

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/21900358>

Resources in environmental chemistry. II. An annotated bibliography of water, life and health, and population problems.

ARTICLE *in* JOURNAL OF CHEMICAL EDUCATION · MAY 1976

Impact Factor: 1.11 · DOI: 10.1021/ed053p240 · Source: PubMed

READS

4

2 AUTHORS, INCLUDING:



John Moore

University of Wisconsin–Madison

96 PUBLICATIONS 110 CITATIONS

[SEE PROFILE](#)

John W. Moore
Eastern Michigan University
Ypsilanti, 48197
and Elizabeth A. Moore
Ann Arbor, Michigan 48103

Resources in Environmental Chemistry

II. An annotated bibliography of water, life and health, and population problems

Presented below is the concluding portion of this bibliography, covering the areas of Water; Life and Health; Population; and Science and Government.¹ The broad areas have been divided into sub-topics, each arranged generally in the order of increasing complexity. Where it exists, information about experiments, computer models and simulations, and films has been included in addition to the traditional sources—books, periodicals, abstracts, and government documents. The two portions of the bibliography have been numbered consecutively, hence cross-references to numbers (1) through (164) refer to Part I.

Water and Water Pollution

An adequate and safe supply of water is essential for all life. This fact has become a current issue with the passage of the Safe Drinking Water Act of 1974 and in light of the apparent relationship between the presence in water of trace organic compounds which are known carcinogens and cancer mortality in the New Orleans area. There is evidence that chloroform, bromodichloromethane, dibromo-chloromethane, and bromoform are produced from a common precursor by chlorination. Thus chlorination, which has been so successful in removing pathogenic bacteria, may again prove the rule that there is no complete solution to any environmental problem. In the references below many aspects of industrial and municipal water pollution are considered (e.g., eutrophication, heavy metals, effluents of the pulp and paper industry), as well as water treatment, water quality criteria, and the nature of rivers, lakes, and oceans. As multiple-use of water becomes commonplace, these topics will increase in importance.

About Water

Chemistry and biochemistry of water

- (165) Penman, H. L., "The Water Cycle," *Sci. Amer.*, 223 (3), 99 (1970). The unusual and unique properties of water are described and provide a background for understanding its importance in the biosphere.
- (166) Jenkins, D., Snoeyink, V. L., Ferguson, J. F., and Leckie, James O., "Water Chemistry Laboratory Manual," Association of Environmental Engineering Professors, Univ. of Texas, Austin 78712 1973. This group of intermediate-level experiments is available for \$3 at the above address.
- (167) Dugan, Patrick R., "Biochemical Ecology of Water Pollution," Plenum Press, New York, 1972. A microbiologist's view of water pollution, in terms which can be understood by any scientist.
- (168) Stumm, W., and Morgan, J. J., "Aquatic Chemistry," Wiley-Interscience, New York, 1970. Detailed descriptions of chemical equilibria in natural environments.
- (169) Sykes, G., and Skinner, F. A., (*Editors*), "Microbial Aspects of Pollution," Society for Applied Bacteriology Symposium Series No. 1, Academic Press, New York, 1971. A wide variety of papers relating to the role of microorganisms in water pollution.

Water quality criteria/drinking water standards

- (170) U.S. Environmental Protection Agency, "National Water Quality Inventory," U.S. Government Printing Office, 1974 (2 volumes). The first systematic survey of U.S. water quality. Also sets goals for 1977-83.
- (171) U.S. Environmental Protection Agency, "Water Quality Criteria Data Book," Volume 2, U.S. Government Printing Office, 1971. Results of a review of more than 5000 publications on inorganic chemicals in water with regard to toxicity, carcinogenicity, mutagenicity and teratogenicity.
- (172) Crossland, Janice, and Brodine, Virginia, "Drinking Water," *Environ.*, 15 (3), 11 (1973). A survey of problems relating to contamination of drinking water supplies.

¹ This is Part II of a two-part series. Part I covered General; Air; and Resources, Wastes and Recycling (J. CHEM. EDUC., 53, 167 (1976); an earlier bibliography treated energy and energy-related topics (J. CHEM. EDUC., 52, 288 (1975). All references are numbered consecutively throughout.

- (173) Marx, Jean L., "Drinking Water: Another Source of Carcinogens?" *Science*, 186, 809 (1974). A report of studies done on the lower Mississippi River which detected the presence of carcinogens. Chlorine used to destroy bacteria is suspected of reacting with hydrocarbons in the water to form their chlorinated derivatives.
- (174) U.S. Environmental Protection Agency, "Interim Primary Drinking Water Standards," *Federal Register*, 40 (51), 11990 (March 15, 1975). These are the EPA's proposed interim standards under the Safe Drinking Water Act; the enactment of standards is especially important in view of the previous report on carcinogens in drinking water.
- (175) "Are You Drinking Biorefractories Too?," *Environ. Sci. & Technol.*, 7 (1), 14 (1973). Problems with organic compounds in drinking water along the lower Mississippi River.
- (176) Gushee, David E., "Clean Water: What is it? How will we achieve it?" *ChemTech*, 334 (June 1973). An analysis of scientific and political aspects of passage of the Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500.

