Fifty years of food research. Part 3

By D. McG. McBean, M. B. Smith and Josephine M. Bastian

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By D. McG. McBean, M. B. Smith and Josephine M. Bastian

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This issue of the *Quarterly* forms the third and final part of the story of the Division of Food Research during its 50 years existence.
Part 1 appeared as Vol. 36, No. 3, September 1976 and
Part 2 formed Vol. 36, No. 4, December 1976.

Chapter 10. Post-war growth of Division of Food Preservation

At the end of World War II, after five years of work on short-term problems, the staff at Homebush were giving much thought to a return to more fundamental or long-term investigations, and to a reorganization of staff and facilities. These thoughts were crystallized in J. R. Vickery's 'Statement on Nature and Scope of Food Preservation Investigations in Australia' (1947), a typically thorough report on research policy and needs which set the stage for post-war expansion and development.

Vickery's plans for the future

The first part of his document was aimed at defining the scope of food preservation research in terms of the fields of investigation and of the scientific disciplines involved. Vickery suggested that applied investigations could be 'organized either by staffing the technological sections with people trained in all the sciences required or by confining the staff mainly to technologists who call upon the services of specialists, as required, from the various fundamental sections.' Although the first type of arrangement would give rise to fewer administrative difficulties, Vickery favoured the latter, 'because particular talents are not scattered throughout different technological sections and expert teams of physicists, chemists etc. under competent leadership and having common interests can be established.'

In discussing the balance between applied and fundamental studies he urged that, 'If the Division is to maintain its leading position, a primary duty should be to make substantial contributions to the fund of scientific knowledge on foods and their reactions to different environments. Not less than one-half of the resources of the laboratory should be devoted to these ends.'

Lines of work

The second part of Vickery's report contained his suggested program of investigations, selected because, 'in the light of the scientific and economic criteria . . . the major lines of work are important from the point of view of present inadequacy of scientific data and/or because they will help major branches of the food industries.' We shall be looking in some detail at these major lines of work in later chapters, so it is sufficient here to mention only the broader aspects.

In meat research it was expected that work on the loss of 'bloom' in chilled beef would be resumed, although problems of frozen beef were first to claim the attentions of an expanded Brisbane laboratory. Investigations on the storage and transport of fresh fruit were to continue with a wider range of fruits and in cooperation with several Departments of Agriculture; however Vickery thought that 'at the same time, the Division will need to give a great deal of attention to fundamental studies of a physiological and biochemical character.' Work on the canning of fruit and vegetables was to be concentrated on long-term studies of quality and nutritive value, and on tinplate and other packaging materials. Physical problems of cooling, cool storage, and evaporation were considered to be important together with fundamental work on bacterial spores and food-poisoning organisms, and new chemical and biochemical investigations on proteins, enzymes and fats.

Organization in sections

In considering the organization of staff that would be needed to implement his post-war regimen, Vickery favoured 'a number of small, independent teams, with some, though not all, having a senior investigator or leader.' In the applied investigations, definite direction of the working team was needed, but the fundamental investigator 'should be free to pursue his studies as he thinks fit.' His plan was to form the nucleus of the research organization from four 'basic' sections—Physics and Engineering, Microbiology, General Chemistry and Plant Physiology. There were to be two separate applied sections, General Fruit and Vegetable Processing, and General Meat, Fish and Egg Technology, while a third applied section, Fresh Fruit and Vegetable Storage, was attached rather loosely to Plant Physiology but was expected also to be involved with General Chemistry.

These groupings were to a large extent reflections of the aims and interests of the senior staff before 1947, and as Vickery predicted, were to undergo considerable change in the following years. However, the concept of sectional organization and sectional responsibility persisted, even though diversification of research fields and the resulting proliferation of sections occasionally produced the incongruity of a section composed of the senior investigator and one assistant.

Other organizational recommendations made by Vickery concerned cooperation with other research bodies, extension and educational services, the training of research staff and of assistants, and the functions of advisory committees. These topics will appear in later chapters.

Laboratory facilities

In his statement, under the heading 'Location of Staff and Facilities', Vickery considered that the central laboratory should accommodate a maximum of 35 to 40 research workers and a total staff of 100. This was to include the four 'fundamental' groups and some of the technologists. Meat investigations would be located at the Brisbane branch laboratory, while other branch laboratories were foreshadowed in Hobart (for work mainly on fish preservation) and in the Murrumbidgee Irrigation Area (for work on fruit and vegetables). He again pleaded for better working conditions for his research workers; 'the present central laboratory is overcrowded; staff cannot be increased and new and deferred essential investigations undertaken until better accommodation is supplied. Each of the "fundamental" sections needs at least 50 per cent increased space.'

The long campaign for new premises is described in the next chapter; here we need remark only on the effects of the Homebush environment on Vickery's plans for expansion. At a time when there was a general shortage of professionals, attracting new first-class scientists and technicians with what the Homebush laboratories offered was to prove difficult; it would even be difficult to retain staff released from war-time teams and looking at the Universities' green pastures. Vickery's vision of groups of specialists whose services were to be called upon by the technologists was therefore not fully realized until the new laboratories were

Staff at Homebush, 3 October 1948, on the occasion of the tenth anniversary of the occupation of the laboratories. From left, front row: J. Babicci, B. Whitcher, N. Taylor, T. Butler, C. B. Robins, J. Lipscombe, R. Ferguson. Second row: Marge Wilkins, Mrs Gordon, Mrs Hooper, Adrienne Thompson, Jean Hicks, Shirley Sudholz, R. B. Withers, Thelma Reynolds, E. G. Hall, W. J. Scott, Miss E. K. Todd, J. R. Vickery, E. W. Hicks, F. E. Huelin, L. J. Lynch, Shirley Stack, Shirley Anderson, Beryl Cashmere, Miss M. Bartholomew, Mrs R. Ohlsson, Nancy Wonders, Gwen Bitmead. Third row: W. Montgomery, J. C. Siddins, C. W. Stephens, P. Fehon, G. F. Greethead, W. G. Murrell, D. J. Menzies, N. Baird, M. C. Taylor (behind), Rachel Joseph (in front), Heather Smith, Heather Kentwell, Betty Marshall, J. F. Kefford, J. F. Turner, P. Ellis, G. Toft, B. G. Ironside, R. C. Bitmead, A. R. Prater. Back row: J. Shipton, D. McBean, A. Martin, R. Millington, S. M. Sykes, D. F. Ohye, P. Bond, A. Telfer, P. R. Maguire, R. Edwards, C. North, B. V. Chandler, P. C. Thompson, M. B. Smith, G. M. Rostos, A. Howard, T. Swan, F. Fitzpatrick, W. Barnes, R. S. Mitchell.

built; in the interval, half of the fundamental work was done outside the central laboratory.

'Half the resources to fundamental work'

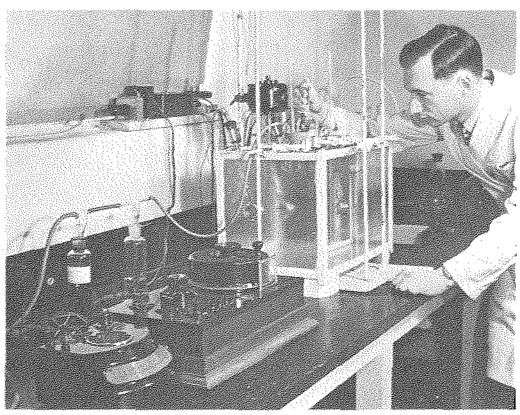
The impetus to restore and expand fundamental research after the war, although encouraged and guided by Vickery, was applied largely by a professional staff anxious to regain a measure of scientific individuality. Two people in particular were responsible for this impetus—F. E. Huelin and R. N. Robertson.

Huelin, who had been transferred from Melbourne to Homebush in 1941 to take part in war-time investigations, had realized by 1944 that it would be desirable to bring together the people engaged in chemical work and to prepare for a return to some fundamental studies when the war ended. In 1945 he was made 'senior investigator' of a chemistry group which was tackling some of the longer-term investigations arising from the war work—the determination of trace metals and dissolved oxygen in canned products, and the catalytic destruction of ascorbic acid. He also returned to an earlier interest in the composition of the waxy coating of Granny Smith apples. By 1947, when Vickery suggested the formation of a Chemistry Section, Huelin and Adrienne White (later Thompson) were well into basic investigations of the skin coatings and volatile substances of apples, and H. A. McKenzie, who had developed improved methods for estimating tin and dissolved oxygen, was now working on the new technique of polarography. This group formed the nucleus for subsequent basic research on lipids, food flavours and proteins.

Physical chemistry of proteins

The plan for chemical investigations in Vickery's 1947 report included provision for work on 'Protein denaturation, with particular reference to the so-called denaturation occurring at relatively low temperatures in dried and frozen foods.' This project was stimulated during discussions, early in 1949, between the DFP and representatives from the British Ministry of Food, the Low Temperature Research Station and the New Zealand D.S.I.R., on future cooperative investigations on frozen beef. Vickery, backed by Ian Clunies Ross (then Executive Officer, CSIR), was keen to make a contribution to the fundamental side of the work, and perhaps to impress his Cambridge colleagues. He wrote to Clunies Ross in April 1949: 'With regard to fundamental studies on the theory of the freezing of muscle tissue . . .. We, ourselves, are very anxious to continue work on the fundamental side, but the major problem is absence of space and adequately trained people. . . . In the immediate future there appear to be two prospects—
(a) that Empey should resume work on the freezing of muscle tissue, with particular reference to fish (results should apply equally well to mammalian muscle) and
(b) if the services of a chemist, thoroughly trained in the physical chemistry of proteins, can be obtained, then some work might be started here at Homebush or at a University laboratory. In connection with the latter . . . the only chance is the possibility of switching McKenzie to this work although his training has not been specifically in the protein field.'

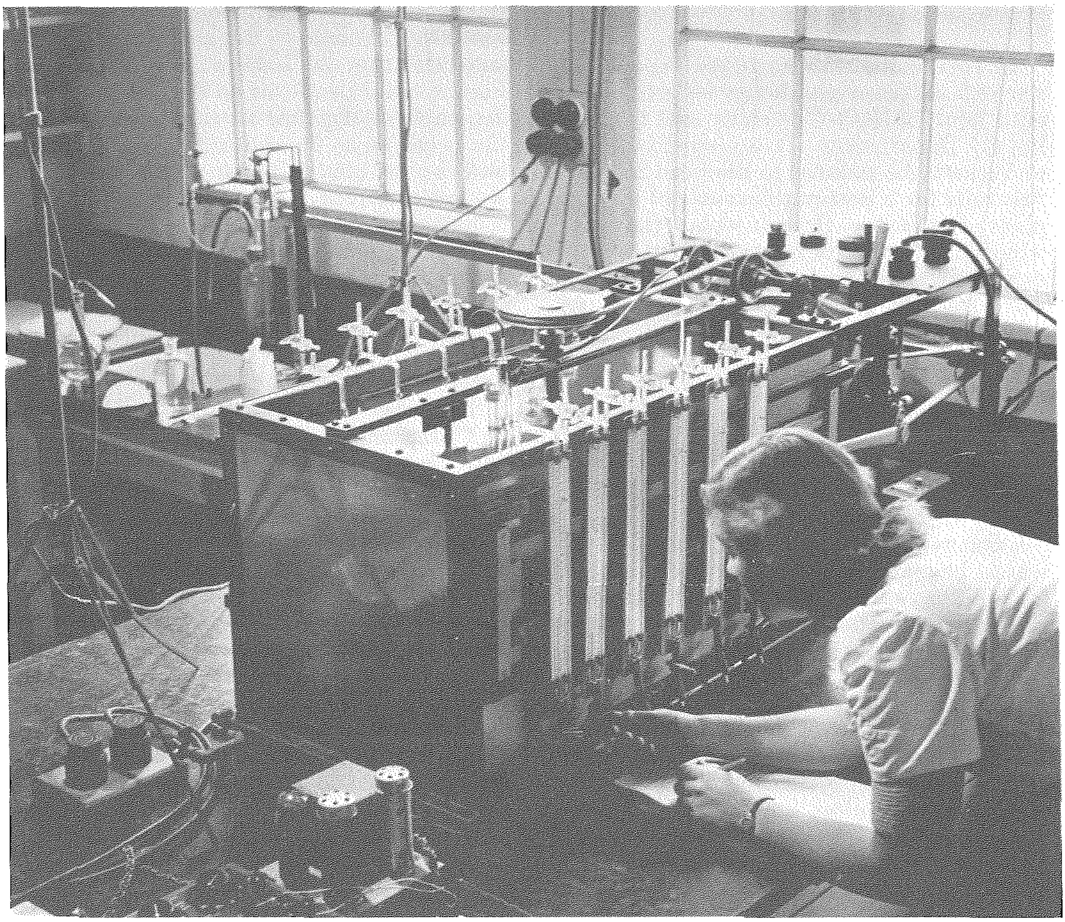
At that time McKenzie was in the U.S.A., working on infrared spectroscopy at Princeton University, and had been asked by Vickery to collect information on techniques of protein chemistry in the U.S.A. and in Sweden, Denmark and France on his way home. It appeared that the new instruments for protein research were both complex and expensive,



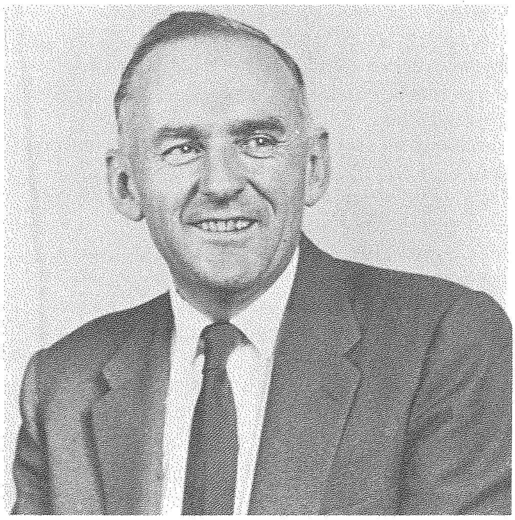
H. A. McKenzie measuring redox potentials (1947) but Clunies Ross promised money, and J. L. Still, newly appointed to the Chair in Biochemistry at the University of Sydney and conscious of the emerging field of physical biochemistry, promised space and facilities. By the end of 1949 both of Vickery's prospects had materialized, with Empey starting work on the freezing of fish muscle and McKenzie setting up to work on physical techniques of analysis and on protein denaturation.

Plant physiology

Robertson was appointed in 1945 to take charge of fruit and vegetable storage investigations at Homebush when Trout transferred to the Queensland Department of Agriculture. Robertson had been senior lecturer in plant physiology at the University of Sydney and after his appointment to CSIR he continued his close relations with the plant physiologists and botanists at the University. The Professor of Botany, Eric Ashby, provided space at the Botany Department for a DFP investigator (J. F. Turner) to work on the metabolism of ripening and senescent fruit, and by 1947 Ashby's successor, Professor N. A. Burges, had made room for two people. After 1946, when E. G. Hall transferred from the N.S.W. Department of Agriculture to CSIR and took charge of fruit storage work, Robertson was able to devote much of his time to basic research as well as giving lectures and supervising some of the postgraduate students at the University.



Marge Wilkins, who worked with R. N. Robertson at Homebush, using the Warburg apparatus to measure respiration of plant tissue (1946).



R. N. Robertson in 1960.

In 1950 Robertson suggested expanding research on plant physiology by setting up a joint CSIRO-University unit in the Botany Department. In a memorandum to Vickery, he pointed to the need in Australia for a postgraduate school in plant physiology: 'In particular, the unit would be of value in relation to the expected expansion of physiology at the Plant Industry Division. Further, it would provide for a continued program of research in fundamental plant physiological problems and a panel of physiologists which would be available for consultations both with CSIRO physiologists and with Departments of Agriculture.' The unit was to be directed jointly by Robertson and F. V. Mercer, lecturer in plant physiology at the University, and CSIRO was to be asked to provide financial aid for building and equipping laboratories and to provide more staff and some annual scholarships for postgraduate students.

A proposal incorporating Robertson's ideas was sent to the Executive of CSIRO by Professor Burges in August 1950. Clunies Ross was far from enthusiastic: 'My own concern is that, with the transfer of some of your more fundamental biochemical work to the University, this further move, however desirable it may be from the standpoint of the development of research and training in plant physiology, might seriously affect what I might term the "research climate" of your Division' (letter to Vickery, September 1950). Clunies Ross also expressed concern at the magnitude of the capital expenditure and the requirements for more staff: '. . . at first sight one would have imagined that the purpose of the move would have been served merely by the bringing together of existing staff without any increase in numbers.'

Vickery's reply was reassuring: 'There would be some loss through the breaking of continuous contact with active groups of workers in the fundamental field, but this disadvantage could be overcome by ensuring that all, or most, of the research officers working at the Botany School would visit the Homebush laboratories once a week or thereabouts to take part in general discussions', and gave his view that the new unit would 'add enormously to the rate of progress of our knowledge'; moreover, 'People in England have suggested that the leadership in fundamental problems on fruit and vegetable storage has already passed from the northern to the southern hemisphere, and, by the establishment of this unit, we feel sure that this leadership will remain pre-eminent.'

By early 1951 a compromise on financial arrangements had been reached between the Executive and Professor Burges, and Robertson had moved to the University.

Fundamental research at Homebush

The other two 'basic' groups, Physics and Microbiology, were more preoccupied with their immediate commitments to urgent and practical investigations. In 1947 Hicks was still a one-man band involved in a wide range of inquiries and Scott was still coping with a large volume of routine microbiological examinations. However, M. R. J. Salton had begun to look at some of the fundamental aspects of the action of bactericidal agents, a field which was to lead him to highly-rewarding work on the structure of bacterial cell-walls and membranes, and in 1948 W. G. Murrell was appointed to study the destruction of bacterial spores by heat. A wartime problem, that of preventing mould growth on fruit cake, was also providing both Hicks and Scott with some fundamental questions about the ability of microorganisms to grow in foods of low water content.

'All aspects of handling, processing and storage'

In his 1947 recommendations Vickery outlined a number of new and renewed studies which he felt would provide a more comprehensive coverage of food preservation and transport. These included the resumption and broadening of work on the physical aspects of chilled and frozen storage, and on rail transport. Much of this work fell on the shoulders of Hicks, who had been trying to resume some of his own basic studies on the cooling of wet bodies and evaporation at surfaces. The other member of the Physics 'team', M. C. Taylor, was also busy, measuring equilibrium water-vapour pressures of dried foods and designing new equipment. There were also the regular chores of maintaining the controlled-temperature storage rooms. However, by 1947 an engineer, G. M. Rostos, had been appointed to investigate the design and performance of fruit cool stores, and a technical officer was found to help him and Hicks with temperature measurements. Technical staff were not easily obtained; the new appointee, M. B. Smith, had been trained in industrial and analytical chemistry and had to be initiated into the mysteries of thermocouples by the junior assistants.

Frozen beef

It had been expected that the export of chilled beef would be resumed after the war, and Vickery recommended a major study of the loss of 'bloom' during chilled storage. However, by 1948 it was apparent that because of continuing food rationing in Britain, frozen beef would be exported in large amounts for some years, as it allowed greater flexibility in distribution. But frozen beef had two defects which brought complaints from the British consumers. One was the unsightly exudation of fluid, or 'drip', on thawing; the other was a reputation for poorer eating quality when compared with chilled beef. As the result of a request from the U.K. Food Investigation Board both problems were tackled in a cooperative investigation involving the DFP and the British DSIR and Ministry of Food. Discussions on the proposed investigations led Vickery to warn A. E. V. Richardson of some future difficulties: 'If we are to participate fully in this proposed cooperative program of investigations, it will mean a heavy load on the Brisbane laboratory where the bulk of the work will probably have to be carried out. It is most unfortunate that, despite many attempts, we have not been able to build up the staff and, moreover, the laboratory needs to be extended and the cold rooms renovated' (November 1948).

E. H. Callow, of the Low Temperature Research Station, and N. E. Holmes, now representing the British Ministry of Food, looked at both the production and preparation sides of the Australian beef industry early in 1949, and with F. B. Shorland of the New Zealand D.S.I.R., worked out details of the cooperative investigations. Vickery was pleased at Callow's reactions to the Australian scene: 'I feel sure that the visit will be an eye-opener to him and will make it much easier for him to see our point of view in future cooperative work on meat investigations. . . . Although we have had brief visits from Gane and A. J. M. Smith, this is really the first thorough interchange of views since organized food investigations have been going in Australia' (Vickery to Holmes, April 1949).

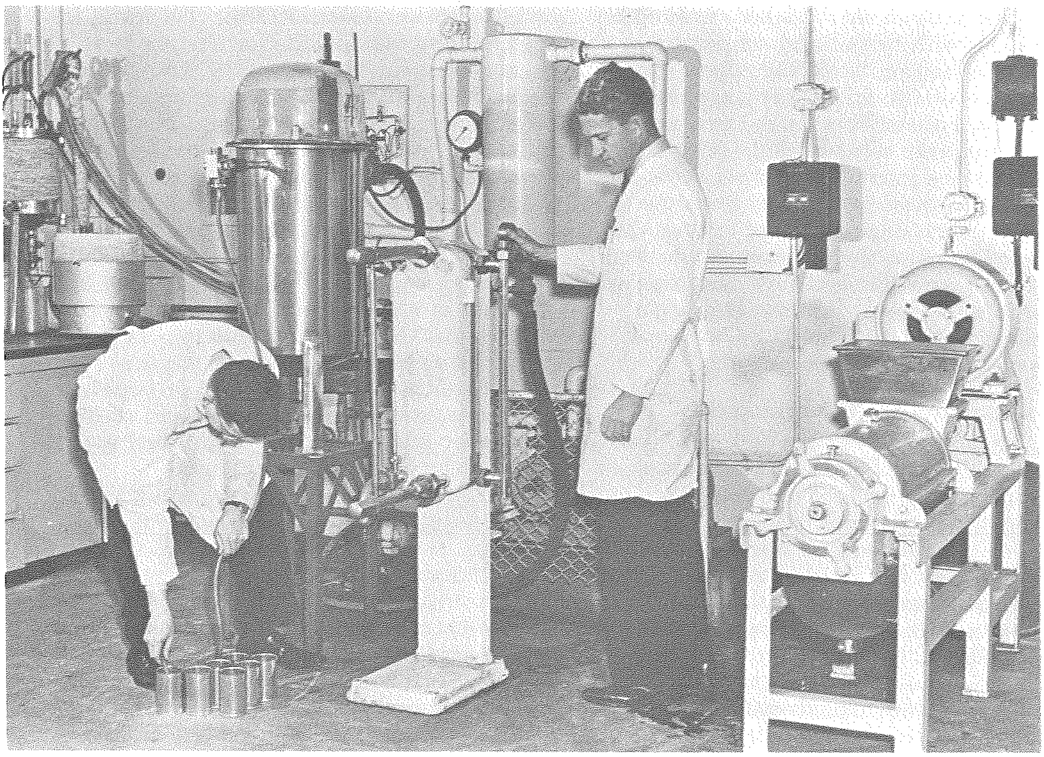
Reorganization of the Brisbane laboratory was now urgently required. A. R. Riddle, who had been in charge since 1938, had been ill for six months, and was unable to cope with the extra demands. Taylor had filled in for a few months but was wanted back in the Physics Section, so in June 1949 applications were called for a new officer-in-charge. With some prompting by Vickery, A. Howard, then on the staff at Homebush, applied for the job and was appointed. At the time, Howard was producing a superior type of dried mutton for the Australian Army in the meat dehydration laboratory at Auburn, but he was able to leave this project in the hands of A. R. Prater and take up his duties at Brisbane in October 1949. He soon received support from G. Kaess, a German food scientist, and acquired a microbiologist, A. D. Brown, and some extra assistants. By the middle of 1950 Howard had set up a taste panel to judge subjectively the differences in quality between chilled and frozen beef, had devised methods for measuring the amount of 'drip', and had arranged the first two experimental shipments of frozen beef for the Low Temperature Research Station.

Food processing

Post-war changes in emphasis which altered the roles of the Canning and Dried Foods Sections required Vickery to make many, often difficult, decisions in directing their return to peacetime activities.

During the war, strong connections had been made with the Australian food processors, who continued to seek technical assistance from the Division when the war ended. L. J. Lynch, an ardent advocate of the needs of the food industry, convinced Vickery that, in particular, the growing but technically weak canning industry should not be denied assistance as a result of reducing the strength of the Canning Section.

J. F. Kefford, R. S. Mitchell, L. J. Lynch, V. M. Lewis, and W. A. Empey juicing oranges (1947).



B. V. Chandler and P. Thompson preparing to can orange juice.

Lynch's stand thus brought several new appointments to his Section, to balance the transfer of Huelin and McKenzie to Chemistry and of Empey to a new Fish Investigations Section. Lynch, Kefford and Mitchell continued to form the core of the Section, with studies of can corrosion, the suitability of fruit and vegetable varieties for canning, and the assessment of maturity as a primary index of quality. The wartime project of improving the quality of orange juice was continued, with further chemical and processing studies by V. M. Lewis (1945–47) and then by B. V. Chandler. With the appointment of P. W. Board and E. G. Davis to investigate heat penetration into cans and the use of can lacquers the Section was back to its wartime strength by 1950.

In contrast to canning, the vegetable dehydration industry collapsed at the end of the war even more rapidly than it had expanded. There was a corresponding diminution of activity, although at a slower rate, in the Dried Foods Section. Thelma Reynolds returned to her discipline of organic chemistry and, by 1950, had begun the study of chemical 'browning' reactions in dried foods that was to be a major project for the next 20 years. Work on dried meat was continued at Auburn by Howard and Prater until Howard transferred to the Brisbane laboratory, then, with financial assistance from the Department of Commerce and Industry, by Prater alone. H. S. McKee joined the plant physiologists at Sydney University. S. M. Sykes joined the N.S.W. Department of Agriculture in 1947 as leader of a joint project with DFP at Homebush on the quick-freezing of fruits and vegetables. J. Shipton and D. McBean then remained to continue the program of the decimated Dehydration Section and took over research on dried fruits when Hall and Trout, who had worked in that area during the war, returned to fruit storage investigations.

There were moments during the transition from war to peace when some scientists, particularly the newcomers, were unsure of their future roles. Vickery worked his changes with finesse and consideration and by 1950 had replotted the course the Division was to follow. It is useless to speculate about how far the new course deviated from what it might have been without the intervention of six years of war. However, quite apart from the direct effects of problems of feeding the armed services, the widespread wartime contacts with the food processing industry made it inevitable that the Division's activities post-war should be far more diverse than they were pre-war.

Instruments for the orchestra

'After World War II, Vickery was like the conductor of a small orchestra which he wished to augment and have play more difficult works' (Scott 1967).

One impact that the war had on research methods was the accelerated development of instruments for observation and measurement. Pre-war, the food research team wanted little more in the way of measuring instruments than some balances, volumetric glassware and remote-reading thermometers. During the war the glass-electrode pH-meter and photoelectric colorimeter made their appearance at Homebush, and there was some excellent specialized apparatus made by technical staff (such as Doug Ohye) with a talent for glass-blowing; but to implement Vickery's post-war plans, especially in fundamental research, a new emphasis on physico-chemical instrumentation was required.

The trend towards the use of more sophisticated methods in biochemical research was evident in many of the overseas laboratories visited by DFP officers between 1946 and 1949. In Australia, the Division of Industrial Chemistry in Melbourne had set up a range of physical instruments—ultraviolet and infrared spectrometers, X-ray diffraction equipment and a mass spectrometer—suitable for work with biological materials, and had established an instrument laboratory. At Homebush the development of interest in the design and operation of laboratory instruments emerged from the new research programs of George Rostos and Hugh McKenzie and from the untapped ideas of Merv Taylor.

Rostos had started the survey of physical conditions in fruit cool stores in 1947 and was looking for new methods of measuring and recording temperature and humidity at hundreds of remote points in cool-storage rooms. His assistant, Smith, when not on field work, was employed in developing the instruments, and revealed a taste for making gadgets which was fully encouraged by Taylor. McKenzie was also looking for help in making equipment for polarography, and later, in setting-up apparatus for the new Physical Chemistry laboratory. Taylor had long had an interest in physical instruments and had worked on moisture meters, colour measurement, and water vapour-pressure measurement during and after the war. He had a sound background in physical design but lacked workshop facilities to try out most of his ideas. There was therefore good support for Smith's proposal in 1950 to set up an instrument workshop.

Vickery had neither objections to the proposal nor money and space to carry it out. Fortunately Smith had two enthusiastic helpers (S. J. Rose and J. Lipscombe) and there was a small collection of machine and hand tools. An old store-room across Ash Lane was cleared out and a ceiling was put in as protection from the pigeons which nested in the roof. Disposal yards were searched for bench frames, cupboards, timber and possible raw materials. The ceiling was painted blue to discourage the flies and the walls grey to hide the dust!

There was no lack of appreciative customers. Hicks wrote to W. H. Cook of the National Research Council, Canada, in 1951: 'Some of the boys have designed and built a device for reading a Cambridge potentiometer in a moving train using a magic eye as the final detector. I have just returned from a trip on which we used it and it proved very satisfactory.' He subsequently sent details to his Canadian, South African and English correspondents on rail transport. This 'device' replaced the vibration-sensitive galvanometer, which could not be used while the train was moving, and allowed Hicks to make uninterrupted temperature readings. It was also used with a further development, a thermopile heatmeter, for directly measuring the heat flow through the insulated walls of rail vans. Hicks wrote to C. E. B. Cooper in Cape Town: 'This test was a large scale one with 102 measuring points, including 29 heat flow meters . . .. Our heat flow meters were home made and very cheap and useful. We made the couples . . . and cast the lot in the acrylic plastic used for dental plates' (with materials and advice from Hicks's dentist!). Since the workshop was part of the Physics Section, its staff also helped in the rail transport work and could test the utility of its inventions. When Hicks was lent an old refrigerated rail van for experiments at Homebush, 'the boys' built a sensitive amplifier and automatic switching and recording gear for round-the-clock measurements. Hicks was pleased with the arrangements, although Smith, with some doubts about automation, spent the first night at Homebush watching the recorders.

Scott had resumed his experiments on the influence of the availability of water on the growth of microorganisms and needed equipment for the precise measurement and control of the equilibrium water content in the growth medium. This was provided by the instrument workshop; the bald description of the apparatus, 'the copper block (holding the solutions) was placed in an evacuated desiccator which was submerged in a water-bath at $25 \pm 0 \cdot 01°C$ and continuously rotated in a plane about 12° from horizontal at 40 r.p.m.' (Scott 1953), does not indicate the headscratching which led to the eventual fulfilment of Scott's requirements. Vickery and F. S. Shenstone wanted apparatus to observe the thinning of egg white on storage; Robertson had ideas on a conductivity method for measuring respiration of fruit; Huelin and R. A. Gallop needed pumps for a low-temperature crystallizing bath, and McKenzie wanted vacuum systems and electrical gear built to Taylor's design. By the end of 1952 some fifty jobs had been completed. Not all were successful in operation, but even the failures encouraged a critical appraisal of commercial instruments, and such interest was also fostered by regular meetings of the Instrument Discussion Group, started by Taylor, McKenzie and 'the boys'.

The largest and most complex instrument to be designed, built, and tested by the instrument workshop was the moving-boundary electrophoresis apparatus for the analysis of protein mixtures. Its four-metre optical bench and 150-litre refrigerated bath of distilled water were set up on massive foundations in the Physical Chemistry Laboratory at the University of Sydney. Although the prime cost ($1500) of this instrument was low by today's standards it represented the first step taken by the Division towards sophisticated and expensive instrumentation.

Space at the University

In 1948 the DFP had a professional staff of 34 working at the Homebush laboratories and a further 7 at other places. Five years later these staff numbers were 39 and 23, a good indication of the enforced solution to the problem of lack of space at Homebush.

By 1960, the year before the move to new laboratories at North Ryde, the staff at Homebush had reached 42, there were 7 at the Brisbane laboratory and 12 at the University of Sydney. Thus in terms of staff numbers the space provided by the University had an appreciable effect on the activities of the Division. The effect was even greater in terms of the numbers of scientific 'hands', when the postgraduate students working in the University units were included.

The two units—Plant Physiology in the Botany School, Physical Chemistry in the Biochemistry Department—differed in their initial objectives, in formal associations with the University, in size and in scientific output, but suffered equally for many years from their isolation from the rest of the Division. The Plant Physiology Unit was set up primarily as a postgraduate research and teaching unit with well-defined participation and considerable responsibility in University affairs, and secondarily as a source of fundamental information for the applied workers on fruit storage. It was planned as, and became, a 'centre of excellence' which generated its own research objectives. In contrast, the smaller Physical Chemistry Section had the defined aims of providing some new physical techniques of analysis and of studying protein denaturation at a fundamental level. Its responsibilities to the University were more elastic and less onerous: to demonstrate new methods and equipment for protein research, to carry out specialized measurements for the Biochemistry staff, and to supervise one or two postgraduate students.

The professional staff at both units were expressly directed by Vickery in a memo late in 1950 to make regular visits to Homebush: 'In order to maintain good contact with the central laboratories, please make arrangements always to visit Homebush for important scientific and staff meetings. Such visits might amount to about half a day or more per week.' This arrangement, in practice, meant that the burden of maintaining contact rested on Robertson and McKenzie. They were personally involved in cooperative projects with Homebush colleagues, were required to attend senior staff meetings, and were best able to arrange transport. Other staff were often faced with the prospect of wasting two hours or longer in travelling to and from Homebush, and had little or no incentive to use Homebush facilities when libraries and secretarial and workshop services became available at the University. Visits in the reverse direction, which might have been of more value, were equally difficult and even less frequent. Feelings of estrangement developed as more staff who had never known the Homebush scene joined the University units, and despite the efforts of Robertson, McKenzie, and Huelin, persisted until the two groups rejoined the central laboratory at North Ryde.

Although space was available at the University, setting up functioning laboratories still required the parsimonious and 'do-it-yourself' approach only too familiar to Robertson and McKenzie. The Executive had finally agreed to provide $2500 towards the initial cost of alterations at the Botany School and $1000 for a laboratory in Biochemistry. Further sums amounting to $1700 were also provided by CSIRO for the Plant Physiologists up to 1956, when further expansion was made possible by an allocation of $10 000. But in their first year of existence the University units each had to rely heavily on the Homebush services to supplement the University assistance. Charlie North—workshop assistant, cleaner, painter, 'stores supervisor' and general handyman—was sent to help with carpentry and painting, and A. ('Tiny') Clark, then the Divisional truck-driver, demonstrated his versatility and skill in all branches of building construction from bricklaying to joinery.

The Physical Chemistry Section had additional problems connected with acquiring and installing their new instruments. In the 1950–51 financial year, $5520 was allocated for equipment including an infrared spectrometer and an electrophoresis apparatus. Head Office had pared $1200 from the estimated cost of the spectrometer, a move which would have provided the instrument, but little of the accessory equipment required to use it. McKenzie's solution was to save money on the electrophoresis apparatus by buying only the optical components and cell parts, and building the rest. He had enough faith in, or was prepared to gamble on, the newly-operating instrument workshop being able to produce the instrument, and, he hoped, a better instrument than those available commercially.

The most expensive piece of equipment for protein research, the analytical ultracentrifuge, was estimated to cost over $10 000. Developed by Swedish chemists during the war, the original instruments ('machines' might be a better description) were driven by high-pressure oil turbines, occupied two storeys in a building and required elaborate installation. The enormous centrifugal force of the ultracentrifuge had then been used in the first demonstrations that proteins and enzymes were giant molecules with characteristic sizes and shapes, and not just amorphous 'colloids'. Less elaborate and cheaper air-turbine instruments were developed later, and in 1950 an electrically-driven instrument, self-contained and with high resolution, reached commercial production in the U.S.A.

The CSIRO group working in Melbourne on wool proteins had decided to buy an air-turbine instrument, but McKenzie, supported by Vickery and Hicks, stood out for the newer and more expensive instrument. It took two years, in the face of financial cuts which played havoc with Vickery's plans for new work, to obtain the necessary $15 000 from CSIRO and approval to spend it as American dollars. The decision was fully justified by subsequent experience, when in 1953 McKenzie had the first operating ultracentrifuge in Australia.

The three major instruments were far more particular about their working environment than any research scientist. Each needed a dust-free room, preferably temperature-controlled, that could be blacked-out for aligning their optical systems; and the ultracentrifuge and electrophoresis apparatus needed separate solid foundations, free from vibration. The last requirement was difficult to achieve in the Biochemistry Department which was then housed in a war-time 'temporary' building, steel-framed and asbestos-clad, on the site of an old rubbish dump. Professor Still had obtained a grant from the University to provide an additional room for the ultracentrifuge, but it would not suffice for all three instruments.

Space was found for the infrared spectrometer in an air-conditioned room at the adjacent National Standards Laboratory, and J. J. Macfarlane began infrared measurements early in 1953. Having completed the construction of the electrophoresis apparatus and acquired a fresh interest in chemistry, Smith was transferred to Physical Chemistry in 1953 and given the job of installing both the ultracentrifuge and the electrophoresis apparatus. McKenzie decided that the University grant could be stretched to house both instruments if CSIRO looked after the installations and air-conditioning. With considerable assistance from 'Tiny' Clark and Stan Rose, partitions were moved to make the best use of available space, holes were cut in the floor and concrete and brick foundations for the instruments were built. Rostos designed a novel, highly-efficient, air-conditioning system, which was built and installed at a third of the expected cost. The ultracentrifuge was assembled with some trepidation because the instructions supplied by the makers were very sketchy and there were no Australian agents to consult—it was only after two years of successful operation that an American field engineer came to check the installation. By the end of 1953 all instruments and equipment were in use.

Chapter 11. Long campaign for new premises

A sense of urgency

The reasons for placing the DFP at Homebush and the many problems associated with that site have been described in Part 1. Although Vickery had little choice but to accept the Executive's decision to move there, it seems that he had no intention of allowing Homebush to become his permanent headquarters. In August 1944—a full year before the end of the war—he again spelt out the disadvantages of Homebush: 'It is desirable, therefore, that a more central site be found and a laboratory building in keeping with the Australian-wide importance of food preservation and processing be erected . . ..' He defined a favourable position as 'not more than 5 miles from the GPO, in Sydney metropolitan area' but his eagerness to leave Homebush was shown when, in 1944, he leapt at a suggestion by the Executive that some buildings at St Marys munition factory might shortly become vacant (Vickery to Rivett, Nov. 1944). St Marys is about 50 km from Sydney and, perhaps luckily, the suggestion came to nothing. Vickery has sometimes been accused of having endured the cramped and ugly quarters at Homebush for too long, or else of having been personally oblivious to them, but documented evidence points the other way.

The end of the war found the Division more badly housed than ever. Additional laboratories had been built almost every year during that difficult period but the standard of most of these extensions was poor owing to extreme shortages of suitable building materials and of skilled tradesmen. Finance for many of the additions came from other Commonwealth departments, principally the Department of Commerce and Agriculture, which depended on the Division for technical assistance. Vickery showed a marked reluctance to ask for large sums of CSIR money to spend on buildings at Homebush; probably the structures and the site could never satisfy the aims which he had in mind for the Division and certainly he did not want to become permanently committed by the expenditure of large amounts on capital works.

A letter from Vickery to the Town Clerk at Ryde in June 1945 showed that the Chief had been given the green light by the CSIR Executive to look for a site not only for his own Division but for others as well: 'It is the intention of our Council (CSIR) to locate this Division in more appropriate surroundings at the conclusion of the Pacific War and it is possible that several divisions of CSIR, not at present established in Sydney, will be associated each in its own building on the same site. . . . it would appear that we will need to locate an area of approximately 20 acres somewhere within that belt of land extending from Chatswood through Ryde and Dundas to Parramatta. . . . I would like to add that it is probable that in the early stages not less than 100 employees will need to be conveyed by bus from the nearest railhead . . .. We stipulate that provision must be made for adequate transport during the peak periods as well as for regular transport at, say, not more than half hourly intervals during the daytime and at night up to 10 or 11 p.m.' There is no record of a reply to Vickery's letter which, however, proved to be prophetic in defining the area in which the Division was ultimately located, North Ryde. Understandably he failed to foresee the declining use of public transport services and the flood of motor cars that would appear.

In August 1945—only two months after the letter to Ryde Council—negotiations were in full swing with P. D. Riddell, Superintendent of Technical Education in N.S.W., about a coordinated Sydney Technical College and DFP building scheme at Ultimo, an inner city suburb. Dr R. K. Murphy, Lecturer-in-Charge, in the Chemistry Department and Dr F. H. Reuter, Senior Lecturer were keen supporters of the plan because it would strengthen the course in food technology which they were evolving. Vickery, for his part, would get new laboratories for about $200 000, the sum which the Commonwealth was prepared to contribute to the complex. Rivett, suspecting that money for scientific work was not going to be freely available Rivett to Vickery 18 Aug. 1945), supported the plan with muted enthusiasm but Vickery, after canvassing the views of the professional staff at Homebush, rejected it on the grounds of the difficulty of expansion on the tiny site, lack of tenure, and the possible dilution of research effort by teaching commitments at the College.

