concerned is placed on the appropriate "Official List" of valid names or on the appropriate "Official Index" of rejected names. This procedure, while of great convenience to systematists, inevitably throws a greatly increased burden of work upon the secretariat of the International Commission and, through the increase in the amount of material to be published in the *Bulletin of Zoological Nomenclature*, will increase still further the financial difficulties of the International Trust for Zoological Nomenclature, the incorporated body which conducts the business affairs of the (unincorporated) International Commission. So serious, indeed, are the difficulties of the Trust—which possesses no income other than that obtainable from the sale of its publications—that the Right Hon. Walter Elliot, chairman of the Trust, paid a special visit to Copenhagen for the express purpose of warning the zoologists and palæontologists there assembled—and, through them, the great scientific institutions in which they work—that it would be impossible for the Trust to continue to maintain the work of the Commission unless a scheme were to be devised for providing the annual income essential for this purpose.

During the Congress, the colloquium drew up a report setting out in detail the recommendations for the reform of the code which it had adopted in the week preceding the opening of the Congress, and this report was discussed in draft both with the International Commission on Zoological Nomenclature and with the Section on Nomenclature of the Congress. As the result of these discussions, the report of the colloquium was submitted jointly by both these bodies to the Copenhagen Congress, by which it was unanimously adopted at the final *Concilium Plenum*. The report of the colloquium accordingly constitutes the official record of the decisions on nomenclature taken by the Copenhagen Congress, and, as such, will be an indispensable work of reference to all systematists until such time as it is possible, on the basis of the Paris (1948) and Copenhagen (1953) decisions, to prepare and promulgate a revised text of the code. In agreement with the Congress and at its request, the International Trust for Zoological Nomenclature is publishing the report of the colloquium in book form. In order to bring this work within the reach of every zoologist, the Trust is subsidizing this publication to an extent sufficient to enable it to be placed on sale for five shillings (75 U.S. cents); copies will be obtainable from the offices of the Trust (41 Queen's Gate, London, S.W.7). It is expected that publication will take place towards the end of November. Francis Hemming

## CHEMICAL RESEARCH LABORATORY, TEDDINGTON

### OPEN DAYS

THE annual open days of the Chemical Research Laboratory, Teddington, were held this year during September 22–25. A feature of the previous year was the new building provided for radiochemical work, and this year another new laboratory was open for inspection. This was a building of prefabricated type but specially fitted for microbiological research. It has a floor space of about 3,000 sq. ft. and contains five research rooms, an instrument room, a small library, a general fermentation laboratory with cold and warm chambers, and a 'kitchen' for the preparation and sterilization of media and glassware. The design is such that the risk of contamination of cultures is brought to a minimum. The air is filtered before entry, sliding doors are provided to prevent draughts, and the walls and floors are finished to allow easy cleaning. This building was occupied during November 1952.

The main topic of the Microbiology Group is the fundamental study of the metabolism of sulphate-reducing bacteria. Interesting exhibits related to the counting of these bacteria, and a demonstration was given of the presence of cytochromes detected for the first time in anaerobic bacteria. The production of sulphide and methane by anaerobic digestion of sewage sludge supplemented with sulphate was demonstrated. Another exhibit illustrated the breakdown of aromatic compounds by bacteria isolated from filter beds in which effluents from chemical works are rendered innocuous. An important section of the Group is the National Collection of Industrial Bacteria. The primary purpose of the Collection is to supply on request cultures of bacteria required by industry and research establishments, and some seven hundred cultures were sent out during 1952 to organizations all over the world. The Collection now maintains nearly six hundred strains of bacteria, as well as several antibiotic-producing organisms deposited by the United Nations World Health Organization. Research is being carried out on the effect of freeze-drying on the biochemical characteristics and viability of the cultures.

