UNDERWOOD LECTURES
For 1986 and 1988

In honour of Professor Eric J. Underwood, OA, C.B.E., B.Sc.(Agri)(Hons) W.A., Ph.D.(Cantab.), Hon.D.Rur.Sci.(NE), Hon.D.Sc.(Wis.), Hon.D.Sc.(Agric.)W.A., Hon.D.Sc.(Melb.), F.R.S., F.A.A., F.T.A., F.A.I.A.S., F.A.S.A.P., Hon.FIA.C.V.S.
Agricultural Scientist, 1905-1980

The 1986 lecture by HECTOR J. LEE†

When invited to present this, the second of our Society's Underwood Lectures, I was at first flattered and, finally frightened.

I knew of Professor Reg. Moir's well-considered' and informative inaugural lecture presented to this Society in 1984. Further, I refreshed my incomplete recollection of Sir Kenneth Blaxter's extraordinarily comprehensive account of Underwood's origin, education, development and scientific career published in 1981 in Biographical Memoirs of Fellows of the Royal Society. .

These two compilations left little to be said about the scientific achievements and influence of this great and unassuming man and, ordinarily, in a Society such as ours, biographical emphasis in this lecture might have been expected to give way to the presentation of original scientific findings as a memorial tribute.

However, I felt that as one born not many years after Underwood and one who had known him well, if intermittently, for more than forty years, often at the fringe of his professional commitments, I should attempt to make personal recollections reveal something of the qualities of the man which might not be apparent to those who did, not know him or did not know him well.

I first met Underwood in November 1934, when I was a fresh young graduate holding my first scientific appointment at the Division of Animal Nutrition of what was then the Council for Scientific and Industrial Research in Adelaide. He visited the Division at that time, when visitors from far-distant Perth were rare, and was invited after morning tea to speak to the scientific staff about his current research activities. 'This encounter, which made such an impression on me and. had such an, unexpected outcome, has been variously described by others, but' I offer my own recollections for. I must certainly be the last survivor of those present at the time and history recorded by one who lived through it has a fascination for me.

Underwood then held an appointment in the Western Australian Department of Agriculture as Animal -Nutrition Officer and he spoke at length. about his collaborative studies with J.F. Filmer, then Senior Veterinary Officer in the department, relating to Enzootic Marasmus or Denmark Wasting Disease 'in cattle and sheep in the south-west of Western Australia.

This was a commonly 'fatal wasting disease recognized to have features in common with "Coast Disease" in South Australia and seemingly similar diseases elsewhere.

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† CSIRO, Adelaide (retired); M.Sc., F.A.S.A.P., A.M.

In order that the circumstances in which his work was carried out may be appreciated I should stress that the early 1930s represented the depth of the great depression years, years never to be forgotten by those who experienced them and poorly comprehended by those who didn't (for instance, during one year, I was appointed, received three salary increments and two cuts and finished up worse off than when I started!).

I later saw the dungeon-like laboratory, partly below surface level, in which Underwood had worked at that time and marvelled at what must have been his enthusiastic and productive dedication to his work.

One of the features of Denmark Wasting Disease, or Enzootic Marasmus, and related diseases throughout the world was a profound anaemia. The first practical control of one of them (Bush Sickness) was achieved in New Zealand by dosing anaemic sheep with massive doses of crude, powdered iron-ore. I was told long afterwards by New Zealand workers that they had recognized fairly early a weakness in the iron deficiency theory, in that not all deposits of the same iron-ore were equally effective, but that they had been prevented from pursuing their discovery.

A curative iron-ore from New Zealand, when systematically administered to cattle suffering from Enzootic Marasmus in Western Australia brought about appreciable improvement, while later another ore, limonite from New South Wales, proved fully effective.

By June 1934, Filmer and Underwood had recorded that there was a widespread and growing realization that iron deficiency alone did not account for the positive response to curative iron compounds and they had undertaken to determine in which fraction the therapeutic properties lay. The onerous task of fractionation fell, of course, to Underwood the chemist.

Working in the extraordinarily primitive conditions which faced him he set about his task. Imagine his laborious separation of iron from the other components in a solution' of crude limonite while working in circumstances such that, as he told me later, his submitted request for a 200°C thermometer was returned with the advice that two 100°C thermometers would be much cheaper!

However, achieve separation he did and proved unequivocally that the benefits of limonite administration lay not with the iron fraction, but with the contaminants or non-ferrous components.