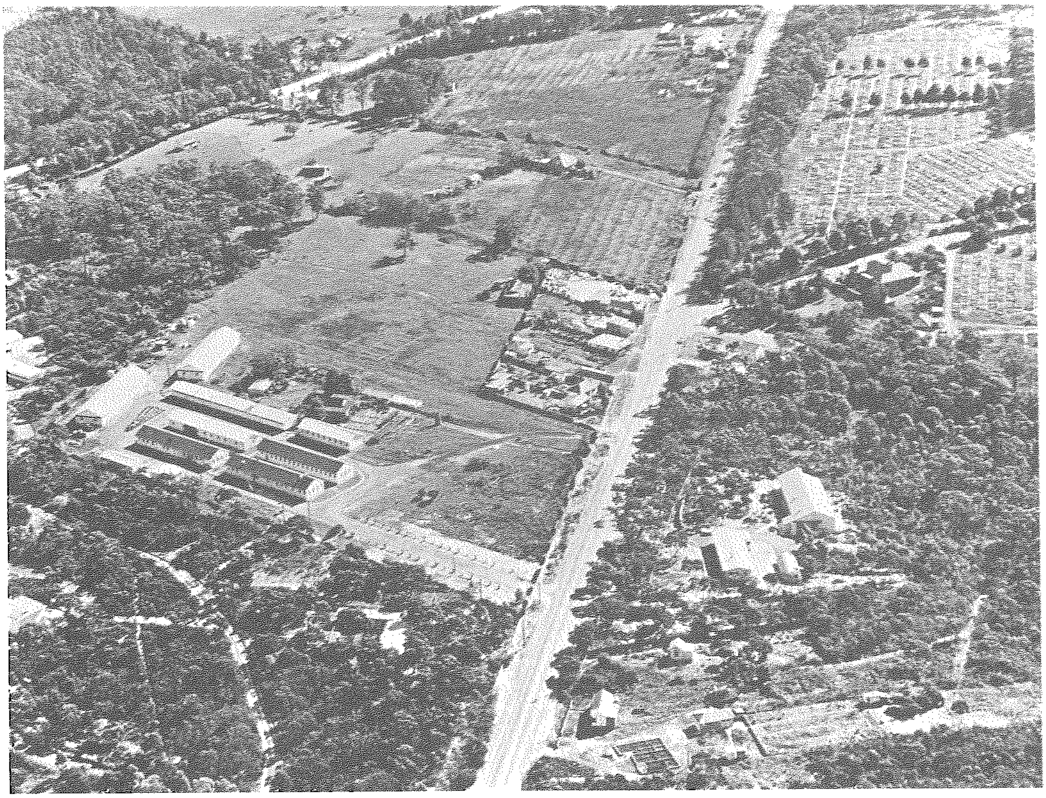
The possibility of other sites arose and subsided: these included Crown land at the Randwick Rifle Range or at Georges Heights on Middle Head (both in Sydney). This flurry of activity, all aimed at finding an alternative to Homebush, showed that Vickery was acutely aware that if he did not move quickly the Division would remain where it was for many years. The war had caused CSIR to fall a long way behind in its planned building program and other Divisions were even worse off than Food Preservation. Higher priority had to be given to the needs of Wool Research, Plant Industry, Entomology and Industrial Chemistry.

Frustration — and patience

In 1947 Vickery prepared a lengthy statement on the scope of food preservation investigations in Australia in which he again spelt out his views on the unsuitability of the Homebush site. Rivett replied in sympathetic terms (Nov. 1947): 'As to the immediate problem of the laboratory, Cook will send you a note suggesting that you might perhaps look further afield than Sydney. We must get a new place for you with abundant room for future spread and it may well be that this can be satisfactorily found only in one of the provincial cities or towns. It is essential, of course, to pick one where housing and educational facilities are readily available; we do not want a repetition of the troubles which encompass Homebush.

'Moreover, we shall be looking soon for a home for a Fuel Research Laboratory and, if we could get 20 or 30 acres in a suitable spot, we might very well build both places on it. Would Newcastle be a possibility for your work?'

Newcastle proved unsuitable to the Fuel Research Laboratory (later the Division of Coal Research) and soon after—in 1948—they were to be found



CSIRO site at North Ryde just before construction began. The buildings belong to Coal Research.

housed in fibro-cement huts on a block of ground that CSIR had by now acquired at North Ryde. This block was in the Green Belt about 10 km north-west of Sydney, adjacent to other Commonwealth research establishments. Because Coal Research needed more land for permanent buildings and the Executive favoured congregation of Divisions, Rivett's earlier suggestion was revived and sufficient land (7·7 ha) was resumed to accommodate at least two Divisions. Food Preservation was not immediately given a lien by the Executive on the excess land at North Ryde but the probability that the Division would ultimately be housed there gradually increased. By 1954 about 3·2 of the 7·7 ha had been earmarked for Food Preservation. It was not until 1955 that the Executive decided that the Division would have new laboratories as soon as they could be planned and built, and that they would definitely be sited at North Ryde adjacent to Coal Research. Further pockets of land had to be acquired and some of the resumed blocks were tenanted. The last portion of the site became available to the Division only in 1974, on the death of Mr H. Bain who owned a peach orchard originally covering much of the site, and who had been given permissive occupancy of a small block for life.

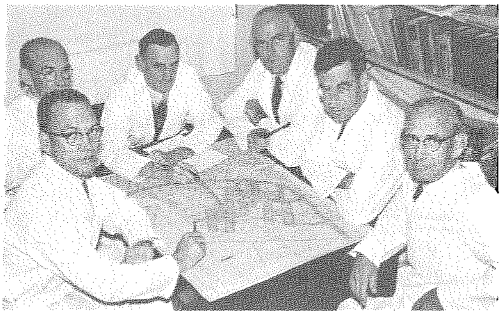
The period between 1948 and 1954 was one of frustration from which a good-natured cynicism developed; researchers began to wonder whether they would ever get new laboratories. The main stumbling block in the early 1950s was booming inflation followed by persistent annual cuts in financial allocations. This economic stringency flowed through into CSIRO capital grants and retarded the rate of development of almost every Division. The first break came in February 1954 when the Executive, after ruling that it was unlikely that more than $200 000 could be made available at any one time for the move to the North Ryde site, proposed that the Division should

Rural atmosphere at North Ryde.

transfer in three stages. The proposed cost of new headquarters had now risen to $600 000. Vickery sought the views of his senior staff on the advisability of accepting this piecemeal plan; they were less than enthusiastic, owing mainly to the lack of assurance that the three stages would follow one another closely. The prospect of having part of the Division at North Ryde and the residue at Homebush, with a possible long time between their reunion, pleased nobody. Vickery summed up the situation in replying to Bastow who had initially conveyed the bad news to him: 'The alternative of building in stages is far from being a happy prospect and, moreover, will undoubtedly be more costly in the long run. The work of this laboratory is co-ordinated to such an extent between the various sections that to have them rent asunder for a considerable period while the Ryde building goes up in stages, would be a most awkward matter from a scientific and administrative point of view.' Fortunately this problem was resolved quickly, when the Executive in a turn-about decision in April 1954, advised that the project at North Ryde would be built in one operation.

Start — stop — restart

Then came the planning, a long and somewhat anxious time that made the later period of building seem straightforward by comparison. Vickery took much of the early planning upon himself. He wrote to Bastow (Oct. 1954): 'As we have no drawing office or even a tracer in this Division, I have had to do all the work myself and fit it in at odd intervals with my other work.' This, of course, applied to the early or sketch-plan stage. All staff members took part in planning individual laboratory requirements up to the stage at which the project received Parliamentary approval in 1956, but some members, notably R. B. Withers and Thelma Reynolds, were heavily involved in the early planning. In 1957, K. M. Digby



From left to right: E. G. Hall, F. E. Huelin, J. R. Vickery, W. J. Scott, E. W. Hicks and L. J. Lynch discussing plans for the new laboratories at North Ryde.

was appointed as architect to assist in the overall scheme and to act as link between the Division and the Commonwealth Department of Works, which was responsible for the project. Digby stayed on until the Division was settled at North Ryde. The final plan took shape as a complex of nine buildings to cost $1 300 000. This was a far cry from the proposed pre-fabricated aluminium huts of 1950 or the single large building ($600 000) of 1952.

There were, however, further delays to the project. In November 1954, the CSIRO Advisory Council, after briefly discussing the building of the new laboratories, decided that, because of the large sum of money involved, the time was ripe to review the Division's work. The Committee of Review reported favourably to the Advisory Council in mid-1955 and the planning surged ahead.

The matter was further complicated in November 1954 by an official offer from the University of Technology of a site for the Division on their land at Kensington. This new prospect received careful consideration but was rejected a year later. The main objection to the Kensington site was that it did not appear to offer advantages over the proposed North Ryde site. In any event, considerable progress had already been made in the lay-out of the North Ryde laboratories, and to negotiate and re-plan for another site would cause further delays.

The Parliamentary Standing Committee on Public Works heard evidence on the North Ryde project in October 1956 and approval to proceed was given by the end of November. In presenting evidence to the Standing Committee, Bastow was careful to justify what might look like an almost over-attractive appearance in the building and the 3·2 ha site. The move to a Green Belt area, still remote from the city's spread, meant that 'people will have to make an effort to come to the laboratory from the surrounding districts. We must have a place that is attractive for them to come to . . ..' These were droll sentiments to anyone who had been connected with the exigencies of CSIR planning throughout most of its existence and particularly to people who had worked for years at Homebush.

In placing before the Standing Committee the need for a well-established food research laboratory, Bastow presented some interesting facts: the value to Australia of its food exports was, by the 1950s, $176 million annually, and was 'just shading minerals as the second biggest export trade Australia has'; he reminded the Committee that 'the maintenance of our competitive position in overseas markets is dependent upon our ability, not only to maintain exacting standards of processing and preservation, but also to discover and perfect improved new methods. Our Division has the responsibility of doing this, and there are few other bodies which carry out any work at all in relation to food preservation techniques. In regard to meat, eggs and fish we are definitely the only body doing any work at all on the development of new methods of preservation but State Agricultural Departments are doing good work in regard to fruit and vegetables.'

The heart of the project was to be a main laboratory block 90 m long, with 40 laboratories and 25 controlled temperature rooms; this came to be called the Food Science block. The Food Technology block was to have 24 laboratories and a large and well-equipped food processing area. The Administration block included offices, the library and a meeting room. The other major building on the site contained the store, metal-working and wood-working shops and an instrument workshop. It took another two years to complete the full drawings, a contract for construction of the laboratories was let in May 1959, and they were occupied two years later, in May 1961.

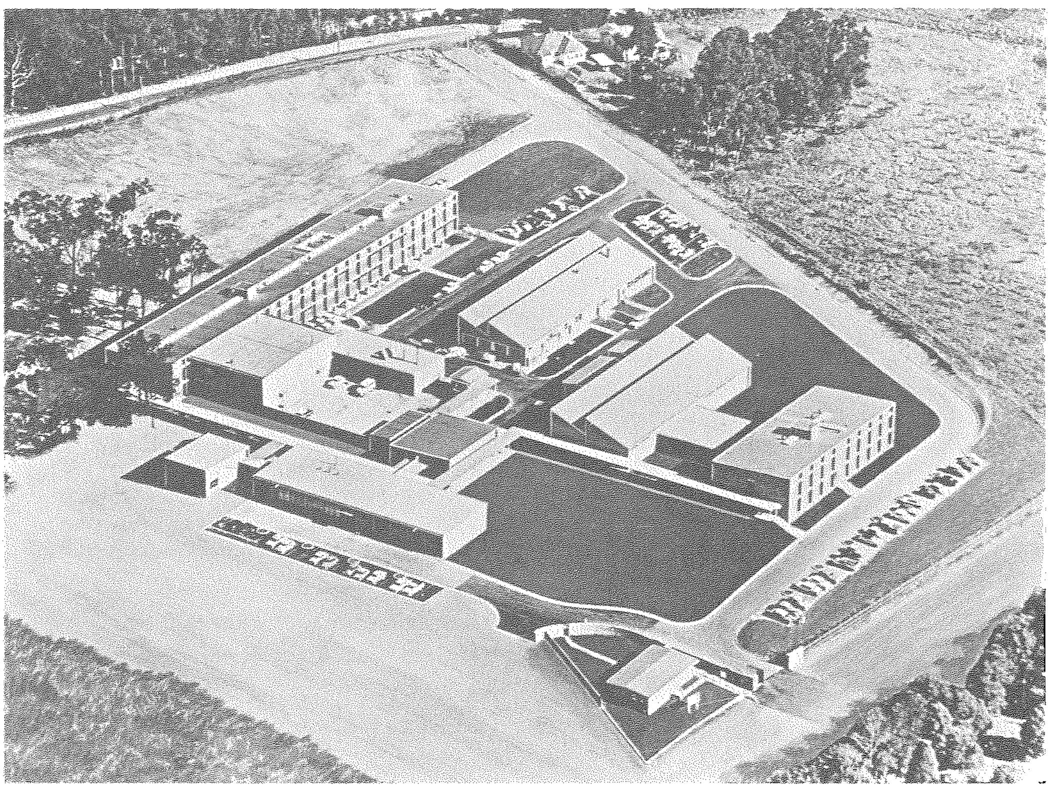
Thus was completed the largest CSIRO project since World War II. The Division had been provided with new laboratories that occupied 2400 m^2 of floor space. The staff was no longer overcrowded, research facilities were good, allowance was made for a 50% expansion and the surroundings were pleasant.

Official opening

The new headquarters and research laboratories of the Division were officially opened on 18 September 1961 by the Minister in Charge of CSIRO, the Hon. D. A. Cameron. Dr F. W. G. White, Chairman of the CSIRO Executive, described the opening as 'a very important occasion in the life of the Division.' To those who had waited and hoped for so long this was a monumental understatement. Representatives of the food industry, universities, and other CSIRO laboratories as well as many other distinguished visitors gathered for the opening. On the morning of that day, more than 100 representatives of the food and associated industries met at North Ryde to discuss the role that industry might play in food research. Drs White and Vickery for CSIRO and Messrs F. Eagle and H. W. Cottee for the food industry all stressed the collaboration which should exist between the Division and the food industry but few definite ideas for further strengthening of this liaison emanated from the meeting.

The Division organized a Food Science Conference from 19–22 September 1961 to inaugurate the new laboratories. Sessions were interspersed with other activities such as inspections and demonstrations. One such activity was the unveiling on 21 September of a memorial to the late E. W. Hicks; a sculptured design in bronze, showing a portrait head and some of the mathematical equations with which Hicks 'played' so skilfully. The ceremony was performed by Mr D. E. Seale, Chairman, N.S.W. Division of the Australian Institute of Refrigeration, Air Conditioning and Heating, in the presence of Mrs Hicks and her daughter Helena and a gathering of colleagues and friends. The memorial rests in the Divisional meeting room which has come to be known as the Hicks Room. Surplus donations were used to found the Hicks Memorial Fund, for a prize to be awarded annually to the technical assistant who gained the most meritorious results on graduation. Appropriately, the first joint recipients, Joan Hayhurst of the North Ryde laboratory and D. Plate of the Brisbane Meat Research Laboratory, had shown outstanding abilities in mathematics and physics.

The Conference was opened by Dr R. N. Robertson, a former Assistant Chief of the Division, who was by now a member of



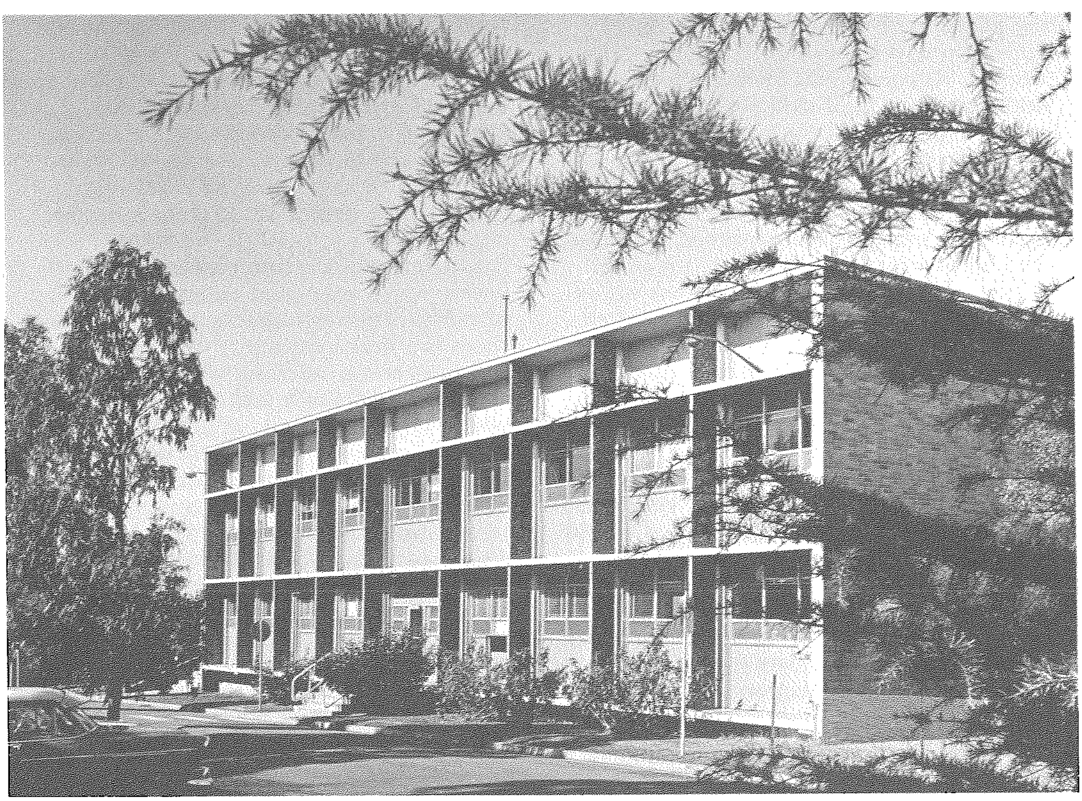
The new laboratories before landscaping.

the CSIRO Executive. More than 300 delegates attended, including 51 from other States and 11 from overseas. Among the latter were Dr E. C. Bate-Smith, Director, Low Temperature Research Station, Cambridge, on his first visit to Australia; Dr C. O. Chichester, Associate Professor of Food Technology, Davis, California; Dr J. B. Biale, Professor of Plant Physiology, Los Angeles; and Dr. H. Wilkinson, Head of the Unilever Food Research Laboratory, England. Robertson expressed the hope 'that the Conference will assist materially in strengthening the level of science in the food industry.' Fifteen years afterwards much of the Australian food industry still lacks a scientific research component.

'Beauty and utility'

At the official opening of the laboratories, Dr White stated that the new buildings could be admired for their beauty and utility. He was obviously impressed, like many others, by the grouping of the buildings, interconnected as they were by internal roads and wide covered walkways, and by the colourful painted aluminium panels which, with glass, formed the side walls cladding the laboratory buildings. The picture was completed with all other walls constructed of face bricks ranging from cream through pink and apricot to light brown.

The 3·2 ha site allotted to Food Preservation was certainly an excellent one but during construction many areas had been scraped back to underlying shale and clay. By the time of the opening, rehabilitation had scarcely started, only a few areas near the main buildings showed a frail covering of winter-sown grass. The Division agreed to plant at least 500 trees and shrubs on the site to comply with the County of Cumberland's request to reestablish the Green Belt nature of the area. Following discussions with arboriculturalists of the Commonwealth Department of Works, $16 000 was transferred to the Division to cover the cost



The North Ryde laboratories in 1966.

The north side of the Food Technology Building after trees had grown.

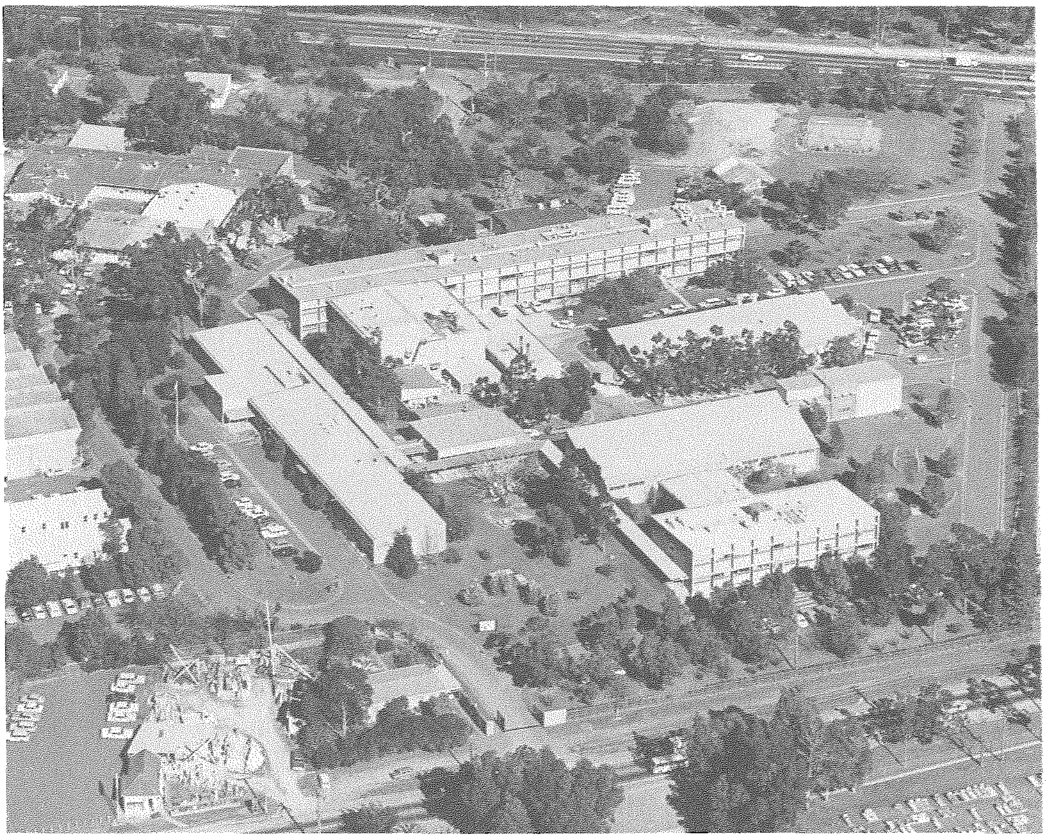
of ground preparation, grassing, paving and the planting of trees and shrubs. In undertaking responsibility for these tasks, Thelma Reynolds and Don McBean spent many hours of their own time selecting suitable species and the places to plant them. In all, more than 600 plants, a mixture of native and exotic species, were planted. The Division was fortunate in finding an experienced gardener, Bill Ellis, who had been forced to vacate his small nursery due to ill-health. With the aid of casual labour, the lawns were established and trees planted over a period of 18 months. Under Ellis's care, few plants failed in the harsh environment, although a shot-firer had to be employed to break up shale beds with gelignite in some places before plants could be set out. An indigenous population of rabbits ring-barked a few plants but they never reached plague proportions because of the presence of myxoma virus, which appeared to be endemic in the area and flared up after each extended rainy period. In later years enthusiastic staff members established a native garden and a section that includes many species found in Australian rain-forests. The Green Belt concept has long disappeared from the area surrounding North Ryde but none of the staff who use and appreciate the grounds regrets that it was in force when the laboratories were built, and many of the Division's visitors comment favourably on the surroundings.

After fifteen years' occupation, some good and bad aspects of the design of the laboratories have become apparent. In general, the buildings have served their purpose well as housing for a research centre. The design allowed for a future expansion of up to 50%; additional controlled-temperature rooms were built within seven years and extensive updating of refrigeration equipment connected with them has been necessary; the Administration building was extended to the north and south and the Hicks Room was enlarged. A series of additions to the Food Science block occurred in a direction that was not originally envisaged—in the basement area. Many internal walls were wood-framed so that they could be shifted if necessary, but such alterations have been few and, in practice, the walls are extremely difficult to move. The laboratories, with their peninsular and side benches, have remained virtually unchanged but they have gradually assumed their own characters because of specialized usage. Perimeter ducts, carrying service pipes in the laboratory blocks, take up 15% of the total floor area; this is excessive in relation to their utility.

Some major defects in the North Ryde complex have led to high needs for maintenance, which have taken up a major part of the time of the workshop staff and limited their usefulness in backing up experimental programs. Roofs have been corroded by gases from fume cupboards which are expelled just above the roof line, and both laboratory blocks have had two roof replacements. Many of the original fume cupboards have been replaced by better models. Most of the seven fires that have occurred started in old-style fume cupboards but fortunately they have been limited to minor proportions by the automatic sprinkler system. Within the laboratories, solid timber bench tops warped and split, and were gradually replaced by sheets of heavy waterproof plywood coated with resistant epoxy resins. It is easy to detail such defects but it must be remembered that many parts of the Division function satisfactorily for long periods with little or no attention. An example is the food processing pilot-plant which is used not only by Divisional staff but is also made available to the food industry for trial runs of processes and equipment.

Orientation of the buildings and architectural features, which limit sun penetration during summer and allow partial entry on the northern side during winter, have worked well. Air conditioning was available initially only in the library and in the tasting booths but many laboratories now have individual units to protect the sophisticated equipment that they house.

The Bread Research Institute (BRI) stands on a part of the original 7·7 ha site, made available by CSIRO on a 99-year lease. With its official opening in 1960, the Institute narrowly beat the Division to North Ryde. The close association that had existed before 1960



The North Ryde site in 1976.

between the BRI, under the Directorship of Mr E. E. Bond, and the Division, was further strengthened by their proximity.

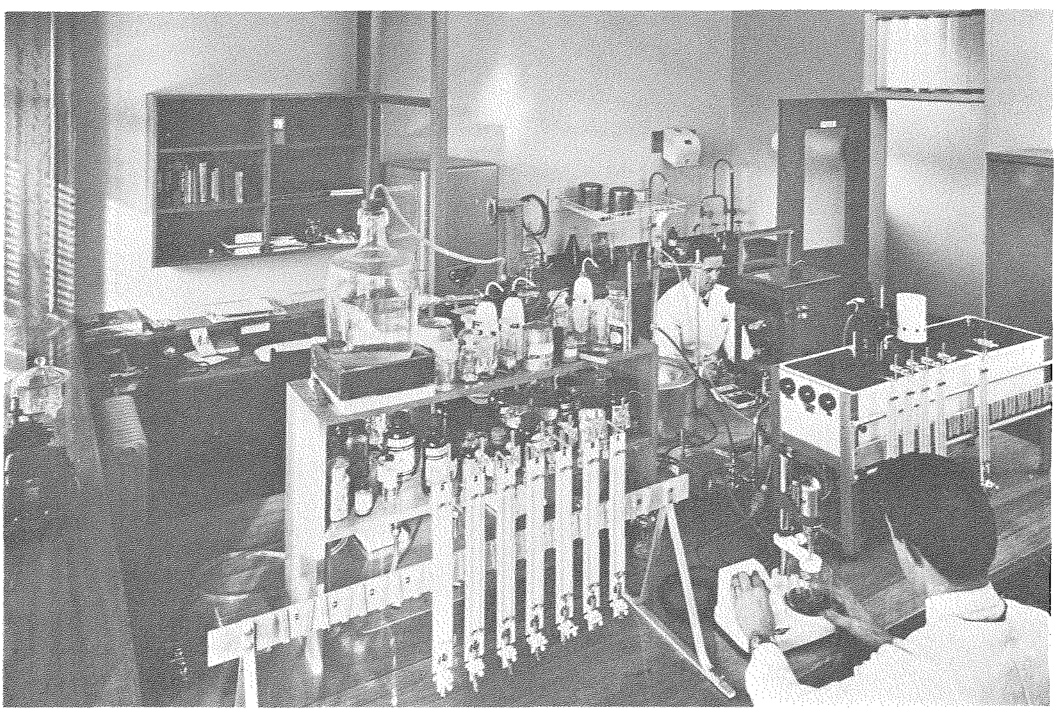
The prospect of growing experimental crops, often advanced as an important consideration in selecting the site for new laboratories, looked promising at North Ryde, and a small orchard was planted in 1962. It was pulled out in 1972 mainly because of the difficulty in controlling fruit fly in the area. A few plots of vegetables were also tried but the results were so poor that the effort was abandoned. However, excellent crops of wheat and triticale have been grown by the CSIRO Wheat Research Unit which is housed within BRI.

In 1969, an experimental glasshouse was erected adjacent to the Food Science Building and in 1976, a Plant Growth Building capable of holding ten cabinets in which a wide range of environmental factors could be controlled, was also built nearby.

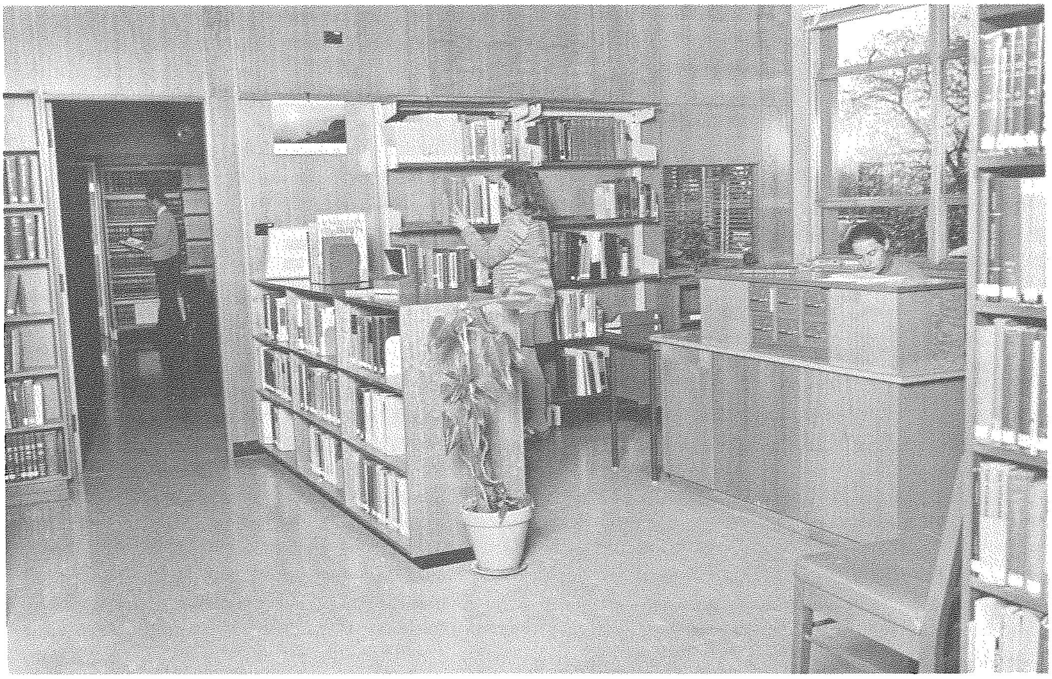
Malcolm Franklin working on pineapples in the glasshouse.

All roads lead to North Ryde

In planning for new laboratories at North Ryde no provision was made for the three groups that worked within the University of Sydney—Plant Physiology, Physical Chemistry and Electron Microscopy. This is surprising because Vickery was originally keen to have all fundamental work done within the central laboratory, and in 1956, he wanted research on muscle biochemistry to be done at North Ryde and handy to Physical Chemistry. Possibly he was unwilling to seek more money than that necessary to



A typical chemical laboratory at North Ryde.



The Library at FRL.

house the Homebush staff or he may have thought that he had an obligation to maintain these groups at the University.

The Electron Microscopy unit, consisting of Joan Bain and D. Ohye, took delivery of a Siemens microscope in February 1963 but it was not installed until the following October when laboratories to house it in the basement of the Food Science block were completed. This was the start of piecemeal construction which was, over the next 14 years, to fill the basement for about 75% of its total length. Owing to the slope of the land, excavation was minor at the western end of the block, but as expansion moved eastward, large amounts of earth had to be removed from between the pillars which form the foundations of the building. At the far eastern end where head room was too low for more laboratory construction, the staff rifle club built a 23-metre indoor range.

In early 1962 Professor J. L. Still of the Biochemistry Department advised Vickery that a new building was about to be planned for him at Sydney University and asked if he should make provision in it for the Physical Chemistry unit. Vickery decided that this successful collaboration should be concluded so that the work of the unit could be more closely integrated into the program at North Ryde. The basement of the Food Science block was chosen to house the unit because it was simpler and cheaper to provide vibrationless supports for the electrophoresis and ultracentrifuge installations at ground level. CSIRO Executive was loath to provide funds for this extension so soon after the completion of the main contract, and Vickery was forced to approach the Australian Meat Board in June 1962 seeking approval to use $22 000, which was the balance of a grant of $30 000 made by the Board in 1956, to build laboratory accommodation for basic studies on meat. The Board agreed but the sum was less than adequate to complete the construction; the interior of the laboratories was satisfactory but external walls and the floor of the central corridor in the basement remained an eyesore for another 10 years. Physical Chemistry moved to North Ryde in August 1964 leaving only PPU at the University of Sydney.

An opportunity to consider the future location of PPU arose in 1963–64 when

Sydney University mooted the establishment of a school of biological sciences that would incorporate the departments of botany and zoology. The view gradually developed that PPU should move, although in 1967 the Committee of Review still offered three alternatives:

- remain at the University of Sydney
- transfer to the new Macquarie University at North Ryde
- establish headquarters at the Division at North Ryde with some staff at Macquarie.

Professor F. V. Mercer, joint leader of PPU with R. M. Smillie, had left the University of Sydney in 1965 to become the first Head of the School of Biological Sciences at Macquarie University. He was keen for the Unit to transfer to Macquarie and the staff also preferred that site to Divisional headquarters. In spite of these leanings, there were cogent reasons why PPU should join the rest of the Division and preliminary plans were drawn up for another new building at North Ryde. The Executive baulked at the cost and the N.S.W. Universities Board was reluctant to agree to PPU moving to Macquarie. A critical impasse had developed by mid-1970 with the Board still not agreeing to the proposal and, of course, it would take some years to build at North Ryde. Suitable accommodation was available at Macquarie and there was the prospect that the University might provide interim accommodation for PPU while laboratories were built at North Ryde. At last, the Board agreed to the proposal and, after some negotiation, a draft agreement was signed; CSIRO was to pay an annual rental for laboratory and office space at Macquarie as well as an annual payment for overheads and services. In addition, a special allocation of $35 000 was made by CSIRO for equipment. It also cost a considerable sum to leave Sydney University; $14 000 was paid by CSIRO to refurbish the area that had been occupied by PPU since 1952 and significant amounts of equipment were left there. The total cost of the move was appreciable but far less than that required to build new laboratories. When the Unit moved to Macquarie University in December 1970, staff members, most of whom resided in the vicinity, no longer faced the arduous, slow drive to the University of Sydney, and they were only 5 km from the Food Research Laboratory. Thus the last group of research staff from the University of Sydney came to North Ryde even though it did not come right into the fold.

Chapter 12. Lines of research— many and varied

Much of our History is concerned with the motivation and environment of research; with changes in programs, and with finance, staffing, buildings and facilities, but this is a relatively small part of the activities of 50 years. We could describe the research effort and results by a list of scientific and technical publications, but while impressive, it would be indigestible and inappropriate; hence we are faced with the necessity of selection, of choosing some aspects that best illustrate the research activities of the post-war years at DFP. It is inevitable that some significant aspects will be omitted or treated too lightly.

The physics of transport and storage

On the evening of Saturday, 1 October 1949, a goods train carrying fruit and vegetables left Roma Street station in Brisbane, bound for Cairns, 1600 km to the north. The guard's van at the end of the long line of trucks on this occasion had two passenger compartments, from one of which bundles of thin wires looped across the couplings to the preceding insulated van. Inside the compartment were two long seats, one half-covered by electrical gear, the other piled with parcels of food, blankets, a spirit stove, clothing, utensils and notebooks. Watching the train depart, E. W. Hicks of DFP and S. A. Trout, then Director of Horticulture of the Queensland Department of Agriculture, waved to their assistants, M. B. Smith and J. Saint-Smith, who were to work, eat and sleep in a space smaller than the average bathroom for three days, while the train ambled along at 20 to 30 k.p.h. At every stop—usually only a few minutes' wait for a signal change—temperatures in the load of fruit and vegetables were hurriedly measured by means of the thermocouples and a portable potentiometer (the galvanometer on which became useless when the train was moving) while an occasional passenger was directed to the other compartment. The water supply ran out in half a day and for the rest of the trip washing was proscribed.

Fortunately, few of the rail transport investigations were as epic as this, and in most, Hicks was an active participant. He thoroughly enjoyed the two- or three-day break from desk work, and the opportunity to test the fit of his theoretical calculations of temperature changes against actual measurements in the field. In New South Wales, where most of the tests were made, Mr Ottley Barr of the Mechanical Engineering Branch of the Government Railways was able to provide a mobile laboratory, the 'dynamometer car', which had six bunks, a kitchen, and even a shower, with plenty of room for instruments and calculations. Hicks often had his report on the test drafted by the time the last measurements were taken, plotting each measurement on sheets of graph paper as it was read out; the Railways had expressed horror at his suggestion that Beth Adamson, his assistant, should go along to help with the paper work.

Between 1948 and 1955, Hicks and Barr tested two new types of rail vehicle and investigated several new methods for transporting meat and fruit in N.S.W. Practical advances and new theory emerged together from these investigations. The self-cooling of bananas carried in ventilated vans between the north coast and Albury (where the change in rail gauge necessitated trans-shipment) prompted Hicks to return to his early fundamental work on the evaporation from and cooling of wet bodies. Tests with chilled meat in a new, top-bunker, refrigerated car stimulated the development of new methods of measurement and calculation, while consideration of the performance of cooling systems for frozen transport of meat, vegetables and egg-pulp led to further laboratory trials at Homebush. Hicks was often able to suggest more effective use of older refrigerated cars, and gained a high reputation with railways officers who were sure Hicks could solve any problem after a few minutes calculation 'on the back of a tram ticket.'

In Queensland the emphasis was on the northward transport of temperate fruits and vegetables, which were often loaded in Brisbane without adequate pre-cooling. After years of cooperative work with the Queensland Railways and the Queensland Department of Agriculture, Hicks, C. D. Stevenson and J. R. Blake reported on the satisfactory cooling performance of a mechanically-operated fan car, shortly before Hicks's untimely death in 1959.

Survey of fruit cool stores

Hicks was the principal source of advice to the cold storage industry on cooling, freezing, and low-temperature storage of foodstuffs, and often had to collect data for assessing the performance of cooling systems and storage rooms. However, the variety of designs and storage methods used in cool rooms for fruit prompted a thorough survey, which was undertaken between 1947 and 1955 by Rostos, with help from Smith and J. D. Mellor. Temperature surveys and measurements of humidity and weight loss were made in 23 cool rooms, representing 14 different types, in New South Wales, Victoria and Tasmania.

In contrast to the rail transport measurements, tests in cool stores were protracted and unexciting. A selected room was wired with thermocouples while empty in late summer, and the thermocouples (up to 150) were positioned in cases and air spaces while the room was being filled with fruit. After measurements of cooling rates, lasting perhaps a week, the room was left to equilibrate and sets of measurements were then made every two to three months until the fruit was removed in the spring. The measuring potentiometer invariably had to be operated in a draughty, ill-lit corridor, where, in Tasmania, the temperature was sometimes lower than inside the cool room. Although the cool store operator was usually cooperative and interested, many tests were aborted by the early removal of fruit for overseas shipment, or by a poor season which only partly filled the room.

Rostos had great patience and perseverance, worked long hours (and expected his assistants to do likewise) and established excellent relations with the industry. He was a sound refrigeration engineer but did not have Hicks's flair for experimental design nor for lightning extrapolation of a few measurements to a significant conclusion. He collected masses of data that were eventually condensed into a long report published in 1959 after he had transferred to the CSIRO Division of Mechanical Engineering. Although the delays in digesting the experimental data exasperated Hicks and reduced the wider impact of the survey, a great deal of useful information and many practical suggestions were passed on to cool store operators during the tests. The value of the survey was increased by the involvement of E. G. Hall and other officers from the Fruit Storage Section and departments of agriculture, which meant that a direct relation could often be observed between the physical conditions of storage and the final condition of the fruit.

After Hicks's death, Hall continued to take an active interest in the temperature conditions in cool stores, and with help from T. J. Riley (Fruit storage), J. D. Mellor, Joan Hayhurst and M. Coffey (Physics), he also studied the cooling of fruit in bulk bins. Changes in packaging methods, such as the introduction of fibreboard cartons instead of wooden cases for bananas, and the use of traypack cartons and polyethylene liners for apples, led Hall and his team to further studies of cooling rates and of rail transport, and to cooperative investigations with the British Shipowners' Cargo Research Association and with several departments of agriculture on the overseas shipment of apples and pears.

