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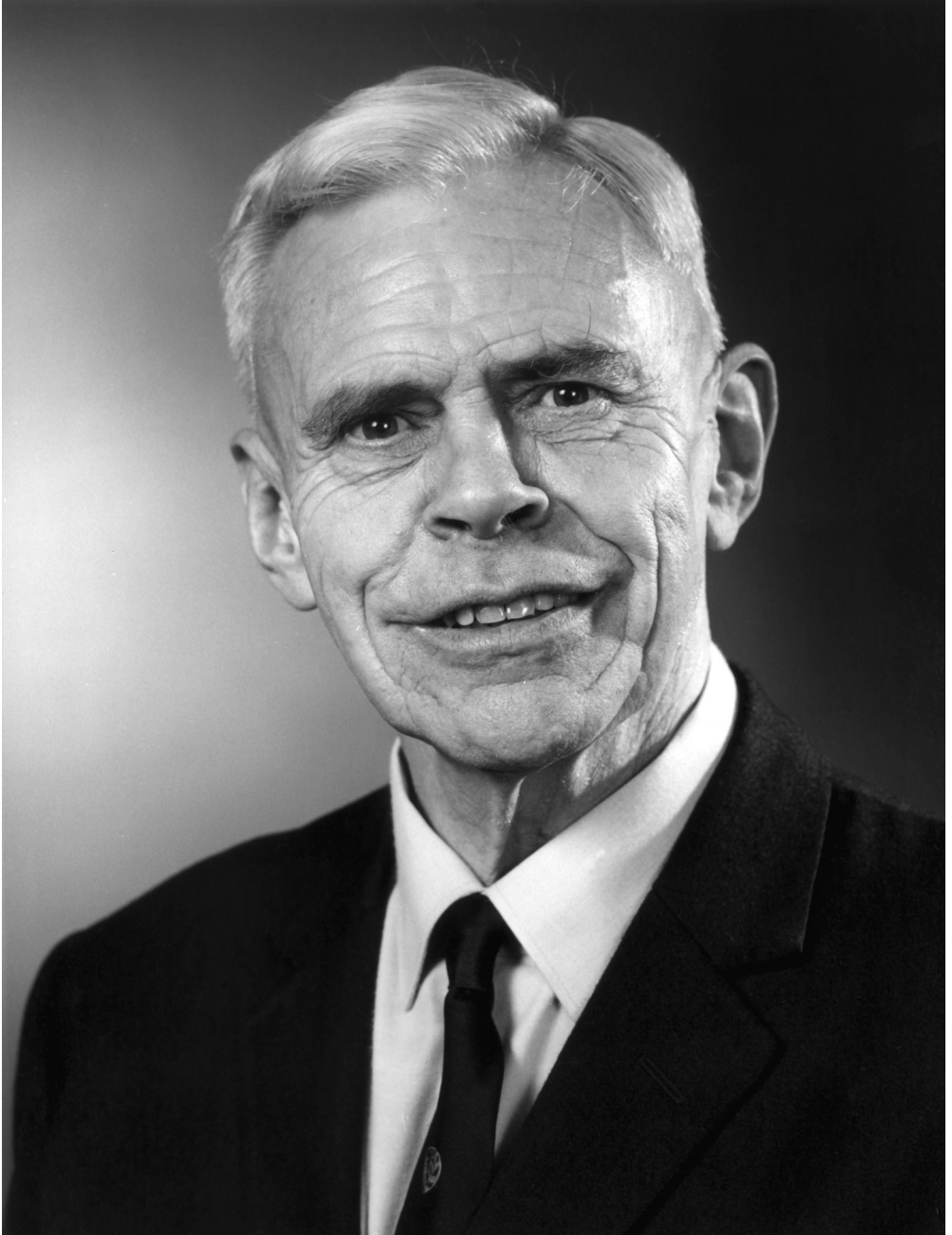
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27 February 1919 — 1 January 2002



*Erni H. H. H.*

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Elected FRS 1982

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Eric Hewitt was a plant physiologist, distinguished internationally for his research on the detection of deficiencies in trace elements in the mineral nutrition of plants and for elucidating the biochemical roles of some of these elements, particularly in the reduction of nitrate and nitrite ions. The research of his laboratory at Long Ashton Research Station, Bristol, was based on the meticulous applications of basic inorganic chemistry to techniques for sand-and-solution culture of experimental plants. Typically, trace elements are required by plants in concentrations of a few parts per million in the substrate in which they are grown. Consequently, to detect and measure effects of such nutrient elements on the growth of experimental plants, it is necessary to remove traces of these elements from the sand medium and from the plant nutrient solutions. His methods achieved astonishingly low levels of contaminating trace elements in plant growth media (Russell 1966, pp. 361–371). The element under study is then added to the test plant cultures at low concentration, and the growth and composition in test and control plants are compared. Hewitt's initial contribution was to devise techniques that could achieve such objectives. These techniques have been applied to solve problems of plant nutrition in agriculture and horticulture in many countries and they were the foundation on which his achievements in plant biochemistry were built.

