in the early days, the president's office was filled by such well-known figures as Sir Halford Mackinder, Douglas Freshfield, Prof. E. J. Garwood, Sir John Scott Keltie, Hilaire Belloc, Prof. Gilbert Murray, Viscount Cecil, Sir John Russell, Sir Richard Gregory, Sir John Myres, Dr. H. R. Mill, Lord Meston and Lord Stamp; while in more recent years Sir Patrick Abercrombie, Sir Cyril Norwood, Sir Alexander Carr-Saunders, Sir Harry Lindsay, and Profs. H. J. Fleure, L. Dudley Stamp and F. Debenham have officiated. The vital post of secretary passed from B. B. Dickinson to Prof. A. J. Herbertson in 1900, who later had the assistance of Prof. J. F. Unstead. In 1917 Prof. H. J. Fleure became secretary, and for thirty years until 1947 he successfully guided the Association through contrasting phases of difficulty and prosperity. Among geographers, too, the work of Leonard Brooks, C. C. Carter, James Fairgrieve, J. S. Masterman, P. M. Roxby and T. C. Warrington for the Association will not be forgotten.

The aim of the Association "to improve the status and teaching of Geography" has involved it in a great variety of activities. These range from the maintenance of a well-stocked lending library of books and lantern slides at the headquarters in Sheffield, and the publication of a quarterly magazine *Geography* (formerly called *The Geographical Teacher*), to the holding of conferences in the Christmas and Easter vacations and summer schools in the long vacation. Active standing committees deal with geographical matters appertaining to the public and preparatory, and primary and secondary schools. Other committees exist for the teacher-training colleges and further education, while some fifty branches covering the United Kingdom arrange local lecture and excursion programmes. The Association publishes books and reports relating to geography in the schools and its teaching, and it has conducted many inquiries into examinations and syllabuses. It has worked ardently for special classrooms in schools for geography, encouraged visual aids and assisted the B.B.C. in the broadcasts to schools.

The Association has further fostered the founding and encouraged the growth of the Ship Adoption Society, the Council for the Promotion of Field Studies, and probably most notable of all the Land Utilization Survey. The latter project began with the work of Messrs. J. Fairgrieve, E. E. Field and J. L. Holland: this led to the creation of a standing committee of the Association to deal with land-use mapping. The chairman was Prof. L. Dudley Stamp, who eventually carried the work, by means of the independent Land Utilization Survey, to such a brilliant conclusion. The Geographical Association has also had close and friendly relations throughout its growth with the Ordnance Survey, the Royal Geographical Society, the British Association for the Advancement of Science, the Le Play Society and the Institute of British Geographers (which emerged in the 1930's as a result of the growth of university staffs).

For many members of the Geographical Association the annual conference has become one of the more important events in their geographical calendar. This has been held for many years past in the London School of Economics during the Christmas vacation, and the conference which has just concluded, organized by Dr. W. G. V. Balchin, proved to be one of the most successful and largest yet: nearly four hundred teachers and intending teachers of geography attended the various lectures, exhibitions and

excursions arranged for them between December 30, 1953, and January 2, 1954.

In his presidential address to the Association, Dr. O. J. R. Howarth put forward a plea for the greater prominence of Commonwealth studies in the normal geographical syllabus as an intermediate and essential step to a full recognition of world citizenship. The Commonwealth was also the underlying theme of an extensive exhibition organized to show the teacher the range of visual aids now available to assist him in this task. The wide and varied field of interest covered by matters geographical was illustrated by lectures on the work of the Nature Conservancy by Captain Cyril Diver, on recent exploration in the polar regions by Mr. A. Stephenson, and on land and population problems in British Tropical Africa by Mr. R. W. Steel.

