available to the participants, by a prodigious effort of organization, some 3 weeks prior to the meeting. The full proceedings will be published by l'Institut Textile in 1966.

The 1970 conference will be held in the United States; an organizing committee under the chairmanship of Harold Lundgren (Western Regional Research Laboratory, U.S. Department of Agriculture) has undertaken its planning.

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Radiation and Terrestrial Ecosystems

The development of tracer studies by which normal processes in ecosystems can be investigated and the effects on ecosystems caused by ionizing radiation have been major problem areas in the field of radiation ecology. In order to discuss these subjects a symposium on radiation and terrestrial ecosystems was held at Richland, Washington, 3–5 May 1965. The symposium was the fourth in the series of Hanford Biology Symposiums. Over 200 persons from nine countries attended.

In the opening address E. P. Odum (University of Georgia) expressed the hope that radiation ecology will continue to be interdisciplinary and derive impetus from the many related fundamental and applied fields on which it verges. Descriptive phases of work have largely been completed, and the clarification of fundamental processes in ecology is the problem facing researchers.

The status of environmental radiation and radioactivity was reviewed with respect to man-made radionuclides in fallout as well as radionuclides from natural terrestrial and cosmic sources. Carbon-14 and tritium have been used, and with the development of more sensitive detection instruments other cosmic-induced radionuclides are being detected and should play a larger role as tracers in identifying mechanisms of cycling in ecosystems. Fourteen radionuclides were considered in the light of their origin, concentration, and entrance into biological systems. The extensive literature on fallout and terrestrial nuclides was apparent in reviews of these fields and the summary of this literature was helpful in giving perspective to man-made, as contrasted with naturally occurring, radioactive sources.

Mechanisms by which radionuclides enter into the plant portion of a food cycle were reviewed. Direct deposition is currently the major way in which fallout materials contaminate plants and will continue to be so until the rate of fallout is substantially reduced below that existing at this time. Deposition is largely as particulate material under 40 microns in diameter. Knowledge of the extent to which particulate deposits are retained on different plant surfaces is meager. Much of our present information is based on tests involving application of dissolved nuclides and the special circumstances surrounding bomb testing.

Ion retention on the exchange complex and factors which affect this retention are important in the movement of radioactive materials from soil into plants. Extensive work on soil-plant relationships provided data by which concentration factors for essentially all elements were presented. From the magnitude of these concentration factors, it appeared that plants are in general excluding ions rather than preferentially absorbing them.

S. A. Cain, (Assistant Secretary, designate, for Fish and Wildlife) described the current status and projected objectives being proposed under the International Biological Program. It was also of immense interest to us all to learn more about the problems which the United States faces in preserving intact natural areas in the face of the ever mounting pressure to "utilize" such areas to the fullest.

Reports were presented on cycling and redistribution of radionuclides. Fallout materials, naturally occurring radionuclides, and ecosystems to which tracers had been added were all reported on. Systems ranged from forest and forest understory to desert and arctic, and from observations of entirely natural systems to agricultural and laboratory studies.

Research on cycling through plant and animal communities has been carried out. However, there are few data on how microorganisms convert fallen organic matter, and radionuclides associated with it, into a form by which these nuclides may be recycled, fixed to soil, or consumed with the microorganisms.

Levels of cesium-137 in Lapps continue to parallel closely those levels in Eskimos. High human burdens are related to the ^{137}Cs concentration in reindeer and caribou, and these in turn to the consumption of lichens by these animals. It was interesting to note that lichens sampled in Georgia contained appreciably more ^{137}Cs than found in Arctic lichens. The southern lichens do not, however, enter significantly into a food chain. These higher levels only reflect changes in fallout as a function of latitude and climate.

The importance of the individuality of each ecological system was emphasized by a comparison of ^{137}Cs concentrations in Colorado deer and Alaska caribou. Burdens in deer rose during the summer months as the deer moved to higher elevations where rainfall and fallout deposition were higher. In caribou, the peak occurred during winter months because of a higher consumption of lichens when other plants were not available.

Although substantial amounts of alpha emitters were shown to be taken into crop plants of Brazil and India, no estimate was made of the relative importance of this uptake compared with the external radiation doses to which humans are exposed. This external radiation was reported to give doses of nearly 10 roentgens per year; this amount appears to be more in one year than can reasonably be projected as a 30-year dose to Eskimos and Lapps from the ^{137}Cs to which they will be exposed.

A panel discussion of approaches to a study of radiological hazards in the environment brought together the experiences derived from environmental monitoring in the vicinity of a nuclear industry, in a region of bomb testing, in an area planned to test peaceful uses of atomic bombs, and in the worldwide area where fallout is deposited. The opinion was given that the term "hazard" is a misnomer because none exists relative to the essentially trace levels of nuclides which now exist in our environment. Special interest was expressed in the problem of nuclear excavation of a sea-level canal and the kind of early studies which will assure adequate evaluation of potential effects to the ecosystems and to man.

