SECOND INTERNATIONAL CONFERENCE ON PROTOZOOLOGY

THE first International Conference on Protozoology was held in Prague in 1961, and the second at the Imperial College of Science and Technology in London during July 29–August 5, 1965. Approximately 570 delegates attended the Conference from 26 countries; 370 papers or films were read or shown.

In place of full proceedings, a shortened version of the papers was printed and given to delegates on arrival at the Conference, in a volume entitled *Progress in Protozoology*[1]. This service was much appreciated and certainly is preferable to reports of congresses, which are not produced sometimes until as long as seven years after the meeting has ended, while the abolition of formal proceedings allows speakers a greater freedom to speculate and report on very recent work.

The patron of the Conference was H.R.H. the Duke of Edinburgh; the honorary president was Prof. E. Fauré-Fremiet, and the Conference was organized by a national committee under the chairmanship of Prof. P. C. C. Garnham.

The annual meeting of the Society of Protozoologists was held under the presidency of John Corliss (Chicago) during the course of the Conference.

The Conference was divided into two parts: the mornings were devoted to plenary sessions based on single topics; the afternoons to special symposia and contributed papers in four simultaneous sessions. At the end of the afternoons, ciné films were shown. The plenary sessions were selected to give non-specialized workers the present views on the following subjects: morphogenesis and life-cycles, types and preservation of strains, genetics, biochemistry and physiology, cytology and ultrastructure, and locomotion.

The afternoon sessions were devoted to specialized subjects, including : marine protozoa, piroplasms, protozoa of invertebrates, metabolism and drug action, cultivation of Protozoa, ecology of free-living Protozoa, ecology and host–parasite relationships, and little-known parasitic Protozoa. The remainder of the contributed papers were arranged around their individual subjects, such as *Toxoplasma*, malaria parasites, coccidia, and ciliates. The day after the close of the Conference itself, a symposium was held on the classification of the Protozoa, when various schemes, originating from the Society of Protozoologists, from the U.S.S.R. and from Poland, were discussed. No finality was reached, but arrangements have been made for the continuation of this discussion by the International Commission on Protozoology. This body was formally instituted at the Conference, following a proposal by Prof. Pierre de Puytorac (Clermont-Ferrand). It has the responsibility for organizing future International Conferences, to work for the establishment of relations with other international biological organizations, such as the International Union of Biological Sciences and Unesco, and particularly to appoint various committees to consider such subjects as the preservation of types, the maintenance of culture collections, the revision of systems of classification of the Protozoa, and the participation of protozoology in the International Biological Programme. The Conference itself passed a resolution requesting that the World Health Organization should be invited to convene a meeting for discussing how international co-operation could assist in the preservation of strains and types of Protozoa. The Conference also resolved that an abstracting service for protozoology is highly desirable, and the feasibility of the provision of this service is to be investigated. The final resolution of the Conference was that the third International Conference on Protozoology should be held in Leningrad in 1969.

The importance of the Protozoa in the whole field of genetics was emphasized by Sonneborn (Indiana), who pointed out that while work on viruses, bacteria, yeasts, etc., appeared to have overshadowed that on Protozoa, it was nevertheless the protozoologist who, in the past, had pioneered a number of important routes for use in general genetics. The Protozoa are likely to become increasingly important in this field, by virtue of their special suitability for investigating certain types of genetical activity, including the special role they have in cytoplasmic genetics. This aspect was further developed by Preer (Philadelphia) in a discussion on *Kappa* and its relatives; he showed that the mate-killing *mu* particle is maintained by the gene *M*, by producing " 'metagons'—particles which prevent destruction of *mu*. Metagons in extracts prevent loss of *mu* in metagon-depleted paramecia. The latter are produced by treating mate-killers with ribonuclease or replacing *M* genes by *m* genes using suitable crosses and autogamy. Metagons are present in the RNA extracted from ribosomes of paramecia bearing the *M* gene. Metagons hybridize well with DNA from paramecia containing *M* genes and poorly with DNA from paramecia containing *m* genes. Consequently metagons are thought to be messenger RNA. Metagons from paramecia, when introduced into certain ciliates such as *Didinium*, become self-reproducing, like RNA viruses". Recent Russian work, for example, by Judin (Leningrad), involving nuclear transplantation and amoebae, appears to minimize the control of genetic effect by the cytoplasm; he concluded that the inheritance of all the characters studied is conditioned exclusively by the nucleus. Grell (Tübingen) explained the new ideas on sexuality in foraminiferans, in particular autogamy or the mating of gamonts, which could be differentiated into two morphologically similar types, reacting differently in the course of their lives.

