Mrs. Bassett. No activity was found in the mixed pastures. Thirty species of common pasture plants were also examined individually, but the only ones in which oestrogenic activity was detected were subterranean clover and red clover.

Toxicological Studies

(a) Toxic principle in poison honey

Following an outbreak of poisoning of human beings by honey several years ago, and the isolation of mellitoxin from the honey by Sutherland and Palmer-Jones (21) work on other toxic principles in honey from the same area was continued by Mr. E. P. White in conjunction with Mr. T. Palmer-Jones at Wallaceville. (Mellitoxin is a derivative of tutin formed by the leaf hopper *Scolytopa australis* infesting the tutu plant (*Coriaria arborea*) and secreted by them in the honey dew which is collected by bees.) Mellitoxin was found to account for only about one third of the toxicity of the honey, as indicated by reactions in guinea pigs. Small amounts of material with approximately the same activity per mg as tutin have been obtained from toxic honey but it has not been proved that this substance is tutin. The principles responsible for about half of the toxicity of the honey have not yet been extracted.

Mellitoxin was not found in the tutu plant itself, tutin being the only toxin which could be isolated (22). In the honey dew only traces of tutin were present.

(b) Toxic principle in paspalum ergot

The ergot occurring on *Paspalum dilatatum* causes a nervous disorder, manifested by severe tremors, in cattle. Mr. E. P. White has developed methods for extraction and concentration of the toxic principle and for its assay by feeding to guinea pigs. The manipulations include saponification of the fat-free ergot, removal of the non-saponifiable fraction by ether, and precipitation of the toxic components from this fraction by petrol ether. Further purification is brought about by chromatographic separation and fractional precipitation from benzene-petrol ether mixtures. About

25 mg. of material obtained in this way is equivalent in toxicity to 3-4g. of ground ergot.

Neither the material isolated from the ergot nor the few derivatives which it can be induced to form have been obtained crystalline. It appears to be a mixture of related components of which some may be physiologically inactive. Counter current extractions have revealed at least two fractions in the most "pure" material so far isolated, but unfortunately this technique has led to considerable loss of toxicity. Different preparations show a relatively constant elementary composition, approximately C 74.5—76% H. 7.4—8.0%, N 4.3—4.4%. Physical properties such as absorption spectra and optical rotation are very similar for both toxic and non-toxic fractions and no particular property can yet be associated with the toxicity. The absorption spectrum suggests the presence of a steroid nucleus, and the nitrogen atom which appears to be an essential part of the toxin shows no basic properties. A carboxyl group is present but it has not been possible to regenerate the original toxic material after reactions involving the carboxyl group. Apart from these observations a definite opinion on the chemical nature of the toxic principle cannot yet be given.

(c) The alkaloids of leguminous plants

The systematic survey of alkaloids in leguminous plants in this country, started by Mr. E. P. White before joining the Department, has been continued. This study has given information relating to the question of taxonomy and alkaloid status, has revealed the presence of mixtures of many of the well characterized bases of the Papilionaceæ in many species not previously investigated, and has led to isolation of several new bases. One generalisation is that the typical "papilionaceous" alkaloids are restricted almost entirely to three tribes of the Papilionaceæ. Details of the investigations will be found in the *N.Z.J. Sci. and Technol.* (**33B**, 38-60 and earlier papers).

Many of the species investigated are of rare horticultural origin and investigation which could be done was limited by the material available. The use of organic microchemical techniques has been essential. It is desirable to examine tops and seeds of a species and if possible to examine samples of tops at different seasons of the year and from different plants.

Of the new bases found calycotomine has been postulated as 1-hydroxymethyl-6, 7 dimethoxy—1, 2, 3, 4—tetrahydroisoquinoline on the evidence of oxidation products, group determinations, and physical properties. The structural evidence on monspessulanine and virgiline is not yet sufficient to define the ring structure of these bases. The d-iso-form of lupinine has been found in a lupin; previously lupinine of plant origin has always been in the l-form.