One question of special pertinence to the problem of radiation in the environment was raised during the panel discussion. If nuclear release is predicted as potentially annihilating an animal population, but with no implications to man, would this be adequate basis for precluding the use of nuclear devices for a construction project? No answer was provided but it does illustrate the kind of problem which must be faced in relating man with the environment.

Of particular interest to people studying population dynamics of animals was a report showing that calcium-45 implanted in an adult female can be identified in her offspring up to a year later. This technique will overcome many of the problems inherent in such studies and permit collection of results unbiased by trapping, marking, or other techniques currently in use. Other papers described the use of operations research techniques, identification of root distribution, and prediction of decay characteristics of neutron-activated soil.

Rodents and lizards are subjects often used in testing effects of radiation on animal populations. One project which was initiated as a study of radiation effects on mice became a study of effects on predators after these same predators had consumed the mice of the initial project. Results of this modified experiment tended to show that radiation damage to wild species is quite comparable with that of domesticated animals of comparable body size. Attention was drawn to the need for special dosimeters to evaluate absorbed dose and to the difficulties of interpreting results of field exposure to radiation. Irradiated lizards showed a substantially different growth pattern as compared to the pattern observed in control areas. However, it could not be conclusively shown that the change was not due to changes in the environment independent of the radiation. Acute exposure to doses of 450 roentgens was shown to cause a significant decline in lizard natality the year following irradiation.

An intense interest exists in how radiation affects trees. This interest derives from the initial observation at Brookhaven that conifers are affected by relatively small doses of radiation. In some studies a stimulation of growth, germination of seeds, or other specific responses was observed with low radiation doses. Lethal doses vary with species, but for x-rays or gamma rays doses of about 5 kilorads were required. With fast neutrons, however, doses as low as 250 rads produced observable effects on growth and viability of needles. Moisture stress was shown to significantly increase the damage to trees from exposure to radiation. Whether this effect is in any way related to the well-known relationship of moisture in seeds and radiation sensitivity was not indicated. Recovery from large doses of radiation occurs largely by new sprouts arising from subsoil and stem areas of trees. Rate of growth of such sprouts was proportional to the radiation exposure.

Two papers presented results which superficially appear to be widely opposing. In one, effects of background radiation dose rates of 0.5 mr/hour were observed in the highly sensitive plant *Tradescantia* when other environmental features were adequately controlled. In the other, doses of 4 to 6 kr appeared to be of less consequence to die-back in desert shrubs than the intense dust deposited on the foliage.

The symposium was sponsored by the U.S. Atomic Energy Commission and the Battelle Memorial Institute, Pacific Northwest Laboratory.

The proceedings will be published as the December 1965 issue of *Health Physics*. It will also be available in bound form from Pergamon Press.

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The Education of Professional Physicists

An international conference on the Education of Professional Physicists was held in London 15–21 July 1965. This gathering was the third in a sequence initiated by the Commission on Education of the International Union of Pure and Applied Physics. The Institute of Physics and the Physical Society arranged the conference, which met at the Imperial College of Science and Technology.

The aim of the conference was to illuminate problems arising in the education of physicists who will pursue careers in pure or applied research. The discussions were organized under the headings: the needs of industry; mathematics for physicists; technical universities; the purpose of practical work; first-degree courses; graduate or postgraduate training; films; and relations between government or industrial research establishments and universities. Papers on these topics were presented by speakers from the United Kingdom, France, the Soviet Union, the Netherlands, the United States, Belgium, South Africa, and Poland. Seventeen other countries were represented. Most of the approximately 90 participants were drawn from universities, but several distinguished industrial scientists attended and played a significant role in both the scheduled program and the discussions.

Was it accident that brought together the site and the theme of this meeting? For a display of crosscurrents in British educational thought was an unannounced but dominant feature of the affair. The "brain-drain" is only the most visible symptom of troubled waters. A number of traditional attitudes and practices, the growing abstractness of physical concepts, and the needs of present-day industry all cross each other at deeper levels. A long-standing aloofness between academics and industrialists has led to charges that sometimes take extreme form. On the one hand, a doctoral degree has been held to be valueless to an industrial physicist, being merely an award for time spent on a confining, irrelevant detail. The countercharge is that the uses to which industry puts young physicists disregard not only their education but also the personal characteristics that led them to study physics. Within the universities there is self-criticism of the traditional gap between theoretical and experimental studies. The opening of new universities and the conversion of erstwhile technological colleges into universities are regarded as an opportunity to develop broader educational patterns. This dialogue among the hosts was lively and provided most of the spice of the meeting.

A canonically correct amount of time was given to instructional laboratory courses, but the central problem for at least one participant, that is, the amount of time a student *should* spend in the laboratory, was not mentioned by any speaker. Perhaps there is no generally acceptable answer, but the problem is worth discussing at an international meeting, if only to offer perspective to countries endeavoring to finance physics curricula. Who among us can give a closely reasoned quantitative justification of his department's laboratory requirements?

A United States representative participating for the first time at one of these meetings was struck more than he had anticipated by the comparative diversity in our higher education. Thus, it appears possible for a speaker from almost any other country to characterize his nation's physics curricula fairly accurately and in a reasonably brief time; the audience knows the