Meetings

Eutrophication

Many lakes the world over are becoming less desirable places on which to live because of nutrient wastes pouring into them from a man-changed environment. Man's activities, which introduce excess nutrients to lakes, streams, and estuaries and thus produce an enriched environment, are rapidly accelerating the process of cultural eutrophication. Excessive enrichment, brought about by population and industrial growth, intensified agriculture, river-basin development, recreational use of public waters, and domestic and industrial exploitation of shore properties, accelerates the natural aging of waters. The process causes changes in plant and animal life which usually interfere with multiple uses of waters, reduce their aesthetic qualities and economic value, and threaten the destruction of precious water resources. Overwhelming excessive growth of algae and aquatic plants chokes the open water, makes the water nonpotable, decomposes and fouls the air, and consumes the deep-water oxygen vital for fish and animal life.

These problems concerned nearly 600 water research scientists, industrial representatives, state and federal government officials, and others interested in water pollution control who attended the first international symposium on eutrophication, 11–16 June 1967, at the University of Wisconsin. Taking part in the program were 36 invited speakers from the United States and abroad, representing the fields of botany, chemistry, limnology, zoology, hydrology, law, and sanitary and agricultural engineering. In addition, three government officials discussed public policy and the social and economic consequences of eutrophication (R. F. Clevenger, Great Lakes Basin Commission; J. Bregman, Department of Interior; Gov. W. P. Knowles, Wisconsin).

Reports documenting case histories of eutrophication of lakes in Europe, eastern Europe, Scandinavia, Asia, and North America, many within 10 to 20 years after human interference, were presented by E. A. Thomas (Switzerland); M. Straskraba (Czechoslovakia); W. Rodhe (Sweden); S. Horie (Japan); and W. T. Edmondson (Washington). Special reports were presented on the Great Lakes (A. M. Beeton, University of Wisconsin-Milwaukee); Canadian streams (H. B. N. Hynes, University of Waterloo); and estuaries (B. H. Ketchum, Woods Hole Oceanographic Institution; J. Carpenter and D. W. Prichard, Johns Hopkins).

Archeological studies of cores of lake sediments reveal that the Romans inadvertently changed the drainage of a landscape, possibly by cutting the trees or constructing roads, to produce eutrophication in an Italian lake (G. E. Hutchinson, Yale). Prehistoric changes of climate and geology also affected the richness of lakes, as determined by the abundance and variety of the remains of microscopic organisms, plankton, and molluscs. Many lakes in sterile landscapes are still beautifully oligotrophic and little changed by time (S. Horie, Kyoto University; D. G. Frey, Indiana).

The history of Lake Erie's sad plight, caused by the inflow of tremendous additions of sewage and silt from Detroit and other large cities, was reported by Beeton. Abatement of pollution on the St. Clair and Detroit rivers, however, should improve Erie's condition because it is theoretically possible to exchange all its water in 3 years since the lake is so shallow and its flow so great. Lake Michigan is rapidly deteriorating for similar reasons, but the long-term outlook for this lake is not as encouraging because of its low flow of water and the fact that many of its tributary streams bear a heavy nutrient load. As yet, lakes Superior and Huron show little change due to man's activities, except for accumulation of insecticides in fish and bird life.

Lake Michigan's deep waters, however, do not readily mix with coastal waters, due to a difference in currents caused by the earth's rotation (C. L. Mortimer, University of Wisconsin-Milwaukee). This condition may forestall the eutrophication process in the deeper waters of the Great Lakes, already heavily affected by pollution from adjacent cities.

Other speakers described how plankton, bacteria, bottom organisms, and fish can be used to detect and measure the rate and degree of eutrophication. In the progression of eutrophication, fish families change from trout, to warm water bass and perch, to plant-eating types, and finally to bottom feeders (P. A. Larkin, University of British Columbia). In the final stages of enrichment the number of benthic organisms may drop to zero, as in vast areas of Lake Erie (P. M. Jonasson, Denmark).

