MODIFICATION OF THE WEATHER

"He who controls the weather controls the world."
LEONARDO DA VINCI

SINCE the day when primitive man first became aware of, and was awed by, the forces of Nature he has sought to control them. Although throughout the centuries he has been successful to some extent in moulding his environment and harnessing the forces of Nature to his advantage, his success in controlling those natural phenomena which have marked the behaviour of the Earth, oceans and sky throughout time has been very limited, if not negligible.

With the rapid advances which have been made in the atmospheric sciences during the past two decades, it is not surprising that meteorologists have looked towards weather and climate control as a serious goal capable of attainment. Besides this desire is the natural wish of mankind to make his environment more comfortable and less hazardous. This is particularly true for the inhabitants of those parts of the world where the weather can cause loss of life or destruction of property or economic ruin, either by sudden catastrophic storms, or by slow, but just as disastrous, occurrences such as drought or floods which bring about crop failure or destruction and famine; and behind all this there are, of course, the military and political dreams of controlling the climate on a large scale. These thoughts may have existed for a long time; but it is only in the past fifteen years that any real attempt has been made to answer them, and only in the past three or four years has such an attempt been transformed into a major scientific programme. This programme is world wide. Within the global programme there exists a United States programme in weather modification, defined by natural needs for weather control. The responsibility for the national programme is held by the National Science Foundation, which has been directed to initiate and support a programme of study, research and evaluation in this field. The Foundation is advised by an Advisory Panel for Weather Modification*.

A great deal of the work which is being carried out under the heading of weather modification is concerned with basic studies in cloud physics. The work of Prof. B. J. Mason in Great Britain (*Nature*, 195, 647; 1962) is an example of the way in which the problem is being attacked. Fundamental laboratory research into the properties of condensation and freezing nuclei and cloud droplets and the mechanism of precipitation processes is essential before experiments in the atmosphere to stimulate precipitation artificially can be expected to give successful results as judged by accepted statistical evaluation tests. It is interesting to note that in the kaleidoscopic pattern of jargon the former much-used phrase of 'artificial precipitation' appears to have been replaced by the wider and more sober one of 'weather modification'. However, the more spectacular possibilities of rain-making seem, in part, to lie hidden behind the broad front of the programme of weather modification.

* National Science Foundation. Weather Modification—Third Annual Report for Fiscal Year ended June 30, 1961. Pp. vi+78. (Washington, D.C.: Government Printing Office, 1962.) 30 cents.

Much work on cloud seeding has been carried out not only in the United States but also in many other countries. Argentina, Australia, Canada, France, Israel, Italy, Japan, Mexico, South Africa and the U.S.S.R., among others, have all engaged in such experiments. But the conclusion cannot be escaped that success has been very limited indeed. All the results confirm that, although rain can at times be stimulated artificially, much more needs to be known about all the variables before cloud seeding can be carried out with predictable results.

Artificial precipitation is, of course, not the only form of weather modification. Cloud seeding has been used in an effort to evaluate the possible suppression of hail. Hail samples have been gathered from areas within and outside a seeded district to determine the amount of silver iodide, the seeding agent present, and to examine the effect the agent may have had in suppressing hail. Present theory is quoted as indicating that hail can be suppressed by cloud seeding. However, statistically the results of hail suppression projects are contradictory and confusing. It is certain that the physics of hail formation must be better understood before much further progress can be expected. In Switzerland, a Federal Commission for studying formation and prevention of hail was established in 1950 and at present operates three laboratories. A number of field experiments have been carried out. The experimental evidence shows that seeding with silver iodide has no extensive effect in terms of an overall suppression of hail. At the same time, it is not possible to determine from the available data whether the seeding has altered the extent and intensity of hail-fall. Generally speaking, the number of days on which hail falls is too small to justify a thorough statistical evaluation of the results according to the areas over which hail of varying intensities falls.

Other aspects of weather modification have also been considered. Some investigations have been made at New York University on the feasibility of the artificial modification of tropical storms; but even this involves the possible effects of cloud seeding. Wider objectives, such as the effect of modifying the air/sea boundary and the internal energy transformations, or altering the physical composition of the storm will also be studied. A U.S. Weather Bureau project will use standard cloud-seeding methods to release latent heat and so try to create asymmetries in the storm.

Another project is concerned with the absorptive power of a pure carbon cloud. It was found that for 3×10^5 particles of carbon per c.c. and a zenith distance of the Sun of 60°, 32 per cent of the Sun's radiation is absorbed in a cloud 100 m thick. Such a cloud would require 30 kg of carbon per km^2. The effects in the atmosphere are complex and depend on many variables such as the water vapour content above and below the cloud, the elevation of the Sun and other factors.

In Sweden plans were laid, but not carried out, to spread radiation-absorbing dust on snow-fields to accelerate melting in late spring. Experiments were conducted there to spread fatty alcohols on snow-

fields in order to diminish their evaporation. Attempts have been made in several countries to reduce the natural evaporation from lakes and reservoirs by spreading and maintaining a suitable chemical film over the water surface.