The presence of appreciable concentration of β -phenylethylamine and of tryptamine in tops of some *Acacia* species (of the Mimosaceæ) is of some interest as these amines have not previously been found in more than traces in plants. To these bases has been added N-methyl-phenylethylamine. Tops of one species may contain the amine or its N-methyl derivative or mixtures of both.

The alkaloids of species grown in New Zealand are in general much the same as the alkaloids of the species growing overseas. Only in one case does there seem to be a serious discrepancy and this being followed up by the growing in New Zealand of the *Genista* species concerned from seeds of the plant which was investigated in Spain.

It may be added that techniques for isolation and characterisation of some components of the bases of certain species, and in one case the major alkaloids of an *Acacia* species, have not yet been devised.

In addition to the various projects reviewed in this article investigations are being carried out by Mr. W. G. Whittlestone, Physical Chemist at Ruakura, on the mechanism of milk secretion and the milking process, on cleansing materials for milking machines and on the physical properties of sow and cow milk. His work in these fields is a fit subject for a future article in the Journal and will not be summarised here.

As this review illustrates, much of the work of the Station offers the challenge of the special difficulties (such as those of obtaining suitable samples, and dependence on weather, season and animal) commonly associated with biological research in which the objective is the solution of a specific problem. Such work often demands of the chemist an appreciation of, and participation in, all aspects of the project before he can secure reliable material for application of the more formal chemical techniques. It is frequently necessary also to fill in gaps where difficult subjects have been left by more disinterested seekers of knowledge.

It must be emphasised that many of the most important animal production problems which may involve chemical research are as yet ill-defined. Autumn unthriftiness in hoggets, infertility in ewes and cows, bloat, milk fever and grass staggers are all problems

which may be associated with seasonal variation of feed constituents or of metabolic processes in the animal. Determination of the nature of these conditions and the framing of hypotheses as to their causes still require the collection of much more data, a task in which chemists must play their part. That may involve the development of techniques for use in nutrition studies, the assembly of fundamental information on plant or animal metabolism, or the provision of analytical services. (This latter, incidentally, carries always the onus of improvement of analytical methods). However he contributes, the chemist has an important place in the improvement of efficiency of animal production which is the basic purpose of the Ruakura Animal Research Station.

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CONFERENCE NEWS

The session on "N.Z. Investigations of Plants of Economic Importance" has been deleted from the programme, as it is understood that the Manawatu Branch has been considering a similar topic for next year's conference at Palmerston North and it is considered this would be a more appropriate occasion and place.

The response to the first circular has been excellent and indications are that Conference attendance will be up to previous years. The choice of accommodation has been overwhelmingly in favour of a Residential Hall, and the committee feels that this innovation will be most successful.

Members will receive a second circular in due course giving further particulars and asking for a definite commitment.

NEWS AND NOTES

At the April meeting of the Canterbury Branch Dr. R. O. Page discussed "Science and Leather."

Mr. S. R. Siemon, head of the department of chemical engineering at Canterbury University College has returned from overseas. Mr. Siemon spent a year at Cambridge, on a Nuffield Foundation Dominions Travelling Fellowship, working on the technology of finely divided solids and on the kinetics of zinc sulphide oxidation.

Mr. Siemon returned via the United States as a recipient of a travel grant from the Carnegie Corporation. He took the opportunity of visiting the chemical engineering departments of several universities and also made a study of objective testing of suitability for university entrance.

The Auckland Branch listened to a most interesting address on the "Geology of the Auckland District" by Mr. E. J. Searle of the Auckland Teachers' Training College at their April meeting.

Mr. J. Rogers of the Otago School of Mines is to visit Australia shortly. He intends to be away about six weeks during which time he will attend the 5th Empire Mining and Metallurgical Congress and he also intends visiting institutions and universities to discuss recent advances in metallurgical engineering.

