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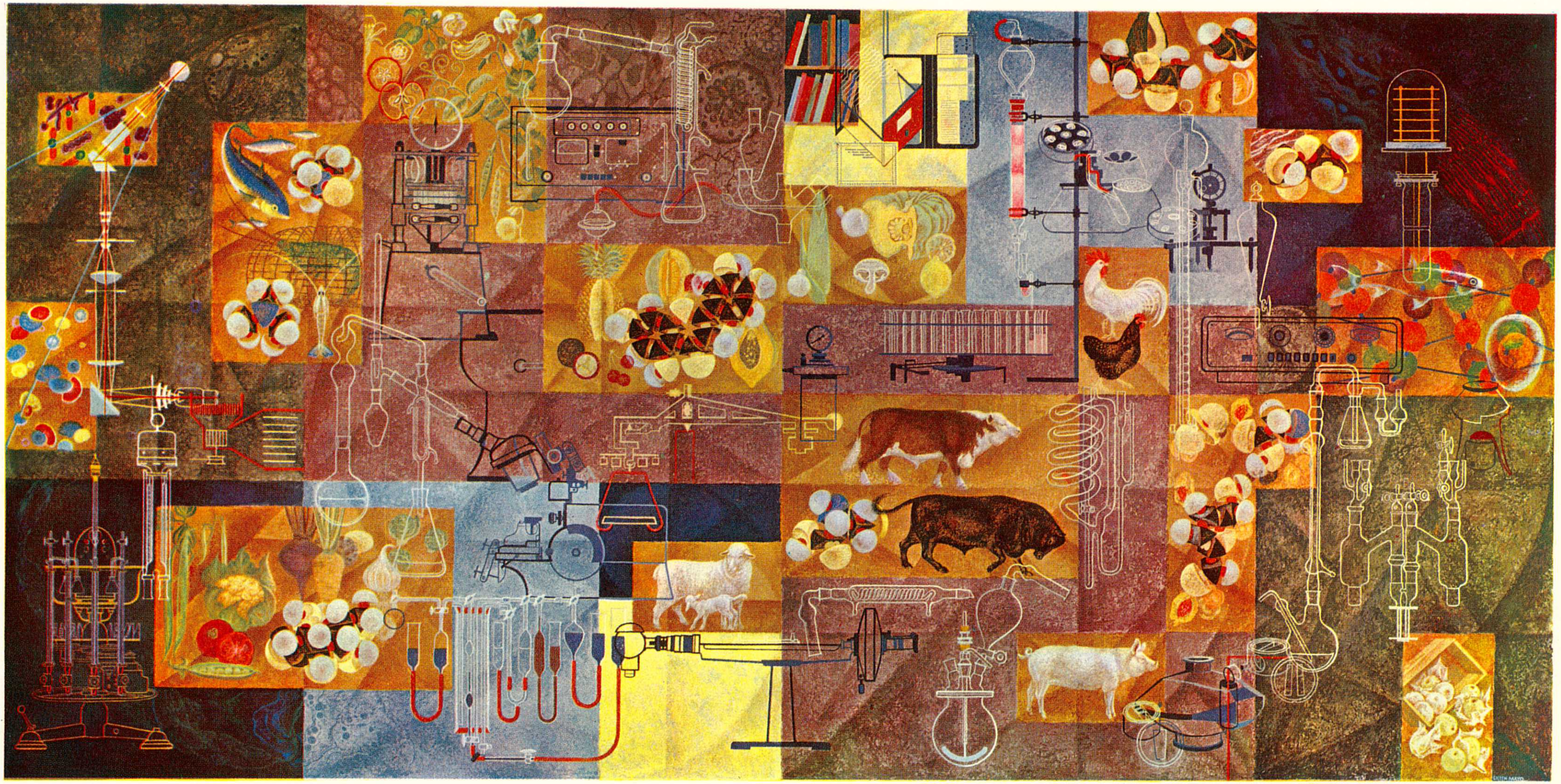


This mural in the foyer of the Administrative Building of the new laboratories of the Division of Food Preservation was designed to depict the activities of the Division. Diagrammatic representations of laboratory apparatus overlie rectangles showing research materials and primary products: books, chemicals, microorganisms, fruits, vegetables, animals, fish, poultry, and eggs. Chemical compounds are represented by atomic models. The background patterns are derived from magnified sections of animal or vegetable tissue. The artist was Miss Eileen Mayo of Sydney.

New Laboratories of the Division of Food Preservation

Official Opening

THE new headquarters and research laboratories of the Division of Food Preservation at North Ryde, N.S.W., were officially opened by the Minister-in-Charge of C.S.I.R.O., the Hon. D. A. Cameron, on September 18, 1961. In introducing the Minister, Dr. F. W. G. White, Chairman of C.S.I.R.O., said it was a very important occasion in the life of the Division. He was impressed, he said, by the large number of representatives from the food industry, the universities, and other C.S.I.R.O. laboratories as well as other distinguished persons, from many walks of life, who had gathered for the opening of the new premises.

Dr. White said the new buildings could be admired for their beauty and utility and he congratulated all associated with their design and construction. C.S.I.R.O. had been fortunate in acquiring such an excellent site, in a semi-rural area, so convenient to the City of Sydney. He found it particularly pleasing that the site now housed three institutions, two within C.S.I.R.O. and one, the Bread Research Institute of Australia, so very closely related. In the past the headquarters of the Division of Food Preservation had been accommodated in premises generously provided by other institutions. He took the opportunity to acknowledge the debt of gratitude owed by the Division to the Sydney Metropolitan Meat Industry Board for the accommodation and facilities provided at Homebush since 1938. The Division also had cause to thank a similar body, the Queensland Meat Industry Board, which was still providing premises and facilities for the meat research being carried out in Brisbane. While he regretted severing the intimate contact which had been established at Homebush, the time had come for the Division to be more adequately housed. The opening of the new laboratories was an occasion of great significance in the life of Dr. Vickery, the Chief of the Division, who had been associated with its activities since he was a young man. He had steered it through the difficult war years and had seen it rise to its present eminence. It was a matter of deep regret that another pioneer member of the Division, the late Mr. E. W. Hicks, had not lived to see this day.

Dr. White said he was pleased that Lord Casey, a former Minister-in-Charge of C.S.I.R.O., had been able to attend, and also the present Minister, Dr. D. A. Cameron, whom he had great pleasure in asking to open the new premises.

In his address, Dr. Cameron said he regarded the Division of Food Preservation as one of the most important in C.S.I.R.O. It had made major contributions to the development of food industries in Australia, especially the export trade, and he felt sure it would play its part in the task of feeding the rapidly increasing population of the world. In 1940 this had been estimated at 2246 million; by 1960 it had risen to 2950 million and by the year 2000 it was expected to be in the neighbourhood of 6700 million. Such an increase, said Dr. Cameron, would bring with it tremendous international problems. At present mankind was faced with the anomaly of accumulation of large food surpluses in some countries while others were finding it difficult to feed their populations. Several Divisions and Sections of C.S.I.R.O. were concerned with production of food, but only the Division of Food Preservation had the task of finding the most effective methods for its preservation and distribution.

Dr. Cameron said the preservation of food had concerned mankind from the very early days of civilization. The armies of early

The Hon. D. A. Cameron, Minister-in-Charge of C.S.I.R.O., addressing the assemblage at the Official Opening of the North Ryde Laboratories.

civilizations, such as Rome, had probably lived very largely off the lands they invaded, but the navies of seafaring nations must have acquired the rudiments of food preservation—cooking, drying, and salting. They had undoubtedly developed techniques well ahead of their comprehension of the reasons for their success, just as lime juice came to be carried by ocean-going ships well before the role of vitamins was understood. The use of ice and snow for refrigeration appeared to date back to time immemorial, but preservation by canning was of more recent origin. In Australia the first attempts to can meat were made by Dangar Bros. in 1847. Development in food preservation had been rapid since then. The major wars had played their part, as had the changing social habits of people in the more highly developed countries where populations had tended to crowd into cities. Recently in Australia the lack of domestic help and the increasing employment of married women had resulted in a demand for packaged, often precooked, foods.

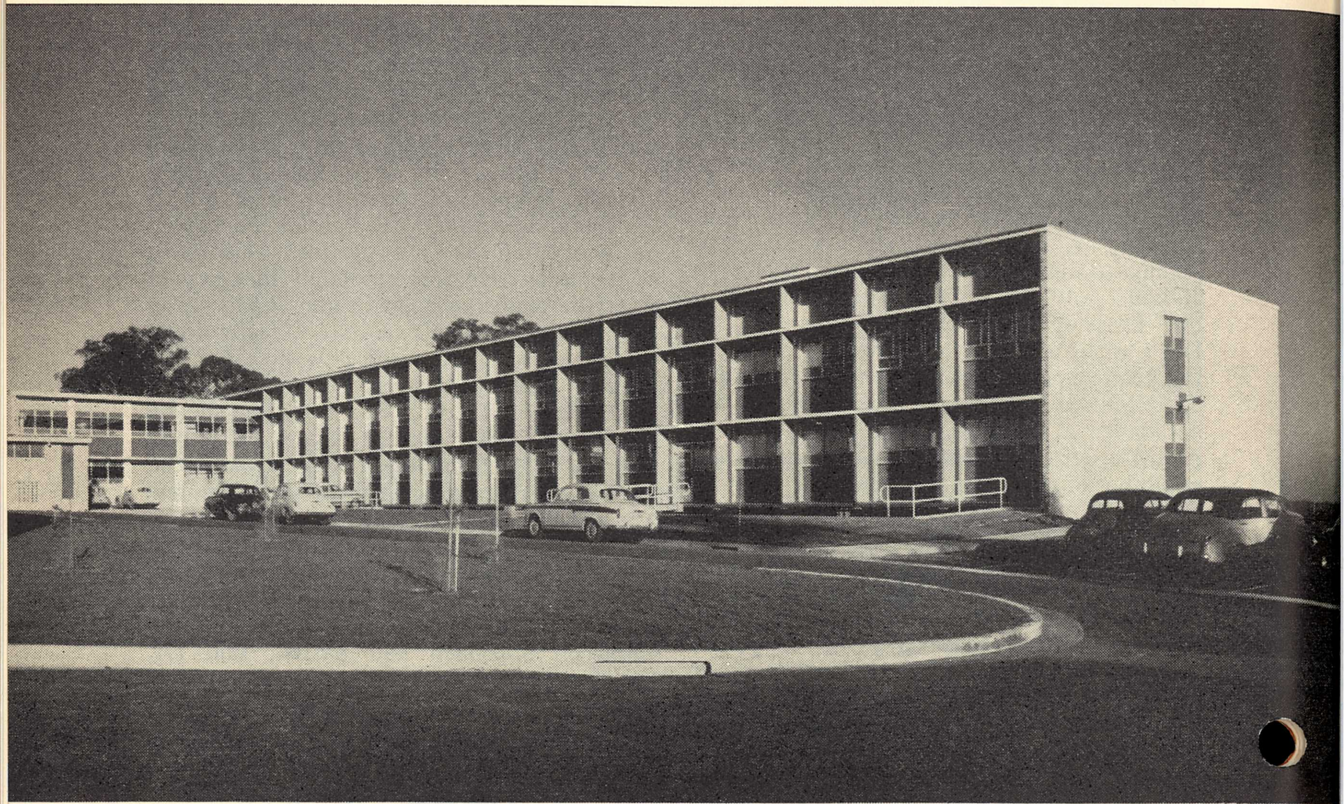
Australia, said Dr. Cameron, was faced not only with meeting the requirements of its own population but, as a primary producing country, also with ensuring that its food products reached consumers throughout the world in an acceptable form. Its products must remain competitive with similar produce from other exporting countries often more conveniently located. Recently, said Dr. Cameron, much had been heard about the construction of new roads for the beef industry in Northern Australia. Such roads were undoubtedly of great importance but equally so was the handling of the cattle from the time they reached the market until the meat appeared on consumers' plates, perhaps on the other side of the world.

