major concerns of government research for the civilian economy.

Although most of the participants in the symposium and many of the contributions came from those actually engaged in directing or administering large research establishments, considerable interest was shown in the 'research into research' papers, such as those from the psychologists, sociologists, statisticians and the trade union side. It is now clear to many research directors that, to borrow a phrase from Dr. Ellis Johnson, we should have more "operations research looking at research operations".

A surprise to the organizers of this symposium was the large number of people from many parts of the world who wished to attend, and it has become clear that discussion of problems such as those dealt with, and of the many more which time did not permit to be raised, must continue. The form which this follow-up and possible extension should take is now under consideration.

All papers presented at the symposium and summaries of the discussions will be published as soon as possible by H.M. Stationery Office, London.

E. S. HISCOCKS

INTERNATIONAL SOCIETY OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

THE first business and scientific meeting of the International Society of Bioclimatology and Biometeorology was held at Unesco House, Paris, during August 29-31. Approximately sixty members, representing sixteen nations, were present. The major items covered included the drawing up of a set of statutes; the election of an executive board and a governing council; the introduction to members, through a series of area reports, of the various aspects of bioclimatological research in progress in different parts of the world; and the presentation of a small number of scientific papers.

Bioclimatology is not a new science, nor is it yet a unified one. The scope of the subject was brought out at the Paris meeting, and it speaks well of the new Society that its prime purpose should be to "unite . . . all Bioclimatologists working in the fields of Medical, General Botanical, Agricultural, Forest, General Zoological, Veterinarian, Entomological and Cosmic Bioclimatology and other future branches of Bioclimatology". To achieve these ends it proposes to organize symposia, create a clearing house for publications, inaugurate a journal, institute sub-committees in specialized fields and, so far as possible, obtain funds for the fostering of research. The administration of the society is under the aegis of an executive board of seven members, assisted by a governing council of twenty-five. The following were elected to the executive board: *President*, Dr. F. Sargent (United States); *Vice-Presidents*, Prof. H. Berg (Germany), Dr. H. Boyko (Israel) and Prof. L. Emberger (France); *Secretary-Treasurer*, Dr. S. W. Tromp (Netherlands); and *Advisory Members*, Mr. W. E. Arnould-Taylor (Great Britain) and Dr. W. G. Wellington (Canada).

A total of seven area reports briefly described the work of individual bioclimatologists in North America, Western Europe, Africa, South-East Asia

and Israel. Such a review provided an excellent, up-to-date account of research in progress. In addition, the width and variety of interests within the subject were made apparent through these reports, as can be seen from the inclusion of such topics as: asthma and hay-fever studies in relation to pollen, fungi and meteorological conditions of the atmosphere; the influence of climate on the behaviour and survival of forest insects; the use of weather data in connexion with irrigation; and a study of problems of clothing and resistance to extreme climates arising from pilgrimages by sea and land to Mecca.

Four sub-committees were instituted, the function of which is to collate and disseminate information on the respective specialized fields of ionic research in bioclimatology, allergy, ecological climatology and bioclimatological instruments. A proposed fifth sub-committee on nautical bioclimatology was referred to the executive board for further consideration.

It was proposed to hold a second meeting of the Society in Vienna in 1957, although a subsequent annual periodicity is not necessarily to be inferred. However, the Paris meeting showed many potential attenders to have been pre-occupied with earlier commitments, and lacunae in some area reports suggest that scientists in certain areas and disciplines may not have fully realized the extensive nature of the Society's intentions. For these reasons and others, an early re-assembly appeared desirable.

The Society largely owes its inception to the initiative of Dr. S. W. Tromp, who got into touch with bioclimatologists in different parts of the world during the previous twelve months and also played a major part in the organization of the Paris meeting. His acceptance of the secretaryship, which he will conduct from 54 Hofbrouckerlaan Oegstgeest, Leyden, is a fortunate event for the Society.

