indentations produced by the particles on impact, a technique developed by the Mechanical Engineering Department of the Royal Aircraft Establishment, Farnborough. It has been found that small cumulus clouds, a few thousand feet thick, contain droplets about 100μ in diameter in concentrations of 0·1–1·0 per litre, which is of the same order as the concentration of raindrops at the surface. Examples were also given of the way raindrop sizes vary with height in layer clouds at temperatures above freezing, particles growing to raindrop size by overtaking and amalgamating with smaller droplets falling at slower speeds. The same technique is also being used to examine the development of rainfall by the Bergeron mechanism, which involves the ice-phase. Crystals in cirro stratus cloud rarely exceed 250μ in diameter, but in alto stratus and nimbo stratus snow flakes of 1–2 mm. diameter, increasing in size as they fall, are found. There is some size decrease as they melt at the freezing-level and then further increase during the rain stage below. Conditions in cumulo nimbus clouds are much more complex, liquid water drops often being found at temperatures of −10° C. to −30° C. The particles are larger and greater in number than in frontal clouds. In each case a size spectrum of precipitation elements can now be measured at all levels, and it seems likely that it will soon be possible to obtain reasonably complete cross-sections of particle distributions in frontal systems, and study the way they are developing to produce the rainfall observed at the surface.

The discussion took a new and interesting turn when Dr. T. W. Wormell (Cavendish Laboratory, Cambridge) described the results of recent work on electrification processes associated with precipitation near the ground.

The introduction of conducting particles, cloud particles or precipitation elements, disturbs the normal ionic equilibrium in the atmosphere and the particles may acquire considerable charges. The importance of such processes has been emphasized of late by Ross Gunn. In the presence of an electric field, and of droplets with appreciable fall-velocities, other effects of selective capture are likely to be of greater importance.

Once precipitation has started, the effects of splashing may seriously affect electrical observations at the ground and, indeed, cause difficulties in any type of observations. Recent work by Adkins at Cambridge has emphasized the importance of such effects ; there may be copious production of ions at the ground and a rapid vertical variation of field in the lowest layers of the atmosphere. Further, laboratory work by Hon, also at Cambridge, showed that the continuous splashing of distilled water on many types of target builds up a space-charge of negative large ions which, if not removed, completely alters the effect attending subsequent individual splashing processes.

During quasi-steady rain the electrical effects are often feeble, being comparable in intensity with those of fine weather. According to a recent systematic study by Chalmers, the typical effect in such conditions is a negative potential gradient near the ground accompanied by a downward total current (convection current on rain plus ionization current). In other words, the total current into the ground is in the reverse direction to the ionization current. Chalmers suggests that there is in the upper part of a nimbo stratus cloud some electrification process which gives the top of the cloud a positive charge, with a negatively charged region beneath ; and a second process lower down, beneath the freezing-level. Dr. Wormell suggested that this second process might be due to splashing at the ground and turbulent diffusion upwards of a negative space charge on slow moving ions. The electrification in the upper part of a nimbo stratus cloud is of the same sign as the main electrification of a cumulo nimbus, and it is conceivable that the mechanism is the same. It has been common of recent years to assume that this process involves ice. Processes which have been discussed include riming, glaze ice formation and the friction or violent collision of ice particles with different electrical properties. On the other hand, the writings of C. T. R. Wilson and Vonnegut demand a reconsideration of the possibility of influence mechanisms, and the common assumption that a thunderstorm necessarily contains ice in its upper portion has been challenged.

Dr. Wormell felt that the nature of the predominant charging mechanism in thunder clouds is still far from settled, that we still lack the information necessary to make a reliable quantitative assessment of the ice processes, particularly in the presence of an electric field, and that influence mechanisms cannot yet be finally dismissed.

The meeting owed much to excellent arrangements made by the staff of the Department of Natural Philosophy, who were very generous hosts.

B. J. Mason

HILL CLIMATE

On the second morning of its summer meeting held on July 4 and 5 in the Department of Natural Philosophy, University of Glasgow, the Royal Meteorological Society directed its attention to problems of hill weather. The topics discussed were not peculiar to this branch of meteorology, as they included such general considerations as the information we have and how it can be used ; the information we need and how it can be obtained ; and the correlation of non-meteorological field data with weather or climatic factors.

As the main sink for observations, and the chief source of information, the Meteorological Office is the recipient of most technical and academic requests for help and advice, so it was appropriate that Mr. R. Cranna, of the Edinburgh Office, should provide the introductory paper on "Problems of Hill Climate". He quoted a number of examples to show that, apart from water balance and land utilization studies, many specific inquiries were being received which could not be adequately answered. Looking further ahead, water supply seemed to be emerging as a limiting factor in industrial development, and he foresaw that light industry might have to move to where water is available, in which event the Meteorological Office would find itself with a much bigger demand for information about hill climate. These inquiries would be for detailed wind and temperature data for

