Limnologists and Oceanographers Discuss Lakes, Rivers, and Aquatic Life

Because of the ever-growing importance of pure water supplies, the need for foods from aquatic sources, and concern about the effects of pollution and radioactive fallout on water resources, limnology and oceanography are becoming increasingly important sciences. Recent advances in both fields were discussed by over 600 limnologists, oceanographers, and other scientists, from the United States and 33 foreign nations, at the 15th International Congress of Limnology, held from 20 to 25 August at the University of Wisconsin. The great lakes of the world, the behavior of aquatic animals, aquatic plants, and other related topics were covered. Visitors from abroad were made aware not only of the extensive number of lakes on this continent but also of the unity of limnology and oceanography, a feature of aquatic science which has been strongly developed here, where lakes have actually been used as experimental models for testing oceanographic problems.

Six parallel sessions and three plenary sessions were held, and 165 papers were presented. The great lakes of the world were discussed in one plenary session; extensive studies of these great freshwater inland oceans should result from the discussions. Because the Russian representatives did not attend, coverage unfortunately did not extend to the great lakes of Eurasia.

D. Chandler (U.S.A.) reviewed the glacial origin of the Great Lakes of the St. Lawrence drainage basin (246,000 square kilometers), their limnological features, and their growing interest to research workers both in the United States and in Canada. A 12-year study of water-intake temperatures of Lake Michigan (C. H. Mortimer, Great Britain) disclosed large fluctuations in thermocline depth, initiated and largely controlled by wind but also propagated as internal waves counterclockwise around the basin.

Of more recent glacial origin, the Canadian lakes Athabasca, Great Bear, Great Slave (with an area of 25,300 square kilometers and a depth of 614 meters), and Winnipeg share, despite differences in latitude, a continental climate (P. Larkin, Canada). The first two have small drainage areas, low mineral content, and low productivity; the others have large drainage areas and thus surprisingly high productivity.

Wurtz (France) reported on a Uganda Government expedition to Lake Rudolf, in the desert, where the enormous production of fish (300 kilograms per hectare per year) cannot be exploited because of a lack of roads, equipment, and processing facilities.

Beauchamp (Great Britain) emphasized three features which distinguish the Great Rift Valley lakes of Africa from most other lakes: their extreme thermal stability, their meager water supply, and the variety of endemic species. In Lake Tanganyika decomposition occurs at depths below 200 meters, under conditions of perpetual anoxia. More water is received directly from rain than from inflow. Despite the obvious difficulties, plans are being made to develop these potentially productive lakes for commercial fishing.

A. C. Redfield (U.S.A.) discussed the peculiar hydrography of Lake Maracaibo, Venezuela, and presented a mathematical model for the prediction of long-term salinity changes. D. Harding (Southern Rhodesia) outlined the changes—some rapid—in the limnological features of Lake Kariba (the largest of all man-made lakes) that have taken place since filling began in 1958. These changes include thermal overturns, deoxygenation of water, changing habitats for the fish population, and the appearance of free-floating aquatic plants (*Salvinia auriculata*, a fern) which cover more than 580 square kilometers.

In a session on lake history, G. E. Hutchinson (U.S.A.) reviewed an analysis of fossil material from the bed of Lake Monterosi, Italy. The analysis had disclosed that the lake had changed abruptly in about the 3rd century B.C. (after some 20,000 years of little change) from a deep, slightly acidic, soft-water lake to a shallower, somewhat overfertilized hard-water lake. The change is attributed to the construction of the Via Cassia, a famous Roman road. New geochemical information on lakes and rivers, much of it as yet unpublished, suggests that the rates of gain and loss of sodium by the earth's water bodies have been almost equal during the greater part of geological time (D. A. Livingstone, U.S.A.).

The behavior of aquatic animals was discussed in several sessions. Endocrine factors relating to modifications of physiological and migratory behavior in salmon were reviewed by M. Fontaine (France).

C. O. Berg (U.S.A.) reported on his discovery that the larvae of a fly of the family Sciomyzidae attack, kill, and feed on aquatic snails. He reared 100 species, all snail killers, from North and Central America, Europe, and Australia.

