of brighter galactic cepheids in two colours; the results are in course of preparation for publication, and curves for fourteen are already available. Dr. O. J. Eggen carried out photoelectric observations of short-period variables and discovered variations in four of these. Under the heading of spectroscopy, it is reported that the three-prism spectrograph at the Cassegrain focus of the Reynolds 30-in. reflector has been used for photographing more than five hundred spectra for radial velocity and about a hundred and eighty plates have been measured. This programme includes, *inter alia*, a study of the Scorpio–Centaurus cluster and some southern stars from the *N*30 Catalogue. In work on nebulæ and clusters, the theoretical studies are reported of the former Commonwealth Astronomer, Dr. R. v. d. R. Woolley, assisted by Mrs. D. A. Robertson, on the equilibrium conditions in globular clusters. Mr. A. W. Rodgers investigated obscuration in the Coal Sack region, and red and blue photographs of seven selected representative regions each approximately one square degree in area were obtained; the iris diaphragm photometer was used for measuring about two thousand stars. Under the heading of stellar atmospheres, reference is made to the work of Dr. A. Przybylski in the theoretical investigations on stellar atmospheres, on which he prepared two papers for publication.

In Section 3, dealing with buildings, grounds and equipment, the installation is announced of three major telescopes on which preliminary tests have been carried out: the 74-in. reflector, the 50-in. reflector which was previously the Great Melbourne telescope, and the 26-in. Yale–Columbia refractor. The first of these was officially opened by the Governor-General of Australia on November 8, 1955, and preliminary tests indicated a certain amount of astigmatism which, Hartmann tests at the prime focus suggest, is related to the method of supporting the primary mirror. The 50-in. reflector, set up as a Gregorian for a few nights for photoelectric observations, has proved satisfactory for this purpose. A plant for aluminizing the mirrors of both reflectors was in the course of delivery. The refractor has been installed, and extensive modifications by the Stromlo workshop have been carried out to such an extent that it has been possible to make preliminary tests. Among other matters referred to may be mentioned the Hilger recording microphotometer which is already in operation, and a spectrograph for use at the Newtonian focus of the 74-in. reflector, received from Carl Zeiss, of Jena.

In Section 4, in which workshop activities are reported, reference is made to the main work on the two reflectors and the 26-in. refractor, all of which have required attention from the electrical, mechanical and optical sections of the workshop. Essential maintenance was performed on telescopes, and mirrors of the 30-in. and 20-in. instruments were aluminized. A Muller-type double-image micrometer has been nearly completed.

The ionospheric prediction service (Section 5) has continued under Dr. W. Baker, and regular publication and exchange of ionospheric data have been continued. Routine measures of ionospheric characteristics were carried out at Canberra, Townsville, Brisbane and Hobart and in Macquarie Island. Dr. G. R. Ellis, working at Hobart, completed the investigations of the *Z* propagation hole in the ionosphere, and in association with Dr. G. Reber observations were made of low-frequency radio emission in the previously unexplored region below 9 Mc./s. Mr. F. E. Cook has continued the forecasting of ionospheric disturbances and has recommenced the observation of sunspots. Special ionospheric reports published include: "An Improved Method of Making High Frequency Radio Propagation Predictions", by J. Turner (Ionospheric Prediction Service *R5*); and "Forecasting of Geomagnetic Disturbances", by F. E. Cook (*R6*). Other sections of the report deal with publications, visiting astronomers and staff.

## WEST AFRICAN MAIZE RUST RESEARCH UNIT

In 1949 a rust disease, hitherto unrecorded in Africa, appeared on maize in Sierra Leone. Within three years the disease, which is caused by *Puccinia polysora*, had spread right across the continent and had appeared on islands more than a thousand miles from the east coast. The West African Maize Rust Research Unit, Ibadan, was instituted late in 1952, and the first annual report (1953) of this Unit gives an account of its first year's work. The general background to the problem is given in a foreword by Mr. D. Rhind, the sponsor of the scheme. The Unit is small, being staffed by two scientists, Dr. W. R. Stanton (geneticist) and Mr. R. H. Cammack (mycologist), who have the assistance of a locally recruited technical staff. The main centres of the work are Nigeria and the Gold Coast. The volume of data here accumulated pays tribute to the foresight of the authorities in establishing the scheme, as well as to the energetic activities of those undertaking the work. The three articles from the scientific staff of the unit are backed by a detailed body of information in the form of appendixes.

The plan of the work falls into two sections; first, observations on the course and causes of the epidemic; secondly, the breeding of resistant varieties of maize. The observations on the disease and the associated factors are thorough, and are well tabulated for ease in examination. The record forms an impressive catalogue of the facts that have been considered. The initial spread of the disease, with details of date first recorded in different countries, and with notes on severity and distribution within these countries, is well documented, forming a clear example of the severity with which a new disease may attack and spread. This disease is likely to become a classic to future generations of students of plant pathology. However, purely academic interest is not for long allowed to remain: the economic effects of the disease as quoted appear quite serious. Even before the Research Unit was instituted interim palliative measures, suggested by field observations, were applied, and had somewhat improved the situation. The value of the field observations presented in the report is increased due to the use of a highly standardized, quantitative field assessment method for determining the intensity of rust on a plant or plot, with a minimum of subjectivity. An early observation from plot experiments revealed that intensity of rust was variable with the site of the plot in the territory; this variation in intensity has now been correlated with rainfall and humidity factors. Some further interesting associations are found between time of planting and intensity of rust, time of onset of rust, rate of spread of rust, and yield of the plant. Reduced host vigour later in the season, and increase in potential inoculum of the pathogen, are probably effective in the increased susceptibility of late planted maize. However, fast correlation of disease intensity with specific predisposing factors has not yet been made. Experiments on the effects of host vigour on susceptibility are promised. Such experiments may prove of wide importance, since soils in the maize-growing areas of West Africa, in common with those of other parts of the region, are poor in many of the properties regarded as desirable for the growth of plants. A comparative table of the major differences between *P. polysora* and the more common rust fungus which attacks maize, *P. sorghi*, is presented. This information should help to prevent the confusion between the disease caused by the two species which has apparently been possible in the past. It is shown that the two species differ in the physiology of their urediospores in respect of qualities relevant to infection in this part of the world. The greater virulence of *P. polysora* may be attributable in part to this factor.