These problems, and others of a similar nature, had resulted in the formation, in 1932, of the Section (now Division) of Food Preservation. Today, those present had heard of its growth and seen its current activities. All could appreciate what the new premises would mean to the Division in the way of improved research facilities. Dr. Cameron referred to the great help which the Division had received from many branches of the food industry. Like Dr. White, he felt that the opening of the new laboratories should be regarded as a milestone not only for the Division but also for C.S.I.R.O. He could only wish that in the future all C.S.I.R.O. units would be as satisfactorily housed.

In moving a vote of thanks to Dr. Cameron, the Chief of the Division, Dr. J. R. Vickery, reminded his hearers that Dr. Cameron was Minister for Health as well as Minister-in-Charge of C.S.I.R.O. He, nevertheless, seemed to find time to take a keen interest in all phases of C.S.I.R.O. activity. Members of the Division had pleasant memories of Dr. Cameron's visit to Homebush earlier in the year when he had spent the day getting acquainted with the research workers and had taken a keen interest in their activities. As Minister for Health Dr. Cameron had a number of officers in his Department whose main responsibility was the formulation of uniform food standards throughout Australia. Dr. Vickery said the question of food additives was a matter of great concern to the food industry, and the Division of Food Preservation had been happy to cooperate with the Department of Health in a study of many difficult problems arising out of the use of additives. Dr. Vickery said his Division was the only scientific body in Australia at present carrying out research on the preservation of meat, fish, and eggs. That alone imposed a major task on the Division, which also had considerable responsibility for research on fruit and vegetables. When it was realized that these perishable products accounted for £140 million out of Australia's total exports of £920 million, the need to eliminate waste and to improve the quality of foods sold on overseas markets was very apparent. Dr. Vickery said that with the opening of the new laboratories the research staff of the Division had many of the facilities they had been seeking for a number of years, and this imposed on them the obligation to do sound scientific work for the benefit of the Australian food industry and the country as a whole. He was confident they would meet the challenge. Australians had, in the past, played a major part in food technology. It was just a century since the world's first freezing and cold storage plant had been established at Darling Harbour, Sydney, by Thomas Sutcliffe Mort, working in association with a French engineer, while some 81 years ago a syndicate, headed by Andrew McIlwraith, had made the first successful shipment of frozen beef in the world. The early advances largely resulted from the employment of empirical methods by energetic and intelligent men. The days of the empirical approach had passed, said Dr. Vickery, and it was now a matter of applying to food preservation the principles of physics, chemistry, biochemistry, botany, and microbiology. Dr. Vickery concluded his remarks by calling upon the assembly to carry with acclamation a vote of thanks to Dr. Cameron.

Prior to, and after the official opening ceremony the guests were given an opportunity to inspect the new laboratories and displays of the work of the Division.

A section of the audience.



View of the Food Science Building (north side), the block of Controlled Temperature Rooms, and the Engine Room.

Buildings and Equipment

THE new headquarters and research laboratories of the C.S.I.R.O. Division of Food Preservation at North Ryde, N.S.W., were designed by the Commonwealth Department of Works and constructed by A. W. Edwards Pty. Ltd. Brewster, Murray and Partners, Architects, prepared contract documents for the architectural and internal hydraulic work. The refrigeration equipment was designed by the Commonwealth Works Department in conjunction with James Budge Pty. Ltd., who were responsible for its installation. The cost, including services, was about £630,000.

The premises consist of eleven individual buildings with a total floor space of 71,000 sq. ft. The buildings range in size from the Food Science Laboratories (35,000 sq. ft.), including a suite of controlled temperature rooms, down to the smallest, a solvent store (150 sq. ft.).

Provision was made in planning the laboratory for an overall future expansion of 50%. This factor determined, to a large measure, the initial disposition of buildings on the site, which is such that extentions can be made in any desired sequence with minimal interference to the normal functioning of the establishment. The engine room, compressor room, workshops, and stores form a central core surrounded by major buildings on three sides. The Canned Foods, Dried Foods, and Frozen Foods sections occupy laboratories in the Food Technology building, which is on the north side of the site. Adjoining this is the Food Processing Block, with an open floor area of 130 by 50 ft. On the south side of the site is the Food Science building, housing Physics, Microbiology, and the Chemistry sections, and accommodating the Animal Products (fish, poultry, and eggs), and Fruit and Vegetable Storage sections. Forming a wing to the Food Science building is a block of 31 controlled temperature rooms.

The laboratory buildings are linked by an internal road system and by covered footways with those housing the administrative section, the library, canteen, and food-tasting suite. The covered footways provide overhead carriage for steam and telephone lines and, in some sections, hot water.

Building Construction

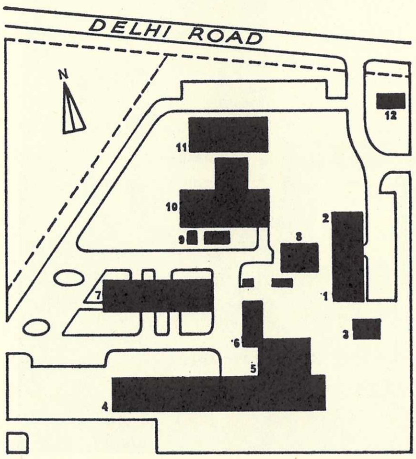
The two-storied Food Science building, 302 ft long, has its load-bearing corridor walls in brick with reinforced concrete supporting piers at 12-ft centres on the external walls. The roofing, windows, and removable fill-in panels are of aluminium. The end walls are of light-coloured brick and the floors of concrete. At fixed points the internal partitions are brick, but elsewhere they are removable, being fabricated of hardboard. Sun penetration on the north and south sides is controlled by continuous concrete hoods with vertical precast fins. The hoods serve as servicing platforms. The same construction is used for the Food Technology Laboratories. The Food Processing building, workshops, and stores have brick walls with saw-tooth roofs providing good overhead light. Administration, library, taste-test cubicles, and the canteen are housed in two single-storied steel-framed buildings which have the same exterior treatment as the laboratories. Subsidiary buildings are of brick construction.

Laboratory Services

The services available in the two laboratory blocks are hot and cold water, distilled water, gas, A.C. electric power, and, when required, compressed air. Water and gas are conveyed in copper pipes, distilled water in stainless steel. A hot-water system feeds finned space-heaters, and steam is supplied where required. The waste pipes are made of "Polythene" and glass. Access to all services, except electric power, is available through the external aluminium panels. The end walls of buildings have been kept free of service lines, which should greatly facilitate the construction of any extensions found necessary.

KEY TO SITE PLAN

1. ADMINISTRATION
   Inquiries, Chief, Technical Secretary, General Office
2. LIBRARY
3. E. W. HICKS MEETING ROOM
4. FOOD SCIENCE BUILDING
   GROUND FLOOR, Animal Products, Fruit and Vegetable Storage, General Chemistry, Organic Chemistry
   FIRST FLOOR, Animal Products, Mathematical Statistics, Microbiology, Physics, Muscle Biochemistry
5. CONTROLLED TEMPERATURE ROOMS
6. ENGINE AND BOILER ROOMS
7. WORKSHOPS AND DIVISIONAL STORE
8. LUNCH ROOM AND TASTE TEST ROOM
9. SULPHURING ROOM AND CHEMICAL PROCESSING LABORATORY
10. FOOD PROCESSING BUILDING
11. FOOD TECHNOLOGY BUILDING
    Canning, Dehydration, Quick Freezing
12. CARETAKER



Layout of buildings at North Ryde.

Laboratory Finishes

Laboratory bench tops are of solid timber, finished with a clear epoxy-resin while a white-pigmented epoxy-resin is used for fume cupboards. Bench units and perimeter ducts are sheeted with plywood finished with clear polyester resin.

Laboratory Layout

Although the layout of laboratories falls generally into two types, to serve the needs of chemical or biological work, certain laboratories have special layouts. There is also a considerable variety of service facilities to meet the needs of the different research groups, ranging from balance and instrument rooms to specially designed preparation and sterilizing rooms for microbiological work.

Laboratory Equipment

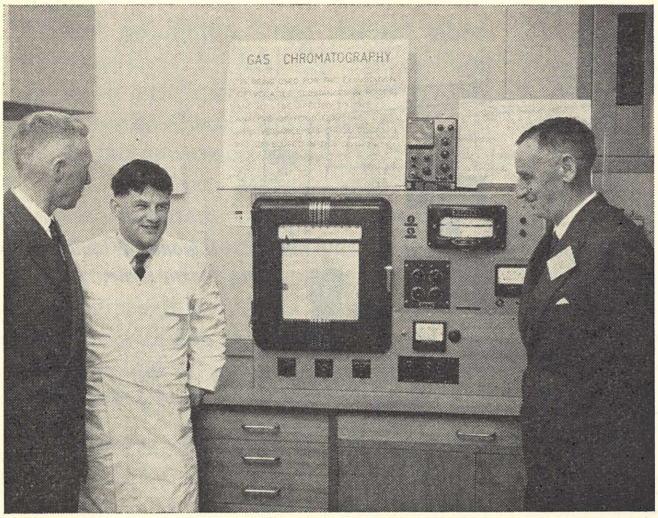
The laboratories are furnished with the normal range of chemical and physical equipment as well as, where required, more specialized items. Almost every type of chromatographic equipment is represented. Automatic collectors, fabricated within C.S.I.R.O., are in use as well as several L.K.B. collectors. Many types of column are in use, including L.K.B. paper columns.

A very sensitive detector, developed by C.S.I.R.O. for use in flavour work, is among the equipment available for gas chromatography. The spectrophotometers available include a Perkin Elmer 221 for infrared spectrophotometry. Several groups have high-speed centrifuges and the Physical Chemistry section, located at the University of Sydney, operates a Spinco Model E refrigerated ultra-centrifuge.