M. J. DELANY

F. L. WATERHOUSE

YEAST IN INDUSTRY

UNDER the joint sponsorship of the Dublin and District Section, the Microbiology Group and the Food Group of the Society of Chemical Industry, a symposium on "Recent Studies in Yeast and their Significance in Industry" was held in Dublin during September 17-19. The sessions were held in the Rupert Guinness Hall by kind invitation of Arthur Guinness Son and Co. (Dublin), Ltd., on behalf of whom Sir Richard Levinge welcomed the 125 members of the symposium; some seventy-five members attended from overseas. The basis of the symposium was provided by thirteen papers, the reading of which was followed by lively discussions in which many members participated. The chair was occupied in succession by Mr. H. J. Bunker, Prof. T. Dillon, Dr. A. K. Mills, Dr. A. J. Amos and Dr. I. A. Allen.

The first paper, by Dr. A. A. Eddy (Brewing Industry Research Foundation), dealt with "Some Chemical Aspects of Yeast Growth". First, Dr. Eddy described the use of media containing L-lysine as sole major source of nitrogen for the isolation of wild yeasts and the estimation of the extent to which they contaminate brewery pitching yeasts. He then discussed three commercially important aspects of the behaviour of yeasts, namely, head retention, flocculence and finability, which are associated with the surface structure of yeast. In particular, he

indicated how these aspects may vary from strain to strain and suggested the division of yeasts with respect to flocculence into those which (a) flocculate under the influence of chemical factors (sugars, pH, ethanol); (b) undergo mutual flocculation; and (c) are non-flocculent.

Presenting a paper on "Inositol Deficiency in Yeast with Particular Reference to Fat Production" on behalf of S. W. Challinor, N. W. R. Daniels and J. C. Hall (University of Birmingham), Dr. Challinor reported that the fat content of the cells of a brewer's yeast is greatly increased by growth in a medium deficient in inositol. The possible commercial value of this phenomenon is enhanced by the fact that such fatty, inositol-deficient cells are also more fragile than are normal cells, so that extraction of fat is facilitated.

In his paper on "Amylase Systems in Brewery Yeasts", Prof. R. H. Hopkins (University of Birmingham) pointed out that, although glucose, maltose and maltotriose are the only sugars of the starch series fermentable by them, brewer's yeasts elaborate (a) a debranching enzyme ('isoamylase') which splits α -1.6-linkages in branched structures such as amylopectin and its β -limit dextrin, and (b) a branching enzyme which transforms the straight-chained amylose into a branched compound. Yeasts which ferment starch and dextrin may occur as contaminants in the brewery. Such is *Saccharomyces diastaticus*, which secretes glucamylase (amyloglucosidase) at or near the cell surface. This enzyme splits successive terminal glucose residues from α -1.4-linked polyglucosans to yield β -glucose. Infection by *Sacch. diastaticus* may therefore cause 'super-attenuation' in bottled beers. In other circumstances, *Sacch. diastaticus* is potentially useful for producing ethanol from starchy materials and for carrying further the attenuation of beers.

Mr. F. W. Beech (Long Ashton Research Station) spoke on "Yeast Control in Cider Fermentation". The inoculum which initiates the fermentation of apple juice is provided by the natural microflora of the fruit. After outlining the changes in the yeast populations of fermenting ciders, Mr. Beech discussed some methods of microbiological control. Thus, a French method consists in reducing the nitrogen content of the juice. In England, aerobic spoilage organisms may be suppressed by keeping fermenting and stored ciders under anaerobic conditions, the yeast population being controlled simultaneously by mechanical methods. Sulphur dioxide, added to the original juices, effectively controls both yeasts and bacteria.

Two prominent Continental scientists provided papers to illuminate those little-understood, but fundamental, aspects of yeast behaviour which centre around the phenomenon known as the 'Pasteur effect'. Dr. H. Holzer (University of Hamburg), in his contribution, "Regulation of Carbohydrate Metabolism in Yeast Cells", adduced evidence for the theory that the key enzyme system affected by the change from anaerobic to aerobic conditions is that catalysed by triosephosphate dehydrogenase, the action of which depends on the available adenosine diphosphate and orthophosphate. Thus, there is a decrease in concentration of orthophosphate associated with the functioning of terminal respiratory processes brought into action when oxygen is introduced into a system fermenting under the action of living yeast. The resultant limitation of supply of orthophosphate will therefore restrict glycolysis.

