MEMORIAL ADDRESS

BERNARD CRACROFT ASTON

First New Zealand Official Agricultural Chemist

By R. E. R. GRIMMETT.

Introduction:

IT is with mingled feelings of pleasure and regret that I take up the task allotted to me this morning — pleasure that so worthy a name as Aston is being honoured by your Society, and regret that a more facile pen than mine has not been selected to formulate that honour in words. Words are indeed a poor substitute for the heart, and in thinking of Aston those who knew him intimately must always feel strong emotion. Boyish in his enthusiasms, informed yet unorthodox in his approach to problems, generous of attention to those of like interests, he was, as first Chemist of the Department of Agriculture, a unique and lovable figure.

In using thus the past tense, one is happy to know that "B. C." continues in retirement an active interest in scientific matters, especially through his membership of the Councils of the Royal Society of New Zealand and the Forest and Bird Protection Society, and through his personal devotion to the cultivation of New Zealand plants.

The recent recognition of the value of his work by the bestowing of a C.B.E. was some rebuff to public forgetfulness, but that Aston has left his mark, a notable one, for all time on the history of New Zealand can be appreciated by no gathering better than the present. The pleasant and prosperous farms of the pumice lands, with thrifty cattle and sheep that now contribute immensely to animal production are themselves the best memorial to his unremitting effort and tenacity, often amidst lack of interest and discouragement.

Just fifty years ago in May, 1899, B. C. Aston was appointed to the newly-created position of Chemist to the Department of Agriculture. At that time J. A. Gilruth was Chief Veterinarian and Pathologist, and actively pursuing investigations of live-stock diseases in New Zealand. Aston, previously engaged on chemical and bacteriological work in various laboratories in Dunedin had been offered by Gilruth accommodation and facilities for bacteriological work in Wellington, and a chance to do original research on some of the poisonous native plants known to cause losses in stock. Of these, one of the chief was Tutu-Coriaria sarmentosa. That the accommodation was makeshift, a room in an old building originally a boilerhouse, and with no certain prospects of position or pay, was no deterrent to a young man of Aston's enthusiasm. Not until after six months of such "honorary" effort and with pocket considerably strained, was Aston given a regular appointment.

Despite, however, the inevitable difficulties and frustrations inherent in establishing a new laboratory under such conditions, and with very little equipment or funds to purchase it, Fate had prepared an event in the year of his appointment which was to encourage and influence profoundly the course of Aston's development and indeed the development of agricultural chemistry in New Zealand.

At the newly-founded Victoria University College, the Chair of Chemistry was filled by the appointment of a man of culture, charm and high character, Professor T. H. Easterfield, whose wide knowledge of chemistry, and experience in European universities found splendid opportunity in the virgin soil of New Zealand. He met Aston soon

after his arrival and the latter lost no time in accepting a proposal of collaborative chemical research in the College laboratory. Thus was born a friendship which endured through half a century, and was not only the corner-stone of notable researches and discoveries, but also a landmark and guide to several generations of chemists who later came under their joint influence.

Early Life and Training:

Bernard Cracroft Aston was born in Kent, England, in 1871. His family was well represented in London and the Home Counties in legal and scientific circles, Jas. K. Aston, K.C., being Secretary to the Queen Ann's Bounty Office; Stafford Aston, F.I.C., Public Analyst for Middlesex; and Emily Aston a collaborator of Sir William Ramsay. Educated at Christchurch Boys' High School and later taking courses in Dunedin at the Technical College in chemistry and botany, he won the Professor Black prize, entitling him to a special course of study under that celebrated chemist at Otago University.

His predecessor in the Black prize was the world famous chemist, J. W. Mellor, and Aston was thrown into an atmosphere of intense activity in chemical research proceeding in Black's laboratory. Mellor, of course, later became Britain's foremost ceramic chemist and author of the most complete handbook of Inorganic Chemistry ever published. "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," a work to which all students in chemistry, agricultural or otherwise owe a continuing debt of gratitude.

Here I might interpose that when I visited Britain in 1927, Aston kindly gave me a letter of introduction to Mellor, whom I quickly found retained an extraordinary interest in and memory of his New Zealand colleagues and their work. He was still a typical New Zealander, bluff and hearty in his ways and standing on no ceremony.

This academic success confirmed Aston in his determination to abandon the position of insurance clerk in which he had worked for some years, and to take up analytical chemistry as a career. His earliest appointment was to a cement company where he had to conduct daily analyses of the raw materials for lime in three forms, so that after compounding and clinkering these could result in a standard product. The precursor of this company had previously worked on rule of thumb and had had many failures and complaints. These Aston soon rectified. The experience gained there with the need for rapid and accurate manipulation provided a background of skill that stood him in good stead in later years when working in more elaborately equipped laboratories and with a wider variety of materials. After leaving the cement works, where he had been given facilities to continue studies at the University, two years assaying and one year metallurgy, Aston was appointed a consulting analyst to the Government, who also arranged accommodation for him at the University. Among other duties he had to test wines and spirits and it was perhaps here that he developed the sense of discrimination in taste and smell (flavour and aroma perhaps one should say) which in later years was the envy and despair of his assistants. Acuity of sight was perhaps trained largely at week-ends when with other members of the Dunedin Field Club he tramped the many bush-clad hills about Dunedin and Otago Harbour, gaining not only recreation from tedious indoor work, but an amazing capacity to cover the ground with his long legs and an intimate and precise knowledge of the native flora.