Bodies of water: fresh/ocean

- (177) Howells, G. P., Kneipe, T. J., and Eisenbud, M., "Water Quality in Industrial Areas: Profile of a River," *Environ. Sci. & Technol.*, 4 (1), 26 (1970). A thorough report on the biological status of a major industrial river—the Hudson—which has been carefully studied.
- (178) Carter, Luther J., "Galveston Bay: Test Case of an Estuary in Crisis," *Science*, 167, 1102 (1970). A good example of problems which can occur in the biologically essential area where fresh and salt water meet.
- (179) U.S. Environmental Protection Agency, "Annual Report on Fish Kills by Pollution" (current issue). An indication (though not infallible) of the extent of pollution of natural waters.
- (180) Sillén, L. G., "The Ocean as a Chemical System," *Science*, 156, 1189 (1967). An expert on the equilibria of ionic solutions considers the largest example in the world.
- (181) Bascom, Willard, "The Disposal of Waste in the Ocean," *Scientific American* 231 (2) 16 (1974). After describing the nature of the ocean and the wastes that are being discharged into it, the author discusses the ocean's ability to accept some wastes.
- (182) Colton, Jr., John B., Knapp, Frederick D., and Burns, Bruce R., "Plastic Particles in Surface Waters of the Northwestern Atlantic," *Science*, 185, 491 (1974). The authors provide useful information about the quantity, distribution, and source of various plastics found in this area; the main environmental dangers would appear to be non-biodegradability and surface area on which bacteria and other organisms can grow.

Economic considerations

- (183) U.S. Environmental Protection Agency, "The Economics of Clean Water," U.S. Government Printing Office, 1972. This report (in three volumes) details the investment levels needed to meet water quality objectives by both municipalities and industries.
- (184) *Chem. and Eng. News*, "Water Pollution Controls to Cost a Bundle," 13, (October 15, 1973); "EPA Sees no Economic Blocks to Clean Water," 16, (February 4, 1974). Reports on economic impacts of water pollution control.

Water Pollution, From Various Sources

Introductory level

- (185) Berg, George C., "Water Pollution," Scientists' Institute for Public Information, 1970. A brief, general survey.
- (186) McCaul, Julian, and Crossland, Janice, "Water Pollution," Harcourt Brace Jovanovich, New York, 1974. Written at a popular level by two members of the staff of *Environment*.
- (187) Pettyjohn, Wayne A., "Water Quality in a Stressed Environment," Burgess Publishing Co., 1972. A collection of readings dealing with ground water and surface water combination.
- (188) *Environ. Sci. & Technol.*, 8 (10), October 1974. This special issue devoted to water pollution contains much useful information.
- (189) Committee on Nitrate Accumulation, "Accumulation of Nitrate," National Research Council/National Academy of Sciences, 1972.

Intermediate level

Information about water pollution at an intermediate level may be found in refs. (2)-(5).

Comprehensive coverage of a more specialist nature

- (190) Weber, Jr., Walter J., "Physicochemical Processes for Water Quality Control," Wiley-Interscience, New York, 1972. Chemical processes are emphasized, whether they pertain to natural waters, water supplies or wastewater. The author holds that artificial distinctions among these classes are becoming less relevant as multiple usage of water becomes commonplace.
- (191) Fair, G. M., Geyer, J. C., and Okun, D. A., "Elements of Water Supply and Wastewater Disposal," 2nd ed., John Wiley & Sons, New York, 1971. A detailed treatment of all aspects of the subject.
- (192) American Public Health Association, American Water Works Association, Water Pollution Control Federation, "Standard Methods for the Examination of Water and Wastewater," 13th ed., American Public Health Association, 1971.
- (193) American Water Works Association, Inc., "Water Quality and Treatment," 3rd ed., McGraw-Hill, New York, 1971. The field is fairly completely covered by 28 authors in 19 chapters.

Eutrophication

Description of the problem

- (194) Hutchinson, G. Evelyn, "Eutrophication," *Amer. Sci.*, 61 (3), 269 (1973). A thorough treatment of the scientific background of the problem.
- (195) National Academy of Sciences, "Eutrophication: Causes, Consequences, Correctives," 1969. These proceedings of a symposium held in 1967 contain 33 articles by different authors. The introduction, summary and recommendations are quite useful.
- (196) Allen, H. E., and Kramer, James R., *Editors*, "Nutrients in Natural Waters," Wiley-Interscience, New York, 1972. A collection of chapters by different authors, most of which were presented at an ACS Symposium in 1971, this book concentrates on nutrients and eutrophication, especially with respect to the Great Lakes.

A simulation

- (197) Anderson, J. M., "System Simulation to Test Environmental Policy: The Eutrophication of Lakes," *Environ. Lett.*, 3 (3), 203 (1972).

