ince, antibodies against group A arboviruses were found mostly in bovine serums, whereas antibodies against group B arboviruses were found mostly in human serums. Two strains of group A arboviruses were isolated from *Culex pipiens* mosquitoes from one state farm in this region.

The geographic distribution of toxoplasmosis was noted by D. N. Zasukhin (Gamaleya Institute). This protozoan disease occurs not only in wildlife but also in farm animals, pets, and man. It has been found in the U.S.S.R. in various species of suslik, rat, mouse, vole, jird, hare, and shrew, and in the polecat, wildcat, and korsak.

Some papers dealt with the different zoonoses which occur in specific regions. G. M. Maruashvili (Virsaladze Institute of Medical Parasitology and Tropical Medicine, Tbilisi, Georgia) discussed the most important ones in Georgia, U.S.S.R. Among these are visceral and cutaneous leishmaniosis (to which the major part of his paper was devoted), tick-borne spirochetosis, toxoplasmosis, leptospirosis, trichinellosis, ornithosis, brucellosis, and Q fever.

P. C. C. Garnham (London School of Hygiene and Tropical Medicine) described six natural foci of human infection which succeed each other along the course of the Kuja River, which arises in the Kisii Highlands of Kenya and empties into Lake Victoria on the Tanganyika border. Man-made malaria, transmitted by *Anopheles gambiae* and *A. funestus*, occurs in the highlands. Rhodesian sleeping sickness, caused by *Trypanosoma rhodesiense* and transmitted by the savannah tsetse flies *Glossina swynnertoni* and *G. pallidipes* with a reservoir in the bushbuck, occurs in the game country of the Transmara at an altitude of 1800 meters. The Kuja river then drops through deep clefts and runs rapidly through the well wooded, hilly terrain of the Bassi and Riana regions. Here onchocercosis is transmitted by the blackfly *Simulium neavei*; the chimpanzee, now extinct in the area, was probably the original reservoir of this disease. Plague used to exist where the country flattens out below this region, but it disappeared spontaneously. From 1300 to 1100 meters, the Kuja flows slowly, and a narrow strip of vegetation on its banks provides a habitat for the riverine tsetse fly *Glossina palpalis*, which transmits Gambian sleeping sickness due to *Trypanosoma gambiense*, a disease which does not have a wildlife reservoir. At the mouth of the river and along the nearby lake shore, the snails *Biomphalaria pfeifferi* and *B. sudanica* breed. These are vectors of the blood fluke *Schistosoma mansoni*; its wildlife reservoir is the baboon, more than half of which are infected in this region.

Of the 147 registrants attending the symposium, 57 were from outside Czechoslovakia. They included 17 from the U.S.S.R., 8 each from Poland and Yugoslavia, 4 each from Great Britain and Austria, 3 each from Bulgaria and Hungary, 2 each from France, East Germany, and Rumania, and 1 each from Finland and the United States.

Mimeographed abstracts or full papers in English were sent to all participants ahead of time, and a few more were distributed at Prague. Simultaneous translations of all talks and discussions were provided in English, German, and Russian by means of individual transistor radios and earphones. The entire proceedings are to be printed in English and published as a book by Academic Press. Since the symposium provided a good picture of Russian and Eastern European research to date, its proceedings can serve as an invaluable source of information for western scientists and as a foundation for further research by all.

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Neutron Irradiations: Biological Effects

Because of their unique physical characteristics, neutrons form a special type of radiation hazard on the one hand and a potential tool for applied radiobiology on the other. Compared to x- and γ-irradiation there is less known about, or long-range experience with, neutron irradiation. A symposium to bring together existing knowledge on the biological effects of neutron irradiations was held at the Brookhaven National Laboratory, 7–11 October 1963. This was the first scientific symposium to be held in the United States under the sponsorship of the International Atomic Energy Agency (IAEA), a United Nations–affiliated organization with headquarters in Vienna, Austria. Approximately 150 scientists from 17 nations and four international organizations attended.

