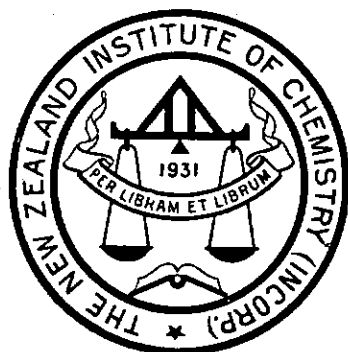


# JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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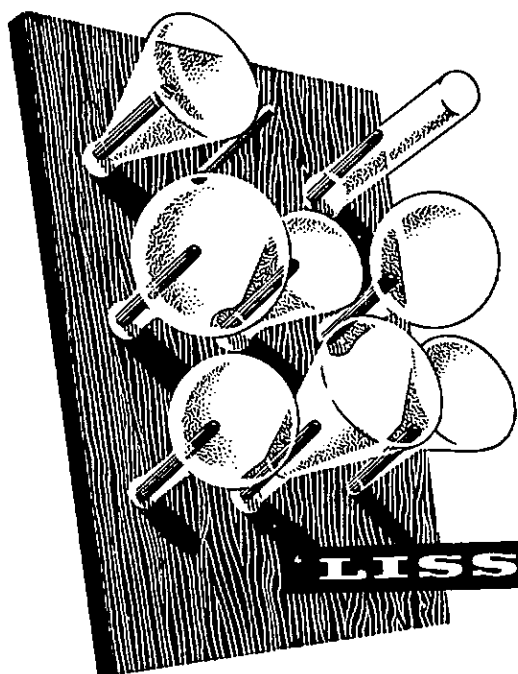
### SYMPOSIUM: PROBLEMS CONNECTED WITH FOOD AND AGRICULTURE IN NEW ZEALAND.

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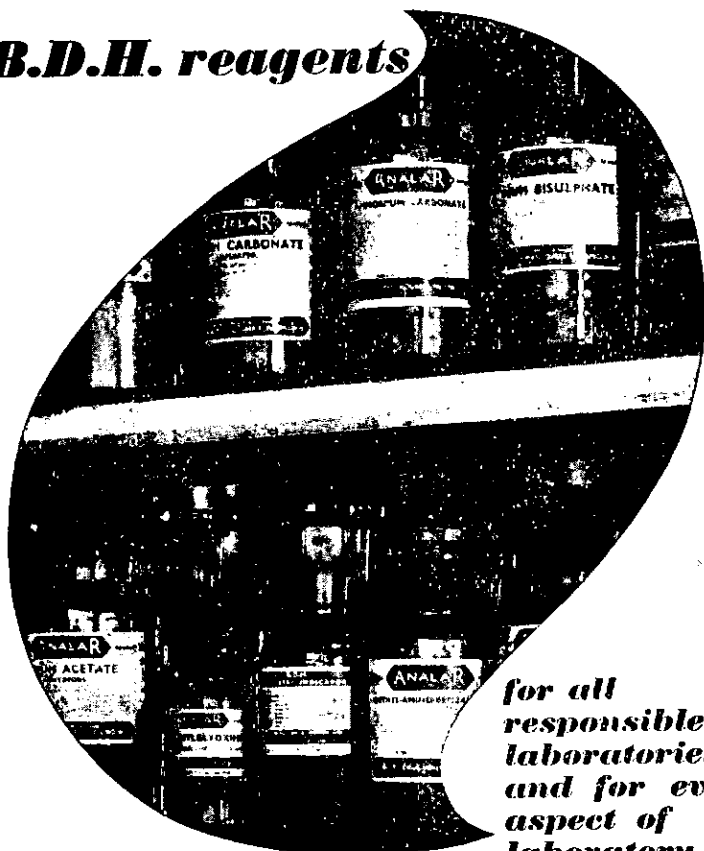
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**PROBLEMS CONNECTED WITH FOOD AND  
AGRICULTURE IN NEW ZEALAND**

(Symposium held at the Annual Conference, Hamilton, August,  
1951)

**SOIL AND FERTILISER PROBLEMS**

**Dr. M. M. Burns, Fertiliser Manufacturers' Research  
Association, Otahuhu.**

Except for what comes from the sea, the forests and the mines, agriculture furnishes the ultimate source of all wealth and—need I remind you?—agriculture is based on soil: that living, dynamic, highly variable, skin over the earth's land surface which we take so much for granted.

To-day when world food problems are so acute it is fitting that this conference of the Institute of Chemistry should have as a theme "Food and Agriculture," especially as it is being held in the Waikato, which has been developed into one of the most productive agricultural areas in the world largely through the application of the findings of research in the primary industries.

As an introduction to a review of soil and fertiliser problems I feel that it is desirable to give you a background of what soil is and why it is so extremely variable.

Soil consists of four broad groups of materials: the mineral matter, derived from the disintegration and decomposition of rock materials and composed of rock fragments, sand, and silt, partly held together by a colloidal coating of crystalline clay: the organic matter, derived from plant and animal residues and the products of microbial activities; the soil water, which is a solution of the various soluble and partially soluble salts: and the soil air, which is heavily charged with carbon dioxide and water vapour.

Soil is living and in a state of constant change: a fertile soil

is one in which change is continuous and vigorous, an impoverished soil is one in which change is irregular and slow. Many fertile soils actually maintain a population of soil organisms which exceed in terms of weight, and far exceed in terms of effects, the weight and effects of crops or of animals raised on the same area. Soils may be built up, degraded and otherwise changed not only by natural agencies but also by man's treatment of them. In their young stages they have properties which are dominantly those inherited from the parent soil material, but as they age these properties tend to be modified by the environment, particularly by climate, vegetation and water movement and to develop characteristics in response to these factors.

It is essential to grasp this dynamic concept of soils to appreciate the reasons for the development of different soil types, to understand the complexity of the problems which develop and the difficulties which have to be met in their solution. In this country, because we have a wide range of different parent soil materials, great variations in climate within short distances, many different plant communities and a rapidly changing topography, there are many different and diffusely spread soil types.

The recognition in the field of these distinctive soil types and the interpretation of the pedological processes which produce them was initiated in New Zealand by one of our most distinguished chemists, Sir Theodore Rigg, and it has been developed, intensified, and applied to the country as a whole by officers of the Soil Bureau.

You may well ask what is the value of all this work on soil pedology, and to that the answer is decisive, for it provides information of basic importance to land development, land utilisation and to all aspects of soil and plant research.

Much has already been done—though it is not as well known as it should be—on the chemical side: much remains to be done, especially on physical aspects. One of the major difficulties in the past experimental work has been to determine over what range of soil types the results obtained can be applied.

The very diversity of our soil types makes grouping of related types important, and one of the most urgent projects—which can only be done by the Soil Bureau—is the drawing up of a short list of the most representative soil types so that research done on these soils will have the widest possible coverage.

One example of the practical value of such work is given by

the "Single Factor" maps on which the soils have been classified by the Soil Bureau into groups according to their contents of, or requirements for, various nutrients.

Such information, especially when correlated with the many field trials conducted by the Department of Agriculture, has already proved of great value in assessing the potentials of soil types, and marked increases in production can be and will be obtained through the more widespread use of this information and of the chemical tests adapted for use under our conditions by the Soil Advisory Service of the Soil Research Station. I have devoted so much time to the development and classification of soils to give many of you a background which I hope will indicate the complexities of soil problems and provide some basic reasons why many of the problems arise in plant nutrition and ultimately in the development of soils to maximum production.

Now let us look at the nutrient side. Plants, like all other organisms, are built up of carbohydrates, fats, proteins and nucleoproteins and need for the functioning of their tissues many enzymes the activities of which are associated with the essential mineral trace nutrients. Plants require for building up their tissues large amounts of the so-called major nutrients: carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur, and to a lesser extent potassium, calcium and magnesium—together with the trace nutrients, iron, manganese, zinc, copper, boron and usually molybdenum.