Mr. A. W. Mackney, M.Sc., chief chemist of N.Z. Forest Products Ltd., has been visiting Canada, the United Kingdom, Scandinavia and Finland arranging the engagement of trained operatives for the company's pulp and paper mills at Kinleith.

Mr. F. Barnes, M.Sc., of the Laboratory staff of N.Z. Forest Products Ltd., attended the meeting of the Testing Committee of the Australian Pulp and Paper Industry Technical Association in Melbourne. He also represented the company at the Annual General Conference of the Association in Sydney and presented a technical paper there.

We very much regret an unfortunate error in the wording of Messrs. Watson Victors' advertisement in our last issue. The heading should have read "A new Hilger Biochem Absorptiometer."

The Royal Institute of Chemistry is now issuing its Journal monthly and it has been improved by a much simpler cover design and by a series of illustrated articles on the Schools of Chemistry in Great Britain and Ireland.

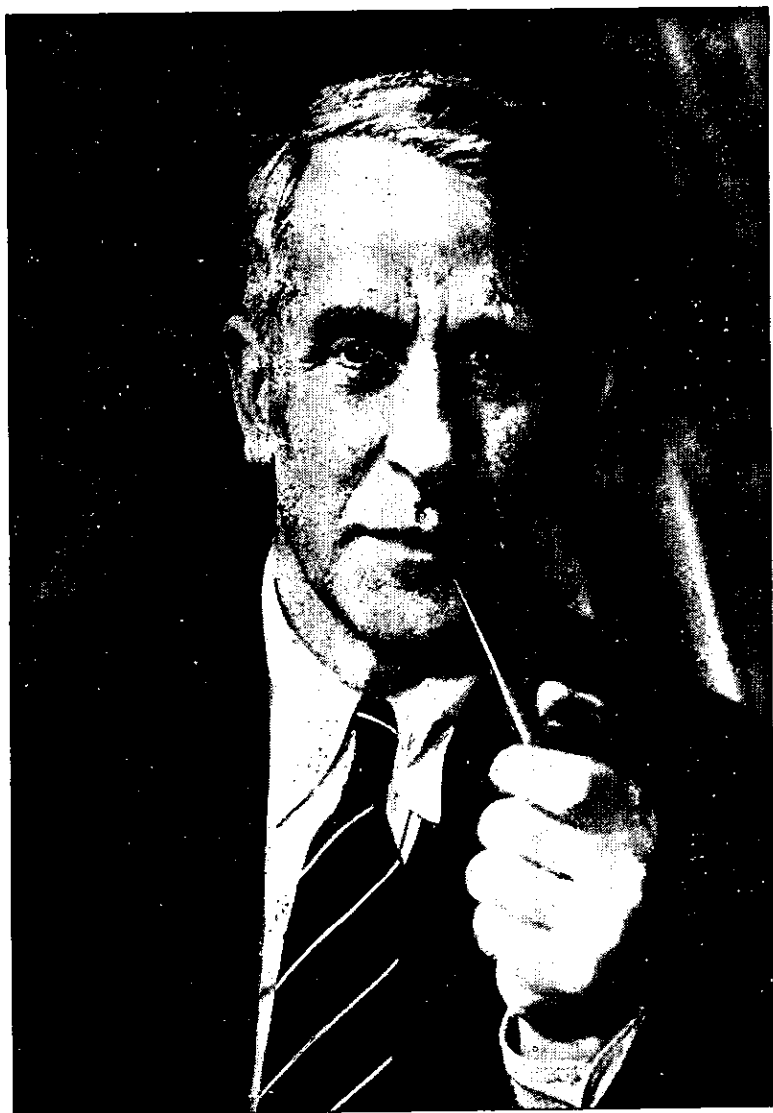
ERRATA

The following corrections are noted for Dr. Askew's article in our last issue:—

Page 40, line 23 and line 3 from bottom:

" β -ketoglutaric" should be " γ -ketoglutaric."