Abatement techniques

- (198) Grundy, R. D., "Strategies for Control of Man-made Eutrophication," *Environ. Sci. & Technol.*, 5 (12), 1184 (1971). Reports on the status of scientific and legislative attempts at control of eutrophication. Concludes that long-term solutions will have to go beyond control of detergents or even phosphates alone.
- (199) Daniels, S. L., and Parker, D. G., "Removing Phosphorus from Waste Water," *Environ. Sci. & Technol.*, 7 (8), 690 (1973); Adams, Jr., Carl E., "Removing Nitrogen from Waste Water," *Environ. Sci. & Technol.*, 7 (8), 696 (1973). This pair of articles surveys methods for removal of the two elements most often implicated in accelerated eutrophication.
- (200) Lee, G. Fred, "Role of Phosphorus in Eutrophication and Diffuse Source Control," *Water Research*, 7, 111 (1973). Argues that attempting to control P inputs to lakes is a sound approach to controlling accelerated eutrophication, but that a better understanding of the relationship of phosphorus input and plant growth is necessary.
- (201) Hubschman, Jerry H., "Lake Erie: Pollution Abatement, Then What?" *Science*, 171, 536 (1971). A proposal that excess productivity due to accelerated eutrophication be harvested for human use.

Industrial Water Pollution

General

- (202) Nemerow, N. L., "Liquid Waste of Industry," Addison-Wesley Pub. Co., 1971. Mainly useful for its catalog of emissions by a variety of industries and listing of abatement procedures. Contains many references.
- (203) Cox, Geraldine V., "Industrial Waste Effluent Monitoring," *American Laboratory*, 36, (July 1974). The paper summarizes the methods of wastewater analysis which meet Federal standards. The data, presented in table form, contain references to the literature for each parameter.
- (204) The ACS periodical, *Environ. Sci. and Tech.*, regularly carries articles about industrial and municipal water pollution and treatment. Some representative topics covered recently are: metal finishing industries, 7 (3) 209 (1973) and 4 (5) 381 (1970); plastics manufacturing, 4 (8) 637 (1970); farms and animal feedlots, 7 (9) 797 (1973) and 8 (12) 985 (1974); textiles, 6 (1) 37 (1972); organic chemical industry, 8 (7) 621 (1974); oil refinery, 5 (11) 1099 (1971); photographic processing, 5 (11) 1085 (1971); and fertilizer manufacturing, 6 (8) 693 (1972).

Mercury and other heavy metals

- (205) Wallace, R. A., Fulkerson, W., Shultz, W. D., and Lyon, W. S., "Mercury in the Environment: The Human Element," Oak Ridge National Laboratory, ORNL-NSF-EP-1, 1971. This report contains, in its own words, "all you may ever want to know about mercury," although a number of things have been learned since its publication.
- (206) Goldwater, Leonard J., "Mercury in the Environment," *Sci. Amer.*, 224 (5), 15 (1971). Argues against a "panicky reaction" to episodes of mercury poisoning. Also presents an excellent photograph of chromosomes damaged by high blood levels of Hg.
- (207) Gavis, Jerome, and Ferguson, John F., "The Cycling of Mercury Through the Environment," *Water Research*, 6, 989 (1972). A thorough review of what is known about cycling of Hg in local and global environments.
- (208) Wood, J. M., "Biological Cycles for Toxic Elements in the Environment," *Science*, 183, 1049 (1974). Considerable space devoted to methylation of Hg. Concludes that care must be taken in deciding what compounds of a toxic element are to be monitored if its full environmental impact is to be assessed.
- (209) Webb, J. Leyden, "Enzyme and Metabolic Inhibitors," Volume II, Academic Press, New York, 1966. Chapter 7 gives very thorough coverage of the chemical properties and health effects of mercury compounds.
- (210) Potter, Loren, Kidd, David, and Standiford, Donald, "Mercury Levels in Lake Powell. Bioamplification in Man-Made Desert Reservoir," *Environ. Sci. & Technol.*, 9 (1), 41 (1975). An analytical study which illustrates bioamplification in a new reservoir in an area remote from man-made pollution.
- (211) Krenkel, P. A., "Mercury in the Environment," *CRC Critical Reviews in Environmental Control*, 3 (3) 303 (1973); "Mercury: Environmental Considerations, Part II," *op. cit.*, 4 (3) 251 (1974). A thorough treatment; attempts to evaluate results in terms of cost-benefit analysis.
- (212) Dean, John G., Bosqui, Frank L., and Lanouette, Kenneth H., "Removing Heavy Metals from Waste Water," *Environ. Sci. & Technol.*, 6 (6), 518 (1972). Surveys techniques for treatment of water containing heavy metals.

A simulation of mercury pollution

- (213) Anderson, A. A., Anderson, J. M., and Mayer, L. E., "System Simulation to Identify Environmental Research Needs: Mercury Contamination," *Oikos*, 24, 231 (1973). This paper describes a Limits to Growth simulation of mercury pollution which suggests the need for additional data on the environmental cycling of Hg.

Pulp and paper industry

- (214) Gehm, Harry, "State-of-the-Art Review of Pulp and Paper Waste Treatment," U.S. Environmental Protection Agency, U.S. Government Printing Office, 1973.

A somewhat industry-oriented view of paper-mill waste treatment, but contains much information.