Ultimately, the Pasteur effect appears to be associated with a shift of adenosine triphosphate from the cytoplasm to the mitochondria. Dr. Holzer also discussed the occurrence of aerobic fermentation in connexion with growth. Aerobic fermentation increases when ammonium salts are added to yeast cells which are oxidizing glucose. In these circumstances, the increase in cell substance is largely due to the amination of α -ketoglutarate to glutamate catalysed by glutamic acid dehydrogenase in the presence of coenzyme I. This enzyme and the transaminase catalysing the formation of aspartate from glutamate and oxalacetate are present in yeast.

An obverse aspect of the Pasteur effect was presented by Dr. P. P. Slonimski (University of Paris) in his paper, "Respiration and Growth of Yeasts", in which he described studies involving respiratory mutants and the measurement of cell synthesis under anaerobic and aerobic conditions. Growing baker's yeast, even if aerated, ferments glucose: in the exponential phase, respiration is weak, the Pasteur effect is inoperative and ethanol accumulates. In this phase cytochrome synthesis is inhibited by glucose fermentation (the 'counter-Pasteur-effect'). Only in the last phase of growth, when "yeast dissimilates the alcoholic products of its own dissipation", is ethanol respired. Apart from his main thesis, Dr. Slonimski directed attention to a serious systematic error caused by absorption of carbon dioxide in work involving the measurement in conventional manometric apparatus of oxygen uptake when the ratio of carbon dioxide evolution to oxygen uptake is large, as is indeed the case with yeast. He also reported a requirement for ergosterol shown by yeast growing under strictly anaerobic conditions.

In passing, it would appear that some of the work described by Drs. Holzer and Slonimski supports the contention that the pathways of aerobic and anaerobic dissimulation in yeast are common at least up to the pyruvate stage.

Reading the paper by P. F. E. Mann, W. E. Trevelyan and J. S. Harrison (Distillers Co., Ltd.) on "Measurement of Levels of Metabolites within the Yeast Cell during Fermentation", Mr. Mann described the application of ion-exchange resins to the analysis of heat-killed yeast for intermediates and coenzymes. Such analyses promise to yield important information concerning the mechanism of regulation of the fermentation cycle. After a routine of elution has been established, separations are effected and fractions are analysed by simple techniques including measurements of ultra-violet absorption and estimations of total hexose, pentose, fructose and total phosphate. The quantitative results support the hypothesis that the enzymes which catalyse the reversible reactions of fermentation are in excess, so that, at the steady state of fermentation, their substrates are in equilibrium. Furthermore, in a simple medium, the saturation of carboxylase by its substrate, pyruvate, imposes on the rate of fermentation an absolute limitation which can be lifted by addition of thiamine. The high metabolic activity of trehalose and trehalose phosphate during the early stages of fermentation, as noted by these workers, is strong presumptive evidence that these substances play important parts in the metabolism of yeast.

Prof. E. J. Conway (University College, Dublin) contributed a paper on "Active Transport across the Yeast Cell Membrane", a subject with which his name is inseparably connected. He described how the

material requirements of yeast enter the cell largely as a result of active transport during fermentation, a process requiring energy derived from other systems and effected by means of carriers, the general cationic carrier being a redox carrier of the cytochrome type. The affinity of the carrier for potassium ions is much greater than that for sodium or magnesium ions.

Aspects of yeast genetics were dealt with in two papers which followed the showing of the film, the "Life Cycle of the Yeast Cell", made for the Anheuser-Busch Co., with a commentary by C. C. Lindegren. Mr. R. B. Gilliland introduced the film and followed with a paper on "Yeast Genetics in Industry". He said that, as yet, the application of the technique of breeding yeasts for the purposes of brewing beer is disappointing, partly because of difficulties inherent in a yeast-breeding programme and partly because the assessment of desirable qualities is so difficult. The situation with respect to other yeast industries appears to be more hopeful, and the possibilities of polyploid yeasts have yet to be examined. On the more positive side, the study of yeast genetics has accumulated valuable data on the inheritance of the ability to flocculate and to ferment maltotriose, dextrin and starch. In more academic fields, the genetic analysis of yeast hybrids may find use in the separation of yeast enzymes.

In a paper on "Some Genetical Aspects of Panary Fermentation", Mr. R. R. Fowell (Distillers Co., Ltd.) presented the results of fermentometer tests on standard doughs fermented by yeasts obtained by breeding in a scheme which permitted subsequent genetical analysis. The results for the 1 hr. volume tests can be explained in terms of four major genes operating for dominance, but those for the 1-3 hr. test are complicated by action of genes operating negatively. He concluded that detailed genetical analysis of the haploid parents is necessary before the panary performance of individual hybrids could be predicted.