Earlier work of the Laboratory's Inorganic Group revealed that certain flue dusts provide a concentrated source of germanium and gallium, and the dusts are now being used commercially for the production of these elements. A new extension of the work on the recovery of valuable products from wastes or low-grade materials is a search for selenium in dusts and sludges arising in the purification of the sulphur dioxide produced by the burning of pyrites in the new flash-roaster plants. In most of the dusts the selenium content is small, ranging from 10 to 100 parts per million; but in one type of sludge the amount rises to 1–2 per cent, while in another type, three samples of which were shown during the open days, the content varies from 7 to 21 per cent on a dry basis. If these sludges occur in sufficient quantity, they may prove to be a useful source of this increasingly important element. In addition to pure germanium and gallium prepared in the laboratory, samples of twenty other metals in a high state of purity were exhibited, the most striking of these being titanium prepared by the van Arkel process. These metals form part of the stock held by the Pure Metals Committee of the Department of Scientific and Industrial Research.

The Inorganic Group is also responsible for microchemical and spectrographic analyses required either by the Laboratory or other stations of the Department. The sections concerned are well equipped with modern apparatus, and the expert teams are prepared to give advice on the applications of these instruments.

The exhibits in the Radiochemical Group were largely concerned with separation techniques for metals and acid radicals, with particular emphasis on chromatography and ion exchange. Of special interest in chromatography is the development of this process to geochemical prospecting by a simple and rapid method for use in the field. Extracts of the mineral samples under study are obtained usually by simple

acid treatment. Portions of the solutions so obtained are then applied to the bottom of a rectangular sheet of adsorbent paper on which a series of vertical slots are cut to form separated strips joined at the top and bottom. The sheet of paper is then rolled into a cylinder and placed upright in a beaker containing a small quantity of solvent and upward diffusion allowed to proceed for 10–15 min. The sheet is then removed, dried and sprayed with test solution when coloured bands of the metals become visible. Comparison with standard stains provides a rough quantitative measure of the metal in the sample. This method has proved successful with copper, cobalt, tin, zinc, uranium, lead, gold and niobium.

Several exhibits demonstrated the application of ion-exchange resins to metal separation, and in two of these experiments, dealing respectively with recovery of gold from cyanide solution and separation of copper and nickel, organic solvents were used for elution of metal from the resin. Equipment shown in this building included apparatus for radioactive measurement, automatic testing of the behaviour of ion-exchange resins on repeated treatment with solutions, continuous recording of concentration of metal in solution by a polarographic technique, and fluorimetric determination of uranium. Apparatus and methods for concentration of metals from minerals and ores were also exhibited.

The work of the Corrosion of Metals Group is concerned with the study of corrosion and its prevention in aqueous solutions, in underground conditions and in the atmosphere. In these researches methods of reproducing the effects of prolonged exposure in a short time are required, and many of the exhibits related to such accelerated tests. These included high- and low-speed rotors, a standardized atmospheric test of a simple type, and a totally enclosed 'weatherometer' in which cycles of spray, light and heat could be applied automatically in predetermined proportions. To the same category belongs the study of the corrosion of boiler tubes. Here the effort is directed to the introduction of conditions so that rapid corrosion occurs, reproducing the effect of prolonged use in service conditions. Once this accelerated test is established, it will be used for the study of inhibitive measures. Apparatus assembled for the corrosion of steels by hot flue gases was exhibited.

Much progress has been made in studies of the inhibition of sulphate-reducing bacteria. Examples of well-preserved iron articles, found in the site of an ancient tannery, led to the discovery of the inhibitive action of tannin and tannic acid; certain metallic salts are also effective, and from some non-aggressive soils a species of *Actinomyces* has been isolated which produces a thermolabile substance that also inhibits the bacteria. Elementary sulphur is often found in the products of bacterial corrosion. It has been found that aqueous suspensions of sulphur exert a rapid attack on steel comparable with that of dilute acid, and it is possible that sulphur may play a more important part in underground corrosion than was hitherto suspected. The specific action of sulphur on iron and steel has been applied to the examination of the completeness of other metallic films on ferrous metal surfaces; it has also been applied to the etching of steel, and several striking examples of this were exhibited.

Other subjects illustrated by exhibits included the removal of films from metal surfaces and their examination by the electron diffraction camera, the study of inhibitive action by radiometric tracer technique, the use of electrical measurements in studying paints on steel in sea water, and the application of inhibitors in temporary protectives and in packaging.