The balance of a lake becomes upset when bacteria are unable to convert dead organic matter into plant and animal food. The balance is upset further in northern temperate zones where bacteria grow only during summer months, while sewage and garbage nutrients from cities and feed lots are dumped into the waters all year. Farm animals in the Midwest alone provide excrement which is equivalent to that from a population of 300 million people (E. F. McCoy and W. B. Sarles, Wisconsin).

Phosphate content of water appears to be the determining factor in pollution of European lakes (E. A. Thomas, Switzerland), although the rate at which nutrients pass through chemical and biological cycles is also important (Hutchinson). Sources of plant nutrients are principally human sewage and industrial wastes, including the phosphate-rich detergents. Drainage from farmland is second in importance as a nutrient source in temperate zones, where farm manure spread on frozen ground in winter is flushed into streams during spring thaws and rains. Substantial quantities of nitrates of fossil fuel origin augment these sources (G. F. Lee, Wisconsin; S. R. Weibel, Robert A. Taft Sanitary Engineering Center). City streets also provide a source rich in phosphates and nitrates.

Nutrients other than phosphates and nitrates—vitamins, growth hormones, and amino acids—were implicated as stimulants to aquatic growths (L. Provasoli, Haskins Laboratories; R. J. Benoit, General Dynamics). Some of these other nutrients are synthesized in the biological processes of sewage treatment.

Even outlying lakes in recreational areas, such as Lake Tahoe and Lake Windermere (England), are changing at a rapid pace due to drainage from septic tanks and resort and hotel sewage (Edmondson; J. W. G. Lund, England; R. A. Vollenweider, Italy).

Speakers concurred that it is now of greatest urgency to prevent further damage to water resources and to take corrective steps to reverse present damages. Suggested preventive and corrective measures include removing nutrients from municipal, industrial, and agricultural wastes; controlling algae and aquatic plants with chemical and mechanical removal methods; and establishing shoreland corridor regulations to protect lakes from further damage.

Rohlich emphasized that significant advances in sewage treatment have been offset by the huge increase in the population; hence corrective measures now necessary—such as diverting treated sewage through long pipes around highly populated lakes or even chemical stripping for removal of nutrients—are expensive. Treated sewage has been diverted around lakes Monona, Waubesa, and Kegonsa (Wisconsin); Lake Okoboji (Iowa); Lake Washington (Seattle); four lakes in Germany, two in Austria, and one in France. Recovery of these lakes after diversion of sewage effluent has been significant and promising (Edmondson).

Machinery, some still in the idea stage, was described by D. F. Livermore (Wisconsin) for harvesting large aquatic plants which choke irrigation ditches, floodwater canals, and shallow areas of tropical and temperate lakes. Chemical poisons which accomplish a less desirable effect of killing unwanted aquatic plants were evaluated by H. F. Mulligan (Cornell). Chemicals, however, distort the structure of multispecies aquatic communities and hence are less useful in lakes than they are in agriculture, where weeds for a single crop such as wheat have to be eradicated. In addition, chemicals are more difficult to manage and to restrict to problem areas within a body of water.

Several reports dealt with the positive features of eutrophication, namely, how to utilize sewage to fertilize forests (C. F. Cooper, Michigan) and augment crops of fish (Larkin), and how to direct the biological processes to yield useful and desirable species rather than objectionable ones. In addition, farm manure, particularly phosphorus, can be kept on the land at a profit if farmers could fluidize it and sprinkle it in spring and summer when the soil will hold it, rather than spread it on frozen land in winter (J. W. Biggar, Wisconsin).

The racing processes of eutrophication are too rapid to risk delay in taking legal action, emphasized J. H. Beuscher (Wisconsin), a leader in applying new concepts of water law to the alleviation of eutrophication. He stressed the need for proper zoning ordinances and forthright public initiative in modernizing the law when the scientific data, while not complete, suggested action. A new law in Wisconsin, which he was instrumental in formulating, requires a 1000-foot setback for all cottages and buildings on lakes and a 300-foot setback on streams, together with stricter specifications for septic tank construction depending upon soil percability. Edmondson described citizen participation in the bonding of a community for development of an expensive, $100-million sewage diversion program around Lake Washington, Seattle.