The third annual report on Weather Modification of the U.S. National Science Foundation shows that these problems are much in mind at the present time. It seems, however, from the existing results that progress will be slow. The next few years will see a consolidation of facts and basic ideas on the mechanism of the physical meteorological and climatological processes which govern the behaviour of our atmosphere, rather than any spectacular advance in man's attempts to modify the weather to any marked degree. Small local phenomena may indeed be brought into being, dissipated or modified. For the time being, meteorologists should not allow their imagination to run wild with the hope of changing things effectively on a wide scale. A. H. GORDON

THE LOW TEMPERATURE RESEARCH STATION, CAMBRIDGE

THE first International Congress of Food Science and Technology held in London during September directed attention to the ever-increasing interest in the nature of food materials and modern techniques of food production. The recent publication of the annual report for 1961 * of the Low Temperature Research Station, Cambridge, is therefore timely and will, no doubt, be received with particular interest by those who visited the Research Station during the week of the Congress and attended sessions which dealt with papers on the progress of its activities.

An account of some of these activities, set against a background of the present state of each subject, forms the essential content of the report. Together with its accompanying brochure, *The Low Temperature Research Station, Cambridge* †, the wide range of interests of the Station is well presented. A particularly noteworthy aspect is the substantial contribution to modern food handling and processing practices emerging from the results of its research work.

The preface describes the function of the Station as research into the principles of the preservation of foods. As would therefore be expected, considerable attention is directed to the newer methods of food preservation, such as radiation sterilization and freeze dehydration.

"Accelerated Freeze Drying of Meat" is the title of the second report, dealing with ultimate *p*H on the quality of freeze-dried meat. The results obtained should be of particular interest to those concerned with potential applications of accelerated freeze drying to the preservation of meat. This report is preceded by a detailed survey entitled "Anatomy and Physiology in Meat Research". Factors influencing quality are summarized under the headings of "Constitution" and "Condition".

The data presented on immersion freezing (air and liquid) of poultry are of immediate practical interest. A reassessment of heat extracted in freezing chicken should be found useful in equipment design. It will be of advantage to have further data with the publication of full experimental details.

Much of the pioneer work on liquid whole egg pasteurization was carried out by the late Dr. J. Brooks. This has now led to the successful development of the amylase test. The effectiveness of the test can be judged from the last paragraph of this account: "The results of a number of technical trials recently carried out indicated that the amylase test could be used to detect an error of 0·5° F (1° C) in the setting of the temperature control instrument of a commercial pasteurizer; serial results could be made available 1 h after taking the first sample. The amylase test has also been applied to samples of pasteurized whole egg of widely different origin and has correctly indicated the severity of the heating treatments used".

Under the title "Twelve Years of Radiation Preservation Research" progress in another branch of food research is briefly reviewed. Much interest has been shown to exist in this new method of food preservation and some of the results reported here show considerable promise. The study of radiation pasteurization of frozen whole egg carried out in collaboration with the Isotope Research Division of the Atomic Energy Research Establishment was reported at the Congress. This may prove to be of commercial value. The effects of irradiation of other foods, including pork sausage and fish, are also mentioned. The latter application deals with white fish species which have been found to respond well to treatment and, at the maximum tolerable dose, considerably extended the storage life at 0° C and 4° C.

The successful application of all methods of food preservation so far discussed depends on adequate packaging. Gas sampling in vacuum packs forms the main topic in the report entitled "Physical Problems in Packaging of Foodstuffs". Gas analysis is of great importance in assessing this type of package performance and a systematic study of the subject should be welcome.

The technique of gas chromatography has also been applied to the analysis of flavour. Work recently started on the flavour of meat and poultry and preliminary results indicate that here, too, the breakdown products of amino-acids can make a notable contribution to flavour. The study of flavour during irradiation should yield further results of considerable interest.

Two other reports, dealing with phospholipids and the classification of micro-organisms, complete a review of some of the activities during 1961.

The report contains a comprehensive list of recent publications. In addition, references to the literature are quoted at the end of most of the reports presented. A photograph depicting one of the rooms at the Meat Research Laboratory, Cherry Hinton, is included.

Other photographs appear in the accompanying brochure together with selected excerpts from the annual reports 1959–62. This booklet also includes an account of the work and achievements of Sir William B. Hardy, founder of the Low Temperature Research Station. R. A. P. WERTHEIM

* Agricultural Research Station. Low Temperature Research Station, Cambridge. Annual Report, 1961. Pp. 40. (London: H.M. Stationery Office, 1962.) 2*s*. 6*d*. net.

† University of Cambridge and Agricultural Research Council. *The Low Temperature Research Station, Cambridge*. Pp. 48 + 3 plates. (London: H.M. Stationery Office, 1962.) 2*s*. 6*d*. net.