There were numerous contributions from the French School (headed by Fauré-Fremiet, de Puytorac, Hovasse, Savoie, Mme Noirot-Timothée and others) on the ultrastructure of the ciliates, and the structures were not merely described, but also considered from the point of view of their nature, morphogenesis, and mode of action.

The paper by Satir (Chicago) presented evidence for a sliding filament mechanism in the peripheral fibres of flagella and cilia. The 'doublets' consist of a longer and shorter filament; the shorter filaments are apparently different in the two cases and they are always distal to the cell of origin compared to the longer filaments. This agrees with expectations for sliding-filament models of filament function where the filaments at the bottom of the cross-section would move out past those at the top to accommodate curvature.

Progress has also been made in other aspects in the study of flagella and cilia. The great versatility of these organelles, especially in relation to the presence and arrangement of mastigonemes, was stressed by Jahn (Los Angeles). The mathematical analysis of the hydrodynamic principles involved in both flagella and cilia has advanced considerably, as illustrated by the papers of Rikmenspoel (New York), Holwill (Dorking) and Machin (Cambridge). Further, the co-ordination of ciliary action was shown by a number of speakers to be mediated mechanically and not, as has often been assumed, by the transmission of neuromotor impulses by infra-ciliary fibres. The Polish workers in particular (Dryl, Grebecki and others) reported extensive experimental work correlating various forms of ciliary activity with surface potential, thereby providing a physiological interpretation of ciliate movement and reaction (for example, the induction of anodal galvanotaxis in *Paramecium caudatum* by membrane calcium). Mendelson and Warmouth (Boston) made an attempt to demonstrate learning in *Paramecium caudatum*, in which repeated mechanical stimuli, paired with light or absence of light, were presented to individual animals in a designated region of a capillary test chamber. The animals avoided the area in which the mechanical stimuli were given only under conditions of low-intensity illumination. Although avoidance persisted for a period of several minutes following cessation of mechanical stimuli, this response cannot be interpreted as learning since it was not dependent on pairing of any other stimulus with the mechanical stimulus. Further, during stimulation of one animal, a second animal also present in the chamber, but not receiving the stimuli, developed the avoidance response to the area in which the first animal was stimulated. Since it is unlikely that mechanical stimulation produces changes directly in the medium, it is suggested that a material is elaborated by paramecia in response to noxious stimulation. A simpler aspect of locomotion was beautifully demonstrated by Freyvogel (Basle) in a speeded up ciné-film to show the movements of malarial ookinetes. In recent years their inherent motility had been denied. The film clearly demonstrated that two types of movement are to be distinguished: in the first the ookinete is attached to the substrate with one pole as a sucker; with the free part of the body it carries out circling movements, but it remains on the spot. By the second a more or less even locomotion is made possible; this is brought about by circular contraction waves which originate at the anterior pole and which migrate on the surface of the body, well over its central portion. With reference to the substrate these contraction waves remain on the spot and the protoplasm with its inclusions is driven forward through them. In this way, on one occasion, an ookinete was shown to cover about 100μ within 40 min.

Few papers dealt with amoeboid movement, doubtless because this has been the subject of a recent symposium elsewhere, but the demonstration by Seravin (Leningrad) that amoeboid locomotion is produced not by a single but by many physiological mechanisms strikes a new note.

While the importance of the organelles, as revealed by electron microscopy, is fully recognized, Cheissin (Leningrad) pointed out that their presence or absence should not be regarded as an indication of the taxonomic position of the organism concerned; such organelles have a common function throughout the animal and plant kingdoms, and their existence is an indication of function rather than of taxonomy. On the other hand, as Jahn (Los Angeles) states, locomotion itself has always been regarded as the most important and generally accepted single taxonomic criterion of non-fossil Protozoa from subphyla to species, and this function of the organism is dependent on such organelles. Polyansky (Leningrad) extended these ideas in an interesting discussion on evolution in the Metazoa and Protozoa; in the former, there is a tendency to a decrease in the number of organs, in the latter an increase (polymerization). This is accomplished either by increasing their actual number (for example, the nuclei of opalinids), their duplication as in *Giardia* or their differentiation into two types as in the macro- and micro-nuclei of ciliates. A further extension of the process is by polyploidization with the emergence of new evolutionary forms.