Line 25: "acetate" should be "acid."



PROFESSOR H. J. EMELEUS, F.R.S.

Professor H. J. Emeléus, who is expected to be in New Zealand in August and to be at the Conference for at least part of the time, has written to say that he is keenly looking forward to his visit and to meeting many old friends and to making new ones. We are pleased therefore to be able to publish a photograph of the Professor and to give our readers the following brief sketch of his career.

Professor Emeléus was born in London in 1903, and attended Hastings Grammar School before entering Imperial College in 1921. There he took his degree and subsequently Ph.D. and D.Sc. of London University. From 1926 to 1929 he held an 1851 Senior Studentship and worked under Professor Stock in Karlsruhe on the chemistry of the boron hydrides. In 1929 he was awarded a Commonwealth Fund Fellowship and worked with Professor H. S. Taylor at Princeton, U.S.A. In 1931 he returned to Imperial College as a member of the staff, and remained there until 1944 when he went to the U.S. Atomic Energy Project at Oak Ridge, Tennessee. In 1945 he went to Cambridge where he now holds the chair of Inorganic Chemistry. Most of Professor Emeléus' recent work has been on the chemistry of boron, silicon, and fluorine compounds; earlier he investigated chemical kinetics and photochemistry.

Professor Emeléus is married and is the father of two boys and two girls. His hobbies are gardening and fishing and there is scope for both of these in New Zealand.

MR. N. T. CLARE

Mr. N. T. Clare, the author of the main article in this issue was educated at New Plymouth Boys' High School and at Victoria College where he obtained M.Sc. with Honours in 1934. After two years on the staff there, he joined the Chemistry Section, Department of Agriculture and was transferred to Wallaceville Animal Research Station in 1938. In 1940 he spent a short period with Dr. R. Lemberg at the Rofe Institute for Medical Research, Sydney, studying methods of pigment chemistry. He was appointed Chief Biochemist at Ruakura in 1947, and shortly afterward undertook a tour overseas, visiting South Africa, United Kingdom and U.S.A. His chief research interest has been in facial eczema and photosensitivity diseases which has involved work on porphyrins and other natural pigments, and the metabolism of phenothiazine. He



is the author of a number of papers on these subjects and has published a very useful review on "Photosensitization in Diseases of Domestic Animals" (Commonwealth Agricultural Bureau Review Series No. 3: 1952: 7s. 6d.) which establishes his world-wide reputation.

He has taken his part in Institute affairs and has served at various times on the Editorial Committee, the Examinations Committee, and on the Committees of the Wellington and Waikato Branches. He was Chairman of the Conference Committee in 1951. He was elected a Fellow in 1947.

Mr. Clare's wife was formerly Miss Eunice Wall, who was also on the staff of the Chemistry Section, Department of Agriculture. They have two sons.

DR. B. W. DOAK

The appointment of Dr. B. W. Doak of the Grasslands Division, Palmerston North, to the post of Director, N.Z. Fertilizer Manufacturers' Research Association has recently been announced.

Dr. Doak attended Rangiora High School and Canterbury University College. He was Senior Scholar in botany and graduated M.Sc. in chemistry in 1927. His appointment to D.S.I.R. in 1928 was the first agricultural appointment to this department and, after an eighteen month secondment to Cawthron Institute, he set up a laboratory at the Plant Research Station, Palmerston North, which was then under the direction of A. H. Cockayne.

Dr. Doak became a member of the Plant Chemistry Laboratory at its inception in 1938 and he was appointed Assistant Director of this laboratory in 1948. Following the amalgamation of the Plant Chemistry laboratory

and Grasslands Division in 1951 he became Chief Chemist of the Grasslands Division.

In 1942 he was awarded the degree of D.Sc. by the University of New Zealand.

