

PREFACE TO THE FIRST EDITION

We wrote this book to share with other ecologists what we have learned about the structure and use of theory and its relationship to the myriad activities that constitute modern science. Our own quest was motivated by the sometimes unclear way in which the term "theory" is used in both scientific publications and informal discussions. We needed to find out what theory was and how it was built. We also wanted to evaluate the varied and often contradictory claims made about what constitutes proper scientific practice. Is prediction really the highest or only goal of science? How might it relate to other activities in which scientists engage?

We began with a series of readings and discussions that fortuitously included works describing the tumult in the modern philosophy of science. This process was tough going for us ordinary scientists, and the concepts took a long time to fathom, but eventually a picture began to emerge that we thought would be valuable for the discipline of ecology. We do not pretend to have become philosophers in the process. In fact, what we have learned and can present here is only a sampling of the wide, deep, and swift stream of the philosophy of science. However, we do attempt to draw our insights together into a coherent picture relevant to ecology. This book is a system of ideas about the philosophy of science by practicing ecologists for practicing ecologists. We beg the forbearance of any philosophers who may encounter it.

We have taken advantage of the current spirit of ecological integration. Ecology deals in novel discoveries, establishing new contexts for existing information, and integrating both into established knowledge. These various endeavors are usually practiced within a suite of disparate specialties, and yet more and more ecologists seem to be willing to cross disciplinary boundaries and levels of organization. The syntheses and unification that might ultimately result from such migration and cross-fertilization have the possibility to revolutionize ecology. The new philosophical understanding of theory and its use may help provide a framework in which integration can be nurtured. Thus, integration is a central theme of this book.

In order to think about how integration can be accomplished, we begin with an overview of understanding, relate that to the structure and dynamics of theory, and indicate how changes in understanding relate to integration in ecology. We also examine the nature of large paradigms that affect ecological integration and the social constraints and contexts of ecological understanding and integration. We end with a discussion of some of the important ways in which ecological understanding intersects with the larger society. In a sense, the book has a symmetrical structure motivated by the need for integration. We begin with a look at the nature of understanding and the tools and methods used to construct it. We then examine the generation of new

understanding and proceed outward again to the growth and connections of the new understanding that can result from enhanced integration.

In particular the book examines these questions:

1. Why be concerned with integration in ecology?
2. What is understanding and how does it relate to integration?
3. What is theory and what are its parts? How is theory classified and how does it change?
4. What drives change in theory and hence change in understanding?
5. How, exactly, does change in understanding promote integration?
6. What scientific and social factors limit integration?
7. How does ecological understanding relate to the larger society?

In our discussion, several themes emerge. First, a broad view of theory is supported by modern philosophy and the history of science. This broad view links the empirical and conceptual approaches that are often considered to be separate. Second, an objective view of scientific understanding emerges that can accommodate the variety of seemingly disparate activities that scientists practice. Finally, we identify some large targets for integration in ecology.

This book is intended for anyone who has some background in ecology, beginning with advanced undergraduates. We do refer briefly to some ecological examples but must depend on other sources for the detail. To supply a large number of ecological examples here would obscure the broad picture of understanding and the use and structure of theory we wish to present. We hope the book will be useful and interesting to ecologists of all kinds. Of course, we hope it stimulates application of the general approach in a variety of ecological realms. Using the framework we present, ecologists should be able to assess the status of theory and understanding in their own topic areas.

We have received the good advice of a number of people on early essays and in discussions that advanced our progress on this book and clarified our thinking. We thank James H. Brown, Richard T. T. Forman, Marjorie Grene, Elizabeth A. Lloyd, Robert H. Peters, Peter W. Price, and Richard Waring for help along the way. We thank our colleagues at the Institute of Ecosystem Studies (IES) for providing a stimulating and open intellectual environment that made these explorations possible. We thank IES librarian Annette Frank for help in obtaining references and Sharon Okada for redrafting and improving some of our problem artwork. The financial support of the Mary Flagler Cary Charitable Trust, of the U.S. National Science Foundation for essentially "empirical" work (BSR 8918551; BSR 9107243) and for Research Experiences for Undergraduates (BBS-9101094), and of the Canadian Natural Sciences and Engineering Research Council has contributed to the instigation and completion of this book.

S. T. A. P. and C. G. J., Millbrook, New York
J. K., Hamilton, Ontario

PREFACE TO THE SECOND EDITION

We have often wondered why the second edition of a book needs a new preface and why the preface for the first edition remains intact. It always seemed like a quaint, librarian-like tradition. In case you are wondering the same thing, the goals, motivation, and organization of the book laid out in the preface of the first edition remain. If you are new to the book, be sure to read the original preface to the first edition. We are still trying to introduce the wider field of ecology to a philosophical view that can be helpful in integration and synthesis. In fact, we think that this need has only grown. As ecology embraces new areas, such as biocomplexity, guidance in the strategies and tactics for integration are, if anything, even more needed than they were a dozen years ago. Similarly, growth in the desire to link ecology with other disciplines has been shown to be increasingly important. So the perspectives and tools we bring together in this second edition are all the more important today than when we began the first edition.

The second edition is substantially revised and updated. While we retain many of the classic ecological examples we used in the first edition, we have updated the references underpinning these and have added many new examples. We have also reported on progress and new controversies that have arisen in the philosophical literature relevant to the topics we cover.

One major goal of this second edition is an attempt to increase the accessibility of the text. Some readers found the density of ideas per line made reading rather slow going. We have tried to reduce the idea density and to intersperse more examples to make reading and comprehension easier. We have also clarified passages that startled us with their stylistic complexity. The fact that they escaped our notice in the first edition was an unfortunate oversight. We have also taken this opportunity to add a number of illustrative diagrams and figures that reinforce or extend the message of the text. The use of text boxes has increased as well, while retaining the flow of the central text arguments, to permit their consideration and discussion as issues worth focusing on. Some of the boxes are intended to help readers recall key points.

This preface gives us the opportunity to add new acknowledgments beyond those in the first edition. S. T. A. P. thanks Dr. M. L. Cadenasso and a graduate discussion group of Dr. S. R. Carpenter at the University of Wisconsin for comments that improved the quality of the text. Dr. Cadenasso also helped put the bibliography together, which is much appreciated, and beyond that, her addition to our understanding of ecological frameworks has been profound. S. T. A. P. also thanks the owners and staff of the Armadillo Bar and Grill in Kingston, New York, for providing a welcoming venue for many productive Saturday afternoons of work on the manuscript.

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S. T. A. P. and C. G. J., Millbrook, New York
J. K., Hamilton, Ontario