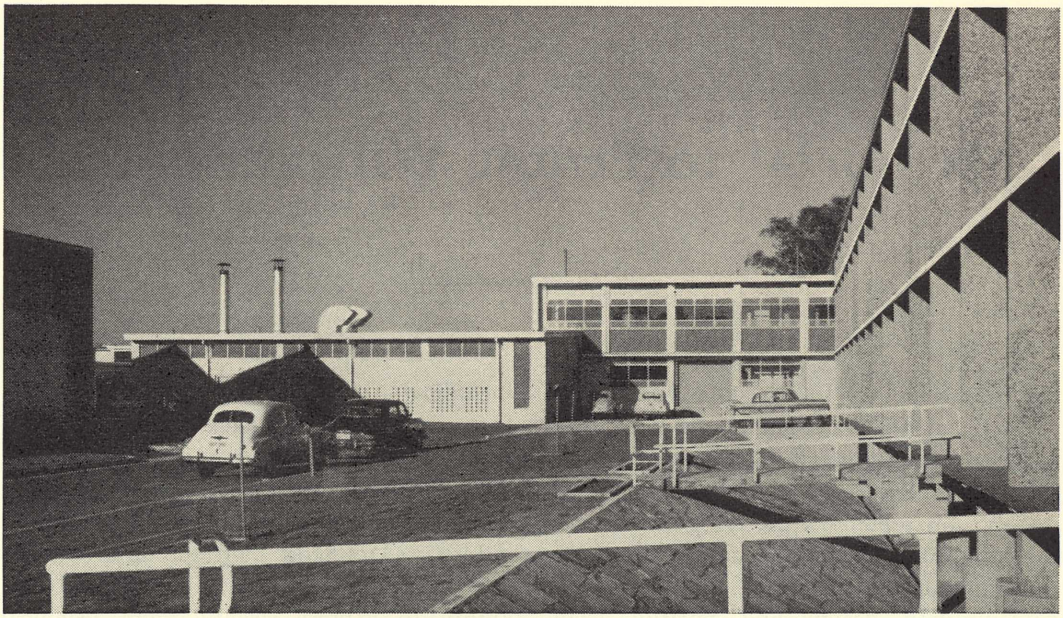
Controlled Temperature Rooms

The two-storied refrigerated section which forms a wing of the Food Science building is 30 ft wide. It is constructed in brick and reinforced concrete. Floors are insulated with corkboard and the walls and ceilings with expanded polystyrene slabs. The rooms vary in internal floor space, from 66 to 330 sq. ft. Six rooms are designed for the temperature range 5 to 20°C; seventeen for +1 to −1°C, and three for −10 to −30°C. Four of these rooms are gas-tight to permit the storage of fruit in controlled atmospheres. Five non-refrigerated rooms giving a range of 20–50°C are located in the uninsulated working spaces on each side of the cold room block on both floors.

All refrigerated rooms are cooled by ceiling-mounted coolers consisting of banks



Dr. D. A. Cameron and Dr. J. R. Vickery inspecting an exhibit on gas chromatography.



View looking along north side of Food Science Building, showing Controlled Temperature Rooms, Engine Room, and on the extreme left, part of the Workshop–Stores Block.

of finned pipes with fans. The room at −30°C is cooled by direct expansion of Freon 22. All other rooms are cooled by the circulation of calcium chloride brine in two separate circuits. Each room has its own solenoid-operated on-off valve on the brine delivery circuit, which is activated by a sensitive toluene-mercury thermostat. Small air conditioners are located in each air lock to prevent excessive moisture condensation on walls and doors.

Food Processing Building

The Food Processing building, which has a floor area of 6500 sq. ft, is equipped for canning, freezing, or dehydrating a wide range of foods on an experimental or pilot-scale basis. It is equipped with drum washers, comminuting and slicing or dicing machines, steam and water blanchers, jam pans, vacuum and automatic can closers, a stationary retort, atmospheric and pressure spin-cookers, through- and cross-flow dehydrators, and a small blast freezer. There is also a vacuum glass jar closer, and it is intended to have full facilities for glass packing available in the near future. A new blast freezer and a continuous atmospheric spin-cooker will also be installed.

Associated with the pilot-scale plant are a small control laboratory, and store rooms for machinery and for raw and finished products. Adjacent buildings house the compressors for air and refrigeration equipment, and facilities for the controlled sulphuring of food products with gaseous sulphur dioxide.

The pilot plant is used by associated groups of workers in the preparation of test packs to evaluate packaging materials, suitability of varieties for processing, influence of processing procedures on final product quality, and for the development and evaluation of processing equipment. It is used also for the production of new food products and the testing of new formulations.

Memorial to Ernest William Hicks

A MEMORIAL to the late Mr. E. W. Hicks* was unveiled at the new headquarters and research laboratories of the Division of Food Preservation, North Ryde, N.S.W., on September 21, 1961, and a meeting room was dedicated to his memory. The unveiling of the memorial, in the form of a sculptured design and portrait head, together with a commemorative plaque in bronze, was performed by Mr. D. E. Seale, Chairman of the N.S.W. Division of the Australian Institute of Refrigeration, Air Conditioning and Heating, in the presence of Mrs. Hicks, her daughter Helena, and a representative gathering of former colleagues and friends.

Dr. J. R. Vickery, Chief of the Division, said they had assembled to honour a very great man. Although Ernest William Hicks had indelibly engraved his name in the history of the Division through his work, his many friends had decided to contribute funds for a more tangible memorial. Dr. W. J. Scott, Assistant Chief of the Division, paid tribute to the late Mr. Hicks as a man and scientist. Ernest Hicks, a graduate in science, commenced his career as a food scientist in 1929, as a biochemist. It was soon apparent that he possessed a great variety of talents including a flair for mathematics. During the war years Mr. Hicks proved a very versatile food technologist. Throughout his career he had been a friend and adviser to many within the Division and also in the food industry. Dr. Scott paid special tribute to Mr. Hicks's skill as an editor and to his ability to express scientific and technical knowledge with precision and clarity. Mr. Hicks had inspired his colleagues by his ceaseless search for agreement between theory and experiment. When confronted by a problem he would often work out the answer theoretically but there was never any fear that this would cause him to introduce any bias into his subsequent experimentation. When necessary his work was precise to a high degree, but he would never waste time on unnecessarily elaborate experiments. Some decades ago, when the layman did not have the respect for science which he had nowadays, Mr. Hicks had shown the ability to demonstrate scientific work in a practical and convincing way. He had been quick to detect ambiguity, a talent which often gave him keen enjoyment.

In his address Mr. Seale said he had been impressed with the sound judgment possessed by Mr. Hicks and by his fund of dry humour. Mr. Hicks had been a leading member of the International Institute of Refrigeration and his contributions to its activities had brought great credit to his country.

* An appreciation of the life and work of Mr. Hicks, who died on November 2, 1959, was published in the Food Preservation Quarterly Vol. 20 (1960), pp. 23–29.

The memorial to the late Mr. E. W. Hicks above the entrance to the meeting room which has been named after him. The Chief of the Division (Dr. J. R. Vickery) is seen presenting a prize from the Memorial Fund to Miss Joan Hayhurst (North Ryde laboratories), who shared with Mr. D. E. A. Plate (Cannon Hill), the honour of obtaining the most distinguished results among Technical Assistants in the Division who graduated in 1960.

He was also held in great esteem in Australia. Orchardists, who were concerned in the cold storage of fruit, had come to accept the views of C.S.I.R.O. on the subject, as authoritative, a state of affairs due in no small measure to Mr. Hicks. In performing the unveiling ceremony Mr. Seale said the meeting room would serve as a lasting memorial to Mr. Hicks's highly meritorious work in the field of food science and technology.

Hicks Memorial Prize

At the conclusion of the unveiling ceremony Dr. Vickery announced that it had been decided to devote surplus donations to the Hicks Memorial to a small prize to be awarded to the Technical Assistant in the Division obtaining the most outstanding results on graduation. Accordingly he had pleasure in announcing that the first Hicks Memorial Prize would be shared by Miss Joan Hayhurst, of the North Ryde Laboratory, and Mr. D. E. A. Plate of the Brisbane Meat Research Laboratory, each of whom had shown outstanding ability in their courses in mathematics and physics at the Universities of New South Wales and Queensland respectively.

Industrial Support for Food Research

OVER 100 representatives of the food and ancillary industries were invited to the laboratories on the morning of September 18—the day of the official opening—for discussions on the role of industry in scientific research. They were addressed by Dr. F. W. G. White, Chairman of C.S.I.R.O., and Dr. J. R. Vickery, Chief of the Division of Food Preservation, and conducted on a tour of the laboratories.

The bulk of the funds for the Division, it was explained, came from the Commonwealth Treasury, but approximately £20,000 was being contributed in 1961-62 by other Government Departments, statutory bodies, and private firms for specific researches. In addition, over £23,000 had been donated by the food and related industries, since 1955, to support food research in general.

In a speech of welcome, Dr. White referred to the obligations imposed on the Organization by the Act of Parliament which defined its responsibilities. It was the duty of the Organization, he said, to initiate and carry out scientific research for the promotion of primary or secondary industries in the Commonwealth and its territories. The C.S.I.R.O. Executive had given considerable thought to the best means of doing this. It recognized that the solution of a technical problem often involved investigations on underlying scientific principles, and that it was therefore essential for C.S.I.R.O. to lay up a store of basic knowledge.

One of the major aims was to discover the optimum conditions for the preservation of food, in order to maintain its quality and attractiveness. It was necessary for food research workers to acquire an understanding of the changes which foodstuffs of plant and animal origin underwent during their growth and maturation. Changes subsequent to harvest or slaughter were equally important. Studies were made of specific industrial problems, and the Division sought opportunities for the application of scientific principles to food production, processing, and storage. The research worker was prepared to take his work through to the stage of practical application, but this could lead to C.S.I.R.O. being pressed to shoulder responsibility for a major part of industrial research, to the extent of finding itself faced with an impossible task. Success depended very much on the interest and, where possible, the participation of industry. It was gratifying to note the ever-growing interest of industry in science and technology. Only by the application of scientific knowledge could the food industry attain the level of efficiency required for the development of export markets in the face of strong competition. Demands by consumers for new products, and for exports of improved quality, could be met only if the industry was prepared for a flexible approach to its problems, based on a sound knowledge of raw materials and processing. C.S.I.R.O. was prepared to do its part and he felt confident that the food industry would encourage, and if the need arose, press for, the necessary research.

Dr. Vickery, speaking in support of Dr. White, stressed his desire for the fullest possible collaboration with industry. He briefly described the facilities possessed by the Division, and explained that in addition to the new laboratories at North Ryde the Division had four branch laboratories, the activities of which were closely integrated with those of the central laboratories. The Division was organized into four basic research groups, (chemistry, physics, microbiology, and plant physiology), and five applied groups, covering canning, dehydration, freezing, animal products (meat, fish, and eggs), and fresh fruits and vegetables.