H. L. Evans became leader of the Physics Section early in 1960 but in 1962 left to take up an academic post overseas. His position was filled by J. Middlehurst, who transferred from the CSIRO Division of Physics. Using new analogue and digital computing methods—a far cry from Hicks's handcranked calculator—Middlehurst was soon engaged in constructing mathematical models of heat flow in the cooling of fruit in different containers. He also carried out (with J. F. Kefford) an elegant study of the

A. R. Irving making physical tests on a loaded container at North Ryde.

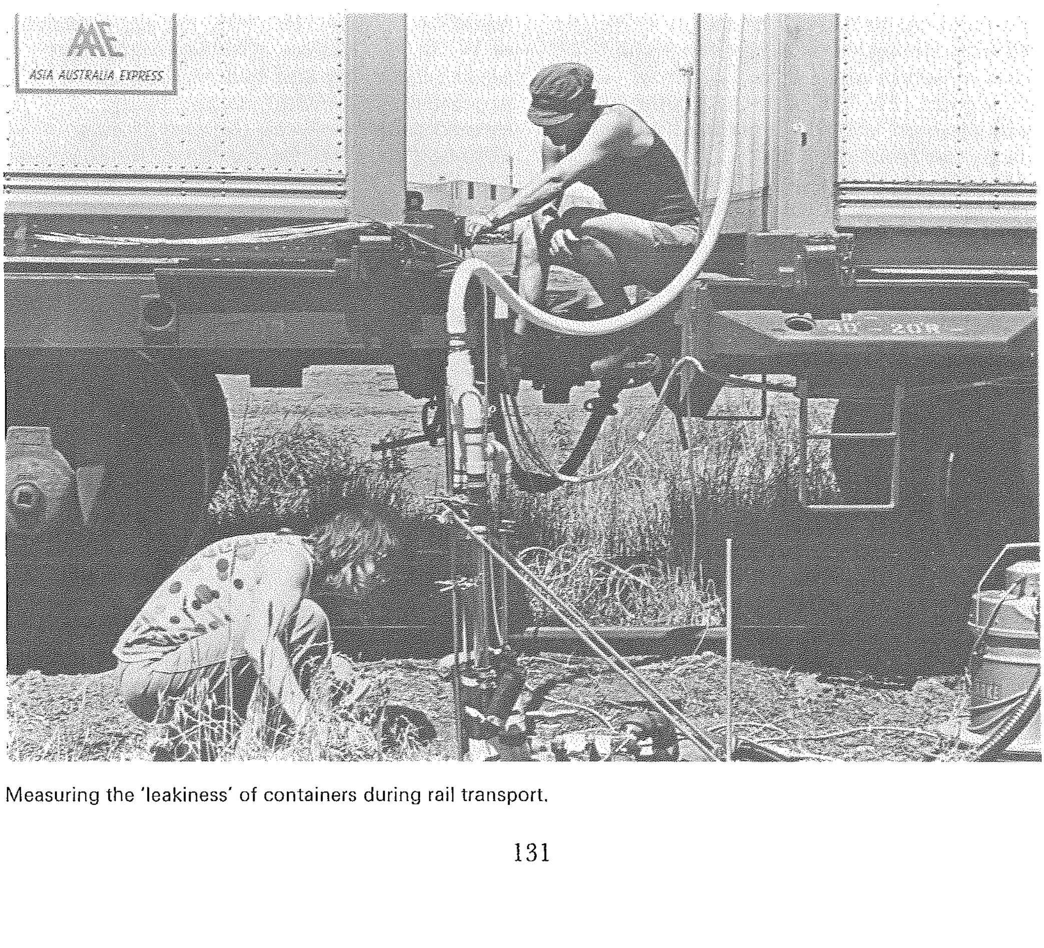
condensation of moisture on canned foods shipped from Australia to the United Kingdom, and laid the foundations for later work on the shipment of a variety of products in the new shipping containers. Middlehurst came to the Food Research Laboratory with an expertise in physical instrumentation which not only brought new sophistication to the studies of storage and transport but restored the image of the Physics Section as the main source of information on instruments.

Fruit and vegetable storage

Early successes chalked up by the DFP in the area of fruit storage ensured that by 1950 conditions for the satisfactory storage of principal Australian varieties of apples, pears, and stone and citrus fruits had been defined. The work of Trout and Huelin, and later Hall, along with that of collaborators in other organizations, had paid off handsomely. However, some problems remained unsolved and the best storage conditions for many other fruits had still to be established.

R. N. Robertson was pressing his claim for the establishment of a group to work on plant physiology and biochemistry with statements such as 'While we have defined the limits of what we can do with certain storage conditions, we have often done so with only the vaguest knowledge of why we have done certain things; . . . In other words, most of the work consists of investigations of better conditions, the "hit or miss" method. . . . Some of this work is excellent and great improvements have come from it but we have reached the end of our tether and new developments will come only from increased basic knowledge' (Robertson 1950). Robertson's arguments fell on appreciative ears within the Division and among members of the CSIRO Executive; the Plant Physiology Unit (PPU) was established in 1951, and how it grew to become one of the largest Sections in the Division is described later in this chapter.

In 1952 Joan Bain was appointed to the Fruit Storage Section. Earlier she had worked with Robertson at the Botany



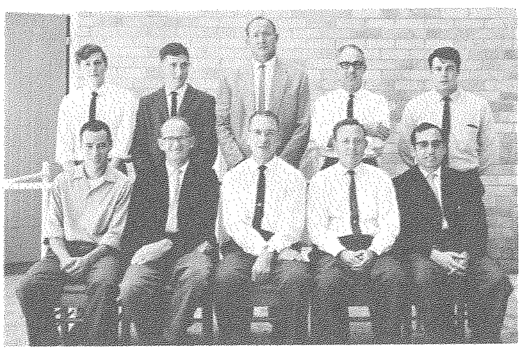
Measuring the 'leakiness' of containers during rail transport.

Department of Sydney University on the relation between cell size and the storage characteristics of apples. They had found that cell numbers were similar in different-sized Granny Smith apples; thus cell sizes were smaller in the small fruit which was found to keep better in storage than large apples. This subject was also studied in Tasmania by D. Martin and W. Carne of the CSIRO Division of Plant Industry. At DFP Joan Bain made a histological study of the development of superficial scald in Granny Smith apples and then proceeded to investigate the anatomical and physiological changes in oranges and pears as the fruits developed. Gradually her interest switched to electron microscopy and she left the fruit storage group about 1960.

It frequently occurs that the name of a particular person becomes almost synonymous with work in a particular field; no name is more widely known by Australian workers on fruit storage than that of Eric Hall. He established a close relationship with the industry and continued to do most of his own extension work right up to his retirement in 1974. Hall held strong views about the right course of action and backed up these views with vigour. He hated to waste time and is still credited with the unofficial record time by car from the Gosford Laboratory to Homebush, a trip which he did frequently because his duties included supervision of programs at the jointly operated Citrus Wastage Research Laboratory. Hall, a former officer of the N.S.W. Department of Agriculture, fostered relations with other officers from that Department who were stationed at DFP. These included R. S. Millington, Marie Austin (later Mrs S. M. Sykes), A. E. Roberts, B. B. Beatty and K. J. Scott.

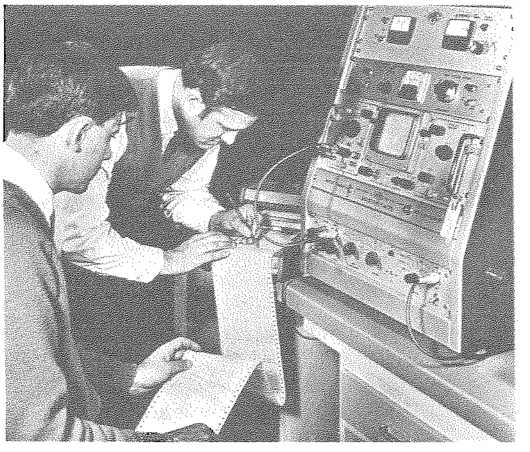
In spite of the successful results of the earlier fruit storage work, other avenues for practical research opened up: superficial scald, that injury to which the Australian apple variety, Granny Smith, is so susceptible in cold storage, was reduced, first by the use of oiled wraps, and later by dips containing the antioxidants diphenylamine or ethoxyquin. Controlled atmosphere (CA) storage was studied extensively as it was in many other laboratories in the world. This investigation extended as far as converting old stores to CA and the designing of new ones; an important role in this section of the program was played by R. A. Atkins, the Divisional Engineer from 1963 to 1974. The ripening of bananas was controlled by sealing them in polyethylene liners in cartons; natural volatiles such as ethylene, which initiate the ripening process, were removed from the atmosphere within the sealed liner by reaction with potassium permanganate dispersed on vermiculite. Of course, empirical studies on variety, time of picking, within and between tree variability, temperature and atmosphere of storage, also continued.

The roles of the Fruit Storage Section and PPU should have been complementary but at best, their contact could only be described as desultory. When Robertson left the Division in 1959 to join the CSIRO Executive, the possibility of collaboration between the two groups receded still further. Their geographical separation was only partly to blame for the lack of cooperation; officers at PPU looked down upon the empirical studies being done on fruit storage and saw no way in which they could be helpful. In 1964, the appointment of W. B. McGlasson, who was trained in plant physiology and had worked previously in the fruit storage field, formed a link between the two groups, although by 1968, he was formally absorbed into PPU. His presence at North Ryde, however, together with a few PPU members stationed there, stimulated research which took a middle course; Scott, Wills and McGlassson performed experiments that suggest that the keeping



The Fruit Storage Section in 1965. Front row: R. B. H. Wills, W. B. McGlasson, E. G. Hall, J. K. Palmer, K. J. Scott. Back row: D. Pierce, L. Dixon, T. J. Riley, J. A. Boss, B. B. Beattie.

K. J. Scott and R. B. H. Wills investigating low temperature breakdown in apples.



N. S. Scott and R. M. Smillie using a spectrophotometer in studies on the photosynthetic activity of chloroplasts.

quality of apples—and some other fruits—depends on their calcium content or on their calcium/potassium balance which is affected by fruit size. Subsequently, Kevin Scott showed that postharvest application of calcium salts to apples resulted in improvement in their storage characteristics.

Although PPU staff showed little interest in the fruit storage program, many forays were made into this field by other members of the Division, notably chemists and biochemists. For instance, Huelin and Adrienne Thompson identified some of the volatile materials produced by apples and J. B. Davenport studied the composition of the natural coatings of the fruits—particularly the changes that occurred during storage. Investigations such as these were aimed at finding the reasons for storage disorders.

Eric Hall tried unsuccessfully on many occasions to enlarge the Fruit Storage Section which consisted of never more than four research scientists, including one or two from the N.S.W. Department of Agriculture. In the rearrangement following Hall's retirement in 1974, PPU and the Fruit Storage Section were amalgamated.

Plant physiology and biochemistry

The PPU may not have provided the Fruit Storage Section with the 'new developments (that) will come only from increased basic knowledge' as prophesied by Robertson, but there was no doubt about the excellent reputation they achieved in academic circles. Robertson established the nucleus for subsequent growth, and kept in close touch with the problems of fruit storage, but after 1959 his successor, D. D. Davies, had much less involvement with Homebush. The Unit was then breaking new ground with fundamental studies of glycolysis and carbohydrate metabolism (J. F. and D. H. Turner, M. D. Hatch) and with biophysical investigations of cell membranes, initiated by A. B. Hope. Scientists newly appointed by CSIRO to the Unit (J. Giovanelli, G. P. Findlay, D. Graham, T. ap Rees) were wholly concerned with these areas of research. It was not until 1966 that R. M. Smillie, appointed joint leader in 1963, reestablished contact with fruit storage work at North Ryde through the new investigations of postharvest physiology by McGlasson and J. K. Palmer.

The research output of the PPU, assessed in terms of publications in scientific journals, was immense and abstruse. In the ten years after its formation 59 papers from a total of 32 authors were published, and subsequently the output more than doubled. About half the authors were University staff and postgraduate students working in the Unit; the distinction was not always definite, as some students later joined CSIRO. There was also a flow of research workers from the Unit to senior positions in other CSIRO Divisions, State and university departments, and private industry; by

1968 26 positions, including 6 professorial appointments, had been filled by scientists who had trained in or worked in the Unit. Much of the credit for its academic success must go to F. V. Mercer, who was joint leader at the University of Sydney from its inception until he was appointed Professor at the newly formed Macquarie University, a few years before the Unit also transferred to Macquarie.

Organelles and enzymes

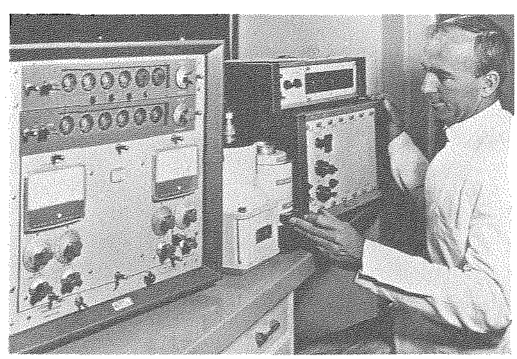
The nature of the fundamental work carried out at the PPU was often found hard to grasp, even by scientists in other Sections. We must risk over-simplification in attempting to indicate changes in the direction and scope of plant physiological research, as reported in submissions to the Committees of Review of 1955 and 1967.*

In 1955, physical studies of the fine structure and organization of plant cells were being made with the electron microscope, and the organelles in the cell (plastids, mitochondria, nuclei) responsible for growth and development were being delineated, whilst the electrical properties of the cell membrane gave information on the mechanisms which maintain the correct ionic environment inside the cell.

The sequence of events in the synthesis and breakdown of sugars, and the enzymes responsible for specific links in the chain of reactions were being investigated by biochemical methods. The process of respiration, on which all plant cells depend, has always been related to storage behaviour of fruits and it was known that the enzymes of aerobic respiration are associated with the mitochondria. The properties of mitochondria were being studied after extraction from apple, beet, carrot and pea tissues. These materials were obviously relevant to food preservation; less obvious were experiments with *Chara*, a water plant, whose exceptionally large cells were advantageous in biophysical measurements, allowing, for example, the insertion of micro-electrodes.

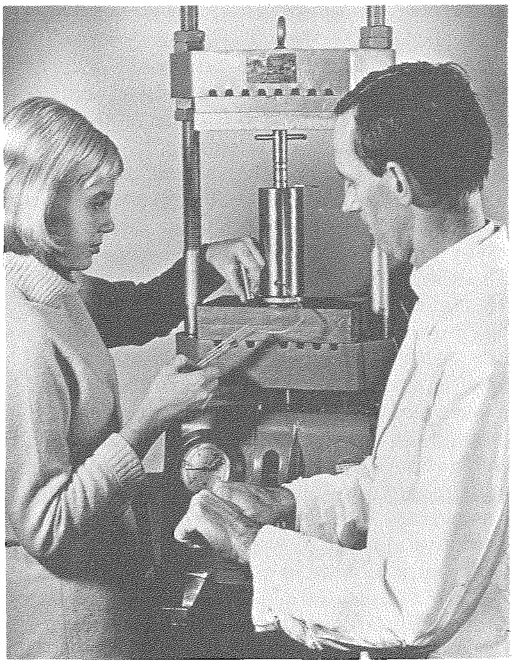
By 1967 the new field of molecular biology had shown how structure and function could be related at the molecular level of organization; new instruments and methods, such as dual wavelength spectrophotometers, preparative ultracentrifuges, and a host of radio-isotope tracers and new chromatographic separations, had given the plant physiologists more delicate and perceptive tools. The main focus of attention was now the molecular biology of the developing chloroplast—the organelle which contains chlorophyll and is responsible for photosynthesis. This process could literally be switched on and off by light, and as a model for following the processes of development, the chloroplast was amenable to biochemical analysis. N. S. Scott had been appointed to study the roles of nucleic acids, and in a group including Smillie, Graham and several graduate students, significant advances were made in a new and active field of research. C. J. Brady was investigating protein and amino-acid metabolism and the process of aging and, with J. K. Palmer at North Ryde, was working on the physiology of banana ripening. In addition to this work with bananas, the plant physiologists worked with such materials as the developing shoots of pea and wheat, the leaves of mung bean, and the green algae *Chlorella* and *Euglena*.

By 1967, research had diverged even further from direct relevance to fruit and vegetable storage. However, the first



C. J. Brady using a radiation counter in studies on amino acids in plant cells.

* Two Committees were appointed by the CSIRO Advisory Council to report to it and the Executive on the activities of DFP. The first, prompted by rehousing proposals, conducted its review and reported in 1955. The second Committee was appointed in 1966 and delivered its report shortly before Vickery's retirement in 1967.



Jan Conroy and N. F. B. Tobin operating a French pressure cell to disrupt algae for enzymic analysis.

recommendations were then being made by DFP to the Committee of Review to establish closer relations with North Ryde, either by moving to the North Ryde laboratories or to Macquarie University. In the next ten years a close connection emerged between the practical problems of cold injury to plant tissue and events that could be studied at the molecular and sub-cellular level.

Melting in membranes

A new theory to explain cold sensitivity of plants and chilling injury in fruits and vegetables of tropical and sub-tropical origin was developed in 1969 as a result of the collaborative work of John Raison and a visiting scientist from the University of California, Dr J. M. Lyons. Chilling injury was one of the problems listed by R. N. Robertson in 1950 in his discussion of plant physiology in relation to storage of fruit and vegetables. In 20 years no progress had been made in finding the physiological basis for the disorder. Although the end result was well defined and the storage conditions for chilling-sensitive fruits had been determined by trial, the development of observable injury was a long process which was obviously the end result of unknown primary events. The value of the Raison–Lyons approach was in indicating a temperature-dependent change at sub-cellular level which could be studied with isolated cell fractions, and which showed immediate differences between the responses to low temperatures of chilling-sensitive and chilling-resistant plant tissues.

Plants and fruit respire, as do all living tissues, and the rate of respiration becomes less as the temperature is lowered. Respiration, associated with biochemical reactions in the cell mitochondria, had been studied by plant physiologists for many years. Raison and Lyons measured respiration rates at different temperatures with mitochondria extracted from a variety of plants. They found that whereas mitochondria from chilling-resistant plants showed a steady decline in respiration rate as the temperature was lowered from 30° to 0°C, the decline in respiration rate of mitochondria from chilling-sensitive plants was much steeper below 10°C than above. This effect was later observed in animals; mitochondria from rat livers had a more rapid decline in respiration rate below 23°C than above, while experiments with fresh-water trout indicated a steady decrease in rate between 30° and 0°C.

The next step was to look for the cause of this behaviour. Mitochondrial enzymes concerned in respiration are located on membranes; membranes have a lipid component; and some lipids show abrupt changes in physical properties, akin to melting or freezing, as the temperature is raised or lowered. Were the observed effects caused by a change in the physical state of the membrane lipid?

A new technique that could be used to examine the fluidity of lipid dispersions (electron-spin-resonance (esr) of 'spin-labelled' lipids) had been developed in the U.S.A. in the late sixties. Raison spent a year with Lyons in California from October 1969, and during this time he worked with the esr technique and found that temperature-dependent changes in both membrane lipid and whole mitochondria could be demonstrated. By 1972 a new esr spectrometer had been installed at North Ryde and measurements on lipids and membranes from a variety of plant and animal sources were under way.

Thus evidence was obtained connecting the change in temperature dependence of respiration with a physical change affecting the motion of a 'reporter' molecule in the membrane lipid. Although differences in interpretation and explanation occurred (a popular but superficial account was that 'lipids congeal at low temperatures—like butter in a refrigerator—causing a change in respiratory activity') a great stimulus was given to research at North Ryde on membrane structure and function, and to the use of other techniques, such as differential scanning calorimetry, for measuring thermal changes in lipids. Also, while the theory of 'phase-changes' in membrane lipids has not fully explained the primary event in chilling injury, it has provided a useful tool for assessing temperature effects on cell organelles, and has led to current work by B. D. Patterson, Smillie and Graham on the complex secondary events leading to cell death.

Food chemistry

Superficial scald

'Superficial scald is a storage disorder of apples and pears caused by the death of hypodermal cells, and shows up as brown patches on the outside of affected fruits . . . it can be controlled either by wrapping the fruit in oiled tissue paper or by treating it with antioxidants such as diphenylamine or ethoxyquin. However oiled wraps are not always successful in controlling scald, especially for fruit stored in controlled atmosphere, and while the antioxidants provide complete control they are not permitted as food additives in some countries. Other remedies are needed; and it is hoped that if we can gain a clearer understanding of the causes of scald we may be able to work out better control measures . . .' (Anet 1974).

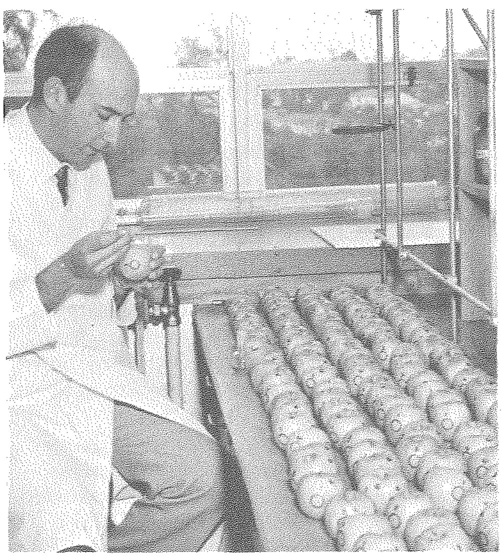
Thus E. F. L. J. Anet summed up an investigation which had been in progress for 30 years and had been led by F. E. Huelin until his retirement in 1970; an investigation which had involved some 10 scientists in Chemistry and Fruit Storage, and which was to be terminated by Anet's unexpected death in 1976. Although many of the secondary reactions causing scald still remain to be investigated, the isolation and identification of the volatile compound, α-farnesene, and the establishment of a relation between its oxidation products and the incidence of scald form one of the Division's main success stories.

As early as 1919 it was postulated that scald is connected with volatile products of the fruit's metabolism that can be carried away by moving air or removed by absorbents. We have already mentioned Huelin's early involvement, with Adrienne Thompson and R. A. Gallop, in the analysis of volatile compounds released from stored apples, and of the oils and wax that form a natural barrier at the skin, and that change on storage. When Gallop moved to Tasmania in 1952, J. B. Davenport continued the work on fractionation and analysis of the skin coating. In parallel with the analytical work, Huelin ran innumerable tests in which he introduced volatile compounds, already identified, into the storage atmosphere, or explored the uptake of volatiles by oiled wraps, or tested possible inhibitors. One compound, diphenylamine, proved an effective inhibitor, but its mode of action was unknown. By 1955 a mass of experimental data had been accumulated but the cause of scald was still a mystery.

A recommendation of the 1955 Committee of Review led to a new approach. The Committee had suggested that, 'The work of the biochemistry, organic chemistry and physical sections at Homebush should be integrated. In the Committee's opinion this can be best done by appointing a common leader of very high calibre.' Disturbed by what he felt was uninformed criticism, Huelin drafted a lengthy survey of the work of the chemical sections (which Vickery passed on to the Executive with the comment, 'This appears to be a carefully thought-out statement which is both moderate in tone and informative'). Early in 1956 Vickery and Huelin also organized a conference of all chemical investigators in the Division, with the object of exploring coordination, if not integration. Detailed reviews of current and future work were circulated and the two days of discussion stimulated new thoughts on a number of old problems, including the cause of scald.

During discussion, Davenport suggested that diphenylamine might be acting as an antioxidant in its role as scald inhibitor, and hence could affect the degree of unsaturation of a component in the apple cuticle oil. He and Huelin later tested this hypothesis, and found there was indeed a volatile, labile compound, marked by a characteristic ultraviolet absorption spectrum, in both cuticle oil and storage air. It then became possible to trace this compound during storage trials, and over the next three years, to collect circumstantial evidence that this was the causal volatile substance that had been sought for so long. But it was present in only minute amounts, and would require sophisticated techniques for isolation and identification.

Fortunately, help in this direction was at hand from K. E. Murray, a long-standing adviser and colleague of Huelin's, who was about to transfer from the Division of Industrial Chemisty to start a new series of investigations on the volatile components of foods at the new North Ryde laboratories. Huelin persuaded Murray to take on the task of identifying the new compound. After the inevitable delays associated with setting up laboratories and acquiring new instruments success was achieved, and Murray, Huelin and Davenport reported (1964) on the 'Occurrence of farnesene in the natural coating of apples'.



I. M. Coggiola applying α-farnesene to the surface of apples.

α-Farnesene had never previously been isolated from natural sources or prepared in the laboratory, but once characterized, was soon identified in other natural substances. Professor G. W. K. Cavill at the University of N.S.W. identified it in certain types of ants, and I. M. Coggiola, who had assisted Huelin for many years with the scald investigations, worked with Professor Cavill on the photooxidation of farnesene, and thereby earned his M.Sc. degree. Coggiola's research career was cut short by his death in 1972 at the age of 37. Even after retirement Huelin continued to take a keen interest in Anet's work on the oxidation products from farnesene until his death in 1976, shortly before Anet's.

The browning of foods

A brown coloration in processed food may be desirable, for instance on the surface of roast meat or baked bread, but undesirable if it occurs in dried fruit. Browning may be caused by an enzymic reaction at the cut surface of plant tissue (the rapid discoloration of apple slices exposed to air is well known); the remedy is to inactivate the enzyme by heating (blanching) or by using chemical inhibitors such as sulphur dioxide. There is another, slower, process which produces a brown pigment in foods by chemical reaction between sugars and the amino groups of proteins, amino acids, and other nitrogenous constituents. It was the latter process, poorly understood and difficult to control, which Thelma Reynolds set out to study in 1951.

The post-war collapse of the vegetable drying industry had directed the attention of the Dried Foods Section towards the problems of the dried fruits industry, which was steadily expanding. One problem was the slow darkening of dried fruit on storage. Little was known about the constituents of fruit—sugars, organic acids and amino compounds—which were supposed to react at low water content to form the brown pigment. Accordingly, Reynolds, Nancy Wonders and A. S. F. Ash, working as the Organic Chemistry Section, began to separate and identify these compounds in apricots, peaches, pears and apples. New methods of paper chromatography and ion-exchange fractionation were successfully used, and by following changes in the amounts of extractable compounds during storage of the dried fruit, Reynolds showed that the organic acids acted only as catalysts, and did not enter into the reaction between sugars and amino-acids.

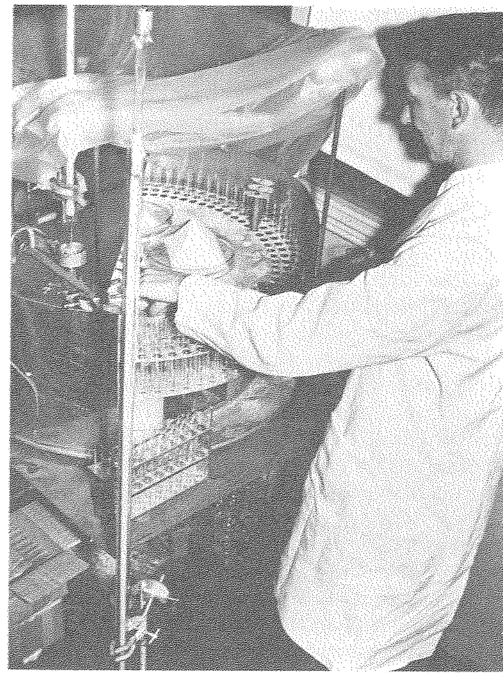
When Ash returned to England in 1953, Anet joined the section and made many important contributions to these investigations. 'Model' systems—mixtures with known concentrations of single sugars and amino acids—were used to explore the series of chemical reactions that led to browning. D. L. Ingles joined the Section in 1955 and began separating intermediate compounds, which Anet identified and fitted into the complicated sequence of reactions. Ingles later studied the reactions of sulphur dioxide and sulphites with sugars, and investigated the inhibiting effect of sulphur dioxide on non-enzymic browning. In a paper presented in 1962 at the First International Conference of Food Science and Technology in London, Reynolds, Anet and Ingles reviewed their progress in elucidating the course of events in browning and the mechanism of inhibition. The importance of their contribution to this fundamental area of food science may be gauged from the 15 research papers from their group that were cited in the review.

Although reactions in the early stages of browning were charted successfully, investigation of the later stages of polymerization to the brown pigment was, and still is, hampered by a lack of methods yielding quantitative information. The problem had moved into one of the ill-defined realms of colloid chemistry. Reynolds and Dorothy Fenwick continued to battle with the problem until 1969 when the project was terminated.

Anet and Ingles also changed their research programs; Anet became involved in 1968 in studies of the chemistry of α-farnesene, and Ingles, in 1969, began a fundamental investigation into the degradation of natural polymers by free radicals.

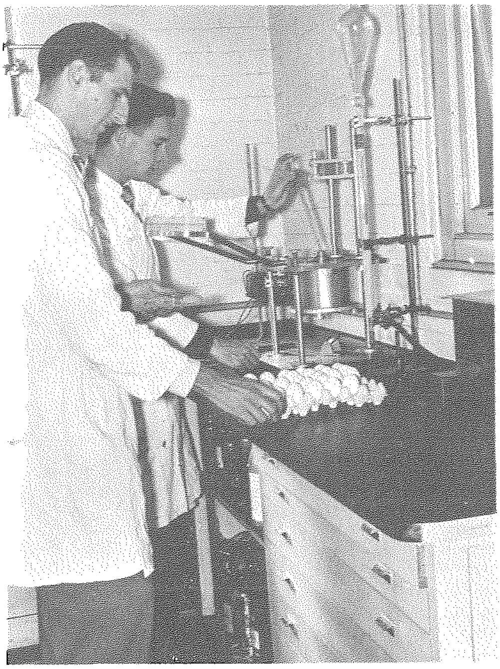
Pink whites in eggs

Because food must be acceptable to the eye as well as to the mouth and nose, many problems in food preservation concern changes from normal appearance. There is no doubt that an egg with a pink-stained white and a yolk of semi-solid consistency is unacceptable, even though little change in eating quality may have occurred. This 'pink white, pasty yolk' defect was traced in 1928 to the ingestion by laying hens of certain substances from plants of the order Malvales. The pink colour of the white was shown in 1946 to be the result of abnormal diffusion of iron from yolk to white.



D. L. Ingles setting up a fraction collector (1956).

In 1951 Vickery and F. S. Shenstone began an investigation of outbreaks of this disorder in Australia, and by 1956 had isolated from the leaves of the mallow plant a fatty acid that produced the disorder when fed to laying hens. With help from J. J. Macfarlane, the purified compound (named malvalic acid) was shown in 1957 to be an 18-carbon fatty acid containing the unusual cyclopropene ring in its structure. A related, 19-carbon, cyclopropenoid fatty acid—sterculic acid—had already been found by a South African worker in the seeds of a semi-tropical tree, also in the order Malvales, but this compound had not been connected with the egg problem. In a study of the seed of the cotton plant, the important commercialized member of the order Malvales, Vickery and Shenstone found



F. S. Shenstone and G. Stanley engaged in egg investigations (1956).

both malvalic and sterculic acids in the oil.

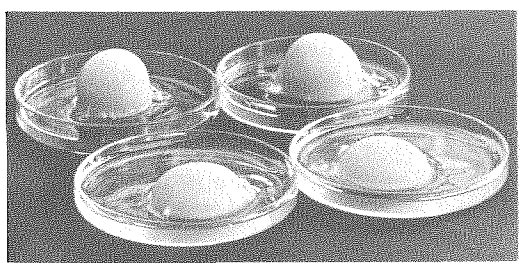
The mallow plant was an accidental component of the hens' diet and could easily be excluded, but cotton seed meal is a widely-used source of protein for both poultry and animal feeds. Cyclopropenoid fatty acids were found to affect the hatchability of hens' eggs, as well as to produce the pink-white disorder. Hardening of the fat of pigs and of butter could also be caused by these compounds in feeds. It was, therefore, very desirable that more knowledge should be obtained about the effects of these fatty acids on both animals and poultry.

In 1960 it was shown in the U.S.A. that the hardening effect was caused by an increase in the ratio of stearic acid to oleic acid in the fat, thus raising its melting temperature. The same change occurred in the lipid (fat) in egg yolk; this was thought to explain the change in consistency of yolk on cool storage, but did not explain the pink whites. At that time the development of gas chromatography was revolutionizing many analytical methods, including the analysis of lipids for their component fatty acids, so it became much easier to follow changes in lipid composition. At DFP the only gas chromatograph, built by B. H. Kennett, was in full use for the apple scald research, and it was not until after Murray's arrival in 1961 that further instrumentation was planned.

Further research on the biological effects of the cyclopropenoid compounds was made possible in 1963 by a grant from the United States Department of Agriculture (Public Law 480) with the object of increasing the utilization of cotton seed products. This grant, for $92 000 over a term of five years, was in obvious recognition of the pioneering work of Vickery and Shenstone. Murray was initially named as 'principal investigator', but when he became fully involved in flavour investigations, he was succeeded by A. R. Johnson, who had joined the new Animal Products Section in 1961.

Johnson had previously been Leader of the Commonwealth Antioxidant Research Project, and after its closure had worked in the Fats Research Laboratory of the D.S.I.R. in New Zealand. Although he was later to play a leading role in lipid research at North Ryde, his first project was to study the liberation of volatile sulphur compounds from some canned meats which caused staining of the inside surface of the can. This investigation resulted in a neat explanation of the relationship between breakdown of sulphur amino acids under alkaline conditions and the abnormally alkaline meat from the emaciated sheep often used for canning.

The appointments in 1964 of A. C. Fogerty and Judith Pearson to work on the biochemistry of the cyclopropenoid fatty acids created a strong research group which was to make considerable progress over the next five years in understanding the chemistry and biological effects of



High standing yolks (back) resulting from the feeding of cyclopropenoid fatty acids to hens.

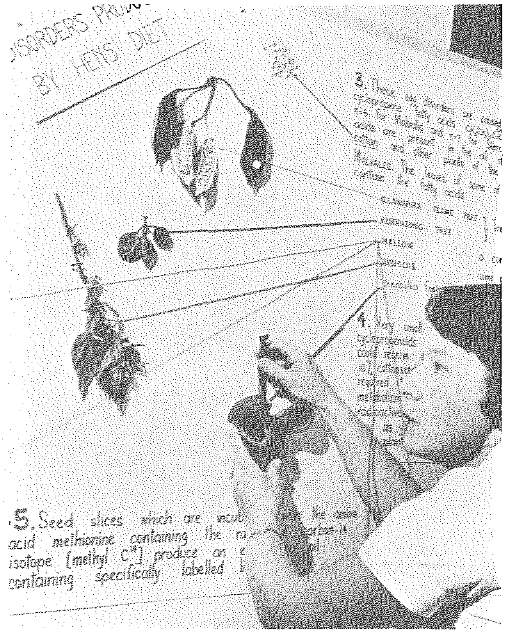
these compounds. Insight into the biochemical pathways between substances fed to a hen and the lipids in the yolk provided a way of altering some physical properties of yolk at will, and a new tool for studying the structure of yolk lipoproteins. The experience gained and methods developed proved of value in later projects on dairy foods and meat with increased levels of polyunsaturated fatty acids (see Chapter 14). This research also prepared the ground for subsequent investigations involving poultry and animal nutrition. Under Johnson's leadership a summer school was organized on 'Biochemistry and Methodology of Lipids' in February 1969. The material from this school, edited by Johnson and Davenport, with contributions from nine staff members of DFR, and published under the same title, has established itself as a definitive text in the field.

Food proteins

By the time H. A. McKenzie had left the Physical Chemistry Section in 1959 and moved to the Australian National University, Canberra, to establish a new Department of Physical Biochemistry, his Section had gained considerable experience in separating proteins from egg white, milk, blood serum and fish muscle. The denaturing effects of heat, acid and urea on these proteins had been studied with the aid of graduate students from the Biochemistry Department, University of Sydney, and the laboratory had established a position as one of two centres of protein research in Australia.*

McKenzie had continued his interest in analytical methods after moving to Sydney University in 1950, and with Heather Smith (later Wallace) and D. F. Ohye developed improved methods and equipment for determining the amount of nitrogen in proteins. Between lecturing and organizing protein research he also found time for research on polarographic methods of analysis, and developed new instrumental techniques in collaboration with M. C. Taylor. In 1960, Taylor also left DFP to take a position in the Australian National University and was able to continue the collaborative work on polarography with McKenzie in Canberra.

* The other centre was the CSIRO Division of Protein Chemistry in Melbourne, which was then primarily concerned with wool proteins.



Judith Pearson preparing a display on egg disorders caused by cyclopropenoid fatty acids.

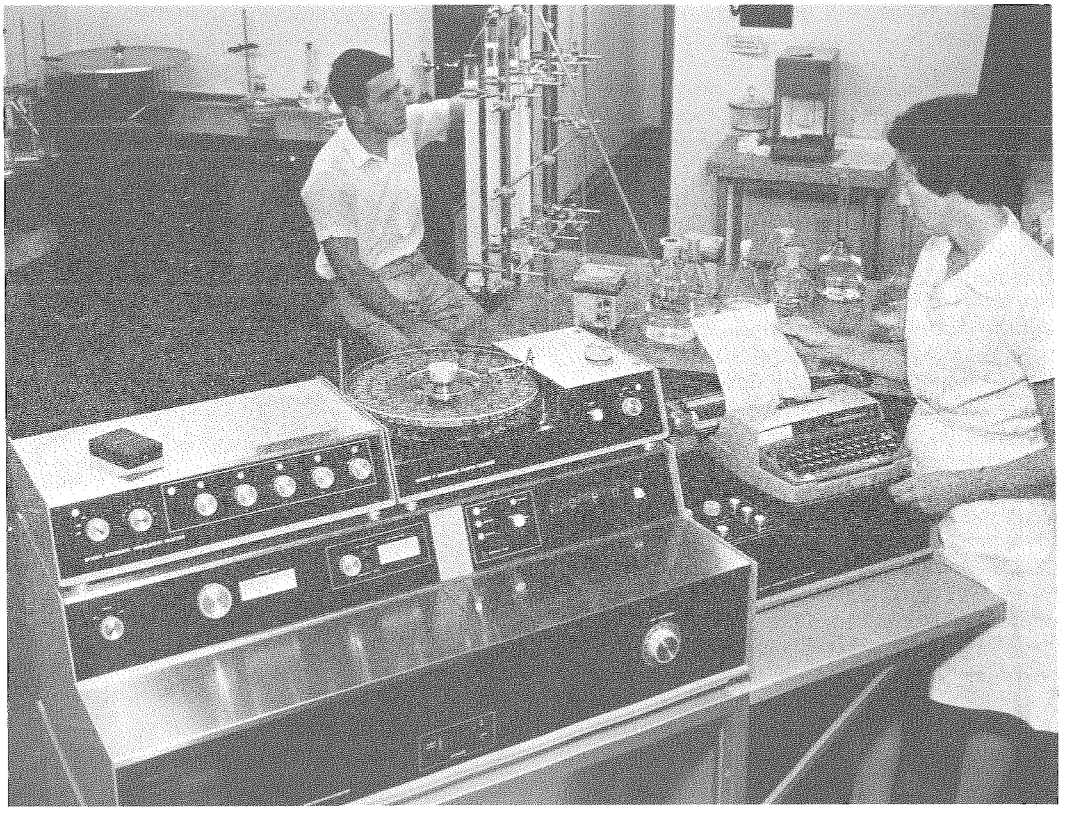
McKenzie's first graduate student in Biochemistry, R. G. Wake (who is now Professor in his old department), prepared and studied ovalbumin from egg white, the lactoglobulins of milk, and blood serum albumin, and later fractionated casein and studied the action of the milk-clotting enzyme, rennin, on casein. Research on milk proteins after 1959 was continued under McKenzie's direction at Canberra, with grants from the Dairy Produce Research Committee.

The 'denaturation' of proteins, a continuing theme for 25 years, requires some definition. In 1947, Vickery referred to the 'so-called denaturation . . . in dried and frozen foods'. This is now regarded as a loss of solubility in salt solution, and denaturation is defined as the unfolding of the ordered structure of the protein molecule without change in chemical identity. During the 1950s a detailed picture of the protein molecule emerged from the application of new hydrodynamic and spectroscopic methods for observing changes in size and shape, new techniques for identifying the sequence of amino acids along the protein chain, and a new approach to X-ray crystallography. But these techniques were applied mainly to soluble, globular, proteins; it also became clear that 'denaturation' caused by drying or freezing the fibrous proteins of muscle, or the protein-lipid complexes of egg yolk, occurred at a level of organization higher than the protein molecule.