As was to be expected, educational aspects figured conspicuously in the proceedings: symposia were arranged on the place and use of Ordnance Survey maps in the primary school, on problems in using visual aids, on geography in further education, and also on specialization in sixth forms—which it was unanimously agreed should be strongly resisted. In addition, Mr. J. B. Goodson discussed sketch maps in the teaching of geography, and Mr. R. C. Honeybone lectured on balance in geography and education. A selection of recent geographical films was shown, including some excellent Kodachrome colour films of field work in Cornwall presented by Prof. P. W. Bryan. On Friday, January 1, the Association joined forces with the Institute of British Geographers and the Royal Geographical Society for the customary annual joint meeting at the Royal Geographical Society. On this occasion the subject could be none other than Everest, and a large audience heard Mr. T. D. Bourdillon and Mr. C. W. F. Noyce lecture on the ascent of 1953 and its significance.

Two popular features of recent conferences again figured prominently in this year's proceedings. A publishers' exhibition of books, maps and appliances for the study and teaching of geography was arranged and more than fifty publishers participated. The founders of the Association would indeed have been surprised, but no doubt extremely gratified, could they have seen the extensive and varied display of geographical material now available. Secondly, the conference was brought to a successful conclusion by an interesting series of excursions: conducted visits were paid to the Map Room of the British Museum, the Central Forecasting Office of the Meteorological Office at Dunstable, and the Port of London; while field work was undertaken in Kent under the direction of Prof. S. W. Wooldridge and Dr. O. J. R. Howarth.

COLOUR-RENDERING PROPERTIES OF FLUORESCENT LAMPS

THE phenomena and problems of colour rendering are by no means new. One need only instance the false values often introduced by faulty photographic technique, the strange make-ups necessary for the stage or in front of the ciné and television cameras, or, even commoner experience, the cheerfulness of the bright colours of a sunny day contrasted with the gloomy dullness produced by a heavily overcast sky. The sudden widespread use of fluores-

cent lamps, however, has placed a new emphasis on colour rendering, and the symposium organized by the Colour Group of the Physical Society on December 9 was an endeavour to gather and summarize present work on the subject in Great Britain.

According to experiments mentioned by J. M. Waldram in the discussion (unfortunately never published), the assessment of the colour-rendering properties of a lighting installation depends very largely upon what the observer was looking at immediately beforehand. In many cases it was found possible to reverse a decision by suitable pre-adaptation. For example, an observer, having been for some time in a room illuminated by true daylight, found the colour rendering objectionable on going into a room illuminated by fluorescent 'daylight'; but when first adapted to fluorescent 'daylight', he found true daylight objectionable. Such observations clearly divide the colour-rendering problem into two parts: (a) a more-or-less sudden change from one illuminant to another produces responses from observers which may be ephemeral, or even reversible; (b) if the change is large enough, the observers' responses will be permanent (for example, a plain low-pressure mercury lamp is so deficient in red that no normal observer ever accepts it as satisfactory). The avoidance of complaints of class (a) is a matter of illuminating installation and design; but complaints of class (b) bring one to the heart of the problem, namely, the determination of what might be called an absolute threshold of change in colour rendering.

Ever since fluorescent lamps were produced commercially, attempts have been made to describe them so that their colour-rendering properties might be apparent. Both Miss B. M. Young and G. T. Winch ("Binocular Viewing Investigations") and Dr. S. T. Henderson and D. T. Waigh ("A Critical Review of Colour-Rendering Problems") set forth these attempts in some detail. Broadly speaking, three types of description have been proposed: (a) the complete spectral energy curve, with some convention as to representation of energy in spectral lines; (b) a system of spectral bands, the data being the relative energy or luminance in each band; and (c) a single figure of merit. The single figure of merit, proposed by some workers in the United States, is worked out on so arbitrary a basis that it may prove very misleading unless its application is severely limited. Systems of spectral bands, the number of bands varying from five to sixteen or so, have been proposed by many workers, and a specification of this sort appears the most promising, striking as it does a happy mean between the complexities of the complete spectral energy curve and the over-simplification of the figure of merit. In passing, mention may be made of the red index favoured by Henderson and Waigh. As its name implies, the red index of a lamp gives on an arbitrary scale the proportion of red light in the total visible radiation; but this, like the figure of merit, is such a limited description of a lamp that it scarcely helps in the general solution of the problem.