The carbon dioxide of the air and water from the soil provide the carbon, the hydrogen and the oxygen: all of the remaining elements are usually taken up from the soil as simple inorganic ions either directly from the soil solution or by contact ionic exchange between the plant root hairs and the surfaces of the colloidal soil particles.

As I have already indicated, soils vary greatly in their contents of plant nutrients and still more widely in their contents of available plant nutrients. Some soils carry adequate reserves of all nutrients, while others may be well supplied with some nutrients and yet be deficient in others. These deficiencies may be due:

*Firstly* to actual low levels of the nutrient in the parent soil material; as for instance in the case of potash in the peats and some Taranaki soils; of phosphate in the soils derived from volcanic materials and of boron in soils derived from greywacke.

*Secondly* these deficiencies may have developed in the soil as a result of soil-forming processes as have been the low lime and potash levels in the very leached soils.

Thirdly the deficiencies may have been induced by farm management practices—as has been shown by Dixon and Taylor for magnesium on some of the Waikato soils and by the deficiencies of boron, manganese and other nutrients produced in fruit-growing and market garden areas by excessive liming or by insufficient liming.

For convenience I am going to refer to the trace nutrients first. In the detection and correction of deficiencies of them in this country, chemists have a proud record. I need only remind you of the work of Sir Theodore Rigg, Dr. Askew, Miss Kidson and others of the Cawthron staff on boron and magnesium; of Dr. J. K. Dixon and his associates in the Soil Bureau on manganese and other nutrients, and of Dr. Davies of the Soil Research Station on molybdenum. Possibly too, I should mention the deficiencies affecting animals since they also are directly traceable to soil conditions and recall the outstanding work on cobalt to which so many chemists have contributed and on copper, with which is inevitably associated the name of Dr. I. J. Cunningham.

The amounts of the trace nutrients required by plants are usually of the order of fractions of an ounce to a few ounces per acre. In the case of very marked deficiencies the plants usually show distinctive growth symptoms, but there is accumulating evidence that many crops which do not show these definite symptoms may actually be reduced in vigour and productivity because of insufficient supplies of various trace nutrients.

Indeed it is certain that the yields from many of our fruit and market garden crops are lower than they should be because of such deficiencies, and it is highly probable that pastures are affected in some parts of the country.

But before I leave trace nutrients I must refer to another characteristic of many of them, and that is the very narrow range between an adequate supply and a toxic concentration. Because of this the trace nutrients must be used with restraint and at rates determined by research.

Although excellent work has already been done on the trace nutrients I have no hesitation in saying that we are only at the outset of research in this field. Studies of the soil conditions and treatments associated with trace nutrient deficiencies, on the actual functions of these nutrients and on the inter-relationships between them, as for instance between potash and magnesium and between copper and molybdenum, are important problems for the future. So much for the trace nutrients.

Now what about the major nutrients? Of those derived from soil sources the outstanding deficiency in our soils is that of phosphorus—a condition brought about by the extent of parent soil materials low in phosphorus content, and intensified by the pedological processes associated with moderately high rainfalls and evergreen forests.

Indeed, so dominant has been the deficiency of phosphate in our soils in their natural state that it has been possible to build up to high productivity millions of acres of soils by the application of phosphate fertilisers alone and many more millions of acres by the use of lime plus phosphates.

There is a long way to go on the same road with many soils and applications of lime and phosphates will dominate the soil treatment programmes for years to come. Even so, potassium, which is naturally deficient in some of our sandy soils and the peats, is becoming increasingly important on other soil types, and there are many aspects concerning potash mobilisation and availability that warrant investigation. However, in the time at my disposal I am going to concentrate on phosphorus.

Phosphorus exists in soils in many different combinations which we can group into two broad classes:

(1) The inorganic compounds in which it is associated largely with calcium, magnesium, iron, aluminium and the clay minerals.

(2) The organic compounds present in plant and animal residues and products of microbial synthesis such as the phytins, phospholipids and nucleic acids.

These groups are linked by the organic and inorganic compounds present in the cells of living organisms. These compounds vary in their availability to plants from those which are readily available to those which are highly stable and practically useless.

The inorganic forms of phosphate present in soils have been intensively studied overseas—though, I must add, with limited success so far—but the significant part played by the organic forms is only now being recognised. For example, Fife, by fractionating the various phosphorus compounds in soils, has shown that some of our intensively top-dressed soils devoted to pastoral farming may carry up to 80% of their phosphorus in organic combinations.

Phosphorus, like nitrogen, passes through a cycle of uptake by plants of available forms from the soil, synthesis in plants, return in residues or animal excreta, followed by mobilization and

mineralization by the soil microflora. The rate of progress through the cycle and the combinations of the phosphorus are strongly influenced by soil conditions, but far more important than the rate of progress is the relative proportion of phosphorus which remains in forms which the soil organisms and plants can use as compared with that proportion which enters insoluble compounds.

We already know some of the conditions which lead to the diversion of much of the phosphorus—whether of soil or fertiliser origin—into stable, unavailable combinations, and the application of this knowledge through liming, the use of special phosphate fertilisers and placement of fertilisers has helped to increase the efficiency of added phosphates.

Nevertheless, fixation of phosphorus in soils—which is simply the diversion of available forms to unavailable forms, mainly by chemical precipitation and physical adsorption—is still so serious that it is usual to recover in the crop only from 10-20% and rarely up to 40% of the added fertiliser phosphate.

That being so, you will readily appreciate that a fuller understanding of the steps in the phosphorus cycle—especially under intensive pastoral farming and on those soil types with high fixing powers for phosphorus—provide a major field for future research. We need to know the influence of lime, potash and nitrogen on phosphorus mobilisation; the part played by iron, aluminium, fluorine and the organic compounds in the fixation mechanism and the influence of the soil organisms and of chemical and physical conditions.

So far I have dealt entirely with soil problems, though of course they are inseparable from fertiliser problems. What for instance is the relative effectiveness of the various forms of nitrogen, potash and phosphorus on different crops and soils? We certainly have many field results, but we require more detailed information. Again let me illustrate this by reference to the phosphate fertilisers.

Jacob of the U.S. Department of Agriculture showed in the 1930's that there was a close co-relation between the fluorine content of rock phosphate and the availability to plants of the associated phosphate—yet on some of our soil types rock phosphates quite high in fluorine are considered to be more effective than ground Nauru rock phosphate with a much lower fluorine content. It is logical to ask if this is so and, if so, why? The significance of fluorine in phosphate fertilisers and in soils awaits investigation.

We do not normally think of sulphur as a major plant

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

These references to fertilisers have been related to their utilisation and reactions with soils. I need scarcely point out that the problems of fertiliser technology are likely to provide considerable scope for our chemical engineers—a field which I am sure Dr. Bridger will review for them!

Now to revert to soil and fertiliser problems. So far much of the research on soils and soil treatments, including lime and fertilizer applications, has been devoted to solving local problems and to measuring the results of these treatments. In short it has had an immediate and essentially practical basis. There are still many similar problems to be solved. For example:

What is the best treatment to bring into production some of the more difficult soils, such as the ironstones, the heavily leached soils, and the peats on which excellent work is being done at the Soil Research Station?

What are the most effective fertiliser applications in terms of quantities, composition and placement to make on different crops and soils?

What are the effects on the soils and the crops of controlled irrigation, drainage and cultivation practices?

What are the effects of soil conservation practices on the hill country soils?

The answers to these problems will make possible marked increases in our primary production, and the necessary chemical work must be carried on. At the same time you—as scientists—may well ask whether we should not be approaching many of the difficult problems from a more fundamental basis. With that I whole-heartedly agree—for we are entering the critical stage where it is becoming necessary to learn more of the reasons why we get the results we do and of the mechanisms of the processes involved. As yet our knowledge is fragmentary of the phosphorus cycle, the mobilisation of mineral nutrients by soil organisms, the inter-relationships and actual functions of these nutrients, the effects on soil structure of the root systems of pasture plants and of the by-products of the activities of the soil organisms.