The purification of industrially important organic compounds to the highest attainable standard ($\sim 99{\cdot}9$ mol. per cent) and the measurement of the physico-chemical properties of such materials has been a leading theme in the work of the Organic Group for some years. For its effective prosecution this project requires specialized techniques and methods which are outside the scope of many industrial or academic laboratories. Nevertheless, the results which flow from this class of work have wide interest: on one hand, accurate and trustworthy data (melting points, boiling points, densities, refractive indices, solubilities, heats of combustion and ultra-violet and infra-red absorption spectra) are accumulated which are of theoretical and practical use; on the other, standard reference samples can be made available to outside workers needing them for calibration or analytical purposes. Several hundreds of such standards have already been distributed. Many of the exhibits exemplified the techniques which have been applied in various parts of this work. Thus, several kinds of very effective fractional distillation columns were shown, including an example of the spinning-band type. Fractional crystallization at temperatures between $-180°$ and $-20°$ C. was also displayed in suitable apparatus. Spectroscopic methods are used, in conjunction with the plotting of freezing-point/time curves, for the estimation of residual impurities, and this crucially important side of the work was fully illustrated by assemblages of equipment, much of which, including a mass spectrometer, has been constructed at the Laboratory. Other apparatus displayed was used in accurate measurements of boiling point, heat of combustion, liquid–vapour equilibria and solubility in water.

In a different field of organic work the Intermediates Section of the Organic Group has applied its chief effort to the preparation of new potentially useful materials by carboxylation procedures and to the preparation of new ion-exchange resins containing phosphonic or arsonic acid groups. Work on the applications of isotopically labelled compounds has also been continued. Many exhibits indicated the extent of success which has attended these lines of work during the past year.

In the High Polymer Group work on semi-permeable membranes, the determination of molecular weight, and ion exchange was shown. A new laboratory maintained at constant temperature has been built which is now being used for osmometry and other physico-chemical measurements, and apparatus on show in this laboratory included precision thermostat baths, a light-scattering photometer, interference refractometer and allied equipment. A range of membranes of graded permeability and suited for use in non-aqueous systems has been produced from polyvinyl alcohol. Using membranes of an appropriate permeability, the molecular weights of simple compounds of known structure may be determined by osmometry. Thus details were shown of the determination of the molecular weights of tristearin, pentaiodobenzene and sucrose octaacetate.

A new type of ion-exchange resin containing chelating groups was exhibited. Resins of this type

are of considerable potential importance in certain industrial applications of ion exchange. One exhibit showed a chelating resin being used for reducing the copper content of tap water from 1 p.p.m. to less than 0·05 p.p.m. Other ion-exchange materials shown included a range of resins containing ion-exchange groups at the surface only.

## RUMINANT DIGESTION

A DISCUSSION on "Ruminant Digestion" took place on September 8 at a joint session of Section I (Physiology) and Section M (Agriculture) of the British Association, during its meeting in Liverpool.

The opening speaker, Mr. A. G. Singleton (University of Liverpool), discussed the significance of the rate of passage of food through the ruminant stomach, and some of the factors controlling it. The efficiency of the ruminant as a cellulose digester depends mainly on the delaying power of the rumen, which determines the time available for cellulose digestion to occur. If the contents of the four stomach compartments are examined in an animal killed soon after feeding, the rumen and reticulum are found to contain pieces of hay or other food of a relatively large size, the omasum always contains very finely divided particles in a relatively dry state, and the abomasum contains particles of about the same size suspended in a more fluid medium. It seems either that particles do not leave the rumen and reticulum until they have attained a certain smallness of size, or that the omasum reduces their size by a grinding action. Rumination and bacterial action tend to reduce particle size in the rumen. There is little evidence of any triturating activity of the omasum; the dryness of its contents could be due to a squeezing action, but it seems more likely that it is produced by water absorption. There is some evidence that the reticulo-omasal orifice has a valve-like action, and the omasum may control the flow of contents from the reticulum to the abomasum.

