metre-wave discharges in rare gases, were described respectively by A. Vassy (Paris) and by I. Eyraud and J. Janin (Lyons). Measurements of wave-length standards by means of a reflecting échelon were described by T. A. Littlefield (Newcastle), who directed attention to the necessity for certain corrections; P. Risberg (Lund) explained the establishment of accurate vacuum ultra-violet wave-length standards by application of the combination principle to newly measured long wave-length lines of Mg II and Ca II.

Mrs. C. E. Moore-Sitterly (Washington) spoke on one of the several valuable compilations of data for which all spectroscopists are indebted to her, namely, a second revision of Rowland's Solar Wave-length Table. Announcement of the preparation of a useful table of forbidden multiplets of astrophysical significance was made by J. W. Swennson (Liège). Of the specifically astrophysical papers, that of E. Finlay-Freundlich (St. Andrews) on his well-known hypothesis in explanation of the general red-shift in celestial spectra produced much discussion; the possibility of fluorescence by line-coincidence was illustrated by J. Gauzit (Lyon), and Mrs. C. Payne-Gaposchkin (Cambridge, Mass.) contributed results of a spectrometric study of a rotating star. The conference ended with a general discussion, under Prof. Edlén, concerning proposals for defining the metre in terms of the wave-length of a chosen spectral line produced under specific conditions.

Limitations of space preclude a fuller account of the many important contributions to this conference, which demonstrated that the study of line spectra continues to flourish.

W. R. S. Garton
L. F. H. Bovey

RIDERLESS MICROCHEMICAL BALANCES

At the recent symposium on analytical chemistry held in the University of Birmingham by the Midlands Society for Analytical Chemistry, one of the most interesting features in the display of modern laboratory apparatus was the adoption of the riderless beam principle by the firm of L. Oertling, Ltd. (Cray Valley Road, St. Mary Cray, Orpington, Kent), in the construction of its two new microchemical balances.

There is little doubt that one of the most serious sources of error in weighing on a microchemical balance (apart from the personal factor) is associated with the use of the rider. These errors have been attributed to variations in the mass of the rider, its angular placement on the beam, the shape of the notch and the accurate location of the notches on the beam. The cumulative effect of these errors over the several weighing operations involved in a gravimetric analysis may result in considerable inaccuracy. Some workers have estimated the probable error of any one reading on a microchemical balance at $\pm$ 3 μgm., while work undertaken for the American Chemical Society by others gave values of 0·9–23·3 μgm. for the standard deviation of thirty-two different microchemical balances used with a 1-gm. load. The elimination of every possible source of error is therefore highly desirable.

Few fundamental advances have been made in the design of microchemical balances since the evolution of the original Kuhlmann model, but the elimination of the rider error in these two new microbalances by Messrs. Oertling will undoubtedly be hailed as such by many.

In place of the conventional rider system, a plain beam is used in conjunction with a series of fractional rider weights. These fractional riders are loaded on to a special carrier bar, attached to the pan-suspension system, by means of levers operated by a calibrated dial attached to the right-hand side of the balance case. In the more sensitive of the two balances, these fractional riders have a displacement value equivalent to 9 mgm., so that when the 1-mgm. range of the graduated optical scale is added, a total displacement of 10 mgm. can be observed, rendering the use of weights less than 10 mgm. superfluous.

Needless to say, the possibility of errors of another nature is introduced by the riderless beam principle, and one still has to reckon with variation in the weights of the fractional riders; but nevertheless weighing operations are speeded up considerably, and the inherent errors involved would seem to be less serious, for the manufacturers claim that for the first time in microchemical weighing it is possible to weigh with certainty to the nearest microgram.

T. S. West

ACTIVITIES OF THE INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

The Policy Board of the International Union of Biological Sciences met in Paris during June 28–30 and made a number of recommendations regarding the future structure of the Union. The Board consisted of Prof. P. Weiss (United States) and six other members: Prof. A. Frey-Wyssling (Switzerland), Prof. J. Monod (France), Dr. L. Harrison Matthews, representing Prof. C. F. A. Pantin (United Kingdom), Prof. B. Rensch (German Federal Republic), Prof. John Runnström (Sweden) and Prof. M. J. Sirks (Netherlands); a number of officers of the Union and of other International Unions were also in attendance for parts of the meeting. One of the principal recommendations was that the Union should consist of eleven Sections, as follows: Biochemistry, Biometry, Botany, Cell Biology, Developmental Biology (including embryology), Ecology (including limnology), Genetics, Microbiology, Physiology, Experimental Psychology and Zoology (including entomology). This would involve setting up four new Sections—those of Biochemistry, Developmental Biology, Physiology and Experimental Psychology—and incorporating the present Sections of Embryology and Entomology as indicated.

The work of the Union is of a varied nature. Research institutes available to workers of all nationalities have been supported or founded: for example, a culture collection of wild species of *Drosophila* at Pavia; Centres for the Biological Control of the Pests of Plants at Geneva and Mentone; the International Depot of Microscopical Preparations at Louvain; the International Bureau of Human Heredity at Copenhagen; and the Serological Museum at Rutgers University, New Brunswick. The Union organizes and partly finances symposia for the discussion of current research (usually three a year) by small groups of specialists, and also helps in the organization of international congresses relevant to its work. Catalogues of types in national museums, and a list of type-genera and species of mites have been published, thanks to financial aid from the Union, and annual grants have been made to certain periodical publications of an international character concerned with bibliography, such as the *Zoological Record*, *Biological Abstracts*, *l'Année Biologique* and *Resumptio Genetica*; the publications of the International Commissions for Zoological Nomenclature, Botanical Nomenclature and Bacteriological Nomenclature have also been supported financially.