Briefly stated in this way, these problems may appear to you as being straightforward, but this is far from being the case. Unlike chemists in a laboratory who can isolate and control reactions

with comparative ease, the soil chemist must deal with reactions in a complex living environment. The most that he can do is to control some conditions by using pot cultures or small plots, replicate the treatments sufficiently to enable corrections to be made, and carry out the experiments over a number of years to compensate for climatic variations. That means long-term projects and we do urgently need some long-term soil fertility experiments laid down on definite soil types, for which the most complete basic information is known, to study the effects of the chemical, physical and biological properties of the soil brought about by crop rotations and by regular additions of lime and fertilisers to high-producing, grazed, pastures. It is only by the use of such long-term projects, soundly designed and comprehensively studied by integrated teams of research workers who can apply and interpret the rapid advances in chemistry, physics, biology and agronomy, that we can make real progress in the solution of the most difficult problems. Such projects are costly in terms of time, effort and money, but they are our problems—results of work done overseas cannot be directly interpreted for our conditions—and if this country is to remain in the forefront of efficient food-producing countries we must concentrate on them: and in this connection what a wonderful opportunity there is to follow the changes in soil properties induced by developing some of the raw pumice soils!

These fundamental investigations must of course be carried on concurrently with the more applied agronomic studies already mentioned.

This review of the soil and fertiliser problems has been brief and broad. Much has been accomplished by chemists in the past, especially on the applied side of soil treatments and fertiliser use. Much more remains to be done on the intensely practical problems of land development and utilisation. At the same time we must not overlook the fact that we are entering the stage wherein a fundamental approach is necessary to solve the problems which are developing on the intensively farmed soils—or to put it another way—there still remain many problems to be solved to make two blades of grass grow in place of one on many different soil types. But even more important are the problems of keeping the two blades growing in a vigorous and nutritious condition on the soils which have been developed. In the solution of these problems teamwork among scientists from many fields is becoming increasingly important—a viewpoint aptly summed up by that eminent soil scientist C. E. Kellogg: "As we go forward there will be increasing emphasis on symmetry in science—upon putting the parts together. Only in this way can even a small part of our agricultural potentialities be realised or more than a small part of our soil science put to work."

## **PROBLEMS CONNECTED WITH AGRICULTURAL PLANTS IN NEW ZEALAND**

**by Dr. J. Melville, Grasslands Division, Palmerston North.**

The difficulty which faces me during the next twenty minutes is not so much what to include in this talk in order to fill in the time allotted, but what to leave out. Just as with soils and with animals, there are so many outstanding and unsolved problems in the growing of agricultural plants that the best one can do is to pick on one or two examples and hope that they serve as satisfactory illustrations for the field as a whole.

But before coming down to specific problems a certain amount of background and some enunciation of general principles are necessary, particularly for those members of the Institute who are not in close contact with agriculture. Firstly the dietary of the terrestrial animals of this planet is synthesized almost exclusively by the higher plants, the raw materials for this synthesis being carbon dioxide, water and nitrogen with relatively tiny amounts of a dozen or so other elements. Those of you who were at last year's conference in Christchurch may fear that I am going on with the talk on photo-synthesis which I gave then, but all I want to do is to stress that so far as animal foodstuffs are concerned the only real synthetic agent is the chlorophyll-containing cell.

Secondly these synthetic reactions result in a wide range of final products of varying degree of usefulness for animal nutrition. Some like lignin are to our knowledge not utilisable by any member of the animal kingdom and are degraded only after long exposure to attack by certain micro-organisms. Others are digested only by animals which have become adapted to them—the diet of the ordinary wood borer is certainly not one on which most members of the animal kingdom would thrive. Some on the other hand are susceptible to attack by the digestive juices of a wide variety of animals, and it is with these products and with the plants which produce them that we are particularly concerned. For our immediate purpose, then, the food plants of the world may be conveniently grouped into two major divisions, largely according to the principle of animal adaptation just mentioned. The first division comprises those plants such as the cereals, the root and tuber crops, the pulses and the fruits whose harvested products are used directly as human food and which are quantitatively by far the most important part of the world's dietary. The second consists of the

so-called fodder plants which cannot be directly used for human food, but which support the world's domesticated animal population and through them supply edible animal products.

You will note that, in the first division, the plant products which are actually suitable for direct human consumption are, in the main, storage organs characterised by high starch or soluble carbohydrate and low cellulose content. The vegetative organs of plants form only a small part of the human dietary.

The outstanding characteristic of the major groups of our domesticated animals is their ability to deal with much more fibrous foods than can be dealt with by the human animal. Cattle and sheep both possess a rumen as the first component of their digestive equipment, and the rumen is little more than a fermentation vat with a mixed population of micro-organisms, capable of breaking cellulose down to simpler compounds which then pass to the bloodstream as easily available energy sources. Such animals are therefore able to deal with a wide range of foodstuffs and particularly with the vegetative fibrous organs, mainly leaves, petioles and stems, of a great variety of plants.

Now as between ruminant animals and human animals there need be no competition for the available plant food supply, although quite an amount of plant food which is suitable for human consumption has always been used for feeding sheep and cattle. But there are other domestic animals, notably pigs and poultry, which cannot deal with high concentrations of cellulose in their diet, and which are therefore in direct competition with human beings for non-fibrous plant foods. In those areas of the world where pressure of population on the available food supply is greatest, one would expect to find few animals of any description and particularly few direct competitors in the shape of pigs and poultry. Under such conditions it is very much more efficient (and efficiency is used in the sense of maximum number of people per unit area of productive land) to grow plants for direct human consumption rather than to feed plants to animals, regardless of how desirable an addition to the diet the resulting animal products may be.

This is a very sketchy outline, first of the higher plants in their role of synthesizers of animal food, and secondly of the demand made on the food and fodder crops of the world by man and his domesticated animals; the latter theme is one which I hope Dr. McMeekan can enlarge on in his contribution. And that brings me to my final point so far as background is concerned. Keeping the argument to the major theme of this symposium, viz., food and agriculture, any soil expresses itself only in terms of the plants

which can be induced to grow on it; in exactly the same way the agricultural plants of the world are significant only by virtue of the animals, both human and otherwise, which can use them for food.

Now even without that background it is not unduly difficult to state the general problem of plant growth which faces the agriculturalists and the horticulturists of the world. It is simply to grow more plants per unit area and to grow better plants. Let us see what that statement means when it is broken down into its component parts, and to do this we must start with the obvious truism that plants, like all living organisms, are the product of their heredity and their environment. Traditionally the plant chemist and the plant physiologist are concerned with the latter factor—the plant's environment. Speaking in very general terms, the physiologist is interested in the plant as a living entity and with its reactions to variations in temperature, solar radiation, soil moisture, food supply and the like. The chemist on the other hand is interested in the multiplicity of compounds, organic and inorganic, which go to make up the total organism, and in the mechanisms whereby such compounds are synthesised and degraded. Very approximately we may say that the physiologist investigates the external environment whereas the chemist is concerned with the internal environment of the plant.

In a gathering such as this it would be reasonable to restrict the discussion to the field of environment in relation to plant productivity, but I think it essential to draw to your attention the importance of plant-breeding in achieving the goal of greater food production. To take only two examples of New Zealand origin out of the dozens which could be chosen from the world collection: between 1929 and 1935 Dr. Frankel of the Wheat Research Institute produced a wheat variety known as Cross 7 which combined shortness of straw, resistance to lodging, high yield and good baking quality. Within three years of its release on the commercial scale, it had supplanted the standard variety, Tuscan, on 75% of the land on which the latter had hitherto been grown. The introduction of Cross 7 was a major advance towards the goal of making New Zealand self-sufficient, on quality grounds, with regard to her wheat supply.

Between 1938 and 1945 Mr. Corkill of Grasslands Division produced a hybrid between perennial ryegrass and Italian ryegrass which combined in large degree the perennial habit of the former with the winter growing capacity and palatability of the latter. The importance of this hybrid, Short Rotation Ryegrass, is more difficult to assess than is that of Cross 7. I can only say that the

name is always mentioned whenever pasture seeds mixtures are discussed, and that few pastures on the higher producing grasslands areas of New Zealand are established without its inclusion.