- (215) U.S. Environmental Protection Agency, "Atmospheric Emissions from the Pulp and Paper Manufacturing Industry," Research Triangle Park, N.C., 1973. Information on the nature and quantities of air emissions from chemical pulping, especially the kraft process.
- (216) *Environ. Sci. & Technol.*, "Changes are in Store for Pulping Technology," 9 (1), 20 (1975). A qualitative description of non-sulfur pulping techniques.
- (217) Eckert, R. C., Chang, H., and Tucker, W. P., "Oxidative Degradation of Phenolic Lignin Model Compounds with Oxygen and Alkali," *Tappi*, 56, (6), 134 (1973). This article in the journal of the Technical Association of the Pulp and Paper Industry describes mechanisms of degradation of model lignin structures in oxygen pulping.
- (218) *Environ. Sci. & Technol.*, "Cleaning Up: Paper Industry's Mess," 8 (1), 22 (1974). Concludes that some returns on investments in pollution control equipment are possible if proper plans are made.

Chapters 13 and 33 of ref. (131) are devoted to chlor-alkali and pulp and paper industries, respectively.

Water Treatment—Advanced Techniques

- (219) Pohland, Frederick G., "Anaerobic Biological Treatment Processes," Advances in Chemistry Series No. 105, American Chemical Society, Washington, D.C., 1971. Proceedings of a symposium.
- (220) Luttinger, L. B., and Hoché, G., "Reverse Osmosis Treatment with Predictable Water Quality," *Environ. Sci. & Technol.*, 8 (7), 614 (1974). Describes applications of ultrafiltration in water purification.
- (221) Higgins, Irwin R., "Ion Exchange: Its Present and Future Use," *Environ. Sci. & Technol.*, 7 (13), 1110 (1973). A description of uses of ion exchange in water purification.
- (222) *Environ. Sci. & Technol.*, "Ozonation Seen Coming of Age," 8 (2), 108 (1974). Predicts a rosy future for ozonation in water and sewage treatment.
- (223) Culp, R. L., and Culp, G. L., "Advanced Wastewater Treatment," Van Nostrand Reinhold, New York 1971. An all-inclusive and fairly detailed treatment.
- (224) Zajic, J. E., "Water Pollution: Disposal and Reuse" Marcel Dekker, 2 vols., 1971. Fairly complete coverage of the subject.

Deep-Well Disposal of Wastes

- (225) Evans, D. M., and Bradford, A., *Environ.* 11 (8), 3 (1969). Details of the construction and possible problems of deep injection wells are given. The first author called public attention to the relationship between earthquake frequency and deep well injection of wastes.
- (226) *Environ. Sci. & Technol.*, "Deep-well Disposal Continues," 7 (13) 1106 (1973). Discusses increased use for industrial and sewage wastes and cites lack of controls on this practice.

Life and Health

A number of parallels may be drawn between the biosphere as a whole and any particular organism within it. Each has evolved over a relatively long period of time and is dependent on complex interactions among its constituent parts. Each is a highly organized, non-equilibrium system which requires a nearly continuous flow of free energy from its surroundings in order to maintain an improbable, low-entropy state. Finally, each has natural mechanisms which attempt to cleanse it of substances which are present in excess of the necessary quantities and to synthesize those which are absent. Substances which tend to disrupt the natural environment are often capable of destroying *homeostasis*—the regulation and buffering of rapid, large changes—within an organism; acute or chronic illness may then follow.

The references which follow examine protection mechanisms in the human body as well as toxic substances and environmentally-caused illnesses, the methods of producing enough food for increased populations, reasons for and against the use of pesticides, and the energy requirements of modern technological agriculture.

Food

World food supply

- (227) Brown, Lester R., and Finsterbusch, Gail W., "Man and His Environment: Food," Harper & Row, 1972; and Brown, Lester R., "Human Food Production as a Process in the Biosphere," *Sci. Amer.*, 223 (3), 160 (1970).
- (228) "Genetic Vulnerability of Major Crops," National Academy of Sciences, 1972. The contents of this extensive report of a committee of the National Research Council are obvious from its title.
- (229) Committee on Agricultural Production Efficiency, "Agricultural Production Efficiency," National Academy of Sciences/National Research Council, 1975. In this report the committee presents its conclusion that future growth of neither agricultural productivity nor efficiency are insured.
- (230) Nicholas Wade, "Green Revolution (I) and (II)," *Science*, 186, 1093 and 1186 (1974). These two news articles delineate both social and ecological problems associated with increased food production.
- (231) President's Science Advisory Committee, "The World Food Problem," Vols. I, II, III, The White House, 1967. Volume II, the report of the Panel on World Food Supply, contains much useful information over a wide range of topics and a myriad of figures and tables.
- (232) *Science*, 188, no. 4188 (9 May 1975) has devoted the entire issue to food. The pa-

pers contained in it, covering a broad area and many perspectives, achieve the usual high level.

Nutrition/protein supply:

- (233) *Chem. and Eng. News*, 40, (September 29, 1969); 19, (February 21, 1972); 14, (August 6, 1973); 30, (August 19, 1974); 11, December 9, 1974). A series of reports on direct chemical synthesis of protein and carbohydrate.
- (234) Altshul, Aaron M., "Food: Protein for Humans," *Chem and Eng. News*, 68, (November 24, 1969). This fairly complete discussion of the problem of adequate protein supply has an especially useful section on low cost options for nutritional and esthetic improvements in diet.
- (235) Committee on Chemistry and Public Affairs, "Nutrition and Public Policy in the United States," American Chemical Society, 1974. This is the report of a 1972 ACS symposium; it contains the texts of both the papers presented and the discussion sessions.
- (236) Spurgeon, David, "The Nutrition Crunch: A World View," *Science and Public Affairs*, 29, (8), 50 (1974). A good general treatment of the world-wide nutrition problem.
- (237) Hamdy, Mokhtar, "The Nutritional Value of Vegetable Protein," *ChemTech*, October 1974, p. 616.

