have established programs of their own. A typical example is the group of investigators working in respiratory physiology who, at the previous congress in Leiden, held an excursion and dinner in honor of Wallace Fenn. A similar program was developed in Tokyo where the VA/Q Club of Japan arranged a tour to Mt. Fuji and Hakone on 5 September.

An important by-product of the congress meetings was the opportunity for the various groups in Japanese schools to have the privilege of visits and lectures from the many scientists attending the meetings. Many of the participants visited the medical schools in Tokyo, Osaka, Kyoto, and in other cities.

The congress was held under the auspices of the International Union of Physiological Sciences. The lectures and symposia are available in a monograph published by the Excerpta Medica Foundation as International Congress Series No. 87.

HYMEN S. MAYERSON
The Touro Infirmary,
New Orleans, Louisiana

Great Lakes Research

The Great Lakes contain about 30 percent of the world's fresh water, and their basin is estimated to be capable of supporting about 3 billion people. However, much of the water in the lakes is not referred to as fresh, and we are experiencing difficulties in supporting 1/100 as many people. The 9th conference on Great Lakes Research was held at IIT Research Institute in Chicago, 28–30 March 1966. Over 400 persons attended to listen to 120 papers and panel discussions. The topics included water budget and quality, biology, physical limnology, air-water interactions, marine geophysics, geology, and inorganic materials, as well as some economic and legal aspects.

Introductory remarks by B. M. McCormac (IIT Research Institute) emphasized that in planning this conference he concluded that, (i) no single U.S. government agency was responsible for the total Great Lakes problem; (ii) there is poor management of water, but no water shortage; (iii) current pollution control steps are based on very fragmentary information; (iv) the failure of industrial organizations to present papers at the conference was due to fear that the data might be used

against them; (v) there is insufficient multidisciplinary research; and (vi) that although it seems likely that municipalities will eventually be forbidden to inject any sewage effluent into the lakes, the issue is not being faced directly.

The welcoming address was delivered by T. F. Bates (science adviser and assistant to the Secretary of the Interior). When the Federal Water Pollution Control Administration is transferred to the Department of Interior on 1 May 1966, Interior will have a vast responsibility in the Great Lakes. Bates believes that this transfer will improve the U.S. government's role in the support of Great Lakes research. The Cabinet and the White House are going to give more attention to the Great Lakes. The emphasis will reflect the transportation, recreation, municipal, and industrial needs. Much more scientific limnological data must be generated and intelligibly communicated before an effective lake management program can be expected.

A number of papers and discussions were devoted to water quality and budget. Although great interest was shown in T. W. Kieran's (Gibb, Underwood, and McLellan, Sudbury) grand canal scheme for recycling Canadian waters for both Canadian and U.S. use, it was generally believed that there is not a water shortage, but very poor water management. Bates suggested that if there is a water shortage, weather modification might prove more feasible than mass maneuver of North American water flow. It is difficult to study the water budget properly because evaporation has never been adequately measured. It was pointed out by C. R. Ownbey (Federal Water Pollution Administration) that water standards must be precisely specified. Different parts of the lakes will have different standards. These standards are very difficult to establish because of a lack of information about many of the pollutants.

The papers on physical limnology emphasized mass movements of water, temperature distribution, and dissolved oxygen content. As attempts are being made to obtain synoptic data, experimenters are being faced with a large data collection and processing task. Most of these studies were undertaken to investigate the health of the lakes. Dissolved oxygen content provides a good measure of water quality. The dissolved oxygen is in turn dependent upon temperature distribu-

tions and the motion of water masses. The dispersal of effluent by lake currents and eddies has been investigated by G. T. Csanady (University of Waterloo). Although one is interested in probability distributions, only some mean-value data exists. Preliminary results indicate that horizontal diffusion is related to the complex current system and vertical diffusion to eddies. J. L. Verber (Federal Water Pollution Administration) has made extensive current measurements in the lakes which show that complex inertial currents are found in all the lakes at all depths, and at all times of the year.

Several papers covering the whole field of biology from microorganisms to fish were presented. The dominant species are constantly changing. Many parts of the lakes and the contiguous stream and river systems are extremely hazardous because of contamination with the intestinal disease-producing bacteria, salmonella, according to L. E. Scarce (Federal Water Pollution Administration). It is hazardous to swim, fish, or even get the water spray in the face. Tests show that many types of salmonella are not completely removed by the treatment plants of the Chicago Sanitary District. The inland waters of the Chicago area are especially contaminated, as are parts of southern Lake Michigan from time to time.