In 400 hatches of mayflies, waves of emergence occurred at intervals of 6 to 11 days over a 5-year period on the upper Mississippi River. The fact that the waves tended to occur almost simultaneously over a 440-mile expanse of the river raises a question about the causative factors that would operate so widely (C. R. Fremling, U.S.A.).

Ilppo Kangas (Finland) showed that there are significant local differences in the horizontal distribution of zooplankton, and that some of these differences in distribution are the result of species differences. He also reported that the principal cause of *Uferflucht*, or swarming away from shore, is the repellent effect of shallow water.

In the area of biological productivity, I. Findenegg (Austria) found that, of 14 alpine lakes, the well-nourished (eutrophic) ones as a rule showed high carbon dioxide assimilation to a depth of 1 to 2 meters; below this a sharp decline occurred, corresponding to the decrease in the penetration of light. In poorly nourished (oligotrophic) lakes, however, there was low correlation between the curve of assimilation and light penetration, and the rate of carbon uptake was almost the same from the surface to a depth of 5 to 8 meters.

It has been found that a large proportion of the carbon-14 fixed by algae appears in the filtrate. This extracellular product of photosynthesis appears to consist largely of glycolic acid which has been found to be present normally in lake waters in concentrations up to

1 milligram per liter (G. E. Fogg, Great Britain). This is perhaps an equilibrium concentration, since the substance is reabsorbed by algae, under certain conditions, and by other organisms.

The activity of aquatic bacteria in natural waters was simulated in a steady-state continuous-flow system (H. W. Jannasch, Germany). Nutrients that limit growth were determined by increasing the growth rate of the organism in the chemostat until washout of the population occurred. The resulting maximum growth rate in the presence of the highest effective concentration of the nutrient being investigated was used for assaying the rates of decomposition under close approximation of natural conditions.

Oligotrophic lakes have a lower ratio of primary production to total biomass and a higher diversity of species at different trophic levels than eutrophic lakes (R. Margalef, Spain). Thus, they have to be considered more mature and more organized ecosystems than eutrophic lakes. (Eutrophy is mainly a consequence of external disturbance.)

Midge larvae (*Chironomus anthracinus*) grew very little during the summer in the anoxic bottom mud of Esrom Lake, Denmark, but their growth increased 600 percent in October, after the fall overturn (P. M. Jonasson, Denmark).

During the last 25 to 30 years the production of organic material in Lake Constance (central Europe) increased 20-fold because of domestic effluent, which boosted the growth of plankton; in turn, the white-fish population increased (W. Nümann, Germany). In 2 years the fish reached the length they normally reach in 4, and at the same time they showed 30 percent increase in weight. Catches increased almost 600 percent between 1910 and 1960 and another 50 percent in 1961.

In efforts made in recent months to eliminate the increasing pollution of the Oslo Fjord, the newly developed Elkem electrolytic sewage purification process was used. This removes sludge and appreciable amounts of phosphorus and nitrogen compounds from raw sewage and then sterilizes the effluent (E. Føyn, Norway).

A special session was devoted to discussion of the Amazon River, which is chemically rich but of low *p*H (H. Sioli, Germany). Unlike hard waters in other regions of the world, Amazon waters derive their main ions from alkali silicates (W. Ohle, Germany). Great seasonal differences in precipitation cause horizontal displacement of the Amazon's 200-kilometer mixing zone in the ocean (H. Schwassmann, U.S.A.). A mean discharge of 1850 cubic meters per second has been determined for the Rio Guamá, Brazil.

Whereas plant and animal communities on land vary greatly in number between tropic and temperate zones, some aquatic communities in tropical streams are very similar in number to aquatic communities in streams in the temperate United States (R. Patrick, U.S.A.).

J. W. G. Lund (Great Britain) delivered the traditional Baldi lecture. His theme was the ecology of plankton algae.

In a light moment the British representatives were chided for not having submitted a paper on the Loch Ness monster. Two British research expeditions, using the latest electronic detection devices, searched during the summer for this mythical creature. Certainly, had it been found, the congress should have been treated to plesiosaur steak.