When the Field Naturalist Club was revived in Dunedin in 1894, Aston was appointed Secretary, G. M. Thompson being President. In this capacity he had to attend to the re-editing and publication of a guide or handbook to the wild plants of Dunedin. Thompson, Laing

and Petrie were chiefly responsible for checking and rewriting the various sections and it was largely through this contact that Aston became so interested in botanical and ecological exploration. Later on moving to Wellington he kept up and extended his friendship with these and other botanists and took part in many expeditions, of which those to the Snares and Auckland Islands were perhaps the most notable.

As Secretary of the New Zealand Institute (now Royal Society of New Zealand) for many years, Aston quietly and efficiently performed a service of great value to science in New Zealand, but perhaps little known or appreciated by the public. As a very humble member of that Society I can testify to the great help he was always ready to give to anyone interested in any phase of natural history. Identification of specimens, books, references, his time was always freely given, though often unfairly sought by those who did not appreciate how crowded it was.

Aston's Work:

It is now time to consider some of the main lines of work undertaken by Aston in his 35 years as Chief Chemist to the Department of Agriculture. In doing so one is also surveying the development of most of the main lines of chemical research which are now applied to the service of agriculture in this country, many of them in special institutions or laboratories.

Here I wish to acknowledge a personal debt to Mr. Aston. When I told him of this forthcoming address and suggested that though I might personally know the history of the Chemical Laboratory since 1918, only himself could do justice to the early years, he kindly undertook to write a narrative that I might use. Though nearly 80 years of age and with some difficulty in writing, he has carried out his promise and I hope before long he will publish his autobiography. Meanwhile I have drawn on it freely, and here and there have inserted quotations. I am also indebted to Dr. I. J. Cunningham, who had prepared an index and precis of Aston's publications which also have been most valuable. Apart from these sources, I have also consulted all the Annual Reports, and other reports—many of which are filed as unpublished papers.

In the history of the Chemical Laboratory there are three main periods; 1899-1909 when it was called the "Chemical Division of the Department of Agriculture," 1910-1914 when it came under the jurisdiction of the Department of Internal Affairs as part of the Dominion Laboratory, and 1915-1939 when it was called the "Chemistry Section." Its later history is of no concern here. Apart from these administrative epochs there are, however, certain notable years or groups of years when its activity seemed to be in the ascendant, and others when it passed into a state of relative quiesence. To a point these reflect the political and economical state of the country, the former being in time of expansion or boom, the latter in times of retrenchment or slump, for which a small chemical laboratory was an easy and vulnerable target.

The first period of notable progress was in the very beginning when in 1899-1900, Easterfield and Aston solved the long-standing puzzle of the poisonous action of Tutu and published their researches on the toxic glucosides of the various species of coriaria, which have remained standard tests until now. "Toot" is not considered a serious menace to livestock at the present day, but how far this is due to the application of knowledge resulting from these chemical and associated pharmacological studies, and how far to change in stock and pasture management and the general development of the country is difficult to assess. Just recently there has been renewed interest in Tutin on account of the

discovery that bees may carry a modified form of this poison from honey-dew to honeycomb leading to the production of honey causing serious illness in humans. Here I quote a passage from Aston—which may be illuminating to the present-day chemists and also perhaps to the Railway Department:

"These two poisonous trees, Tutu and Karaka, had long been regarded as something mysterious and although attempts had been made by chemists before to isolate them in quantity large enough to study, and to distribute to Pharmacologists (whose duty it was to find out the action of the principles on animals and humans) they had never succeeded. Easterfield, working at Cambridge University Chemical Laboratory with two collaborators on the Indian Hemp (Cannabis indicus) had been successful in isolating Cannabinol—an active principle—and he certainly had the right idea for working on large quantities. After I was successful on a small scale, he invoked everybody's assistance in order to get a large quantity of material. For instance, the New Zealand Railways Department stopped a goods train on the Rimutaka Incline where there were a large number of tree tutu shoots (Coriaria sarmentosa) and unloaded a large number of assistants, students and other enthusiasts. These spent the day gathering these enormous juicy shoots. When the train returned, empty trucks were quickly loaded by many willing hands, and the party returned with vigorous appetites. The trucks were then shunted off at a convenient siding and were taken in charge at one of the Hutt factories where the tutu was crushed and the juice expressed and caught in glass demi-johns. Next the juice was filtered and evaporated in a vacuum pan to a syrup and this was sent to the Laboratory for extracting the crystals of tutin. These crystals were so easy to obtain and they looked so like coarse sugar that some scepticism was openly expressed. Gilruth was the first convert. I weighed him out two grains which he gave to a small pig weighing 35lb. What happened to the pig may be read in the 1900 report of the Department of Agriculture. Sufficient to say that even Gilruth was convinced. Another sceptic was the chemist who hadn't succeeded in isolating the tutin principle. I showed him something which I said was the active principle of tutu. When he saw the sugar-like crystals at the bottom of a crystallizing dish his great, broad tongue came out and licked off the lot—some few miligrams. He visited us a few days later, looking a "bit green about the gills" with the remarks, "I've been ill ever since I saw you last. My wife says I'm never to eat anything in your laboratory again." Another convert!