The Division's activities covered most fields of food research, but it could not hope to cover all, nor did he wish to spread its activities beyond its resources. Before embarking on a research project the Division investigated work being done elsewhere, including overseas, and considered the magnitude and economic importance of the problem. Industry often helped research workers by bringing its problems to their notice, but sometimes officers of the Division made a survey of an industry for the purpose of finding its immediate and future technical requirements. Dr. Vickery said he made no apology for the devotion of some fifty per cent. of the resources of the Division to the basic sciences. Often the carrying out of basic studies was the only sure way of throwing light on a technical problem. The most effective help to the industry, stressed Dr. Vickery, could result from two-way activity. He appreciated the excellent relationship which existed between the Division and the food industry, and he would like to suggest that the industry strengthen its technical staff, for to get maximum value from scientific research full comprehension of it by well-trained technologists was needed. Secondly the industry should develop its own research facilities so as to be able to cope with the host of minor problems which were constantly arising. In conclusion, Dr. Vickery emphasized that officers of the Division were always willing to help industry in any way they could. There need be no hesitation in seeking advice by personal consultation, letter, or telephone.

Mr. Frank Eagle (of P. Methven & Sons, Canners) said there was a need for more financial support of the Division by industry. The Commonwealth Government was known to judge the value of scientific work, carried out by a body such as the Division of Food Preservation, by the interest in it shown by industry. An obvious way of showing interest and appreciation was by the contribution of funds. C.S.I.R.O. had invited the food industry to donate funds for research, but present contributors, some fifty in number, only represented about one-third of those whom he felt should be helping.

Mr. Eagle went on to quote examples of the help being received by the industry and specifically mentioned the development of the maturometer, which had been of great benefit to the pea industry, and looked like being of great help to pineapple and apricot processors. He felt that the diagnostic work and safe processing advice from the Division had proved timely and had been most helpful. Mr. Eagle also mentioned the excellent work being carried out on tinplate, and referred to the substantial contribution made to this research by the Broken Hill Proprietary Company. A very useful fund of knowledge was being built up regarding electrolytic tinplate but there was still a dearth of information on the use of plastic films for packaging. The Division was, however, carrying out research, the results of which should permit the behaviour of plastic films to be predicted with some accuracy. It should be recognized that the Division was doing a great deal of research which was too costly for the industry to do itself. It had a fine group of research workers whose work was now facilitated by a comprehensive library, a group of mathematical statisticians, the use of an electronic computer, and much modern laboratory equipment. Mr. Eagle said the Division was in a position to pioneer new techniques such as preservation by irradiation and freeze drying. It was in a position to help many branches of the food industry, who would find it more economic to subsidize research in C.S.I.R.O. laboratories than invest large amounts of money in research laboratories of their own.

In supporting the remarks of Mr. Eagle, Mr. H. W. Cottee (of Cottee's Ltd.) said the Division of Food Preservation had helped the food industry very much in the post-war years, and had gained the confidence of management. As a result, help was now freely sought and given, and the industry felt most grateful. He expressed his confidence in the future, and felt sure that Dr. Vickery and his team of research workers would make the fullest use of the excellent facilities available to them in the new laboratories.

Food Science Conference

A FOOD Science Conference organized by the Division of Food Preservation, to inaugurate its new laboratories at North Ryde, was attended by some 300 delegates, 51 being from other States of Australia, and 11 from overseas. The sessions, interspersed with other activities such as an inspection of the new buildings and the demonstrations which had been arranged, were spread over the period September 19–22, 1961. They took the form of symposia and panel discussions, each in charge of a chairman selected for his knowledge of the field under discussion.

OPENING ADDRESS

In opening the Conference, Dr. R. N. Robertson, F.R.S., Member of the C.S.I.R.O. Executive, and a former Assistant Chief of the Division, said:

"One disadvantage of opening a food conference the day after the opening of a food laboratory is that there is not much left in the way of general remarks about food. I shall perhaps be excused for reverting to Byron, who said that all history shows:

That happiness for man—the hungry sinner—
Since Eve ate apples, depends much on dinner.

In the same poem, he said later:

Who would suppose, from Adam's simple ration,
That cookery would have called forth such resources
As form a science and a nomenclature
From out the commonest demands of nature.

A small piece of prophecy about food science 'from out the commonest demands of nature', which is remarkable when you consider Byron lived only through the first third of the nineteenth century.

"While much has been said about food in the last day or two, it is perhaps appropriate to remind you that this, as desired by the organizers, is a food *science* conference. As you know—and a glance at the programme will confirm—we shall be dealing with the scientific knowledge and the research which establishes it rather than with the technology of food handling, processing, and preservation. For it is on this advancing knowledge, as Dr. Vickery said yesterday, that the developments in technology depend and it is appropriate that this conference should be held in the Division of Food Preservation which has been in the vanguard of research in Australia on food quality and preservation.

"I have only to remind you of the history of food science to support the statement that the advance in scientific knowledge is the vehicle of progress in food technology. Early last century—despite Byron—few people thought about the chemical composition of foods. All foods were thought to contain a 'universal aliment'. As chemical knowledge and techniques advanced, some development of thinking took place. Sometimes inadequate knowledge was applied too literally. For instance, the famous Agassiz, a biologist of Harvard, was responsible for the argument that brain was rich in phosphorus, fish were rich in phosphorus, therefore fish were food for brains! Later, we went through another stage of misplaced scientific enthusiasm when it became possible to assess the calorific value of foods. Foods low in calorific value were condemned as being wasteful in human consumption. The Yearbook of the U.S. Department of Agriculture, for instance, in 1895 contains a report which, in ignorance of vitamins and with little knowledge of minerals, condemns many foods which are prized today. As late as 1907, the same authoritative publication condemned oranges; four years later, the same author wrote that the unusual merits of fresh vegetables were a hangover from the erroneous beliefs of earlier times. Almost simultaneously, the first vitamin was discovered and within ten years we had a clear picture, based on sound scientific experiment and verifiable hypotheses, of the role of the minor constituents.

"Thinking about these few anomalies of history provides some lessons:

That the knowledge about foods advances only as rapidly as the fundamental knowledge of the sciences on which it depends; a lesson which might well be taken to heart by certain branches of the food industry.

That every advance in knowledge is valuable only with a testable hypothesis. Thus it was that the hypothesis that chemical analysis leading to calorific value should give adequate rations, and the finding that rats did not thrive on such a diet, that led to the discovery of vitamins.

To these we can perhaps add a third lesson—that discoveries of fundamentals occur only as rapidly as techniques, skills, and thoughts develop.

"It is no wonder that, when we turn to a programme of a conference such as this, we have on the agenda chemical aspects of food preservation; meat quality; the physiology of the animal, its husbandry, its ante-mortem treatment; the organization of plant and animal cells and tissues, and microbiological knowledge, which is necessary to maintain both food quality and human health.

"Many people are talking now about the problems we face in producing food for the increasing population of the world. I do not intend to comment on this beyond stating that it is apparent that the amount of money spent by Governments on food research, for the benefit of mankind, is a very small fraction of that which is spent on physical research for space probes and satellites. The diversion of a larger fraction of this money to food research and associated biological problems would seem urgent. While it is true that man does not live by bread alone, it is equally true that he cannot eat satellites and rockets.

"I am happy to welcome many distinguished food scientists to this gathering and to give a special welcome to our friends from overseas. The Division of Food Preservation has specially strong connections with the Low Temperature Research Station at Cambridge, which is represented by its Director, Dr. E. C. Bate-Smith, and also with the University of California, from where we have Dr. C. O. Chichester, Associate-Professor of Food Technology, Davis, and Dr. J. B. Biale, Professor of Plant Physiology, Los Angeles. Other visitors from overseas include Dr. H. Wilkinson, Head of the Unilever Food Research Laboratory, England, Dr. B. Malin and Dr. G. B. Kline, of the Eli Lilly International Corporation, Indianapolis, U.S.A., Dr. R. H. Locker, of the Meat Industry Research Institute, New Zealand, Professor J. K. Scott, Massey College, New Zealand, Mr. M. S. Carrie and Mr. D. C. Miller, of the Canterbury Frozen Meat Company, Christchurch, New Zealand, and Mr. G. B. Latimer, of the Dairy Research Institute of New Zealand. The organizers of the conference are very pleased with the large attendance and look forward to lively discussions. We hope, too, that the conference will assist materially in strengthening the level of science in the food industry."

CONFERENCE PROGRAMME

Symposium and Contributed Papers on "Chemical Aspects of Food Preservation"

Sessional Chairmen:

Dr. R. N. Robertson, C.S.I.R.O. Executive.

Dr. K. L. Sutherland, Colonial Sugar Refining Co. Ltd.

Mr. M. V. Tracey, C.S.I.R.O. Wheat Research Unit.

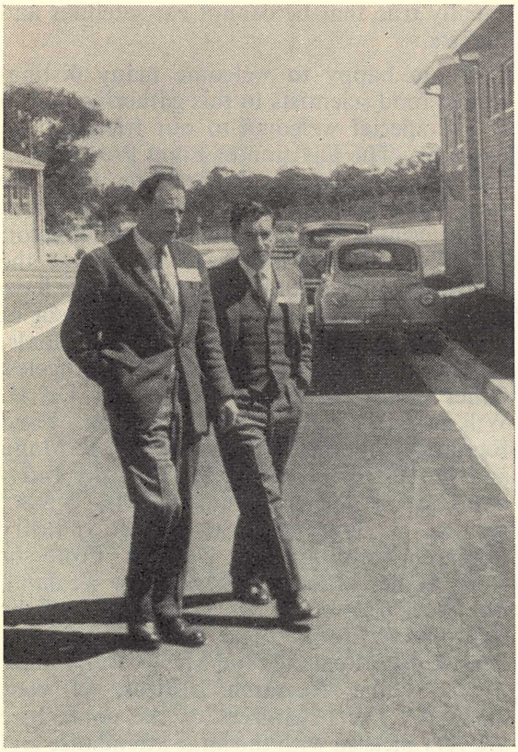
Lecture

CHEMICAL ASPECTS OF FOOD PROCESSING—Professor C. O. Chichester, University of California.

Papers

SOME COLOUR PROBLEMS INVOLVING FLAVONOID CONSTITUENTS OF FOOD—Dr. B. V. Chandler, C.S.I.R.O. Division of Food Preservation.

THE MAILLARD REACTION—Dr. T. M. Reynolds and Miss D. E. Fenwick, C.S.I.R.O. Division of Food Preservation.



Left, Dr. R. P. Newbold, Division of Food Preservation, and right, Professor J. K. Scott, Massey College, N.Z.

AUTOXIDATION OF CAROTENOIDS—Dr. E. R. Cole, School of Chemistry, University of New South Wales.

