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HEMOND, HAROLD F., AND ELIZABETH J. FECHNER-LEVY. 2000. **Chemical fate and transport in the environment.** 2nd ed. Academic Press. 433 p. $64.95. ISBN 0-12-340275-1.

The unifying theme of *Limnology and Oceanography* is the understanding of aquatic ecosystems, and quite a few *L&O* papers would not be out of place in purely ecological journals. Many others, however, would be—particularly those that involve the dynamics of chemical transport. Given the importance of this topic to limnologists and oceanographers, there has been a surprising and unfortunate lack of didactic material on subjects such as chemical fluxes from sediments to the water column or through the air–water interface. Students were faced with either a difficult ''slogging'' through chemical engineering texts (e.g., Schwarzenbach et al. 1993; Logan 1999) or the primary literature. Thus, this book addresses a real need.

The book begins with the basic concepts of mass, concentration, closed and open systems, the units representing these concepts, and dimensional analysis as a tool. It then proceeds to fill a toolbox with the implements needed to work with chemical fate and transport. The first tools comprise the physics of mass and physical chemistry: flow, dispersion, diffusion, activity, reaction kinetics, free energy, and phase equilibrium. These topics are handled in a thorough but very concise manner, and in practice, a teacher would have to expand the treatment and supply additional examples.

Without a solid understanding of the information presented in the first chapter, the reader or student should not proceed with the text, since it is an integral part of the more complex tools developed in later chapters. Chapter 2 begins with a discussion of air–water exchange, focusing on thin film and surface replacement models. The relationship with wind speed is described, but the examples of empirical relationships are from a chemical engineering textbook (Schwarzenbach et al. 1993); *L&O* readers would be better served by examples from more recent aquatics research papers (Wanninkhof 1992; Clark et al. 1994; Cole and Caraco 1998). Given the book's engineering approach, it is not surprising that biological transport and fate are not as completely addressed as are the physical processes: bioconcentration and bioaccumulation in aquatic organisms receive only four pages (air–water exchange gets eight). More disturbing is the fact that although some important concepts are introduced, they are clearly not presented at a working level of understanding. For example, the introductory material describes ''. . . mercury poisoning among the natives of the Hudson Bay area of Canada'' (without giving a reference), saying that it is ''. . . a result of the release of mercury from flooded soils, its transformation to methylmercury . . ..'' Mercury concentration in natives is indeed elevated, but poisoning is a strong description, and the present understanding is that the cause is enhanced methylation in flooded soils, not increased available mercury per se.

In Chapter 3 (''The Subsurface Environment''), the emphasis is on groundwater flow. Again, physics is handled comprehensively (53 pages), whereas chemical sorption in the subsurface environment gets only five pages and biodegradation seven. In Chapter 4 the authors have taken on an ambitious task—describing the ''Greenhouse Effect'' that atmospheric gases have on the Earth's radiative balance (including the calculation of the radiative balance) and some details of the global budgets of carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons—all in 14 pages! Although this chapter provides a very solid description of the general problem, the book's focus on equipping a toolbox with implements and illustrating their application with examples is somewhat lost here. I would prefer to see these case studies extracted and expanded into a text about climate change; such a book would provide a comprehensive challenge to apply the basic tools developed in the present book.

All chapters end with extensive exercise or question sets (169 in total) that are practical, simply presented, and that provide good coverage of the text's topics. This question section improves the utility of the book for the teacher, although the self-teaching reader will not have as easy a time, because no answers are provided (a solutions manual for exercises is available, however).

Although I was unaware of it, this book has been around for a while (this is the 2nd edition). It has not been as widely used in limnology and oceanography as it deserves to be, probably because it is organized and written in an engineering style. Although this approach is very logical, there is no denying that this is a large and complex field, and this book does not shy away from physics and mathematics. This is undoubtedly an excellent way to organize an engineering teaching text, but I doubt that beginning limnology and oceanography students will be comfortable with it. I would, however, highly recommend it to researchers and graduate students, especially biologists and chemists. It is a fine summary of the concepts and approaches to measuring physical fate and transport, which are issues with which biologists and chemists frequently have difficulty. Also, a course based on the book would provide chemists and biologists with physical detail and examples that would enrich their own fields of expertise. Overall, this is an excellent and comprehensive introduction to the physical aspects of fate and transport in the environment. At the very minimum, it will remind readers of where and how these concepts can be used to form a more quantitative picture of aquatic ecosystems.

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