Reg Moir's account of the difficulties experienced by Underwood in the separation and identification of these components and his comment "There are many laboratories today with expensive and sensitive equipment capable of doing Underwood's work in a few minutes, not years" leave nothing that I can add.

I return, therefore, to Underwood's visit to Adelaide in November, 1934. To an interested staff he described the long, laborious and entirely methodical procedures which led to the suspicion that nickel was the active component of the curative limonite.

The seeming proof lay in the efficacy of an acid solution of nickel oxide dosed at the daily rate of 2 mg Ni. This treatment from June to October 1934 resulted in the steady increase in body weight and circulating haemoglobin in a sheep.

I learned from him later that the nickel oxide used was not of analytical reagent grade, but that it was the Ni compound most readily available to him at

the time - perhaps the only one.

When he had finished his address I recall the understandably smug satisfaction with which my seniors invited him to inspect sheep fed in pens on chaff derived from a Kangaroo Island region where Coast Disease was prevalent. Two of these sheep had been dosed with the daily equivalent of 1 mg. Co derived from a cobalt salt of analytical reagent grade and had been dramatically and obviously cured, whereas untreated sheep were in extremis.

The obvious inference was that the curative effect attributed to Ni was in fact due to Co present as a contaminant in the grade of NiO used by Underwood, a probability that could readily be checked.

This Underwood undertook to do, but he agreed without hesitation to withhold further publication until the Adelaide results and their implications had been published.

These were duly presented early in 1935 in two papers by Marston and by Lines in the short-lived and poorly distributed Journal for the Council for Scientific and Industrial Research.

Underwood and Filmer then published their findings relating to the biological potency of Co, in June 1935, in the Australian Journal of Veterinary Science, an established journal with world-wide distribution. In the same paper they recorded that sheep dosed with Ni derived from nickel chloride, at the rate of 2mg Ni daily from 20/10/34, continued to lose weight; sheep dosed with Co from 20/12/34 responded positively. They concluded that the positive responses to NiO had been due to Co present as a contaminant. At the end of their paper they acknowledged the Adelaide proiority in these words:

"In November, 1934, a personal communication intimated that two sheep suffering from "coast disease" had benefited from treatment with cobalt at the laboratory of the Animal Nutrition division of the Council for Scientific and Industrial Research in Adelaide and, in April, 1935, advice was received that success had attended the use of cobalt in the treatment of this disease in the field.

It is a pleasure to acknowledge the courtesy of Mr H.R. Marston, Acting Chief of the Animal Nutrition Division, in placing this information at our disposal. It seems likely that the officers of this division are the first to have successfully used cobalt in thetreatment of a disease of domesticated animals."

Despite this unequivocal statement there was a widespread tendency to attribute this discovery to Underwood and Filmer by readers, who neither saw not knew of the existence of J.C.S.I.R. and Underwood wrote, -years later, to quote Blaxter, "Despite this acknowlegement Marston was very unhappy and made many unfair allegations which led to some acrimony lasting for many years-",.

Although years later R.L.M. Synge,, F.R.S. considered that "Simultaneous publication should have been concerted",,. I am sure that in the atmosphere that prevailed late in 1934, as I remember it, this would have been impossible. Apart from consideration of the personalities involved, the growing recognition of the significance of trace elements in animal nutrition was a new and exciting scientific. field at that time in which priorities were jealously guarded.

In Adelaide, R. Grenfell Thomas, a geochemist in the Division of Animal Nutrition in his assessment of the calcareous "coasty" soils had pointed out that, because of their origin, these soils would lack heavy metals. Further, he

suggested that as Waltner and Waltner had shown in 1929, that cobalt supplements induced polycythemia in normal rats, the profound anaemia which was an invariable feature of "coast disease" in sheep might well be due to cobalt deficiency. Whatever one might think of this reasoning, when Lines tried cobalt therapy it worked in pens and in the field.

The systematic approach of Underwood and Filmer would undoubtedly have solved the cobalt problem and came within an ace of doing so, but they were certainly forestalled.

I recall a published description of the various approaches to scientific research as methodical, intuitive and serendipitous. Some of you are doubtless 'aware that Horace Walpole in 1754 wrote a story of the Serendips (the people of Ceylon) who he said "were always making discoveries by accident and sagacity, of things they were not in quest of".

