THE AGRICULTURAL RESEARCH COUNCIL

IN 1958-59 the Agricultural Research Council administered a grant in aid of more than £4 million. Most of this money has been used for established research programmes, since less than half a million pounds was allocated to capital expenditure such as new buildings and the purchase of special equipment. The large expansion programme, embarked on soon after the War, which resulted in the establishment of a number of new institutes as well as extensions to existing institutes, now appears to be nearing its end. There is still one major gap in the field to be covered, and this is referred to in the recent report*, namely, a meat research institute, for which there is a very urgent need. Meat in all its forms is the most valuable commodity coming off British farms, and evaluation of quality is still a very subjective process. We have no thoroughly reliable basis for meat-grading schemes, and there is no real definition of meat quality to provide standards for selection work. Performance and progeny testing of carcass animals is in urgent need of such standards. It is to be hoped that there will be no further delay in the setting up of this institute.

Altogether there are reports from more than forty institutes and research units which are wholly or partly financed by the Council. At one end of the scale there are the giants like Rothamsted with ninety names on the professional staff list, and at the other there are the research units, usually centred at a university, with as few as three or four people working under the direction of a member of the university whose initiative and academic ability have earned the reward of such assistance.

Such units have a continuity usually determined by the duration of the director's university appointment, but this does not generally apply to the special grants which the Council makes to universities, colleges and similar organizations. These are normally limited to three years. A perusal of the list of projects suggests that it is not feasible to organize and complete many of these research tasks in a period so short as three years. Naturally the Council has to safeguard its funds, but it is very important for it to remember that university research cannot prosper if it is on a hand-to-mouth basis so far as finance and personnel are concerned. The quality of the staff the Council recruits, especially in respect of

graduates in basic sciences who are in demand from other industries, will depend very much on the kind of research that is being undertaken in the departments that train these recruits. This problem is likely to be aggravated as the 'bulge' descends on the universities, to reduce even further the opportunities university teachers have for personal research.

The reports from the individual institutes are brief and give little information beyond the range of the work that is being undertaken. One cannot, therefore, judge the emphasis that is being placed on the various lines, or estimate the progress that is being made. By way of compensation there are some excellent reviews on several aspects of research in Great Britain along the lines followed in the previous year's report. Because these reviews have a perspective, they are really more valuable than the strictly factual routine report. An outstanding review is that covering foot-and-mouth disease. One sees that the scope of the work being undertaken at the Pirbright Institute has very much more than local implications, and illustrates very effectively the importance of the Council's work to the world at large.

Following the same line of thought, it is heartening to see a reference to the secondment of research workers to countries which have recently achieved self-government, in order to fill the scientific gap created by the retirement of expatriate staff. Countries like Ghana and the Sudan urgently need help, and they are unlikely to obtain it by offering short-term contracts, for there is no certainty that the appointee will get suitable employment when the contract terminates. If, however, he knows that his post is open for him on his return, and that a colleague will replace him abroad to maintain the continuity of his work, then a very different atmosphere is created.

Unfortunately, if we in Britain do not provide this help it will be obtained from other countries, to the detriment of our relations with the emergent countries. This is well evidenced by what is happening in the Sudan. The need for this help exists not only in research but also in teaching, especially at the university level, and also in the provision of technical assistance. It is to be hoped that these initial steps are the fore-runner to a more comprehensive scheme of assistance to countries that need our help.

M. McG. COOPER

* Report of the Agricultural Research Council, 1958-59. Pp. 213. (Cmd. 1069.) (London: H.M. Stationery Office, 1960.) 9s. net.

THE BACTERIAL GENERA *PSEUDOMONAS* AND *ACHROMOBACTER*

THE summer conference of the Society for Applied Bacteriology was held at the University College of North Wales, Bangor, during July 5-7. A paper-reading session occupied the first day, the last two days being devoted to a symposium on "*Pseudomonas/Achromobacter*".