The contribution that the plant breeder can make to increased food production is obviously a very considerable one which is deserving of less cavalier treatment than I have given it. But it must be left there for the moment while we go on to consider what are the problems which now face the research worker in the environment field and whose solution will contribute to the same end. Obviously a selection in more senses of the word than one must be made of the dozens of examples which could be cited, and I propose to restrict the discussion to those plants which New Zealand grows more efficiently than any other country in the world, viz., the pasture species. Hence all those plants of the first division which I mentioned earlier and which furnish directly utilizable human food products are excluded, and the field is narrowed down to the second division, which is important for feeding ruminant animals.

Quite different problems face the investigator of pastures on the one hand and of human food plants such as wheat or rice or carrots on the other. The latter are almost invariably grown in pure stand, i.e., within the crop boundary the aim of the farmer is to exclude all plants other than the desired species and variety, while the purpose is unilateral—the harvesting at maturity of the maximum amount of food product per unit area. The plant breeder, the physiologist and the chemist use virtually only this single criterion of productivity in assessing the value of any particular treatment or procedure.

The situation with pasture plants is quite different. Firstly the aim is to grow, not one species or variety, but as many different species in association as is necessary to give the maximum weight of leaf per unit area per year, the various species being chosen to achieve their maximum production in succession so that the grazing animal's requirements are met month by month and season by season. Secondly it is the aim of the New Zealand pastoralist never to allow his pasture plants to come to maturity. This, I admit, is an overstatement of the case since certain habitats demand that annual species be incorporated and these annuals will disappear unless allowed to seed. But I want to stress that grazing animals thrive on the vegetative organs of pasture plants and the farmer meets this requirement by his grazing management: he keeps his plants in vegetative condition by defoliation and, except in special cases, does his best to prevent them reaching reproductive maturity. Thus on both counts, of species complexity and of

lack of a mature crop as a final criterion of measurement, the pasture investigator has a much more difficult problem on his hands than has his confrère of the first division. I might add in passing that there is no more difficult problem in agriculture than the measurement of yield of pasture under grazing conditions.

In the very brief period that remains I shall deal with some aspects of one nutritional element, nitrogen, although much more cursorily than I was able to do for carbon, hydrogen and oxygen at last year's Conference. The background may be briefly summarised as follows:

(1) More than 90% of the organic nitrogenous components of the leaves of pasture plants are composed of proteins and of amino acids, the ratio being usually more than 4:1 in favour of the former.

(2) The chlorophyllous cell is virtually the sole agent on this planet which is capable of synthesizing amino acids and proteins from water, carbon dioxide and nitrogen.

(3) Shortage of protein and particularly of first grade protein is the major nutritional deficiency in the world's human dietary.

(4) New Zealand's exports of cheese, wool and mutton are valued primarily because of the specific proteins which they contain and which are no more than the proteins of pasture plants, re-arranged within the bodies of our grazing animal population. And it is salutary to remember that but for this re-arrangement and for the economic value of the resultant products there probably would be no Conference of the Institute of Chemistry in Hamilton to-day.

I propose to deal with nitrogen in pasture herbage both quantitatively and qualitatively. On the quantitative side, if we leave out of consideration the elements carbon and hydrogen, which account for well over 95% of the fresh weight of pasture herbage, nitrogen is next in order in the list of essential plant nutrient elements. Pasture herbage grown at what we believe to be virtually the highest production levels attainable under the climatic conditions of Palmerston North, contained an average of 4% N, on a dry matter basis, representing an uptake of nitrogen by one acre of pasture of just over 600 lbs. The corresponding amount of phosphorus was approximately one-tenth of this figure at 60 lb., while by reasonably accurate guessing (the analyses were not performed) the amount of boron was about 2 lb. and that of molybdenum about 3oz. The question which naturally arises is, where does this very large quantity of nitrogen come from, and in answering that question we come up against one of the com-

plexities mentioned earlier as being specific to pasture investigation. In the first place it can be stated quite categorically that the soil nitrogen supply is quite inadequate for the purpose, and the explanation starts with the leguminous species in the sward—in this case red and white clovers. These plants have the power in conjunction with their bacterial symbionts, the rhizobia, to fix atmospheric nitrogen and transform it into organic nitrogenous compounds: the actual fixation of N is a function of the nodule bacteria which in turn derive the necessary energy for the reduction from the breakdown of metabolites derived from the host plant.

Apart from photosynthesis itself, I doubt if any mechanism in the plant world has been investigated more intensively than this one, but the results, in view of its importance, are disappointing: Despite the very attractive hypothesis of Virtanen and his school at Helsinki we know little more than that the pathway of reduction leads through ammonia, as the probably key substance, to the dicarboxylic glutamic and aspartic acids. What the intermediates are in the transformation of gaseous nitrogen to ammonia, what enzymes systems are involved and what are their energetics—all these points are still obscure. A great deal is known about the environmental factors, both climatic and nutritional, which promote the efficiency of the fixation of nitrogen by legumes, but until those questions are answered a real integration of our knowledge is impossible. Why, to take just one instance, is molybdenum, an element which activates no known enzyme system, so essential for the fixation reaction.

But to return to the main theme, the important point to note is that one component of the pasture sward is now autotrophic not only in respect to carbon but to nitrogen also, and in view of what has already been said about the inadequacy of soil as a source of nitrogen one might reasonably expect that clovers would be the dominant species in the pasture association. In actual fact, in the trial which I used earlier to illustrate this section, the dominant species is ryegrass, which contributes over 65% of the total yield of pasture herbage, the remaining 35% being contributed by clover. This apparent paradox finds its explanation in the inefficiency of the cow and sheep as a converter of the protein of its diet into flesh, milk and wool. Only a relatively small proportion of the ingested nitrogen finds its way into those finished products, about 80% being voided by the animal as urine and faeces. I am sorry that I cannot describe in some detail the studies made by Sears, Doak and their colleagues on the effect of animal excreta on the botanical and chemical composition of the pasture association, but the net result, attributable very largely to urine, is a stimulation

of grass to a position of dominance in the pasture sward. Of the total protein harvested by the grazing animal from that herbage almost 400 lb. is contributed by the grass leaves and over 200 lb. by the clover leaves.

Here in a nutshell is the problem of pasture growth in New Zealand, a problem which must be investigated as an almost infinite series of dynamic equilibria in which soil, plant and animal all play their part and in which a change in any one component brings about complementary changes in the other two. And occupying a key position in these equilibria is the clover plant, which, in relation to the element nitrogen, is the collecting agent for the raw material, the factory in which the raw material is converted to a valuable product and in co-operation with the grazing animal is also its own distributing agency.

So much for the quantitative side: I should like to say something about certain qualitative aspects of the nitrogen problem. Thus far I have talked of leaf protein as if it were one homogeneous compound scattered throughout the individual cells of the leaf. Even though the study of leaf proteins has been somewhat neglected, enough has been done to show that such an hypothesis is quite untenable. However, rather than considering that evidence, I prefer to discuss the leaf proteins from quite a different angle, namely, that of enzymes. Since Sumner's original work in 1926 showing that the enzyme urease is a homogeneous protein, an enormous amount of work has been done in this field, with the result that every enzyme which has proved amenable to isolation and purification procedures has been shown to be a specific protein. Biochemists are virtually unanimous in their belief that this is true of every enzyme whether it has been isolated or not, while conversely there is good reason for believing that every individual intracellular protein has enzymatic properties. It is essential, therefore, to state the role of enzymes in living cells and the position might be summarised in the simple statement that enzymes are biological catalysts. But this definition is quite inadequate as a measure of the importance of enzymes in cellular processes. Whether we consider photosynthesis, nitrogen fixation, digestion, muscular contraction, the initiation of embryonic growth in a seed which we know as germination, fermentation or dozens of other vital phenomena, chemical changes are going on which are catalysed by enzymes. More than that, among the hundreds of reactions which have been studied in living material, it is extremely difficult to find any which are not so catalysed. Only a minor stretch of the imagination is necessary to reach the conclusion that a detailed knowledge of the vast array of enzymes in any organism would enable us to explain all the aspects of growth, form, dif-

ferentiation; activity reproduction and all the other processes which go to make up that specific individual. From that viewpoint a rabbit is a rabbit and not a man or an oak tree by virtue of the type, number and concentration of the enzymes of its individual cells.

