unionists and engineers. Others joined the team at different times to advise on seating, ventilation, position of controls and the muscular forces required to operate them. Among the problems was the lack of anthropometric data relating to bus drivers, so calculations had to be based on published measurements of National Service recruits. The need to increase the range of anthropometric data was stressed by other speakers, including Dr. J. S. Weiner, assistant director of the Medical Research Council's Unit on Climate and Working Efficiency.

The discussion after the papers was in general lively, and there were many useful criticisms. The now familiar problem of communication was frequently mentioned as one of the reasons for the delay in applying biological research to industry. The biologists were advised that industry must not be led to expect that solutions to all its problems are within immediate grasp, and the industrialist was advised that research workers are not good salesmen, but that did not mean they did not have valuable services to offer.

There is, therefore, a strong probability that there will be a considerable demand from industry for biologists and biological advice. The difficulty will be in supply. O. G. EDHOLM

ULTRACENTRIFUGATION OF BIOLOGICAL MACROMOLECULES

THERE were about a hundred participants from several countries at the informal meeting on ultracentrifugation organized on behalf of the Faraday Society at Birmingham during September 14–15. Prof. K. O. Pedersen (Uppsala) gave a stimulating historical introduction. Papers by Dr. J. M. Creeth (Lister Institute, London) and Dr. H. G. Elias (Zurich) considered thermodynamical aspects of the sedimentation of multicomponent systems, while Dr. M. Gehatia (Frankfurt am Main) discussed various methods of evaluating S and D constants from the shape of the gradient curve of ultracentrifugation. Dr. G. A. Gilbert (Birmingham) described his theory concerning the analysis of moving boundaries in reversibly aggregating systems; examples of its application being provided in papers by Drs. S. N. Timasheff and R. Townend (Philadelphia) and by Mr. K. A. Cammack (Medical Research Establishment, Porton). A paper by Drs. A. J. Rowe and Dr. P. Johnson (Cambridge) considered the interaction of actin and myosin by ultracentrifugal studies.

Dr. P. A. Charlwood (Medical Research Council, Mill Hill) reviewed trends in the determination of molecular weights of macromolecules from transient state measurements in the ultracentrifuge and Dr. H. G. Elias (Zurich) discussed the various methods of determining the experimental values used in the Archibald expression. Dr. G. Träxler (Munich) considered various ways of using the analytical ultracentrifuge in the measurement of diffusion constants of macromolecules. Papers on the sedimentation of charged macromolecules were presented by Prof. K. O. Pedersen and Dr. R. G. Wallis (Medical Research Establishment, Porton).

A new recording device for the ultra-violet absorption was discussed by Drs. J. B. Th'Aten and A. Schouten (Rijswijk, Netherlands), while Dr. I. Wiedmann (Basle) described a new schlieren optical system. Drs. P. A. Bianchi and K. V. Shooter (Chester Beatty Institute, London) considered the study of the sedimentation characteristics of deoxyribonucleic acid by the ultra-violet system.

Application of zone-centrifugation to the analysis of human serum proteins was described by Dr. D. R. Stanworth, Prof. J. R. Squire and Mr. K. James (Birmingham). Drs. P. Johnson and A. Albert discussed the sedimentation characteristics of human serum macroglobulins.

A suggestion by Prof. K. O. Pedersen that sedimentation coefficients should be referred to 25° C. rather than 20° C., as is becoming the practice in the United States, evoked considerable discussion, but no final decision was taken.

Prof. K. O. Pedersen, Dr. A. S. McFarlane (Medical Research Council, Mill Hill) and Dr. R. A. Kekwick acted as chairmen and Dr. P. Johnson summed-up at the end of the proceedings. D. R. STANWORTH

MIGRATION OF MARINE ORGANISMS

A LATIN American symposium on migration of marine organisms was held at Guayaquil, Ecuador, from June 27 until July 1. It was organized jointly by the Unesco Science Co-operation Office for Latin America and the University of Guayaquil.

It was the fifth of the series of meetings on marine sciences which the Office has held since its foundation in 1949. The previous meetings had, like the Guayaquil one, the double character of symposium and working-party session. They were held at Concepción, Chile, in 1954; São Paulo, Brazil, in 1955; Montemar, Chile, in 1956; and Montevideo in 1957.

Dr. Enrique Rioja (Mexico) was elected chairman of the symposium and Dr. Hugo Ferrando (Uruguay) acted as secretary. Thirteen marine scientists participated, from the following countries: Argentina, Brazil, Chile, Cuba, Ecuador, Mexico, Peru, Uruguay. The Unesco Science Co-operation Office for Latin America was represented by Dr. Angel Establier.