In addition to 50 research papers, the program featured an informal panel of eight scientists, moderated by H. H. Rossi (Columbia University). They discussed biophysical principles underlying experiments with neutrons. Survey papers were presented in three areas of general interest: (i) health and safety aspects of the use of neutrons (Y. I. Moskalev, Institute of Biophysics, Moscow), (ii) uses of neutron irradiation in agriculture and applied genetics (A. R. Gopal-Ayengar and M. S. Swaminathan, India), and (iii) the potential of thermal neutrons, fast neutrons, and other heavy particles in radiotherapy (J. F. Fowler, Hammersmith Hospital, London). An informal lecture on the international aspects of science was presented by Glenn T. Seaborg (chairman, U.S. Atomic Energy Commission).

High-energy protons are of interest in connection with the development of aerospace medicine because the Van Allen belt and protons from solar radiation constitute a hazard to man in space. P. Bonet-Maury and coworkers (Radium Institute, University of Paris) described results of experiments in which mice were exposed in the 157-Mev proton beam of the Orsay synchrocyclotron, in the 600-Mev proton beam of the CERN synchrocyclotron, and in the 950-Mev electron beam of the Orsay linear accelerator. The overall results of exposure to these beams indicated a biological effectiveness of the same order as that produced by x- or γ-rays and did not reveal any particular phenomenon that could be considered characteristic of these high energies. C. A. Tobias summarized observations made at the Donner Laboratory and the Lawrence Radiation Laboratory of the University of California on the effects of 730-Mev protons on mammalian systems. In proton-irradiated mice gastrointestinal death predominated, whereas after exposures to x-rays hematopoietic death predominated. It was suggested that the difference in cause of death may be the result of differences in tissue dose distribution. Experiments have been carried out on monkeys by the U.S. Air Force School of Aerospace Medicine in an effort to assess the likely hazards to man from protons during near- and deep-space penetration. Energies of 14-, 40-, 187-, and

730-Mev protons were used in doses ranging from 125 to 2000 rads. Loss of hair was the most constant symptom and no simple clinical signs could be used as reliable biodosimeters, particularly at the lower proton energies.

Neutron irradiation presents special problems in dosimetry. D. Hightower and H. M. Swartz (Walter Reed Army Institute) have developed a technique for measuring neutron penetration by tissue activation based on determining the amount of sodium-24 in tissue samples. It is expected that this technique will eventually permit a better experimental determination of depth dose. Russian investigators proposed a universal radiation dose unit, described a method of determining the contribution of cascade neutrons to the proton flux by using activation detectors, and also discussed Russian equipment for measuring the flux and tissue dose rate of intermediate-energy neutrons.

The pathological effects of neutron irradiation were considered under three main topics: acute effects, delayed effects, and possible applications in radiotherapy. Acute radiation mortality as a function of dose rate was explored over the exceptionally wide range of from 23 rads/min to 10^5 to 10^6 rads/min by E. J. Ainsworth and co-workers (U.S. Naval Radiological Defense Laboratory). They inferred from their results that, in terms of acute radiation responses to fission neutrons, radiation at high intensities was not significantly more or less injurious than at low dose rates. F. Hirose (Hiroshima University) found that 14.1-Mev acute neutron irradiation produced about 20 percent greater tissue damage than x-rays and that injuries in the hematopoietic bone marrow may play a significant role as a cause of acute death of mice from fast neutron irradiation.

The relation between aging and chromosome aberrations produced in mice by acute and chronic neutron and γ-irradiation was shown by H. J. Curtis (Brookhaven National Laboratory). The results strongly supported the concept that natural and radiation-induced aging are caused by spontaneous and radiation-induced chromosomal aberrations (mutations), respectively, in the somatic cells of animals. J. F. Fowler concluded the sessions on pathology by giving a comprehensive review of the use in radiotherapy of slow neutron capture, fast neutrons, and beams of protons, deuterons, alpha particles, and negative π mesons. Slow neutron capture therapy lacks promise

primarily because of the very poor depth doses. This may be overcome, at least in part, by surgically removing the bulk of the tumor before irradiation or by use of epithermal neutrons when these become available with sufficient flux. Fast neutron therapy combines the advantages of greater depth dose and lack of a reduced effect under anoxic conditions, which are characteristic of x- and γ-irradiation. Proton, deuteron, and alpha particle beams are not high LET (linear energy transfer) particles, except in the terminal fraction of a millimeter of their track, and hence do not give the oxygen advantage obtainable with fast neutron beams. Negative π meson beams are particularly promising for radiotherapy, because they combine an improved physical dose distribution with tissue interactions which give alpha particles of high LET (6 Mev, 50 kev/μ) so that they would yield nearly the maximum effect with anoxic tumor cells.