Attempts were made in 1959–60 to study the changes in organization of muscle proteins caused by freezing, and R. W. Burley, who joined the Physical Chemistry Section in 1961, investigated the use of labelling agents absorbed on muscle fibres to follow changes during aging, and examined more powerful solvents for muscle proteins. However, it was research on egg proteins that assumed the greatest importance and established an international reputation for the Section. This research was a good example of interaction between fundamental and applied science, with Burley and Smith working respectively on yolk and white proteins, and Shenstone providing the link with problems of egg quality and storage behaviour.

From molecules to meringues

The coagulation of egg white on heating is probably the most widely observed example of protein denaturation, and possibly the least understood. Ovalbumin, the main protein of egg white, was used in a study of heat denaturation which Smith began in 1956, using the same techniques that Wake had used in his work on urea denaturation. By 1960, after many attempts to obtain reproducible results, and after applying several new techniques to measure the amount of denaturation, it became obvious that ovalbumin was behaving as a mixture of two components that had different stabilities to heat. Also, different preparations appeared to contain different proportions of the components, with less of the more stable component



R. W. Sleigh and Joan Back studying ovalbumin by means of an automatic spectrophotometer.

(eventually named S-ovalbumin) in fresher eggs.

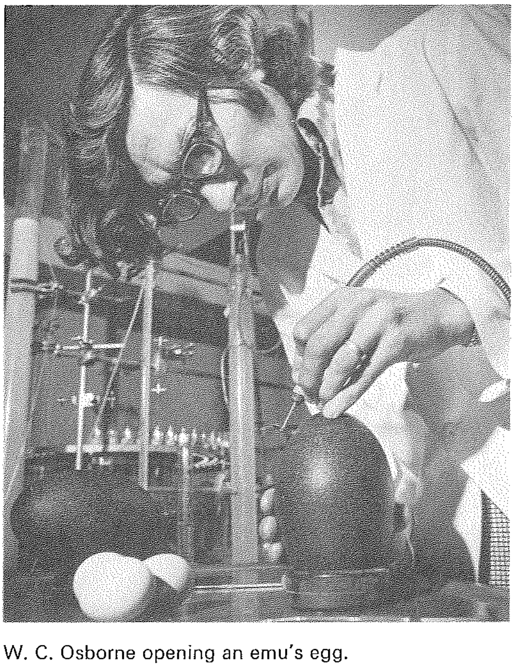
Smith and Joan Back developed a method for estimating the relative amount of S-ovalbumin in egg white, and, with advice from Shenstone, carried out experiments with stored eggs to explore the effects of different storage conditions on the change in stability of ovalbumin. The experiments were successful in identifying the factors affecting the conversion of ovalbumin to S-ovalbumin in the egg. These factors—time, temperature and pH—were later found to apply in exactly the same way with isolated ovalbumin in test-tube experiments. Thus conversion to the more stable form of ovalbumin was an intrinsic property of the protein. Moreover, it was a natural phenomenon, even in fertile eggs. But was it significant in the use of eggs as food? Some work at the Western Regional Laboratory of the United States Department of Agriculture had shown that addition of ovalbumin from fresh eggs to the white from stored eggs restored baking properties, although the change on storage had not been identified. The U.S.D.A. therefore supported further work on S-ovalbumin, by a PL480 grant made at the same time as the grant for cyclopropenoid research, but for a term of three years.

Although further research on the molecular events responsible for the change in stability was stimulated by the grant, and useful basic information on the structure of ovalbumin was thereby obtained, the molecular basis for the change could not be found, and still remains an unsolved problem. The effects of the conversion on domestic culinary properties was found to be slight, and measurement of the amount of S-ovalbumin in eggs was mainly of use in assessing biological 'age'. However, the investigation raised questions about protein stability which were of considerable interest in relation to inactivation of enzymes, destruction of bacteria on heat treatment, and processes occurring during cooking. This has led to current work on new techniques for measuring stability and to investigations on substances which reduce or enhance protein stability.

Yolk proteins and emu eggs

Research on the properties and structures of yolk proteins by Burley was in some ways an extension of his earlier fundamental studies with W. H. Cook at the laboratories of the National Research Council, Ottawa, although the stimulus to continue work on egg yolk came from an applied problem—the 'pink white, pasty yolk' defect of eggs from hens fed cyclopropenoid fatty acids.

Burley became interested in the abnormal properties of these yolks during the course of the U.S.D.A. research grant, and decided to compare the properties of isolated lipoproteins from normal and abnormal yolks. The main lipoprotein of yolk, the 'low-density-fraction' (L.D.F.), contains most of the yolk lipid and is a remarkable complex of 80% lipid and 20% protein, each component on its own being immiscible or insoluble in water, but together forming a water-soluble, stable compound. Burley found that the properties of L.D.F., particularly its response to cooling, were reflections of the properties of the yolk it was derived from. There were also differences in the protein component (the apoprotein) between L.D.F. preparations from normal and abnormal eggs, and this provided the incentive for a study of the composition and structure of L.D.F. apoproteins, which



W. C. Osborne opening an emu's egg.

at the time were completely uncharacterized.

The main difficulty in fractionating apoproteins (which were soon discovered to be mixtures of several different proteins) was their insolubility after removing the lipid. Even in the powerful solvents that had been used for dissolving denatured proteins, the apoprotein molecules were 'sticky', and tended to form small aggregates that made separation according to size difficult. The answer was found when Burley was presented with an emu's egg, and found that the mixture of apoproteins from its yolk was amenable to fractionation. Emus, unfortunately, lay only for a few weeks in winter, and to get enough fresh material for subsequent work entailed some frustrating delays. Success was achieved in 1973 when the major apoprotein from emu L.D.F. was obtained in a pure state, its properties were studied in detail and, with help from CSIRO Division of Protein Chemistry, the sequence of the 84 amino acid residues along its single chain was determined. For the first time a model of an apoprotein from egg yolk could be constructed, and theories of how it interacted with lipid could be tested by inspection.

With the experience gained from the work with emu's eggs, Burley returned to the hen's egg and refined the methods for protein fractionation, and also fractionated apoproteins from duck, turkey and goose eggs. The major apoprotein, named Apovitellenin I, from the five species, has now been purified and sequenced, while a second component, Apovitellenin II, has been obtained from the L.D.F. of hen and goose eggs.

Microbiology Section in 1954. Left to right: Betty Marshall, Doreen Page, Judith Waltho, Shirley Collett, Kate Smith, W. J. Scott, W. G. Murrell, J. H. B. Christian, D. F. Ohye, J. C. Anand.

Microbiology

Microbiology is the most essential discipline in food science, for several reasons. Food must be safe to eat, and in most instances this means that it must be free from pathogenic organisms; spoilage is most often caused by bacteria, yeasts and moulds; and many of the methods that must be used to preserve food from microbial growth (canning, bottling, drying, freezing) cause changes in acceptability that concern other food scientists.

W. J. Scott joined the Section of Food Preservation at Cannon Hill in 1933 as a biochemist. Vickery later remarked: 'I do not know why the position was so described, because we intended that he should work mainly in bacteriology; perhaps the CSIRO Executive of the day did not recognize microbiology as a valid scientific discipline' (Vickery 1972). Certainly Scott did far more in the pre-war investigations of the handling, cooling, and transport of chilled beef than might then have been expected of a bacteriologist, even though it was the extent of bacterial growth that spelt success or failure in the investigations.

Microbiology as a scientific discipline at Homebush received a setback during the war, when the main concern was to reduce the health hazards in foods supplied by Australia to the armed forces. This meant that the first stage of research—observation and development of methods of observation—was predominant, and questions and the testing of theories had to be deferred until the end of the war. We shall describe two of the more important programs of fundamental research which Scott initiated after the war, and which arose from earlier observations.

Water activity and microbial growth

Three of Scott's early papers described the effects of water content, temperature and carbon dioxide on the growth of microorganisms on ox muscle. Of these three variables, water content was the most difficult to control and its effects were the least consistent. The problems that faced Scott were in defining the aqueous environment of organisms growing on a solid surface, and in specifying the water requirements of different organisms. The first problem was extremely complex; it involved movement of water from the tissue to the surface, and loss of water from the surface, at rates which depended on air movement, humidity, temperature, and water content. The second problem had much wider significance in food microbiology, and could be, and was, tackled in a more systematic and quantitative fashion.

Scott realized that *water activity* (the ratio of the equilibrium vapour pressure of the aqueous medium to that of pure water) and not *water content* was the critical factor. Thus he showed that various strains of *Staphylococcus aureus* would grow in a variety of media ranging from dried milk and meat to nutrient broth, adjusted to a water activity of 0·86 to 0·88, but with water contents ranging from 16 to 375% of dry weight. He was helped in these experiments by D. F. Ohye and Betty Marshall (later Stewart). Later, with P. R. Maguire he showed that the rate of growth of moulds was determined almost entirely by the relative humidity rather than the water content of the media studied. J. H. B. Christian, who joined the Microbiology Section in 1951, worked with Scott on the relation between growth rates of *Salmonella* and water activity, controlled either by reducing water content or by adding a mixture of electrolytes or sucrose. Again it was found that growth was determined by water activity rather than by water content or by the concentration of nutrients.

In biological research it is usually safe to assume that fact is more complex than theory, so Scott did not regard water activity as the sole controlling factor. 'Although for organisms such as *S. aureus* the minimum a_w (water activity) levels for growth show a remarkable independence of the principal types of solute in the growth medium, this is not true for all organisms' (Scott 1957). Thus halophilic (salt-tolerant) bacteria studied by Christian had a special requirement for sodium chloride, and analysis showed that their intracellular environment was a concentrated solution of salts. From 1956, Christian and Judith Waltho (later Howard), who had joined DFP in 1954, worked on this complementary aspect of the water relations of microorganisms—the internal composition, physiology, and biochemical processes which achieved balance with the external environment.

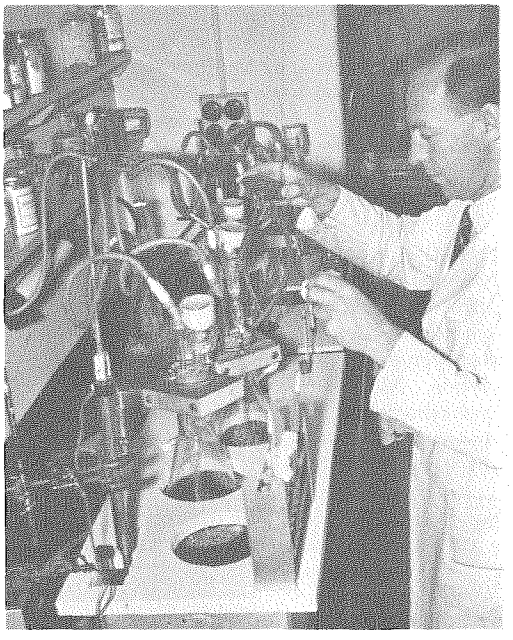
By the end of the 1960s a great deal of data had been collected and basic principles brought to light. The possibilities of growth in particular foodstuffs of most of the food spoilage organisms and of toxin-producing bacteria could now be predicted with some certainty.

Heat resistance of spores

Heating processes for canned foods are based on the requirements for killing bacterial spores, particularly the spores of *Clostridium botulinum*, whose toxin is one of the most lethal substances known. Whereas most vegetative bacteria are killed in boiling water, some spores may survive and germinate after exposure to temperatures of 120°C. The canning process that is necessary to ensure the complete absence of survivors in a can may also reduce the palatability of the contents to an unacceptable level. The problems were only too evident under wartime conditions of processing and storage, and empirical measures for improvement were rapidly exhausted. More basic information was needed on the factors that affect heat resistance, and on germination and substances that inhibit germination.

W. G. Murrell, who joined DFP in 1948, has been engaged for most of his time in seeking this information and in collating Australian and overseas work on spores. Since 1962 he has edited and published 'Spore Newsletter', with about five issues each year, which has served to keep scientists who work on spores all over the world aware of current research and has acted as a forum for the exchange of information.

In his early work on spores, Murrell examined the inhibition of germination by low concentrations of fatty acids, developed techniques for removing inhibitors by adsorption on starch and charcoal, and studied metabolic changes during germination. He also began studies of the chemical and physical properties of



W. G. Murrell preparing bacterial spores for study.

spores of different heat resistance. In 1955, electron micrographs of thin sections of spores, made at the Division of Industrial Chemistry, did not reveal a relationship between the thickness of the spore coat and heat resistance.

Murrell found that spores which have low heat resistance in dilute aqueous solutions and in most foods were much more resistant when in an environment of low water activity; moreover, differences in heat resistance became less under relatively dry conditions. These observations supported the hypothesis that heat resistance is associated with the maintenance of relatively dry conditions within the intact spore. It became more important to study the detailed structure of the spore at a high level of resolution.

During 1959, Ohye and Joan Bain received training in the use of the electron microscope at the Zoology Department, University of Sydney. This instrument was shared with the Division of Animal Genetics until DFP installed its own electron microscope at North Ryde in 1963. Ohye then began to record changes in the fine structure of spores during formation, maturation and germination. While A. D. Warth (appointed in 1959) worked with Murrell on the chemical composition of spores of different heat resistance and of fractions prepared from disintegrated spores, Ohye identified the fractions by electron microscopy. The resistance of these fractions to chemical and enzymic treatment led to the chemical identification of the cortex as a peptidoglycan polymer, the origin of the 'spore peptides' exuded during germination.

These lines of research continued during the 1960s; in 1966 Christian, then leader of the Microbiology Section, reported to the Committee of Review that 'Good progress has been made in defining the stages in spore formation, the structure of the spore and its chemical composition, and certain relationships have been established between these and heat resistance'. Even now, 10 years later, the heat resistance of bacterial spores cannot be completely explained in physical terms, but their central importance in causing food spoilage makes it imperative to maintain a continuing attack on the problem.

Other activities

Apart from the two major areas of research that we have described, there were many other aspects of food microbiology that were investigated in the 1950s and 1960s. Several investigations were directed at *Clostridium botulinum*; the effects of temperature and water activity on the growth of the common types A and B were studied by Scott, Christian and Ohye; and the ecology and water relations of type E, which was of special interest because of its ability to grow at lower temperatures than other food-poisoning bacteria, were investigated by Christian, Ohye and Betty Marshall. For five years from 1953, Scott, R. D. H. Leach, Ohye and Marshall carried out numerous experiments on the drying, storage and rehydration of bacteria, which provided information on the factors affecting the death of microorganisms in the dry state and led to improved techniques for preserving their collection of microbial cultures. Judith Waltho made a special study from 1965 of psychrophilism—the ability to grow at low temperatures—which led to her single-handed involvement in the complex field of bacterial genetics. Work on yeasts and moulds was revitalized by the investigations of J. I. Pitt, whose early interest in mycology arose from his work with McBean in the Dried Foods Section. While continuing research on mycotoxins and water relations of fungi, Pitt has recently tackled a complete new monograph on the classification of the genus *Penicillium*.

Canning and fruit products

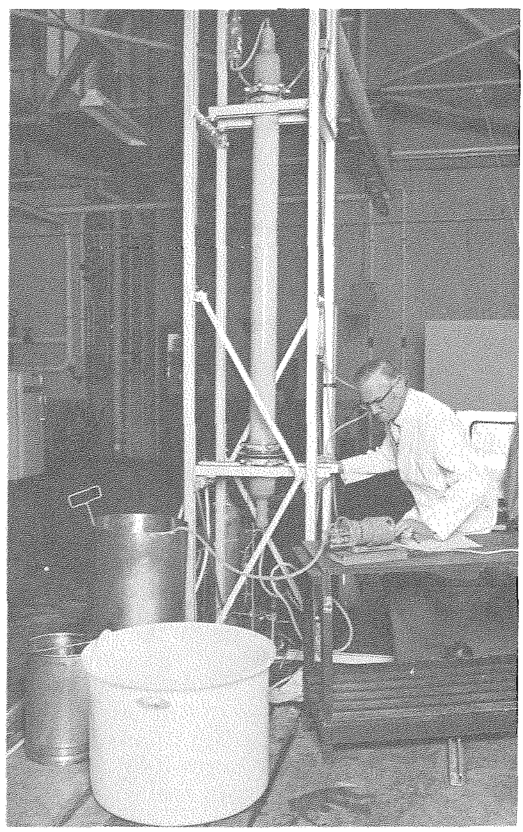
A unique event in the history of DFP that demonstrated the continuing growth of the Division about that time, was when five new research scientists started on the same day early in 1950. The appointees to the Canning Section, E. G. Davis and P. W. Board, remained in the Division but the three appointed to other sections stayed only briefly. Davis worked on problems arising from the introduction into the Australian canning industry of electrolytic tinplate and epoxide can lacquers with superior protective properties. Board's initial role was to study the influence of variety and maturity of fruits and vegetables on canning quality. These studies were carried out in close association with the N.S.W. Department of Agriculture and the food industry, and were formalized through a Fruit and Vegetable Processing Committee which met regularly through the years 1952 to 1965.

The Canning Section, with six research scientists and their supporting staff, was now the largest at Homebush and indicated the determination with which its leader, L. J. Lynch, pressed his claims.

Maturity of peas

In the early 1950s Lynch and R. S. Mitchell were embarking on a project that was to occupy them for 20 years—the assessment and prediction of optimum quality in green peas. Field work on this project in the pea-growing areas of northern Tasmania involved an annual pilgrimage across Bass Strait by CSIRO staff and vehicles carrying equipment. The practical outcome of the project was the Maturometer, a simple but eminently practical instrument that measured the maturity of peas in terms of hardness. It enabled processors to harvest a crop with a maximum yield of best quality peas, and all Australian users agree that the results of this investigation were of great economic value to them. Commercial production of Maturometers was only possible through the keenness and support of E. F. Edwards, a food engineer who had long been a friend to the Division, and Frank Dickson, a former laboratory assistant who had set up a successful engineering business.

The Lynch–Mitchell association had started in the 1930s when they were students in agricultural science at the University of Queensland. At the age of 30, Lynch was then making a courageous change of career from pharmacy to agricultural science. Mitchell, who favoured mathematics, statistics and practical engineering, was as retiring as Lynch, who preferred chemistry and biology, was extrovert. They made a most unlikely pair of collaborators but it is certain that neither could have achieved what he did without the other.



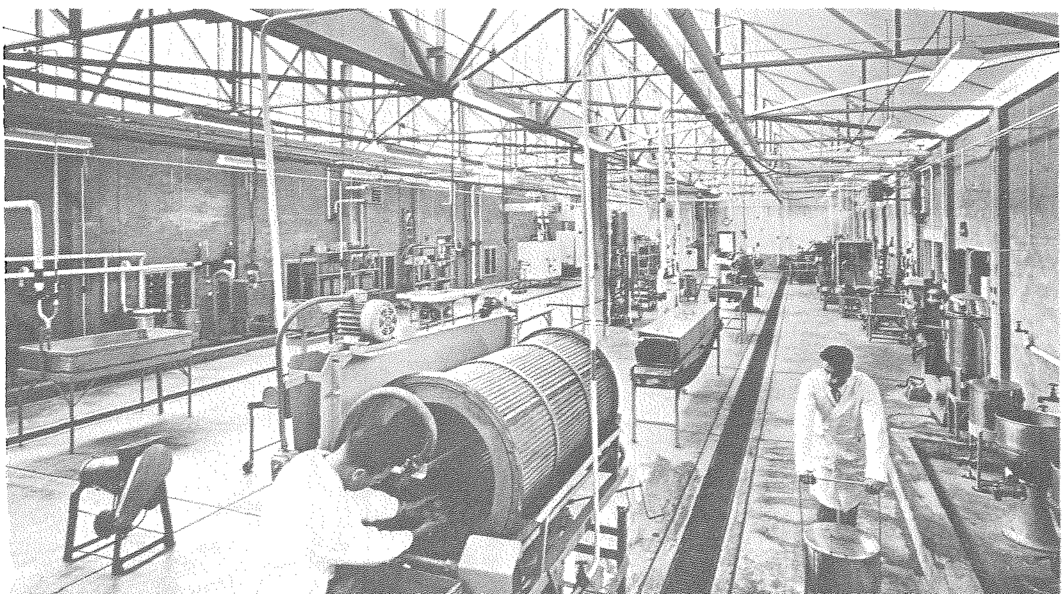
B. V. Chandler operating prototype equipment for debittering citrus juices using gel beads of cellulose acetate.

A bitter blow

Kefford and Chandler continued to work on the chemistry and technology of citrus fruits. They showed that the degree of bitterness in navel orange juice, due to the presence of limonin, depended on cultivar, maturity, and especially on the rootstock on which navel orange trees were grown. Chandler studied the structure of limonin, working in the Department of Organic Chemistry at the University of Sydney. He postulated a structure which, soon afterwards, was shown to be about half right. This was no disgrace because elucidation of the correct structure was only attained by the collaborative efforts of four of the world's leading research teams with 19 coworkers. Chandler was disappointed by this but he went on to develop the first analytical procedure for limonin and, aided by R. L. Johnson, he later devised a patentable process to remove limonin from orange juice by selective absorption on cellulose acetate beads. Although Bruce Chandler has concentrated for 30 years on a relatively narrow field, he rejects any charge that it has limited his research interests. The many disciplines he has used have stimulated his interest in natural products in other fruits and vegetables and in honey, and as he says 'effected his conversion from an organic chemist to a food scientist'.

Serving industry

In the early 1950s, there was a feeling within the CSIRO Executive that much of the work in canning that was being undertaken by CSIRO should be done by the canning industry, possibly by the setting up of a research institute. It was even suggested that dissolution of the Canning Section would help to solve most of the chronic financial shortages of the Division. Vickery was forced to justify the work not only of this section but of all the others as well and he managed to keep his Division intact. These financial constraints, however, encouraged the Division to appeal directly to the food industry for donations, which were used to create a Food Industries Equipment Fund to be used to purchase items of equipment necessary for current programs but not accessible from Treasury funds. Lynch and Kefford were in the vanguard of this highly successful foray for industry support. Contributions were first sought on a wide front in 1956, and by 1963 donations totalled \$66 000; for a few years after this they consistently topped \$20 000 annually but thereafter the need



General view of the processing area at North Ryde in November 1962.

Table 1. Main contributions ($) from outside sources to the annual budgets of the Division of Food Preservation and the Section of Dairy Research, 1946/47 to 1960/61[A]

Contributors	1946/47	1947/48	1948/49	1949/50	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56	1956/57	1957/58	1958/59	1959/60	1960/61
Australian Meat Board, Metropolitan Meat Industry Board, Queensland Meat Industry Board	3450	3450	3450	3450	3450	4950	4950	4550	4550	4550	4038	5035	4312	5022	12 444
Australian Dairy Produce Board	—	—	—	2000	1500	—	—	—	8600	5028	16 600	6700	—	2428	816
Australian Dairy Produce Trust Account	—	—	—	—	—	—	—	—	—	—	—	—	—	268 660	101 930
Commonwealth Department of Commerce and Agriculture (now Primary Industry)	4402	1620	—	—	—	—	3200	11 752	14 972	28 898	4714	4278	6504	7188	6778
Miscellaneous	386	694	492	1070	1070	3900	5700	24 430[B]	2325	4160	23 890	20 354	22 640	5786	13 534
N.S.W. Department of Agriculture	1600	2000	2300	2584	3000	3230	3840	3640	4050	2910	4072	4158	3548	3630	5128
Rural Credits Development Fund	4800	4800	4800	3600	2400	—	—	—	—	—	—	—	—	—	—

[A] From *CSIR/CSIRO Annual Reports* and Divisional (Sectional) Records.

[B] Includes $20 000 contributed by the Dairy Industry towards building the Dairy Research Laboratory at Highett.

Table 2. Main contributions ($) from outside sources to the annual budgets of the Division of Food Preservation (Food Research after 1970) and the Division of Dairy Research, 1961/62 to 1975/76[A]

Contributors	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76
Australian Meat Board, Metropolitan Meat Industry Board, Queensland Meat Industry Board	4588	4614	4684	2064	2390	9295	15 300	897	384	—	—	984	863	1000	—
Australian Apple and Pear Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	10 000	20 000
Australian Dairy Produce Trust Account	150 822	83 348	116 102	141 502	149 379	165 802	175 789	172 064	190 875	205 100	215 492	192 532	198 164	236 230	221 241
Australian Meat Research Trust Account (Cattle and Beef Research Trust Account, 1963–65)	—	—	15 216	24 544	62 690	580 254	159 594	647 920	405 000	405 000	547 302	540 100	598 973	583 724	405 000
Commonwealth Department of Primary Industry	8542	8088	10 172	7600	8000	6607	9741	4487	7013	8676	13 606	10 434	10 625	19 750	30 005
Dalgety Agrilines	—	—	—	—	—	—	—	—	—	—	—	56 000	70 219	71 940	8536
Dried Fruits Research Committee	800	388	168	864	—	—	—	—	—	—	6910	6800	7900	10 700	11 500
Fishing Industry Research Committee	—	—	—	—	—	—	—	—	—	—	17 721	25 000	10 700	33 271	63 540
Miscellaneous	29 508	28 910	57 026	55 846	50 874	46 091	45 738	263 289[B]	113 276	70 725	11 498	41 956	105 269	56 260	n.a.
N.S.W. Department of Agriculture	4548	4292	7152	9262	8291	10 296	9600	10 505	11 397	11 459	11 352	11 954	112 761[C]	21 128	25 123
Poultry Research Advisory Committee	—	—	—	—	—	—	—	—	—	—	—	6000	5525	6568	—
Whey Products Australia Ltd	—	—	—	—	—	—	—	—	—	—	—	—	5623	18 715	17 612

[A] From *CSIRO Annual Reports* and Divisional Records.

[B] Includes $112 500 contributed by the meat industry towards building a new Meat Research Laboratory at Cannon Hill, and $100 000 contributed by the Dairy Industry to extend the Dairy Research Laboratory at Highett.

[C] N.S.W. Department of Agriculture acted as banker for contributions from the Commonwealth and all State Governments to build the Fresh Fruit Disinfestation Laboratory at Gosford.

diminished as Treasury funds were more liberally provided. Many pieces of processing and laboratory equipment throughout the Division carry a small plaque indicating that they were purchased from funds contributed by the food industry; (see Tables 1 and 2).

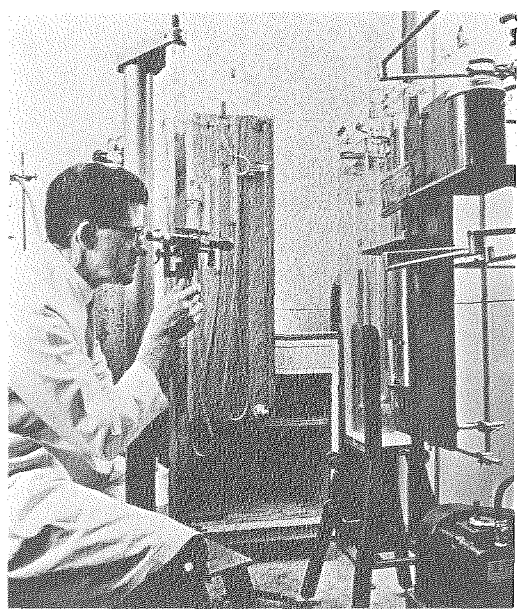
The close contact that Lynch maintained with the food industry provided many benefits to the Division: commercial processing lines were made available for trial runs; crops were freely sampled for maturity studies; materials of all kinds were willingly donated. The *quid pro quo* was advice and assistance on a wide range of subjects by Divisional staff at a time when the industry was still building up its technical strength and when there were few competent consultants. When an American food company planned to start production of a new line of foods through an Australian processor and could not find a consultant to supervise quality control, it was arranged that Lynch and Kefford would carry out regular plant inspections and tasting tests. This indicated the high regard in which the Canning Section was held and it also stressed the liberal attitude of Vickery in allowing his staff to provide this unusual service to the industry.

Change in direction

Early in 1959 Hicks and Scott reviewed the program of the Canning Section at Vickery's request. It was an appropriate time to do this as the move to North Ryde was near, much of the earlier 'horticultural' work had been successfully completed and there was a trend throughout the Division toward more basic studies. Most of the reviewers' suggestions were implemented by Vickery and so an important change in direction occurred for the Section. Emphasis was to be directed to some attributes of food quality such as texture and colour. Kefford, Chandler and Harper were to study the role of anthocyanins, leuco-anthocyanidins and flavonoids in some of the colour changes which were known to occur in processed foods. As a logical extension of their earlier maturity studies, Lynch and Mitchell planned to investigate aspects of food texture, especially means of measuring it objectively. Davis, having spent a study year at the Massachusetts Institute of Technology, switched from metal container research to the rapidly expanding area of packaging in flexible film. Board took up a study of the electrochemistry of tinplate corrosion. He was also, by now, involved with the Physics Section in the calculation of safe processes for canned foods, and on Hicks's death late in 1959, he became the principal worker in the Division on process evaluation. Initially he received support from N. D. Cowell and H. L. Evans in the Physics Section but Cowell was soon on his way back to England and Evans, after becoming engrossed in the mathematical treatment of heat and mass transfer in boundary layers, also returned to the U.K. in 1962. Lynch welcomed the review decisions because, years before, he had disagreed with a proposal by Vickery that technological sections should transfer the more basic problems which they unearthed to the 'purer' sections.

Food packaging

The packaging of foods in plastic containers presents problems that do not occur with metal containers which can be made truly airtight and moisture tight. Davis built up equipment and developed methods for testing the permeability of flexible films to water vapour, oxygen and



E. G. Davis using a cathetometer while determining the absorption of SO_2 by plastic film used for the packaging of foods.

carbon dioxide. With the help of such data, the films most appropriate for packaging specific foods could be selected. For these tests and the many storage trials that were an integral part of the program, Davis found an able and reliable assistant in Phyllis Moy who has worked in the Division since 1951. From the beginning, Davis established close contacts with the flexible packaging industry, and many companies relied heavily on the Division for information and advice. This liaison work, with its many *ad hoc* problems, reached major proportions and Davis was forced to encourage the industry to solve some of its own problems. With the object of increasing the technical strength of the packaging industry, he played an important role in the establishment of an Australian Institute of Packaging and a tertiary-level course in packaging at Sydney Technical College.

It was now possible for Davis to undertake some basic studies on flexible films related to the roles that solution and diffusion play in overall permeability, and to changes in the physical structure of polymers in the presence of sulphur dioxide. This gas is able to penetrate films such as polyethylene more rapidly than oxygen or carbon dioxide, but few investigations had been reported even though it is widely used as a food additive. In addition to providing new knowledge, Davis's work revealed the best packaging materials for dried fruits and indicated how oxidation could be greatly reduced in that unique Australian retail container, the plastic wine cask.

In 1968 M. L. Rooney joined Davis and assisted in the permeability studies. Later he attempted to modify natural polymers like starch and cellulose with the aim of finding new films that were biodegradable—and even edible—as well as having the needed barrier properties. Starch palmitates were the most promising new products but little commercial interest was shown in them.

Food engineering

L. J. Lynch and other officers of the Division who were involved with food processing studies, proposed in 1955 that a case for the establishment of a full-scale food engineering program should be presented to the Committee of Review, which was then considering the future of the Division. Vickery acknowledged the need for such a program but was wary that, if established, it might become an insatiable drain on the finances of the Division. Consequently among his written submissions to the Committee he said 'No new kinds of investigations are planned for the next 5–7 years, although consideration must soon be given to the question of engaging in engineering studies of the design and performance of food processing machinery.'

Lynch again advocated a major food engineering program for the DFP in 1959 when Hicks and Scott were reviewing the Canning Section. Once more he did not win approval for his scheme, but on this occasion, Vickery was prepared to permit what he called 'food processing equipment studies'. These included certain investigations with an engineering component such as spin-cooking of canned foods and fruit juice concentration. This presented an opening for Don Casimir, who had joined CSIRO in 1957, to start a series of projects and for the Division to acquire a wider range of food handling equipment. A pilot-scale belt-trough dryer was built from plans obtained from the U.S. Department of Agriculture and a machine for shelling peas on a commercial scale was devised and built.

The 1967 Committee of Review also recognized a need for food engineering research in Australia and proposed that 'a small engineering research group should be established at North Ryde within the next two or three years. Initially this group might comprise two research scientists (engineers) and about six auxiliary staff and be located within the Food Technology Section.' The Committee saw food engineering in terms of 'the development of processes and the design, operation and control of equipment' and it stressed that the Division should steer clear of agricultural engineering and particularly of harvesting machinery. The Committee considered engineering to be important because it said that, in due course, it might be appropriate to re-name the DFP as 'the Division of Food Preservation (or Science) and Engineering'. In fact, however, the Division has never fully implemented the recommendations of the Review Committee. Admittedly there are now two engineers, Casimir in Food Technology and Sharp in the Physics Section, but they have operated independently and have never been supported by sufficient auxiliary staff.

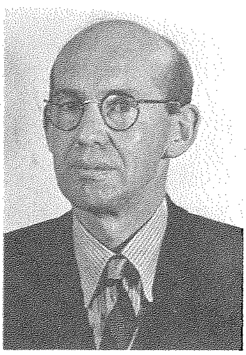
Flame sterilization

By 1960 workers in the Canning Section were well versed in the accelerated processing of canned liquid foods by spinning the can during heating in steam. A process for sterilization of canned foods by rotation directly in a gas flame was first announced in 1961 in France, and the equipment, called Steriflamme, was used for the sterilization of milk, and subsequently for other foods especially green peas and mushrooms. Casimir demonstrated that sterilization times could be reduced still further if cans were rotated, first in one and then in the opposite direction, while they were being heated. Reversal of rotation was achieved by means of a reciprocating shuttle bar that had been devised by a collaborator who was interested in the new procedure. Using single-can equipment, Casimir also showed the importance of the spatial relationship between can and flame for efficient heat transfer, and with $25 000 from the CSIRO Development Fund a pilot-scale unit was built at North Ryde. Noel Huntington, an experienced fitter and turner, transferred from the central workshops to help in the day-to-day engineering problems associated with the construction of the unit. Tests with this first continuous flame sterilizer which incorporated reciprocating rotation, showed that the rate of heating in the unit was six to ten times more rapid than that in the French Steriflamme, owing to greater agitation, and that for the same reason, it could handle a far wider range of products, even viscous foods like milk custards, cream, rice pudding, spaghetti or baked beans in sauce.

Widespread local interest in flame sterilization was demonstrated by an attendance of 40 representatives of the Australian canning industry at a Specialist Course organized by CSIRO in 1973; subsequently 350 requests were made for copies of the proceedings of this Course. In spite of this interest and of the advantages of low labour costs and high thermal efficiency of flame sterilizers, the industry has been slow to adopt the process. Only two small-scale units are in commercial operation in Australia today. This raises the question of how far CSIRO should go towards ensuring that inventions of its officers reach commercial implementation. The experience of DDR with its dairy machinery, particularly the Cheesemakers (Part 2, p. 100), suggests that close collaboration with the right engineering firm during the development of the equipment may provide a possible answer to the problem.

Freezing and drying

At Homebush, the Frozen Foods Section and the Dried Foods Section shared pilot-scale processing equipment as well as the area in which it was housed and they often worked on the same raw materials. In spite of these common interests they remained separate but, as will emerge, some important interchanges of personnel occurred between the sections.



F. E. Huelin in 1952.

W. J. Scott in 1950.

T. M. Reynolds in 1947.

E. W. Hicks in 1955.

Frozen foods

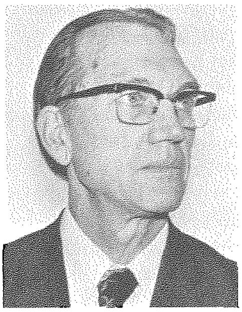
The Frozen Foods Section was started in 1947 as a joint venture between CSIRO and the N.S.W. Department of Agriculture. S. M. Sykes, who had been working at the Division specifically on the storage of dried vegetables, transferred to the Department of Agriculture as leader of the new section. He immediately set out for the United States where he spent seven months on an intensive study of the rapidly expanding quick-freezing industry.

On his return to Australia, Sykes found only one company freezing vegetables and few shops fitted out to sell frozen foods. Thus, education of grower, processor, cold store operator, distributor, retailer and even the customer was needed in this fledgling industry. The Division has played a role, of varying extent, in all of these areas but, at the beginning, most efforts were directed to the grower-processor end of the chain. Data were gathered on the varietal suitability and optimum maturity for freezing of a wide range of fruits and vegetables; these included freestone peaches, apricots, apples, berry fruits (with the Hobart laboratory), tropical fruits, peas, beans, sweet corn, broccoli, mushrooms, capsicums and cauliflower. Processing variables were investigated, methods of freezing were evaluated, and packaging, storage and quality of the frozen products were studied.

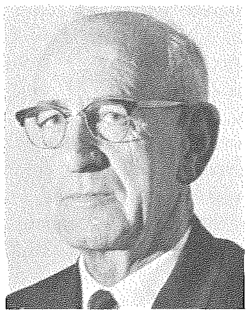
In 1957 Sykes returned to CSIRO to become leader of the Divisional group at the CSIRO Tasmanian Regional Laboratory at Hobart. The N.S.W. Department of Agriculture, after long and careful consideration, decided to withdraw from this research program and Jack Shipton, returning from a long period of secondment to the Department of Commerce and Agriculture, assumed leadership of the Frozen Foods Section in 1958.

Like the Canning Section, the Frozen Foods group found, by this time, that it had covered the 'horticultural' work exhaustively and a major change of direction toward chemical and biochemical aspects of frozen foods was made. Enzymic studies showed that many frozen vegetables were overblanched, and also suggested that lipoxidase activity might be responsible for a hay-like off-flavour which was common in frozen peas subjected to delay between harvesting and processing. Shipton was aided by J. Last, G. C. Walker (1961–1964) and from 1964 by F. B. Whitfield, an organic chemist with experience in the natural products field. He came from the University of N.S.W. where he had been working on the toxic principles of the red bull-ant. Frank Whitfield soon isolated and identified a large number of carbonyl compounds from peas that had the hay-like off-flavour but an explanation for its development remained hidden. In 1968, soon after his appointment as Chief, M. V. Tracey merged the frozen food group with another, led by K. E. Murray, which had built up a sophisticated array of equipment including a mass spectrometer.

Inquiries on frozen foods continued to be directed to the Division after the break-up of the Section and most of these were handled by John Last. In the 1970s, surveys of temperatures in frozen foods during distribution and in cabinets in which they are displayed in retail outlets were made by J. Middlehurst and



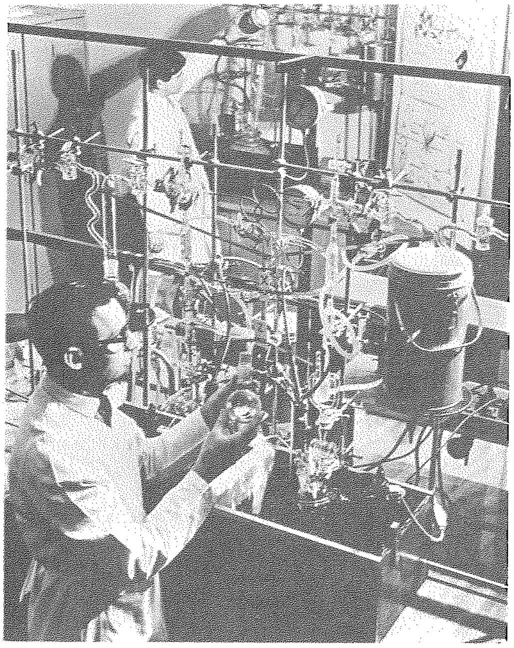
E. G. Hall.



L. J. Lynch.

A. Howard, Officer-in-Charge of MRL for many years.

D. J. Walker, Officer-in-Charge, MRL.



F. B. Whitfield isolating carbonyl compounds from frozen peas.

A. K. Sharp, who have produced useful recommendations to the industry and to the consumer.

Dried foods

Just as the transfer of Howard to Cannon Hill in 1948 left only Prater to continue the research program on dried meat, so the secondment of Jack Shipton to the Department of Commerce and Agriculture in 1952 left McBean as the only research scientist working on the drying of fruits and vegetables. The meat work was concluded in 1961 when the Division shifted to North Ryde and Prater was appointed co-leader of a group to work on animal products.

Dried meat. Meat drying operations were transferred, in the late 1940s, to a meatworks owned by F. J. Walker Ltd at Auburn, a few kilometres from Homebush. This arrangement, which cost the Division little in rental, helped to ease the housing pressures which were ever-present at Homebush. The program received extensive financial support through the Defence Foodstuffs Research Committee, particularly during the years when Shipton was its Chief Food Technologist. The long-standing aim, which was to produce good-quality dried meat with a long shelf-life, was achieved with beef, mutton and pork in the form of mince and slices. The scope of the project was also widened to evaluate the effects of age, breed, sex, and grade of animal, processing techniques and packaging methods on quality and storage life. Data were also collected on the influence of drying factors on the rate of water removal from meat. Although this work had mainly defence implications, there was always the faint hope that some Australian company would produce and market dried meat but, like so many other carefully researched technological advances in this and other countries, this hope was never fulfilled.

