Meetings

Protozoology

While the study of Protozoa is far from new in scientific research, having started with Leuwenhock's pioneering efforts in microscopy during the 1670's and 1680's, the current surge of interest in Protozoa as research tools for solving basic biological problems is exciting. For the purpose of fostering this interest, a group of American protozoologists originated the Society of Protozoologists in 1949 as an international organization. Local meetings (in the United States) quickly became annual events for discussion and presentation of research on Protozoa and the first international conference on protozoology was held in Prague in 1961; the second was held at the Imperial College of Science and Technology in London, 29 July through 5 August 1965.

One area of investigation on Protozoa that has received much attention in recent years, ciliary and flagellar structure and function, was the subject of many papers presented at this conference. By applying hydrodynamic principles and analysis to the recorded movements of cilia and flagella, workers such as Holwill (England), Rikmenspoel (New York), and Machin (England) presented quantitative approaches to the efficiency of movement of unicells. Jahn (Los Angeles) presented evidence of a kind of flagellar apparatus, not previously analyzed, that may well serve as a contrasting model for analysis of flagellar function on hydrodynamic grounds; this flagellum on *Codonosiga* behaves as though its structure includes a surrounding sheath rather than the classical series of fibrillar mastigonemes. The French school of "protistologists" (Faure-Fremiet, de Puytorac, Hovasse, Sovoie, Noirot-Timothée, and others) presented many electron microscope studies on ciliate ultrastructure, and very importantly, considered the nature, morphogenesis, and mode of action of these ciliary structures rather than only their minute architecture. Several of the papers on ciliary and flagellar function centered on the analysis of coordinative processes; Child (Chicago) analyzed chronicity in ciliary movement and Dryl, Grebecki, and others (Poland) described the relation of ciliary activity to the surface potential of the cell. Satir (Chicago) presented evidence that a sliding-filament mechanism in the peripheral fibrils of cilia, rather than contraction of fibrils in localized radii around the central ciliary filaments, is the means of ciliary bending.

Mendeson and Warmouth (Boston) reported continuing efforts to condition *Paramecium* to sensory stimuli. With mechanical stimulation and with the presence or absence of light as the cue stimulus, animals avoided an area of mechanical stimulation when light intensity was low. This avoidance persisted for several minutes after removal of the mechanical stimulation. However, learning is probably not clearly demonstrated, since the avoidance was not dependent only upon change in the level of illumination. Also, on at least one occasion, a *Paramecium* in the test chamber, but not in the stimulation area, developed the avoidance response. Both the experimenters and the conference delegates concluded that we still do not know whether *Paramecium* can learn.

The role of Protozoa in the area of genetic research was pointed up by Sonneborn (Indiana), who also initiated discussions which probably will culminate in a worldwide organization of Protozoa geneticists or at least in direct exchange of information rather than the usual publication routes. It was emphasized by Sonneborn and demonstrated by the 20 or more papers on protozoan genetics presented at the conference that the Protozoa have a particular suitability for genetic research, and especially for research in cytoplasmic inheritance patterns. As an example, Preer (Philadelphia) in his discussion of *kappa* and its relatives, showed the role of *M* genes in the production of "metagons," which in turn prevent the destruction of *Mu* particles (the so-called mate-killer particles) in the *Paramecium* cytoplasm. The discreteness of metagons is now unquestionable since they (i) can demonstrably prevent loss of *Mu* in metagon-depleted paramecia (mate-killers treated with ribonuclease or bred for homozygous *m*); (ii) can be hybridized with DNA from *M*-bearing paramecia but less well with DNA from *m*-bearing paramecia; and (iii) can be introduced into ciliates of other genera (namely, *Didinium*) wherein the metagons become self-reproducing particles simulating RNA viruses. In the cytoplasm of *Paramecium*, the metagons are thought to be messenger RNA. In the same line of cytoplasmic-nuclear interaction in inheritance, Judin (Leningrad) found very little influence of cytoplasmic elements in control of the genetics of amoebas in his experiments with nuclear transplantation. Grell (Tübingen) reported observations on sexuality in *Foraminiferida*; he noted particularly autogamy of gamonts; gamonts were clearly distinguishable on the basis of their mating reactivities.

The phylogeny and evolution of Protozoa formed the basis of much of the research. Even though phylogenetic questions are basic to classification schemes in the Protozoa, the contribution of studies on protozoan ultrastructure, locomotion, and general physiology were emphasized in their essential role in considerations of protozoan evolution. Cheissin (Leningrad) pointedly reminded the conference that while ultrastructure as revealed by electron microscopy of protozoan organelles is important, the occurrence of common ultrastructural detail in various protozoans must not be considered *ipso facto* evidence of linear evolutionary sequence or of taxonomic status, since many such organelles have a common function throughout the plant and animal kingdoms. Thus their existence is evidence of common function surely, but not necessarily of evolutionary and taxonomic similarity. Jahn (Los Angeles) also reminded the conference that locomotion characteristics have traditionally been used as a major criterion in assessing taxonomic and evolutionary characteristics of Protozoa at all classification levels. Since locomotion is presumably determined by the

organelles revealed by the electron microscope, there may still be good justification for tying taxonomy fairly closely to ultrastructural features. In carrying these ideas further, Poljansky (Leningrad) discussed the tendency toward decrease in the number of organs in the evolution of Metazoa. By contrast, among Protozoa the evolutionary tendency seems to favor increase in the number of organelles—for example, multiple nuclei of the same (amoebas) or different (ciliates) types or duplication of kinetic apparatus as in several flagellates. Often the tendency is carried even further, in that some forms of Protozoa are polyploidized and new forms emerge precipitously as a consequence.