ATTEMPTS TO IDENTIFY THE FLAVOURS OF DRIED MUSHROOMS (*Boletus edulis*)—Mr. J. D. Craske, Unilever Australia Pty. Ltd., and Professor F. H. Reuter, University of New South Wales.

ANALYTICAL INSTRUMENTS IN FLAVOUR CHEMISTRY—Mr. D. A. Forss, C.S.I.R.O. Dairy Research Section.

PROBLEMS ASSOCIATED WITH THE PROCESSING OF PINEAPPLE JUICE IN QUEENSLAND—Mr. R. E. Leverington, Food Preservation Laboratory, Queensland Department of Agriculture and Stock.

EFFECT OF LIGHT RADIATION ON REGENERATED CELLULOSE FILM—Messrs. W. B. S. Bishop, F. A. Lee, D. G. Saville, and J. F. Williams, William Arnott Pty. Ltd.

SALT UPTAKE IN BRINE CURING—Dr. H. Wilkinson, Unilever Food Research Laboratory (England).

SOME ASPECTS OF THE EXCRETION AND METABOLISM OF AZO DYES.—Dr. A. Ryan, Pharmacy Department University of Sydney.

ACTION OF RENNIN ON CASEIN—Mr. R. Beeby, C.S.I.R.O. Dairy Research Section.

EFFECTS OF THERMOPHILIC BACTERIA IN SUGAR—Dr. I. R. Sherwood, Colonial Sugar Refining Co. Ltd.

Symposium and Contributed Papers on "Food Preservation and the Organization of Plant and Animal Tissues"

Sessional Chairmen

Dr. D. D. Davies, C.S.I.R.O. Division of Food Preservation.

Professor F. H. Reuter, Department of Food Technology, University of New South Wales.

Lecture

SENESCENCE IN PLANTS—Professor J. B. Biale, University of California.

Papers

SUBMICROSCOPIC ORGANIZATION OF PLANT TISSUES—Professor F. V. Mercer, Botany School, University of Sydney.

CHILLING INJURY IN PLANTS—Dr. F. E. Huelin, C.S.I.R.O. Division of Food Preservation.

FREEZING OF PLANT TISSUES—Mr. J. Shipton, C.S.I.R.O. Division of Food Preservation.

TEXTURE IN CANNED FOODS—Mr. R. S. Mitchell, C.S.I.R.O. Division of Food Preservation.

TEXTURE IN DRIED FOODS.—Mr. D. McG. McBean, C.S.I.R.O. Division of Food Preservation.

Symposium and Contributed Papers on "Meat Quality"

Chairman

Mr. B. M. Cocks, W. Angliss & Co. (Aust.) Pty. Ltd.

Lecture

QUALITY IN MEAT AND FACTORS AFFECTING IT—Dr. E. C. Bate-Smith, Agricultural Research Council, Low Temperature Research Station (England).

Papers

CHEMICAL AND BIOCHEMICAL ASPECTS OF MEAT TENDERNESS—Dr. R. H. Locker, Meat Industry Research Institute of New Zealand.

Husbandry and Meat Quality—Professor N. T. M. Yeates, University of New England (N.S.W.).

The Role of Ante-Mortem Factors in Meat Quality—Mr. A. Howard, C.S.I.R.O. Division of Food Preservation.

Post-mortem Factors Affecting Acceptability—Dr. R. P. Newbold, C.S.I.R.O. Division of Food Preservation.

Panel Discussion on "Public Health Aspects of Handling and Processing Foods"

Chairman

Dr. E. Forbes MacKenzie, Victorian Department of Health.

Members

Dr. K. T. H. Farrer, Kraft Foods Ltd. (Melbourne).

Dr. W. J. Scott, C.S.I.R.O. Division of Food Preservation.

Professor S. E. Wright, Department of Pharmacy, University of Sydney.

Dr. M. M. Wilson, Public Health Laboratory, University of Melbourne.

Panel Discussion on "Trends in Food Research"

Chairman

Dr. J. R. Vickery, C.S.I.R.O. Division of Food Preservation.

Members

Dr. E. C. Bate-Smith, Low Temperature Research Station (England).

Professor J. B. Biale, University of California.

Mr. E. E. Bond, Bread Research Institute of Australia.

Professor C. O. Chichester, University of California.

Mr. J. F. Kefford, C.S.I.R.O. Division of Food Preservation.

Dr. H. Wilkinson, Unilever Food Research Laboratory (England).

PROCEEDINGS

Chemical Aspects of Food Preservation

In the opening lecture* of this symposium Professor C. O. Chichester pointed out that basic engineering processes in food preservation are concerned mainly with water, the chief constituent of many foods. However, the key to many problems in their processing and storage may be found in chemical reactions of relatively minor components of the biological systems. He cited several examples of practical problems related to the chemistry of minor constituents of foods.

In his paper on problems involving flavonoid constituents of foods, Dr. B. V. Chandler provided further examples of the importance of chemical reactions involving minor constituents. Yellow spot and brown discoloration in pickled onions occur only with brown skinned onions which contain much higher concentrations than white skinned varieties of the polyphenolic compounds responsible. Green beans from varieties having coloured flowers contain in the skin of the seeds colourless flavonoids (leucoanthocyanins), which cause brown discoloration when the beans are processed as baby foods. Beans from varieties with white flowers do not show this discoloration. The random occurrence of pink discoloration in canned Bartlett (William Bon Chretien) pears is an embarrassment to the canning industry. Bartlett pears normally contain only small amounts of the leucoanthocyanins, which cause pink discoloration during processing, but marked differences in the concentration of these constituents are shown by pears from trees with differing orchard histories, and higher concentrations also appear in fruits under certain ripening conditions.

In the discussion on this paper, Dr. Bate-Smith referred to an occurrence in Britain of yellow discoloration in tripe and onions, which was traced to a reaction between a flavonoid in the onions and aluminium from the cooking vessels.

The Maillard reaction in foods has been intensively studied in the Division of Food Preservation, as in many other food laboratories, and recent work on the formation and proportion of the brown pigment was described by Dr. T. M. Reynolds and Miss D. E. Fenwick in a paper presented by Dr. Reynolds. Model systems, containing glucose, glycine, and citrate at high solids content, and held at 50°C, were studied at two pH levels. Specific analytical methods were used to follow the disappearance of

* To be published in full in a future issue of the Food Preservation Quarterly.

glucose and glycine, and the formation of fructose-glycine, 3-deoxyglucosone, and hydroxymethylfurfural. Simultaneously the formation of brown pigment was followed and the pigment was separated into dialysable and non-dialysable fractions. Various samples of brown pigment have been isolated and some progress has been made towards elucidating the constitution of the pigment.

Dr. E. R. Cole, in his paper, reviewed present knowledge on chemical oxidations and autoxidations of β-carotene and lycopene. Relationships between autoxidations of simple olefins, terpenes, and carotenoids were explored, with particular reference to the role of active methylene groups and ethylenic centres as sites of autoxidation.

In the discussion of this paper Dr. Bate-Smith reported observations in Cambridge in which gas chromatographic studies had shown that the odour of violets commonly encountered in stored dehydrated carrots was not due to β-ionone, as has been generally assumed.

Attempts to identify the flavour of dried mushrooms (*Boletus edulis*) by Mr. J. D. Craske and Professor F. H. Reuter were described by the former. Considerable quantities of the dehydrated mushroom, *Boletus edulis*, are imported from European countries for use in Australian packaged foodstuffs. An attempt was made to identify some of the flavour compounds in this product with a view to comparing them with those of the locally cultured mushroom *Agaricus campestris*. Water extracts the flavour compounds efficiently and the flavour is concentrated in the basic fractions which may be separated by ion exchange. While all, or most of, the basic substances contribute to the overall flavour profile, the components of highest basicity are those which are most characteristic of mushroom flavour.

Mr. D. A. Forss furnished the Conference with a survey of modern analytical instruments used in flavour chemistry. He dealt with the application of gas chromatography, ultraviolet and visible spectrophotometry, mass spectrometry, and nuclear magnetic resonance to the study of the chemistry of food flavours. He emphasized the expensive nature of the instruments required, and the need for specialized technical "know-how", and made a plea for the pooling of knowledge and facilities in this field. In this connection Dr. K. L. Sutherland pointed out that the C.S.I.R.O. Division of Organic Chemistry would shortly offer to Australian chemists a service for nuclear magnetic resonance determinations along the same lines as the present microanalytical service. During the discussion several speakers emphasized the fact that the major difficulty in the study of volatile food flavours was the development of techniques for the absorption of the volatiles and for their subsequent release for chemical examination.

Problems associated with the processing of pineapple juice were outlined by Mr. R. E. Leverington in a paper which was presented by Dr. S. A. Trout. Production of pineapple juice of consistent quality is difficult because of changes in chemical composition due to seasonal, regional, and maturity effects. Variations in the concentrations of sugar and acid are fairly easy to control, but volatile flavours may vary as much as one hundred-fold. Greater control of volatile flavours is possible with concentrated pineapple juice. A pilot plant had been installed in the Food Preservation Research Laboratory at Hamilton, Queensland, to strip the essences from the juice before concentration and to return a fixed amount of blended essence to the final concentrate.

A paper by Messrs. W. B. S. Bishop, F. A. Lee, D. G. Saville, and J. F. Williams on the effect of light radiation on cellulose films, widely used in food packaging, was presented by Mr. Williams. Regenerated cellulose film, when irradiated with light of various wavelengths, has been found to undergo some decomposition with liberation of products of objectionable odour, such as hydrogen sulphide. The decomposition is most marked when the original surface of the film is disturbed, as for instance, by solvent application in printing or polymer coating. Control of the residual carbon disulphide content of cellulose films, to be used as food wraps, is desirable and techniques for the determination of residual carbon disulphide have been developed.

Dr. H. Wilkinson described experiments on salt uptake in the brine curing of bacon. Salt is not distributed uniformly along the longissimus dorsi muscle in blocks of bacon, even after prolonged soaking. Differences in salt content lead to undesirable variations in taste, and regions of low salt content are potential sites for microbial spoilage. Non-uniform salting occurs only when tanking is a part of the curing process and can be avoided by using a procedure in which salt uptake does not depend on diffusion. During discussion Dr. Wilkinson said that while bacon with 12% salt in the aqueous phase is stable against microbial spoilage for some months, it is too salty for human consumption. At 7% salt in the aqueous phase, the highest level tolerated by consumers, bacon keeps for 21 days, but the storage period recommended to grocers in the United Kingdom is 12 days.