Dr. Doak's early researches were concerned with the mineral content of pastures and were carried out under a grant from the Empire Marketing Board. Later work included pasture and fertilizer studies, and investigations on the cyanogenetic glucoside of white clover, the relation between cyanide content and agronomic type, plant hormones, and plant growth substances in sheep's urine. The Marton pasture trials which are reported in D.S.I.R. Bulletin No. 31 by Hudson, Doak and MacPherson are now one of the classical studies in pasture topdressing and pasture measurement techniques.

During the war years Dr. Doak, as Acting Director of the Plant Chemistry Laboratory, was in charge of investigations on fruit and vegetable dehydration and in 1942 he visited Australia in this connection.

In 1949 Dr. Doak spent some months overseas, attending the International Grasslands Conference in Holland and visiting laboratories in England, Holland and the U.S.A.

Dr. Doak has been a fellow of the N.Z. Institute of Chemistry since 1944.

MR. R. E. R. GRIMMETT, M.Sc., F.N.Z.I.C.

Mr. Grimmett was born in Nelson, N.Z., in 1899, and educated at Nelson College, and at Victoria University College, graduating M.Sc. in 1923 with Honours in Zoology. He joined the Department of Agriculture Chemical Laboratory, Wellington, as a cadet in 1917. He worked under B. C. Aston as Chemist until Aston's retirement in 1935, when he became Chief Agricultural Chemist until the laboratories were removed to Hamilton in 1945. He was appointed Superintendent, Rukuhia Soil Research Station on its establishment in 1946.

Mr. Grimmett spent 1927 visiting Research Centres in Great Britain, working part of the time at the Rowett Institute, Aberdeen, under Mr. W. Godden, Chief of the Chemical Division.

Mr. Grimmett's published work includes papers on the alkaloids of grass, on various aspects of bush sickness, and on the occurrence of arsenic in soils and waters at Reparoa. In 1949 he delivered the Memorial Address to the N.Z. Animal Production Society on "B. C. Aston, First New Zealand Agricultural Chemist". This address was published in the Proceedings of that Society, and gives a fairly complete history of the earlier years of the Agricultural Chemical Laboratory and of the rise of Agricultural chemistry in New Zealand.



MINUTES OF COUNCIL

19th May, 1953.

APOLOGIES received from Dr. McGlashan (Canty.), Mr. Keys (Otago); Mr. Grimmett (Waikato).

PRESENT: Dr. Annett, President (Chairman); Dr. H. O. Askew, Vice-president; Mr. B. E. Jackson (Auckland Proxy); Mr. A. Metson (Waikato Proxy); Dr. A. T. Johns (Manawatu delegate); Dr. L. G. Neubauer (Wellington Delegate); Dr. J. K. Dixon (Canty. Proxy); Mr. L. H. James (Otago Proxy); Mr. W. G. Hughson (Hon. Gen. Secretary-Treasurer); Mr. H. K. Palmer (Registrar); Mr. A. P. Oliver (Assistant Secretary).

CONFERENCE 1953. The Otago Conference Committee reports a good response to the circulars. Members have shown an overwhelming preference for accommodation in one of the residential halls.

JOURNAL COMMITTEE: A draft Regulation and Rule submitted by the Committee were considered and adopted with slight amendments. The position with regard to Journal reprints is now as follows:

The author will receive on request 25 reprints (or Complete Journals) free of charge. These must be applied for prior to publication, together with any extra copies required, the latter to be paid for by the author.

PROFESSIONAL STATUS COMMITTEE. The Committee is engaged in comparing the standards of admission in all the Commonwealth Chemical Institutes.

STANDARDS INSTITUTE. Mr. C. Stonyer was appointed to replace Mr. M. L. Stewart, who has resigned as N.Z.I.C. representative on several committees and convenor. It was recorded that Mr. Stewart be thanked for his long and valuable service.

EMPLOYMENT OFFICER. Mr. E. Borthwick reported that most of the enquiries received were from people living abroad.