But that is just another way of stating a problem which traditionally has been the province of genetics, the scientific discipline to which the plant and animal breeder looks for his fundamental ideas. Geneticists are concerned with the study of heredity and with the reasons why the offspring of a rabbit is also a rabbit and not a man or an oak tree. They have studied the way in which the multitudinous characters which go to make up any particular organism and which enable that organism to be classified as a species or variety, are transmitted from parent to offspring; and in so doing they have arrived at the concept of the gene as the unit of heredity, as the final mechanism whose presence or absence determines the presence or absence of some specific character.

Obviously the relation between the gene of the geneticist and the enzyme of the biochemist is extraordinarily close, and an impressive body of evidence is being built up to support the hypothesis that each gene is a distinct and specific molecule of nucleoprotein which serves as a permanent model or template, in the image of which the enzyme proteins are constructed. Through that hypothesis we see the glimmerings of true integration not only of some of the heterogeneous components of this short talk, but of the hundreds of investigations which are being made and will be made into the vast variety of organisms which inhabit this planet. The student of environment and the student of heredity are at last converging on common problems and they find their ultimate common ground in the structure of the protein molecule. Of course 99% of this lies a long way in the future. Our tools are incredibly crude in comparison with the task that such a concept sets; entirely new methods and techniques must be devised before we can say with certainty what synthetic and degradative functions are inherent in any cell; there is no indication whatever of the ways in which the nucleus, which represents only a tiny portion of the total cell volume, imposes its specific organising function on the growth and reproductive processes nor of the genes through which these functions are governed.

For our purpose, however, this is relatively unimportant. The point I want to make is that, although the relationship between gene and enzyme is the most challenging problem facing every worker in the whole field of biology (and this obviously includes agriculture in relation to the world's food supply) the key to it

all lies in the synthetic process of the higher plants. With the assistance of certain highly specialised micro-organisms which have the power of reducing atmospheric nitrogen to ammonia or closely allied compounds, they are the primary synthesizers of amino acids and proteins. In investigations designed to increase the world's food supply no group of compounds is of greater importance.

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## NEWS AND NOTES

Owing to pressure of space we have held over reports on the new chairmen of the various Branches. These gentlemen will be written up in our next issue.

The following additional journals are being secured in exchange and housed in the library of the Auckland Institute and Museum:—

"Chemie" (Prague), Vol. III, 1951 onwards.

"Nuclear Science Abstracts" (Oak Ridge, U.S.A.), Vol. V, 1951 onwards.

"Svensk Kemisk Tidskrift" (Sweden), 1952 onwards.

"Tidsskrift for Kjemi, Bergvesen og Metallurgi" (Norway), Vol. XI, September, 1951, onwards.

Messrs. G. W. Wilton and Co., Ltd., are kindly passing on to the Institute their issues of "Nature" for filing with our other publications. The file starts from Vol. CLXVI, January, 1950.

Prof. E. C. Dodds, M.V.O., F.R.S., F.R.I.C., has been appointed Sims Travelling Professor for 1952, and will lecture in New Zealand and other Commonwealth countries. He has recently been awarded the medal of the Society of Chemical Industry and is Chairman of the biochemistry section of the International Union of Chemistry.

The Waikato Branch reports a successful initial year. The accounts closed with a balance of over £5, and it has been decided to establish a prize of two guineas for the best chemistry student in form 6B at Hamilton High School.

Dr. R. H. Locker has gone to Cambridge University to study biochemistry under a National Research Fellowship.

The Otago Branch prize, now valued at two guineas, has been awarded to Miss Patricia O'Hara.

Mr. J. R. McGimpsey has resigned from the staff of Otago University to go to Dairy Products Ltd., Edendale. He has been replaced by Mr. F. A. Johnson of Canterbury College.

The attention of members is drawn to an important announcement regarding fees reported in the minutes of Council-in-Person.

## FOOD AND THE ANIMAL

by Dr. C. P. McMeekan, Superintendent, Ruakura Animal Research Station.

Subdivision of the general topic into three fields of the soil, the plant, and the animal, must have appeared both logical and simple to those responsible, but such partitioning is both illogical and an over-simplification if it is not clearly understood that these three links in the chain of conversion of the raw materials of the soil to a form usable by man *are links*, each of which is dependent upon the others, and none of which can exist independently. Both my colleagues have recognised this in their frequent and unavoidable references to all three factors. I might therefore be pardoned the reminder that the animal is not only the end result of soil and plant, but that both soils and plants are considerably modified by the animals living upon them. This emphasis on the mutual dependence of soils, plants and animals would be fatuous if it did not have more point than the usual platitude. I believe that the modern development of specialists in science—chemists, physiologists, anatomists, physicists, geneticists and the like—essential though it may be, often carries with it the serious danger that the resulting inevitable partitioning of agricultural problems into component parts tends to make some workers forget the intimate interdependence of the three basic factors we are discussing to-day.

It would be easy, though dangerous, to quote examples even from New Zealand agricultural researches in support of this contention. That this particular group of specialists is sufficiently aware of the dangers to organise this symposium is an extremely healthy sign. I feel that if our discussion does nothing else than remind us of the complex yet closely integrated nature of the great business of food production it will be worth while.

In my brief contribution, I want to try to define the overall problem confronting present workers in the field of animal production in New Zealand, to attempt to break this problem up into its major parts, to spotlight the more important fields in which research is necessary, and if possible to indicate where the chemist can and must contribute. I appreciate that all this is impossible in the short time available and that many short cuts will have to be taken.

First, the problem. This is readily stated. It is the task of increasing the efficiency of conversion to human food, of Dr. Mel-

ville's pastures, derived from Dr. Burns' soils. Within the general pattern of New Zealand agriculture and to the animal production worker this involves, essentially, increasing the efficiency of utilisation of pasture and the pasture products, hay and silage, by farm animals—the cow, the sheep and the pig. It is worth noting in passing that in this country, even the pig is a converter of grass-land products—the skim milk which provides the bulk of its diet. It is important to point out, however, that merely increasing the amount of fodder—by contributions such as described by the previous speakers—the all-over efficiency of conversion may increase without any increase in efficiency of utilisation. With such aspects the animal worker is also concerned, since more grass has no value unless it is used.

That there is much scope, however, for increasing the efficiency of pasture utilisation *per se* is obvious from even a cursory examination of existing production levels. We have become accustomed to measure efficiency in terms of output of particular products per unit of land. Thus, butterfat per acre, and lamb and beef per acre, are accepted criteria both in scientific and farming circles. Taking butterfat per acre as an example, the present average level of output from our better-class dairy lands is, of the order of 150 lb. of fat. Such land is probably yielding something like 9000 lb. of dry matter per acre in the form of pasture, so that 1 lb. of butterfat is being produced from approximately 60 lb. of pasture dry matter. Yet a dairy cow producing only 300 lb. of butterfat per annum needs and consumes only 25 lb. dry matter per day—about 9000 lb. per annum, thus yielding an efficiency utilisation figure of 1 lb. of butterfat for each 30 lb. of dry matter consumed. Thus, even using cows of relatively poor dairy merit—mature cows of 300-pound average ability are commonplace to-day in New Zealand—the efficiency potential on this basis is 100 per cent. higher than that existing. It should not be necessary to point out that increasing pasture yield per acre in terms of Dr. Melville's objective, and increasing the dairy merit of the cows used in terms of my own, the existing all-over efficiency levels could be raised many times.

