suggesting that further investigation by genetical and cytological means may disclose specific affinities between certain chemical compounds and chromosome regions or even genes.

The broader evolutionary significance of mutagenesis was discussed by A. Gustafsson (Forest Research Institute of Sweden, Stockholm), who illustrated, with examples on barley, how new mutants produced artificially can be superior to the original type under different environmental conditions. W. L. Russell (Oak Ridge National Laboratory, Tenn.), by using an ingenious method of analysis, was able to present data obtained from about 85,000 mice, which show that the X-ray induced mutation-rate is at least fifteen times higher in this mammal than in *Drosophila*. Because of the great likelihood that man belongs more to the former than to the latter type in respect of radiation sensitivity, Russell's data add to the problem of radiation hazards in man a very serious emphasis, which was stressed by Prof. H. J. Muller.

The genetic composition of a population is known to be under the influence of various factors, such as mutation, selection, rate of reproduction, etc. A. Novick and L. Szilard (University of Chicago) have described the 'chemostat', which makes the study of these factors possible in bacteria. It is an apparatus in which the medium is automatically replaced so that the various growth-limiting factors may be added at a slower or higher rate than the reproduction of the bacteria. These workers illustrated with experimental observations the usefulness of the chemostat in genetical investigation, the results obtained being similar to those of K. C. Atwood (Columbia University) and co-workers employing the more conventional method of genetical analysis.

The Symposium devoted one session to the cytoplasmic constituents of heredity. P. L'Héritier (University of Paris) has proved that the sensitivity of *Drosophila* to carbon dioxide is due to a cytoplasmic factor, and closely resembles a virus-caused infection. He was able to show that by injecting extract from carbon dioxide-sensitive flies into resistant *Drosophila*, the latter 'acquired' carbon dioxide sensitivity. When the 'virus' or 'genoid' invades the germ-plasm, then the carbon dioxide sensitivity becomes a heritable property. L'Héritier favours the view that the 'genoids' have an internal origin. A more complex system of cytoplasmic inheritance was presented by B. Ephrussi (University of Paris) in yeast. He finds that the formation of large and small colonies, which differ also in the presence or absence of cytochrome-oxidase, is due to a nuclear gene, inducing an instability in the cytoplasm. The latter can be influenced or affected by environmental factors, such as the presence of trypoflavin in the medium, when the incidence of small-colony formation increases enormously.

A large part of the Symposium was taken up with the genetics of bacteria and bacterial viruses. J. Lederberg (University of Wisconsin) and co-workers gave a detailed review of bacterial genetics, derived from experiments with *E. coli*, line K.12. Lederberg pointed out the complex system of linkage relationships of known genetic loci in this bacterium. The inherent difficulties of bacterial heredity were further stressed by E. M. Witkin (Carnegie Institution), who analysed the method of segregation and recombination in multinucleate bacterial cells. The cytology of bacteria was presented by K. A. Bisset (University of Birmingham) and E. D. DeLamater (University of Pennsylvania). Their papers brought out the basic disagreements in the interpretation of the cytological phenomena, and further emphasized the difficulties of bacterial genetics.

The transformation of various morphological and serological types of pneumococci by deoxyribosenucleic acid extracted from particular mutants was reviewed by H. Ephrussi-Taylor (Institute of Genetics of the C.N.R.S., Paris), who presented new results suggesting that the 'old' genetic determinant is not only altered but is completely replaced by the 'transforming principle'. R. D. Hotchkiss (Rockefeller Institute of Medical Research) has induced penicillin-resistant pneumococci which have yielded another 'transforming principle' (deoxyribosenucleic acid), and was also able to show that by combining this with the morphological 'transforming deoxyribosenucleic acid' they 'segregate' independently. Another interesting case of transformation has been found by N. Zinder (University of Wisconsin) in *Salmonella*, in which a 'stimulating' substance must be liberated first, in order to produce the transforming factor itself. It is claimed that the latter is associated with the microsomes of the cytoplasm.

The various properties of bacterial viruses and their behaviour in heredity were described by S. E. Luria (University of Illinois) and A. O. Hershey (Carnegie Institution). It has been shown that genetical analysis is still the most powerful method by which not only the characteristics but also the organization of the bacteriophage itself may be studied. At the same time it has been possible to demonstrate in these 'simple' forms many of the features of a complex genetic system, such as exists in higher organisms. However, they also show other phenomena, such as 'phenotypic mixing', which at present remain unexplained.

The Cold Spring Harbor Symposium was an outstanding success since it brought together into a coherent and closely integrated system a great deal of new and fundamental information, obtained from studies on the most diverse organisms. It has emphasized two facts: first, genetics is making use of many new organisms and techniques and is thus at present extending its boundaries extremely rapidly and to great profit; and secondly, and consequent upon the specialization which is necessarily occurring, it becomes increasingly desirable to hold meetings such as this, at which the new fields may be integrated.

SECOND INTERNATIONAL CONGRESS ON ASTRONAUTICS

THE second International Congress on Astronautics was held in London during September 3–8. It was attended by nearly fifty delegates representing societies and groups interested in astronautics from Argentina, Austria, France, Germany, Great Britain, Italy, Spain, Sweden, Switzerland and the United States. The first International Congress, held in Paris in September 1950, was purely exploratory in nature and was intended as a series of informal meetings to discuss the possibility of setting up an international federation. As a result of the deliberations of the first two days of the recent Congress, an International Astronautical Federation was founded, "to promote and stimulate the achievement of space-flight". Dr. Eugen Sänger was elected president, and the two vice-presidents are Dr. G. Loeser, of the Gesellschaft für Weltraumforschung, and Andrew G.