The first of these approaches (methodical) would apply to the work of Underwood and Filmer, the second (intuitive) to that of Thomas and of Lines, and I humbly acknowledge that my own report that Co, dosed for an unrelated reason to sheep grazing Phalaris 'tuberosa prevented the development of "phalaris staggers" was quoted as the supreme example of serendipity (i.e. sheer chance), a feature I had made plain but had not stressed in my publication. At that time I had no idea that "phalaris staggers" occurred at Armidale, N.S.W., had never met Bill Southcott, had no idea that he was methodically studying the possible role originally suggested by Ian McDonald, of heavy metals in the prevention of "phalaris staggers" at Armidale, nor that his approach would have forestalled mine except that his typist inadvertently omitted Co from a list of a group of supplementary preventive metals. He was indeed unfortunate - as were Underwood and Filmer!

As Underwood's qualities were increasingly recognized in Australia and other countries he progressed from strength to strength. In the 1940s the responsibilities of a Chair of Agriculture and the Directorship of the Institute of Agriculture in Western Australia did not prevent him from initiating and collaborating in a multiplicity of research projects.

The seeming adequacy of government funding for C.S.I.R.O., as I thought I understood it at the time (having never, really, had to consider it) filled me with wonder at the persistent search for funds which Underwood found necessary to further these projects. It was only gradually, after he had outlined to me his activities in this regard, that I realized how successful' they had been. Blaxter has referred in some detail to the. sources of these funds and to the very considerable size and importance of the sums involved.

Underwood's prestige and the widespread recognition of the 'breadth of his understanding in the areas of agricultural and nutritional research led to his frequent responsibility for summarizing the substance of scientific conferences in Australia and elsewhere. It was on one such occasion, at the Jubilee Symposium of the Waite Agricultural Research Institute and possibly the last time I saw Eric Underwood' in Adelaide, that he provided an example of his essentially human quality. Because of a health problem he had given up smoking but during an interval he accepted and enjoyed a cigarette, remarking with a humorous glint, that he was about far enough from home to avoid the forceful objection of his son, a medical practitioner in Perth!! .

His summary of the presentations to the 3rd Symposium on Trace Mineral Metabolism in Animals, in Munich in 1977, was the last I heard him offer; I marvelled as usual at his erudition and his ability to select the essence of the

diversified contributions.

Underwood's connection with C.S.I.R.O. was, initially, as chairman of the Organization's Western Australian State Committee. He then found time to serve on the Executive from 1966 to 1975 and the influence of his wisdom and experience was considerable. He was, further, invited to conduct an intensive and detailed review of the research activities of the primary research divisions. During these years we saw more of him in Adelaide than had previously been the case. Most of the many recommendations he made were implemented; one of them, I understand, resulted in the radical change in the direction of research in Adelaide division away from animal nutrition when, in 1976, the Division of Nutritional Biochemistry became the Division of Human Nutrition, a change which I could view dispassionately as I was on the eve of retirement.

One of Underwood's even more than usually successful ventures for which he will long be remembered is his textbook "Trace Elements in Human and Animal Nutrition" which first appeared in 1956 and then subsequently in several revised editions. Of this book Blaxter has written "Underwood maintained a wide correspondence to ensure that each edition was fully up-to-date and that any omissions from the published work on which the account was based were made good in the account of it he gave."

From my own experience and from 'my contact with other Australian workers whom he consulted, it was evident that all of these people provided illustrations, statements and interpretations of their work with pleasure, proud that one of Underwood's calibre should seek their assistance. I have no doubt that a great many' overseas scientists were similarly consulted and that they reacted in the same way. All of these contributions were indeed carefully considered and their essence duly included in the book. Underwood made a general acknowledgement of this assistance but there were far too many sources for individual contributors to be named.

There are probably very few research establishments concerned in any way with trace elements in nutrition whose library shelves are not graced by this remarkable book which is likely to survive the author for many years to come. A new edition prepared subsequent to Underwood% death by a number of experts in their different fields, provides a means of ensuring Continuity. ,

Of the very many people who came to know Eric John Underwood during his long and distinguished career - and these would range from his pupils and his colleagues to Senior Scientists in Universities. and Research' Establishments throughout the world - there would be few who would not remember him 'with respect, admiration and affection.

They would remember him, variously, for his learning., his administrative ability, his application to research, his 'gift of collaboration- and his human qualities of integrity, humour, sociability, depth of 'understanding and concern for others.

The practical recognition of his achievements by Universities, learned societies and civic authorities makes an extraordinarily 'impressive list, which I have checked from the accounts of Blaxter and of Moir. He evidently received four Honorary Doctorates in Australia and in the United States of America; five Medals and six Fellowships in Australia and overseas, as well as two awards in Britain and in Australia.

With my recollection1 of the man clearly 'before me I am proud and deeply grateful to have known him.