Dried fruits and vegetables. Work on dried vegetables in the Division gradually fell in volume to a low and intermittent level. The extent of activity was defined by requests for assistance from the industry; these became less frequent as overseas-based companies such as Kraft and Unilever, who had their own research and development departments, became the principal producers. Like the other processing sections, studies were made on the raw materials, processing variables and storage of the dried products, the latter being most important with dried foods because they are subject to browning, a defect which is negligible in canned and frozen foods. Most investigations were done on peas, beans, onions, sweet corn, capsicums, mushrooms and potatoes.

Research on dried tree fruits—apricots, peaches, pears and prunes—expanded as the dried vegetable program declined. Excellent dried cut fruits were prepared with the aid of mechanical dehydrators but growers kept to their conventional but more economical sun-drying methods. Much of the field work was done in South Australia in collaboration with the S.A. Department of Agriculture. Early recollections of this work include long, hot and dusty bus rides through rabbit-infested sandy wastes to reach the irrigated areas where fruits were grown. Once there, McBean hired a bicycle (10 shillings per week) to commute to nearby orchards. Temperatures sometimes reached 45°C (113°F) with 60 k.p.h. northerly winds—ideal for drying but exhausting for a bike-rider.

Research into dried fruits has always

been coordinated through the Dried Fruits Processing Committee which was first convened in 1929 by the then CSIR to consider the question of the sulphuring of dried stone fruits, particularly apricots. The Committee still operates effectively but across a wide range of fruit drying programs; it includes members of CSIRO (Food Research and Horticultural Research), Agriculture Departments in New South Wales, Victoria and South Australia, and the Department of Primary Industry. A short history of this Committee by W. R. Jewell, a foundation member and past chairman, appeared in the *Food Preservation Quarterly* in June 1960.

Lack of uniformity in levels of sulphur dioxide in dried fruits led McBean in the late 1950s to investigate the influence of the many possible variables on the uptake of sulphur dioxide gas by fruit tissue and its retention during the drying procedure. By now it was necessary to transport laboratory and pilot-scale equipment to South Australia and regular mid-summer pilgrimages of 1200 km were made from Homebush in truck or van. The Australian Dried Fruits Association assisted the program financially and helped to convey research results to the hundreds of growers by arranging lectures and demonstrations, and by distributing practical pamphlets prepared at DFP.

In contrast to the sun-drying of stone fruits in South Australia, prunes have been dried in mechanical dehydrators since the 1940s and principally in N.S.W. After testing more efficient U.S. methods of drying, McBean recommended their introduction in Australia; implementation was aided by the fortunate visit to Australia about that time of Professor M. W. Miller of the University of California, Davis. In addition, means were developed for determining and predicting the optimum maturity of prunes for drying, and methods were devised for the safe packaging in plastic pouches of high-moisture fruit. The ailing industry, which was having difficulty in selling prunes in large cans through the new-fangled supermarkets, was revitalized when converted to the use of plastic pouches. Microbial studies during this work enabled John Pitt, a technical assistant who joined the Division in 1954, to obtain a Master's degree at the University of N.S.W. He later joined Miller at Davis, gained a Ph.D. and returned to the Division as a mycologist.

Phyllis Moy and D. McG. McBean preparing onions for drying trials.

In recent years the following studies have been made: the use of sorbic acid to control mould on high-moisture dried fruits, the roller-drying of a wide range of fruit and vegetable purées, and the chemical and physical nature of the waxy coatings on prunes and grapes, in the hope that water vapour transmission—and thus their ease of drying—could be increased. DFP has not been directly involved in research on dried vine fruits; within CSIRO that subject has been the province of staff at the Merbein Research Station (Division of Horticultural Research) near Mildura.

Other drying problems were successfully tackled by a Norwegian chemical engineer, Ole Mykelstad (1962–67) within the Physics Section. These included:

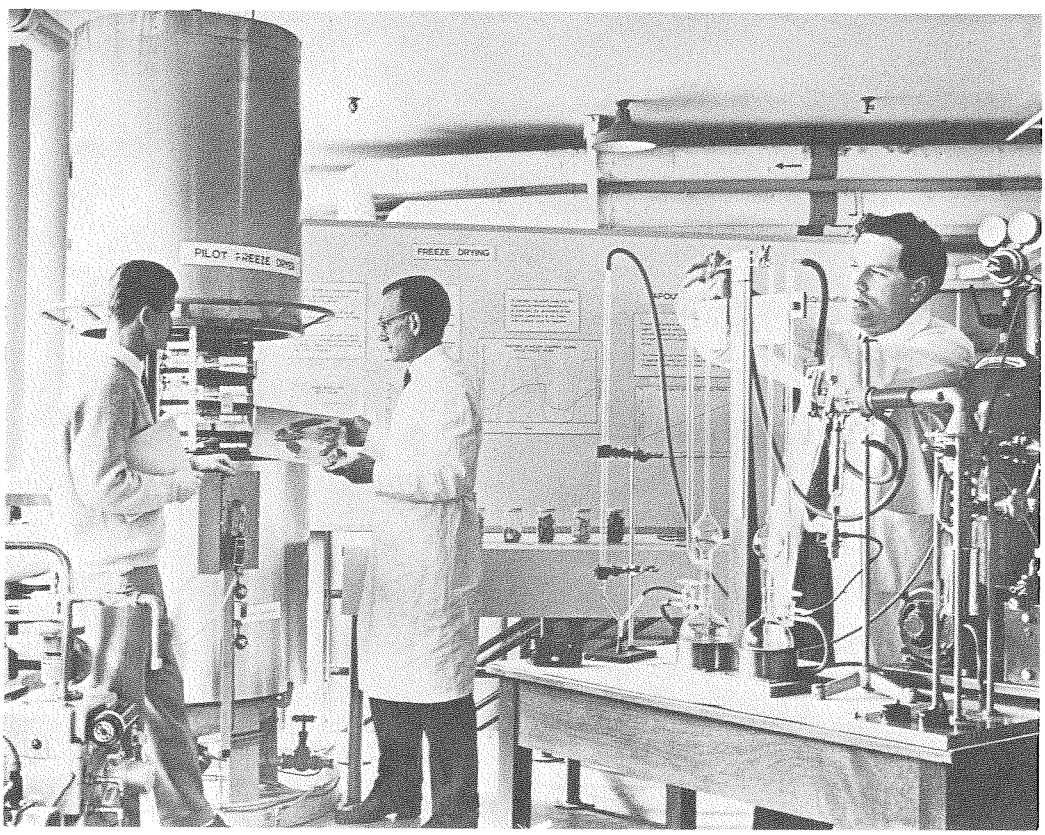
conversion of a rotary whalemeat dryer from Tangalooma Whaling Station to dry ginger roots at Buderim, bulk drying of peanuts at Kingaroy, and automatic aeration of rice in silos so that drying occurred during the hot part of the day and moisture equilibration took place in the cooler part. Mrs Wally Szulmayer collected data on the utilization of solar energy in the drying of sultanas and apricots, but the results did not indicate a simple cheap procedure by which existing drying efficiency could be improved.

Freeze drying

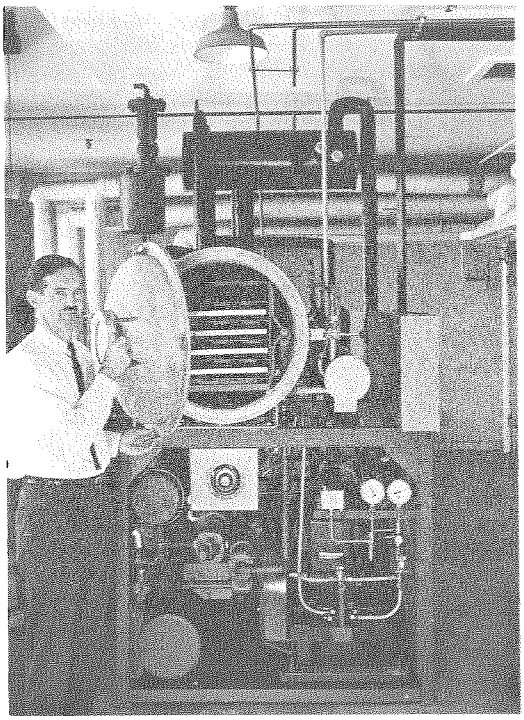
A letter to Vickery in November 1945, in which Kidd said that Ede at LTRS Cambridge was successfully freeze-drying peas, was the stimulus for a program which went on intermittently at DFP for 30 years. In 1947, Rostos acquired the Division's first freeze-dryer, a superseded model from the Red Cross Blood Transfusion Service where it had been used to dry blood plasma in bottles. It was converted to a tray dryer for food products and operated successfully for many years.

In the early 1950s, a small unit was built by J. D. Mellor to freeze-dry fruit purées for studies on non-enzymic browning, and an ampoule dryer was constructed in the late 1950s to handle small suspensions of microorganisms. In the latter equipment, it was possible to dry samples as small as $0 \cdot 2$ ml to pre-defined moisture levels and with a temperature variation of only $\pm 0 \cdot 75°C$ in a sample during drying.

After Hicks's death in 1959, Mellor continued to collect data on heat transfer and vapour phase conditions during freeze-drying, in efforts to attain the most rapid rate of water removal without an accompanying rise in surface temperature of the product. It was during a test run in this program that one of those useful errors occurred which seem to crop up



D. A. Lovett (MRL), E. G. Hall and N. S. Parker at a freeze-drying display at an open day in 1966.



J. D. Mellor with an experimental cyclic-pressure freeze dryer.

persistently in scientific endeavour. When Joan Hayhurst, a technical assistant, was called to the telephone, pressure in a freeze-dryer that she was monitoring rose above the set level. On her return she observed an unexpected increase in drying rate which coincided with the slightly elevated pressure. When this result was found to be repeatable, the concept of cyclic pressure freeze-drying was born. By controlled cycling of the pressure during a drying trial, increases of 25–30% in drying rates were possible compared with tests at a constant pressure. In 1967–68 $80 000 was granted from the CSIRO Development Fund to build a cyclic pressure freeze-dryer using helium as the heat transfer medium, a safer gas than hydrogen which would have given the highest attainable rates of heat transfer. With helium, increases in drying rates were obtained close to the computed theoretical 47–48% as compared with air.

Commercial implementation of cyclic freeze-drying has been disappointing. An Australian company, James Budge & Co., was given exclusive rights to the CSIRO patents and put much effort into the manufacture of cyclic freeze-dryers but they sold only a few small units. The largest was purchased early in the 1970s by the Armed Forces Food Research Establishment at Scottsdale, Tasmania. It has a drying chamber of 11 m^3 and a capacity of 1 t of fresh food in 24 h. In spite of improved techniques, freeze-drying remains expensive and, outside of military usage, is restricted commercially to a few special items including coffee and sea foods.

Lynch retires

L. J. Lynch retired in 1965. Many descriptive terms have been applied to him but the most appropriate is probably ebullient. He often used a show of belligerence which was recognized as a facade by those who knew him. It nonplussed people at all levels and he probably used it in assessing individuals and, one suspects, sometimes as a defence mechanism of his own. Undoubtedly a complex character, Laurie Lynch played a distinguished role in the development of the canning industry in Australia. From the beginning, the Division had established good relations with that area of the food industry of which cold storage was an integral part, namely meat and fresh fruit storage; but it was Lynch who brought the Division into close contact with a major part of the food manufacturing industry in Australia.

After his retirement from CSIRO, Lynch, still full of energy, brought his scientific career to a close by accepting two assignments with the Food and Agriculture Organization of the United Nations, the first in Western Samoa and the second, for three years in Brazil.

Within a short time of Lynch's retirement, canning, freezing and drying investigations were consolidated in the Food Technology Section under the leadership of Jack Kefford. Lynch had proposed just such an amalgamation on a number of earlier occasions but Vickery would not agree. In 1971, when Kefford was appointed Officer-in-Charge of FRL at North Ryde, P. W. Board assumed leadership of the Food Technology Section.

Flavour chemistry

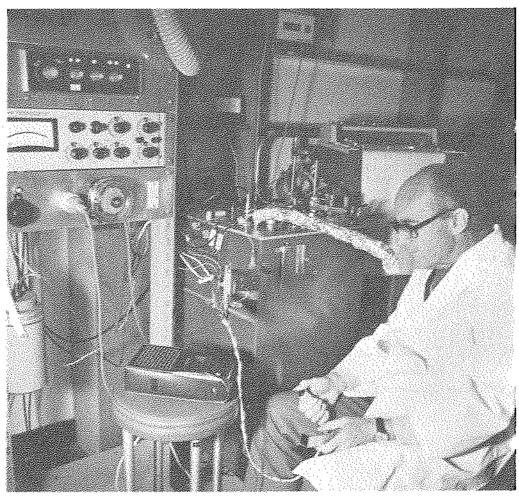
In the latter half of the 1950s, two lines of research on flavour chemistry were under way at DFP. Both arose because of off-flavours in processed foods; Macfarlane began to investigate off-flavours in irradiated foods and Shipton the hay-like off-flavour which was common in frozen peas. Macfarlane, like Forss at DDR, quickly realized the important roles that new techniques such as gas-liquid chromatography (g.l.c.) might play in separating and helping to identify volatile flavour components.

In a memorandum to the staff late in 1959, Vickery announced that, because of the general interest in flavour chemistry in the Division, a Physical Methods Group would be established under the direction of F. E. Huelin, to explore and perfect techniques for the study of food flavours. The main responsibility for research into flavour chemistry shifted to Keith Murray when he transferred from the Division of Industrial Chemistry to DFP in May 1961. Murray was dismayed by the lack of equipment at North Ryde; there was only one gas–liquid chromatograph in the laboratory and that—one of the first in New South Wales—had been built by Bruce Kennett five years before. Progress in flavour chemistry from such a base was slow and Murray made a number of excursions into other research fields (which are described elsewhere) while he continued to tool up for flavour research and to collect a team. Murray became increasingly convinced that the main identifying tool required for flavour chemistry was a high-resolution gas-liquid chromatograph coupled to a mass spectrometer (m.s.), and an Atlas CH4 fast-scanning m.s. was installed in 1964. This view was also in line with that of Forss at DDR.

In studying flavour, significant compounds may occur at concentrations as low as 1 in 10^{12} which is about one thousand times less than the level of gold in seawater. In addition, trace amounts of an important flavour component might be quantitatively overshadowed by several hundred other compounds that are unimportant as flavouring agents. In order to handle such minute quantities, existing equipment had to be pushed far beyond the limits for which it had been originally designed.

It was 1966 before Murray was ready to undertake worth while flavour studies at North Ryde. By this time research into off-flavours in irradiated foods had ceased, but Shipton, aided by F. B. Whitfield since 1964, continued with work on the off-flavour in processed peas. In Murray's view this delayed entry into the field saved the Division from most of the pitfalls experienced by many overseas workers whose over-fascination with novel techniques caused them to identify a vast array of compounds of which the majority had no physiological significance. Murray introduced olfactory monitoring of effluent from a gas-liquid chromatograph —an observer recorded on tape descriptions of the odour of the peaks as they emerged from the instrument. It was suggested by some flavour chemists that effluent sniffing was potentially dangerous but no such ill-effects have been experienced.

As a consequence of these improved techniques the flavour chemistry group, enlarged to twelve persons after Tracey's decision to bring all flavour researchers together in 1968, soon produced rewarding results. Two methoxypyrazines isolated from peas at a level of one in 10^{11} had intense pea-like aromas. These and a third methoxypyrazine were subsequently found in many vegetables and it was suggested that the ratio in which these powerful odorants are present has major influence on characteristic vegetable flavours. However, simple trials to enhance the flavour of processed peas by the addition of synthetic methoxypyrazines



K. E. Murray 'sniffing' effluent from gas chromatograph.

were unsuccessful. A clear-cut solution to the problem of the hay-like off-flavour in peas, which sparked so much of the investigation on flavour chemistry did not eventuate, but the evidence was strong that this was caused by unsaturated carbonyls derived enzymically from the pea lipids.

During the studies on pea flavour it became obvious that the Section needed to enter the field of synthetic organic chemistry. Whitfield, who had been working on the isolation of flavour volatiles, undertook the job of preparing the three 3-alkyl-2-methoxypyrazines. In the following years numerous reference compounds, then unavailable from other sources, were prepared and used in the positive identification of components isolated from natural materials. Whitfield later undertook original syntheses of important flavour components of novel structure. The availability of synthetic flavour compounds of known origin was subsequently to provide a bonus as it facilitated the recording of authentic mass spectra which eventually formed the basis of the Division's mass spectral library.

In 1970, a PDP-15 computer was installed to facilitate the processing of the large bulk of mass spectral data flowing from the gas-liquid chromatograph mass spectrometer, and for other uses within the Division. Acquisition of this expensive but highly effective hardware enabled other projects on flavour chemistry to be initiated. A number of components of passionfruit juice, described as having attractive individual odours like rose, raspberry, cedarwood and ionone, were identified. A mixture resembling passionfruit juice was made by mixing fourteen of the above components. Studies on the flavour components of lamb and beef were also started in collaboration with R. J. Park of MRL at Cannon Hill.

In spite of these notable successes in identifying important flavour components, Murray still held the view that the 'missing link' in the program was knowledge of the processes in the olfactory system by which chemical signals were transmitted and perceived as odour and flavour. His entreaties for a scientist to work in this grey, indisciplined area were rewarded when D. G. Laing, an organic chemist, was appointed in 1970. Laing, stationed initially at Macquarie University where he collaborated with workers in the Schools of Biological Sciences and Behavioural Sciences, set out to develop objective methods for the study of odour discrimination, adaptation, stimulus intensity and other properties of the olfactory system. He found that rats were suitable subjects for studying the physiology of olfaction, as many of their reactions were similar to those observed in humans. Later, when suitable accommodation was available, Laing moved to the North Ryde site.

Success with food volatiles led to requests for assistance in other areas. These included tainting of foods—particularly those in contact with plastics—air pollution and smog formation, medical diagnosis from urine samples, behavioural pheromones of rabbit and rat, and root fungal diseases. These investigations were greatly assisted by the development of techniques for the collection of headspace volatiles from aqueous solutions by absorbing them on porous polymer beads. The immense surface area (600–700 $m^2 g^{-1}$) and non-polar character of the beads permit extensive loading of volatiles without concurrent adsorption of water.

The studies at North Ryde on the identification of volatile compounds are a good example of the increasing complexity of research in general and of food science in particular. The sophisticated methods and equipment which seem to be essential for research today are in startling contrast to those which were used at DFP only 20 years ago.

Chapter 13. Expansion of meat research

We left the history of meat research in Chapter 10 at the time (1950) when Howard had become Officer-in-Charge of the Brisbane laboratory and was preparing for the Division's role in the cooperative investigations on frozen beef with the British D.S.I.R. For the next 17 years he and Vickery were to work together, closely and harmoniously, on a number of new programs in meat research, and when more money became available, on further expansion of activities and on building new laboratories.

With his high capacity for detail and his ability to absorb and apply new concepts Alf Howard became one of Vickery's most useful lieutenants. His original training in physics and chemistry, supplemented by experience at the Irrigation Research Station and at Homebush, enabled him to cope with the elementary science then used in meat research. He soon became familiar with current knowledge of the physiology, biochemistry and microbiology of meat and was able to apply the physical and engineering principles that he had used in work on food dehydration to the design and operation of freezing equipment. As a result of his responsibility for developing accurate methods of taste-testing, he acquired an interest in statistics and psychology which led him to further university studies and to the award, at the age of 62, of the degree of Doctor of Philosophy in Psychology.

Howard's right-hand man during this period was G. Kaess, a German food scientist and engineer whom N. E. Holmes had met while on refugee work in Munich after the war. Despite some initial doubts about language difficulties and his assimilation as an ex-enemy alien, George Kaess was accepted at Homebush as a fellow scientist with high qualifications and was liked for his gentle and unassuming manner. After spending a few months at Homebush he moved to the Brisbane laboratory early in 1950. With German thoroughness and caution, coupled with a flair for experiment and invention, he supplied the counterpart to Howard's vigour and enthusiasm. His main fields of work were to be the continuation of studies on the use of ozone in reducing air-borne contamination of chilled meat, and investigations of that severe surface desiccation of frozen meat and offals known as 'freezer-burn'.

R. H. Turner and G. Kaess working in a cold laboratory.

The other members of Howard's group, all drawing on his energy and drive, under working conditions certainly no better than at Homebush, were A. D. Brown, microbiologist, P. E. Bouton and H. L. Webster, biochemists, and some ten technical and office staff. Brown was to spend a rather lonely existence working under Scott's guidance on the growth of bacteria at low temperatures and in carbon dioxide atmospheres, again relevant to the studies on the chilled storage of beef which Vickery considered should not be abandoned. Bouton was immediately involved in the cooperative projects on frozen beef. Webster was sent to Cambridge for two years to work at the Low Temperature Research Station with E. C. Bate-Smith and J. R. Bendall on the biochemistry of post-mortem changes in muscle, and returned to the Brisbane laboratory in 1953 to initiate fundamental work in muscle biochemistry.

Cooperative investigations of frozen beef

The first of the two major objectives in the joint British-Australian program for research on frozen beef was to ascertain whether, given raw material of equal quality, frozen beef was in fact inferior to chilled when judged by the quality of the final cooked material. The second objective was to explore the effects of different treatments before and after slaughter on the water-holding capacity of meat, in particular on the production of 'drip' after freezing and thawing.

Howard was asked to arrange experimental shipments to Britain of beef quarters with a range of initial qualities, depending on age, breed and growing conditions. To enable valid comparisons to be made between frozen and chilled transport, one side of each carcass would be sent frozen and the other side chilled. However, there were difficulties in obtaining beef of high quality suitable for chilled transport, and in arranging shipment under chilled conditions at a time when most shipping facilities were set up for frozen storage.

The first comparison was actually made on an experimental shipment of chilled and frozen sides sent by the D.S.I.R. of New Zealand on the Dominion Monarch in the latter half of 1952, and examined in England by trained tasting panels from J. Lyons and Co. and the British Ministry of Food. Neither panel found any significant differences in palatability but only three pairs of sides were available for the comparison.

The first Australian experimental consignment of chilled beef after the war was not made until May 1953 and no frozen beef was available for comparison. It was due to Howard's organization of land storage trials and to the establishment of a trained tasting panel that the first significant comparison was made in 1953. Howard had developed methods for preparing roasts and grills under carefully controlled cooking conditions and had selected and trained a tasting panel of nine members of the staff. He was able to say with confidence after the first trials with 22 carcasses that 'Carefully controlled palatability tests have failed to show any difference in odour, flavour, juiciness, colour or general acceptability, of roasts and grills from the chilled and frozen material' (Bouton, Brown and Howard 1954).

Tackling the drip problem

Although further storage trials were to be carried out to study in more detail the effects of initial quality and storage conditions, it was now evident that the second objective—reducing the amount of drip—should receive most attention. Drip was responsible not only for an unattractive appearance and for some loss of nutrients, but also for generating prejudice against frozen beef, although as Howard later pointed out, 'It has been Australian policy, quite correctly, to limit chilled beef export to the best carcasses. . . . Thus the public finds that Australian chilled meat is better than Australian frozen meat, but does not realize that this is due to a large extent to the selection of the carcasses, not wholly to the processing. The presence of drip and to a lesser extent the colour of the meat serve to identify the frozen carcass and hence to discriminate against it.' (Howard 1960).

A. Howard (top) preparing an animal for pre-slaughter injections.

The experimental approaches were based on Empey's 1933 observation that more drip was lost from meat when the muscle pH was low (more acid), and on pre-war work at Cambridge which showed the connection between the amount of reserve sugar (glycogen) in muscle at death and the final pH on subsequent conversion of the glycogen to lactic acid. Experiments had been successfully carried out with small laboratory animals and with pigs but it was not known whether the methods that had been developed for reducing the amount of glycogen could be applied to beef cattle. The director of the Low Temperature Research Station, E. C. Bate-Smith, later remarked, 'From our viewpoint, the most interesting work of this period was a long series of investigations on the effects of pre-mortem treatment of beef cattle, carried out jointly by A. Howard . . . and R. A. Lawrie of the Low Temperature Research Station. It was convenient to carry out these experiments in Australia rather than Britain, because there are fewer legal restrictions on the manipulation of live animals.' (Bate-Smith and Ingram 1967.)

With characteristic attention to the importance of making exact measurements, Howard first worked on methods of assessing the amount of drip from different cuts of meat, and developed a laboratory method which could be used with small pieces of meat and was independent of experimental conditions in butchering. He was then in a position to start on the 'manipulation of live animals' when Lawrie and his assistant arrived at the Brisbane laboratory in the middle of 1953.

Excitable cattle

In their experiments on pre-slaughter treatment it was soon found that it was much more difficult to reduce the glycogen reserves in beef cattle than in rats and rabbits. Prolonged exercise and starvation had little effect on most cattle, but occasionally a steer was found which was naturally 'excitable' and had low reserves of glycogen. These animals supported predictions by having lower muscle acidity and correspondingly less drip, but attempts to bring about this condition at will by hormone injections were unsuccessful. Other injections were tried, and it was found that insulin could be used to completely deplete the muscle glycogen and hence give no acid production and no drip—but the meat was dark in colour and unpalatable. Also, as Lawrie pointed out, 'a dose of insulin of cost comparable with that of the steer itself was found to be necesssary—a completely ludicrous proposition commercially' (Inst. of Meat Bull. June 1958).

Further biochemical studies at Cambridge had shown that the *rate* at which the post-mortem changes occurred was also important in determining the fluid-holding capacity of muscle, and experiments were carried out in the Brisbane laboratory to see whether these fundamental studies could be applied in the drip problem. The post-mortem reactions could be slowed by injection of salts, such as magnesium sulphate, before or immediately after slaughter, and by rapid cooling of the carcass. A blast-freezing tunnel was needed to achieve the required rates of cooling with hot beef quarters and Howard was much involved in the design, construction and testing. Experiments showed that some reduction of drip could be obtained by salt injections and by rapid cooling, but eating quality was often impaired, and, depending on the animal's history of nutrition and stress, and possibly on genetic factors, the effects of a treatment with a particular animal were unpredictable.

The results of these experiments appeared between 1956 and 1959 in a series of eight papers which were regarded as sufficiently important to be published by both the CSIRO in Australia and the DSIR in Britain. This importance might now be seen as relating more to future lines of investigation than to the solution of the immediate problem, which, in the event, diminished in size as changes occurred in methods of distribution, in the requirements of consumers, and in the economic climate. It became obvious during the cooperative investigations that more basic information was needed on the biochemical changes in muscle after death and on the physical changes that affected retention of fluid. Meat quality, particularly tenderness, was to become more important to the consumer than drip, and tenderness was also affected by post-mortem reactions and treatments.

P. E. Bouton injecting an animal post-slaughter.

Muscle biochemistry

The committee set up by the CSIRO Advisory Council in March 1955 to review the activities of the DFP recommended that investigations on frozen beef should be intensified and that increased effort should be devoted to fundamental aspects. 'The Committee was impressed by the fact that whereas the Division was making a considerable research effort at a very high scientific level into the problems of plant physiology there was no effort of comparable level or scale devoted to meat.'

At about the same time a conference on the Beef Export Industry was held in Brisbane. Webster, Howard, Scott, Vickery and Hicks from the DFP, and K. R. Ross from Thomas Borthwick and Sons, gave papers on various aspects of chilled and frozen beef. In his introductory remarks, S. H. Bastow (CSIRO Executive) made a plea for more financial help from the industry. 'It has always been our view and experience that where there is participation by any industry, financially and technically, in our research programs, the work is done better, is applied more quickly, and the industry benefits correspondingly.' His plea did not go unheeded; one member of the audience, J. L. Shute, Chairman of the Australian Meat Board, was able to tell Vickery later in the year that the AMB would provide $30 000 for setting up a Muscle Biochemistry Unit.

Location in Sydney

Backed by industry and the Advisory Council, Vickery was now able to start some wheels turning, and with Howard, prepared a set of estimates for a three-year expanded program of meat research with particular emphasis on muscle biochemistry and the appointment of a senior biochemist. In May 1956 Vickery held a meeting at Homebush to discuss future work in muscle biochemistry and physiology. The meeting was attended by DFP staff, Lawrie, G. F. Humphrey from the CSIRO Division of Fisheries, F. G. Lennox from the Wool Research Biochemistry Unit of CSIRO, and R. Reid from the Sheep Biology Laboratory of CSIRO.

Discussion was based on a review prepared by Webster of muscle biochemistry in relation to meat quality and drip, and on suggestions for future lines of work put forward by Howard. There was no dispute about the need for much more biochemical work; moreover it was agreed that the physical chemists should be asked to look at changes in the muscle proteins on freezing—this was, after all, one of the original objectives in setting up the Physical Chemistry Section. For this reason Humphrey suggested that the new Muscle Biochemistry Unit should be located in Sydney.

Locating the Unit in Sydney was also Vickery's view; he put his reasons to Bastow in a letter (June 1956) as: '1. The probable lines of future investigations will incline strongly towards physico-chemical (or biophysical) aspects, and probably histological. These will require ready access to much modern physical equipment. . . . In the near future it would not be possible to set up these facilities in Brisbane. . . . 2. Close collaboration with an active biochemistry school and with the Division's physical chemists will be very desirable. All present at the conference agreed that, from a biochemical point of view, Brisbane was dead and unlikely to be better for many years.'

Bastow's reply, 'If it is possible to do the associated physiological work for this Unit in Sydney, then presumably it would be possible to do the rest of the meat work in Sydney rather than at Cannon Hill' provoked an immediate and lengthy discussion from Howard on the future location of applied and fundamental meat studies. Howard 'strongly recommended that the applied study be permanently stationed in Brisbane', but thought 'that physico-chemical work should be done in Sydney and that with biochemical (and possibly histological) work a compromise may be necessary between the need for contact with technological reality and the need for scientific stimulation.'

A place to work

The Australian Meat Board had agreed to their contribution being used in Sydney instead of in Brisbane, and an advertisement for a leader of the Unit had been placed; now Vickery had to provide a laboratory. It was obviously desirable to locate the new Unit at North Ryde with the new central laboratories, but plans for these were still in a state of flux. Professor Still offered temporary accommodation for the new leader at the Biochemistry Department, Sydney University, but had to withdraw his offer when expected extensions for his Department were curtailed.

At this time Vickery had several prospects for leader, including two overseas scientists of distinction, and was exploring every means of housing the Unit. (There is a) 'possibility of building temporary hut accommodation on the North Ryde site . . . (but) conditions of work on the site while the new building operations were in progress would be most unsatisfactory' (J.R.V. to Head Office, March 1957). Plans were drawn up for a building at the Wool Textile Research Laboratories at Ryde; 'it is likely that the leader of the Unit could arrive in Sydney towards the end of this year. . . . It is imperative therefore that if we are to go ahead with this project building should start not later than 1st July next.'

But in July Vickery had sadly to inform Bastow that it was likely neither of the two favoured applicants would be able to accept the position, and that the delay in appointing a leader 'may be so great that it would be inadvisable to go ahead with the building of the temporary quarters at Wool Textiles, and to think in terms of putting our money into building the necessary laboratory rooms at our own North Ryde building.'

In the event it was not until July 1959 that R. P. Newbold was appointed the new leader of Muscle Biochemistry, and with C. A. Lee started work in temporary quarters at the Sheep Biology Laboratory, Prospect, where they were to work until the North Ryde laboratories were completed in 1961.

Diffusion of effort

Thus, despite the efforts of Vickery and Howard to implement the recommendations of the 1955 Committee of Review, fundamental work on meat proceeded in a desultory and fragmented fashion for many years. Webster resigned from CSIRO in 1956 to take a position in the Biochemistry Department, Sydney University, where his experience proved of value to the physical chemists starting work on muscle proteins. Bouton and Lee continued some studies of post-mortem biochemical changes. A histologist, J. F. Weidemann, was appointed in 1956 and, working with Kaess on the etiology of freezer-burn, laid the foundations for subsequent investigations of the microstructure of muscle.

Physico-chemical investigations of the effects of freezing on muscle proteins were initiated by McKenzie in 1956, with fish as the source of muscle. Contrary to Vickery's earlier hopes, fish muscle proved to be markedly different from mammalian muscle in post-mortem behaviour and was more difficult to fractionate. Nevertheless, freezing studies on fish proteins were useful in indicating the complexity of the drip problem and the difficulty of applying the techniques used with soluble proteins to the highly-organized structural proteins of muscle.

Newbold's appointment revived interest in integrating the biochemical and physico-chemical approaches to the drip problem, but again the physical separation between the laboratories at Prospect, Cannon Hill and Sydney University proved a barrier. Muscle Biochemistry was the first Section to occupy new laboratories at North Ryde, and Newbold was then able to expand his field of activity and to accommodate guest workers from overseas—R. G. Cassens, Fulbright Scholar, in 1963, and R. K. Scopes, Postdoctoral Fellow, in 1964. An animal physiologist, W. R. Shorthose, was appointed in 1963, but owing to lack of accommodation in the Brisbane laboratories, was stationed at the Division of Animal Physiology (previously the Sheep Biology Laboratory) at Prospect.

Vickery was of course conscious of this diffusion of research effort on the fundamental side, particularly in view of the exciting prospects of receiving substantial funds from the Australian Cattle and Beef Research Committee and the real possibility of new laboratories in Brisbane. In February 1964 Vickery appointed Scott, then Assistant Chief, as Leader of Meat Research. Scott was able to coordinate work in three laboratories in the Sydney area—that of Newbold's group at North Ryde and Shorthose at Prospect and the physico-chemical studies on muscle proteins that had been the responsibility of R. W. Burley (Biochemistry Department, University of Sydney) since his appointment in 1961. However, it was not until Scott, Newbold, Lee and Shorthose moved to the new Brisbane laboratories in 1967 that the close integration of fundamental and applied work envisaged by Howard and Lawrie ten years earlier achieved reality.

A proper home for meat research

The official opening of stage 1 of the new Meat Research Laboratory at Cannon Hill on 31 May 1967, marked the culmination of eight years of planning and concentrated

MRL, Cannon Hill.

effort by Vickery and Howard.

The process began in 1959 with the establishment by Act of Parliament of a Beef Research Trust Account, to which the industry had agreed to contribute by means of a levy on beef cattle matched by an equal contribution from the Commonwealth. CSIRO, with a major interest in research for the animal industries, had discussions starting in December 1959 between the Executive and Chiefs of eight Divisions concerned in beef production and use.*

* Vickery has recently commented: 'The whole thinking in that period (in all parts of CSIRO, except DFP, and in the industry) was that the money should be allocated to the animals themselves—their genetics, pests, diseases and nutrition. After persistent efforts I was able to convince the two most influential men in that period—Sir William Gunn and Mr J. L. Shute—that it was not much use breeding and feeding better cattle if the marketing of the carcasses was hindered by difficulties in processing, storage and transport.'

Not surprisingly, their first estimates for new programs of beef research far exceeded the funds that might be expected.

During the next three years Vickery and Howard drew up proposals, project lists, estimates, and revised plans for expanding meat research and providing research facilities, but could obtain no definite assurances of annual allocations for meat research nor even a decision on the use of beef research funds for capital expenditure. However, in April 1962, the Australian Cattle and Beef Research Committee (ACBRC) agreed in principle to contribute finance for establishing a special meat research laboratory. Howard and his staff then began work on detailed plans for the building to be erected about 1·5 km from the old laboratories at Cannon Hill. Howard also began to press Head Office and the Executive to take some steps towards building. No further progress was made, though, until March 1963, when the ACBRC finally agreed to provide a special grant of $100 000 for 'a beef research institute' and an annual allocation of $180 000 from 1 July 1963.

Other meats

Some weeks before this decision, Vickery and Howard had prepared a wider research proposal to include work on sheep and pig meats as well as beef. In support of their case for a general meat research program, they pointed out that about $90 000 per annum was already being spent by CSIRO on basic meat research and on technological problems in the beef industry, but little or no research effort was directed to the problems of lamb, mutton and pig meats. Other countries that were either just self-sufficient in meat production, or were nett importers, were spending considerable sums of money on meat research, and the million-dollar Meat Research Institute then being built in England, largely on the basis of Vickery's recommendations, was cited. Denmark, Sweden, Poland, France, West Germany and Bulgaria all had meat research institutes with staffs of 60 to 150, while meat research in CSIRO was being carried out with a staff of 20 in Brisbane and six in Sydney.

Vickery and Howard recommended that to meet the requirements of a desired level of meat research, the total staff in Brisbane should be increased to 57, including 13 research officers, while that in Sydney should be increased to 22, including eight research officers. Their proposal was to conduct research into Meat Chemistry and Physiology, Microbiology, Meat Technology, and Physics and Engineering in Brisbane, with Muscle Biochemistry, Muscle Physical Chemistry, and Meat Chemistry and Technology being located in Sydney. It was estimated that the cost of providing new laboratories in Brisbane would be about $520 000 and that about $120 000 would be required for additional laboratories at North Ryde and for renovating laboratories at Homebush.

The grant of $100 000 from the ACBRC and an expected contribution of $52 000

W. J. Scott, J. L. Shute (Chairman, Australian Meat Board), J. R. Vickery and C. S. Christian (CSIRO Executive) at the opening of the new laboratories at Cannon Hill.

from CSIRO would provide the nucleus of funds required for more detailed planning to begin. Also, since the $180 000 per year operating grant was to begin in July 1963, and staff expansion could not take place until the completion of the buildings, the amount left unspent from this operating grant could be allocated to defray the capital cost of building. This arrangement in fact enabled Vickery to proceed with the building of new laboratories at the expense of some reduction in the rate of staff expansion, and eventually to house all the meat research Sections together in Brisbane.

Acceptance of these proposals by the Australian Meat Research Committee (formerly ACBRC) led to the decision to construct the laboratory in two stages. When opening the first stage in May 1967, Mr J. L. Shute, Chairman of the Australian Meat Board, stated that the AMRC had allocated $528 000 towards the cost, and had agreed to a grant of up to $405 000 per annum for the construction and operation of the second stage. In addition, CSIRO and the Australian Meat Board had each agreed to contribute $112 500 towards the first year's budget. Stage 2 was begun in 1968 at an estimated cost of $628 000 and was completed and occupied in 1969.

New environment

In the new laboratories the microbiologists were at last able to study and devise remedies for air-borne contamination of meat without having to battle with air-borne contamination of their working environment. Scott had insisted on having the laboratories fully air-conditioned, although the added cost, and the difficulty of dealing with fume-cupboard exhausts, had led Vickery to have only a few selected rooms at North Ryde with integral air-conditioning. Time has proved Scott's attitude to be correct; apart from the microbiological benefits, the requirement by modern laboratory instruments for dust-free, low-humidity, atmospheres is now almost universal; also, increased comfort for staff during Brisbane's summers is not a negligible factor!

Scott and Howard gained in other ways from the experience of Vickery and his senior staff in planning, constructing and using the laboratories at North Ryde. New instruments, new techniques and new materials of construction had appeared; the Divisional Engineer, R. Atkins, Thelma Reynolds and others at North Ryde were called on for advice, and now that the novelty of the transition from Homebush had worn off, they could look more critically at laboratory design.

Now there was no difficulty in attracting new staff to the 23 laboratories with their special-purpose instrument rooms, cold laboratories and constant-temperature rooms, or to the library, meeting room, canteen, administrative offices and workshops. Special facilities had been provided for handling meat, starting with the holding yards, pens and animal surgery, and continuing through refrigerated preparation rooms to chillers, freezers, processing room, kitchen and taste-testing rooms. New equipment was rapidly acquired, some of it coming from North Ryde with Newbold's Section; there were the light microscopes and the electron microscope for the histologists, the ultracentrifuge, scintillation counter and amino-acid analyser for the biochemists, the gas chromatographs for the flavour chemists, and a range of physical equipment for texture studies.

The last decade

In the years following the opening of the new laboratories Meat Research was able to take on new responsibilities, to explore new avenues of research, and to look from its new vantage ground at old fields of work. One of the most significant developments was the establishment of a section to deal directly with the technical problems of the meat industry.

Industry liaison and extension

The Australian Meat Research Committee had agreed to provide financial support for the Meat Research 'Institute' on the understanding 'that the Institute develops a service and investigation section affording direct and continuing liaison with the meat industry', and 'that meat industry support for augmentary funds for this section be sought through processing, marketing and equipment organizations.'

Two years of discussion on appropriate means for raising the funds from industry led, in November 1968, to Federal legislation authorizing the collection of a levy from the owners of all cattle and sheep passing through Australian abattoirs. The initial levy was 1c per head of cattle and 0·1c per head of sheep slaughtered over a three-year period, and the levy funds were matched equally by a Federal Government contribution. Monies collected under the legislation are available only for the use and operation of the Industry Section.