INSTITUTE PRIZES. The President and Vice-President, with power to co-opt. are the examiners for 1953 entries for the I.C.I. and Morcom-Green and Edwards Prizes.

RESIGNATIONS were accepted from Mr. D. G. Coster, Wellington; Dr. and Mrs. F. D. Collins, National University, Canberra.

ASSOCIATES. The following were elected Associates:

O. L. Gilmore, Auckland; C. W. Harland, Auckland; W. E. Harvey, Wellington; A. H. Hunt, Christchurch; H. G. Ivory, Christchurch; B. R. Law, Wellington; J. J. Molloy, Hastings; B. R. Penfold, Christchurch; A. L. Thomson, Christchurch.

AFFILIATION WITH THE ROYAL SOCIETY.

Negotiations are proceeding with a view to finding a mutually acceptable basis for the affiliation of N.Z. scientific societies.

VISIT OF PROFESSOR EMELEUS. An itinerary for the visit was discussed, and will be finalised shortly. The Professor will be in Dunedin for the duration of the Conference, and will address meetings at all Branches.

LABORATORY ASSISTANTS' CERTIFICATES.

It was resolved that certificates be awarded to Miss S. M. Mason and T. A. Morrison.

HONORARY LIFE MEMBERSHIP. The following were elected Honorary Life Members: R. L. Andrew, H. Rands, F. T. Seelye all of Wellington.

BOOK REVIEWS

ORGANIC CHEMISTRY—By E. S. Turner and M. M. Harris. 904 pages. 1952: Longmans, Green and Co. Ltd., London. £2/10/-. The authors of this work attempt to disarm criticism by stating in the preface that, "It is no longer possible to write an up-to-date textbook of organic chemistry . . . a book of this kind is very much like a tourist guide. The reader glimpses chemical scenery of every sort . . ." However, it can be said quite fairly that there are few new developments that these authors have not touched on, and to some extent therefore it puts out of date all other current textbooks competing for student use. It places rather more emphasis on electronic mechanisms and stereochemistry than is usual and there is a long chapter on aromatic substitution: this is only to be expected from these authors. The expression is clear and straightforward but the system of having an author index without references should at least have dates besides the authors' names in the text for "students to be able to reasonably track down originals." The reviewer believes that selection of actual references is preferable and need not be invidious. The book uses some terms without explanation ("enoxide", page 432; "Spring reaction", page 275) and the last paragraph on thiocyanogen on page 116 is so badly expressed that it fails to give the student a true picture of the use of this substance in analysis. Incidentally, it is stated that thiocyanogen for reacting with unsaturated compounds may be prepared in situ from sodium thiocyanate and bromine, but the student may well ask why the bromine does not itself combine with the unsaturated compound. The printing and binding are very good.

CHEMICAL ANALYSIS OF INDUSTRIAL SOLVENTS—By M. B. Jacobs and L. Scheffan. 501 pages. 1953: Interscience, New York and London. \$10.00. This volume collects much useful information not otherwise readily available. It begins with a discussion on physical and general methods of analysis of solvents, analysis of mixtures and a chapter on toxicology. The various classes of solvents are then discussed in turn. For each solvent, the following information is given: uses, properties, A.C.S. and U.S.P. specifications and tests, separation, detection and assay. It is interesting that in many cases the tests are different from those given in British books of standards and this volume is therefore complementary to them.

ADVANCES IN CATALYSIS. — Volume IV. Edited by W. G. Frankenburg, V. I. Komarewsky and E. K. Rideal. 457 pages. 1952: Academic Press Inc., Publishers, New York \$9.50. The advantages of a volume written by a number of experts in related fields under the guidance of a distinguished editorial committee, are obvious. Each chapter gives an excellent summary of recent advances in the particular topic under discussion. On the debit side, it is inevitable that some unevenness of style and presentation must be apparent when many authors collaborate to write one volume.