Haley, of the American Rocket Society. The headquarters are to be in Switzerland, and the Swiss group (there is as yet no legally constituted society) will handle all international matters, such as the collection, classification and storage of an astronautical library and archives. It is envisaged that the Federation's main tasks will be in the exchange of information between member societies and the organization of technical congresses. The next congress will be held in Germany in 1952.

The latter part of the London Congress was devoted to a symposium of papers on the general theme of orbital vehicles, their construction and uses. There was general agreement among the speakers that such vehicles are possible from an engineering point of view; the first instrument-carrying vehicles could be built within ten to fifteen years; but man-carrying artificial satellites appear to be much further in the future. In all, seventeen papers were read dealing with the engineering problems of raising and constructing such vehicles, return to earth by high-speed glider, travel between artificial satellite orbits, radar tracking of vehicles from the earth, danger from meteors and other relevant topics.

Mr. T. Nonweiler dealt with the problem of descent from a satellite orbit by glider. The most difficult matter is the temperature reached during the descent. In general, the rate of heat transfer to a body moving at very high speeds cannot be accurately calculated. However, Mr. Nonweiler presented an approximate general solution which he has developed and which is applicable at Mach numbers of 10 or more if the Reynolds number is between about 10^5 and 10^8. A return glider would, in fact, be operating within these limits during the greater part of its flight time. The effects of the air slip at the wing surface have also been examined; this has led to an estimate of the maximum rate of heat transfer to the surface. A limit to the skin temperature is also imposed by the conduction of heat along the surface: this has also been calculated. It was shown that the wing surface temperature will be a minimum if a thin, double-wedge wing-section is used, with a position of maximum thickness well aft and with both its inner and outer surfaces acting as good radiators of heat; the temperature will be highest near the leading-edge of the wing under-surface, and its value will vary approximately as the fourth root of the wing loading. If a maximum skin temperature of 1,300° C. be allowable, then it should be possible, for example, to construct an all-wing delta planform aircraft with an all-up weight of 20-tonnes capable of accommodating a payload of 5 tonnes.

In a paper entitled "Meteor Hazards to Space Stations", M. W. Ovenden extended both his own earlier work[1] and that of Grimminger[2]. Grimminger considered a space station of about 100 sq. m. exposed area and calculated the probable times between collisions with sporadic meteors of various magnitudes. The astronomical factors affecting the validity of Grimminger's analysis were examined. The existence of iron meteors was shown to require a reduction in the collision times by a factor of about 2. Radar observations provide direct evidence for the relationship between the assumed number of meteors to their magnitude down to magnitude 7, but extrapolation beyond this limit is uncertain because processes exist which might disturb the distribution. One such process is the sun's radiation pressure, which would repel all meteors smaller than magnitude 30 out of the solar system. Another process affecting much larger meteors is the Poynting–Robertson effect. This may increase Grimminger's times by a factor of about 3, although a much greater possible increase cannot be ruled out. The danger from meteor showers is comparable with that from sporadic meteors. The greatest uncertainty in the estimates of collision times is due to the imperfect knowledge of the mass of a meteor of given magnitude. Error here may require, at worst, a decrease in collision times by a factor of 50. The use of a very thin 'meteor bumper' around a space station, which would explode any incident meteors, was suggested for space stations intended for use for a period of more than about a year.

The greatest problem of interplanetary flight is that of propulsion, and in his paper "Interplanetary Travel between Satellite Orbits", Prof. Lyman Spitzer discussed a method of applying nuclear energy. It was suggested that an electrically accelerated ion beam could be used for achieving a gas ejection velocity of 100 km./sec. without the use of very high temperatures in the propellant gases. Such a unit could not be built with a large enough thrust/weight ratio to allow it to take off from the surface of a planet. It would be capable of travelling from a close-orbital station about the earth to a similar orbit about any other planet. The mass flow of the working fluid in an ion rocket would be low, and hence interplanetary vessels of a very low mass ratio could be built.

In "Biological Problems of the Earth Satellite Vehicle", Médecin-General P. Bergeret discussed the conditions under which the human body would have to function in an artificial satellite. One of the major unknowns is the effect of zero g or 'free fall' conditions. This condition can be obtained for periods up to 10 sec. in high-speed jet aircraft. Artificial gravity may be necessary and this can be obtained by rotating the vehicle.

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[1] Ovenden, M. W., *J. Brit. Interplanet. Soc.*, **6**, No. 6, 157 (1947).
[2] Grimminger, G., *J. App. Phys.*, **19**, 947 (1948).

STRESS ANALYSIS

THE fifth annual conference of the Stress Analysis Group of the Institute of Physics was held during April 4–6 in the Mechanical Engineering Laboratory of the University of Liverpool. Papers were read on relaxation methods, fatigue, applications of electric resistance strain-gauge methods, brittle lacquer methods, a pneumatic strain-gauge, applications and problems of the 'frozen stress' method of photoelasticity, and hydraulic methods of applying test loads.

The opening lecture of the conference was given by Prof. D. G. Christopherson on "Numerical Methods in Stress Analysis with Special Reference to the Relaxation Method". He outlined the development of the application of numerical methods to stress analysis problems, emphasizing the different approach of the mathematician and the engineer. The mathematician faced with an insoluble differential equation or an unreasonably large number of simultaneous linear equations seeks for more rapid means of obtaining an approximate solution. The engineer, on the other hand, concerned in the first place with problems of complicated structural frameworks, rejects the traditional apparatus of analysis and seeks for help in processes in which experience, intuition and imagination about the probable