Besides Tutu, other native poisonous plants investigated in the early years included the Karaka, Ngaio, Pimelia, Rangiora, and the Puketea, from which a series of alkaloids was isolated. A toxic extract was also obtained from the ragwort (Senecio jacobea) which was not then known to be definitely poisonous but was under suspicion by Gilruth as the cause of Winton disease in horses.

In the very first years, Aston was introduced to the subject of Bush sickness through being required to analyse spring water and soils from the pumice areas where the disease was occurring. This subject, however, I feel of sufficient importance to treat under a separate section.

Besides these researches (most of which were done on holidays or at night) Aston reported during the first year on some 93 samples which ran the gamut of almost all types of agricultural materials. These included soils, waters, fertilisers, butter, cheese and milk, grass, silo press liquor, sugarbeets, seeds, preservatives, vinegar, extract of beef, fruit tree wash, stomach contents, Babcock ware, etc. He introduced and tested Dyer's method (1% citric acid) for available plant food, phosphate and potash in soils. In this and the following years was laid the foundation of most lines of agricultural analyses practised in New Zealand during the next 35 years.

In 1903, Aston obtained leave, and made his first visit to Britain, Canada, U.S.A. and Australia, gaining valuable experience and making many useful contacts.

The year 1906 marked the beginning of the second period of notable achievement. A conference of Agricultural Chemists was held in Sydney and this Aston attended. As a result an Association of Official Agricultural Chemists was formed, Aston being corresponding member for New Zealand, and referee for certain analytical methods. The laboratory grew both in rooms, equipment, and personnel, and in the years 1907-8 and 9 a vast amount of the valuable work was accomplished and many lines of research inaugurated.

The objectives and methods of field experimentation were formulated, the need for a soil survey emphasised, and much data about the soils of New Zealand accumulated from flying surveys and investigation of Agricultural problems. In conjunction with divisional and district officers of the Department, many field experiments with fertilisers and crops were devised and laid down at Ruakura, Momohaki and other experimental areas.

The necessity and requirements for sampling and analysing of butter for export which is now an important feature of the dairy industry, were considered in detail and satisfactory routine procedures established. As a development of this, the first regular butter testing laboratory was established in New Plymouth in 1908 as a branch of the Chemical Division.

A comprehensive report on the possibility of establishing a sugar industry in New Zealand was published, and included much data from field experiments and analysis for sugar content of beets grown in various districts.

The annual reports for 1908 and 1909 are important documents enshrining a vast amount of information and chemical data on soils, crops, fertilisers, dairy produce and other matters of interest and importance to agriculture. In particular the outstanding chemical and physical characteristics are given for many, perhaps most, of the soils which characterise the main regions of New Zealand. Special attention was paid to the mica schist soils of Westland and Otago, the Pakihi soils and the peat or humus soils of the Waikato and the Southern Islands.

The development, the promise and the fruition of the years 1907-9 were followed by the contraction and discouragement consequent upon the retrenchment of the Civil Service and reorganisation of 1910. Chilwell, Aston's chief assistant and a brilliant chemist, was allowed to leave the service, and the functions of the laboratory were severely curtailed. While loyally accepting the politicians' verdict and carrying out his duties conscientiously, Aston did not lose his vision of a possible greater future for agricultural chemistry in New Zealand. In 1914, he obtained leave from the Government and paid a second visit to Great Britain and America, renewing old contacts and making new ones which were to prove of value in the future.

In 1914 the laboratory once more was placed under the control of the Department of Agriculture, but with shortage of staff due to the war only a limited amount of research could be sandwiched in between the calls for essential services such as analysis of butter, fertilisers, toxicological specimens and the like. When I joined in 1917, Aston had only one assistant chemist and two cadets, one of whom did the typing. Nevertheless during the next six years several very interesting researches were carried through, and certain new lines of investigation commenced which later developed as the subject-matter of independent and fully-fledged research institutions.

One of these was the milling test of wheats, at first applied to samples of different wheats from Departmental field trials. A model mill was obtained and L. D. Foster given the task of carrying out milling and baking tests. In addition he conducted much analytical research into the relationship between the chemical composition of the wheat grain, the physical properties of the flour, and gluten and the quality of the final product, bread.

Gradually as this work extended and gained appreciation, it was applied to a wider range of wheat samples until it became a major activity of the Laboratory. In the end it out-grew its nest and both mill and work were taken over on the establishment of the Wheat Research Institute in Christchurch.

A second line, the chemical investigation and control of dairy products and accessories that developed from many small scale, yet often intense, efforts in Aston's laboratory commenced about this time to branch into subdivisions that later were expanded and achieved separate existences. These are now to be found in the Dairy Research Institute, the Dairy Laboratory at Wallaceville and the laboratories of the Dairy Division and the Dairy Industry in grading-rooms and factories. In this dairy field, the late Mr. F. T. Leighton did much of the spade work.