Energy and food production

- (238) Steinhart, J. S., and Steinhart, C. E., "Energy Use in the U.S. Food System," *Science*, 184, 307 (1974); and chapter 6 of "Energy: Sources, Use and Role in Human Affairs," Duxbury Press, 1974. The authors provide an excellent discussion of the relationship between food production and energy consumption.
- (239) Hirst, Eric, "Energy Use for Food in the United States," Oak Ridge National Laboratory, report no. ORNL-NSF-EP-57, 1973; and "Food-Related Energy Requirements," *Science*, 184, 134 (1974). The report, based on economic input/output data of the Department of Commerce and energy input/output data from Oak Ridge, concludes that 12% of 1963 energy consumption was required by the food system. The *Science* article summarizes the results of the ORNL report. Both are excellent sources of information.
- (240) Pimentel D., et al., "Food Production and the Energy Crisis," *Science*, 182, 443 (1973). See also a letter, *Science*, 187, 560 (1975). An estimation of on-the-farm energy inputs to food production.
- (241) Martin, Lee R., "Agriculture a Growth Sector—1985 and Beyond," Staff Paper P74-4, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1974. This report examines the possibility that U.S. agriculture would be a candidate for rapid growth in exports. Among other things the conclusion is drawn that the farm sector of the food system is not extremely energy intensive.

Food additives

- (242) Wolff, J. A., and Wasserman, A. E., "Nitrates, Nitrites, and Nitrosamines," *Science*, 177, 15 (1972). Describes the hazards of these substances in the perspective of their very useful properties.
- (243) Kermode, G. O., "Food Additives," *Sci. Amer.*, 226 (3), 15 (1972). This article considers the necessity and safety of the 2500 different substances currently being added to foods for flavoring, coloring, preservation, etc. A list of substances on the Food and Drug Administration's GRAS (generally recognized as safe) list is included.
- (244) Furia, Thomas E., *Editor*, "CRC Handbook of Food Additives," The Chemical Rubber Co., 1968. A good, complete reference on the subject.

Environmentally-Related Illnesses

General information

- (245) Anderson, Jr., Alan, "The Hidden Plague," *New York Times Magazine*, 20, (October 27, 1974). A popular account of the problem of occupational disease associated with toxic chemicals.
- (246) Waldbott, George L., "Health Effects of Environmental Pollutants," C. V. Mosby, 1973. This is a readable and extremely useful book concentrating on airborne pollutants and their toxic effects. It is perhaps the best book in the area at the non-specialist level; good references.
- (247) Carter, Luther J., and Gillette, Robert, "Cancer and the Environment(I) and (II)," *Science*, 186, 239 (1974). These two news reports give a good survey of the problem of chemical carcinogens. The regulation of aldrin, dieldrin, benzidine, and vinyl chloride are included.
- (248) Council on Environmental Quality, "Toxic Substances." Superintendent of Documents, U.S. Government Printing Office, 1971. An excellent summary of problems associated with release of toxic substances into the environment.
- (249) Dinman, Bertram D., "The 'Non-Concept' of 'No Threshold' Chemicals in the Environment," *Science*, 175, 495; also letters in *Science*, 177, 1152. Dinman argues that for most chemicals in the environment the concept of "no threshold" below which no effects occur is counterproductive. The letters cited contain additional interesting views.
- (250) Shakman, Robert A., "Nutritional Influences on the Toxicity of Environmental Pollutants," *Arch. of Environ. Health*, 28 (2), 105 (1974). Shakman describes the effects of nutritional factors such as protein, trace minerals, and vitamins A, C, D and E on the toxicity of pollutants such as pesticides and oxidant air pollutants.
- (251) Schubert, Jack, "A Program to Abolish Harmful Chemicals," *Ambio*, 1 (3), 79 (1972). Schubert asserts that tests commonly used for detection of harmful chemicals are grossly inadequate. He lists a comprehensive series of tests which could protect the population and suggests a technical and administrative program by which such testing could be accomplished.

How the body works and its response to "pollutants"

- (252) Lee, Douglas H. K., "Specific Approaches to Health Effects of Pollutants," *Bull. Atom. Sci.*, 29 (8), 45 (1973). The Associate Director of the National Institute of Environmental Health Sciences presents a brief account of the current knowledge of the effects of environmental agents on man; clearly written.
- (253) Dhar, Sanat K., *Editor*, "Metal Ions in Biological Systems," Plenum Press, New York, 1973. The last four papers on this collection discuss transport and toxicity of heavy metals, especially lead, mercury and cadmium, in the environment.
- (254) Ochiai, Ei-Ichiro, "Environmental Bioinorganic Chemistry," *J. CHEM. EDUC.*, 51 (4), 235 (1974). A good discussion of toxic effects due to inorganic substances, especially heavy metals.
- (255) Lee, D. H. K., and Minard, D., *Editors*, "Physiology, Environment, and Man," Academic Press, New York, 1970. This collection of papers presented at a 1966 National Academy of Sciences—National Research Council symposium includes

penetration of environmental agents into the body, metabolism, toxic effects, adaptation and a good discussion of attempts to define an optimum environment.