During the week preceding the congress most of the 200 overseas visitors, representing 33 nations, participated in excursions to the alpine lakes of Colorado. In addition, five different tours were held after the congress: to the Ontario Lake District, the Great Lakes, the Finger Lakes, the Mississippi River, and the Ohio River Valley. Local tours to the lake district of northern Wisconsin and to Milwaukee and Lake Michigan, where Great Lakes research vessels were berthed, were held during a midweek recess.

Major financial sponsors of the congress were National Science Foundation, National Institutes of Health, Office of Naval Research, Atomic Energy Commission, and International Union of Biological Sciences.

Overseas visitors were assisted in two ways: 98 Europeans were awarded seats on a chartered airplane by an international selection committee. More than 50 other foreign limnologists received travel aid through symposiums and lecture honoraria from North American institutions. Each registrant received, with the program, a book of abstracts. The proceedings will be published in full in volume 15 of *Verhandlungen der Internationalen Vereinigung für Limnologie.*

The congress was organized under the aegis of the American Society of Limnology and Oceanography (ASLO) and the National Academy of Sciences–National Research Council on behalf of

the International Association of Limnology. J. C. Wright, limnologist at Montana State College, was granted leave for a year prior to the congress to serve as executive secretary, in Madison. The executive committee consisted of A. D. Hasler (chairman), D. G. Frey, K. D. Carlander, G. H. Lauff (treasurer), J. C. Wright (executive secretary), T. T. Macan (secretary ex officio), W. E. Ricker, and the late D. S. Rawson.

The committee acknowledges the assistance of many students and employees of the University of Wisconsin and of ASLO members who organized and conducted the excursions.

The United Nations was asked by the International Association of Limnology to set aside specified lakes, rivers, and ponds throughout the world for preservation and scientific study.

G. E. Hutchinson (Yale University) was elected president, to serve from 1962 to 1965; he is the first American to hold this post. It was resolved that the next congress will be held in Poland in August 1965.

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The Teaching of Science

The problems involved in the teaching of science are both international in scope and interdisciplinary in character. There is at present no international body whose primary function it is to discuss educational problems on such a broad and comprehensive basis. Recognizing the need for such a forum, the International Council of Scientific Unions (ICSU) convened representatives from its various scientific unions to consider the advisability of setting up an interunion commission on the teaching of science. This meeting was held in Paris early in May 1962. The following scientific unions were represented: the International Union of Biology, represented by P. Chouard (France); the International Union of Pure and Applied Chemistry, by E. L. Piret (U.S.); the International Union of Geography, by P. Pellissier (France); the International Union of Geology, by T. N. George (Great Britain); the International Union of the History and Philosophy of Science, by R. Taton (France); the International Union of Mathematics, by M. H. Stone (U.S.); and the International Union of Pure and Applied Physics, by S. C. Brown (U.S.).

The plan of constituting an interunion commission on the teaching of science was heartily endorsed, and M. H. Stone, of the University of Chicago, was elected president of the commission. P. Fleury, of the Institut d'Optique, Paris, agreed to fill the important post of secretary. The Interunion Commission on the Teaching of Science then focused its attention on a number of specific areas for action and planning.

The commission decided to enlist the aid of national correspondents in as many countries as possible. These correspondents would be asked to furnish information on the teaching of science in their respective countries and, in particular, to keep the commission informed on new experiments in education which would be of interest in the teaching of science. In return, the commission would undertake to keep the national correspondents informed as to the material the commission received and would ask the correspondents to be responsible for diffusing this information within their own countries insofar as this would be useful and practical.

The hope was expressed that the commission would be able to set up close liaison with official international organizations which are already active in the field of science education, or which plan to be active in the future. To explore this idea the commission met with Albert Baez, chief of the Division of Science Teaching of the Department of Exact and Natural Sciences, UNESCO, and with Ganeff and Trautmann of the Organization for Economic Co-operation and Development and found them all enthusiastic about such a liaison. The Interunion Commission hopes to formalize a liaison with each of these organizations and to establish similar arrangements with other international bodies.

Members of the commission felt that it was the particular responsibility of an interdisciplinary body to call attention to the role of science in general education and, in particular, to the role of the history and philosophy of science underlying all of the various individual disciplines.

In the interest of interdisciplinary science teaching it seemed important to stimulate the writing of books in borderline fields where essentially no interdisciplinary material now exists. Interdisciplinary sequences—such as