Many experimenters have been examining benthic mud samples. The dominant species vary with time. Especially in Lakes Michigan and Erie, the present dominant forms of midge larvae are indicative of pollution. N. W. Britt (Ohio State University) showed that 15 years ago the dominant benthic organism in western Lake Erie was the Mayfly, *Hexagenia*. Many of us remembered how they would collect knee-deep around the base of street lamps near the lake. The Mayfly has almost disappeared to be replaced by the *Chironomidae*, which is now declining in favor of the *Tubificidae*.

An excellent panel on eutrophication was monitored by A. D. Hasler (University of Wisconsin). Eutrophication tends to be used to mean productivity and is a general indicator of the pollution of a lake. The indices of eutrophication were discussed by A. M. Beeton (University of Wisconsin). Not enough indicators of the ecological state of the lakes are being monitored. More research is needed to select the proper indicators. There is also some confusion about the trends of those indices that have been measured, such as ni-

trates and phosphates. It is apparently difficult to compare data because of variations in experimental techniques and uncertainty as to whether a specific phosphorus compound or total phosphorus was measured.

G. L. Harlow (Federal Water Pollution Administration) discussed the sources of nutrients. At certain times of the year, phosphate measurements can be significantly biased by runoff from farmland; however, the major source of nutrients is from sewage effluent. Nutrients in Lakes Erie, Michigan, and Ontario are showing significant increases. These results are compatible with the measurements of the distribution of biological species as reported by C. F. Powers (University of Michigan). The dominant species reflect the increased pollution in the last 30 to 40 years and the spatial distribution reflects the injection of sewage effluent by the various lake border towns. J. C. Ayers (University of Michigan) checked to see if water temperature changes could stimulate the eutrophic plankton species now being observed. He concluded that this is not the case after a very detailed study of the available weather records for the last century. Although the air temperatures over Lakes Erie and Michigan are rising, Lake Erie's water temperature has an upward trend, while Lake Michigan's has a downward trend. Lake Erie, being a shallow lake, more closely follows the air temperature, whereas the deeper Lake Michigan depends on storms for mixing. The number of storms over Lake Michigan has been decreasing.

The removal of pollutants in treatment plants was discussed by G. A. Rohlich (University of Wisconsin). Much more research is required in order to be able to remove more than 99 percent of the effluent. Current techniques of removing 50 to 75 percent of the phosphates are not adequate when the total remaining quantity is considered. Research is continuing on techniques to remove various organic and inorganic compounds. This research should lead to a building block design of a treatment plant depending on the types of pollutants to be removed.

Pollution control programs are being developed under the supervision of W. Kehr (Federal Water Pollution Administration). The Lake Michigan and Lake Erie plans should be ready about 1 January 1967, with the other plans expected within the following 12

months. The standards are difficult to select; however, they will be flexible, that is, they will vary with locale. When more research has been accomplished, the standards will be modified, if necessary. Peter Kuh (Enforcement Branch of the Federal Water Pollution Administration) discussed the enforcement policies. It is hoped that his branch will do most of their enforcement through informal discussions rather than formal hearings or court actions.

There does not seem to be any doubt that Lakes Erie, Michigan, and Ontario are seriously polluted and are getting worse year by year. There are insufficient data on which to base decisions. The biological cycles, chemical cycles, and physical properties of the lakes are not adequately known. There is no doubt that the lakes can be restored to a desirable ecology, but it will require much research, time, and money. Although Lake Erie is more polluted than Lake Michigan, it can probably be improved easier because there is a significant water flow in Lake Erie, whereas Lake Michigan is a culde-sac. These lakes will probably require some positive action, such as the introduction of specific biological species, recovering the bottom with sand, injection of oxygen, and other actions. It seems to be only a matter of time until it is realized that no sewage or other waste can be deposited into the lakes.

In the last session J. L. Verber conducted a review of future Great Lakes research plans. Additional cooperation and exchange of information are required. Although there will be more research accomplished next year than last, it will not be adequate. The Universities of Michigan and Toronto have outstanding research programs, and the University of Wisconsin gives indication of significant growth. The U.S. government agencies have a large amount of research but the only significant State research program is conducted by Ontario. In the United States only Illinois seems to have an active program.

This conference was sponsored by IIT Research Institute in cooperation with the Great Lakes Research Division, University of Michigan, which will publish the proceedings. The next conference will be held at the University of Toronto in April 1967.

BILLY M. MCCORMAC
JAMES E. ASH
IIT Research Institute, Chicago, Illinois 60616