"The Utilization of Flour Sugars during Panary Fermentation" was discussed by Dr. R. R. McKenzie (Distillers Co., Ltd.). The subject had been studied by the application of quantitative paper chromatography to that fraction of flour extracted by aqueous ethanol. The observed changes in concentration of glucose, sucrose, glucodifrutose and laevosine during fermentation were presented and their significance discussed.

The final paper, by Dr. J. White (Fardon's Vinegar Co., Ltd., Birmingham), on "Influence of Environmental Factors upon Yeast Behaviour", urged a greater appraisal of environmental effects as a step towards the production of yeasts of high fermentative capacity and good keeping qualities. The importance of such effects was illustrated by reference to the phenomenon of 'osmosensitivity', the conditions for which are developed by growth of yeasts in direct culture, but not by growth under conditions of incremental feeding. Dr. White also discussed the change in enzyme content of yeasts in relation to the capacity to ferment glucose and maltose and to secrete invertase. The enzyme content is often influenced both by the stage of harvesting of the yeast and by the nature of the sugar present in the medium.

The final summing up of the symposium was made for the brewing industry by Dr. A. H. Cook (Brewing Industry Research Foundation) and for the baking industry by Dr. J. B. M. Coppock (British Baking Industries Research Association). Dr. Cook pointed

to the recent upsurge of yeast research, but also indicated the gulf which still separates pure research from the reality of technological practice. Dr. Coppock directed attention to the new questions posed as a result of every scientific advance. Both speakers brought out the value of work ostensibly carried out in one field to work in another field: in particular, the 'cross-linking' between brewing and baking had manifested itself in this symposium.

Perhaps it was surprising that no paper devoted to questions of the fundamental nutrition of yeast was presented. Such questions, of course, arose incidentally; but it is to be hoped that this deficiency does not reflect a neglected aspect of yeast research. For all that, the symposium was undoubtedly most successful: the amount and vigour of the discussion succeeding each paper testified to the interest aroused at this most informative and stimulating meeting. It is also necessary to add that splendid organization and generous hospitality, for the major part of which the symposium was deeply indebted to the firm and staff of Arthur Guinness, Son and Co. (Dublin), Ltd., contributed substantially to its success.

C. RAINBOW

FREE RADICALS

SYMPOSIUM OF THE CHEMICAL INSTITUTE OF CANADA

A SYMPOSIUM on recent progress in the production, isolation and identification of free radicals was held during September 10-11 in the Chemistry Department of Laval University, Quebec. The meeting was sponsored by the Physical Chemistry Division of the Chemical Institute of Canada, and the arrangements were made by Dr. J. A. Morrison (National Research Council) and Prof. P. A. Giguère (Laval University).

The first group of papers dealt with spectroscopic studies of radicals produced by flash photolysis or shock waves. The paper by Drs. G. Herzberg and J. Shoosmith (National Research Council, Ottawa) discussed the CH_3 and CD_3 radicals. Although their spectra are predissociated, the structure of the CD_3 band at 2140 Å. indicates that one state, probably the upper, is planar with $r_0(\text{CD}) = 1.072$ Å. and that the other state is slightly bent. Further work is in progress with the view of finding a predicted 'forbidden' transition in the visible which would not be predissociated.

Prof. G. Porter (University of Sheffield) presented a paper showing that simple aromatic radicals such as benzyl can be observed in vapour phase and in solution using flash photolysis, as well as in rigid media at low temperatures. He cited recent work by Bridge and Porter on the photochemistry of quinones in solution, where triplet states, semi-quinone radicals and radical ions have been observed and their reactions studied.

Two papers from the National Research Council (Ottawa) dealt with triatomic radicals. In the first of these, Dr. D. A. Ramsay discussed the spectra of HCO , NH_2 and PH_2 , all of which show long progressions of the bending vibration ν_2 due to a large difference in bond angle between the upper and lower states. The NH_2 radical has a 2B_1 ground state with $r(\text{NH}) = 1.025$ Å. and a bond angle of 103° . Its upper state is linear, probably $^2\pi_u$, and