The results of current work, in the Pharmacy Department of the University of Sydney, on some aspects of the excretion and metabolism of azo dyes were given by Dr. A. J. Ryan, a National Health and Medical Research Council Fellow in that Department. Studies of the biliary excretion by rats of some water-soluble azo dyes reveal very great differences in the nature of the metabolites produced from closely related dyes and in their rates of excretion. At present no clear mechanism emerges to explain these differences. The excretion of the metabolic products of the fat-soluble carcinogenic dye, 4-dimethylaminoazobenzene, has been examined quantitatively in rats utilizing a molecule doubly labelled with tritium and carbon-14. By this procedure the metabolism of each benzene ring of the dye can be followed, and it is hoped that the work will lead to a general picture of the excretion of fat-soluble dyes. Dr. K. T. H. Farrer asked the speaker whether his results supported the view that a food dye was safe provided it was sulphonated on both sides of the azo linkage. Dr. Ryan replied that, to him, this was still an open question. In the benzene series both parts of the molecule appear to be completely excreted, but this may not be so in the naphthalene series.

Observations on the action of rennin on casein which point strongly to the fact that the primary action is not proteolysis were described by Mr. R. Beeby. The site of rennin attack is the κ-fraction of casein from which rennin splits off a large fragment in

Left front, Dr. S. A. Trout, Queensland Department of Agriculture and Stock, and right front, Dr. E. C. Bate-Smith, Low Temperature Research Station, Cambridge.

a reaction which is partially reversible on heating. Urea frees the same fragment from κ-casein, suggesting strongly that it is not an integral part of the κ-molecule but a separate fraction intimately associated with it.

Dr. I. R. Sherwood discussed the occurrence and significance of thermophilic bacteria in sugar. Because such bacteria show high heat resistance and may not be destroyed by normal canning processes, there is a demand from canners for sugar substantially free from thermophilic spores. Thermophiles are commonly present in raw sugar and from this source are introduced into the sugar refineries. To produce refined sugar of very low thermophilic spore content, filtration and ultraviolet irradiation are the most effective measures. In answer to a question following his paper, Dr. Sherwood stated that the thermophilic count in liquid sugar is very low because this product receives additional filtration.

Meat Quality

This symposium was introduced by Dr. E. C. Bate-Smith, who gave an entertaining account, enlivened by many personal recolections and illustrated by slides, of the history of work by Commonwealth scientists on meat handling and preservation.* By pointing out that quality in meat may be defined, on the one hand, in terms of the conformation and finish of the carcass, or on the other hand in terms of the appearance, texture, and flavour of the cuts, he opened the way for following speakers to develop these aspects more fully.

Biochemical aspects of meat tenderness were discussed in the next paper by Dr. R. H. Locker. He pointed out that while the increase in tenderness of beef in storage is a well known phenomenon, the mechanism of this change has never been properly elucidated. Dr. Locker presented evidence that the increase in tenderness is not due to proteolysis. Since there is no increase in protein end-groups in aged beef either before or after cooking, it seems that no significant protein splitting occurs. The slow production of free amino acids is attributed to the known presence of amino-peptidases in beef which could remove amino acids from protein chains one at a time with no increase in end-groups. A factor in tenderness which has received little attention is the state of contraction of the muscle. There are widely varying states of contraction among the muscles of a carcass, but a direct relation between contraction state and tenderness is obscured by the dominating effect of connective tissue. Experiments on cut and uncut psoas muscles show that, for muscles of low connective tissue content, contraction is a significant cause of toughness.

Professor N. T. M. Yeates followed with a paper on "Husbandry and Meat Quality". He advanced the view that meat of good quality came from carcasses which contain a maximum of muscle, a minimum of bone, and just sufficient thickness of evenly distributed subcutaneous fat to protect the muscle during storage and dry cooking. Such definition demanded early maturing animals having a high ratio of muscle to bone. Owing to the differential growth rates of bone, muscle, and fat only such animals have the capacity to achieve great muscular proportions and lay on enough fat while bone development is still within the reasonable limits necessary for "handy" carcass size. He maintained that this desired growth pattern could be achieved more efficiently by entire males than by castrated males or females, and that the sex influence does not adversely affect quality provided bull calves are grown quickly and are marketed at 10–14 months of age. Poor nutritive state in animals is associated with diminution in muscle fibre diameter and therefore in total muscle thickness. As connective tissue is relatively constant, nutritive reductions in muscle thickness mean a relative increase in connective tissue content. This gives more "residue" in each mouthful chewed and so is harmful to quality as well as quantity of meat produced.

In answer to a question from Dr. Bate-Smith regarding the significance of marbling as a quality factor in meat, Professor Yeates stated that experiments have shown no relationship between marbling and tenderness. He regarded marbling as a traditional factor which should be ignored in present programmes of quality improvement. Mr. T. Herbert, of the Meat Trades Federation, confirmed the view that marbling is not an important factor in determining consumer preference for meat in Australia.

Dr. W. J. Scott raised the possibility of removing differences in quality between individual muscles of a carcass by attention to breeding and conditions of growth. Professor Yeates considered that there would always be differences within a carcass and that genetic improvement could not be expected to change this.

While some aspects of meat quality are determined to a certain extent irreversibly by

* Dr. Bate-Smith's lecture will be published in full in the next issue of the Food Preservation Quarterly.

the breeding and the nutrition of the animals, treatments applied in the period from the time the animal leaves the farm till it is slaughtered also have their effects. The role of ante-mortem factors in meat quality was the subject of a paper by Mr. A. Howard, read by Dr. J. R. Vickery. It was emphasized that stresses such as muscular activity, starvation, cold, and fear, affect quality by depleting reserves of glycogen which are normally maintained by homeostasis but may be reduced by short-term stress. When glycogen reserves fall below about 0·8% of the tissue, the normal process of rigor will not produce enough lactic acid to lower the pH to the ultimate value of 5·5 found in normal carcasses. High pH lowers the eating quality of beef and darkens the colour, although it decreases the amount of drip on thawing.

Dr. R. P. Newbold followed with a paper on post-mortem factors affecting acceptability of meat. Aging, freezing, and thawing and other post-mortem treatments, bring about changes in the appearance and tenderness of meat. When meat is frozen after rigor has set in, tenderness is improved, but drip exuded on thawing makes its appearance less attractive. Freezing before the onset of rigor increases both toughness and drip.

Dr. Newbold also referred to tenderizing processes involving mechanical treatments, the addition of salts, and the use of proteolytic enzymes. The outstanding problem in the use of tenderizers is that of attaining uniform distribution. In exploratory experiments the post-slaughter injection of the plant enzymes, papain and bromelin, has given promising results.

Food Preservation and the Organization of Plant and Animal Tissues

In his opening lecture* on senescence in plants Professor J. B. Biale pointed out that aging of both plant and animal cells has been described, in general terms, as the lowering of the organization resistance of protoplasm. Within recent years attention has been directed to more precise changes in physiological processes associated with the transition from growth and maturation to senescence. Control of the onset and rate of senescence is possible by the action of environmental factors such as storage temperature or of chemical agents such as ethylene.

The submicroscopic organization of plant tissues was described by Professor F. V. Mercer who stated that modern techniques have resulted in a well-documented picture of the normal plant cell. Much is known about the function of some structures such as mitochondria and chloroplasts, but very little of the way in which the activities of the various components are coordinated to give the functional unit we recognize as the normal plant cell. Presumably many different mechanisms are involved and some of these are likely to have a structural basis, e.g. structure at the molecular level may determine enzyme specificity and therefore metabolic processes; membrane structure at the submicroscopic level may determine the rate of enzyme reactions, and therefore of metabolism, by controlling the concentration of a substrate; or structure at the microscopic level may affect metabolism by determining the spatial distribution of reactants. In contrast to the wealth of information about the normal cell, little information exists about the structure of the abnormal cell, which is unfortunate in relation to food preservation. The few studies which have been made indicate that alterations in structure accompany mechanical damage, bruising, physiological breakdown, and senescence of plant cells, but the functional significance of these changes is not known.

Chilling injury of plants, i.e. low-temperature injury in the absence of freezing, which was the subject of a paper by Dr. F. E. Huelin, is a phenomenon which affects many species of plants but has been studied mainly in connection with the storage of fruits and vegetables. With lowering of temperature the final injury increases, but its rate of development decreases—hence for any period of storage there is a temperature of maximum injury, and this moves to progressively lower temperatures as the period of storage is increased. The injury is sometimes "latent" and becomes apparent only on subsequent exposure to higher temperatures. Chilling

* To be published in full in a future issue of the Food Preservation Quarterly.

injury is most commonly explained as a disturbance of metabolic balance. Below the critical temperature some reactions are inhibited more than others and toxic metabolites accumulate. Alternatively, it may be explained in terms of the solidification of lipid components of subcellular structures.

Professor Biale asked why there is a difference between similar varieties with respect to the minimum temperature tolerated. In reply Dr. Huelin suggested that the lipids of the subcellular structures may have different freezing points in different varieties.

The freezing of plant tissues was discussed by Mr. J. Shipton, with particular reference to studies of tissue changes during the preservation of fruits and vegetables by quick freezing. The most important effect of freezing is to disrupt tissue structure. Histological studies on a wide range of frozen and thawed products have defined the nature of ice crystal formation, and the relative susceptibility to freezing damage of different types of cells. It has been claimed that cells with thickened walls and those containing starch or protein are more resistant to the effects of freezing. The precise mechanism leading to freezing damage is still the subject of controversy. In addition to cell breakdown, freezing induces irreversible changes in colloidal constituents, which lose their capacity to absorb water. This leads to fluid leakage when the tissue thaws. The influence of freezing rate on frozen food quality has been investigated extensively. Ice crystal size is inversely related to freezing rate, but organoleptic studies have indicated that consumer acceptability of frozen fruits and vegetables, with the exception of asparagus and possibly strawberries, is independent of freezing rate.

Mr. M. B. Smith, in his paper, extended the discussion to the freezing of meat and fish, which may result in the development of an undesirable appearance and texture, and a reduced capacity to retain fluid. These changes are attributed to the disorganization of the muscle structure on freezing and thawing, due mainly to the complementary effects of a redistribution of water and a change in the composition of the liquid phase in and around the muscle cell. Since the complicated structure of the muscle cell does not allow direct observation of the state of its separate components or control of their environment without disrupting the structure, it is necessary to use isolated systems to observe changes in colloidal properties, such as coagulation and syneresis, or changes in molecular properties leading to aggregation and loss of solubility of the muscle protein.

Instruments which have been devised for the measurement of texture in raw products for canning or freezing were described by Mr. R. S. Mitchell. Green peas have received more attention than any other product because of their commercial importance, and because maturity is critical and is closely related to physical measures of texture.

Workers in the Division of Food Preservation had developed an instrument, the maturometer, which measures the force required to puncture a sample of peas. It has been used to analyse the maturity of size fractions in developing crops. The maturity data, when compounded with yield values, gave the concept of optimal harvest time and led to a method for short-term prediction of the time to harvest pea crops. By the use of cutting heads of different designs it is hoped to develop the maturometer into a general-purpose instrument for texture measurement. Preliminary studies have been made with pineapples, where the tendency of slices to break during handling presents an important commercial problem.