### ANCESTRY, MEMORIES OF CHILDHOOD AND EDUCATION

Eric John Hewitt was born in Earls Court, London, on 27 February 1919. He was the only child of Harry Edward Hewitt OBE MD and his wife, Blanche (*née* Du Roveray). Little is known of his father's ancestry apart from having a turbulent family at the level of his grandparents, and he apparently had an unhappy upbringing from an early age. Nevertheless, Dr Hewitt became an outstanding scholar of St. Thomas' Hospital Medical School (Science Entrance and Tite Scholar 1893–94, Musgrave Scholar 1894–96) and was awarded the

Treasurer's Gold Medal, 1897–98. Ultimately Dr Hewitt became Chief Medical Officer (Acting) of the General Post Office. Eric Hewitt's mother, daughter of Baron du Roveray, was from a French Huguenot family. Eric's childhood seems to have been very full and happy. In his handwritten Personal Records, he wrote of the 'immense influence' of his father on his early years, noting, *inter alia*, teaching him the Greek alphabet, instilling interests in Roman law, Anglo-Saxon concepts of freedom, elementary astronomy and music (recognizing all the Beethoven symphonies and concertos and with a passion for Wagner). His father had a dogged determination to batter his way through any overgrown or disputed footpath and led him into the farthest corner of every cave they could find during holidays in Cornwall. Also, there were well-remembered holidays sailing together on the Norfolk Broads and his father's help in building a crystal radio set. This led later to the designing and building of a superheterodyne radio receiver with which they listened to symphony concerts broadcast from foreign radio stations.

Eric Hewitt's schooling began at Oakley Park Preparatory School, Hertfordshire (1929–32), where his interest in biology began with class work on an insect collection and display. Later, at Whitgift School in South Croydon (1932–36), he showed no athletic prowess but obtained his Higher School Certificate at the age of 17. His subjects included biology, which was passed after only one year of study (initiated after a school visit to Rothamsted Experimental Station). In this he was greatly influenced by Cecil B. Prime, the botany master. The period between the second-year sixth form at Whitgift and the undergraduate years that followed were 'the most formative, liberating and influential' for his whole scientific development. To help him to achieve the Higher School Certificate in Biology in only one year, his father had established a home laboratory where Eric carried out all dissections and other studies with the aid of his father's medical microscope. There, too, he undertook all of the chemical work that resulted in the award of the sixth-form prize for original work in science.

In 1936, at the age of 17 years and 8 months, he entered King's College, University of London, and in 1939 completed a distinguished undergraduate career with several prizes and medals in every year, and first-class honours in botany and chemistry. In 1937 he had been invited by Professor R. R. Gates FRS to enter the Botany School and was awarded the Carter Gold Medal. Professor Gates greatly influenced his subsequent research career. In 1940 Hewitt obtained a Diploma in Education. He rowed in the King's College Boat Club Eight in the Henley regatta; he was captain of boats in 1940 and was awarded a London Purple for rowing.

#### RESEARCH CAREER AND ACADEMIC APPOINTMENTS

Eric Hewitt's postgraduate work began later in 1940 with a Ministry of Supply appointment to the Royal Ordnance Factory, Pembrey. Apart from service in the Home Guard (1940–45), this was his only wartime occupation. At Pembrey he obtained valuable analytical experience and an appreciation for process approaches to the preparation of materials. Later, he applied this experience to the purification of sand for trace element studies, when he was directed to Long Ashton Research Station in 1942. In 1943 at Pembrey, he married Hannah Eluned, only daughter of J. L. Williams and Evelyn Doris Williams (*née* Bowen) of Burry Port (Carmarthenshire). Later, they had one son, David (recently retired as Managing Director, DuPont Far Eastern Petrochemicals Co., Taiwan, and now living in Kuala Lumpur, Malaysia). At Long Ashton, Eric Hewitt was asked to develop new methods for large-scale studies of

plant nutrition in sand culture, for any plant or any known or possible nutrient. His predecessor in the post had declined to undertake this task as being impracticable; Hewitt was not told of this discouraging assessment! This task yielded a PhD from the University of Bristol in 1948. Extended studies into nutritional physiology and biochemistry followed, especially in relation to the roles of molybdenum in nitrate/nitrite metabolism. The initial task set the course for his entire research career. In 1952 he was seconded to the Agricultural Research Council Unit of Plant Nutrition at Long Ashton. In 1967 he was awarded a DSc from the University of Bristol and a Fellowship in the Institute of Biology. At his retirement in 1984 he was Head of the Biochemistry group in the Plant Sciences Division of the Long Ashton Research Station and Reader in Plant Physiology of the University of Bristol.