Within a short time the Section had a Leader (initially L. E. Brownlie, then J. R. Yates), a microbiologist, an engineer and an extension officer, together with technical and clerical assistants. Further appointments of extension officers based in Perth and in Melbourne were made. So successful were the efforts of the new Section that, well before the expiry of the first period of collection of the levy, the meat industry agreed readily to a request that the legislation be extended for a further three years. More recently, under the leadership of V. H. Powell, the Section has acquired another professional engineer, a food technologist and another extension officer, who together with supporting staff have increased the total number of personnel to 19. The continuing recognition of their work is indicated by the fact that the meat industry bodies concerned have requested that the Government continues to collect the levy indefinitely, and that the amount collected should be doubled.

Investigations undertaken by the Industry Section are mainly short-term and applied in nature, but responsibility is also accepted for keeping the meat industry informed of research developments, by issuing Meat Research Reports which interpret the results of research done by other sections within the Laboratory. Information is also distributed to the processing industry through the production of Newsletters which cover topics of general interest and summarize research done by non-CSIRO laboratories. A further important aspect of the Section's responsibilities is that concerned with the organizing of schools for meat industry personnel, when new techniques and the scientific basis for their successful adoption are taught and discussed.

Changes in leadership

Howard retired from CSIRO in 1971 but did not cease either work or study; after retirement he published long and detailed papers on sensory analysis and continued teaching at Queensland University on aspects of computer programming while still following further undergraduate courses.

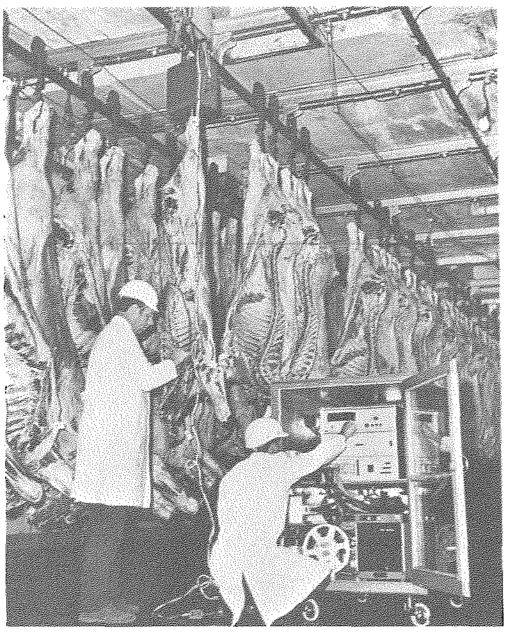
A year later Scott also retired, after a long and highly successful career in CSIRO as an eminent microbiologist and scientific administrator and after seeing his ideas brought to fruition, in the vastly expanded program of research into meat processing and muscle biology, and in the establishment of the Industry Section.

Leadership of the Meat Research Laboratory is now in the hands of D. J. Walker, who joined DFR in July 1972 with a background of research on the biochemistry of bacteria and the protein nutrition of meat animals. Apart from the increase in size of the Industry Section, Walker has moved the research programs significantly in the direction of strengthening engineering research. New programs have also been developed on the utilization of by-products of animal processing for the production of materials that can be used as human foods or as high-value chemicals or pharmaceuticals. These changes resulted from a need firstly to introduce novel and labour-saving technology into animal processing, and secondly to obtain maximum value from both the meat and non-meat portions of every animal slaughtered for human consumption.

Diversity of research

When the first stage of the new laboratories was opened in 1967 the staff at MRL had grown to 41; with building completed at the end of 1969 the total was over 70. Inflation reduced the number of staff supported by AMRC funds, from the original estimate in 1966 of a maximum of 56, to a real maximum of 38. Further erosion of the value of this fixed grant has resulted in a decrease to the current level of 27 positions. Nevertheless, because increased Treasury support has maintained a total staff of 90, including 35–40 professional scientists, research output from MRL has more than matched Vickery's and Scott's expectations, while its size has generated a research atmosphere that has overcome the old feelings of isolation. Increased size has also allowed more specialization and diversity of research.

An aspect of meat research that illustrates this multiform approach is the continuing investigation of meat quality. In the absence of reliable objective measurements, Howard and Lawrie had to rely on taste-testing to evaluate differences between chilled and frozen beef. The group working on meat quality (J. J. Macfarlane, P. V. Harris, R. J. Park, W. R. Shorthose) now has a range of methods for measuring texture, juiciness and flavour in comparisons with taste-panel assessments. Instruments for mechanically testing the shear and tensile properties of meat are used to evaluate the effects of various pre-slaughter and storage conditions on texture. Other techniques measure water-holding capacity by means of high-speed centrifugation, and connective tissue strength by an adhesion measurement. The extent of investigations of quality is wide—from consideration of the influences of age and breed to studies of the effects of heat and pressure on isolated muscle proteins and tendon collagen. The continuing theme of muscle pH has also widened to include problems raised by new processing methods, such as the colour change in vacuum-packed meat of high pH.



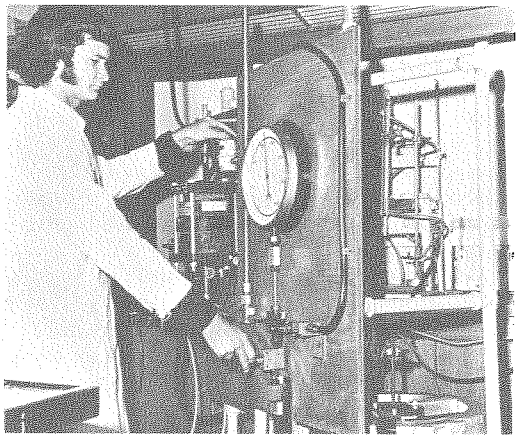
J. Anderson and R. R. Weste measuring temperatures and weight losses in a study of chiller performance.

Investigations of flavour differences benefited from new instrumentation as much in the field of meat science as in the corresponding dairy- and food-research areas. Two major problems were the development of unusual flavours in meat caused by certain fodder plants, and the effects on flavour of feeding protected-lipid supplements that were aimed at producing meat with a high proportion of polyunsaturated fat. The second investigation involved the three laboratories of DFR and is described in more detail in the next chapter; work done at MRL showed that flavour changes were greater in sheep meat than in beef, and identified the main chemical constituents of meat flavour.

Physical and engineering investigations, directed by L. S. Herbert, still reflect the importance of physical factors such as cooling rates in processing, and the development of instruments for measuring time–temperature relations, relative humidity and weight loss has continued. *Processing* has widened in scope to include the treatment of by-products, wastes and effluents from meatworks, with new emphasis on chemical engineering. Processes for dry rendering, for obtaining edible protein from blood, and for isolating steroids from abattoir by-products have involved chemists and engineers from several sections. Trends towards increased mechanization and the introduction of labour-saving techniques in abattoirs have also resulted in investigations of hot-boning processes and the use of high-pressure water for more efficient stripping of meat from bone.

The aim of improving the quality of manufactured products, such as sausages, has led to work by Macfarlane's group on the functional properties of muscle and other proteins. High-pressure treatment was found to promote solubility of muscle proteins (which are effective 'glues' for holding together small pieces of meat); plant and blood proteins were investigated as additives in sausages; the emulsification properties of animal and plant proteins were studied, and pre-rigor meat was shown to have desirable properties for manufactured products.

Microbiological investigations range from strictly practical work on reducing bacterial contamination of meat through



R. Turner operating equipment for the high pressure treatment of meat.

better hygiene to fundamental studies of the structure, metabolism and stability of bacteria. A major program of research resulted in a team, led by F. H. Grau, identifying the causes of contamination of sheep and cattle meats by the food-poisoning organism *Salmonella*. Their detective work showed how these organisms accumulated in animals and their environment before slaughter, defined the factor influencing this accumulation and the subsequent spread of infection in the abattoir, and suggested means of destroying *Salmonella* on carcasses. As with many of the projects outlined, collaboration by members of the Industry Section has ensured the rapid application of research findings in the meat industry. Microbiologists have also been involved in problems arising from new methods of handling meat, such as the growth of anaerobic bacteria and yeasts in vacuum-packaged meat. Most of the basic studies by Grau and A. F. Egan have concerned the outer membrane of Gram-negative bacteria and the relationship of the growth and survival of the cell to the properties of the membrane. Their research has made use of mutant strains of bacteria with different resistance and cells injured by thermal and other environmental stress.

A large part of the research program of MRL has evolved from the earlier studies of Kaess and Weidemann on the microstructure of meat and Newbold and Lee on post-mortem biochemical changes.

This research, fundamental or 'strategic' in nature, is divided between two sections. D. J. Morton, D. J. Horgan and R. W. D. Rowe are concerned broadly with muscle growth and development, and with changes in organization of the components of muscle fibres and connective tissue brought about by different patterns of growth and by post-mortem treatments. Newbold, R. F. Thornton and R. K. Tume are involved primarily with metabolic reactions—the release and uptake of calcium by membranes, glycolysis, fat deposition—and how post-mortem metabolism is affected by treatments such as freezing and thawing and stretching.

We have tried to indicate in this short account of recent activities at MRL the way that common research aims have brought about a coherent and cooperative research structure in the youngest branch of DFR. This is apparent in many projects where a wide cross-section of the staff has been involved in different aspects of the same problem; a current project of this nature is on increasing meat tenderness by electrical stimulation of muscle.

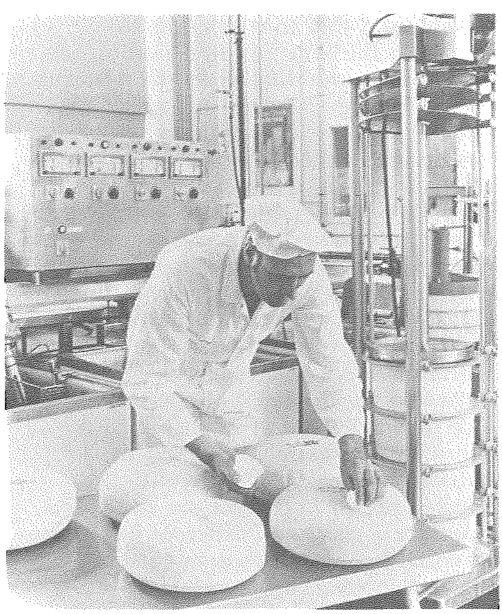
F. Grau (right) collecting samples from the rumen of a cow to test for the presence of Salmonella.

Chapter 14. Dairy research after amalgamation

After the fusion of DDR and DFR, a year elapsed before B. S. Harrap assumed his new position as Officer-in-Charge of the Dairy Research Laboratory (DRL). This was a period when lines of communication were developed with Headquarters at North Ryde. The transition to a new administration was smoothed by J. Czulak, who acted as Officer-in-Charge at Highett during the whole of that time, and did much to persuade the DRL staff that they had much to gain and little to lose by the union. The increased flexibility, in times of financial or staffing difficulties, which is available because of the greater pool of resources in a large Division, is now appreciated by most staff. The suspicions of the dairy industry were rather more deep-seated. It saw the amalgamation as a withdrawal by CSIRO from research in dairy technology, and funds granted to the Division by the Dairying Research Committee declined substantially.

Polyunsaturated dairy foods

Towards the end of Czulak's period as Acting Officer-in-Charge a major new project did much to foster closer relations between DRL and the other two Laboratories of the Division. This was part of a research program on the development of meat and dairy products with increased levels of polyunsaturated fatty acids. Earlier collaborative research between the Divisions of Dairy Research and Animal Physiology had demonstrated that droplets of polyunsaturated vegetable oil coated with casein and treated with formalin were protected from microbial hydrogenation in the rumen, and could be fed to ruminant animals to produce milk and meat with a higher proportion of polyunsaturated fatty acids. A patent on the process for producing protected feed supplement was licensed to Dalgety-Agrilines Pty Ltd, and a substantial contribution from this firm to CSIRO allowed a development program to be started. In addition to CSIRO Divisions, this program involved the Victorian Department of Agriculture, whose Dairy Research Station at Ellinbank made a vital contribution to the development of the so-called polyunsaturated dairy products. Within the Division of Food Research the program occupied some staff in all three Laboratories, with A. R. Johnson at North Ryde acting as coordinator; it was a major factor in helping the research staff at DRL to become acquainted with their counterparts in the other Laboratories.



V. Mackie coating polyunsaturated Gouda cheeses.

The technological development of polyunsaturated dairy products has been completed and cheese and yoghurt have been marketed. At the *Salon International de l'Alimentation*, held in Paris in November 1976, polyunsaturated cheeses manufactured commercially in Australia were awarded the *Prix de la Recherche* for an outstanding new product requiring intensive research and development. Moreover, in addition to its commercial success, research on polyunsaturated dairy foods had other important benefits by pointing the way to further progress. Thus the work carried out by R. D. Hill and by Johnson's team significantly increased the understanding of oxidation in milk. Present work by G. R. Jago, A. R. Hillier, G. T. Lloyd and F. H. Horwood on the metabolic processes in starter bacteria which lead to particular flavour components in cheese and other fermented milk products, was greatly stimulated by the problems faced in developing polyunsaturated cheese.

Utilization of whey

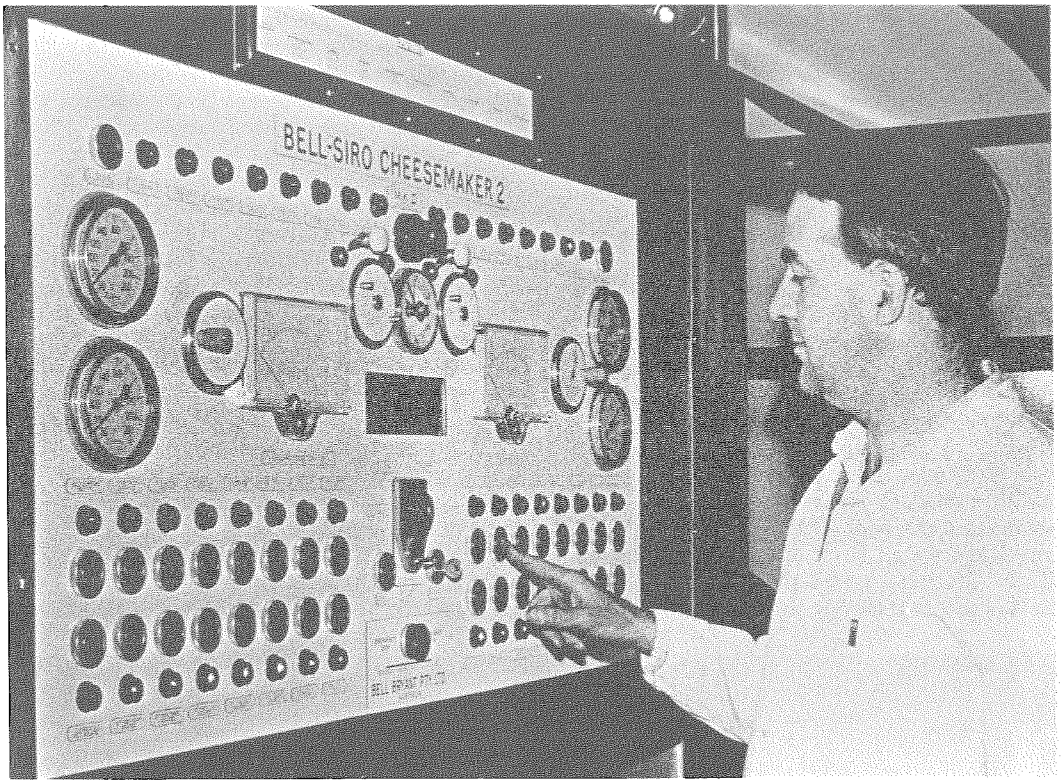
Another major program that was just starting at the time of the amalgamation and that has since proved very productive is that concerned with the treatment and utilization of whey, from both cheese and casein manufacture. L. L. Muller, who led this program, had foreseen the problems the industry would face with the increased community consciousness about environmental protection, since whey can be a major pollutant if untreated. He convinced a group of whey producers of the importance of these problems—which have since become evident—and persuaded them to support a research program designed to give an economic return from the components of whey while at the same time reducing the environmental stress. Muller was able to gather together a working team which involved not only DRL but also the CSIRO Division of Chemical Engineering and the Victorian Department of Agriculture. Close liaison and exchange of information were maintained with the New Zealand Dairy Research Institute and research groups in Ireland. Within five years the work has reached a stage where one of a group of dairy companies has purchased ultrafiltration equipment, to explore the manufacture, as a joint venture, of a range of products from whey.

Cheese technology

Loftus Hills was followed into retirement over the succeeding few years by several other scientists who had been associated with him since his early days in CSIRO, and as a result there has been a change in the character of some of the research carried out at DRL. The first to retire was E. G. Pont, who had lately returned to his original discipline of microbiology and with G. T. Lloyd had developed a system for the production of cheese starter bacteria in a form sufficiently concentrated for direct addition to a cheese vat, avoiding the need for further propagation in the factory and so reducing the ever-present danger of infection by bacteriophage. Lloyd developed a pilot-scale process in association with Mauri Bros and Thomson Ltd who have recently taken it up commercially and are now supplying starter concentrates in frozen form direct to cheese factories.

The first half of the 1970s brought to completion the long-standing program on the mechanization of Cheddar cheese manufacture, with the development of mechanized and partly automated equipment for the pressing of cheese in large blocks. Completion of this project and the retirements of J. Czulak and J. Conochie in 1976 brought to an end an important era in the history of DRL, and allowed reorganization of the work on cheese and other fermented milk products. The overall responsibility for research on cheese and fermented milk products passed to Jago and as a result the work of his group, which was stationed at Melbourne University, became more closely integrated with that at Highett.

The approach to eliminating flavour defects and accentuating desirable flavour notes is many-sided. Poor starter performance is a major factor in poor cheese quality, and is mainly a result of bacteriophage attack on the starter bacteria. The earliest work of Czulak, which was continued by Barbara Keogh, was focused on this problem. Their work held the situation in control for many years; more recently, establishment of large factories working almost around the clock, has led to the recurrence of the problem. The recruitment of R. R. Hull made possible a genetic approach to the problem, and this now proceeds in addition to Barbara Keogh's work which is aimed at preventing the initial adsorption of bacteriophage onto the surface of the bacterial cell. Jago's work over many years on the metabolic processes in starter bacteria is now also directed towards manipulating the formation of desirable or undesirable flavours in cheese and other fermented milk products. Among the flavour chemists, E. R. Ramshaw and F. H. Horwood are now also associated with this work. One of Conochie's late research interests before he retired was the accelerated development of cheese flavour which occurs if a slurry of cheese curd macerated with water is allowed to incubate under controlled conditions. Conochie hoped to control the conditions to produce a palette of different flavours that could be used as components in processed cheese. This research is being continued by G. W. Jameson, who was appointed to Conochie's position, and



N. Freeman at the control board of the Bell-Siro Cheesemaker 2.

B. J. Sutherland, who had worked closely with Conochie for many years.

Jameson also initiated a project in cheese technology aimed at the manufacture of Cheddar cheese from milk from which a large proportion of the water has been removed by ultrafiltration. By retaining in the cheese the proteins that are normally lost in the whey, the yield of cheese per gallon of milk may be increased by as much as 20%.

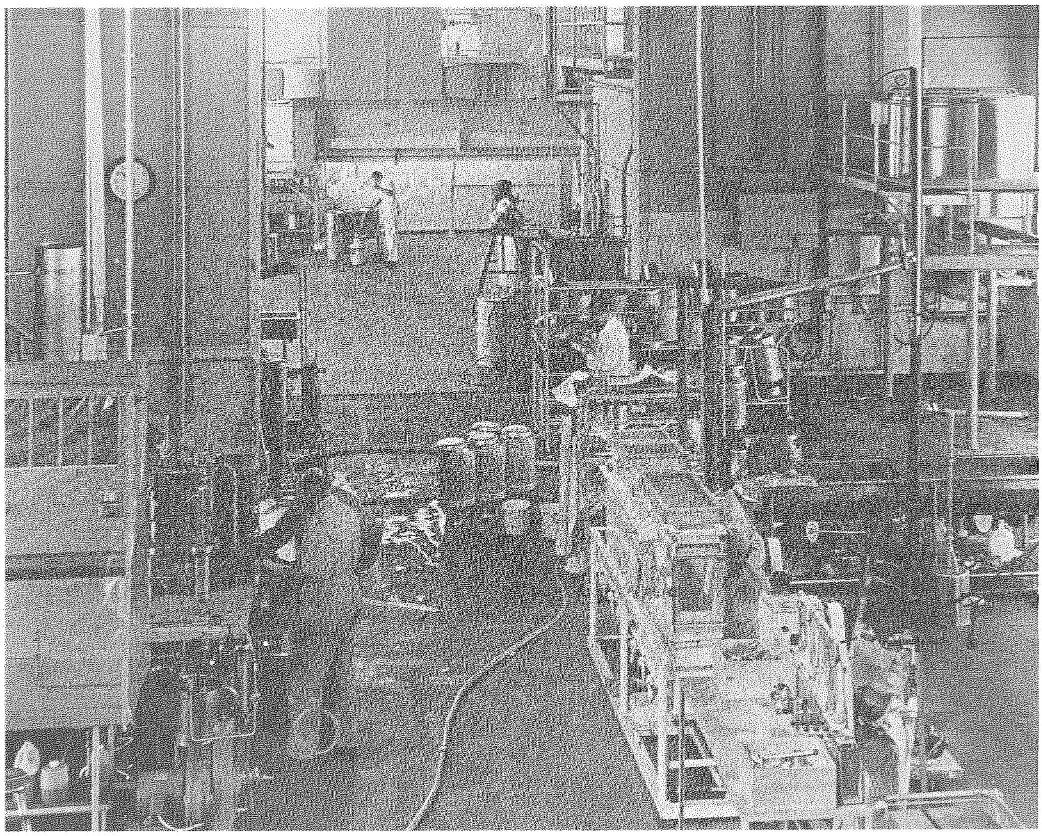
The retirement of Pont, Czulak, Conochie and A. J. Lawrence and the consequent influx of younger scientists coincided to a certain extent with changes in the research philosophy of the Laboratory, changes which themselves reflect the changes in the nature of the dairy industry over the preceding twenty years. By absorption and amalgamation there evolved a much smaller number of very large factories and the nature of the problems changed because of the complexity of modern equipment and the distances over which milk is collected. An even more important change in the industry resulted from the closure of the traditional United Kingdom market for butter and cheese when Britain entered the EEC. The dairy industry was forced to search for new markets at a time when the ruling prices for butter and milk powder were falling below the cost of production. It soon became evident that the future health of dairy manufacturing lay in providing specialized products to meet particular markets.

DRL could best meet these changing demands of the industry by recruiting new staff with specialist skills to replace the generalists who had served the industry so well in earlier days. Fairly rigid groups or sections gave way to working parties focused on particular tasks, often in collaboration with outside bodies.

One working party charged with the responsibility of utilizing milk fat as a raw material in the food industry includes R. E. Timms, who had considerable experience in the physical chemistry and technology of vegetable oils, F. G. Kieseker who brought extensive experience in the technology of butter manufacture, and Gerda Urbach and W. Stark who had established reputations in the flavour chemistry of butter. The working party also includes a marketing specialist from the Australian Dairy Corporation and butter and food technologists from the Victorian Department of Agriculture.

Similarly there evolved cross fertilization between strategic and tactical research on milk protein products tailored to specific applications in dairy and non-dairy foods. One of the major problems remaining in the manufacture of recombined dairy products is the short season over which milk powder can be produced with heat stability characteristics suitable for recombining. R. J. Pearce, a protein physical chemist from Manchester University, was assigned to study the factors responsible for the protein interactions in milk which determine heat stability. Heat stability is only one of many functional properties of milk proteins, and there is now lively interest in this area, not only from Pearce and Kieseker, but also from Muller's group, since one of the first objectives in the whey program was to recover and utilize the proteins from whey.

Another new development that followed the amalgamation of DDR with DFR was the appointment of an officer specifically responsible for information and industry liaison, tasks that had previously been shared among several members of the staff. The first holder of this position was B. F. McKeon, who had had a long association with the dairy industry, as an officer with the Victorian Department of Agriculture and later as a member of the CSIRO Secretariat. His appointment coincided with the upsurge of consumer interest and thus information to consumers



The process bay at DRL.

became an important component of the service developed in the years preceding his retirement in 1976.

Writing now, six years after amalgamation, there is ample evidence that the exercise has been successful and goodwill has been restored both within the Division and between the Division and the dairy industry. In the last two years increased support for DRL has kept up with inflation, in times when the industry funds themselves are under considerable pressure. The dairy industry now recognizes the need to widen its horizons in a search for new markets and to think of dairy products as part of a much wider food industry.

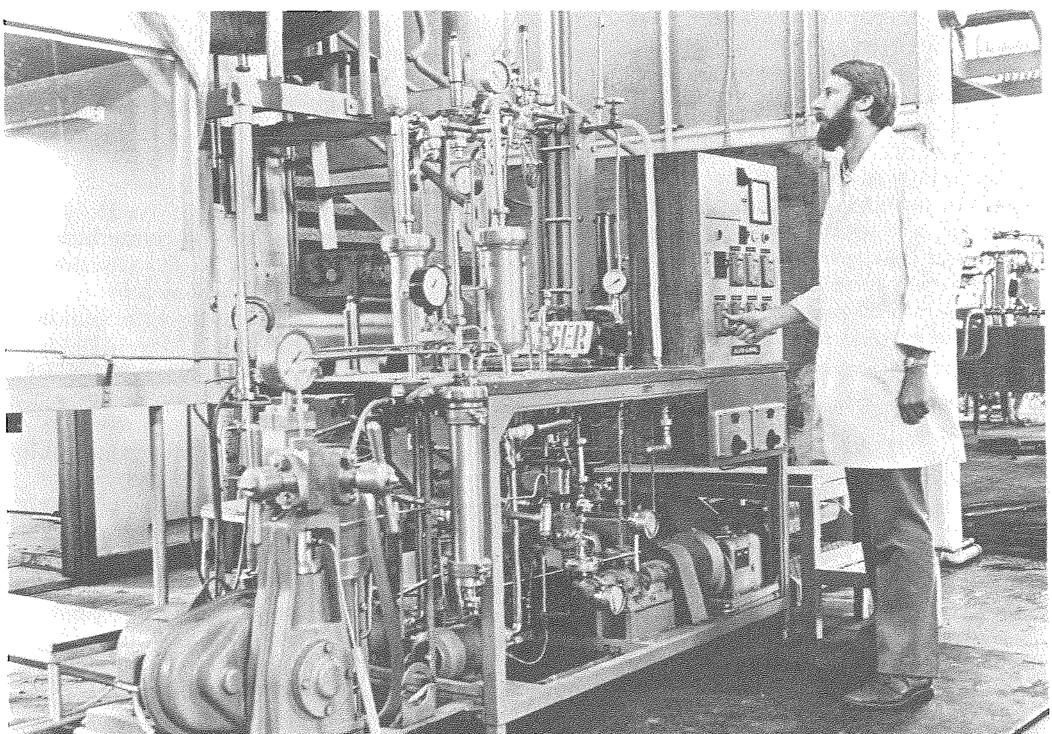
Chapter 15. Regional laboratories and service sections

Outposts of DFP

Even before the war in the Pacific had ended Vickery was giving careful consideration to the establishment of regional laboratories of DFP additional to the existing meat research laboratory at Cannon Hill. Possible locations included Eden on the south coast of New South Wales, Griffith in the Murrumbidgee Irrigation Area, Hobart and Perth. Ultimately branches were established only at Eden and Hobart.

Eden

Negotiations were under way by September 1946 to set up a small research laboratory in a commercial fish processing plant at Eden. Little progress was made until the end of 1947 when the establishment of an official market in the area by the N.S.W. Fisheries Department assured regular supplies of fish. This move resulted in Eden becoming the second largest fishing port in N.S.W. at that time, and Vickery decided to proceed with the



J. Hardham operating pilot plant for ultra-heat treatment of milk.

project. But in July 1948 it was again stalemated by a proposed amalgamation of the cooperating company with another fish processor. This consolidation was completed in April 1949 and an agreement was finally signed between CSIRO and the new company in September 1949. R. P. Bourke took up duty at Eden in December as a Technical Assistant. Initially the work went well but it soon became apparent that the management was antipathetic to research work and in July 1950 Bourke was brought back to Homebush.

Following a reorganization in the company at Eden the new management invited Vickery, in early 1951, to reestablish the laboratory there. He accepted the offer and the company set about reconstructing the laboratory which had been used for other purposes in the interim. Building was slow due to shortages of materials and Bourke resumed his duties at Eden at the end of 1952.

When the laboratory was first established at Eden the program was planned to include studies on smoke-curing, the freezing and frozen storage of fish, canning of Australian species and some basic chemical work. In fact, investigations on the technology of canning blue fin tuna, Australian salmon and barracouta were completed, and analyses of the water, protein and fat contents of many species of Australian fish were made. In addition, the production of volatile bases during the retorting of canned fish was studied.

Late in 1954, the Executive expressed doubts about the desirability of CSIRO continuing active studies of fish preservation. In discussions with Dr S. Bastow, Vickery justified the work and proposed that the fish research program at Eden, and the one which was now in effect at Hobart, should be continued but that, in three years time, the role of Eden in the scheme of things should be re-assessed. However, by July 1955, Empey conceded that chemical investigations at Eden were complete and that canning studies would be finished by the end of the year. The Executive concurred in the decision to relinquish the laboratory at Eden by June 1956. It was planned to bring Rod Bourke back to Homebush once more but by this time he was running the local cinema and he preferred to resign and remain at Eden.

Hobart

Tasmania became an important producer of processed foods during World War II and a number of problems that were peculiar to products from that State required continued investigation when hostilities ceased. Following talks with the CSIR Tasmanian State Committee in 1946, Vickery proposed that the Division should provide facilities at 'Stowell', Hobart, for investigations on fish preservation and the processing of fruits and vegetables. The Executive agreed to the proposal and four rooms were set aside in the main building at 'Stowell' for conversion to laboratories for DFP. Plans were also drawn up for the construction of several cold rooms and an annexe to house pilot-plant processing equipment.

A ghostly site. 'Stowell' is one of the oldest buildings owned by CSIRO. It was built in the early 1830s by Capt. Montagu, a member of Colonel Arthur's administration in Hobart Town. The old mansion had served as a private hospital before World War II and it had been occupied by 'squatters' for a time after the war. It is situated close to the City in historic Battery Point. As a regional laboratory, it was planned to serve as an outlying base for scientists from many CSIRO Divisions. Once again shortages of labour and materials held up occupation of the building. In response to an inquiry in March 1949 from G. A. Cook, then Secretary of CSIRO, Vickery reiterated the intention of the Division to start investigations at 'Stowell' but explained that 'it would not be possible to carry out this work adequately without the provision of a special small processing laboratory about 1200 square feet in area.'

In that same year, 1949, D. Martin, a plant nutritionist from the Division of Plant Industry took up duty as Officer-in-Charge at 'Stowell', a position he was to fill with distinction until he retired nearly 30 years later. Don Martin already had a link with DFP through his interest in fruit storage but, in addition, for more than two years he acted as liaison officer for the Division, forwarding inquiries to Homebush or, if possible, supplying answers directly. Subsequently he was to prove a wise and practical counsellor and a good friend to officers from DFP who were to be stationed at Hobart. 'Stowell', like so many historic buildings, had a ghost—The Grey Lady—who, legend purports, fell from the tower there about 125 years ago. It pleased Don Martin's impish humour to foster the legend, and besides, during CSIRO's occupancy, there was never one case of burglary or vandalism.

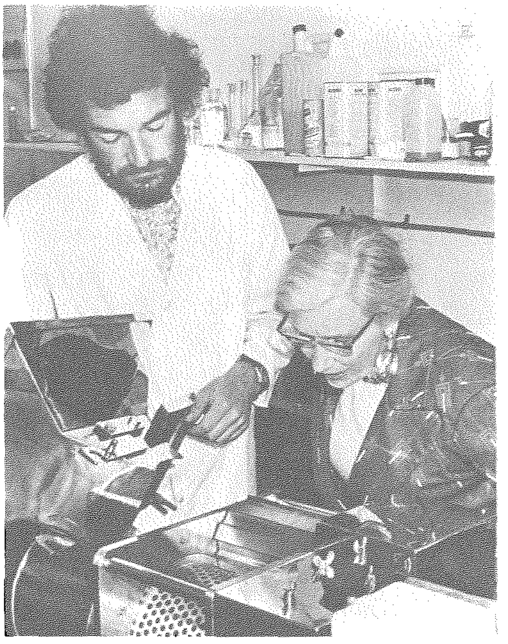
Occupation of 'Stowell'. Midway through 1950, the Tasmanian State Committee set up a subcommittee on food processing, possibly in the hope of accelerating building alterations at 'Stowell'. Vickery welcomed the establishment of the subcommittee but it was the end of 1951 before reconstruction of the four laboratories was complete and two technical officers were transferred to Hobart. The more expensive annexe was again delayed and meanwhile, processing investigations were carried out under great difficulties in a small shed. A contract for construction of the annexe was let in April 1955 at a cost of $50 000 and it was completed in May 1957. It was, however, only about half the size of the building that had been planned ten years earlier.

The two technical officers who moved to Hobart were K. W. Anderson and R. A. Gallop. The former studied the conditions governing the production of ammonia in shark flesh, the composition of barracouta in relation to canning quality and the freezing of rock lobsters. The difficulties of working at 'Stowell' without proper processing facilities may have contributed to Anderson's decision to resign in 1955. His departure marked the start of a long hiatus in fish research studies at Hobart. Reg Gallop investigated the conditions for preparing solid-pack canned apple, the canning of raspberries and strawberries and the freezing of berry fruits. Both officers were called on to do extension work in the Tasmanian food processing industry, an excercise which absorbed about 40% of their working time.

The appointment of a leader for the Hobart group was postponed until the completion of the annexe was in sight, but no suitable applicants came forward when the job was advertised in 1956. P. W. Board was seconded from Homebush to act as leader for a year and was followed by D. J. Casimir for four months. In 1958 S. M. Sykes rejoined the Division as leader of the Food Research Unit (FRU) at Hobart. He soon established a strong rapport with the food industry in Tasmania and expanded the research and development programs on the canning and freezing of berry fruits and peas, and the canning and drying of apples. He also started a project on the measurement of texture in potatoes. Reg Gallop who had been with the Division since 1941 left Hobart in 1958 to further his studies at Oregon State University at Corvallis.

Return to seafoods. Fish investigations at Hobart resumed with the appointment late in 1963 of D. G. James, a graduate in chemistry and physiology from the University of Liverpool. Fish processing studies were now under the leadership of Prater, as Empey had retired in early 1961. James restarted the earlier processing work on Australian salmon and tried once more to find the reasons for unsatisfactory texture in frozen rock lobsters. Ron Prater died suddenly in 1965 and G. Sidhu undertook supervision of the work on crayfish muscle.

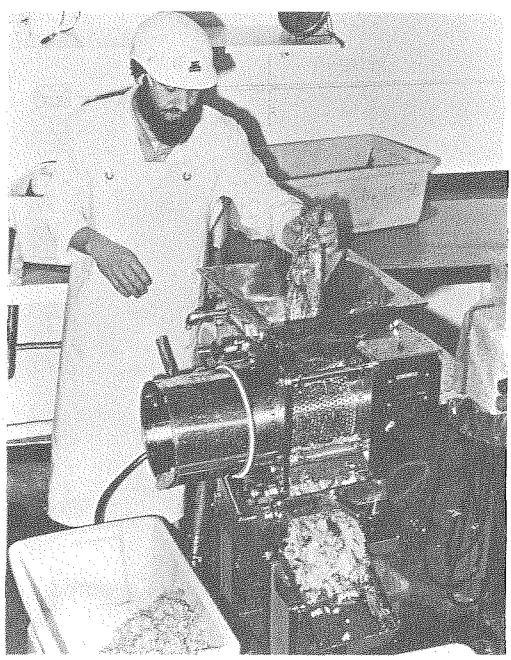
Research on fish and fish products was greatly strengthened by the appointment to the staff in 1968 of June Olley. She had



D. G. James and June Olley, Leader TFRU, examining a new fish meat separator.

come to Australia for three weeks at the invitation of the Department of Primary Industry and the Tasmanian State Fisheries Board to lecture on the possibility of establishing a fish meal industry. She was also about to get married and would make her future home in Hobart. When June Olley turned up at 'Stowell' early in 1968 looking for a job, the Division reacted favourably and she was offered and accepted a position of Experimental Officer, the only one that was vacant at that time. She was already well known to officers of the Division for her theoretical and practical work at the Torry Research Station, Aberdeen, where she had been for eighteen years. June Olley commenced work at 'Stowell' in August 1968.

Following the death of S. M. Sykes in November 1969 June Olley took over the running of the group at Hobart. She had by now been reclassified to research scientist status. Sykes's death greatly reduced the amount of fruit and vegetable work at 'Stowell'; an assessment of the investigations on potato texture and a study of the distribution of solid matter in potato tubers were carried out by A. R. Quarmby. This decline in fruit and



H. A. Bremner using the new Bibun fish meat separator.

vegetable investigations was foretold in a report compiled in 1965 in which Vickery stated 'It appears that CSIRO research results are considerably ahead of the current requirements of industry'. This applied to berry fruits and apples in particular.

In 1972 the group at Hobart was renamed the Tasmanian Food Research Unit (TFRU) under the leadership of June Olley. Fish investigations were expanded and additional appointees were S. J. Thrower, in 1971, and H. A. Bremner who transferred from Cannon Hill in 1975. Many aspects of the abalone, including methods for its preservation, were studied and it is now an export earner in the Far East. High concentrations of cadmium, copper and zinc were found in oysters taken from leases close to Hobart and Launceston. These levels were high enough to cause some oysters to act as emetics, particularly when taken with alcoholic beverages, and many of the leases had to be abandoned. A study is in progress of the suitability of minced flesh from species of Australian fish as raw material for the manufacture of fish fingers.

The program of the Tasmanian regional laboratory has reflected, in large part, the changes that have occurred in food production in Tasmania. As far as one can foresee this program is now firmly oriented toward research on fish and its products.

The service sections

The research activities described in Chapter 12 have required the support of a large number of ancillary staff, who have supplied essential services within the laboratory, and have dealt with the daily demands of other aims of CSIRO, industry (both as supplier and consumer) and the general public.

Statistics and tasting

Most officers at DFP—and apparently in other Divisions too—needed specialized statistical support and so it became the practice in CSIRO for the Division of Mathematical Statistics, with headquarters in Adelaide, to station staff in other Divisions. Nevertheless they always remained very much a part of Math. Stats and the Chief, A. E. Cornish, jealously guarded his far-flung empire. The role of the statistician at DFP was initially a varied one; it included education of the experimentalist, help in the design of trials, collection and reduction of data and assistance in the publication of valid conclusions.

The Division's first professional statistician was Hungarian-born George Ferris. In 1947, he was sent from Adelaide, as assistant to Helen Newton Turner, in the McMaster Laboratory of the Division of Animal Health at the University of Sydney. Ferris was supposed to visit Homebush on one day per week but he found so much work piled up there that he was soon spending most of his time at DFP reducing the statistical backlog. It was strange that, outside the Division, Ferris, whose work was so intimately connected with the laws of chance, should have tried to beat those laws on the race track, but try he did. In 1950, he went to the U.S.A. and was replaced by G. G. Coote who acted as statistician until he retired in 1973.

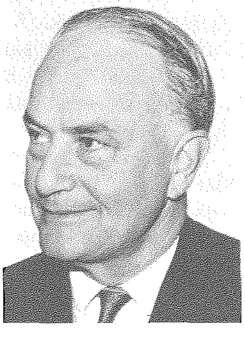
George Coote could only be described as meticulous and unwavering. Invariably, a discussion with him about the plan for an experiment invoked a lecture on the theory of the statistics which were to be employed. Coote, who had been a school teacher, obviously relished his educational role, and while some staff members did not always enjoy the lectures, they were certainly wiser after these unavoidable dissertations. As an ex-Army captain also, Coote always regarded Cornish as his C.O.; in turn Cornish often held Coote up as a shining example of dedication to the job.

An essential part of the statisticians' entourage was a staff of girls to operate the calculating machines. In the 1950s this group was a focal point for the young blades who worked at DFP. In less than 25 years, however, major changes have occurred in methods of handling statistical data; hand-cranked calculators gave way to electric Facits, Marchants and Monroes, punched card systems were introduced and then the computer arrived. Today our statisticians operate through computer terminals connected to the sophisticated SIRONET and they need computer programmers instead of calculating girls.

The results from the tasting tests, which were part and parcel of the trials on stored fruits and processed foods, required particular statistical treatment, owing to the variability of the tasters who were called upon to participate in the trials as part of their duties. The taste tests had to be done under standardized conditions; initially Sections did their own tests in various corners at Homebush but after the appointment in 1952 of Miss E. M. Christie to supervise tests, a centralized area was established where foods could be prepared and where tasters could assess products in pleasant and relaxed conditions. Betty Christie graduated in science from Sydney University, and then studied dietetics. She resigned from the Division in 1971 and was replaced by R. L. McBride, an honours graduate in psychology and statistics.