- (256) Kappas, Attallah, and Alvares, Alvito P., "How the Liver Metabolizes Foreign Substances," *Sci. Amer.*, 232 (6), 22 (1975). An excellent description of how the liver enzymes convert nonpolar compounds into polar ones which can be excreted readily.
- (257) Hansch, Corwin, "A Quantitative Approach to Biochemical Structure-Activity Relationships," *Acc. Chem. Res.*, 2, 232 (1969). An excellent account describing factors which control biological activity of chemicals.
- (258) Parke, Dennis V., "The Biochemistry of Foreign Compounds," Pergamon Press, Elmsford, New York, 1968. The first section of this book describes the mechanisms by which the human body handles foreign substances; the second applies these general mechanisms to specific examples involving food additives, pesticides, drugs, etc.

Some specific toxic substances

- (259) Ahmed, A. Karim, MacLeod, Donald F., and Carmody, James, "Control of Asbestos," *Environ.*, 14 (10), 16 (1972). A thorough yet readable treatment of the subject ranging from early reports of occupational disease to effects on the community. There are extensive notes and references.
- (260) Knapp, Carol E., "Asbestos: Friend or Foe?" *Environ. Sci. & Technol.*, 4 (9), 727 (1970). Hazards, delayed effects and regulations involving asbestos are described.
- (261) "Cancer Deaths Among PVC Workers Cause Concern," *Chem & Eng. News*, 6, (Jan. 28, 1974). This was the first public report of angiosarcoma of the liver among plastics workers.
- (262) Tabershaw, Irving R., and Gaffney, William R., "Mortality Study of Workers in the Manufacture of Vinyl Chloride and its Polymers," *J. Occupational Med.*, 16 (8), 509 (1974).
- (263) Carnow, Bertram W., and Meier, Paul, "Air Pollution and Pulmonary Cancer," *Arch. Environ. Health*, 27, 207 (1973). The results of this study indicate that "an increase of 1 µg of benzo[a]pyrene per 1000 m³ of air as a pollution index was related to a 5% increase in the pulmonary cancer death rate."

A toxic substances reference

- (264) "The Toxic Substances List," U.S. Department of HEW, Public Health Service, National Institute for Occupational Safety and Health, annual editions, U.S. Government Printing Office. A wealth of data on all substances known to be toxic.

Mutagens, teratogens

- (265) Sanders, Howard J., "Chemical Mutagens," *Chem. & Eng. News*, 50, (May 19, 1969); 54, (June 2, 1969). This two-part series gives a fairly complete treatment of possible mutagenicity of drugs. Less emphasis is placed on environmental hazards.
- (266) Ramel, Claes, (*Editor*), "Evaluation of Genetic Risks of Environmental Chemicals," Royal Swedish Academy of Sciences, 1973. The report of a symposium held in Sweden in 1972 gives a general survey of the problem of mutagenic chemicals in the environment.
- (267) Fishbein, L., Flamm, W. G., and Falk, H. L., "Chemical Mutagens," Academic Press, New York, 1970. This book gives a good introduction to the biochemistry and mode of action of mutagenic chemicals. Later chapters tabulate classes of compounds and specific substances known to be mutagenic.
- (268) Mulvihill, John J., "Congenital and Genetic Disease in Domestic Animals," *Science*, 176 132 (1972). Farm and household animals can warn of environmental hazards and provide models of human genetic disease.
- (269) Wilson, James G., "Environment and Birth Defects," Academic Press, New York, 1973. Mechanisms of teratogenesis, effects of environmental agents and methods of testing for teratogens are described.
- (270) Hollaender, Alexander, (*Editor*), "Chemical Mutagens," Plenum Press, New York, 1971. This book describes the molecular mechanisms by which mutagens act as well as methods for detecting such effects.

Statistics relating to pollution and health

- (271) Lave, Lester B., and Seskin, Eugene P., "Air Pollution and Human Health," *Science*, 169, 723 (1970); and "An Analysis of the Association Between U.S. Mortality and Air Pollution," *J. Amer. Stat. Assoc.*, 68 (342) 284 (1973).
- (272) LeCam, L., Neyman, J., and Scott, E. L., (*Editors*), "Effects of Pollution on Health," Vol. 6 of "Proceedings of the 6th Berkeley Symposium on Mathematical Statistics and Probability," Univ. of California Press, Berkeley, 1972. A discussion of this conference, giving the basic problems relating to the statistics of pollution and health, can be found as Neyman, J., "Epilogue of the Health-Pollution Conference," *Bull. Atom. Sci.*, 29 (7), 25 (1973).

Sources of additional/current information

- (273) Two journals—*Archives of Environmental Health* and *Ambio. Journal of the Human Environment, Research and Management* are good sources of current information in the field of health effects of pollutants. The *Journal of Occupational Medicine* provides good information in the area of occupational health.
- (274) For general and current information in the area of pollution and health, the following abstracts and their indexes should be useful: *Selected References on Environmental Quality as it Relates to Health, Abstracts on Health Effects of Environmental Pollutants, and Pesticides Abstracts* (formerly *Health Aspects of Pesticides Bulletin*).