#### LONG ASHTON: RESEARCH IN MINERAL NUTRITION OF PLANTS AND UNDERLYING BIOCHEMISTRY

The following paragraphs contain references to some of the more important of Eric Hewitt's 160 major publications. In addition, there were 30 quite extensive and informative reports in the Long Ashton Annual Reports for the years 1943 to 1965.

Founded in 1903 primarily to serve the cider industry, but with wider reference to 'the best methods of cultivation of all kinds of fruit and vegetables', the Long Ashton Research Station (LARS) became associated with the then recently established University of Bristol in 1912, becoming the nucleus of its Department of Agriculture and Horticulture (Russell 1966, pp. 361–371). LARS remained a very fruit-oriented horticultural research centre, and early in Hewitt's career his research subjects were derived from the station's beginnings. Dr T. Wallace (FRS 1953), a chemist, had been appointed to LARS in 1919 and was among the pioneers in the use of sand-culture techniques to investigate the mineral nutrition of apple trees (Russell 1966, pp. 361–371). He may have instigated Hewitt's PhD research (see above). Wallace was co-author of three of Hewitt's early papers (1, 2, 5)\*. Soon his publications arose from developments of his initial sand-culture work, detailing the purification of water (3), and in 1952, the first of his landmark publications about the methodology of sand and solution culture methods for use in trace element research (7); the second edition published in 1966 (20) was greatly enlarged. Initially, Hewitt used a wide variety of horticultural plants, possibly reflecting problems presented to LARS for experimental solution. Between 1945 and 1965, these included apple, lemon, potato, tomato, several brassicas, marrow, tulip and daffodil. The trace elements studied included iron (2, 6) molybdenum (4), manganese (6), zinc, copper (8) and cobalt (11, 19, 21). For several years the study of molybdenum dominated the research of Hewitt and his collaborators. Ten papers under the general title of 'Molybdenum as a plant nutrient' were published between 1952 and 1957. From this research emerged a growing understanding of the relationship between nitrogen nutrition and molybdenum status of plants supplied with various sources of mineral nitrogen (9) and so to a definition of the roles of the metabolism of nitrate, nitrite hydroxylamine and ammonia in the nitrogen nutrition of plants (13–16).

Sometimes, Hewitt's research was seen as having little relevance to the major objectives of the station's mandate in applied research. In spite of such limitations, particularly in later

\* Numbers in this form refer to the bibliography at the end of the text.

years, his efforts led to a greater level of support, allowing a secure continuation of the research of the small group that he led. When his research progressed into determining the roles of various enzyme systems (9) in the expression and correction of trace element deficiencies, Hewitt began biochemical studies. At the time there were few commercial sources of commodities such as ATP, NADP and some labile enzymes. It was necessary to prepare them from various biological sources and to use them before they decayed. He recollected that all too often, after many hours of work, visitors or other LARS duties prevented their successful use. Perhaps such unwanted interruptions led to his reputation as a somewhat irascible person. He recorded that his initially rather untutored excursions into plant biochemistry aroused sufficient concern that Professor T. Wallace FRS and the Agricultural Research Council suggested that Hewitt should go to Sheffield for guidance from Sir Hans Krebs FRS. This he did, and under the tuition of Dr D. Hughes he prepared from potato tubers, rabbit muscle and yeast the enzymes and intermediates of the glycolytic and pentose phosphate cycles, then purified and tested them. Thus he gained a never-to-be-forgotten competence, which developed into a sound understanding of plant biochemistry. He enthusiastically wrote of his indebtedness to Sir Hans and his colleagues and of their role in supporting the eventual acquisition of appropriate facilities at LARS to enable his research to progress.