A third line was the testing of New Zealand leathers, tan barks and other materials bearing on the utilisation of our locally produced hides. Here again was a forerunner of the extensive and valuable work later done for the leather industry by the setting up of the Leather Research Association with its Laboratory under Mr. P. White.

A fourth and most important line of investigation was one which had occupied Aston's attention from the outset and was now increasingly hammered at by him—the value of and necessity for a properly organised Soil Survey of New Zealand. From time to time he put forward proposals as to how this should be undertaken, but though accepting them in principle the Department never seemed able to muster the necessary funds and other resources to carry them into effect. Time and again a commencement was made, usually with a local problem as focus, only to have to be abandoned owing to lack of staff or room or finance. Not until the middle-twenties when the importance of the work on bush sickness gained recognition was a regional survey—that of the pumice lands—put in hand and carried through to a conclusion which, if modified by later detailed surveys at least served the purpose in hand, the correlation of stock ailment with features of the physiography and soil types of the area.

Here again the early work was taken over, developed later by the soil Survey Division, first established as a branch of the Geological Survey under the guidance of Sir Theodore Rigg (himself earlier trained in Aston's laboratory) with L. I. Grange as field surveyor, and organised in the first instance to complete the classification and mapping of the pumice lands.

The supply and quality of agricultural lime had always received much attention from Aston, who recognised and advocated its extreme importance in a country of predominantly high rainfall and acid soils such as New Zealand. In 1920 a committee was set up to advise the Government on all aspects of the lime supply problem, consisting of Aston and representatives of the Geological Survey and Public Works Department. This committee did much good work in regard to sources of supply, methods and machinery for grinding and burning limestone, and advising about transport and requirements for lime in the various districts of New Zealand. "The Fertilisers Act, 1905," which was Aston's work, was revised by him in the present Act of 1927.

An interesting sideline arising from difficulties of supply of dyestuffs in the first World War was the investigation of the dyeing principles in certain New Zealand native plants, in particular the genus Coprosma, many of which are common and easily grown shrubs. Although perhaps not now of economic importance this research resulted in the discovering of a fine series of colours, many of striking hue, and which have since provided an interesting hobby for many country folk who have tried their hand at spinning and dyeing their own wool.

Prof. Briggs has recently investigated the chemistry of these dyes and has termed one of the shrubs, Coprosma australis, "the best dye plant in the world."

On the whole, however, this was a time of quiet growth interrupted by the depression and retrenchment of the early twenties, and it was not until 1924 that the third and prehaps, from the animal production point of view, most notable and important period of the Chemical Laboratory commenced. In that year the work on "Bush sickness" which had proceeded intermittently over a number of years was reviewed by Aston, who concluded that a farmer could now break in pumice land and rear stock successfully with the aid of molasses and iron and ammonium citrate. This created considerable interest in the Rotorua district and a demand soon followed for more intensive investigation and also for the Department of Agriculture to undertake the supply and distribution of iron and ammonium citrate.

In 1925 the writer was stationed at Rotorua to undertake detailed studies of soil and pasture conditions, as related to "Bush sickness," on the spot, and many field experiments in topdressing, lick and pellet feeding were instituted. In 1926 Aston visited Britain for the third time, delivering a paper on "Bush sickness" to the British Association for the Advancement of Science and visiting the Rowett Research Institute where he and his work met with a very enthusiastic reception from Sir John Orr. It was largely as a result of this contact that a grant was made to the New Zealand Government in the following year. When the Empire Marketing Board decided to adopt Sir John Orr's recommendation to use part of its surplus funds to further research on problems of animal nutrition in the contributing countries, Aston and Sir Theodore Rigg were made official correspondents of the Bureau of Animal Nutrition which was centred at the Rowett Institute, Aston in the first instance being appointed to direct the use of research funds in New Zealand.

The following years, until the depression of the early thirties finally curtailed this and other expenditure of research, were a period of intense activity. The main accent was on "Bush sickness," but under the theme of mineral content of pasture investigation were included a number of other projects of considerable importance. An exchange of workers promoted by Dr. Orr enabled I. J. Cunningham to study and work at the Rowett Institute, while Miss B. Simpson, of Aberdeen, spent two years at the Chemical Laboratory at Wellington. Just prior to this exchange the writer had been enabled to visit the Rowett Institute, Rothamstead and other centres of agricultural research in Great Britain and received a welcome everywhere. This cordiality was largely the result of Aston's visit the previous year.

While in New Zealand, Miss Simpson inaugurated and developed research into the distribution and utilisation of Iodine in our soils and pastures as determined by measurement and analyses of thyroid glands of sheep and cattle. Her work, followed up later by Miss W. Mason and Messrs. Sykes, Denz and D. F. Waters, enabled those areas to be determined where the supplying of Iodine in licks to stock might prove beneficial.

Numerous analyses were made of soils and pastures from sheep and dairying areas where trouble that was considered could have a nutritional basis were reported by Veterinarians. These included "Pulpy Kidney" in lambs in Central Otago, "Morton Mains" disease in Southland, "Mairoa Dopiness" in the King Country, "Milk Fever" and "Grass Staggers" in the Waikato and Taranaki; temporary sterility in dairy cows in Taranaki, bone chewing in cattle in the Wairarapa and elsewhere and hoggett mortality in Canterbury.