Pesticides

General information and effects of

- (275) Dahlsten, Donald L., Garcia, Richard, Laing, John E., and van den Bosch, Robert, "Pesticides," Scientists' Institute for Public Information, 1970. The environmental harm done by pesticides is summarized at an elementary level.
- (276) Irving, Jr., George W., "Agricultural Pest Control and the Environment," *Science*, 168, 1419 (1970). A good survey of the need for and various kinds of pesticides.
- (277) Robinson, J., "Organochlorine Compounds in Man and His Environment," *Chem-*

- istry in Britain*, 7 (11), 472 (1971). A survey of the subject with attention to the problems of analysis.
- (278) "Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health," Parts I & II, U.S. Department of HEW, 1969. This report summarizes a great deal of information on the uses, toxicity and interactions of pesticides as well as giving recommendations for controlling and monitoring their release into the environment.
- (279) Pimentel, David, "Ecological Effects of Pesticides on Non-Target Species," Executive Office of the President, Office of Science and Technology, 1971. The properties and LD₅₀ data of a large number of pesticides are included, as is a useful table relating trade names to chemical composition.
- (280) Edwards, Clive A., "Soil Pollutants and Soil Animals," *Sci. Amer.*, 220 (4), 88 (1969). The small invertebrates living in the soil are of great importance to soil fertility. This article surveys the effects of pesticides on these organisms.
- (281) Epstein, S. S., and Legator, M. S., "The Mutagenicity of Pesticides," MIT Press, Cambridge, 1971. The introduction by Joshua Lederberg is especially useful, as is the listing of all pesticides alphabetically by common names. The latter gives the formula, use and manufacturer for each pesticide.
- (282) Edwards, Clive A., "Persistent Pesticides in the Environment," 2nd ed., CRC Press, 1973. A comprehensive treatment; well written. The section which compares various models of DDT movement in the environment is especially good. One of the models discussed is: Woodwell, George M., Craig, Paul P., and Johnson, Horton A., "DDT in the Biosphere: Where Does it Go?" *Science*, 174, 1101 (1971).

Mode of action of pesticides

- (283) O'Brien, R. D., "Insecticides. Action and Metabolism," Academic Press, New York, 1967. An excellent book easily readable by anyone with a little background in organic chemistry, which describes the mode of action of insecticides without jargon.
- (284) "Report on 2,4,5-T." A Report of the Panel on Herbicides of the President's Science Advisory Committee, Executive Office of the President, U.S. Government Printing Office, 1971. An excellent summary of the chemical and public policy aspects of commercial and military use of 2,4,5-T.
- (285) Corbett, J. R., "The Biochemical Mode of Action of Pesticides," Academic Press, New York, 1974. A thorough survey of the subject which probably requires some background in biochemistry for its understanding.
- (286) "Organic Pesticides in the Environment," Advances in Chemistry #60, American Chemical Society, 1966. Contains a number of useful chapters on toxicity, metabolism, and persistence of pesticides.
- (287) "Fate of Organic Pesticides in the Aquatic Environment," Advances in Chemistry #111, American Chemical Society, 1972. A collection of fairly advanced descriptions of decomposition pathways of pesticides.
- (288) Haque, R., and Freed, V. H., Editors, "Environmental Dynamics of Pesticides," Plenum Press, New York, 1975. A series of articles by experts on the transport and transformation of pesticides in air, soil, and water.
- (289) Ashton, Floyd M., and Crafts, Alden S., "Mode of Action of Herbicides," Wiley-Interscience, New York, 1973. The title is descriptive of the material covered, but the reading is somewhat tough due to the number of specialized terms encountered.

New approaches to pest control

- (290) Worthy, Ward, "Integrated Insect Control May Alter Pesticide Use Pattern," *Chem. & Eng. News*, 13, (April 23, 1973). A good summary of the techniques of integrated pest management.
- (291) Council on Environmental Quality, "Integrated Pest Management," U.S. Government Printing Office, 1972. This report survey techniques other than broad-scale application of chemical pesticides which are available for pest control, and delineates the role of the federal government in their implementation.
- (292) Metcalf, Robert L., "DDT Substitutes," in *CRC Critical Reviews in Environmental Control*, 3 (1), 25 (1972). An excellent survey of the uses and properties of DDT and substitute insecticides. A similar, less rigorous, treatment appears in "Pests and Pollution. Challenge of Modern Insect Control," in Rinehart, Jr., K. L., McClure, W. O., and Brown, T. L., Editors, "Wednesday Night at the Lab," Harper and Row, New York, 1973.
- (293) Djerassi, Carl, Shih-Coleman, C., and Diekman, J., "Insect Control of the Future: Operational and Policy Aspects," *Science*, 186, 596 (1974). The difficulties faced in the development of new chemicals for the control of human or pest populations are similar and are summarized here.
- (294) Wilkinson, C. F., "Insecticide Synergism," *ChemTech*, 492 (August 1973). Quantities of pesticides applied may be significantly reduced if synergists, which enhance pesticide activity by blocking detoxification metabolism, are employed. However, the synergists themselves may cause some problems.
- (295) Allan, G. G., et al., "Pesticides, Pollution and Polymers," *ChemTech*, 171, (March 1973). Much smaller quantities of some pesticides can be used if they are encapsulated in a polymer matrix for controlled release.
- (296) "New Approaches to Pest Control and Eradication," Advances in Chemistry #41, American Chemical Society, 1963. Contains reports on non-pesticidal methods of insect control.