From about 1957, Hewitt's group began to focus on the enzyme systems of plant nitrate assimilation. Nitrate reductase in the plants of interest was located in leaves and dependent upon light. They found that this enzyme, which catalyses the reduction of nitrate to nitrite, was adaptive, its synthesis being stimulated by nitrate and molybdenum, and was dependent on protein synthesis (10, 12, 17, 18, 23). On purification of nitrate reductase from leaves of spinach grown with nitrate and molybdenum, a monomeric protein with a molecular mass of 230–240 kilodaltons was obtained. When  $^{99}\text{Mo}$ -molybdate and nitrate were supplied to spinach grown initially without molybdenum or nitrate and the nitrate reductase was then isolated, purified and subjected to isoelectric focusing, the radioactivity coincided with enzyme activity (24, 25). This work established conclusively the long-held view that nitrate reductase was a molybdoprotein. Under similar conditions using  $^{185}\text{W}$ , although tungsten was incorporated into the nitrate reductase protein, the tungsten enzyme was inactive. Similar experiments with  $^{49}\text{V}$  showed that vanadium was not incorporated into nitrate reductase protein. In 1972 Hewitt reviewed assimilatory nitrate–nitrite reduction research of the preceding six years (26). Of the 359 publications reviewed, many of which dealt with assimilatory processes in microorganisms and algae, 32 originated from Hewitt's group, but at the time of this review the group had worked mostly on nitrate reductase and had only just begun work on plant nitrite reductase. When highly purified, nitrite reductase from vegetable marrow was separated from hydroxylamine reductase and, with ferredoxin as electron donor, quantitatively reduced nitrite to ammonia (22). Nitrite reductases from other sources were then studied (see, for example, (27)) and there were some mechanistic studies (such as (29)), but until Hewitt's retirement in 1984 the main thrust of the group's research returned to nitrate reductases from various photosynthetic sources and even from plant tissue cultures (28). During this period, there were papers about nitrate reductase in barley cultivars and in leaf extracts of mutants lacking nitrate reductase (30–32, 36, 37). There was also an important paper on the electron paramagnetic resonance properties of the molybdenum-centre of spinach nitrate reductase (33). In addition, in this final period of Hewitt's active research there were several publications reiterating and refining earlier research about the mineral nutrition of plants (see, for example, (34, 35)).



## PERSONAL ATTRIBUTES AND RECOLLECTIONS FROM COLLEAGUES

During his first 15 or so years at LARS, Eric Hewitt developed his formidable reputation as having a somewhat irascible nature (James 2002). Sometimes he was impatient with less-informed people and often refused to talk with visitors whom he considered to be unworthy of interrupting his research time (D. Spencer, personal communication). However, in later years, perhaps as a result of the influence of his many research students and international guest workers, he mellowed greatly and often showed a considerable, if sometimes obscure, sense of humour (James 2002). He wrote of the enormous contributions to his research group by students and collaborators from Europe, the USA, India and South Africa, as well as the UK. He played squash regularly, usually on Thursday afternoons, as a means of ‘unwinding’ from the tensions of the day. Often he insisted on the participation of more junior members of his laboratory as opponents. As long as he was able, he delighted in walking in the hills of the southern Lakes District of northern England, which he knew intimately. He recorded that other than a lifetime love of recorded classical music, he had no other recreational interests. Other than visits to Nigeria to study oil palm in 1954 and to Ghana (cacao) in 1958, he travelled little outside the UK. However, he wrote of the entertaining and lively interludes provided by these visits to Africa, which contributed to his understanding of problems encountered there, although the visits yielded little of value to practical agriculture.

An example of the esteem in which Hewitt’s research was held by his contemporaries is given in the following quotation from a recent letter: ‘Dr Hewitt’s logic was obviously very instrumental in our research processes and methodology. He was an excellent scientist whose contribution was great’ (H. J. Evans, personal communication). Evans’s work showed that cobalt was required in trace amounts by symbiotically dependent soybeans but not when the plants were supplied with combined nitrogen (Ahmed & Evans 1961; see (11, 19, 21)). He described how he was readily able to use Hewitt’s methods (7, 20) to purify the chemicals to be used in the plant culture solution (H. J. Evans, personal communication).

## APPOINTMENTS AND AWARDS

- 1942–84 Long Ashton Research Station: 1942–45 Agricultural Research Council grant
- 1945–84 Senior Plant Physiologist and Head of Biochemistry
- 1945–84 University of Bristol: Research Assistant (1945); Lecturer (1950); Reader (1967)
- 1967 Fellow, Institute of Biology
- 1982 Honorary Fellow, Indian Society of Plant Nutrition
- 1982 Elected Fellow of The Royal Society
- 1987 His former laboratory building named the Hewitt Laboratory (a rare honour) by the Agricultural Committee of Bristol University

## ACKNOWLEDGEMENTS

The Long Ashton Research Station was closed soon after E. J. Hewitt’s retirement, and many of his former staff were deployed to other research centres. Others are now deceased. Professor J. R. Postgate FRS provided information that eventually led the author to some of the former members of the laboratory. He also kindly reviewed and corrected a



draft of this memoir. The author is grateful for advice from Dr R. J. Fido, who put him in touch with Dr D. Hucklesby and Mr D. James, who prepared the obituary published in the Bristol University News (James 2002). Mrs Hannah Hewitt provided additional information and kindly reviewed sections of the manuscript for accuracy. Professor H. J. Evans, formerly of Oregon State University, provided an evaluation of E. J. Hewitt's impact on his own research.

The frontispiece photograph was taken in 1985 by Godfrey Argent, and is reproduced with permission.

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| (7)  | (16) | 1952 | <i>Sand and water culture methods used in the study of plant nutrition</i> , 1st edn (241 pages). Technical Communication no. 22, Bureau of Horticulture and Plantation Crops. Farnham Royal, Kent: Commonwealth Bureaux of Agriculture.                                    |
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