The major part of the future work of the Unit would appear to be directed towards the breeding of resistant varieties of maize. So far only the uredial and telial states of the fungus are known: should the rust be truly hemicyclic then there is a high probability of the breeding programme being successful. One appendix to the report gives a list of more than three hundred seed acquisitions originating from most of the world's maize-growing areas. These have been tested under local conditions for resistance to the rust and for yield, and lines from New World sources show a generally high level of resistance. A score of lines promising in several characters, including resistance to other local diseases, have been selected for further work. The report emphasizes that the breeding project aims at a broader end than rust-resistance, the ultimate object of the Unit being to improve on the maize varieties that are currently grown in the region. With this aim in view a comprehensive discussion of the factors affecting maize yields in West Africa is given; in addition to the expected climatic, edaphic and husbandry factors, this discussion includes attention to peculiar local problems such as "elephant and monkey damage". A solution to some of the agronomic and cultural problems discussed here will be invaluable to the future development of the region as a whole.

Although this rust fungus appeared with great suddenness, and found local conditions and host plants favourable for its attack and spread, yet one feels from this report that the problem of the disease is well in hand.

DAVID PARK

# ELECTRON SPIN RESONANCE IN MYOGLOBIN AND HÆMOGLOBIN

## Orientation of the Hæm Group in Myoglobin and its Relation to the Polypeptide Chain Direction

In experiments on two crystal forms of myoglobin, Bennett and Ingram[1] have found that the orientation of the hæm groups (one per molecule in myoglobin) relative to the crystal axes can be determined with considerable accuracy by measurements of electron spin resonance. The methods which they used are similar to those described in the following communication on hæmoglobin. They have now extended their investigations to include three further forms of myoglobin crystal (Bennett, Gibson and Ingram, data to be published), and in this paper we shall show how the results can be correlated on one hand with optical measurements of dichroic ratio, and on the other with indications of the predominant polypeptide chain directions derived from Patterson syntheses computed from X-ray diffraction data.

The hæm group contains a planar system of conjugated double bonds. Accordingly, one would expect it to act as a weak absorber of light when the electric vector of the incident (polarized) ray is normal to the plane of the group, and strongly when it lies in the plane. If it were known exactly how the absorption characteristics of a single hæm group varied with direction, then the three absorption coefficients of any myoglobin crystal could be calculated from the orientation of the hæm groups found by electron spin resonance. In the absence of precise data, one must make simplifying assumptions: the results to be quoted here indicate that in the met-form of the protein, it is a fair approximation to treat the hæm group as a two-dimensional circularly symmetrical absorber. It follows that if the direction cosines of the normal to the hæm group are $l$, $m$ and $n$ (relative to the crystal axes), and if, for example, the crystal is viewed in a direction parallel to $c^*$, the dichroic ratio is $(1-m^2)/(1-l^2)$ (this result is true for both monoclinic and orthorhombic crystals, the orthogonal axes of reference being taken as $a$, $b$ and $c^*$ in the former case). Table 1 gives the predicted and observed dichroic ratios for five different crystal forms of myoglobin; in all of them the agreement is satisfactory (except in type *D*, where the magnetic results are less accurate than the rest, and where the arrangement is such that the calculated dichroic ratio is very sensitive to

Table 1

| Type | Species | Space group | Direction cosines of hæm group normals $l$ | $m$ | $n$ | Dichroic ratio Calc. | obs. | Direction cosines of rod directions $l$ | $m$ | $n$ | Angle between rod direction and hæm normal | hæm plane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *A* | Sperm whale | $P2_1$ | 0·89 | 0·36 | 0·25 | ($\parallel c^*$) 4·2<br>($\parallel a$) 1·15 | 4·0<br>1·15 | 0·44 | 0·34 | 0·78 | 40°, 59–65° | 50° |
| *B* | ,, ,, | $P2_12_12_1$ | 0·07 | 0·95 | 0·29 | ($\parallel c$) 0·09 | 0·08–0·14 | 0 | 0·41 | 0·91 | 50°, 83° | 40° |
| *C* | Seal | $A2$ | 0·69 | 0·20 | 0·69 | ($\parallel c$) 1·8 | 1·8 | | | | | |
| *D* | Blue whale | $P2_12_12_1$ | 0·7 | 0 | 0·7 | ($\parallel c$) 0·7–1·3 | 1·4 | 0·57 | 0·46 | 0·68 | 43°, 83–89° | 47° |
| *F* | Finback whale | $P2_12_12$ | 0·57 | 0·50 | 0·66 | ($\parallel c$) 1·1 | 1·2 | 0 | 0 | 1 | 49° | 41° |