In this volume solid surface catalysis is dealt with mainly. The chapters by R. C. Hansford on "Chemical Concepts of Catalytic Cracking", Herman E. Ries Jr., on "Structure and Sintering Properties of Cracking Catalysts and Related Materials" and "Twenty-five years of Synthesis of Gasoline by Catalytic Conversion of Carbon Monoxide and Hydrogen" by Helmut Pichler, are excellently written and authoritative. Useful tables of physical properties are included together with graphs and diagrams. On

the more academic side there are chapters by J. H. Baxendale on "Decomposition of Hydrogen Peroxide by Catalysts in Homogeneous Aqueous Solutions" which gives an excellent summary of the bulky literature on the subject, "Acid—Base Catalysis" by R. P. Bell, who has himself contributed about thirty original publications on the subjects, and "Theory of Physical Absorption" by Terrell L. Hill who bases his discussion to a large extent on the B.E.T. isotherm. A chapter by George D. Halsey on "The Role of Surface Heterogeneity in Adsorption" is too brief to be of any real value. In any case, most of the material of this chapter appears elsewhere in the present volume—hence it seems that some blame for the inadequacy of this chapter must rest with the editors. A chapter by Joseph Weiss on "Free Radicals in the Reactions of Hydrogen Peroxide," duplicates to a certain extent some of the material in the chapter by Baxendale but is nevertheless very useful. The final chapter is by Philip George on "The Specific Reactions of Iron in some Hemoproteins."

Although some of the material of this book has been published in other books and reviews, it is felt that the authors are fulfilling a very meritorious task in assembling the information in the present treatise. The references given are up-to-date and very numerous, while the volume is well printed on paper of good quality.

—H.B.

KINETICS and MECHANISM by Arthur A. Frost and Ralph G. Pearson, of the Northwestern University, 343 pages. 1953: John Wiley and Sons, Inc., New York. \$6.00 In this field, which is well covered by published books, any new book must justify itself by some advance either in context or method of presentation. The reviewer feels that this book does manage to justify its appearance because of the many excellent modern examples it includes on calculations of kinetics and mechanism of chemical reactions. It is clearly a text book which will be most useful for University teaching (Stage III), is fully documented and well printed on good quality paper.

—H.B.

NON-AQUEOUS SOLVENTS by Ludwig F. Audrieth and Jacob Kleinberg. 284 pages. 1953. John Wiley and Sons Inc., New York. \$6.75. The present volume is not as useful as it might have been because the authors have preferred to present their facts in rather flowery language instead of making greater use of tables. The tables and graphs which are included are, in many cases, unspecific—it is irritating to read that the solubility of a certain compound in a given solvent is "soluble", "slightly soluble" etc., where often the numerical data are available. Regardless of the above criticism the book is a very useful guide to the literature on non-aqueous solvents. Printing and binding are excellent, in keeping with the usual practice of the publishers.

—H.B.

MR. F. T. SEELYE

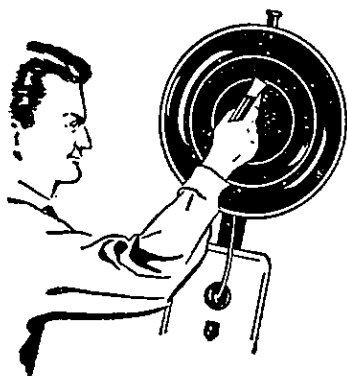
Mr. F. T. Seelye, who was selected as one of the scientists in a world-wide investigation in the analysis of rocks, has recently retired from the Department of Scientific and Industrial Research.

To meet the need for reliable standards for use in the spectro-chemical analysis of rocks, an investigation was commenced some few years ago by the geophysical laboratory of the Carnegie Institution of Washington, and the Massachusetts Institute of Technology, in which twenty-four laboratories from various parts of the world co-operated in the analysis of two selected rocks by the best available techniques.