While many of those troubles were eventually shown to be due to other causes, the mass of data on the composition of New Zealand pastures under varying soil, climatic, seasonal and management conditions has provided a background for other and subsequent work. Some was published but much is to be found only in the quarterly reports to the Empire Marketing Board which that body, becoming defunct, did not utilise in a comprehensive publication on the mineral status of Empire grasslands as had originally been envisaged.

Bush Sickness:

The earliest records of "Bush Disease," "Bush Sickness," or "Tauranga Disease" as it was variously called must go back into the "eighties" or beyond but are not easy to trace. In 1893 in the first Annual Report of the Department of Agriculture, E. Clifton, then Inspector of stock, Auckland, records: "At Tauranga this year the death rate caused by the 'Tauranga Sheep Disease' is excessively high. Further investigation into the cause of this mortality among their sheep is anxiously expected by the farmers of that district, and it must be recognised that this mortality has stopped all progress and settlement, for their land cannot be brought into useful occupation except through the sheep." A year later he reported: "At Tauranga the mortality was so serious that cattle have replaced sheep; fortunately creameries have commenced work there or the district would have fallen out of occupation." In 1895 he refers to the desire of the settlers at Tauranga to have an experimental farm established in their district principally to investigate this disease. David Ross, Inspector for the Waikato in 1896 reports: "In the Rotorua bush lands a peculiar malady, locally known as "Bush Sickness" affects cattle at certain seasons of the year." Again in 1897, Clifton refers to a percentage of cattle in the wooded country between Waikato and Tauranga being affected with "Bush Sickness" and recovering when removed. The owners would like this affection investigated. In the 1898 report he states "No special disease has been reported during the year except that termed 'Bush Sickness.' This is causing serious loss to the settlers who keep cattle in the forest clearings between Rotorua and Lichfield, not as much from the number actually dying but that the cattle commence to waster after be depastured for a few months in that district." A. Park, Veterinarian, in the same year reports on "Bush Disease in Cattle"—No organic disease—on post mortem, and complete recovery of two other animals removed to fresh pasture—without any medicinal treatment. . . "This form of anaemia in cattle is due apparently to something deficient in the soil of that locality." He suggests medicinal treatment with carbonate of iron. Referring to "anaemia in sheep" he reports that sheep on pig-rooted paddocks near Tauraunga are healthy but on apparently better pastures in the same locality they pine and die. If taken from this locality to a paddock near the sea they recover in condition rapidly—"cattle do well."

In 1900 Gilruth who had been appointed Chief Veterinarian in 1894 and had meanwhile satisfied himself that no contagion was responsible, decided to try a somewhat heroic experiment (heroic that is for those days of slow and difficult transport) to prove whether any deficiency in the pasture were involved in the causation

of "Bush Sickness." He arranged to transport freshly cut grass and clover regularly from the pumice area near Mamaku and feed it as a sole ration to thirteen "Bush Sick" sheep at Wairangi (now Waerenga or Te Kauwhata), a healthy locality. Forty-two similar sheep were grazed on the area where the grass was cut and gradually became worse while their mates at Wairangi improved in condition on the transported fodder. It is perhaps unfortunate that Gilruth did not apparently take into account the implications of Park's observations regarding the health of sheep on pig-rooted pastures at Tauranga when he arranged for the sheep at Wairangi to be run on a two acre paddock specially ploughed to keep it bare of all vegetation. Possibly had they been penned on a wooden floor they might have died of "Bush Sickness" rather than as it would seem in the light of present knowledge, gaining a sufficient supply of the deficient element (cobalt) by licking the clay soil at Wairangi as had probably also happened in the case of subsoil material turned up by pig-rooting at Tauranga.

Thus although many of the characteristic features of "Bush Sickness" had been recognised and described by the time of Aston's appointment this experiment of Gilruth's had clouded the issue, so that for the next decade experimental work was largely directed by Veterinary and Stock Officers towards such possible factors as lack of sufficient drinking water or a possible injurious substance in waters or soils or native plants. In case some abnormality in the composition of the ash might yield a clue, Aston in 1904 made detailed analyses of the minerals present in various organs of "Bush Sick" and healthy sheep. As spectrographic or other "trace element" methods of analyses were then not developed, it is not to be wondered that the results are described as "perplexing." The next year he visited some of the bush sickness areas and obtained samples of soil and blood for analysis.

In the period 1910 when the Chemical Laboratory came under the Dominion Analyst until 1916, two lines of investigation were pursued by Aston and were facilitated by the establishment of experimental areas first at Lichfield in 1910 and later at Mamaku in 1912. The first line was the resuscitated idea that a mineral deficiency might exist in the pasture and the second the possibility of excess of an otherwise normal constituent—copper—which Aston found from an extensive series of analyses of ruminant livers to be higher in various localities in New Zealand than recorded overseas and especially so in samples from some of the bush sick areas. The lack of consistency in this abnormal copper content together with feeding experiments however finally convinced Aston that it was fortuitous as far as bush sickness was concerned. These results are of interest today in view of the puzzling incidence of **Enzootic icterus,** a type of poisoning in sheep associated with high copper content of livers and often occurring in areas of the North Island where soils are of volcanic origin. Here again any connection with soil type may be purely fortuitous.