The feeding of hay or of straw which has been chopped or ground reduces its digestibility, a fact which was assumed to be due to an increase in the rate of passage of the feed. Balch (1950)[1], however, found that when ground hay was fed with normal hay it passed through the rumen more rapidly; but when the whole ration was ground, it remained in the rumen for an abnormally long period, and fibre was less completely digested. The reason for this is unknown, but the shorter time spent in ruminating, which is known to occur when the ration is ground, may be a contributing factor. This would reduce the amount of salivation, and it is known that an increase in the dry-matter/water ratio reduces the rate of cellulose breakdown.

It has been shown that the composition of duodenal contents influences the motility of rumen, reticulum and abomasum. Acid, protein and fat introduced into the duodenum inhibit the movements of these three compartments. Distension of the duodenum and abomasum also inhibits the movements of other compartments. It appears that chemical and physical factors may exert an important influence on the emptying of the stomach, in addition to the factor of particle size.

Mr. Singleton then described an electromagnetic method which is being used for continuously recording flow through the duodenum, and with which the factors affecting the emptying of the stomach are being investigated.

Dr. R. S. Comline (University of Cambridge) spoke on the nervous control of the ruminant stomachs. A strip of reticulum, attached to its blood and nerve supply, contracts in response to stimulation of vagus, right splanchnic nerve (with the right adrenal removed), left thoracic sympathetic chain, and the intravenous injection of adrenaline. The vagal effects are stronger than the sympathetic and are abolished by atropine. The sympathetic effects are unaffected by atropine, but are prevented by sympatholytic drugs, such as 933 *F.*, and by vagal stimulation. In chronic experiments, ruminants are unable to survive double vagotomy, which abolishes the normal propulsive motility, whereas the sectioning of both splanchnic nerves is without obvious effect.

In decerebrate calves and lambs, the œsophageal groove closes in response to water flowing over the pharynx, or to stimulation of the cut superior laryngeal nerve, which could also produce reflex swallowing. The reflexes of groove-closure and swallowing are closely integrated, but the two responses are affected differently by different stimuli. Reflex groove contractions can be inhibited by stimulation of the abomasal branch of the vagus. In decerebrate adult animals, reflex contractions of the reticulum could be invoked by stimulating the central ends of the abomasal, reticulo-omasal and reticular branches of the ventral vagus. Stimulation of the hypothalamus can produce movements in the alimentary canal, and even rumination.

Dr. Comline then criticized the tendency to call a particular part of the ruminant stomach a pace-maker. The stomach movements are not myogenic, as are those of the heart; they disappear when all extrinsic nerves are cut. A more profitable analogy, he said, is with the control of respiration, where a central rhythm is modified by afferent stimuli.

Dr. A. T. Philipson (Rowett Research Institute) contributed a paper on absorption from the rumen of the sheep. The rumen, reticulum and omasum are lined by stratified squamous epithelium, but the layer of keratinized cells is much thinner than in skin. The finding that the concentration of short-chain fatty acids is about 7–10 times greater in the rumen than in the abomasum suggests that absorption takes place, and this has been proved by showing the presence of fatty acids in significant concentrations in the blood leaving the rumen. Many investigations have been made on the rates of absorption of short-chain fatty acids, and it is agreed that absorption is more rapid when the *p*H is acidic than when it is neutral or just over *p*H 7, and that an acidic *p*H has a greater effect with propionic than acetic acid, and with *n*-butyric than propionic acid.

A comparison of the fatty acids in the rumen with those in blood leaving the rumen does not agree with these findings. It is found that the proportions of fatty acids in blood and rumen are similar, except that less butyric acid is present in blood. This led to an investigation of the metabolism of these acids by the rumen wall, which showed that considerable losses of butyrate occur, while losses of acetate are small. Metabolism of propionate is increased by the presence of carbon dioxide. The discrepancy is explained by the fact that about half the butyrate absorbed enters the blood stream, the rest being metabolized, while a little less than one-third of the propionate disappears. The acetate losses are likely