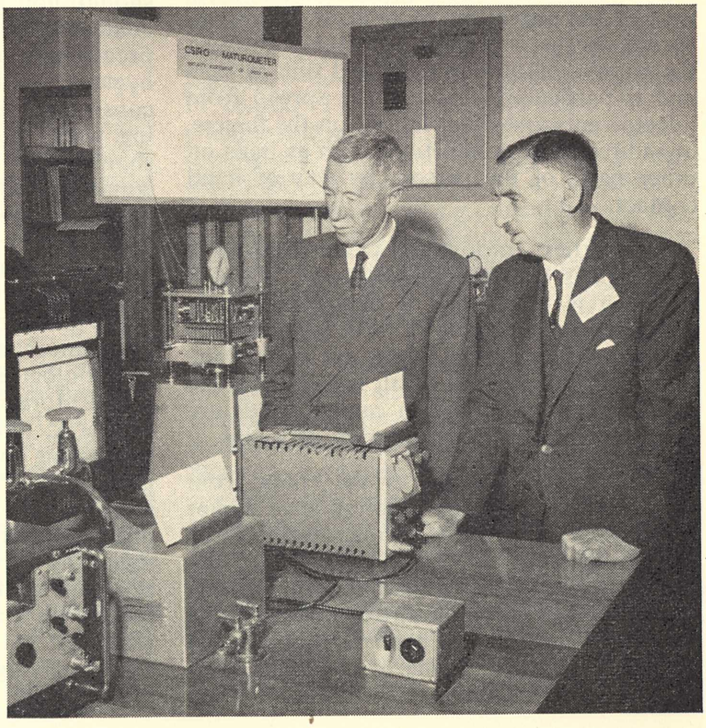
In the discussion on this paper, Professor F. H. Reuter asserted that frozen peas imported from Britain were superior in quality to Australian peas and inquired whether maturity standards were different in the two countries. Dr. H. Wilkinson quoted ranges of tenderometer readings for freezing and canning peas in Britain which when converted to maturometer readings were stated by Mr. Mitchell to be similar to the ranges applied in the Australian industry. Dr. R. N. Robertson drew attention to the fact that phytotron experiments had shown that the sugar and starch contents of peas of a given size were greatly influenced by the temperature during maturation.

Texture defects in dehydrated foods after reconstitution present major problems which were discussed by Mr. D. McBean. Histological studies of changes in the structure of fruits and vegetables caused by blanching, sulphuring, and drying have provided data on changes in intercellular spaces, release of components from cells, gelling of starch, and softening of cell walls. They have not, however, suggested any reason for incomplete reconstitution or undesirable changes in texture. The pectin-cellulose complex, which makes up the cell walls of fruits and vegetables, shrinks and distorts during drying, but nevertheless remains intact. Moisture diffusion constants are very low in low-moisture content foods. In products composed of small particles or thin flakes, reconstitution is rapid and relatively satisfactory. Freeze-dried foods, with their porous structure, reconstitute quickly, but often remain tough even though they contain as much water as the cooked, unprocessed material. The quantity of water absorbed by dry tissues does not ensure an acceptable texture: distribution in the tissue may be of critical importance. The skins of fruits and vegetables act as a barrier to water movement during drying and reconstitution.

Public Health Aspects of Handling and Processing Foods

In introducing this panel discussion the Chairman, Dr. E. Forbes Mackenzie, Assistant Chief Health Officer of the Victorian Department of Health, pointed out that food processing and distribution have become matters of public health concern from a number of points of view. Foods, he said, may become contaminated with pathogenic microorganisms or they may undergo microbial spoilage, with the production of toxins. Nutritional deficiencies may arise owing to the widespread use of sophisticated foods, while the consumer may be subjected to hazards, known or unknown, through the presence of accidental adulterants, or by substances from the very numerous group known as food additives. Following this introduction the Chairman invited members of the panel to enlarge upon the various matters he had mentioned.

Dr. M. M. Wilson, Assistant Director of the Public Health Laboratory of the University of Melbourne, on dealing with microbiological hazards, said there were no comprehensive statistics covering the incidence of bacterial food poisoning in Australia, but it seems permissible to argue by analogy from those collected in the U.K. and U.S.A. salmonellosis is the commonest form of



The Hon. D. A. Cameron (Minister-in-Charge of C.S.I.R.O.) and Dr. J. R. Vickery (Chief of the Division) viewing a display of equipment used to assess the maturity of green peas.

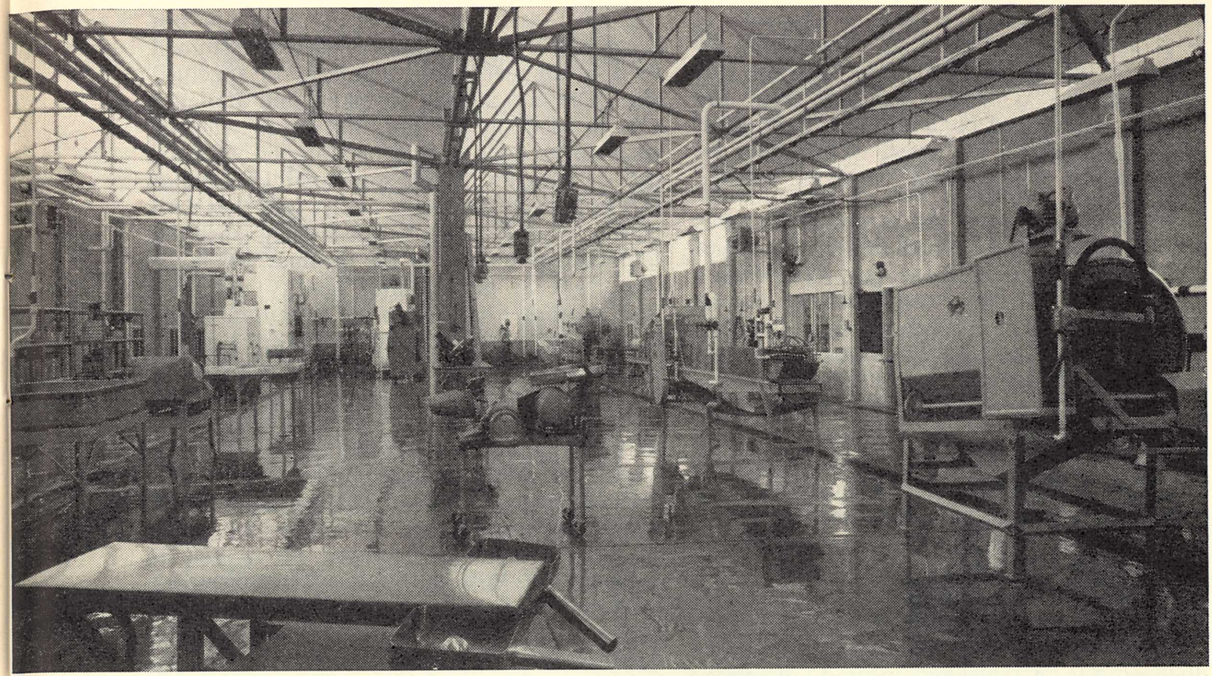
infective food poisoning, and *Salmonella typhimurium* accounts for more than 50% of its incidence the world over. Foods especially liable to be infected are meats, particularly pig meats, egg products, artificial creams and ice creams, shellfish, and desiccated coconut. The principle of pooling a large amount of primary material and passing it along the same production line is very conducive to the dissemination of a small dose of organisms throughout a large batch of products. Growth of salmonellae in food may occur without obvious signs of putrefaction. Salmonellae may be introduced by the raw materials, or somewhere along the production line through unhygienic handling or contamination by dust, flies, rodent excreta, dirty utensils, etc. Other organisms may also be introduced in this way and give rise to food poisoning, e.g. *Clostridium welchii*, shigellae, streptococci, tubercle and diphtheria bacilli, brucellae, and to a lesser degree rickettsiae of "Q" fever.

Most cases of food poisoning due to toxin are caused by strains of *Staphylococcus aureus*. In this case the enterotoxin is a by-product of bacterial growth and is sufficiently heat stable to survive treatments which destroy the organisms themselves. *Staphylococcus aureus* is widely distributed through the population among nasal and skin carriers and is particularly liable to be spread from infected cuts and other lesions on the fingers, or indirectly from infections such as boils on other parts of the person, by way of hand contact.

The other important toxin-producing organism is *Clostridium botulinum*. Though botulism is fortunately a rare disease, this organism is important to food technologists for two reasons: the spores are among the most resistant to heat of all bacterial forms, and the conditions within canned foods are ideal for growth and formation of toxins.

All persons involved in the chain from food production to consumption have a joint responsibility to ensure that microbial hazards are avoided or at least minimized, said Dr. W. J. Scott, who illustrated dramatically the magnitude of the hazards involved in the very large numbers of bacteria that may be present in food. Some fresh foods may contain 10 million or more bacteria per gram before they are regarded as spoiled. As there are 1 million grams in a ton, a ton of such food with 10^7 bacteria per gram would contain 10^{13} bacteria, which is 3000 times the present human population of this planet. Although most eggs are free of bacteria, an infected one may carry as many as 10^9 bacteria per gram. If these organisms were salmonellae, a single infected egg could make 50,000 tons of egg pulp potentially dangerous and bacteriologically unacceptable in some markets. Another important factor is the exponential growth of bacterial populations. A single organism with a few milligrams of food could increase to 10 million cells in 24 hours, and this speck of infection could be distributed to provide one cell per gram throughout 10 tons of product. Incubation and mixing are therefore a very menacing combination. Dr. Scott went on to enumerate the precautions that are necessary to prevent potentially dangerous situations from becoming a reality.

The food manufacturer must be rigid in excluding infected raw materials and make every effort to avoid additional contamination within the factory. The hands of employees should not be allowed to come in direct contact with food and all concerned with processing must observe strict personal hygiene. Equipment should be designed and constructed so as to facilitate effective cleaning, which must be practised regularly. Food should not be allowed to remain under conditions which will permit the growth of any dangerous organisms which it may have acquired. Failure to observe this can cancel the value of all previous measures. Terminal heat treatment can very greatly increase the safety of many foods. Wholesale and retail distributors cannot usually improve a product bacteriologically, but by providing appropriate storage conditions they can prevent further deterioration. Products capable of supporting the growth of pathogenic organisms should not be held at temperatures above 40°F. There is a need in Australia to instruct food distributors more adequately regarding proper storage conditions and expected shelf life. The practice of labelling foods with the date of manufacture should be extended. At the end of the chain, the consumer may aggravate the bacterial condition of foods by providing extended incubation



A view of some of the equipment in the Food Processing Building, North Ryde.

conditions, or on the other hand he may correct a dangerous situation by thoroughly cooking the food and so destroying bacteria and their toxins.