On Coote's retirement in 1973, R. I. Baxter who had been trained at North Ryde before going to MRL in 1970 as a statistician, returned to the Food Research Laboratory. In recent years the statistical load at DFR has fallen, mainly due to a reduction in horticultural and storage

D. Martin, Officer-in-Charge at 'Stowell'.



S. M. Sykes (1969).

Barbara Johnston (1948).

G. G. Coote (1973).

trials, allowing Ron Baxter time to develop computer programs that can be used not only in the Division but also in the rest of CSIRO through SIRONET.

Library

A history of the library services of the Division becomes, almost inevitably, a catalogue of the talents and achievements of its first librarian, Miss B. E. Johnston (1940–1975), who was mentioned in Part 1. She graduated in science from the University of Sydney before qualifying for membership of the Australian Institute of Librarians. There are many in the Division who would accept no other view but that Barbara was a scientist first and a librarian second; she saved scientists countless hours by answering thousands of inquiries herself, or by attaching to an inquiry the pertinent published paper from which a scientist could readily extract the answer. Even though Barbara Johnston spent a lot of her time aiding the scientific staff, her influence on the development of scientific and technical libraries in Australia, through publication and committee work, was also profound.

Starting with a table and without even a typewriter, Barbara Johnston acquired, as the first library, part of a room bridging Mutton Lane. Later, in one of the many expansions at Homebush, a large and quieter room was built but it was soon overflowing. This was indicative of the surge of information that was emerging on food science and technology in the 1950s. It was only when the Division moved to North Ryde that the library acquired a level of accommodation commensurate with its importance. Air-conditioned reading rooms, adjoining stack room and sufficient work areas, seemed like sheer luxury after Homebush. Even at North Ryde, however, Vickery found it difficult to allocate enough funds to build up the library to an appropriate level. Extensions, planned as early as 1959, were built in 1971; these included another stack room and a 'sanctum' where staff could study or write without interruption, free even of the ubiquitous cursed telephone. These additions reflected the importance which Michael Tracey, even more than Vickery, attached to a library. He somehow managed to allocate more money to the library, and the range of journals it acquired and the text books purchased greatly increased. Notable among Barbara Johnston's attributes was her memory in ferreting out those hard-to-find items which occur in every library. At the time of her retirement, the library at North Ryde was one of the best of its type in Australia, capable of providing good service to the Division, to the industry DFR serves, and to a wide range of other institutions.

Betty Christie preparing for a taste testing of peas.

Editors

The dribble of scientific papers flowing from the Division became a steady stream during the 1950s. Vickery was always zealous for high quality in publications by his staff and senior members were expected to act as referees and editorial advisers. Hicks bore the brunt of much of this work.

The flow of papers was such that in November 1960 a Divisional Editor was appointed for the first time. As well as editing he was expected to help with publication of the *Quarterly*, for which an Editorial Committee was still responsible, and with the preparation of annual reports. The first editor was G. Cunningham who had been Director of the Leather Research

Institute until it closed down. He stayed for only five months and was succeeded by H. Hirst who came from the CSIRO Kimberley Research Station in Western Australia. Hirst resigned in March 1963 and Cunningham, disenchanted with patents work in a large electronics company, returned as Editor until his death in April 1968 following a long illness. George Cunningham was most helpful to many authors at DFP, particularly the less experienced ones. If he had a fault, it was that he was far too willing to rewrite papers, a fact on which a few members of staff capitalized.

G. J. Walker succeeded Cunningham late in 1968; he had worked for CSIRO for a while in the Information Service, but for the ten years before 1968 he was in charge of the Chemistry Division of the Research Laboratories of the Postmaster-General's Department. His responsibilities were extended appreciably by the amalgamation of DDR and DFP and in 1972 Josephine Bastian was appointed as Assistant Editor.

Workshops and engineering

A research laboratory cannot operate effectively without workshops; staff are needed to maintain equipment and to provide the everyday services required in laboratories. While this maintenance is essential, people are also needed who can translate into practical pieces of equipment, scientists' somewhat ethereal ideas. Thus, training and experience are not always enough, initiative and special skills are often demanded of workshop staff. In the early days at Homebush, a miscellany of tradesmen, including fitters and turners, refrigeration engineer, marine engineer, auto body builder and bricklayer, occupied the workshops. On a shoestring budget they performed minor miracles in an environment continually swept by a fine faecal dust seeping from adjacent sheep-holding pens.

It was realized early that more staff would be needed in the workshops at North Ryde; the Division would miss the steam fitters and plumbers from the maintenance staff of the State Abattoirs at Homebush. Vickery decided that a professional engineer was also needed to organize the workshop and engineering services at the new site. In 1959 Ivor Rey was appointed as the first Divisional Engineer and he stayed about three years.

R. Atkins (1974).

R. B. Withers (1966).

One of the mechanical engineers of the Commonwealth Department of Works (CDW) who helped to supervise building operations at North Ryde was Dick Atkins. In 1963 he became Divisional Engineer, a position he filled until he retired in 1974. Atkins's intimate knowledge of the workings of the CDW was to prove invaluable. Not only did he know who should be contacted there when a problem arose, but he was an expert in locating finance. Sucking on his pipe, Dick Atkins looked like an ex-major who had served in the British Army in India—which, in fact, he was. Never a communicative man, most of his cryptic contacts remained undiscovered. Atkins played important roles in the building of the MRL at Cannon Hill and the Fruit Disinfestation Laboratory at Gosford. In addition, he developed a special interest in the design and construction of cool stores for fruit, especially CA stores. At North Ryde, he left behind two large, white, monumental buildings—a cool room with the dimensions of part of a ship's hold that could, therefore, house containers, and a CA store capable of holding 4000 bushels of fruit. Irreverently, the first is commonly referred to as the White Elephant House and the second and taller one as the Giraffe House.

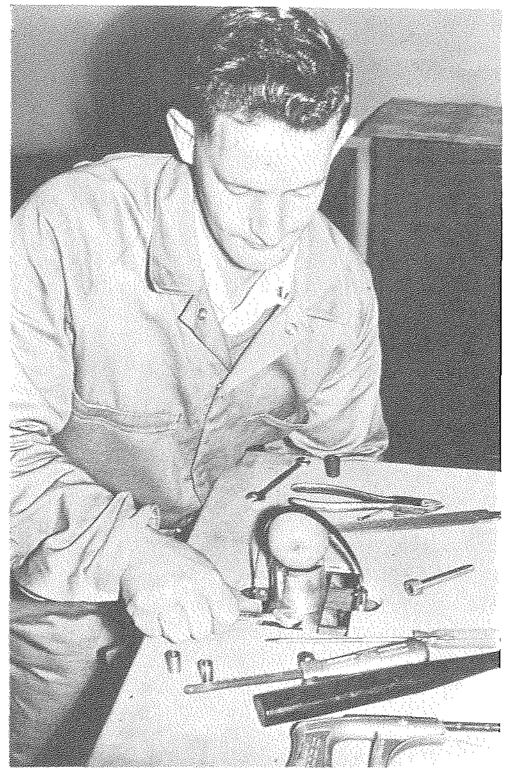
Beyond the orbit of the central workshops and generally outside the control of the Divisional Engineer, specialized satellite workshops sprang up. They usually consisted of one craftsman who worked closely with a section which was developing or adapting specific equipment. Physics (S. Hines), Flavour chemistry (E. Bourn) and Food Technology (N. Huntington) followed, at North Ryde, a trail blazed by Physical Chemistry (S. Rose) when that group was housed at the University of Sydney.

One other workshop which operates almost independently is that of the glass blower. Doug Rose joined the Division in 1953 after 10 years' experience at Crown Crystal Glassworks in Sydney. For some years he also had a contract at Luna Park performing his craft before a crowd of goggle-eyed fun seekers.

The main criticism levelled at the central workshops by research staff is the delay in getting jobs done, particularly manufacturing ones. Allowing for the fact that scientists tend to be impatient—even impossible—about hold-ups to their pet projects, delays that have occurred are attributable to the relatively lower increase in workshop numbers compared with that of research staff, and the high maintenance demands of the North Ryde laboratories. Most research staff, however, are appreciative of the craftsmanship in the workshops.

Administration

Extensive decentralization of the administration of research has always been fostered within CSIRO because it is considered to be profitable and efficient. The term 'Administration' loosely encompasses the clerical services, supply and stores, transport and amenities, and until they were brought under the wing of the Divisional Engineer late in the 1950s, the workshops as well. Many of this ancillary staff remain in a Division for only a relatively short time because progress in their careers depends on transfer to another position with more responsibility. In exceptions to this general rule, some staff have been able to progress within a Division or they prefer to stay on for personal reasons. Notable amongst such exceptions in DFP are Ross Kirkwood who has been a Clerk since 1952, Les Roberts, who was temporary Driver, Driver and then Transport Officer from 1957–76, Miss Marjorie Bartholomew who was Secretary to the Chief from 1946 till 1964, Miss Sandy Henderson, ex-nursing sister, who has been Secretary, Private Secretary to the Chief and first-aid officer since 1961, Fred Brown, ex Rolls Royce stores, who was Storeman from 1961–76, and Mrs Minnie Hooper who was Canteen Attendant from 1947–1967.



D. W. Davis constructing a simple but effective device for testing the hardness of apples.

Miss Ella Todd's retirement as Chief Clerk in 1953 marked the end of an era in more ways than one. A significant change was that her successors—whether they were known as Chief Clerk or later as Administrative Officer—were all males. They included W. Burridge, B. Byrne, R. Potent and R. Lipscomb. This prejudiced attitude applied throughout CSIRO, as female Administrative Officers were extremely rare, and it is only in recent years that a significant number of female clerks have been inducted into the Organization.

It has frequently been argued whether service groups in CSIRO should be administered by a professional scientist or by a professional administrator. In the early days of CSIRO a Chief administered his Division with the aid of a solitary clerk. War-time expansion resulted in many Chiefs becoming weighed down with so much management detail that they were in danger of losing contact with the research work of their Divisions. Several used a trusted research colleague to help ease the load of paper work and these helpers became known as Technical Secretaries. This experiment was so successful that by 1945 the job became a full-time one and by 1949, emphasis had shifted so that administrative experience became a decisive factor in selection of Technical Secretaries.

DFP appointed its first Tech. Sec. in 1946 when R. B. Withers, who had been a teacher in the Victorian Department of Education for 24 years, joined the Division. He soon became a useful aide to the Chief although Vickery probably did not transfer to him as much scientific responsibility as he might have done. Withers was appointed as Secretary and Executive Officer of a number of committees which coordinated research work of the Division with other Commonwealth and State authorities. He played an important part in publication of the *Food Preservation Quarterly*, organized visits to the Division from industry, universities and schools, and was a target for many telephone inquiries when a specialist could not be found. It was in dealing with people, however, that Bob Withers excelled. His humanitarian ideas were well known to new appointees and visitors to the Division, particularly those who came from Asia to study at Homebush or North Ryde. For such people, he went far beyond reasonable expectation in settling them into the Division. This was done under the handicap of chronic debilitating illness with which Withers battled courageously.

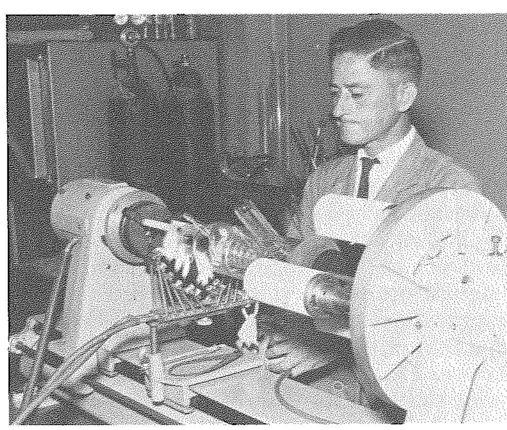
Clerks in CSIRO gradually became restive about the amount of clerical work that was being done by Tech. Secs. and they argued that this was limiting their own opportunities for promotion. In due course the Executive decided, in 1958, to introduce the new category of Administrative Officer; this class would control all management except the research program and the workshops. At the same time, the Executive severely limited appointments of Tech. Secs. although many existing ones laboured on for a long time after this decision. The days of the Technical Secretary as a position within CSIRO were numbered. Bob Withers retired in 1969 after 23 years at DFP only to return to his old profession, teaching, for another five years. His place was taken in 1970 by G. Fisher, and one of his main duties in the Division is now consumer liaison.

When the Division of Dairy Research was absorbed and the Division of Food Research was established, a headquarters group was set up at North Ryde. Ian McDonald, a former Administrative Officer from the Division of Animal Production at Prospect, was appointed in 1971 to act as Divisional Secretary. His duties, in many ways, resembled those of the original Technical Secretary, his role being to reduce the managerial load on the Chief and the Associate Chief.

As might be expected, the blending of scientist and administrator has not been devoid of friction in CSIRO. Many scientists are critical of the strictures put on them by regulations which flow through from the Public Service Board into statutory bodies. These have tended to increase as the Organization has grown but the DFR, with few exceptions, has been well served by its back-up staff.

Liaison and consumer education

Dr F. W. G. White, who was to become Chairman of the Executive of CSIRO from 1959 to 1970 in succession to Sir Ian Clunies-Ross, was appointed Assistant Executive Officer in February 1945. Almost at once he became involved with the secondary industries side of the Council's activities and prepared a statement on the subject for consideration

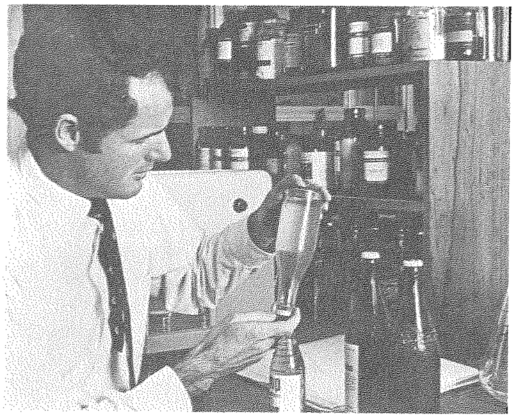


D. C. Rose making the condenser for a spinning-band fractionation column (1960).

by the full Council in July 1945. Among other things he said: 'It is accepted as a fundamental principle of CSIR that the scientific workers in the Divisional laboratories should have as great a contact with industry as possible.' But he also put forward the view that too great a contact by too many officers could result in reduced research output. He then went on: 'it should be the function of any particular Division to have at its command a complete picture of the industry with which it is concerned. This is really one of the functions of the Chief of the Division and he will always need at least one man—his Technical Secretary—to assist him in maintaining this relationship. It still remains to be seen whether the Divisions themselves should go further than this—whether, in fact, they should have a small staff carrying out the functions of a liaison and information service.'

The Australian food industry was then a lot smaller and a lot less diversified than it is today and Vickery established contact with most parts of it. He was aided in this task by almost every research officer at Homebush having a close association with some part of the industry. By 1952, liaison activities of some staff were assuming major proportions and it was agreed that a liaison officer was necessary. However as money was then short, it was decided that an appointment should be deferred, but not beyond two years. In fact, many more years were to pass before a liaison officer was engaged. At the time of the 1955 Divisional review, it was reported that about 700 inquiries were received each year and that 20–25% of officers' time was occupied in liaison work. This load was not evenly spread across the whole staff so that some had a very heavy burden to carry in this area.

The Division still did not have a liaison officer by the time of the 1967 Committee of Review, when it was estimated that 15–20% of professional officers' time was spent in extension-type activities. This was a significant drain on the research program and the Committee considered 'as a matter of urgency that a Scientific Services Officer of high calibre and of senior status in the Division should be appointed to accept the main responsibility for the Division's information services.' Tracey, the new Chief, moved quickly on this recommendation and in May 1968 K. C. Richardson, a microbiologist by training and a food technologist by experience, was appointed as Food Technology Liaison Officer. His defined role included 'positive promotion of new processes and products of potential value to the Australian food industry as well as assistance with general inquiries and manufacturers' problems.' Richardson proved to be an excellent selection for the job; he soon eased the pressure from most officers whose extension duties had become onerous, without inhibiting direct contacts where these were appropriate between food manufacturers and individual officers.



K. C. Richardson examining haze in apple juice.

In 1974, the then Minister for Science, the Hon. W. Morrison, feeling that the knowledge and expertise accumulated by CSIRO were not sufficiently accessible to the general public, vigorously pressed the Division to enter the field of consumer education. Pamphlets on subjects that were judged to be of interest to consumers were prepared and distributed to groups such as home science teachers and consumer organizations. Some typical titles are *Don't poison your family*, *Handling food in the home*, *Storage life of foods*, *Prawns fresh and frozen*, *Citrus juices—how to preserve your own* and *Milk and cheese and all that*. When the availability of these pamphlets was announced on television and radio, the Division was inundated with requests from consumers. More than 50 000 copies of the best-seller, *Handling food in the home*, were distributed. Newspapers and magazines also used the material extensively.

These and other measures such as appearances on television and radio, and talks to clubs and associations by staff members, replaced the low-key approach which had existed for decades when the Division had answered inquiries from consumers but had regarded liaison with the food industry as its primary extension function. Most staff members recognized the propriety of this new approach even though for some it meant an increased workload; G. Fisher, the Technical Secretary, found himself doubling as Consumer Liaison Officer. It also thrust before some members the problems involved in writing science for a lay audience—an audience that was sometimes confused by the rising output of unfavourable publicity about foods and that avidly sought facts and reassurance.

By the 1970s then, the Division was advising consumers, industry and government on many food issues. Some were highly contentious but it has become clear that the Division, and indeed CSIRO as a whole, have earned the confidence of the public as bodies giving sound advice without bias or vested interest.

Chapter 16. Collaboration with other organizations

The early history of the Section of Food Preservation is studded with examples of collaboration with other organizations, first in Melbourne, and then at Cannon Hill and Homebush. In all three places Vickery had to depend on others for his laboratory accommodation, and it says much for his diplomacy that these associations remained cordial. The wartime work of the Division forced it into close contact with many Commonwealth Government departments and with companies providing food for civilian and defence purposes. Consequently, most members of staff found that they had many widespread contacts when peacetime projects were being re-established in the Division, and they continued to use these with mutual benefit.

State departments of agriculture

The Division has collaborated with all six State departments of agriculture over a range of diverse subjects which include

Citrus Wastage Research Laboratory, Gosford, N.S.W.

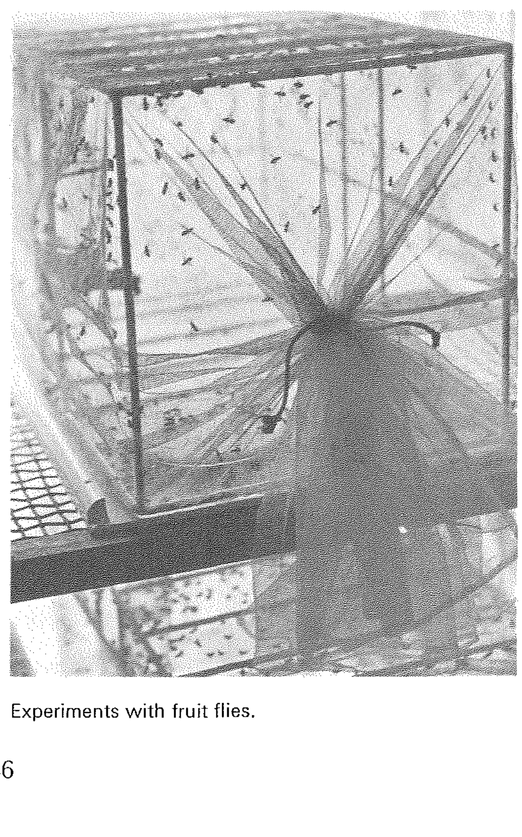
the storage of fruits and vegetables, the preparation and storage of dried fruits, mechanical harvesting and processing of fruits and vegetables, and the quality testing of potatoes. State departments, with their field stations, were often sources of raw material for DFP and, through their extension services, they channelled research results to primary producers. CSIRO concentrated on postharvest problems such as storage and processing, and tested varieties that were either bred by the departments or were introduced by them from overseas.

It is not surprising that cooperation was most pronounced in N.S.W., the State in which the Division had its headquarters. Senior officers of the Department of Agriculture, and the Chief Horticulturalist in particular, have always maintained links with the DFP, but none were closer nor more effective than those forged by C. G. Savage. As Director of Horticulture (1934–50) he arranged, for the first time, for members of his staff to be stationed at the Division—an association that has persisted without interruption to the present day. Eric Hall (fruit and vegetable storage), who was the first of these collaborators, came to Homebush in 1939. Another early appointee was S. M. 'Bill' Sykes (frozen foods) in 1947. Both scientists later joined DFP and played significant roles as described in previous chapters. Of all departmental collaborators, Kevin Scott has by far the greatest number of 'years of service' at the Division. He has worked at the DFP for 21 years, mainly on fruit storage.

Mould and fruit flies

The most conspicuous cooperative venture between the Division and the N.S.W. Department of Agriculture was the establishment in 1948 of the Citrus Wastage Research Laboratory at Gosford, 80 km north of Sydney. It was built in response to urgent requests from the citrus industry, which was suffering serious losses from mould wastage in oranges, particularly in the Central Coast area. In a rare threeway operation, Sungold Cooperative Citrus Packing House provided land, CSIRO met building and running costs for the Laboratory and the Department of Agriculture supplied the staff. During the next 20 years, more than 150 fungicides were tested against green mould and stem-end rot. As a result, the use of sodium orthophenyl phenate (SOPP) was recommended in the early 1950s; later, benzimidazole compounds were found to be as effective as SOPP and had less tendency to cause skin damage. These treatments are estimated to have saved the industry \$1·5 million per year. The Laboratory also defined the best ways of applying fungicides, of waxing fruits to reduce shrinkage and improve appearance, and of de-greening citrus fruits with ethylene.

In 1955, studies on postharvest disinfestation of citrus against fruit fly were intensified at Gosford using cold storage and fumigation. Low temperature treatments were applied at Homebush where cold rooms were available, and divisional staff who had particular skills were called upon to assist at Gosford. For instance, Ili Coggiola explained the fate of ethylene dibromide (EDB) during fumigation. As a result of this work, EDB fumigation was accepted by New Zealand authorities for unwrapped oranges in 1961 and for wrapped, packed fruit in 1964. Also, in 1967, U.S. authorities accepted a



Experiments with fruit flies.

treatment for apples and pears which involved holding the fruit for 14 days at 0·6°C; the advantage of this treatment was that it could be applied while fruit was aboard ship in transit. At the Atomic Energy Commission at Lucas Heights near Sydney J. J. Macfarlane studied the effects of gamma radiation on fruit flies. Unfortunately, dosage rates that were necessary to kill the insects, caused damage to the rind of many oranges.

The expanding work of the Gosford laboratory called for additional space, and in 1963 it moved to a new building across the road from the original site. On the grounds that the problem of mould wastage in citrus fruits was beaten, disinfestation studies continued to assume greater importance at Gosford; programs on bananas and tomatoes were undertaken to assist the interstate trade in these fruits. Fumigation with EDB and the application of the insecticide dimethoate proved effective for bananas but the investigations on tomatoes were less successful. Disinfestation of citrus fruits had to be reexamined in an effort to meet the more stringent demands of the Japanese, and in 1972, work began to develop a treatment against light brown apple moth. Any satisfaction arising from the apparent solving of the citrus wastage problem suffered a jolt in 1975 when *Penicillium* strains appeared that were resistant to benzimidazoles. The ability of microorganisms to mutate and circumvent control measures was once again demonstrated.

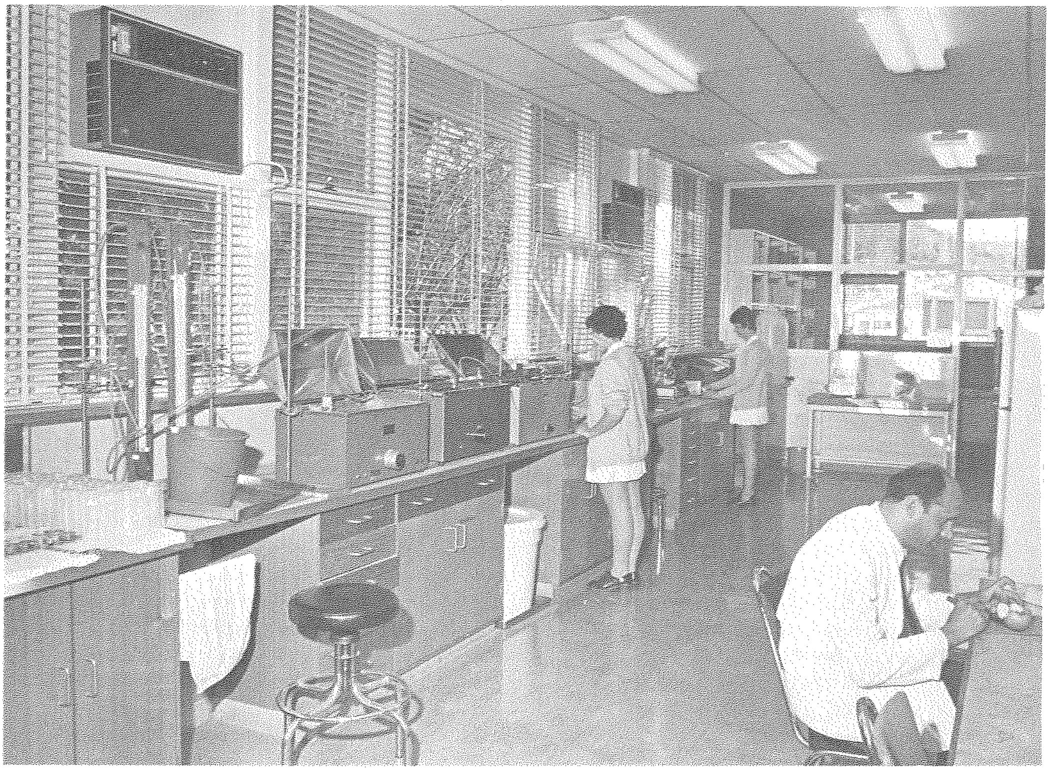
A new Fresh Fruit Disinfestation Laboratory was opened in August 1974, and at the same time, the name of the unit was changed to the Gosford Postharvest Horticultural Laboratory. The new laboratory cost $100 000 which came from the Commonwealth Department of Primary Industry, State departments of agriculture and CSIRO. Representatives from these organizations are now responsible for direction of the program of the Laboratory, reflecting the nation-wide importance it has attained.

It is significant that past officers-in-charge at Gosford such as Kevin Long, Don Leggo and Alan Seberry have moved to senior positions in the N.S.W. Department of Agriculture. Modestly they suggest that their association with DFP assisted their progress; manifestly it gave them an opportunity to publish research papers that may have improved their future prospects—a point that they also accept.

Other government departments

The DFP with its interests straddling primary and secondary food industries, has collaborated with many other Divisions of CSIRO. Shared activities include personal discussions, the development of new, or the sharing of commercial equipment, service on committees, and occasionally, major cooperative research programs. In the late 1940s vegetables for the Division's processing studies were grown at the Irrigation Research Station at Griffith, and by the Division of Plant Industry at Canberra. In return, DFP processed varieties that were introduced or bred by other Divisions. DFP helped the Division of Wildlife Research in its early experiments on rabbit control; black thistle roots—a favourite food of this once major threat to Australian agriculture—were preserved by drying at Homebush and then distributed in severely infested districts after rehydration in water containing poison. The Divisions of Food Research, Mechanical Engineering, and Chemical Engineering assisted the Division of Horticultural Research in studies on the drying of vine fruits at Merbein. A prime example of cooperation within CSIRO was the production of meat and dairy products containing high levels of polyunsaturated fatty acids; the Divisions of Food Research and Animal Physiology provided the scientific expertise and worked closely with the commercial licensee for the products, Dalgety Agrilines Ltd. This project is described more fully in Chapter 14.

A number of Commonwealth Government departments, lacking enough scientific and technical expertise of their own, have often sought the assistance of the Division on many matters concerning foods and food preservation. A close link, initiated before the war, and persisting to the present day, was forged with the Department of Commerce and Agriculture—later the Department of Primary Industry (DPI). This Department was responsible for setting and controlling quality standards in foods for the Armed Forces and for export markets, and as it



A laboratory in the new Fresh Fruit Disinfestation Laboratory.

had no food technologists of its own at that stage, it frequently called on the DFP for help.

At a meeting of the Commonwealth Advisory Committee on Defence Science in London in 1949, it was made clear that many of the research results on processed foods acquired during the war would be lost unless at least some were translated into commercial practice. Consequently the Department of Commerce and Agriculture established a Defence Foodstuffs Research Committee (DFRC) under the chairmanship of Brigadier Sir C. Stanton Hicks. Jack Shipton, who had worked on dried foods at DFP since 1943, was seconded from 1951–58 to supervise the Committee's research program as Chief Food Technologist. The present Armed Forces Food Research Establishment at Scottsdale, Tasmania, originated as part of that program. In Adelaide, another DFRC group, under the leadership of Dr A. R. Johnson, a biochemist trained at Leeds, studied the use of antioxidants. Later, in 1961, Johnson joined the DFP as co-leader with A. R. Prater of the Animal Production Section.

Members of the Division, working through the National Health and Medical Research Council, have played a noteworthy role in the regulatory processes covering food in Australia. Vickery was on the first Food Additives Committee and Kefford was appointed to the first Food Standards Committee. Initially W. J. Scott, and then J. H. B. Christian served on the Food Microbiology Subcommittee which was established later. Divisional representation on subcommittees of NHMRC dealing with food has been maintained to the present day.

Codex Alimentarius

The Division is also involved with food standards in the international sphere; in 1963 Kefford accompanied I. H. Smith of DPI to the first meeting of the Codex Alimentarius Committee in Rome. From that time the Division has continued to provide expert opinion to Codex through DPI, and Christian, Board, Johnson and Richardson have served on international expert and commodity committees of Codex. The estimable aim of Codex of securing international acceptance of standards for foods involved in international trade had not been achieved for any commodity by 1976, but slogging work by international committees has produced a position where standards for a number of foods are ready for final acceptance.

Foods for Antarctica

During 1954–55 the Division cooperated again with the DFRC and with the Antarctic Division of the Department of External Affairs in evaluating a range of processed foods after they had been stored for 13 months at Mawson, the mainland base of the Australian National Antarctic Research Expedition. These foods, on their return to Sydney, were compared with samples that had been held at 0°C at Homebush. Dried foods withstood Antarctic storage conditions well, a fact which was confirmed by favourable reports from members of the Expedition; in particular, ice cream mix was popular even in the land of constant snow and ice. Glass-packed foods were unacceptable due to the risk of breakage of the containers when their contents froze. Canned fruits were slightly mushy owing to constant freezing and thawing during the storage period, and many canned vegetables were so broken down as to be suitable only for soup.

Nuclear exposure

In 1956 the DFRC, in conjunction with the British Ministry of Agriculture, Fisheries and Food, asked the Division to assess the quality of a series of foods that had been exposed to a low-yield nuclear blast at the testing range at Maralinga in Central Australia. Having received an assurance on the safety of the products, the Executive agreed that the tasting tests should be done. After decontamination, the foods were divided equally between a U. K. laboratory and Homebush. No detectable organoleptic defects were observed in any of the products in either country.

Australian Atomic Energy Commission (AAEC)

In 1956 Franklin Kidd suggested that Vickery should send somebody to the Low Temperature Research Station (LTRS) at Cambridge to participate in a new and promising field of preservation—the irradiation of foods. From respondents to the consequent advertisement, John Macfarlane, who was already working in the Physical Chemistry Section on infrared studies, was selected and left for LTRS in May 1957. For a while he worked with Hannan at Cambridge on the development of gas–liquid chromatography (g.l.c.) for analysing volatiles (odours) from irradiated foods, but finding the facilities for irradiation studies restricted at LTRS, he moved to the U.K. Atomic Energy Authority at Wantage, a part of the Harwell complex. At Wantage, not only were irradiation facilities excellent but Macfarlane was able to continue his work on g.l.c. He returned to Australia in early 1959 and in the following May it was decided that he would work at the AAEC at Lucas Heights.

The Commission agreed to provide and operate irradiation facilities and to measure dosage rates, and a third party, the Armed Forces Food Research Establishment (AFFRE), agreed to carry out consumer testing of irradiated foods. The AFFRE was particularly interested in reducing expensive refrigeration requirements in military supply systems, and saw irradiation as a possible means of doing this. At this early stage, W. J. Scott sounded a warning note on the deterioration in colour, smell, taste and texture of meat, induced by dosages of irradiation sufficient to sterilize it. In spite of doubts such as these, it was decided that active research in this field should be done in Australia not only because of its possible importance here but also for the DFP to be in a position to exchange information with other researchers.

The laboratories at Lucas Heights were not ready until early 1960 and when Macfarlane got there he found the first irradiation facilities inappropriate; a 20-tonne crane, with driver, was needed to handle a half box of apples. However, the work on fruit fly disinfestation got under way. When more suitable facilities—

an irradiation pond and a cobalt source—became available, studies on the inhibition or destruction of microorganisms on fruit and meat started. Serious consideration was also given to a proposal to build a mobile irradiator; the idea of treating food right at its point of production seemed to have distinct advantages. AAEC personnel were keen to demonstrate their skills by building the machine, but CSIRO held back mainly because Macfarlane could not yet foresee what products might be irradiated satisfactorily. The decision not to build was probably correct because similar equipment, built in other parts of the world, was soon parked away unused.

In 1966 Macfarlane attended an International Conference on Food Irradiation; there, the consensus was that the future of food irradiation was extremely limited. In March 1967, CSIRO and AAEC representatives met to consider the future of irradiation investigations in Australia. By now the CSIRO Executive had doubts about even a holding research program, but Vickery was unwilling to make a final decision on CSIRO's role as he was about to retire and, characteristically, he felt the decision should be taken by his successor. Early in 1968 the new Chief, M. V. Tracey, decided that the Division would cease irradiation studies and Macfarlane went to the Meat Research Laboratory in Brisbane in mid-1968. Although he did no further experimental work on food irradiation, he continues to keep a 'watching brief' on this field of work.

Division's role in education

The Division may fairly claim to have played a significant role in launching education in food science and technology in Australia. In November 1943 a meeting of the staff at Homebush pointed out a need for courses at several levels: trade courses to train skilled operatives for the food industry, diploma courses in technical or agricultural colleges, and university courses. There is little doubt that Vickery and his staff were influenced by their experiences in dealing with a food industry which, under wartime pressures, had shown a lack of technical strength. The outcome was that Vickery appointed a committee, with Kefford as Secretary, to consider Education in Food Technology.

The first action of the committee was to seek information from educational institutions in Australia, and from some overseas organizations, about courses already available. The replies indicated that in Australia, only trade courses in butchering, smallgoods making, bread baking, and pastry cookery, and higher level courses in dairy technology and oenology were available. The reply from Sydney Technical College (STC), however, showed that it had already been prompted by the activities of American food technologists in Australia to consider a course in food technology. Early in 1944 Dr F. H. Reuter, then Senior Lecturer in Organic Chemistry at STC, provided a copy of a proposal that he had submitted to Dr R. K. Murphy (Head of the Chemistry School) for a Diploma Course in Food Technology to be offered to students employed in the food industry as a six-year part-time course, the first three years being identical with the existing Diploma in Chemical Engineering. Some years were to elapse, however, before the proposal came to fruition.

In their immediate enthusiasm, Reuter and Murphy organized a series of lectures entitled 'Some Aspects of Food Technology', under the aegis of the Sydney University Extension Board, but held in the Chemistry Lecture Theatre at STC, Ultimo. The lecturers were Major C. R. Fellers, Major M. A. Joslyn and R. S. Scull (three food technologists with the U.S. Army), Dr Reuter from STC, J. R. Fisher, S. C. Hodgson and W. S. Sutton (from the N.S.W. Department of Agriculture), F. S. Bradhurst from the food industry, and Hicks, Kefford, Mitchell, Scott and Taylor from Homebush. The 13 lectures, delivered in successive weeks from 13 July 1944, were enthusiastically received by audiences of around 200 and there is no doubt that they made the technical community in Sydney aware of food technology as an area of interest.

As a result of the success of this series, two short extension courses were offered in January 1945, one at STC on 'The Operation of Steam Equipment in Food Manufacture', and one at Homebush on 'The Laboratory Examination of Canned

Foods'; Hicks and Kefford lectured and Lewis, McKenzie, Thompson and Greethead acted as demonstrators. The courses were repeated as a Winter School at STC in August–September 1945, with the addition of bacteriological aspects covered by W. J. Scott, and in July 1946, a course on 'Fresh Fruit and Vegetable Storage and Handling' was presented by Hall and Robertson.

Sydney Technical College

Formal teaching of food technology began in 1948 at STC, Ultimo, with lectures in Food Technology I. Practical classes in food processing were managed in crude conditions amongst the chemical engineering equipment in the basement of the Chemistry School. By 1951, part of the STC had become the N.S.W. University of Technology, and a Diploma Course in Food Technology, with improved facilities, was advertised; the department was housed in temporary buildings erected behind the Chemistry School at Ultimo. Dr F. H. Reuter was in charge of food technology courses but almost all the teaching during these years was done by external lecturers from the food industry, the University of Sydney and the DFP (Christian, Hicks, Kefford, Scott, Shipton, Sykes, Taylor and Vickery).

Throughout these years much thought was given to the establishment of an Institute of Food Technology which would embrace both research facilities provided by CSIRO and teaching facilities provided by the Department of Technical Education. The situation was complicated by some confusion in the Department of Technical Education between food trades courses and food technology courses and, instead of amalgamation, the following disposition occurred: teaching of food technology was established at Ultimo and later moved to Kensington; food trades courses went to East Sydney Technical College; and CSIRO food research remained for the time being at Homebush.

Overtures for the DFP to move to Kensington were mentioned in Chapter 11. Reuter, by now Associate Professor of Food Technology, wrote in August 1954: 'We are at the present time leaning heavily on the CSIRO Division of Food Preservation and Transport, Homebush, for members of its staff to assist us with the teaching of specialised subjects of our food technology course. . . . Would it be desirable to establish a closer and more permanent basis of cooperation with that institution which contains in Australia the highest concentration of professional people in all branches of food science and technology? . . . It is considered desirable that we invite the Division to erect its new laboratories at our Kensington site.'

Although the Division did not take up this invitation and the University gradually built up its own teaching staff, close and friendly relations were maintained. Reuter was joined by a Lecturer, R. A. Edwards, who had been a Technical Assistant in the Homebush laboratories. The N.S.W. University of Technology moved to Kensington and became the University of N.S.W. In 1960 the Faculty of Applied Science approved a four-year degree course in the School of Chemical Engineering leading to B.Sc. in Food Technology. Associate Professor F. H. Reuter retired in 1970; a Chair was established in 1974 and Edwards was made first professor of Food Technology. In 1976 Food Technology achieved the standing of a School in the Faculty of Applied Science.

Formal contact between the Division and the School of Food Technology is maintained by M. V. Tracey and J. F. Kefford as members of the Visiting Committee, but there is, in addition, extensive continuing contact through joint research and student projects, vacation employment of students in FRL, and sharing of facilities and personnel in the conducting of specialist courses for the food industry.

Hawkesbury Agricultural College

The Division also played a major part in developments which led to the establishment of a Food Technology Course at Hawkesbury Agricultural College (HAC). These developments occurred in parallel with progress in the teaching of food technology at STC. Both C. G. Savage, Director of Horticulture in the N.S.W. Department of Agriculture, who was keenly interested in the processing of horticultural products, and E. A. Southee, Principal of HAC, sought the help of the Division in providing a course at the College and facilities for practical teaching.

In December 1948, Southee wrote an official letter to Vickery thanking him for the cooperation of his staff 'in connection with the erection and equipping of the new College cannery and the proposed inauguration of a course in Food Technology. Special appreciation is extended to your officers—Messrs Lynch, Kefford and Mitchell—for their constructive criticism and particularly helpful advice in formulating a curriculum for the course.'

In the first instance, a course on Principles of Food Technology was included in the program for the Diploma of Horticulture at the College. Pending the appointment of a lecturer, CSIRO was asked by Dr R. J. Noble, Under-secretary and Director of Agriculture in N.S.W., to make officers available to teach the course in 1949. The Executive and Vickery agreed, and indicated that the officers would be permitted to receive remuneration at the rate of $2.50 per hour. Vickery gave the introductory lecture in May 1949 and a regular program of lectures was continued by Lynch and Mitchell.

G. F. Greethead, who had been a Technical Assistant at Homebush, accepted the position of Lecturer in Food Technology at HAC in 1950, and in the following year, he initiated a Diploma Course in Food Technology. Although the course was only of two years' duration, and provided highly practical training, many of the early HAC diplomates quickly advanced to positions of production and general management in the food industry. It is now hard to believe that the fees for this residential course, including tuition, board and lodging, were only $192 per year.