building design ; wet-bulb data for cooling towers ; humidity data for air conditioning ; and rainfall data for sewer and drain design. Reviewing the sources of data, Mr. Cranna showed that the Scottish network of climatological stations is very open, and until fairly recently was concentrated on or near the coast. New stations set up or contemplated have improved the inland network, but vertical distribution is poor. Although one-fifth of Scotland is above 1,250 ft., there is only one station at about that height, and none higher ; and since Ben Nevis Observatory was closed fifty years ago there has been no place in Scotland at which variations of weather with altitude can be studied without complicating factors. Most of the stations are set in the bottoms of glens in an effort to attain the standard ideal site—a bowling green on an infinite plain—and there is a real need for more observations on slopes. Too much of existing information is about valley climates in hill country. The observations themselves might be modified, particularly as many stations report only once daily at 0900 G.M.T., and as an example of possible improvement it was suggested that maximum and minimum wet-bulb thermometers should be part of the standard equipment.

Mr. R. W. Gloyne, also from the Meteorological Office, Edinburgh, spoke first of the classification of dissected country. There already exist concepts of ground configuration which attempt to express departures from the infinite plain, and in a brief review of some of these concepts Mr. Gloyne summarized the meteorologists' experience as indicating that, very roughly, a vertical irregularity affects local weather over a distance of about one hundred times the height. Some measure of 'ruggedness' could be useful in interpreting local climatic differences. He then gave a sketch of a possible mathematical description of a land cross-section that incorporates estimates of mean slope, ruggedness, and the extent of contact between the ground surface and the atmosphere above it.

Next he turned to climate and plant growth, and as a basis for his argument accepted the conventional definition of the growing season as the "period of the year when mean air temperature remains above 42° F.". From records in the same broad region, but at different altitudes, it was shown that the effect of increased altitude is to decrease the mean annual air temperature without any marked effect on the amplitude of the approximate sine wave, that is, the two curves are nearly parallel. The part of the curve lying above the intercepts of $T=42$ will always be shorter for the higher altitude station, but simple geometry shows that the reduction is relatively less when the amplitudes are great, that is, the change in length of growing season with altitude will be more marked in an oceanic climate than in a continental climate. Some regional regressions demonstrated the point clearly. For height H (unit, 100 ft.) and growing season L (days) the relation for southern Scotland is $L=242-4{\cdot}4\ H$; for south Devonshire it is $L=365-9{\cdot}0\ H$; that is, the shorter Scottish season is only half as sensitive to change in altitude as that of Devon. Comparisons with other parts of the world included Conrad's formula for Switzerland ($L=268-2{\cdot}1\ H$; reference level $T=43°$ F.), giving at the height of Ben Nevis a growing season of about 150 days. From the old temperature records, $L=0$ on top of Ben Nevis, and from Gloyne's equation $L=50$, but this involves a long extrapolation. The variation of growing season with altitude is obviously a very sensitive climatic discriminant.

The remaining papers came from outside the ranks of meteorology, two of them from the University of Glasgow being accounts of field-work in which attempts were made to interpret findings in terms of weather. Dr. D. H. N. Spence (Botany Department) outlined some of his ecological work on plant communities in Shetland, Rhum, the central Highlands, the Faroes and Iceland. Where there is a combination of stable soil and protection from wind (as, for example, close to a stone wall in otherwise exposed areas) a relatively close-growing community of mixed grass and heath is found, but away from such shelter it is possible to find a small number of arctic-alpine species of plants growing in the open among rock debris that consists of small stones over finer material. These sites, occurring at different altitudes in the different regions, are characterized by frost-heaving and slipping of the soil so that they occur within what is broadly the same environment everywhere. Specification of this environment is far from complete, but first attempts at correlation suggest that the mean air temperature of the warmest month is an important climatic element in it.

Soil slip was the main factor in the survey from Mr. C. A. Halstead (Geography Department) of some of the surface features of hills in southern Scotland. Between 2,200 and 2,700 ft. there is evidence of an instability in the cover of soil and mountain-top debris, the downhill movement producing terraces having a tread of the order of ten feet wide, a riser of the order of a foot, and a length of about forty feet. The treads have grassy vegetation with peat ; the risers have blocky faces with bilberry. Isolated blocks of rock below such terraces appear to be sliding down-hill, producing bow-waves of turf, and grooved tracks of disturbed vegetation behind. He suggested that these features are related to a zone of maximum frequency of alternating frost and thaw. To test this speculation he has devised a simple instrument to measure the frequency with which soil temperature passes through freezing point, and is hopeful that it will help in future studies of moving soils and sliding boulders.

The remaining paper gave added point to Mr. Cranna's regret about lack of Scottish stations above 1,250 ft. Lieut.-Col. P. D. Baird (Geography Department, University of Aberdeen) has been trying to use a local site for his ice and snow studies, and to this end has himself maintained weather observations at 4,120 ft. on Ben Macdhui since February 1956. Here, just below the summit, is a near-permanent snow patch and on this, in spite of damage and difficulties produced by high winds and icing, he has been able to obtain records of temperature, humidity and wind speed throughout the period. During May–October 1956, the record was complete, and a comparison with Braemar records for the same period, and then with the long-term averages for Braemar, led him to an estimate of the probable annual cycle of mean monthly air temperatures on the mountain. On this basis, the mean annual temperature is just below freezing point. Photographs were used to show the contraction of the snow patch during the summer, the drift of 30-ft. depth just surviving in 1956, but not in 1955, and—confidently—it cannot survive in 1957. Time was too short for more than a very brief discussion of the ablation process, but it seemed clear to Col. Baird that air conduction and

convection play an overwhelming part in it, that is, the dominant factors are aerodynamic rather than radiative.