The foregoing topics largely concerned the free-living Protozoa, although many of the conclusions can also be applied to the parasitic forms. The latter represent specialized subjects, progress on which has advanced since the preceding conference on predictable lines.

The subject of piroplasms was selected as representing an area where important gaps in knowledge exist, in the hope of stimulating fresh work, but unfortunately little major progress in relation to the life-history of these organisms or even on their taxonomic position has yet been effected.

It was obvious that a great deal of work is being done on the biochemistry of the Trypanosomatidae, and this is commencing to throw light on their phylogeny and classification. Guttman (New York) explained the different nutritional requirements in special media of *Leishmania*, *Leptomonas* and *Crithidia*.

Artificial immunization of animals against the malaria parasite (Margaret Weiss, Michigan) and the trypanosomes (Soltys, Cambridge) has at last been accomplished. In the former case, mice were actively immunized by the injection of a strain of *Plasmodium berghei* which had become non-invasive for mice. This strain had lost its infectivity for mice, though not for rats, following a number of sojourns in tissue culture in a medium containing hamster serum. An initial immunizing dose containing few parasites was followed 2 weeks later by a booster injection containing 1–2 million parasites of the same strain. The mice were afterwards challenged by the parent strain which kills control mice within 3 weeks. Immunity was slow to develop, and during an initial period extending for about 4 weeks after the booster injection the mice were particularly susceptible, and succumbed even faster than the controls to challenge infection with the virulent strain. But after this sensitive period good immunity developed which was solid in many cases; in others single parasites were seen, and in a few cases peak parasitaemias of 1–2 per cent red blood cells parasitized were observed. This degree of immunity persisted for about 4 months. Soltys showed that *Trypanosoma brucei*, inactivated by treatment with β-propiolactone, could be used as a living vaccine to protect mice against the homologous, virulent strain.

The recent discovery by Mme Landau (Paris) of a new species of rodent malaria parasite is likely greatly to facilitate malaria research, because *Plasmodium chabaudi* represents a model where an infection in a small laboratory mammal can be used with much greater ease and success than the well-known *P. berghei* in mice or *P. cynomolgi* or *P. knowlesi* in monkeys. The latter systems present many technical difficulties; on the contrary, the new species is easily transmitted by mosquitoes and enormous numbers of exoerythrocytic forms are produced. This work stems from the highly successful recent experiments of Yoeli[2] (New York) on the transmission of *P. berghei* and the discovery of its exoerythrocytic cycle in the liver of mice and hamsters.

Further knowledge of the ultrastructure of the Sporozoa was advanced by Scholtyseck's (Bonn) work on sporozoites of *Eimeria perferans*, Cheissin's (Leningrad) on *E. bovis*, Sheffield and Hammond's (Utah) also on *E. bovis*, Vivier's (Lille) on gregarines and coccidia, and Bardele's (Tübingen) on *Eucoccidium dinophili*.

A special topic of the first Conference was *Toxoplasma*; little new information has emerged in the past four years relating to the life-history of this organism until very recently when Hutchinson (Glasgow)[3] described the apparent transmission of *Toxoplasma* through the egg of *Toxocara catti*. He did not give a paper on this subject, but discussed the implications in the session dealing with the organism.

A newly discovered disease of man, due to the free-living amoeba, *Hartmanella castellanii*, was described by Culbertson (Indiana), who gave details of his experimental work with this organism in rabbits and mice, and showed slides of the organism as found in the tissues from 7 fatal human cases.

The role of *Pneumocystis carinii* as a pathogen of man becomes more formally established following papers by Kučera (Prague), Frenkel (Kansas) and Yaeger (New Orleans).

P. C. C. GARNHAM

[1] *Intern. Congr. Ser.*, No. 91 (Excerpta Medica Foundation, Herengracht 119–123, Amsterdam, C).

[2] Yoeli, M., *Trans. Roy. Soc. Trop. Med. Hyg.*, **59**, 255 (1965).

[3] Hutchinson, W. M., *Nature*, **206**, 961 (1965).