The officers of the Union are as follows: *President*, Prof. S. Hörstadius (Sweden); *Vice-President*, Prof. R. E. Cleland (United States); *General Secretary*, Prof. G. Montalenti (Italy); *Secretary*, Prof. R. Ulrich, France (Laboratoire de Physiologie Végétale, 1 rue Victor Cousin, Paris 5e); and *Treasurer*, Prof. A. Linder (Switzerland). Publications of the Union are available from the secretary, Prof. Ulrich. All other communications should be directed to the general secretary, Prof. G. Montalenti, at the headquarters of the Union, Istituto di Genetica, Via Mezzocannone 8, Naples.

CRYSTALLINE BACTERIAL ARRAYS AND SPECIFIC LONG-RANGE FORCES

By Dr. R. J. GOLDACRE

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THE purpose of this communication is to show that, like viruses, some bacteria can be crystallized. The bacterial cells form regular three-dimensional arrays in which each cell corresponds to a molecule in a conventional crystal; with rod-shaped bacteria, the rods are parallel.

This helps to bridge the gap between the microscopic and the molecular. For the first time it is possible to see easily with the light microscope particles which behave in some respects like molecules. This can be done when they are in their natural medium, without drying as required for the electron microscope.

There is reason to think that specific forces may operate over distances much greater than the range of ordinary valency forces. While the work of Rothen[1] remains controversial and has been to some extent disproved[2,3], it is undisputed that in suspensions of bentonite[4], solutions of tobacco mosaic virus[5] and of some other colloidal substances[6], individual particles are under certain conditions held orientated parallel to one another when the distances separating the particles are as large as several hundred angstrom units. The largest spacing so far recorded is 8000 A. in the Schiller layers of iron oxide[7]. As Bernal[8] has said: "There is evidence that between extended particles there are forces which act at distances of the same order as the size of the particles themselves". In the bacterial aggregates to be described the forces appear to operate over distances of 10,000–50,000 A. Regular arrays were obtained both in two dimensions and in three.

(*a*) *Two-dimensional arrays*. During work on *Amoeba proteus* in hanging drops of Chalkley's[9] medium—a very dilute balanced salt solution—it was noticed that fine parallel striations appeared on the surface, especially if the drops were set aside for a few days. These gave brilliant diffraction colours with the light from the condenser, and on close inspection the striations were found to be made up of thousands of parallel bacterial rods. These bacteria occurred naturally in association with the amoebæ and multiplied after the amoebæ cytolysed. Stirring with a micromanipulator disorientated the rods, but after the removal of the needle they rapidly became parallel again. This shows that the orientation was not due to adhesion of the cells after division. Small islands containing about thirty parallel rods sometimes occurred. These were in dynamic equilibrium with the free individual bacteria in the solution, which were highly mobile either due to locomotor organs or lively Brownian movement. Bacteria approaching an island were captured, and snapped parallel to the rest of the group, and others broke free from time to time elsewhere and escaped into the solution. A cell prized off by the micromanipulator by more than 5 μ from the edge of the island would swim away freely in the solution.

In regions of the surface where the cells were not parallel, they could be made to become so by stroking with a micromanipulator needle, and the influence spread far beyond the area stroked. This recalls the scratching technique used by chemists to induce crystallization in a supersaturated solution. A needle placed in the surface of the drop induced the cells to arrange themselves in palisades on each side, the orientation extending outwards for about ten rows or 40 μ before fading out. The tip of the needle by itself induced a radial arrangement, resembling an aster. Similar effects could be produced by fragments of glass, algal cells or other relatively large disturbance of the surface. When two such fragments were within about 80 μ, the appearance of the mitotic spindle was simulated. Tripolar effects could also be obtained.

The side spacing between the rods was commonly about 3 μ, compared with a cell width of about ½–1 μ and a length of 3 μ, but spacings of from one to five microns were sometimes observed with smaller and larger species. The cells were not in contact, for (1) electron micrographs showed no jelly, capsule, flagellæ or other material between them; (2) they could be pushed closer together by the micromanipulator and sprang apart when released; (3) if mobile rods of a smaller species were introduced, they swam up and down between the rows in straight lines without disturbing the structure, or being captured.

The aggregates appear to be the result of a long-range attraction and a shorter-range repulsion. Specificity is suggested by the occurrence side by side of many homogeneous aggregates of different species which separated out from a mixed suspension; and also by (3) above.

Surface tension forces probably account for some, but not all, of the interaction. Some of the effects (parallel orientation, spindles, asters) could be duplicated with human hair, chopped into 1-mm. lengths, floating on water, and by cardboard rods with alternate water-attracting and water-repelling bands, creating a pattern of attraction and repulsion which attracted a similar pattern but in general repelled a dissimilar pattern. But always the bodies came into contact, and surface tension cannot account for (1)