A reference series

- (297) Gunther, Francis A., and Gunther, Jane D., Editors, "Residue Reviews," Springer-Verlag, New York. This multi-volume series contains numerous useful articles on residues of pesticides and other foreign chemicals in foods and feeds.

Population; Science and Government

Inherent in all of the previous pollution problems is the population factor. Pollution problems will continue to in-

crease with increases in population, even if technology and affluence remain at the same level—which is improbable. Thus the control of a rapidly growing population plays a fundamental role in improving environmental quality.

Another important topic is the role science and scientists should have both within society and on the legislative process in order to effect solutions to environmental problems. Both of these topics will be treated briefly below.

Population

Statistics and data

- (298) U.S. Department of Commerce, Bureau of the Census, "Estimates of the Population of the United States and Components of Change: 1973," U.S. Government Printing Office, 1974. And, United Nations Secretariat, "World and Regional Population Prospects," E/CONF. 60/CBP/15, The United Nations, 1974. These documents, or current versions of them, present official data and projections.

General description of the population problem

- (299) "The Human Population," *Sci. Amer.*, (special issue) 231 (3) 1974. The eleven articles in this issue are invaluable in providing an understanding of the principles of population growth and the problems inherent in such growth.
- (300) Hardin, Garrett, *Assembler*, "Population, Evolution, and Birth Control. A Collage of Controversial Ideas," 2nd ed. W. H. Freeman and Co., San Francisco, 1969. The sub-title is an apt description of these writings selected from a wide range of literature and science.
- (301) Hardin, Garrett, "The Tragedy of the Commons," *Science*, 162, 1243 (1968). A classic paper which leads to the conclusion that there is no technical solution for the population-resources-competition problem. For a lengthier treatment see Hardin's "Exploring New Ethics for Survival. The Voyage of the Spaceship 'Beagle,'" Viking, New York, 1972.
- (302) Commoner, Barry, "The Environmental Cost of Economic Growth," *Chem. in Britain*, 8 (2), 52 (1972); "The Closing Circle," Alfred A. Knopf, New York, 1971. Both the article and the book state Commoner's thesis that growth of the wrong kinds of technology is a major factor in the recent environmental crisis in the United States, perhaps a more important factor than population.
- (303) Holdren, John P., and Ehrlich, Paul R., "Human Populations and the Global Environment," *Amer. Sci.*, 62 (3), 282 (1974). The authors have written widely on the subject of population. Here they deal with various environmental problems and see population as a central issue in both their cause and solution.
- (304) Brown, Lester R., "In the Human Interest," W. W. Norton & Co., 1974. Brown develops the problem of overpopulation and presents a strategy to stabilize world population.

Scientific description of population problems:

- (305) "Mechanisms of Reactions," in Rochow, Eugene G., Fleck, George, and Blackburn, Thomas R., "Chemistry. Molecules That Matter," Holt, Rinehart and Winston, New York, 1974, p. 360 ff. A model to simulate global population change is developed as an illustration of the exponential function and the principles of chemical kinetics.
- (306) Giddings, J. Calvin, "World Population, Human Disaster and Nuclear Holocaust," *Bull. Atom. Sci.*, 29 (7), 21, 45 (1973). Giddings classifies population-related problems according to the order of their dependence on population size. Those with negative orders become smaller with increasing population, zero order are independent and positive orders are exacerbated by population growth. An interesting, although far from quantifiable, concept.

Birth control technology

- (307) Marx, Jean L., "Birth Control: Current Technology, Future Prospects," *Science*, 179, 1222 (1973). A general survey of the technology of birth control.

Science and Government

- (308) Platt, John, "What We Must Do," *Science*, 166, 1115 (1969); Cellarius, Richard A., and Platt, John, "Councils of Urgent Studies," *Science*, 177, 670 (1972). The new large-scale crises of our society are not merely recognized and described, but also methods of solution—Involving scientists—are proposed.
- (309) Perl, Martin, Primack, Joel, and von Hippel, Frank, "Public Interest Science—An Overview," *Physics Today*, 23 (June 1974). Describes the ways scientists—individually and collectively through scientific societies—are involved in public issues.
- (310) Bipper, Alfred W., "Pollution Problems, Resource Policy, and the Scientists," *Science*, 169, 11 (1970). The author describes some principles for dealing with environmental problems, the scientist's role in implementing them, and a case study to illustrate his points.
- (311) Freeman III, A. Myrick, and Haveman, Robert H. "Residual Charges for Pollution Control: A Policy Evaluation," *Science*, 177, 322 (1972); Levi, Donald R., and Colyer, Dale, "Legal Remedies for Pollution Abatement," *Science*, 175, 1085 (1972). Prevention of pollution may be effected by economic penalties or legal action, in the view of the authors of these papers.

The authors wish to thank Academic Press for permission to use material which has appeared in their textbook, reference [5].