The contributions to this session covered a wide field of both fundamental and applied problems concerning these two groups of bacteria, but the

themes which recurred and which promoted most discussion were differentiation and classification. As interests varied widely from the bacterial flora of meat, eggs, fish, water and soil to human and plant diseases, there were wide contrasts of approach and this led to useful exchanges of ideas.

In an introduction to the symposium, Dr. M. Ingram (Low Temperature Research Station, Cambridge) traced the history of the two genera through

the various editions of Bergey's "Manual of Determinative Bacteriology". He showed how over the years there has been a change of emphasis with regard to the importance of flagellation and pigmentation in the definitions of *Pseudomonas* and *Achromobacter*. Some species previously included in the latter genus have now been transferred to the former because of their polar flagellation; previously they had been excluded from the genus *Pseudomonas* because they showed no evidence of pigmentation. Even now that these two genera have been more clearly defined, reconsideration of the placing of some species seems called for. Dr. Ingram made it clear that he in no way wished to deprecate the value of the "Manual", and this point was later taken up in discussion when the meeting was reminded that the value of the contents of Bergey's "Manual" depends on the standard of work of the bacteriologists whose published descriptions of bacteria are included in it.

Dr. J. M. Shewan (Torrey Research Station, Aberdeen) followed with an account of the methods used in his laboratory for the differentiation and classification of the Gram-negative rods associated with fish and for the broad grouping of *Pseudomonas* isolates. For initial separation, these methods depend on the following tests: colony form, pigment production, Gram's stain, motility and morphology (using phase-contrast microscopy), mode of insertion of flagella, antibiotic sensitivity, the oxidase test (Kovacs' method) and metabolism of glucose (Hugh and Leifson's test). *Pseudomonas* isolates are thus divided into three groups. Group I produce a soluble green pigment, oxidize glucose with the production of 2-keto acid and are generally resistant to terramycin. Group II are non-pigmented, oxidize glucose but are usually sensitive to terramycin. Group III are also non-pigmented but fail to oxidize glucose, giving a negative or alkaline reaction in Hugh and Leifson's test. Gram-negative coccoid rods which are non-motile and non-pigmented are classified as *Achromobacter* or *Alcaligenes* according to whether or not they oxidize glucose, while peritrichous rods are classed as Enterobacteriaceae. Other Gram-negative rods recognized are: *Vibrio*, *Aeromonas*, *Flavobacterium* and *Cytophaga*.

Basically the same procedure is being followed at the Low Temperature Research Station, Cambridge, for the examination of isolates from chilled poultry; in addition, they have found the arginine test useful for distinguishing *Pseudomonas* species from *Achromobacter*.

Prof. J. C. Ayres (Food Technology, Iowa State University) has employed further tests for the differentiation of *Pseudomonas* species isolated from poultry, meat and eggs, namely: growth temperature, gelatin liquefaction, fat hydrolysis, nitrate reduction and citrate and carbohydrate utilization. He groups *Pseudomonas* isolates according to whether they resemble *Ps. fluorescens*, *Ps. geniculata*, or *Ps. fragi*.

For isolates from soil, Dr. A. J. Holding (Edinburgh School of Agriculture) has used a similar range of tests; but he has found that litmus milk reactions and nitrogen utilization tests give useful additional information. Unlike workers in the fish and poultry fields, he classes as *Achromobacter* organisms which are motile and predominantly rod-shaped.

A note of caution was sounded by Dr. K. Klinge (Hygienischbakteriologisches Institut, University of Erlangen) in connexion with undue reliance being placed on individual biochemical tests. He instanced

the oxidase test where, using Graby and Hadley's method, he found that the number of strains of *Ps. aeruginosa* giving a positive reaction depend on the medium in which they are grown. A yeast extract medium has proved the most favourable.