The deficiency idea focussed on iron as the most probable element. In view of the limitations in the state of knowledge at the time, both in physiology and in animal, plant and soil chemistry, this was a logical development supported by considerable evidence. The animals exhibited anaemia, the iron content of blood, pasture and soil was low, though how low bloods and pastures could go in iron without being abnormal was a moot point not then illuminated by veterinary or physiological knowledge of types of animal anaemias. Knowledge as to factors involved in the availability of iron in the soil or its possibility of assimilation by the animal if ingested in various forms was also lacking. Field experiments at Lichfield in 1910 in which a topdressing of 5 cwt. per acre of sulphate of iron was applied had given promising results with sheep, and at Mamaku other forms of iron in topdressing and licks had also proved more or less successful.

In the Annual Report for 1916 it is recorded that eight ewes at Mamaku had remained healthy for 18 months and fattened on a paddock topdressed with spent iron oxide at the rate of 20 cwt. per acre. In 1918 when I first visited Mamaku in company with Mr. Aston I remembered that a smell of 'gasworks' still faintly lingered about this paddock. That the effect was somewhat transitory is recorded by Reakes, Director of Livestock Division in the 1917 Annual Report where he states that at the end of the second year only three ewes remained alive. "This experiment," he says, "is notable as showing the efficiency of iron dressings in keeping sheep healthy for a much longer time on affected country than otherwise would be possible."

In the following years shortage of staff and pressure of other investigations slowed down research on "Bush Sickness," most attention being given to the trial of various iron-containing licks and drenches. Of these the Double citrate of iron and ammonia proved the most palatable and easiest to administer. In 1920 a brief study was made of a disease at Glenhope and it was considered that this was similar to "Bush Sickness."

By 1924 the stage was set for the resumption of intensive research into the nature and causes of "Bush Sickness" and into improvements in the supply and application or practical remedies. Some phases of this period have been described already. Following the inauguration of the Mineral Contents of Pastures Investigation in 1927, many analyses of pastures and soils from the bush sickness areas were made and attention was drawn to the high manganese content of some of the pastures.

"Trace elements" were now beginning to receive attention and Aston's reference to a possible role of manganese in iron untilisation by the animal showed that he was willing to modify the iron deficiency theory should evidence warrant this course. From a practical point of view, however, much could still be done to apply and extend existing knowledge and it was largely to further this angle that C. R. Taylor was appointed field assistant at Rotorua in 1930.

Meanwhile the use of citrate of iron and ammonia as a drench or feed with hay had become standard practice with excellent results among dairy farmers in the Rotorua, and Bay of Plenty bush sick areas and attention was therefore directed to possible methods of treating sheep and also to cheaper and more automatic methods for cattle. Pellets containing meals plus iron compounds and also licks at first of salt plus citrate of iron and ammonia and later native carbonate of iron and finally limonite were tried. Extensive invasions of ragwort in the pumice areas had made dairy farming precarious and emphasised the importance of enabling sheep to be carried.

Following preliminary experiments, a large-scale trial was commenced by Taylor in the Atiamuri district in March 1931. Four groups each of 50 ewes were given the following treatments: 1 control, 2 lick of native carbonate of iron and salt, 3 lick of citrate of iron and salt, 4 lick of limonite and salt. All sheep were weighed at regular intervals. Almost from the outset the limonite group forged ahead of the others and by September had lambed very satisfactorily, lambs being forward and healthy while in the other groups many had died. The producers of the limonite were not slow to capitalise on this success and before the end of the year had established agencies and sold considerable quantities to farmers in the Rotorua district. Reports generally were favourable.

In February 1932, the experiment at Atiamuri was a striking success. All the lambs and many of the ewes in the other groups were dead, while in the limonite group 44 lambs from 45 ewes were

an outstanding feature, the ewes being particularly bright and healthy, while the lambs were well built, robust and with a healthy bloom in the wool, giving the impression that they had come off good sheep country. The cost of materials for this group was 5½d per head. At a field day held at the time, a large number of farmers from Tokoroa and Putaruru districts attended, Mr. D. Marshall, then Government Veterinarian at Hamilton, who had closely followed the experiment, officiating with Mr. Taylor in the demonstration.

The report of this experiment, when published in the Journal of Agriculture, aroused widespread interest, and reprints were distributed to large numbers of farmers in the bush-sick areas by Dairy Companies and Government officers. The Tokoroa Progress League, impressed by this and similar experiments in their own district, started an enthusiastic campaign among farmers. It was claimed that dairy herds in very poor condition had responded almost immediately limonite was given them, milk yield improving as well as health ,and calves recovering in striking manner. At the Mamaku Farm all stock were given limonite lick and were in thriving condition. Sheep were also being used to control ragwort, previously impossible on account of losses from "Bush Sickness." The use of limonite rapidly spread to the Bay of Plenty and farmers on all the bush sick country became optimsitic, the value of land in this area rising sharply. Towards the end of 1932 the Supervisor of the Dominion Herd Testing Federation wrote stating that he considered the Department of Agriculture was to be congratulated on the success attending the experiments. He appreciated the changed outlook of th dairyfarmers. Where despondency was prevalent a few years before, he found optimism as to the future. Prices were not worrying these men since they had been satisfied that they could keep their stock in a healthy condition and rear young stock. The great success of these experiments would definitely assist the Herd Testing Movement, especially in the Bay of Plenty district.