In the area of research on protozoan parasites, progress in explaining the differential nutritional requirements of the related flagellates, *Leishmania, Leptomonas,* and *Crithidia* was reported by Gutmann (New York). Efforts to achieve artificial immunization against humoral parasites are beginning to show success, according to reports by Weiss (Michigan) on malaria parasites and Soltys (Cambridge) on the trypanosomes. The immunization against malaria involved immunization of mice by a noninvasive strain of *Plasmodium berghei.* This particular strain is noninfective for mice, but does infect rats. It was developed by culturing the parasite in a tissue culture containing hamster serum. The administration of these forms to mice, followed by booster injections of parasites 2 weeks later, conferred immunity to the parent strain of *Plasmodium* which was still lethal to control mice. An initial, sensitive period (4 weeks following the booster injection) to the challenge dose was recorded during which the experimental mice appeared more sensitive than the controls. However, this sensitive period was followed by clear, and in some cases total, immunity lasting as long as 4 months.

Landau (Paris) reported work with a new species of rodent malaria parasite, *Plasmodium chabaudi,* which shows several behavioral characteristics which may prove to be of great value in laboratory work; specifically, it appears to be easier to transmit through mosquitoes than *P. berghei* from mice or *P. cynomolgi* and *P. knowlesi* from monkeys. Also, the new species produces greater numbers of exo-erythrocytic forms than any of the above species.

Further work on *Hartmanella castellanii,* the free-living amoeba that has been implicated in human infections, was reported by Culbertson (Indiana). He described successful efforts to infect rabbits and mice with the amoebas and to develop immunity against such infections in mice. Culbertson reported that of the seven human cases of apparent invasion of brain and other tissues with *H. castellanii,* reported to date, none have been confirmed by culture studies. Conversely, work reported by Kučera (Prague), Frenkel (Kansas), and Yeager (New Orleans) strengthened the conclusion that *Pneumocystis carinii* is truly a pathogen of man.

The conference itself passed three resolutions: (i) a request that the World Health Organization call a meeting for discussion of means for international cooperation in preservation of strains and types of Protozoa; (ii) support for establishing an abstracting service for protozoological literature; and (iii) acceptance of the invitation from the Russian delegation to hold the next international conference on protozoology in the U.S.S.R.

The papers presented at the conference were published in shortened versions as *Progress in Protozoology* (International Congress Series No. 91, Excerpta Medica Foundation, Herengracht 119-123, Amsterdam-C, Netherlands). This volume was given to each delegate as he registered; it replaces the usual reports of congresses which often do not appear for several years after the meeting has ended.

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Molecular Basis of Differentiation

The cross-fertilization between embryology on the one hand and genetics and biochemistry on the other is responsible for the new impetus which research in the field of differentiation is experiencing. However, progress in this area of research is often hampered by the lack of communication among specialists in different disciplines. In order to bring together in an informal way biologists working in diverse fields, a workshop on the Molecular Basis of Differentiation was held at the International Laboratory of Genetics and Biophysics, Naples, Italy (22–26 February 1965).

In order to encourage communication among the participants, it had been decided that no formal papers should be presented; instead, some of the participants were asked to introduce a subject for discussion. Each participant had to submit a list of questions which he wished to have brought up for discussion. The list of questions was circulated in advance. The principal question which loomed in the background was: What can we learn about the problem of development by applying the conceptual and methodological parameters of molecular biology?

The discussion was opened by C. H. Waddington, who focused attention on some of the problems for the solution of which the embryologist is in the greatest need of help from biochemists. The results of D. D. Brown (Baltimore) on the synthesis of the various species of RNA during oögenesis and development served as a basis for the discussion. Particular attention was paid to the role of the nucleolus in the control of synthesis of ribosomal RNA, a problem which has been illuminated by the work of Brown and Gurdon on the anucleolate mutants of *Xenopus,* and by S. Spiegelman (Urbana) with his work (with Ritossa) on *Drosophila* with genotypes carrying various doses of the nucleolar organizer.

One of the central problems of differentiation is that of regulatory mechanisms. At the molecular level, the question can be studied by investigating control of synthesis and repression of enzymes. The subject was introduced by A. B. Pardee (Princeton) and A. Kepes (Paris), who discussed bacterial systems. The question arose as to how far the results obtained on microorganisms can be extrapolated and applied to more complex cells and to higher organisms. This led to interesting discussions from the enzymological point of view by S. Kaufman (Bethesda), G. L. Cantoni (Bethesda), and E. Antonini (Rome). P. A. Marks (New York) and E. Scarano (Naples) then presented some of their data on erythroid cells and embryos, respectively. A mathematical model for the interpretation of regulatory mechanisms was discussed by B. Goodwin (Edinburgh).

H. Kroeger (Zürich) introduced the subject of control of chromosomal puffs by focusing on the role of ionic balance. E. Hadozn (Zürich) presented his findings on long-term cultures of imaginal discs of *Drosophila* in vivo. S.