Dr. A. M. Paton (Department of Bacteriology, Aberdeen) described media that can be used in the isolation and identification of plant pathogenic bacteria. He has found that a gluconate basal broth is semi-selective and is a useful enrichment medium prior to plating on nutrient agar and 5 per cent sucrose agar. With regard to the latter medium, it is important to realize that production of lavan from sucrose is not restricted to certain plant pathogens but is characteristic also of some saprophytic pseudomonads associated with plants. Other tests for identification of plant pathogens suggested by workers in this field were, phage sensitivity and the ability to produce poly- β -hydroxy-butyric acid, a sudanophilic substance, which is characteristic of certain of the non-fermentative Gram-negative rods.

It was evident both from the main papers and from subsequent discussions that the approach of each worker to questions of differentiation and classification depended on the particular problems encountered in his own field. Some, notably those concerned with fish and flesh, wanted at an early stage to be able to separate the non-pigmented *Pseudomonas* from *Achromobacter*. Dr. Holding indicated a further difficulty with soil isolates; saprophytic *Xanthomonas* strains which have lost their ability to form pigment appear to be indistinguishable from the non-pigmented *Pseudomonas*. In contrast to the workers in the above fields, the medical bacteriologists required tests for the rapid detection of *Ps. aeruginosa* and of relatively few other non-fermentative Gram-negative rods. Dr. Klinge described tests he had used to distinguish *Ps. putida* and *Ps. fluorescens* from *Ps. aeruginosa* and also mentioned *Bacterium anti-tratum*, which he and some other workers have suggested should be included in the genus *Achromobacter* (this view has been questioned by others). For Dr. K. B. Rogers (Children's Hospital, Birmingham), speed of diagnosis is an urgent necessity, and his aim is to find a means of recognizing *Ps. aeruginosa* within 12 hr. of culturing. Plant bacteriologists also were seeking means of distinguishing the pathogenic from the saprophytic *Pseudomonas* within a reasonable period.

Although differentiation on the basis of a few tests was the primary task of most, many were deeply concerned with the classification of their isolates. Several speakers made a plea that the two should not be confused, though it was recognized that what proved to be a useful scheme for differentiation might also be a logical basis for classification. None appeared entirely satisfied with the present position regarding the two genera, *Pseudomonas* and *Achromobacter*, but there was no move to make drastic changes at this stage. The main need seemed to be for all named species to be very fully described and for them to be available in the culture collections. Prof. Ayres stressed the need for rigid standardization of the constituents of media and other factors such as temperature, age and size of inoculum and growth-medium when characterizing bacteria. He also pointed out that the present system of classification is based to a great extent on unstable characters. A number of workers, in the fields of fish, food and water bacteriology, have been using an electronic

computer to analyse their collected results, applying the theory that, in classification, every feature of an organism should be given equal weight. For this procedure, a minimum of 80 different features was quoted as necessary.

Apart from problems of differentiation and classification, considerable attention was paid to the ecology and development of *Pseudomonas* and *Achromobacter*. Workers at the Torrey Research Station have found that, while on fresh fish *Achromobacter* species are present in rather larger numbers than *Pseudomonas* species, after about 15 days on ice the latter become dominant. Many of them are dependent on sea-water and can multiply at 0° C. Similarly, it was found at the Low Temperature Research Station that non-pigmented *Pseudomonas* species become dominant on stored chilled poultry. They are associated with 'putrid' off-flavours compared with 'fruity' ones produced by *Achromobacter*. Prof. Ayres has also found that on raw flesh the dominant organisms are coccoid, motile, aerobic and non-pigmented. On eggs, he has encountered various *Alcaligenes* and *Pseudomonas* species, but only a small proportion can penetrate the inner membrane and cause spoilage. Dr. J. Brooks gave an account of factors which limit bacterial multiplication in egg-white; they included lysozyme, pH and the inavailability of protein and of iron, biotin and probably other trace elements. He has found that, so far as penetration of the egg membrane is concerned, age is an important factor, and by the twelfth day entry by infecting organisms is much more rapid.