Whatever type of description is eventually adopted, its curves or figures must be provided with upper and lower limits between which the characteristics of all lamps of a given class must lie. A distinction is to be made here between the relatively small manufacturing tolerances between one lamp and another of the same type, and the much larger tolerances between different types of lamp belonging to the

same class, for example, the class of daylight lamps. It is these latter tolerances which are the concern of the colour-rendering investigator, and which Winch and Young at the Research Laboratories of the General Electric Co., Ltd., and Crawford at the National Physical Laboratory are endeavouring to determine experimentally.

The method of Winch and Young (described fully in the *G.E.C. Journal*, 19, No. 4; 1952) is an adaptation of the binocular matching technique used by W. D. Wright ("Researches on Normal and Defective Colour Vision", Kimpton, 1946), R. W. G. Hunt (*J. Opt. Soc. Amer.*, 40, 362; 1950) and others. Very briefly, their method is as follows. The two eyes of an observer view two fields identical in pattern and intrinsic colour, but differing in colour of illumination. For example, one field may be illuminated by north-sky light, the other by a fluorescent 'daylight' lamp. Each field has at its centre one of a pair of identical coloured test panels. On first looking at the fields, the two eyes of the observer will, in general, perceive different colours in both surround and test panel, but after some minutes the fields will tend towards the same appearance owing to adaptation of the observer's eyes. Any residual difference between the test panels is compensated by addition of an adjustable red-green-blue mixture to the illumination of one of them (but not to the surround). This addition is a direct measure, under the conditions of the experiment, of the change in appearance of the test colour due to the given change in illumination. Such measurements have been carried out in great number and variety by Winch and Young, and there is no doubt of the value of the method in the ease and precision with which it can map out changes in colour appearance for different conditions and for a number of observers. Unfortunately, the method still leaves uncertain the exact tolerances on energy distribution which are applicable to any particular case.

The work now in progress at the National Physical Laboratory is designed as a direct attack on the problem of tolerance determination, and was described by Dr. B. H. Crawford in the third contribution to the symposium ("A Logical Method of Investigating Colour Rendering"). In the first place, a light source has been set up in the form of a very large double monochromator of the type which recombines at the exit slit the light dispersed in the central spectrum. The emergent light can thus be completely controlled in spectral composition by shutters and diaphragms placed in the plane of the central spectrum, and can be used for illuminating pictures, patterns, or objects to be viewed by the subject of the experiment.

The general method of experiment has been designed for the determination of the absolute thresholds of change in colour rendering discussed above in connexion with the work of Waldram and his colleagues. By means of mechanically moving shutters in the central spectrum, the emergent light is changed in composition so slowly that the adaptation of the observer's eyes is in a sensibly steady state the whole time; and when he signals that a definite change, either specified or general, has come over the pattern he is viewing, he has made a determination of threshold change in colour rendering which approximates closely to the ideal specified above. The threshold thus determined is, in fact, a tolerance, and when such thresholds or tolerances have been determined for a sufficient variety of objects and observers, it should be possible to propose

tolerances for the figures which describe a lamp of any particular class.

Some preliminary results were described by Crawford on the basis of a division of the spectrum into six bands. As the tolerance for any one band was of the order of 50 per cent, it is clear that any considerably larger number of bands would be futile from the point of view of colour rendering. These six bands are not regarded as a final choice: further work should enable them to be modified so as to give each one an approximately equal weight in, say, the assessment of mean daylight. But there are certain features which any system of bands should have if it is to be acceptable from the colour-rendering aspect, namely, divisions where blue changes to green and green to red, giving three fundamental bands, and equal subdivision of these three, so that the final number of bands would be three, six or nine. Considerable importance has been attached in the past to avoiding coincidence between mercury lines and divisions between bands; but this can be easily attained by very small wave-length shifts once the bands most suitable for colour-rendering specification have been determined.

B. H. CRAWFORD

SPOILAGE OF INDUSTRIAL MATERIALS BY MICRO-ORGANISMS

A VAST amount of spoilage of the perishable materials fabricated or harvested and used or stored by man is brought about by micro-organisms. Incalculable losses are incurred by the rotting of textile fabrics and paper, the making unpalatable of food and feeding-stuff and the decay of wooden structures, quite apart from the less vital but none the less economically important 'mildewing' of these and other organic materials. These matters were discussed at the autumn meeting of the Society for Applied Bacteriology, which was held in London at the Royal Society for Tropical Medicine and Hygiene on October 20, 1953, and which took the form of a symposium on "Microbial Spoilage in Industrial Materials".