A major portion of the symposium was devoted to studies on cellular and genetic effects of neutron irradiation, particularly with reference to their relative biological effectiveness compared to x- and γ-irradiation. J. J. Broerse and G. W. Barendsen (Netherlands) reported on the damage to reproductive capacity of cultures of human kidney cells when irradiated with monoenergetic neutrons. Within the energy range of from 3 to 15 Mev there was a shift from an exponential to an accumulative survival curve, indicating a shift from predominantly "1-hit" events to a "multiple-event" dose response. Most of the papers in this symposium, and in the literature in general, report values of relative biological effectiveness of below 10 for fission spectrum neutron versus x- or γ-ray effects. These are based mostly on mortality or certain pathological symptoms.

Three of the papers reported higher values of relative biological effectiveness; each was based on more specific genetic criteria. T. Fujii (National Institute of Genetics, Japan) found that 14-Mev neutrons were about 13 times more effective than γ-rays in producing chlorina mutants in wheat. A. G. Searle and R. J. S. Philips (Harwell) observed that with specific locus (point) mutations in mice the relative biological effectiveness of fast neutrons versus γ-rays at low intensity is about 26, and possibly as high as 50. H. H. Smith and his co-workers (Brookhaven National Laboratory) re-

ported an average relative biological effectiveness of about 70 for loss of a specific chromosome arm in maize due to irradiation with monoenergetic neutrons (0.43 to 1.80 Mev) compared with 250 kvp x-rays. It appears that more studies on relative biological effectiveness based on subtle intracellular events may be needed, particularly with reference to establishing minimum permissible doses of neutron irradiation for man.

In discussing the use of neutron irradiation in agriculture and applied genetics, A. R. Gopal-Ayengar and M. S. Swaminathan concluded that neutrons have an important place in the array of mutagens available by virtue of the relative insensitivity to modification of biological responses they produce, the absence of secondary physiological effects associated with their action, and their high relative biological effectiveness values for induction of chromosome aberrations and mutations.

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Forthcoming Events

April

1. **Thermoplastic Materials**, conf., Soc. of Plastics Engineers, Akron, Ohio. (W. H. Nicol, RETEC, Goodyear Tire and Rubber Co., Akron 16)

1–2. **Engineering Aspects of Magnetohydrodynamics**, symp., Cambridge, Mass. (G. S. Janes, Avco Everett Research Laboratories, Everett 49, Mass.)

1–2. Methods for Measurement of **Weak Beta-Emitters**, Karlsruhe-Leopoldshaven, Germany. (Gesellschaft Deutscher Chimiker, Gesellschaftsstelle, Postfach 9075, Frankfurt/Main, Germany)

1–3. **Structures and Materials**, American Inst. of Aeronautics and Astronautics, 5th annual conf., Palm Springs, Calif. (R. R. Dexter, AIAA, 2 E. 64 St., New York.

1–3. **Optical** Soc. of America, spring meeting, Washington, D.C. (M. E. Warga, OSA, 1155 16th St., NW, Washington, D.C. 20036)

1–4. National Soc. for **Programmed Instruction**, annual, San Antonio, Tex. (NSPI Program Committee, Trinity Univ., 715 Stadium Dr., San Antonio, Tex.)

1–5. Latin **Oto-Rhino-Laryngology** Soc., 15th congr., Bologna, Italy. (G. Motta, Via Modica 6, Milan, Italy)

2–3. American Soc. of **Civil Engineers**, Engineering Mechanics Div., spring conf., Boston, Mass. (ASCE, 33 W. 39 St., New York 18)

2–3. Alexander Graham Bell Assoc. for the **Deaf**, southeastern meeting, New Orleans, La. (R. Tegeder, Utah School for the Deaf, 846 20th St., Ogden)