The year 1933 marked the climax of Aston's work in "Bush Sickness" and as it also marked the contraction or cessation of much of the research work in his laboratory due to the depression and retrenchment in the Public Service, a quotation from the final report to the Empire Marketing Board may be permissible:—

Reporting on the use of limonite C. R. Taylor stated:—"The position of the limonite treatment of stock in the bush sick areas of the Tokoroa and Putaruru districts has been one of steady progress associated with some phenomenal results. Limonite is now being extensively used in these districts for both sheep and cattle—its efficacy is now beyond dispute . . . . Unlike other years not a single beast has left Tokoroa for a change on to outside healthy pastures. Limonite has proved wholly sufficient in keeping dairy herds in a healthy and high producing condition, and I have it on excellent authority that the heaviest bobby calves arriving at the Putaruru Railway Station for trucking are coming from the once despised Tokoroa district. In the past I have seen fully 25 per cent of calves die where they were dropped—and of the balance nearly all would be dead by the following autumn. Last year's calves, yearlings now, are a picture of health—Regarding the dairy herds at Tokoroa an idea of the wonderfully improved condition may be gained from their production for the past season.

With five herds less supplying the factory ,82 tons of cheese extra have been made above the previous record and the factory is only a small one—on the 17th April 1933 a conspicuously successful show was held at Tokoroa. This was Tokoroa's first livestock show—high praise was showered upon the various classes by the judge. With regard to the hoggets reared in the district, Mr. Lopdell, the judge, said that he had farmed sheep in Gisborne and Hawke's Bay district but had never

seen better grown or better woolled sheep . . . As an additional result of the limonite treatment rendering it possible to farm the worst types of bush sick country economically it is interesting to note the present keen demand for land for farming purposes that only two years ago was considered suitable for afforestation only . . . On practically every farm virgin country is being broken into pasture . . . the spirit and outlook of the people are vastly changed and in place of despondency is a feeling of unbounded confidence in the future.''

Here perhaps the story of ''Bush Sickness'' may be left. The subsequent researches both in the Chemical Laboratory of the Department of Agriculture arising out of the failure of certain batches of limonite to live up to the performance of these earlier supplies, and by Marston, and Filmer, and Underwood in Australia and Rigg and Askew at the Cawthron Institute, whereby cobalt in trace amounts was discovered to be the active ingredient in all the iron remedies and the missing element in the bush sick pactures, these belong to a later era and a later generation. Aston had pioneered the way and provided a practical remedy, and that others building on his foundation could reinterpret his findings and provide an even cheaper and more certain remedy in no way detracts from his achievement .Attempts have been made to calculate this achievement in acres of farmland or butterfat or money values, but they are subject to a considerable ''uncertanty factor.'' According to how one considers actual or potential farmland, or severely or slightly bush sick country, the estimate of area affected in the North Island may vary from one to several million acres. If one extends the view to the South Island and other countries, the area is considerably enlarged. On a conservative estimate, however, it may be stated that the results of this one piece of work more than paid for all the expenditure on agricultural chemical research in New Zealand up to the time of Aston's retirement.

Personality:

Among his colleagues, Aston was regarded as something of a ''character.'' His exploits in tramping and botanical exploration and his capacity for arriving back from an expedition with pockets and bags bulging in every direction with specimens were doubtless responsible for some of this. No more charming companion could have been found for anyone interested in the outdoor or in any phase of our natural history and among the laboratory staff the opportunity to accompany him on any field trip was keenly sought .When investigating any problem of soil, crop or animal, difficulties of access or transport never stood in his way, and if walking were the only means, then walking was a pleasure rather than a task. I remember one occasion when advantage was taken of an offer of a lift on the rear tender of an engine on a logging train to reach a remote section of the Mamaku Plateau at the end of a bush tramway. After sundry hair-raising ''switch-backs'' up grades where the trucks with their massive logs lagged and stretched out, and down grades where they compensated by closing up on the engine and one another with a series of shattering blows that threatened to dislodge one's insecure foothold, it was indeed a pleasure to walk back, even with a load of soils. On another occasion, preparations were made overnight for a very long day at Mamaku and after ''early'' breakfast at the hotel in Rotorua there was considerable satisfaction in settling into a comfortable seat on the 6 a.m. train five minutes before its time of departure. Not so satisfying however was the sound of the departing engine and the dawning realisation that the carriage selected was ''unattached.'' Feelings and expressions were somewhat explosive, but soon became ''sublimated'' in the interest of a walk round the Rotorua Gardens with an extra breakfast for good measure before setting out on the usual express.

