formers, stabilizer and a Ward Leonard set with a connected motor alternator. The last two are situated in a cellar but are controlled from two points in the laboratories. On the third floor a large glass de-aerator of special design has been fitted in order to supply oxygen-free water for researches on boiler feed-water problems. Compressed air of high and low pressure is supplied to all laboratories, with an extra high-pressure supply in the mechanical laboratory.

The building was completed in the remarkably short time of just under one year by Messrs. J. Jarvis and Sons, Ltd. (London and Manchester), to the design of the architects, Messrs. Edward D. Mills and Partners. Light oak furniture with teak tops has been supplied to all the laboratories by Messrs. Baird and Tatlock (London), Ltd.

These laboratories are now fully occupied and, with an expanding staff, a large programme of research and development work is being undertaken. This programme relates to improvements to instruments which are already being manufactured, as well as to a number of entirely new projects in which the Company is interested.

CARBON-DATING CONFERENCE AT GRONINGEN

SEPTEMBER 14–19, 1959

ON the invitation of Prof. Hl. de Vries (Natuurkundig Laboratorium) and Prof. H. T. Waterbolk (Archäologische-Biologisches Instituut), of the University of Groningen, a small conference of scientists from carbon-dating laboratories was held in Groningen during the week September 14–19. It was similar in character to the conferences held in Copenhagen, Cambridge and Andover, Mass., already reported in *Nature*[1,2] and *Science*[3]. Twenty-two dating laboratories were represented, some well established and others just getting into their stride, from twelve countries. We were happy for the first time to welcome Russian colleagues at these meetings. Some thirty-five communications were made to the meeting, which was partly concerned with the technique of carbon-dating and partly with selected aspects of its application to geological and archæological problems.

There was less emphasis than hitherto upon the techniques of counter and circuit design, but nonetheless there was a very interesting survey of the methods in use at various laboratories. Two laboratories described their scintillation counting techniques, that at Saclay, using paraldehyde, and that at Trinity College, Dublin, using methanol. While a few laboratories use acetylene or methane in their proportional gas-counters, it seems that the majority of dating laboratories now favour carbon dioxide counting. Considerable emphasis was laid on the need for careful pre-treatment of samples, especially with difficult materials such as bone, charcoal, cave-earths and all samples of great age. Accounts were given of several promising investigations into matters affecting the principles of the method and its applications, as, for example, those at Heidelberg illustrating possible seasonal variations of radiocarbon content of the atmosphere. Particular interest was attracted by an account of the joint investigations of Cambridge, Copenhagen and Heidelberg upon possible fluctuations in the initial atmospheric carbon-14 concentration during the past 1,200 years; this is a promising extension of ideas recently suggested by de Vries[4] as possibly offering insight into past climatic changes.

Without attempting to summarize all the interesting contributions, it may suffice to point to two or three fields in which the application of carbon-dating has now apparently led to a highly significant advance in knowledge. First, we may note a series of datings made at Groningen of the earliest Neolithic cultures from south-eastern and central Europe, indicating a spread from the Near East across these regions as early as 4000 B.C.; these findings were paralleled to some extent by numerous datings made in Pisa upon Italian material.

Several contributions concerned the dating of stages of the last glaciation characterized by stratigraphy, archæology or biological and climatic evidence. Here the contribution of Groningen was particularly important, since the technique of isotopic enrichment had permitted the addition of several half-lives to the maximum possible age attainable[5]. With favourable materials that warrant this costly and lengthy process, ages as great as 64,000 ± 1,100 years are attainable. This in fact appears to be the date of the first mild interstadial period after the last (Eemian) interglacial. There is considerable evidence now for an interstadial about 30,000 years ago at several places in western Europe. From the American laboratories comes very convincing evidence obtained by dating ocean cores, and deposits both in the Caribbean and in salt lakes, for a very abrupt amelioration of climate about 11,000 years ago. It is striking that this climatic break corresponds exactly with the well-dated Late-Glacial period of climatic change in Europe.

A substantial part of the time of the meeting was properly devoted to various matters of co-ordination of the work of different laboratories. The successful outcome was reported of two policy decisions taken at earlier conferences, namely, to establish an agreed system of publication of date-lists and to publish a punch-card system of all published dates. The first of these objectives has been met by the publication of the Radiocarbon Supplement of the *American Journal of Science*, the first volume of which appeared in May of this year. The second was met by the formation of Radiocarbon Dates Association, Inc. Mr. Fred Johnson gave a description of the principles he had adopted in designing the punch-card system and reported the first issue of cards to subscribers. It is not yet sufficiently widely known by archæological, geological and biological laboratories concerned with the history of the past 70,000 years how massive is the contribution already made by carbon-dating to knowledge of this period, nor what a very rich source of information this punch-card system will provide. (Inquiries for subscriptions to the carbon-dating punch-card index should be directed to Radiocarbon Dates Association, Inc., Robert S. Peabody Founda-

tion for Archæology, Philips Academy, Andover, Massachusetts, U.S.A.)