As a result of the reputation gained by Mr. Seelye as a rock analyst, the Dominion Laboratory, Wellington, was one of the twenty-four laboratories selected to collaborate in this work. The results demonstrated the precision that could be attained by analysts using the best known methods. In order to test also the accuracy inherent in the methods when used with precision, the Carnegie Institution decided to prepare an artificial silicate sample of accurately known composition, and have it analysed by some of the same highly expert analysts.

As only a limited amount of the synthetic standard was available, the number of participating laboratories had for this work to be reduced to twelve. The selection of these laboratories and analysts was based on the quality of the work done in the preliminary investigations. Mr. Seelye had the honour of again being chosen as one of the twelve. He is a foundation member of the Institute and was elected a Fellow in 1943.

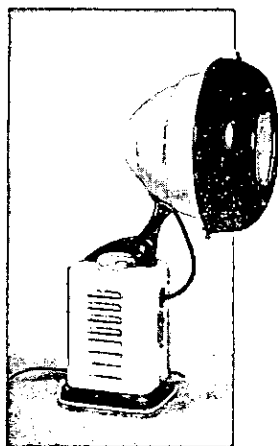
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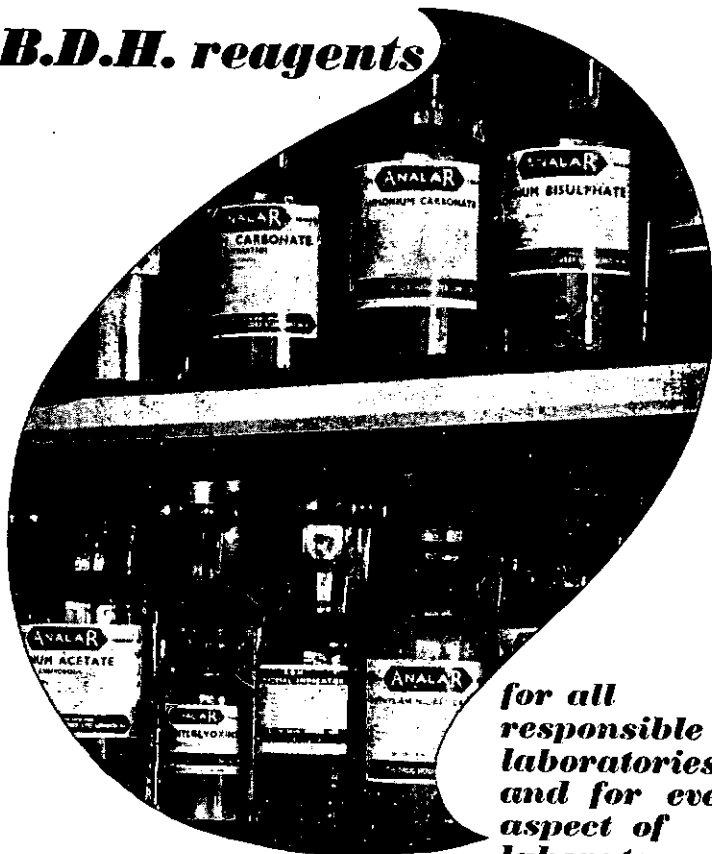
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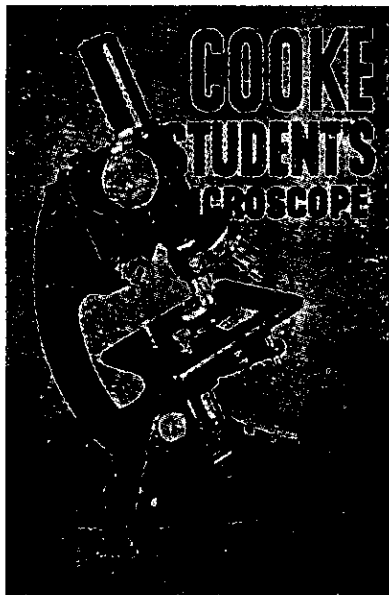
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