The programme of the meeting was as follows: (1) migration of marine organisms, namely (*a*) fish, (*b*) invertebrates, (*c*) cephalopods, (*d*) birds, (*e*) other vertebrates; (2) study of environmental factors causing migration, (*a*) oceanographic factors, (*b*) biological factors; (3) standardization of methods for studying migratory phenomena, with the view of comparing results; (4) establishment of regional programmes for work on migration of aquatic populations; (5) general discussion of other problems related to migration of marine organisms.

At the conclusion of the symposium, six recommendations were unanimously approved by the participants. First, considering that the study of the migration of marine organisms by its very nature requires a joint effort on the part of the countries concerned, regional action was recommended. The following delimitation of problems common to a number of countries was made with a view to their being undertaken regionally: Argentina, Brazil and Uruguay: Thunnidae, Scombridae, Clupeidae (*Sardinella* sp.), Galeorhinidae (*Galeorhinus vitaminicus*) and Mugilidae (*Mugil* sp.); Chile and Argentina: Merluccidae (*Merluccius* sp.), Decapoda (Macrura—"Langostinos"—Shrimps and "Langosta" de Juan Fernández); Peru and Chile: Thunnidae (*Neothunnus macropterus*), Engraulidae (*Engraulis* sp.), Scombroidae (*Sarda* sp.) and Decapoda (*Munida* sp.); Peru, Ecuador and Colombia: Thunnidae (*Katsuwonus* sp.) (*Neothunnus macropterus*), Decapoda (Macrura—"Langostinos"); Mexico, Caribbean and coast of Venezuela: Thunnidae (*Katsuwonus* sp., *Thunnus* sp.), Centropomidae (*Centropomus* sp.), Decapoda (Macrura—*Panulirus* sp. and Penaeidae–*Penaens* sp.).

Secondly, it was recommended that information be exchanged between Argentina and Chile covering research results and methods used in work on the principal species of *Merluccius*. Thirdly, marking trials should be held in conjunction with studies on the biological cycle of the species (growth, reproduction, alimentation, etc.) with the view of relating migration and the different phases of life of individuals. Similarly, the importance of the study of environmental conditions emphasized at the meeting of the Unesco Marine Sciences Working Party, held at Montevideo during May 22–24, 1957, was underlined.

In view of the importance of movement and mixture of different bodies of water, it was expressly recommended that Argentina, Brazil and Uruguay should study the northern and southern limits and fluctuations respectively of subantarctic and subtropical waters and also the origin of the water of the coastal region. It was hoped that similar work might be undertaken for the south-east Pacific area in the fairly near future.

Unesco was also asked to interest the Governments of Latin America in helping this type of scientific work, which is an indispensable basis for a proper knowledge of the renewable resources of the sea. Finally, it was recommended that the next marine sciences meeting to be organized by the Unesco Latin American Science Co-operation Office should be divided into two sections: 'abiotic oceanography' and 'marine biology'.

ABSOLUTE DATING OF THE MIDDLE ORDOVICIAN

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A NUMBER of recent papers have amply emphasized the need for absolute dating of geological samples which meet two essential requirements: (1) occupy an unambiguous position in the classical stratigraphic column; (2) contain unaltered mineral conducive to age determination by the well-established stable-isotope methods.

This communication presents additional results from our work[1,2] on the dating of the Middle Ordovician and discusses the factors which must be considered when sufficient data become available to consider revision of existing geological time-scales.

Several years ago, G. Hamill[3] made a petrographic and geochemical study of bentonites, particularly of the fine, euhedral zircon found in low concentrations (one part in 20,000–40,000). This work and the results of further experiments have consistently led to the belief that the zircon was indigenous to the volcanic ash falls which gave rise to the bentonite beds. The bentonites occur as beds in fossiliferous marine deposits, and hence their positions in the stratigraphic column are usually unambiguous, so that zircons in bentonite clearly offer an excellent possibility of ascribing absolute ages to the geological time-sequence of marine deposits.

The bentonites also contain biotite, generally in greater concentration than the zircon. In 1958 we published preliminary age determinations by the rubidium–strontium method on biotites of Devonian and Ordovician age which were later cited by K. I. Mayne, R. St. J. Lambert, and D. York[4] in an article in which they proposed a much more radical revision of the Holmes time-scale than was suggested by our results. In our original publication, we stressed the fact that these measurements were of a preliminary nature and that the experimental error could probably be reduced by a study of the zircon in bentonites.

During the past year, samples of pure zircon and of zircon with small amounts of monazite and apatite, in quantities of about 1 gm., were obtained from several bentonites. Zircons from four bentonites were chosen for age determination because they occurred in relatively high concentration, and because the stratigraphic position of occurrence was well established[3].

Microscopic examination showed that the zircons were euhedral, and none exhibited rounding of the crystal edges or overgrowths that would be inconsistent with a pyroclastic origin. The zircons were commonly associated with subhedral biotite flakes, euhedral apatite, sanidine and euhedral quartz. The appearance of the quartz was consistent with a high-temperature morphology (positive and negative rhombohedra with little or no development of prism

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