According to the HAC practice of employing external examiners, Lynch was nominated as external examiner in Food Technology subjects in 1950, and with the help of his colleagues, he acted in this capacity for many years. Former students of the College have instituted the Lynch and Mitchell Proficiency Award in the final year of the Food Technology course, and the award certificate bears this citation: 'Laurie Lynch and Robert Mitchell were the driving force in founding the Food Technology Course at Hawkesbury College. Their aim was to train food technologists for the Australian food industry who would enhance the technical and managerial status of the industry. To achieve this objective much personal effort and time was willingly given. This honour, therefore, is granted only to those who excel in Food Science and Technology and approach the high standards set by these pioneer educators.'

The College is now the Hawkesbury Agricultural College of Advanced Education; the School of Food Sciences, recently housed in handsome new buildings, is led by Paul Baumgartner and offers a three-year course leading to a degree of B.App.Sc. (Food Technology). The Division maintains its close association with HAC by providing lecturers for special courses and by membership of advisory boards on curricula and standards.

Technical and professional bodies

Technical strength in the Australian food industry has been built up not only by the input of trained people from food technology courses but also by the formation and growth of technical associations and professional institutes. Here too, the Division has provided much encouragement and support through the years. Indeed it has always recognized the great value of such bodies as a means for two-way exchange of technical information with the food industry.

The interest in food technology, kindled in the food industry during the war, was demonstrated by the formation of Food Technology Associations (FTA) as divisions of Chambers of Manufacturers, first in N.S.W. (1945), and subsequently in all the States. The State FTAs are now linked in the Council of Australian Food Technology Associations (CAFTA). From its inception Vickery was elected an Honorary Member of the FTA of N.S.W., and he has been a member of the Technical Standing Committee of CAFTA for many years.

There was a further need, however, for a professional body made up of qualified individual members, in contrast to the company membership of the FTAs. The initiative in creating such a body was taken by one of the food technologists in the U.S. Army, Capt. C. E. (Chuck) Norton, who returned after the war to a technical position in Australia and began recruiting Australian members for the American Institute of Food Technologists (IFT).

When he convened an inaugural meeting of nine Australian members in Sydney on 29 May 1950, two officers of the Division, Vickery and Kefford, were present. An Australian Regional Section of IFT was formed—the first to be chartered outside the United States—with Norton as the first Chairman. He was followed by Vickery in 1951. The new Section grew rapidly, and in 1952 when the membership was 80, it divided into Australia Northern and Australia Southern Sections. The two Sections continued to flourish and to meet in an annual convention.

By 1967, when the combined membership was 450, the time was ripe for an independent national body; the Australian Sections of IFT were dissolved and the Australian Institute of Food Science and Technology (AIFST) was constituted with Vickery as its Foundation President. In the 10 years since then the membership of AIFST has grown to 1350. Kefford was the third President of AIFST in 1971–73, and other members of the Division who have held office in the Council and Branch Committees are Board, Casimir, Chandler, Davis, Nicol, Rooney and Whitfield.

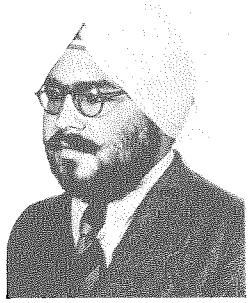
The Australian Sections of IFT established two awards: in 1955, the International Award of IFT to 'promote international exchange of ideas in the field of food technology', and in 1957, the Australian Award for 'meritorious contributions to the advancement of food science and technology in Australia'. Of the three Australians who have won both of these Awards, two were members of the Division: J. R. Vickery (1960 and 1966) and L. J. Lynch (1962 and 1965); the other was F. H. Reuter (1962 and 1972). In addition J. F. Kefford received the Australian Award in 1961. This Award was continued by AIFST as the Award of Merit and has been won by three other members of the Division: M. V. Tracey (1974), B. V. Chandler (1977), and R. A. Buchanan (1978); and by G. Loftus Hills (1971) when he was Chief of the Division of Dairy Research.

The moves that led to the birth of AIFST were prompted in part by concurrent activity directed towards an international body in the field of food science. In 1960, Vickery was one of a group headed by Dr Emil Mrak of the University of California which began informal discussions about an international union. Congresses were held in London (1962), Warsaw (1966), and Washington (1970), and at the Washington Congress an International Union of Food Science and Technology was founded. At this time Kefford was the Australian delegate to the General Assembly of IUFoST; he was elected to the Executive Committee and appointed Chairman of the Education and Training Committee and in 1978 was elected Secretary-General of IUFoST.

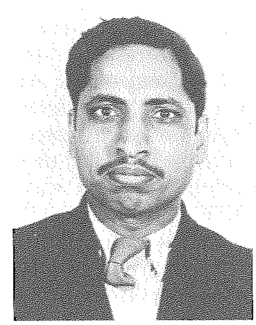
The Division also established links with the International Union of Pure and Applied Chemistry (IUPAC); M. V. Tracey was elected in 1974 as a Titular Member of its Commission on Food Contaminants, and in 1975, A. R. Johnson was appointed to the Commission on Oils and Fats. In 1971 the election of J. H. B. Christian to membership of the International Commission on Microbiological Specifications for Foods began an international involvement which has continued with his engagement on several occasions as consultant to the World Health Organization in this field, and his appointment as Chairman of the WHO Expert Committee on Microbiological Aspects of Food Hygiene.

Overseas students at DFP

Another educational sphere in which the DFP played an important part was the training of students from overseas in food science and technology. From 1947, when the first trainees came to Homebush, 119 foreign students have worked in the Division for periods ranging from 3 to 12 months or more (Table 3).



Kirpal Singh (1947).



Ram Chand Bhutiani (1948).

Table 3. Number of students from each of 22 countries who have worked in the Division between 1947 and 1975

India	28	Iran	3
Pakistan	24	Brazil	3
Indonesia	18	Turkey	2
Thailand	9	Taiwan	2
South Korea	9	Sri Lanka	2
Philippines	7	Sudan	2

One each from Burma, South Africa, Ghana, Singapore, Nigeria, Czechoslovakia, Western Samoa, Malaysia, Cook Islands, West Indies

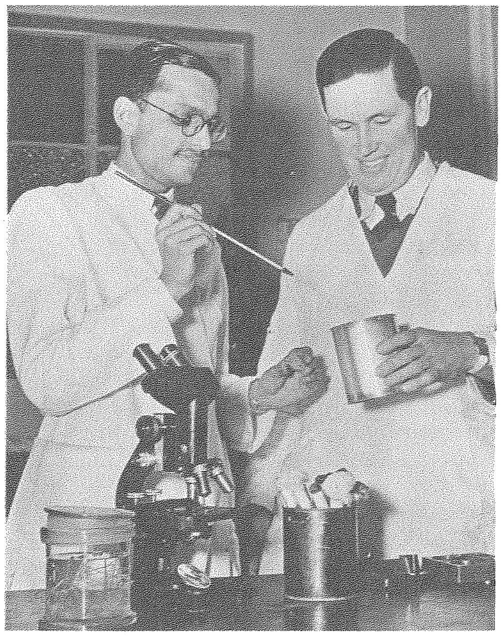
Most trainees came under the auspices of the Colombo Plan or of FAO. However, the first two arrivals in April 1947 had Government of India scholarships. They were Kirpal Singh, a Sikh of imposing stature and quiet disposition, from Amritsar, and Ram Chand Bhutiani, a Hindu of typically sparse frame and agile mind, from the Ministry of Agriculture at Lyallpur. Singh worked on the handling, storage and transport of fresh fruit and vegetables while Bhutiani studied food processing procedures. They experienced a few difficulties, most of which arose from the inadequacy of the stipends they received from their Government while in Australia. They were in Australia when the partition of the sub-continent occurred in August 1947. Bhutiani's family disappeared for a time among the refugees in India, and he shortened his stay by two months sailing for home from Perth in February, 1948.

A problem which worried the two Indians and many of the students who followed them, was the inability to gain further academic qualifications during a traineeship with CSIR. On a visit to Canberra, Bhutiani and Singh raised with Sir David Rivett the possibility of initiating a 'Diploma of the Associateship of CSIR'. In a subsequent letter to Vickery, the Chairman commiserated: 'Had it just been possible for us to give them the coveted piece of parchment which evidently means such a great deal to the Indian mind, our stocks would have been exceedingly high'. Although disappointed by this decision, the Indians, on return to their home country, wrote: 'We badly miss the atmosphere of cordiality, cooperation and friendship which we enjoyed with you'. Despite the lack of that additional 'piece of parchment' both Indians established satisfactory careers in their own country.

Time and effort from the staff of DFP assumed major proportions in these training programs and it is almost impossible to assess whether the efforts were justified. In a few cases nothing further has ever been heard from or about the trainees, but sufficient numbers have had highly successful careers in their own countries to suggest that the efforts were worth while. In the last decade, the number of trainees at the Division has declined but during that time, many staff members have been involved with training programs in developing countries particularly in South-east Asia.

International recognition

The Cambridge connection, which was so important to DFP during its formative years, continued after World War II. Many younger staff members of the Division beat a path to the Low Temperature Research Station as post-graduate students. They were mainly microbiologists and biochemists and



J. C. Anand, a research student from India and J. F. Kefford sampling the contents of a can for microbiological examination (1954).

included Salton, Christian, Webster, Brown, Macfarlane and Davenport. The bonds between LTRS and DFP were further strengthened by the despatch of many food parcels from Homebush to Cambridge at the end of the war when Britain's food imports were strictly limited. Training at Cambridge was not obligatory, however; Anet and Murrell studied at Oxford and V. M. Lewis received his Ph.D. from the University of Massachusetts in the U.S.A. The strong links that were forged with food scientists in the U.S. through the Army and professional institutions have already been described, but W. J. Scott had established a link with U.S. scientists by spending a year in the Bacteriology Department of the University of Wisconsin directly after 12 months at LTRS in 1938–39.

The period 1956–61 saw recognition of the growing stature of the DFP. Not only were members of staff being invited as visiting scholars to universities and research institutions overseas, but also their opinions were sought as reviewers of fields of research. In addition, there was an increasing flow of overseas scientists coming to work in the Division on sabbatical leave or on fellowships. Some of the earliest were J. C. Moyer from Cornell University, H. L. Pratt and G. F. Stewart from the University of California at Davis and G. Hamoir from the University of Liège. The additional space and improved facilities which came with the transfer of the Division to North Ryde in 1961, allowed a marked expansion in the number of visiting scientists and it has now become commonplace for a number to be working at the laboratories at any one time. Five or six staff members now travel overseas each year on either short-term (up to 3 months) or long-term (12 months) tours of duty.

However, it is Vickery's accomplishments which provide probably the most favourable guide to the international reputation of the Division. In 1956, he visited Rome on the invitation of FAO and WHO to serve on a panel formulating principles governing the use of additives in foods. Then at the request of the British Government, Vickery spent the first half of 1958 in the U.K. advising on the development of meat research in that country. The adoption of his recommendations resulted in the establishment of the Meat Research Institute at Langford near Bristol. This situation arose because, in 1956, LTRS had been given notice to quit the Cambridge site within 10 years; the Station was to split into two institutes, one on meat research and the other, the Food Research Institute, at Norwich. Vickery must have had mixed feelings about this task; it was obviously a feather in his cap to be invited to do such an important job, but here he was, a protégé of LTRS, having to play a significant part in its dismemberment.

The bestowal of International Awards by the U.S. Institute of Food Technologists on Vickery in 1960 and Lynch in 1962 was clear evidence of the world reputation that the Division had acquired. In 1964 Vickery was invited to deliver one of three lectures at Cambridge to commemorate the centenary of the birth of Sir William Hardy whom many regard as the founder of food science. The other two lecturers were Sir Eric Rideal, formerly Professor of Chemistry at King's College, University of London, and Professor A. V. Hill who was Foulerton Research Professor of the Royal Society for many years. Vickery's lecture was entitled 'Hardy's contribution to the application of science in the food and refrigeration industries'. In 1966 Vickery delivered the first International Lecture to the Food Group, Society of Chemical Industry, London, on 'The scope and status of food science', (Vickery 1967).

The scientific status of DFP has also been recognized by a number of financial grants from overseas sources. These include \$32 500 from the Charles F. Kettering Foundation (1963–64) for the purchase of equipment for research on photosynthesis; \$16 400 from U.S. Department of Agriculture PL480 funds for research on the structure of ovalbumin (1963–65); and another \$92 000 from PL480 funds for a 5-year (1963–67) study of the chemical and biological effects of cyclopropenoid compounds that occur in cottonseed.

This record may appear to dwell on the international reputation of J. R. Vickery but, in the ten years before his retirement in 1967, his role was unquestionably pre-eminent. Of course the reputation of a research laboratory is meticulously built up on the achievements and long-term contacts of many; liaison was established between the Division and food research organizations in Britain, Canada, New Zealand, South Africa, Holland, Denmark, Sweden, France, Germany, U.S.A., India, Thailand and Japan. More recently these international links have been further extended to the developing countries of South-east Asia—Indonesia, Malaysia, Singapore and the Philippines.

Chapter 17. A new Chief — and new directions

The diverse activities described in the preceding chapters reflect the post-war status of the DFP as Australia's main centre of food research. By the 1960s it had become one of CSIRO's leading Divisions, both in size and in reputation. Its foundation Chief, Dr J. R. Vickery, was now close to retirement; he had guided the development of food research in CSIR/CSIRO for some 36 years, not only as leader of food preservation studies but also as the Executive's adviser on matters broadly affecting food research and as its chosen representative on several influential committees.

In mid-1966, the Executive, under Sir Frederick White, arranged to review the Division's activities. Such a course was customary on the retirement of a Chief. It gave the Executive the opportunity to make any evolutionary changes needed to ensure that the Divisional program covered the needs of the industry or community it served and to see that it was not hampered by inappropriate organization. The review would also guide the Executive in choosing a successor to J. R. Vickery.

A stock-taking and a new Chief

A Committee of Review was formed, consisting of people from industry, the universities and CSIRO, and headed by Mr V. G. Burley, Director of Cadbury Australia Pty Ltd and Chairman of the Tasmanian State Committee of CSIRO. The Committee met in late 1966 and handed its recommendations to the Executive in February 1967.

Victor Burley commented later, in writing privately to Sir Frederick White,

Sir Frederick White (then Chairman of the Executive of CSIRO) and W. J. Scott (left) farewell J. R. Vickery (centre) on his retirement.

that the Committee's task had been made unexpectedly difficult by the acknowledged high calibre of the DFP's work: it was not easy to criticize constructively or to make helpful suggestions about new directions for research. In order to offer any recommendations for change the Committee had needed to ask wide-ranging questions about the nature and purpose of such a Division. Its overall verdict was complimentary. 'The present Chief has set an extremely high standard for cooperative effort, and undoubtedly has laid the basis for the continued eminence of the Division as a food science laboratory, both in Australia and internationally. Inevitably your Executive will be faced with a most difficult task in selecting a successor of satisfactory calibre to preserve the status and to advance the work of the Division.' The Committee had been impressed by 'the very wide scope of the research program and the generally high quality of the research in progress. . . . If there is one impression which predominates, it is the dedication and scientific modesty with which the research is carried out.'

Nevertheless, the Committee made some significant criticisms in its report to the Executive, and these were spelt out at greater length in Burley's personal letter to White. The gist of the criticism was that the DFP was a highly conservative Division and was too close to the immediate problems of the industry it served; it should move further and faster into basic scientific studies, shedding some of its *ad hoc* work onto industry. It should cease to be a Division of Food *Preservation* and should become a Division of Food *Research*—a development that would take it into a broader field and make it more akin to a 'subject' Division and less one of the so-called 'industry' Divisions. According to Burley's letter to Sir Frederick, the DFP was misusing its best resources—the scarce and expensive human resources. The research staff was 'too problem-oriented, not sufficiently opportunity-conscious'; too much of the officers' time went into solving short-term problems, often problems foisted upon them by industry. While they executed all this admirably, it was keeping them from work they should be doing even better: that of studying foods in a far broader way and attempting to predict Australia's needs for research in five or ten years' time.

A realist with vision

In a report written on the eve of his retirement in July 1967, Vickery stated his belief that the organizational structure and research programs of a Division may be regarded as deriving largely from the personal ideas of its Chief. Despite the vital role of ideas and suggestions coming from staff members and the influence of outside events, the concept is accurate: a Division is the creation of its Chief to an extent that offers both satisfaction and challenge to any would-be leader. Conversely, Vickery has always considered that the greatest satisfaction in his own long career has stemmed not from his considerable personal reputation as a scientist, but from the high standing of the Division itself.

Vickery began food research studies for Australia in inauspicious circumstances, at a time when the need of the food industry for assistance far outstripped the capacity of the Commonwealth Government to respond in terms of money or staff or buildings. Over four decades, during which he had to contend with the effects of unusually severe financial depression and world war, Vickery had managed to sustain the singleness of purpose, the imagination and optimism, needed to achieve his objectives. By the mid-1950s he had been able to build up a well balanced organization covering most aspects of food science and technology; from the beginning he possessed an enviable ability to attract first-class men to his staff, and by the early 1960s he was at last able to give them excellent laboratories to work in.

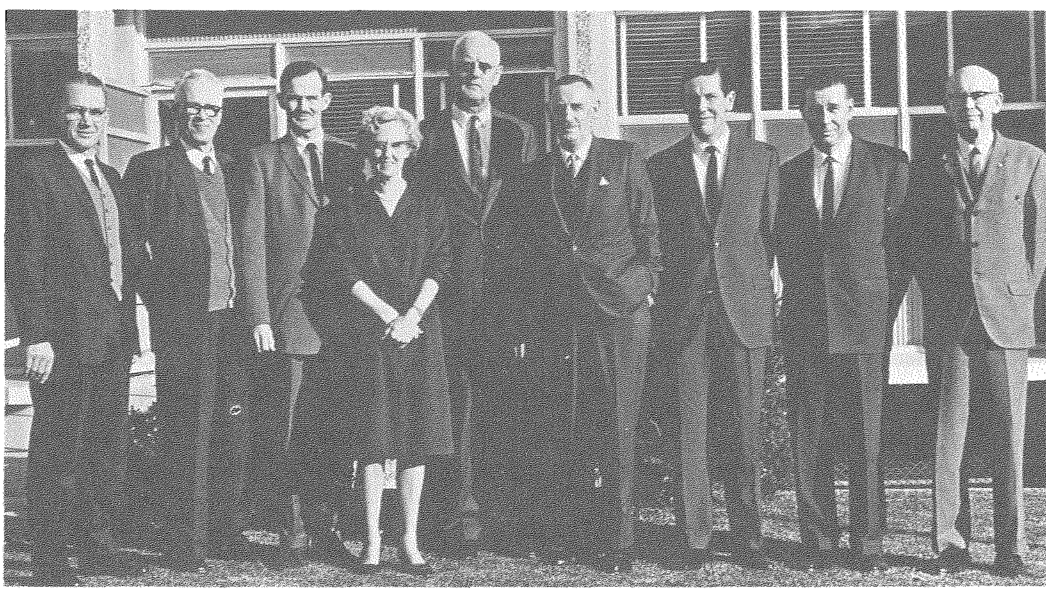
Among a wealth of descriptions of Vickery and estimates of his work as Chief, a few stand out as particularly apt*: 'The Executive used to hold him up to the rest of us, as a paragon' (Sir Ian Wark as Chief of the Division of Industrial

* Quoted from interviews and, in the case of Scott, from a letter to Josephine Bastian, 19 August 1975. We have preferred these off-the-cuff comments to the more formal written tributes paid to Dr Vickery's work on his retirement, as showing more of his style as Chief.

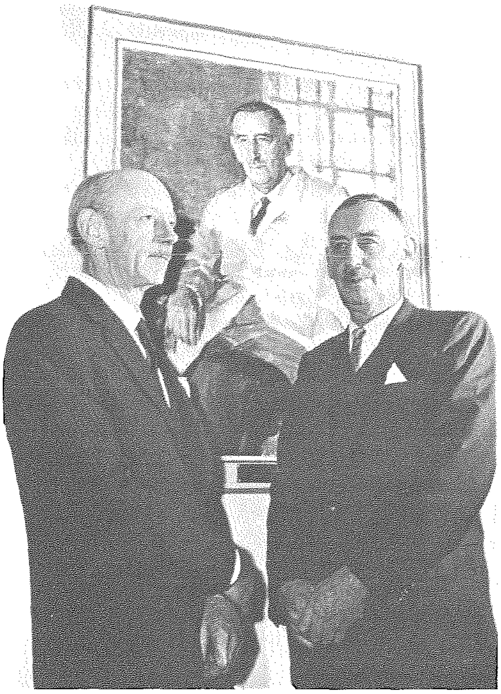
Chemistry); 'He was Rivett's white-haired boy: *he* never asked for more' (L. Lewis as Technical Secretary of the Division of Industrial Chemistry); 'I think it is easy for old men like Dr Vickery and myself to look back on the early work of the Division with some satisfaction. We were busy and probably achieved a fair amount of useful work with very modest resources. On the other hand, we were fortunate in being presented with some relatively simple problems and, in our early beef research, an extremely interested industry willing to take advantage of new information' (Dr W. J. Scott); 'He had great stature as a scientist and this helped him in his dealings with industry: he was not to be dictated to' (Wark commenting on industry-funded research in the 1950s and 1960s); 'He used to go around the laboratories of an evening, switching off the lights. Once I put in a requisition for a pair of scissors and he sent it back, marked "Use the pair in the Office".' (J. Shipton, Officer of DFP); 'He was modest in demeanour, yet without the limitations to vision that modesty sometimes implies. His success lay in valuing what was really important and dispensing with frills; possibly few other Chiefs could have got so much from their scientists with such frugal equipment and such uncomfortable quarters. He never inhibited ideas, and he contributed good ones himself. He listened responsively to your plans and judged them wisely—and once he gave you the go-ahead on a project he would fight, if necessary, to get everything you needed to do it' (Sir Rutherford Robertson).

The man who never asks for more, the Chief who is a paragon in the eyes of the Executive: might he not be a dragon to his staff? Vickery won praise, rather, for the freedom he allowed his officers and for his humanity at the personal level. Nevertheless, his austerity could have unfortunate consequences. His officers probably put up with inadequate or obsolescent equipment for longer than necessary; and for a long time, promotion was a slower process in the DFP than in other CSIR/CSIRO Divisions. These weaknesses diminish in importance, however, when placed beside his undoubted strengths. He was a realist with great breadth of vision—a powerful combination. In addition, he possessed a 'self-righting tendency', a sense of balance and judgment that was immensely valuable for the sound development of the DFP.

After his retirement in July 1967,



Long-serving members of staff at North Ryde at the farewell function for J. R. Vickery, 7 July 1967. From left: E. G. Hall, P. R. Maguire, J. D. Mellor, Barbara Johnston, W. J. Scott, J. R. Vickery, J. F. Kefford, D. F. Ohye and F. E. Huelin.



W. E. Pidgeon with his portrait of J. R. Vickery (1967).

Vickery returned to the laboratory, now as an honorary Senior Research Fellow of the DFP. He was thus able to renew his attack on certain problems of the cyclopropenoid fatty acids and of plant taxonomy that had interested and frustrated him for some years.

The new Chief

The man appointed as the DFP's second Chief answered closely to the guidelines suggested by the Committee of Review, who considered that the new Chief must certainly have a vital interest in the scientific problems of the food industry but must be 'determined to increase substantially the emphasis towards basic studies or long-term research . . .'.

Michael Vincent Tracey graduated in Biochemistry at the University of Cambridge in 1940 and was then caught up in war service—first as a chemist in Royal Naval cordite factories and then in the Blood Transfusion Service in Cambridge. In 1945 he joined the Biochemistry Department at Rothamsted Experimental Station, where he worked with N. W. Pirie in the early development of leaf protein as a food for man, and carried out fundamental research on the enzymic breakdown of cellulose and chitin by soil organisms. A year spent in Australia at the CSIRO Division of Protein Chemistry in 1956, as the holder of a Royal Society and Nuffield Foundation Commonwealth Bursary, produced a favourable reaction towards both Australia and CSIRO, and led in 1958 to his departure from Rothamsted to take up the position of Leader of the new CSIRO Wheat Research Unit in Sydney. When the Wheat Research Unit and Bread Research Institute occupied their new laboratories at North Ryde in 1960, Tracey took a keen interest in the construction, fifty metres away, of new premises for the DFP, little imagining that in seven years he would govern that Division.

Tracey took up his new duties on 27 November 1967. He recounts that his awareness of the hat he now wore was sharpened by the first moments behind his new desk: there he was confronted by a letter from the Hon. R. G. Casey, offering the Division a problem worthy of its powers. At an official dinner, Casey had

M. V. Tracey, Chief.

been regaled by the Japanese Ambassador with a mournful account of the Japanese people's dislike of the flavour of sheep-meats. Now Casey asked, what was the Division doing about the problem? Surely it could arrange to alter the flavour, thereby making Australian lamb and mutton acceptable to the Japanese market? The new Chief did not have his answer off pat; however, research that the Division was shortly to undertake on the development of polyunsaturated foods showed a way in which the question could be resolved by using dietary changes to modify the flavour of ruminant meats.

Tracey's first moves were to broaden the administrative leadership in the Division. For some months after Vickery's retirement, John Christian and Jack Kefford had shared the day-to-day administration of the North Ryde laboratories since the Acting Chief, Bill Scott, was stationed at Cannon Hill. Tracey now appointed Christian and Kefford as Assistant Chiefs, intending that their complementary interests would foster a good relationship between pure and applied science at North Ryde.

Within a few years of the appointment of the new Chief there had been many changes, the most conspicuous being the increase in staff of the Meat Research Laboratory and the union of the Division of Food Research with the Division of Dairy Research. Subsequently in 1971 Christian became Associate Chief of the Division and Kefford Officer-in-Charge of the FRL. In 1976, Tracey asked Kefford to accept the role of Assistant Chief, External Relations, with responsibility for coordinating the Division's links with industry, government departments, academic institutions and some international bodies. He was succeeded as Officer-in-Charge of FRL by A. R. Johnson.

The stationary phase

The gradual and almost uninterrupted expansion that the Division, in common

A. R. Johnson, J. H. B. Christian, M. V. Tracey, J. F. Kefford (1978).

with the rest of CSIRO, enjoyed for nearly 50 years slowed and then finally halted in 1975. Inflationary pressures caused the Government to order a reduction in staff numbers not only in CSIRO but across the entire Commonwealth Public Service.

Staff numbers

The number of professional staff in DFP rose from 30 in 1945 to 60 in 1955 and reached 91 by 1967. Early records on non-professional staff are incomplete but their numbers also built up, particularly when the Division moved to North Ryde and had to provide services that had been supplied at Homebush by the Metropolitan Meat Industry Board. Table 4 shows the peak in staff numbers reached in 1975; it also shows that, in the relatively short time since then, scientific staff numbers have continued to climb while a substantial reduction has occurred in non-professional ranks. For a scientific group to operate most efficiently an appropriate balance must be maintained between the numbers of professional and non-professional staff. This balance is, of course, a subjective assessment for scientific managers. The point made here is that should restriction on recruitment continue for a long time, it will become necessary to correct the imbalance that is presently developing in DFR.

In 1976 the Prime Minister (Mr Malcolm Fraser) initiated an Independent Inquiry into CSIRO under the chairmanship of Professor A. J. Birch. The Birch Committee pinpointed some of the problems that reduced recruiting has inflicted on CSIRO. These include a fall in the proportion of new scientists and a corresponding rise in the proportion of older researchers in the Organization. Limiting our observations to the research scientist classification, in 1970/71, 22·5% were in the lowest category of Research Scientist and 51·3% were Principal Research Scientists or higher; by 1974/75, only 17·7% were Research Scientists while PRS and higher had risen to 55·2%. Within the DFR, Research Scientists were well below the average percentage for the whole of CSIRO, making up only 11% of the research staff in 1974/75.

Table 4. Staff numbers in the Division of Food Research* from 1971 to 1977

At 30 June in year	Professional staff	Non-professional staff	Total
1971	141	192	333
1972	138	199	337
1973	146	192	338
1974	153	198	351
1975	157	199	356
1976	157	191	348
1977	168	175	343

* After amalgamation of DDR and DFP in 1970.

Finance

Although staff numbers have fallen, the annual budget of the Division continues to rise because of persistent inflation. Table 5 shows expenditure at 10-yearly intervals since 1944–45 as well as inflation-adjusted figures.

In 1976/77, expenditure in the DFR exceeded $6 million.

During the 1950s and 1960s, the DFP, like many other Divisions within CSIRO, set aside about a third of the annual budget for non-salary items such as equipment, maintenance and travel. More recently, however, salaries have taken a larger share; at DFR they reached almost 80% before falling back slightly to the present 75–77%. This limit on non-salary funds imposed 'frugal housekeeping' on the Division and restricted travel within Australia to some degree. The allocation of a third of the budget for non-salary items may no longer be apposite in a long-established Division like DFR but sufficient funds must be available to ensure that the return from salary expenditure is as high as possible. Although careful management of day-to-day expenses has been necessary in recent years, DFR has received generous grants

Table 5. Expenditure in the Division of Food Research (Food Preservation and Dairy Research)

Fiscal year	Expenditure ($)	Expressed in 1974/75 prices*
1944–45	77 778	486 510
1954–55	444 076	1 122 069
1964–65	1 503 069	2 935 636
1974–75	4 923 211	4 923 211

* Adjustment using the price index; i.e. the deflator for the gross domestic product (GDP), supplied by the Reserve Bank.

from the Executive enabling the recent acquisition of expensive major items such as a new mass spectrometer ($250 000), a computer facility ($150 000), and in collaboration with the adjoining Mineral Research Laboratory, a nuclear magnetic resonance spectrometer ($250 000).

Table 6 shows the average cost of maintaining a research worker at DFP and DDR at 10-yearly intervals since the war. In 1944/45 it cost less to employ a scientist at DRL than at FRL, but 10 years later this situation was reversed and by 1964/65, the gap had widened still further. The higher average costs at Highett probably developed because of generous support from the dairy industry and costly developmental programs such as automatic cheese-making.

Figures collected in 1977 for the Australian Science and Technology Council (ASTEC) showed that the annual costs per professional worker in government and industrial food research laboratories were virtually identical at $40 000. Most of this cost is taken up by the salaries of the researcher and his back-up staff.

Data from the Birch report show that Australia expends about 1·2% of its GDP on research and development. On an international scale, this places it in the medium-low group and makes it 'comparable to those countries which do not, on the whole, possess prosperous high technology industries.' According to Project Score (1973–74), R and D expenditure by the Australian food industry was only 0·1% of the value of products manufactured by all companies; this rises to 0·2% if calculations apply only to the value of production from those food companies doing R and D. A number—including some international giants—admit that activities in their Australian laboratories cannot be called research and development. Many Australian companies spend nothing on R and D and relatively few spend substantial amounts; clearly expenditure in this area is low and uneven.

Table 6. Total expenditure ($) per research worker at Division of Food Preservation and Division of Dairy Research

	DFP		DDR	
Fiscal year	Actual	At 1974/75 prices	Actual	At 1974/75 prices
1944–45	2 328	14 562	1 558	9 931
1954–55	5 981	15 112	7 103	17 946
1964–65	12 716	24 836	20 474	39 988
1974–75*	35 166	35 166		

* DFR (after amalgamation of DDR and DFP in 1970).

Human nutrition and health

Animal health was one of the earliest major concerns of CSIRO but it tried sedulously to avoid involvement in research directed to human health (Part 1, p. 4). By the early seventies, however, the Organization was engaged in some topics with relevance to human health; these included diseases transferable from animals to man, influenza virus vaccine, the production of polyunsaturated ruminant foods, climate physiology and biomedical engineering. All had arisen from programs not initially designed to tackle problems of human health.

In 1972 the Executive invited Professor F. Fenner to report to the Advisory Council on the relationships of CSIRO work to medical research. Acting upon his recommendations, the Executive set up the CSIRO Medical Research Liaison Committee in November 1973, comprising M. V. Tracey (Chairman), the Secretary of the National Health and Medical Research Council, Dr K. W. Edmondson, the Acting Director of the John Curtin School of Medical Research, Professor Robert Whelan, and the Chairman of the CSIRO Animal Research Laboratories Committee, Dr K. A. Ferguson. As its first task this committee advised the Executive on formulating an attitude to medical research in CSIRO.

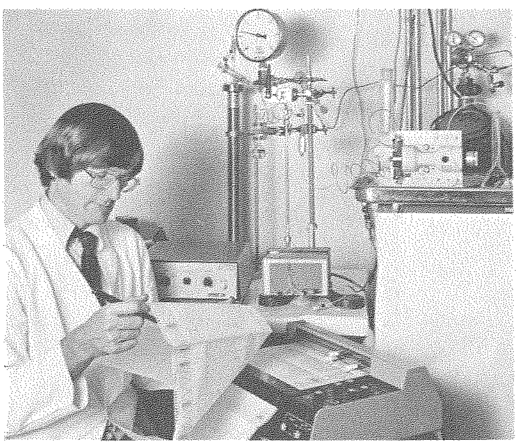
Consequently the Organization's new policy is that research in clinical medicine should be undertaken only in conjunction with a recognized medical research organization, that, except in the field of human nutrition, the Organization should not initiate programs with the sole objective of solving problems of human health, and that research findings having relevance to human health should be drawn to the attention of the Medical Research Liaison Committee so that satisfactory development of the discoveries may be ensured by cooperative involvement of recognized medical research groups.

On 1 January 1975 another of Professor

Fenner's recommendations was implemented by the formation of the Division of Human Nutrition in Adelaide. Dr B. S. Hetzel was appointed Chief of the new Division and joined the Medical Research Liaison Committee.

The creation of the Division of Human Nutrition has given the Division of Food Research an excellent opportunity for collaboration in those aspects of its developing program which may be relevant to human nutrition, and this collaboration is expected to develop significantly in the future. The work already done on the technology of polyunsaturated ruminant milk and meats is very obviously relevant to the nutritional needs of those at risk from coronary heart disease. Investigations on the fatty-liver syndrome of chickens, undertaken to solve an industry problem, may have unexpected relevance to cot-death syndrome in infants. A research project recently undertaken on amines in foods may assist a proportion of migraine sufferers, and a survey of foods for the presence of salicylates, believed by some to be related to hyper-activity in children, has been undertaken at the request of nutritionists.

New initiatives concerned with the possible effects of food constituents on human health are likely to continue and expand. At present there is, for example, considerable interest in the provision of milks free from lactose or free from galactose for children suffering from lactose intolerance—a condition particularly prevalent in Aboriginals and in some populations to the north of Australia. Ultrafiltration of milks can provide lactose-free (and hence galactose-free) milk, while enzymic hydrolysis splits the lactose into galactose and glucose, thus preserving the galactose content which may be of nutritional importance, while removing the lactose. The emphasis of the Division's research is likely to move increasingly towards finding means for the provision not only of foods of unimpaired quality, but foods with improved nutritional qualities for particular sub-groups of the community having special requirements not adequately met by natural foods.


M. A. Brown separating vitamins by high performance liquid chromatography.

The future of food research

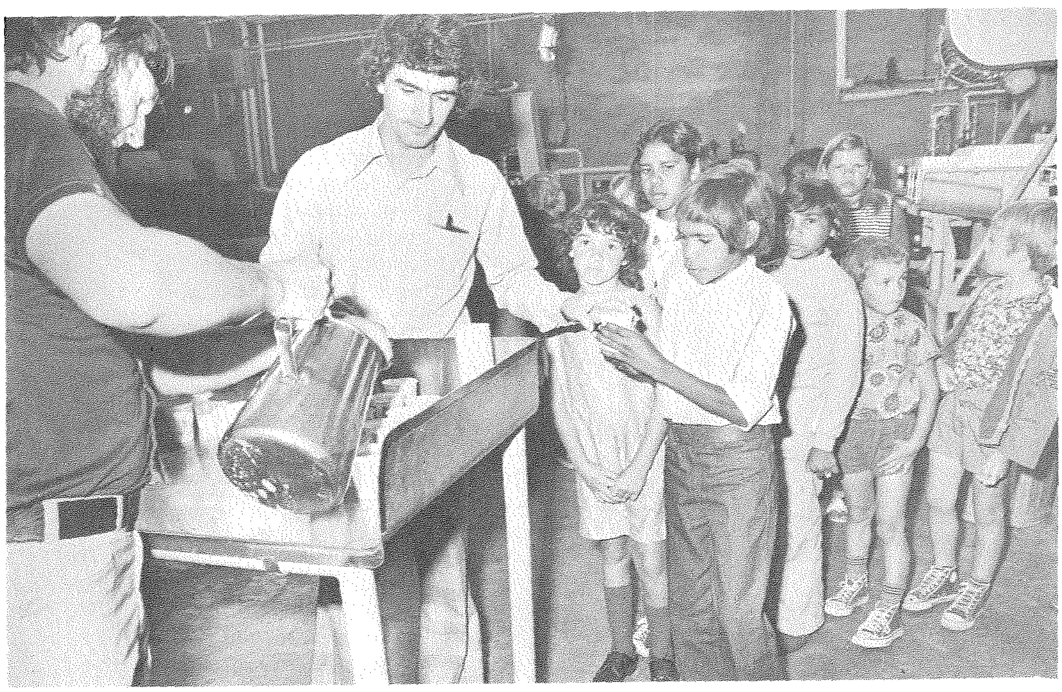
In December 1954, just before the 1955 review of the DFP, S. H. Bastow of the Executive wrote to Vickery in the following terms: 'It is extraordinary how widespread the impression is (a) that food preservation problems have largely been solved, and (b) that anyway food research is only trimming around the edges. I am quite certain that after the Advisory Council has had a good look at you next May they at least will not be in any doubt about the real and proper importance of food preservation in CSIRO.' The expansion that the Division has experienced and the enhanced reputation it has achieved since 1954 confirm Bastow's optimistic views about food research in CSIRO. And yet here and in other countries, uncertainty about the direction in which food research should progress surfaces from time to time.

Methods of preservation such as drying, freezing and canning arose empirically from an urgent need by man to store food and not from any intuitive grasp of the basic principles of preservation. These principles were gradually elucidated and the many gaps in our knowledge of foods began to be closed. Even today, there is still only imprecise understanding of many of the changes that occur in foods when they are preserved and stored, and the filling of these gaps might well appear to many as 'trimming around the edges'. The more obvious and easier problems in food research have been thoroughly worked over, pressing scientists to delve more deeply into extremely complicated areas involving principally chemistry, physiology, physics and biochemistry. The complexity of foods calls for multi-disciplinary attacks on many problems and sophisticated and expensive instrumental tools to tackle them are almost essential.

In the light of present knowledge, the development of any new methods of food preservation seems unlikely. Novel methods of sterilization will undoubtedly arise from time to time but they must not only be approved by regulatory authorities but must also give a product that is acceptable to consumers and that is economically viable. For example, R. V. Holland recently showed at North Ryde that microorganisms in liquid media can be killed by shock waves, but the process is not applicable to commercial practice.

In its formative years the Division grew side by side with the Australian food industry and 'had a finger in almost every pie'. But, for reasons that are difficult to define, this connection gradually became more diffuse. Without doubt, the Division consciously shed some of its troubleshooting on behalf of the food industry; this was in line with recommendations of the 1967 Committee of Review but there were other reasons too. One of the most significant was the growing influence of foreign-owned companies that import much of their research and technology. In addition, the food industry has become more self-sufficient technically and employs many more food technologists than it did 20 years ago. Recently it has come to be realized again within CSIRO that strong contact with industry is essential, and in an effort to reinforce and expand its bonds with the Australian food industry, the Division has reorganized its liaison group. This will not be at the expense of the present strong links with consumers, who are now better informed and thus more inquiring, particularly about food safety and nutrition; this contact will certainly be maintained and expanded by the Division.

The Birch Committee recommended that CSIRO should concentrate on 'strategic mission-oriented research', i.e. on long-term studies with clearly defined objectives. Much of the Division's program meets this requirement. However, 'tactical problem-oriented research' also falls within the orbit of the Organization. The Division has already been asked to develop new techniques, or apply existing technology to try to overcome problems arising from



Children from Enngonia in the far north-west of N.S.W. sampling a product prepared in the Processing Laboratory.

surpluses of primary produce in Australia and those associated with the disposal of waste materials such as whey, blood and fruit and vegetable peelings.

As the Birch Committee says: 'Research is basically an investment in the future. There is always an element of a gamble in the unknown, but the odds are improved if problems are appropriately chosen, if properly selected people are given the right jobs to do, and if the technical organization supports them.' The Division's programs have been reviewed at roughly 10-yearly intervals but, in future, it may need to re-examine its research aims more frequently, to maintain relevance with rapidly changing scientific skills and social attitudes.

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