The arduous mountain ascents, often in bad weather, need have been made much less frequently if there had been an automatic weather station available, but there has been no British development of such an aid to climatology. Much more to be regretted is the complete absence of any manned mountain weather station. Other less wealthy countries regard these as essential, and Col. Baird's final plea was for the establishment of at least one in the British Isles.

The brisk discussion brought out useful criticisms, comments and questions from physicist, climatologist, geographer, and ecologist, and it was exhaustion of available time that forced its closure by the chairman.

H. L. Penman

ENDOCRINOLOGICAL PROBLEMS IN AGRICULTURE

By Dr. I. W. ROWLANDS

Agricultural Research Council Institute of Animal Physiology, Babraham, Cambridge

THE rapid growth of the science of endocrinology beginning about thirty years ago arose from the discovery that the pituitary gland regulates body growth and the functional activity of the gonads and other endocrine organs. The past three decades have witnessed the separation and purification of growth hormone (somatotrophin), thyrotrophin, gonadotrophin (follicle-stimulating hormone and luteinizing hormone), adrenocorticotrophin and prolactin (or luteotrophin) from the pituitary gland and the chemical characterization of steroid hormones, œstradiol, progesterone and testosterone from the gonads, together with many of their metabolites from urine. A variety of substances having hormone-like actions (for example, diethylstilbœstrol) have been synthesized, and in more recent years, a wide range of pure hormones have been isolated from that endocrinological enigma, the adrenal cortex. Armed with these new products, physiologists and biologists have attempted meanwhile to appropriate to each its precise biological function and to determine its role in the complex hormonal mechanisms which exist in the animal body. One important result of the extensive studies made in laboratory animals is the absence of any great measure of uniformity in the response of different species to the same hormonal stimulus. Our understanding of the role of hormones in the endocrine mechanisms of the large domestic species cannot, therefore, be obtained by inference; every species requires separate and individual investigation.

The Agricultural Research Council, in October 1952, assembled a committee known as the Technical Committee on Endocrinology consisting of eight specialists in various branches of the subject, with Dr. S. J. Folley as its chairman, to keep under review all endocrine problems in farm animals, and to recommend to the Council research projects within this field which it considered to be of value to the farming community and also those which would advance basic knowledge. After between three and four years work, during which a total of twenty-three scientific memoranda on a wide variety of subjects were prepared and discussed by its members and co-opted specialists, the Committee has submitted a report to the Council. Some of the earlier reviews have become out-dated by the rapid march of events in this science, so that publication of all the papers as a book is being withheld; but in view of the breadth of their scientific interest a list of titles and dates of preparation of memoranda is being prepared by the Council* which will be made available on request to interested research workers. Memoranda selected from this list will be sent on application.

The earlier memoranda concern the regulation of the reproductive processes. They include the role of external stimuli, for example, daylight and day-length, on hormone secretion and the various neuro-hormonal mechanisms which more recent work has exposed. In regard to the former, attention was directed to the need for further fundamental studies on the mode of transmission of the light stimulus to the pituitary gland which is necessary for the evocation of reproductive activity in animals breeding seasonally. Its elucidation would supply a background of information which would be useful to workers interested in the hormonal induction of œstrus and fertility in anœstrous sheep, on the lactational performance in cows and in egg-production in hens. Two of the memoranda on neuro-hormonal mechanisms favour the extension of research into the mode of release of hormones, especially those from the pituitary gland. Much of this work is of considerable academic interest to the neuro-endocrinologist and has also an important bearing on animal husbandry. The vigorous prosecution of research is recommended into (*a*) milk ejection in cows, (*b*) sperm transport in the female reproductive tract, (*c*) the temporal relation between mating and ovulation, (*d*) parturition and (*e*) suckling. The elucidation of the mechanism integrating the continuous release of the anterior lobe hormone (prolactin) and the intermittent, reflex stimulation of secretion (oxytocin) from the neurohypophysis is of special interest.

Further advances in many branches of endocrinology are seriously impeded by the lack of assay methods of sufficient precision and sensitivity of identify and measure the very small amounts to various steroids circulating in the blood and tissues of normal animals. Special mention is made of the bio-assay of progesterone as being the key to the problem of evaluating the relative activities of the corpus luteum and the placenta in the maintenance of fœtal life. Of no less urgency is the need to discover sensitive methods for the bio-assay of adrenal hormones, in order to elucidate the metabolism of corticosteroids in ruminants as a preliminary to further research into physiological abnormalities such as parturient paresis and ketosis in farm animals.

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