Professor S. E. Wright spoke next on public health aspects of the use of chemicals in foods, and drew attention to two contrasting approaches to this subject. One is that of some chemical manufacturers, wanting to have as much of their products used as possible, who claim that so little of the chemical gets into the diet that danger is unlikely. Other persons maintain that all unnatural synthetic substances added to food during production or processing are harmful. The need to arrive at some sort of compromise based on scientific evidence is obvious, but unfortunately those responsible for food legislation usually have a difficult task as adequate data concerning the safety of chemicals likely to find their way into food is scanty or on occasion not available. The insidious hazards of chronic toxicity are difficult to assess. It is generally agreed, however, that chemicals will have to be used more and more in food production and processing if world food requirements are to be met. Authorities in many countries are facing the problem of appraising the hazards of residues of agricultural chemicals in foods. In Canada, tolerances for 50 chemicals in about 1100 food items have been unofficially listed and, in addition, a "zero tolerance" is required for a number of dangerous substances e.g., nitrophenols, alkyl phosphates, and mercury and selenium compounds. In Australia tolerances are recommended for about 15 substances, apart from the organic phosphate insecticides.

The term "food additive" is usually applied to substances added intentionally during processing, such as dyes, antioxidants, preservatives, emulsifying agents, humectants, flavours, acidifiers, etc. A decision as to whether substances should be allowed is based upon data derived from animal feeding tests, and on biochemical principles such as whether or not the addition is likely to fix calcium and prevent it becoming available in the diet. A frequently used criterion of toxicity is to determine whether the substance is safe in long-term animal feeding studies when the substance is fed in amounts at least 100 times as great as those likely to occur in the human diet. In Australia our resources for collecting toxicity data are limited, but we can contribute to the fund of information about the safety of additives by carrying out fundamental metabolic studies.

The point of view of the food manufacturer was presented by Dr. K. T. H. Farrer, Chief Chemist and Research Manager, Kraft Foods Ltd. While affirming the need for manufacturers to use permitted additives for such purposes as enhancing the keeping quality, stability, and acceptability of foods, he condemned the abuse of additives to mask inferior products, to simulate missing characteristics, or generally to cover up poor sanitation and processing. He pointed out that adventitious contamination of foods with chemical substances may occur through carelessness, ignorance, or avarice, as exemplified by the widespread occurrence of penicillin in milk because dairymen are unwilling to remove treated cows from production for a specified period of time. Dr. Farrer maintained that there are several sanctions which make it inexpedient for the food manufacturer to depart from good public health practices. Powerful economic sanctions operate since it costs money and prestige to have products returned; it is costly too to make deliberate additions, and over-coloured, over-flavoured, or over-stabilized foods are rejected by the consumer and lead to falling sales. Food regulations provide legal sanctions which food manufacturers do not deliberately flout, and finally ethical sanctions are important because a sense of responsibility for the health of the public *does* exist among most food manufacturers.

The discussion which followed the papers was active and prolonged and many important questions were raised. The panel expressed the view that microbiological standards are likely to be included more generally in food regulations in the future, especially in relation to ready-to-eat foods. They stressed however that such standards in themselves do not provide complete safeguards. A given product might meet the required standards and yet still be potentially dangerous. Microbiological standards should be written in terms stating that a particular organism may be present in numbers not exceeding a given number when determined by a given method in a sample of specified size. Opinion among the panel and audience was divided on the question as to whether perishable foods should be stamped with the date of packing. While some maintained that this practice is desirable, others said that with frozen foods it could be misleading since the temperature history of the product was more important in determining quality than the total storage time. In order to minimize the likelihood of food poisoning by staphylococci or salmonellae, it was agreed that more widespread use of refrigeration during food distribution was desirable, and it was suggested that refrigeration of foods likely to spoil might be made obligatory by regulations directed especially towards wholesalers and restaurant proprietors.

In answer to a question about colouring matters for foods permitted in Australia, Professor Wright pointed out that the Australian list is more conservative than the British one. In particular, oil- or fat-soluble dyes are not permitted in Australia. Further, the Australian list includes only those azo dyes which have a sulphonic acid group on each side of the azo group and which therefore would be expected to give two water-soluble sulphonated amines when the azo linkage is broken. A delegate pointed out that butylated hydroxytoluene (BHT) had been approved as an antioxidant in the U.S.A. and the U.K. but not in Australia and asked whether all additives approved in other countries are likely to be re-examined in Australia. Professor Wright replied that he saw no need to re-test every compound, but when new facts became known they must be taken into consideration. Australian work had shown some evidence of liver damage in rats receiving BHT and so approval of this compound had been withheld until more information became available.

Trends in Food Research

The concluding session of the Conference took the form of a panel discussion on trends in food research, with Dr. J. R. Vickery in the Chair. The Chairman directed the thoughts of conference members to the problem of food supplies in relation to the increase in world population expected to occur before the end of this century. Research was needed, he said, on better utilization of animal and vegetable crops already used for food, on the exploitation of new sources of food, and on the synthesis of food. Dr. Vickery also drew attention to some frontiers in food science where the need for basic knowledge is restricting technological advance. The nature of texture and flavour in foods, particularly in flesh products, is incompletely understood. The factors controlling microbial growth and spore formation and germination require elucidation, and great advances are possible if ways can be found of increasing the susceptibility of spores to heat and ionizing radiations.

The first speaker on the panel, Dr. H. Wilkinson, raised the question: "What kind of people are required to carry out food research?" He expressed the view that it requires scientists highly trained in the basic disciplines—chemistry, biochemistry, physics, and engineering. Food technologists should not be asked to do food research, although they have their own important place in the food industry in product development and production. It was difficult, he said, for the food industry to recruit first-class workers, since they tended to be attracted to more glamorous employment, such as in the chemical industry. Young research workers generally do not realize the complex and interesting scientific problems which arise in research on processed foods. To attract worthwhile people, the food industry must encourage them to undertake speculative research, to work on subjects of their own choosing, provided that they bear some relationship to food, and to publish the results of their work freely. Small companies, however, cannot afford to do basic research and therefore must depend upon research associations. But, too often, the small company expects the research association to do all its trouble shooting, and then the association has no time or resources for basic research. If research associations are to survive and perform a useful role, they must be given the opportunity to carry out basic research.

Professor C. O. Chichester said he proposed to deal with two types of trends in food research: those concerned with improving the quality of foods, and those concerned with increasing the total quantity of foods available to mankind. Up to the present, the main emphasis in food research has been on quality improvement. He forecast that future trends in this direction will involve new modifications of unit processes. In order to place the design of food equipment and food processes, such as freeze-drying, on a sounder fundamental basis it will be necessary to have more complete knowledge of the physical properties of food materials. Irradiation, though restricted in its application, will extend its usefulness, he predicted, and antibiotics will be used more widely as inhibitors of microbial growth. Improvement in food quality will come about also as a result of closer liaison between growers and processors, and improved procedures for transport from field to factory. To increase the total quantity of food supply for the world's population, Dr. Chichester considered that the direction of future research will lie towards food synthesis, beginning with synthesis of amino acids from elementary sources and extending to that of proteins. Proteins will also be derived from the sea, and directly from leaves, while carbohydrates will come from cellulose.

Advances in biochemistry provide opportunities for new attacks on old and new problems in food research, according to Professor J. B. Biale, the next speaker on the panel. Maturity in fruit and vegetable products for processing is one of the most important factors determining quality, but there is a great need for better indices of maturity. In citrus fruits, for instance, the Brix/acid ratio is only a rough measure of maturity. Many individual acids take part in the Krebs cycle and it is possible that changes in the concentration of one of the minor acids may provide a better index of maturity. Again, in the avocado, the fat content does not change greatly as the fruit approaches maturity, but recent studies suggest large changes in the mitochondria with ripening, and these changes may lead to useful indicators of maturity. We know too little, said Professor Biale, about the pectic constituents of fruits and vegetables. We still talk about protopectin, but as yet we know nothing about the chemistry and structure of this hypothetical substance and its relationships with other polysaccharides.

Mr. E. E. Bond dealt with trends in cereal research and bread making. Research on bread must take account of some artificial restraints, such as price control and restricted working hours in the industry, which limit expansion and development in certain directions. Bread making is changing rapidly from a craft to a mechanized industry, and in so doing is becoming more dependent upon research. The quality of bread is intimately connected with that of the flour available. There is a marked trend in cereal research towards biochemical methods for the assessment of wheat quality, but the baking test remains the principal test for quality. Typical problems which the bakers expect the research institute to solve are the inhibition of staling, improving the attractiveness of bread, and improvement of bread-making machinery. Continuous production of bread has been successfully accomplished, and it is likely that the orthodox fermentation process may be largely supplanted by mechanical mixing.

Mr. J. F. Kefford spoke on a number of specific trends of a technological nature. He referred to trends towards foods of reduced water content, which had been made possible by new techniques of evaporation and drying. A primary research problem involved is the elucidation of the role of residual water in the storage reactions of concentrated and dried foods. Current practices in food packaging underline the need to regard the package as an integral part of most processed foods. Research in packaging, he felt, should be directed towards reducing costs, particularly for foods for regions of low purchasing power. There are instances where the package costs as much as, or more than, its contents.

There is a marked trend towards objective methods in quality assessment and control. Instrumental methods for colour measurement are now well developed and objective methods of texture measurement, while generally feasible for fruit and vegetable products, are more difficult for meats. It is important, Mr. Kefford contended, not to regard flavour as a factor which will never be amenable to objective assessment. There are possibilities for objective approaches analogous to colour measurement making use of the concept of a standard observer, but complications arise because of the dual sensory mechanisms of gustation and olfaction.

The final speaker on the panel, Dr. E. C. Bate-Smith, spoke of the need for research in the area of macromolecules and their interactions, instancing such systems as pectins and celluloses, lignins and tannins, and proteins such as collagen and elastin. He expressed the view that progress in the study of these systems required a new break-through in methodology—for instance, a rapid technique for following the change in molecular weight in a polymerizing system. He drew attention to the importance of association reactions, for instance between actin and myosin, and the chemical and non-specific associations of lipoproteins. The effects on texture of changes in the water-holding capacity of lipoprotein systems should be investigated.

Moving to another subject, Dr. Bate-Smith deplored the lack of information on man as a feeding animal, and urged that fundamental psychological research should be directed towards exploring the basic factors determining consumer preference for foods. With respect to the need to increase world food production, he considered that systematic searches should be made for new plants for human food, since only a very small fraction of existing botanical species is at present utilized.

Mr. Michael Tracey, C.S.I.R.O. Wheat Research Unit, supported this contention by Dr. Bate-Smith and pointed out that plants now used for food have been chosen through the ages because they were easily processed. This was a challenge to the scientist to take a look at other plants, even toxic ones, which may, with a little more difficulty, be processed into satisfactory human foods. While it appeared unlikely that new forms of animal foods will be developed, it is distinctly possible that new forms of plant foods will be found. Present trends in world population indicate that the peoples of the world will soon be faced with real hunger, and refinements in flavour, texture, and other qualities will then become less important. It is likely to be a long-term problem for food scientists to develop new foods and since the need will shortly be urgent work should start now.