For the purpose of this paper, however, I want to confine myself to the narrower field of efficiency of utilisation of existing herbage rather than complicate the case by considering increases in volume of fodder even though these may occur concurrently. In essence, what are the leaks responsible for a theoretical potential of 1 lb. of fat per 30 lb. dry matter from pasture being only 1 lb. per 60 lb. in practice? Similarly, why can a similar picture be painted in respect to fat lamb, beef and pig production?

Continuing with efficiency of utilisation by the dairy cow as an example, the avenues of wastage may be broadly grouped under four heads:—

(1) **Wastage due to inefficient cows.**

Though normal mature cows average 300 lb. fat at present, the range is from less than 20 lb. to more than 600 lb. per cow. This variation appears to be associated with genetic constitution, with size, with age, with departure from optimal calving dates, and with disease as the major variables.

(2) **Wastage due to incomplete utilisation of available pasture.**

This varies with the extent of losses in fodder preservation methods such as haying and ensiling, with the extent of soiling of herbage by dung and urine so that available nutrients are not consumed, and with the destruction of herbage by trampling, lying and pugging by the grazing animal.

(3) **Wastage due to the overhead of unproductive animals.**

Here the inevitability of death necessitates the carrying and feeding of immature replacement stock, the ratio of which is influenced largely by disease, which in turn adds its quota of temporarily or permanently unproductive mature cattle.

(4) **Wastage due to human incompetence in controlling husbandry factors affecting the efficiency of the dairy cow.**

Milking methods, feeding methods in relation to functional needs of the animal at different times, and a host of general management influences associated with animal well-being, and having their origin in a proper understanding of animal behaviour, appear as the major influences.

You might comment that all these are obvious and practical questions simple in their make-up, the concern and interest of the agriculturalist, the animal husbandman, the veterinarian rather than the chemist. It might further be argued that they are largely questions where the empirical approach, the technique of trial and error, is likely to pay immediate and worth-while dividends. Yet is this really so? Let us take but two examples. Though the biochemists in the Grasslands Division first drew our attention over ten years ago to the huge wastage of nutrients normally occurring in the process of conserving pasture as silage, I have yet to meet the individual or group prepared to study the silage-making process with a view to reducing these losses from their present level of 40 to 50 per cent. Yet ensiling is essentially a fermentation process, an adequate understanding of which is surely impossible without the active contribution of the biochemist. Yet

again, the annual failure of a large proportion of the dairy cows of New Zealand to calve at a time of the year which permits them to make optimum use of the seasonal variation in pasture feed supply, although simply posed as the "problem of getting cows in calf" surely involves far more aspects than pathology. Its solution awaits, among other things, a thorough understanding of the endocrine control of reproduction and to this task the biochemist is certainly more important at present than the biologist.

Time does not permit any detailed examination of the specific limiting factors that have been mentioned. Still less is it possible to formulate a comparable break-up for sheep, beef cattle, and pigs. Sufficient to say that closely similar limiting factors restrict the efficiency of utilisation of fodders by these other farm animals. More profitably the remaining time might be spent in indicating the general fields of work that must be covered—and well covered by closely integrated and balanced teams—if the necessary control over our animals and their performance is to be more effective. Still more narrowly, but perhaps even more profitably, what are the major gaps in our knowledge of animal production that have to be filled?

Probably more important than anything else on the animal production side is the need for accurate definition of what constitutes an efficient animal. Without such definition there can be no meaningful objective to animal breeding; without it there can be no really effective control of the environment to achieve maximum efficiency of utilisation. It is easy to suggest that for New Zealand conditions the efficient animal is one which is capable of converting to the greatest amount of human food a given amount of pasture nutrients. Yet, looking again at our case of the dairy cow, just what does this mean? Does it mean the cow producing 500, 400, or 300 lb. of fat? Is extra production above 300 lb. only obtained at such a high food cost that the lower producer is really the more efficient? Is it the large, the small or the intermediate-sized cow? As Dr. Melville has pointed out, all animals are relatively inefficient in converting food energy to milk and meat energy. This is due largely to the high overhead cost of maintenance. Thus, a small-bodied, medium-level producer may be more efficient than a larger-bodied, high-yielding animal. Again, does it mean that maximum efficiency is attained only by the animal calving in high condition as a result of high-level feeding during the winter dry period, or is the cost of these gains too great relative to the added production they permit? Is the efficient animal one that maintains a constant body weight throughout its productive period, or do seasonal gains or losses have a beneficial rather than a harmful effect upon overall efficiency? How is efficiency affected by the

test of the milk produced, where butterfat, rather than milk, is the key end-product, as it is for over 90 per cent. of our output? How is efficiency affected by age? Will it always be necessary to employ age correction factors with their obvious statistical limitations in evaluating the dairy merit of cattle in selection work, or is it possible to compare stock on a basis of their efficiency of conversion of grass to butterfat independent of age? All these, and other questions, are involved in attacking the problem of what may be termed the energetics of animal production on pasture, essential no less for sheep and pigs than for dairy stock. Its solution involves the measurement of the intake of the free-grazing animal. Dr. Melville commented that there is no more difficult problem in agriculture than the measurement of yield of pasture under free-grazing conditions. Might I suggest that he has a try at measuring intake under the same conditions? One obvious approach is the calculation of intake from measurement of faeces output and digestibility of grass actually consumed in grazing. Here the biochemist is essential. Much progress has been made in New Zealand by Lancaster, Coup and others, but much still remains to be done before a standard of accuracy adequate for all purposes is obtained. In the broader field of energetics, Wallace, using the Ruakura technique even at its present stage of development, has been able to partition nutrient intake between requirements for maintenance, for gains and losses in body weight, and for milk production of *grazing* dairy cattle. Working with animals widely differing in size and performance, he has shown that it is possible to calculate pasture intake with a high degree of accuracy, from these three criteria. Calculation of gross efficiency with all its applications is thus possible and present indications are that this major gap in our knowledge is at least on the way to being stopped. The field, however, is barely touched. A lifetime of highly interesting and profitable endeavour undoubtedly awaits the enterprising student of the bio-energetics of growth and milk secretion of the grazing ruminant.

The second major gap is what may be termed the paucity of our knowledge of qualitative factors in pasture nutrition. I have noted with interest that Dr. Melville has confined himself very largely to quantitative considerations insofar as pasture production is concerned. I am not reproaching him for this. No one has been a stronger advocate in his own field of animal growth than the speaker, for confining attention to the quantitative aspects of the growth pattern before attempting the more elusive qualitative features. Similarly, in the general field of animal production, it is clear that more immediate progress can be made by eliminating obvious quantitative deficiencies. Yet no worker in the field can

fail to be impressed with the marked qualitative weaknesses of our pastures, when we measure their usefulness by the performance of the animals living on them. The observation of the Ruakura nutritional team that dairy cows are apparently incapable of attaining adequate intakes of digestible dry matter when given ad lib access to autumn-saved or early spring pasture of high digestibility and nutritive value when measured by current standards, yet find no difficulty in doing so later in the year on relatively sparse pastures of lower quality, will bear more than a little thought. The curiously erratic incidence of bloat hardly suggests that our pastures are always qualitatively adequate. Facial eczema is such a hardy annual that I hesitate to mention it. Yet the fact remains that, periodically, animals suffer severe liver damage, apparently from consuming pasture which normal nutritional standards rate as of the highest quality. Less obvious, but probably even more important nationally as limiting factors to efficient performance of live stock, are the so-called metabolic disturbances of the female near parturition time. Hypocalcaemia, hypomagnesemia, ketosis and the like, have an undoubted qualitative as well as quantitative nutritional background. Still more insidious are problems of skeletal growth and development, of teeth, and of general thrift of animals at specific periods. For example, no satisfactory explanation has yet been advanced for the unique superiority of highly localised areas in Manawatu and Wairarapa for the development of the thick-boned, heavy-framed N.Z. stud Romney, or the deterioration in the frame of the Gisborne sheep compared with the stability of those of the Taihape zone. The poor teeth of sheep from many areas is well known, while Barnicoat's observation that teeth tend to have a shorter life on the so-called "improved" pastures is a challenge to the pasture specialist.