A description of the distribution of Gram-negative organisms, including *Pseudomonas* species, in fresh-water, by Miss Vera G. Collins (Freshwater Biological Association, Windermere) threw light on the importance of layering effects on the distribution of bacteria in lakes, while the final paper of the symposium, by Dr. Rogers, showed how a single species, *Ps. aeru-*

ginosa, could persist in and heavily infect surgical apparatus which could not be sterilized by heat. This organism proved highly resistant to the non-corrosive chemical disinfectants and the use of infected apparatus could lead to severe and even fatal infections in children. From the discussion which followed, it appeared that dairy cows have become more liable to infection by this organism in recent years.

Two remaining papers dealt with fundamental approaches to two distinct problems. The first was by Prof. J. de Ley (Microbiology Laboratory, State University, Ghent), who gave a clear and convincing account of the carbohydrate metabolism and localization of enzymes in micro-organisms related to *Pseudomonas*. During the discussion which followed, there was a plea that bacteriologists and the biochemists should work more closely together in the future. It was the feeling of several workers that knowledge of metabolic pathways is of fundamental importance in the classification of bacteria. In the second paper, Dr. A. M. Paton (Department of Bacteriology, Aberdeen), discussed the role of *Pseudomonas* in plant disease. He welcomed the recent increase in knowledge of the metabolism of members of this genus, though as yet the results referred to relatively few species and their general validity is still unknown. After referring to various fundamental problems concerning plant/*Pseudomonas* relationships, he went on to describe the use of plant tissues embedded in nutrient agar for the investigation of pathogenicity mechanisms. He thought that, until more is known of such mechanisms, progress in plant disease control will be limited.

The papers read at the symposium and also contributions to the discussion on "Methods of Isolation and Differential Techniques" will be published in full in the *Journal of Applied Bacteriology*.

EVE BILLING

PHYSIOLOGY OF THE BANANA PLANT

COMPREHENSIVE investigations of the physiology of the banana plant are now being undertaken by Prof. F. C. Steward and colleagues in Cornell University. Of the three parts which have now appeared (*Ann. Bot.*, N.S., 24, 83, 117, 147; 1960) Part 1 deals with the detection and estimation of biochemical substances in the banana plant, in particular, the nitrogenous constituents of alcohol-soluble extracts, and keto-acids and non-volatile organic acids. The classes of nitrogen compounds to which attention is given are the amino-acids and their amides, certain volatile amines, ureido and guanido compounds, and certain indole compounds. In view of the large amount present in fruit of the Gros Michel variety, free histidine was isolated and critically identified. The use of various reagents and tests for these various classes of substances on paper chromatograms are described.

The range of substances which have been detected by these means in the banana leaf, leaf-sheath, fruit (pulp and peel) and stem exudate is shown by their location on paper chromatograms. Evidence is presented which indicates qualitatively the degree of prominence of the different substances in the tissues or extracts which have been examined.

Part 2 relates to factors which affect the nitrogen compounds of the fruit of several varieties subsequent to harvesting. In Gros Michel from Honduras, the amides (asparagine and glutamine) and histidine are of special importance in the soluble nitrogen fraction of the fruit. Prominent changes occur in the nitrogen compounds as the fruit ripens, and these are shown to be markedly influenced by the conditions that obtain during the development of the fruit. The nitrogenous composition of the fruit (Gros Michel) is markedly affected by the season of the year at which it forms; this affects the balance between the amides (asparagine and glutamine) and histidine, and also influences the post-harvest metabolic behaviour in ways which are described. While the total protein of the fruit is relatively stable in its amino-acid composition, certain differences were noted which seem to characterize the Gros Michel as it grows in Central America, and some shifts in the amino-acid balance in the protein seem to occur with ripening. It was also ascertained that the very young inflorescence is at first relatively rich in soluble nitrogen compounds.

After the early phase of growth, involving cell division, has elapsed, the fruit utilizes its soluble