In an introduction to the symposium, Dr. T. Richards (Reading) pointed out that the spoilage organisms belong almost entirely to the two groups, bacteria and moulds. Their deleterious effect is due to actual destruction of the material as in rotting, or to the development of unsightly microbial growths, or the production of toxic or offensive metabolic products. Dr. Richards surveyed the principles governing the growth of micro-organisms, since a knowledge of these provides a means of restricting microbial proliferation and consequent spoilage.

Only materials having an available carbon source together with a nitrogenous and mineral salts supply are susceptible to spoilage. Atmospheric ammonia can supply available nitrogen to an otherwise nitrogen-free material. Limiting the supply of nitrogen or mineral salts exercises a marked preservative effect in carbohydrate materials.

Control of moisture offers the most widely applicable means of restricting microbial growth. Atmospheric humidity is the critical factor, and to limit mould growth for storage periods of several years the relative humidity of the storage atmosphere must be

less than 65 per cent, although at 72–73 per cent no mould growth may be noted for several months. The same concept of relative humidity is useful in assessing the preservative value of strong solutions of sugar or salt. In solutions the vapour pressure of which can be equilibrated with relative humidities of about 72 per cent, yeast growth and mould growth are inhibited. Many moulds are inhibited at humidities less than 90 per cent, and, apart from micrococci and possibly *Pseudomonas*, bacteria seem to require conditions approaching actual wetness.

Hydrogen ion concentration is a factor of importance in preventing spoilage, especially in combination with anaerobiosis, although these applications are of necessity largely confined to food and fodder. Bacteria are all inhibited at about pH 4, save for a few aerobes, and in the absence of air these and all aciduric moulds cannot grow. Yeasts can only proliferate in the limited cases where there is a fermentable carbohydrate.

Low temperatures are of much greater general application in preventing microbial spoilage. 'Chilling' processes, from 0° C. to about 6° C., are successful over short storage periods and with lightly infected material, although preservation over an indefinite period is possible at the –20° C. or so of modern deep-freeze technique. Lack of oxygen, already mentioned, has no preservative effect *per se*, but in acid or low-moisture conditions it becomes a decisive factor in the inhibition of aciduric and xerophilic moulds.

Much could be said concerning the use of specific antimicrobial agents, antiseptics, fungistatics, etc.; but rightly these should be depended upon only when the fundamental necessities of microbial growth cannot be eliminated. In general, where deep refrigeration is impossible, impracticable or uneconomic, one must rely on low pH and anaerobiosis, or upon storage in an atmosphere of low relative humidity. Failing these, resort must be made to antiseptic substances, but this is advisedly a last resort: there is no ideal antiseptic, no rules govern their use, their mode of action is obscure, and in many cases tolerance is readily acquired. Some such agents have been successfully used, and examples were given in the symposium by ensuing speakers.

The problems of wood spoilage were dealt with by Mr. J. G. Savory (Princes Risborough), who emphasized the huge bill of damage caused by one species of wood-rotting fungus alone—the true 'dry-rot'. Quite apart from the structural damage due to rotting, much spoilage arises from the fungal discolorations. The so-called 'blue-stain fungi', all Ascomycetes or Fungi Imperfecti, have brown mycelium but stain the wood blue or grey. These organisms do not attack cellulose or lignin, but utilize the starches and sugars in the sapwood.

Basidiomycetes cause the brown and the white rots of timber. Brown rot fungi attack the wood cellulose leaving the lignin, and as the attacked wood dries out the characteristic cubical fracture is seen. The white rot fungi have an oxidase system and attack both lignin and cellulose, leaving the wood after attack with a white fibrous appearance. In the case of brown rots, extracellular enzymes are responsible for much of the decay, and much structural weakening may have occurred at a stage where there is little visual attack.

Originally, bacteria were thought to attack only chemically de-lignified wood, but Virtanen's work from 1928 onwards has shown that thermophilic