It is difficult to escape the conclusion that our pastures must involve nutritional factors other than those normally described and measured. It is much more difficult to suggest a line of attack, but it seems reasonable that much greater knowledge is required at least of ruminant digestion and assimilation and of liver function before most of these problems can be described sufficiently accurately to give the biochemist a fair chance of putting a name to the unknowns. Even in such description the chemist must play a major role.

Apart from animals failing to breed at all, approximately 30 to 40 per cent. of all apparently normal farm females fail to conceive when given the opportunity. We commonly refer to these as the 40 per cent. "mistakes" of the cow or the ewe. Some of us are rapidly coming to believe that a level of reproductive inefficiency of this order is inevitable and part of the price which must be paid

for seasonal reliance upon pasture as the sole source of diet for the lactating female. Is this attitude the correct one, or can this leak also be stopped? The answer will not be easy. It appears to be one of those problems where, once again, the hit-and-miss approach is not likely to pay off. Rather does it seem one where a more complete understanding of the whole process of reproduction in both male and female is vital. We must know more of the obviously complicated hormone control mechanism responsible for the initiation and timing of the various phases of the oestrus cycle; we must have a much clearer view of the histo-chemical picture of the reproductive tract at all stages of the cycle, and we must obtain a more precise measure of the role of nutrition, both quantitative and qualitative, as an environmental modifying factor. In particular, we need to know the factors controlling implantation and subsequent normal development of the embryo. Chemists again, and good ones, prepared to devote a lifetime to the chase of perhaps but a single cog in the whole complex mechanism are needed.

Although it is reasonably true to say that no form of animal production in New Zealand provides a better fit between the seasonal yield of nutrients from pasture and the varying demands of the animals used than does fat lamb production, it is equally true that still greater efficiency of output would accrue if lambing percentages could be reliably increased by 20 or 30 per cent. Adequate pasture is normally available sufficient to permit these extra lambs to be carried without any increase in total pasture yield. Indeed it has been argued that no greater contribution could be made to the sheep production economy of this country than by increasing the effective lambing percentage. Four lines of approach suggest themselves: genetic, or the raising of the ceiling reproductive rate by suitable breeding techniques; nutritional, or exploitation of the phenomenon known as flushing when a rising plane of nutrition at the appropriate period increases the number of ripening eggs; hormone control, or the stimulation of extra egg production by artificial hormones, and finally the elimination of the non-breeding or sterile ewe. It will be obvious that in most of these the chemist can contribute to a worth-while degree.

In leaving the discussion at this stage, it will be clear our problems are not as well defined as those of the soil or plant specialists. This is inevitable since organised work in the field of animal production necessarily commenced long after the first two links in the chain began to receive attention. Animal research work in New Zealand is just beginning. Much of it, on the chemical side as well as on all others, must involve laborious routine observations aimed merely at more precise description and

definition. Much time will have to be devoted to the development of techniques. It has been my experience that many chemists, particularly newly-fledged graduates, are not prepared to face up to the long grind so clearly facing them. How much this is due to deficiencies on the part of the biologist in highlighting the problems in the field, or how much results from the fact that few chemists in New Zealand have ever had a normal training in biochemistry, with the result that they possess neither the techniques nor the interest even to start, I am unable to argue. I do suggest, however, that so wide is the field and so important to this country and the world the solution, that your organisation should give serious consideration both to increasing opportunities for and strengthening training in biochemistry in this country.

Finally, I would point out that a large proportion of the great men of world agriculture have been chemists who have not sought fame and fortune in their pursuit of chemistry as such but who have brought to the service of agriculture the scientific discipline and techniques of chemistry. Such men are still needed. Great names still remain to be made.

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### **A.N.Z.A.A.S. SYDNEY MEETING, AUGUST, 1952 SECTION B (Chemistry)**

The Australian and New Zealand Association for the Advancement of Science will meet in Sydney from 20th to 27th August, 1952. A committee of both academic and industrial representatives has been set up in Sydney to arrange the programme for Section B (Chemistry) of the Conference.

Chemists throughout Australia and New Zealand, who intend to attend the meeting, are invited to contact the Section-committee regarding any matters which, in their opinion, require attention. Suggestions of subjects for inclusion in (or exclusion from) the programme; comments on the form which the programme might take; and requests for special activities or arrangements other than the usual readings of papers and excursions, will be received by the committee with pleasure.

Persons attending the conference must become members of the Association, application forms being available from the Hon. Local Secretary of the Association in New Zealand (Dr. Gilbert Archey, Auckland Museum). There are three grades of membership: Annual (£A1/1/- p.a.), ordinary (£A1 per meeting), and associate (10/6d. per meeting).

The Secretaries of Section B for the Sydney meeting, to whom correspondence should be addressed, are Dr. F. H. Reuter (Senior Lecturer in Organic Chemistry, N.S.W. University of Technology) and Mr. H. C. Freeman (Lecturer in Physical Chemistry, University of Sydney).

## NOTES FROM THE MINUTES OF THE ANNUAL MEETING OF COUNCIL-IN-PERSON

Held in Wellington on Friday, 23rd November, 1951, at 10 a.m.

*Present:* Mr. P. R. Parr, President (in the chair); Professor S. N. Slater, Vice-President; A. W. Mackney, Auckland Delegate; I. G. McIntosh, Proxy for Waikato; Dr. C. R. Barnicoat, Manawatu Delegate; A. P. Oliver, Wellington Delegate; F. H. G. Johnstone, Canterbury Delegate; O. H. Keys, Otago Delegate; W. G. Hughson, Hon. General Secretary; H. K. Palmer, Registrar. B. E. Jackson, Proxy for Auckland, and L. H. James, Proxy for Otago, were present by invitation.

*Conference, 1951.—Resolved:* That the Waikato Branch Conference Committee be thanked for the manner in which the Conference was managed, and for the Report.

The Waikato Branch Committee suggested that since three Conference Addresses would be published in the Journal, 150 extra copies be printed for distribution to the authors, the cost to be met by a grant of £9 from the Conference balance. This was agreed to.

*Conference, 1952.—Resolved:* That it be a recommendation to the 1952 Conference Committee that it should invite as participants in Conference members of the Oil and Colour Chemists' Association and of the Institution of Chemical Engineers.

*Journal.—Resolved:* That Council authorise the Journal Committee to spend up to £200 in excess of receipts in 1952 from advertising and subscriptions.

A motion that the number of Journals be limited to four per year was lost.

*Resolved:* That legal opinion be obtained on the question of Publisher of the Journal.

*Resolved:* That all Local Members other than bona fide students be required to pay an annual Journal subscription as from 1st November, 1951.

*Salaries.—Resolved:* That the Salary Survey Committee be asked to conduct a survey after the publication of the next Public Service Classification List. A letter having been received from the New Zealand Association of Scientific Workers asking for liaison between the two councils in connection with future salary surveys, it was *resolved:* That the Salaries Committee be asked to discuss the matter with the New Zealand Association of Scientific Workers.

*Finance.—Resolved:* That the drafts of Income and Expenditure Account for the year ended 31st October, 1951, and the draft Balance Sheet as at 31st October, 1951, be approved and sent to Audit.

*Accounts for Payment.—Resolved:* That the total amount, £255/6/8, be passed for payment.

*Registrar:* A motion introduced by Canterbury, recommending that the Registrar's salary should not exceed £120 per annum, with the suggestion that more work be done voluntarily, lapsed for lack of a seconder.

*Resolved:* That the Registrar be granted £20 to cover increased costs during the year 1950-51.

*Resolved:* That the Registrar be reappointed and that his salary for 1952 be £200.

#### TRUST ACCOUNT AND NATIONAL SAVINGS ACCOUNT:

*Resolved:* That the present system of investments continue, and the sum of £75 be transferred from the General Account to the Trust Account.