With regard to future procedure, it was decided that all carbon-dating laboratories should check by a common standard and that this should be the oxalic acid standard of the U.S. Bureau of Standards. It was agreed that a value of 95 per cent of this standard activity could be taken as the agreed radiocarbon activity for organic material (but not shells) originating in A.D. 1950. This decision should remove many of the minor difficulties caused by the different laboratories having individual standards of contemporary activity on which to base their calculations of age, and it is hoped that either the next or the next but one date-list of every laboratory will be based upon this agreed standard, which will take care of the industrial carbon and hydrogen-bomb effects upon recent samples. It was at the same time recognized that the carbonate sample provided by Heidelberg would be a further check of importance; that laboratory has undertaken the co-ordination of all inter-laboratory calibration measurements.

It was agreed to defer decision on a carbon-13 standard, pending exact absolute determinations to be made in the Lamont Laboratories.

It was agreed to use the methods of presentation of bibliography now employed in the Radiocarbon Supplement and in *Quaternaria*: the conference also recommended that new dating stations should adopt as their index letters the most distinct and simple combination possible, avoiding those that have already been used even by stations not at present producing dates.

While there was no agreement as to whether dates ought preferably to be expressed as B.P. (before the present), or B.C. (and A.D.), there was considerable sympathy for the view that dates primarily relevant to archæology should be given in the B.C./A.D. scale, even where the date B.P. had also been given.

Members of the conference had the concentration of lecture room attendance broken by visits to Prof. de Vries's laboratory, to the great peat bog and moraine region south of Groningen and to the dramatic areas of reclamation where carbon-dating is assisting the Geological Survey to provide fundamental knowledge of the stratigraphy of coastal deposits.

The thanks of all participants are due to all our Dutch hosts, to the Rektor Magnificus of the University of Groningen, to the Royal Dutch Shell Company, to the Chief Engineer and Director of the Rijks Waterstaat, and above all to the primary organizers of the conference.

H. Godwin

[1] Godwin, H., *Nature*, **174**, 868 (1954).
[2] Levi, H., *Nature*, **176**, 727 (1955).
[3] Johnson, F., Arnold, J. R., and Flint, R. F., *Science*, **125**, 240 (1957).
[4] Vries, Hl. de, *Proc. Kon. Ned. Akad. van Wetenschappen*, *B*, **61** (2), 1 (1958).
[5] Vries, Hl. de, Vries, A. E. de, and Harris, A., *Science*, **128**, 472 (1958).

ENZYMES IN THE FOOD INDUSTRY

THE Committee of the Food Group of the Society of Chemical Industry has an established reputation for organizing symposia on subjects of vital importance and with a wide range of interest to food scientists and technologists. The most recent, held on October 1–2, dealing with enzymes associated with the manufacture, storage and distribution of food, attracted an audience which taxed the capacity of the hall of the Royal Society of Medicine in which it was held. The organizers very wisely decided to limit the scope of the contributions and to divide them roughly into two groups: one dealing with the production of enzymes and their use in manufactured foods and the other with the activity, both useful and deleterious, of naturally occurring enzymes in foods.

Dr. Malcolm Dixon opened the symposium with a paper, giving in his own characteristic way the necessary background information on the types of reactions which may be catalysed by enzymes, and such of their properties as would have a bearing on the matters discussed by later speakers. The value of such an introduction to a symposium covering a broad field of biochemistry cannot be too highly stressed when it is appreciated that the audience was composed mainly of persons connected with the food manufacturing and processing industries, specialists maybe in rather limited fields, who frequently find it hard to keep abreast of fundamental developments.

The remainder of the first day was given over to papers dealing with fungal amylase, invertase, rennin, glucose-oxidase, the pectin-degrading enzymes and proteinases from plants and micro-organisms. The main interest in fungal amylase and invertase was in the methods adopted to secure conditions of culture of the selected organism so that high yields of high-purity enzyme are possible on a commercial scale. The discussion on the papers not unexpectedly centred around the newer applications of enzymes by the food industry and in particular the use of amylase in bread-making, the application of such proteinases as papain, bromelin (from pineapple) and ficin (from figs) to meat with the view of increasing its tenderness, and the recent availability of glucose oxidase as an oxygen scavenger in packaged foods.

The proceedings of the first day having presented the enzymes in a favourable light, as processing aids in a variety of food products, the second day, devoted to "Innate Enzymes: Their Action and Control", revealed the reverse side of the medal and showed enzymes in a less co-operative mood. This was not unexpected: Dr. Dixon, in his introductory remarks, had already pointed out that foods are the product of enzyme action in the living plant or animal and are metabolized after consumption by enzyme action in the body of the consumer, stressing the fact that in the living cell the urge of the enzyme processes is towards synthesis and that enzyme changes in foods, which can be regarded as post-mortem changes, may well be deteriorative in character. It is, however, sometimes difficult to draw the line; the enzymic ripening of fruit leads progressively into the deteriorative changes of over-ripening. Other cases are more specific: papers presented during the day dealt with enzymic deterioration in colour (blackening of potatoes by polyphenolase), in flavour ('soapiness' in coconut and palm kernel oil products due to liberation of free fatty acids by lipase action) and in nutritive value (oxidation of ascorbic acid and of vitamin A precursors in plant tissues).