Predicting the consequences of eutrophication would be highly desirable for decision-makers. F. E. Smith (Michigan) described new techniques for constructing mathematical models of a drainage basin to make it possible to evaluate changes which might take place as various eutrophicating factors occur. Systems analysis is a powerful tool in dealing with these complex problems in which multifactor cause and effect are involved.

Scientists, engineers, and society in general will find in the forthcoming proceedings of the symposium, to be published early next year, facts about the accelerating process of eutrophication and suggestions for future action in coping with the rapidly worsening problem. It is paradoxical that the ancient night soil is still the most efficient use of man's manure; the flush toilet and sewers, which dump ever-increasing amounts of nutrients into our water resources, are a mixed blessing.

The renowned Wisconsin naturalist Aldo Leopold once said that the outstanding scientific discovery of the 20th century is not television or radio but rather the complexity of the land organism. It appears the general public, as well as the scientific community, is just beginning to realize the full impact of his statement.

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ARTHUR D. HASLER
MARLETTE E. SWENSON
Laboratory of Limnology and
University-Industry Research Program, University of Wisconsin, Madison 53706

Calendar of Events—October

National Meetings

20–23. American **Heart** Assoc., 40th annual mtg., San Francisco, Calif. (AHA, 44 E. 23 St., New York 10010)

21–23. American Soc. of **Cytology**, Denver, Colo. (W. R. Lang, 1025 Walnut St., Philadelphia, Pa. 19107)

21–26. American Acad. of **Pediatrics**, annual mtg., Washington, D.C. (R. G. Frazier, 1801 Hinman Ave., Evanston, Ill. 60204)

22–26. American **Documentation** Inst., New York, N.Y. (J. E. Bryan, 2000 P St., NW, Washington, D.C. 20036)

22–26. American Soc. of **Sanitary Engineering**, annual mtg., Boston, Mass. (S. Schwartz, 228 Standard Bldg., Cleveland, Ohio 44113)

23–24. American College of **Preventive Medicine**, annual mtg., Miami, Fla. (J. J. Wright, Box 1263, Chapel Hill, N.C. 27514)

23–25. National **Electronics** Conf., Chicago, Ill. (R. J. Napolitan, 228 N. LaSalle St., Chicago 60601)

23–25. Society of **Rheology**, 38th annual mtg., Washington, D.C. (J. C. Miller, Plastics Div., Union Carbide, Bound Brook, N.J.)

23–26. American **Vacuum** Soc., 14th natl. mtg., Kansas City, Mo. (P. J. Bryant, Midwest Research Inst., 425 Volker Bldg., Kansas City, Mo. 64110)

23–27. American Inst. of **Aeronautics and Astronautics**, 4th annual mtg., Anaheim, Calif. (Meetings Manager, AIAA, 1290 Sixth Ave., New York 10019)

23–27. **Drug Discovery and Development**, symp., Hopatcong, N.J. (W. Oroshnik, Saul Gordon Associates, Center for Professional Advancement, P.O. Box 66, Hopatcong 07843)

23–27. American **Public Health** Assoc., 95th annual mtg., Miami Beach, Fla. (B. F. Mattison, 1790 Broadway, New York 10019)

25–27. **Antimicrobial Agents and Chemotherapy**, 7th interscience conf., Chicago, Ill. (R. W. Sarber, 115 Huron View Blvd., Ann Arbor, Mich.)

25–27. **Graphics Arts**, 4th conf., Rochester, N.Y. (K. G. Chesley, TAPPI, 360 Lexington Ave., New York 10017)

25–27. Gulf Coast Assoc. of **Geological** Socs./American Assoc. of **Petroleum Geologists**, San Antonio, Tex. (A. M Borland, Sun Oil Co., Box 3308, Lafayette, La.)

25–28. American Acad. of **Periodontol-**