While always considerate to his assistants in the laboratory, Aston was to some of them somewhat remote and enigmatical. This was partly because of his intense interest in the job he personally had in hand at the moment and the necessity for anyone sharing his company to be interested in it too. With a just pleasure and pride in his manipulative skill he did not usually find deputing easy or satisfactory.

Ideals and Objectives:

Essentially an optimist, Aston never considered any problem insoluble or too difficult to tackle. He was a great lover of New Zealand and of its mountains, plants, and climate. Under our climatic advantages he considered almost any soil could be made productive if its characteristics were determined, and necessary adjustments made. In particular the pumice soils appealed to him as having many attractive features and great undeveloped potential for agriculture. As early as 1911 when giving evidence before the Parliamentary Committee considering the application of the Taupo Totara Timber Coy. to extend its line and purchase huge blocks of undeveloped pumice land—then considered by most people as worthless agriculturally—Aston stated a case for pumice soils which an agricultural or soil chemist would not find easy to criticise or improve on at the present day. After drawing attention to the richness of the pumice in potash he emphasised the need for phosphate, stating that "improvement in pumice soils must depend largely on increasing the store of humus and by application of phosphatic fertilisers" . . . "it seems certain, then, that once these sandy plains are covered with vegetation they may be expected greatly to increase in fruitfulness."

In the days before soil conservation came into prominence, or any service to study or control soil losses was thought of in New Zealand, Aston was concerned at the denudation of the water-sheds consequent on destruction of bush by the ravages of fire, deer and goats. He strongly supported the setting aside of such areas as forest or national reserves and the stringent control or destruction of these and other introduced pests.

It may be said indeed that Aston strove for the greatest good for the greatest number, with the reservation perhaps that the "greatest number" should include the original inhabitants of these islands, the native plants and animals, as well as their domestic cousins who form the basis both of the wealth and beauty of our farm lands and countryside.

Publications:

Aston was a prolific writer and a list of his papers, excluding some 35 Annual Reports, covers not less than 236 titles. These vary from short notes to articles of almost book scale covering original research and with much tabular matter and many photographic and diagrammatic illustrations. In verifying references, checking data and proof reading he was most meticulous, as I can testify having spent many hours with him in this work.

Few of the earlier volumes of the Journal of Agriculture are without some article of Aston's, and these cover almost every phase and subject of the huge field of agricultural chemistry. Toxicology was one of his favourite topics and he took pleasure in delving into the earlier records of poisonous plants and inorganic elements.

Aston's Graduates and his influence on Agricultural Chemistry in New Zealand.

The role of Aston's laboratory as a training ground for agricultural chemists and other scientific workers was perhaps one of its most valuable features. A list of those who worked under him reveals many well-known names. One of the earliest was H. W. Lawrence, later founder of the firm of H. W. Lawrence and Son, Private Analysts. Chilwell became a director of companies in Australia and New Zealand. L. Foster went to Australia as Chief Chemist to Mauri Bros. & Thompson: W. Udy is now chief chemist to the N.Z. Co-op Dairy Co. and T. Fielder chemist to the Challenge Phosphate Co. Dr. P. P. Lynch was there for a year or so before taking up a medical career and achieving note as a pathologist; R. Waters ,now lecturer in Bacteriology at Massey College was a cadet in the early years of the Chemical Laboratory. Perhaps the most notable is Sir Theodore Rigg, now Director of the Cawthron Institute, who as a cadet between 1907 and 1911 was regarded very highly by Aston. Others who came later were J. G. Myers, who was one of New Zealand's most brilliant students and later well-known for his researches in Tropical America and the West Indies, in the field of economic entomology. I. J. Cunningham, now Superintendent of Wallaceville Animal Research Station, A. W. M. Greig, now Director of the Horticulture Division, F. J. A. Brogan, who was later Assistant Secretary to the Department of Scientific and Industrial Research; W. Sykes, now occupying an important position with Imperial Chemical Industries in England, Miss E. Kidson who has made a notable contribution to analytical chemistry as well as in agricultural research at Cawthron Institute, Miss R. Strand, who after her marriage worked and published jointly with her husband, Wm. Alcroft, on animal chemistry at Weybridge; Miss E. Mason who worked on Iodine Deficiency in England, S. G. Brooker now Chief Chemist to Abels Ltd., F. B. Shorland of fish oil fame and now in charge of the Fats Laboratory; I. McIntosh now toxicologist at Wallaceville and D. F. Waters and E. B. Davies who still remain chemists in the present laboratories at Hamilton. One quiet but highly competent chemist who spent most of his life and died in the service of the laboratory, helping to train many of these chemists was F. T. Leighton.

Aston also took part in educational and professional activities being an active member of a number of chemical societies and a Fellow of the Royal Institute of Chemistry. It was largely as the result of the activity of several chemists in his laboratory and the Dominion Laboratory that a Chemical Society was established in Wellington, later growing and becoming incorporated into the New Zealand Institute of Chemistry.

At this close range it is not possible to assess accurately the full impact and importance of Aston's influence on agricultural chemistry in New Zealand, but in a few years others of these chemists who were trained or worked in Aston's laboratory, will doubtless record the progress in their own fields and enable some more detached and able historian of the future to clothe a massive personality in fitting proportion.