#### APPLICATION FOR ASSOCIATESHIP:

*Resolved:* That the following applicants be elected to the Associateship: James Raymond McGimpsey, M.Sc., Dairy Products Ltd., Edendale, Southland.

Raymond Annesley Scott, M.Sc., Dip.Ed., Takapuna Grammar School, Auckland.

Harry Jackson Todd, B.Sc. (Lond.), Dominion Laboratory, Wellington.

John Milton Wood, M.Sc., Dairy Products Ltd., Kaponga R.D., Taranaki.

#### HONORARIA TO EXECUTIVE OFFICERS:

*Resolved:* That the following honoraria be paid for the year 1950-51: Hon. General Secretary, 25 guineas; Editor of Journal, 10 guineas.

*Resolved:* That as a matter of principle, members of the Membership Committee should not serve more than two three-year terms of office.

*Sales Tax Remission.—Resolved:* That insufficient evidence has been submitted to make an approach to the Government.

*General.—Resolved:* That representation be made to the Government with a view to increasing the supplies of Hydrochloric Acid, A.R. Sulphuric Acid, and all grades of Ethyl Alcohol.

*Resolved:* That it be recommended to the Rules Sub-Committee that the Committee consider the advisability of including in Branch Committees the retiring Chairman and Branch Sub-Editor as ex officio members.

**Resolved: That the subscription for the year 1951-52 be as follows: Associates, £2/2/-; Fellows, £3/3/-.**

An amendment proposed by Canterbury, that the Subscriptions be £2 and £3, lapsed.

*Resolved:* That a letter be sent to Dr. V. Armstrong thanking him for his generous action in replacing his own name with that of the Hon. General Secretary as official representative of the N.Z. Institute of Chemistry at the meeting of the American Chemical Society in New York and Washington. (Dr. Armstrong was originally nominated as our representative.) The Hon. General Secretary had prepared a report, but owing to the lateness of the hour it was decided to circulate it with the next Agenda. A very brief verbal report was given and some questions answered.

*Resolved:* That the Hon. General Secretary be granted the sum of £50 towards the cost of his representation of the Institute.

#### RUTHERFORD MEMORIAL FUND:

*Resolved:* That the sum of five guineas be donated to the Rutherford Memorial Fund Central Committee.

*Thanks.—Resolved:* That Council record its thanks to Mr. W. A. Joiner for inscribing certificates during the year; to the D.S.I.R. for providing meeting facilities, and the Registrar and the Hon. General Secretary for their services.

Professor Slater, on behalf of Council and all members, thanked Mr. P. R. Parr, the retiring President, for his services to the Institute.

## BOOK REVIEWS

*INORGANIC SYNTHESSES*, Vol. III. L. V. Audrieth, Editor-in-Chief. 230 pages. 1950: McGraw-Hill Book Co., New York and London. \$3.75. The need for precise directions for the preparation of inorganic compounds is perhaps greater than for organics, as they may be in more frequent demand, and such a series as this needs no apology. In this volume there are many useful preparations, including a valuable section on poly- and meta-phosphates. In some places there are discussions on a whole class of compounds rather than precise directions for individuals, which seems rather a departure from the true spirit of the series. This applies particularly to the section on organosilicon compounds, which can also be questioned as to being inorganic at all, a distinction they share with many other compounds in this book. Apart from these criticisms, this is a good book and a useful addition to the rather scant definitive literature of inorganic chemistry.

*CHEMICAL ENGINEERING OPERATIONS*. By F. Rumford, Glasgow. 376 pages. 1951: Constable & Co. Ltd., London. 30/-. British books on chemical engineering have been so remarkably few that particular interest attaches to this volume. It is subtitled "An Introduction to the Study of Chemical Plant" and the preface states that it is concerned with those processes which are peculiar to chemical plant practice; thus refrigeration, for example, is not discussed. These limitations are necessary to get adequate coverage in a book of this size. All the various types of chemical plant are described, and the calculations involved in their use are illustrated with worked examples, but there are no problems to be worked out by the student himself. The book is illustrated with numerous line drawings of chemical plant, but they are not annotated in many cases and the student will find it difficult to follow the working of the apparatus shown. Some photographs of chemical plant, especially British, would have been an improvement. The printing and binding are adequate and the price reasonable.

*AN OUTLINE OF ORGANIC NITROGEN COMPOUNDS*. By E. F. Degering, Chicago. 752 pages. 1950: University Lithoprinters, Ypsilanti, Michigan. This is apparently a reprint of the 4th (1945) edition of this book, as there are only a few references to later dates and these have been inserted in the text. Some parts are of even earlier date, as chapter 41 on Pyridine and Quinoline refers to a review subsequently published in 1944. Several chapters have been contributed by other authors and overlapping has not been entirely avoided; e.g., with urea. On the other hand, more space could have been devoted to N-ring compounds, and those having more than two nitrogens in the ring included for the sake of completeness. Otherwise the coverage is good and much space is given to aliphatic nitro and nitro-o compounds. An unusual feature is that the index refers to the paragraphs, which are numbered consecutively throughout the book with small figures in the margin. Once the reader becomes used to the idea, this facilitates reference. The various types of nitrogen compounds are discussed and their methods of preparation and reactions set out in a very straightforward and logical manner so that they may easily be studied. Equations are given wherever possible, and there are full bibliographies and index. These excellent features will do much to recommend this book.

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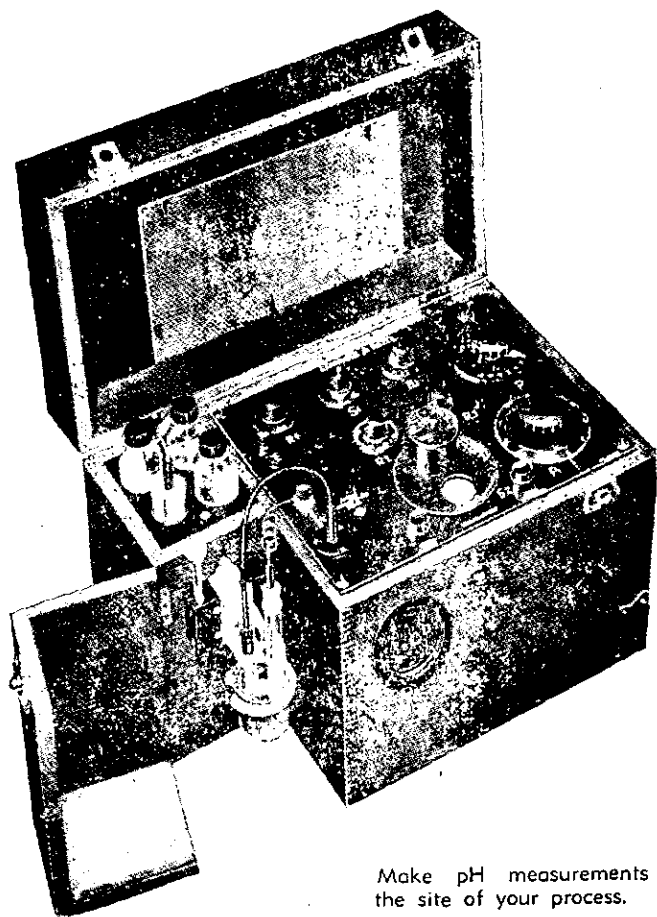
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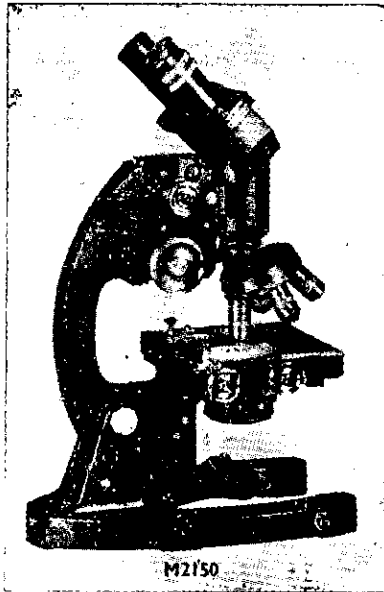
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