# Cause and Correlation in Biology: A User's Guide to Path Analysis, Structural Equations and Causal Inference with R

*By Bill Shipley*

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Many problems in biology require an understanding of the relationships among variables in a multivariate causal context. Exploring such cause-effect relationships through a series of statistical methods, this book explains how to test causal hypotheses when randomised experiments cannot be performed. This completely revised and updated edition features detailed explanations for carrying out statistical methods using the popular and freely available R statistical language. Sections on d-sep tests, latent constructs that are common in biology, missing values, phylogenetic constraints, and multilevel models are also an important feature of this new edition. Written for biologists and using a minimum of statistical jargon, the concept of testing multivariate causal hypotheses using structural equations and path analysis is demystified. Assuming only a basic understanding of statistical analysis, this new edition is a valuable resource for both students and practising biologists.

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## Editorial Review

Review
Review of previous edition:
"... the perfect introduction to SEM. This book can be used as the primary text in a SEM course given within any discipline, and can be used by scholars and researchers from any area of science."
Structural Equation Modeling

Review of previous edition:
"Addressing students and practising biologists, Shipley does a terrific job of making mathematical ideas accessible ... Cause and Correlation in Biology is a nontechnical and honest introduction to statistical methods for testing causal hypotheses."
Johan Paulsson, Nature Cell Biology

Review of previous edition:
"I highly recommend the book for those interested in multivariate approaches to biology."
Annals of Botany

"Bill Shipley has done an excellent job in tackling the fundamental issue of testing causality in biology and making it accessible to any biology student or scholar. This book is about statistics, but the storytelling is for biologists. When the first edition for this book came out, in 2000, path analyses were not a common tool for biologists. Although the first edition convinced us to use structural equation modelling, this second edition supplies the essential toolbox. This book is the best route to take if you want to master structural equation modelling in biology, and the very good news is that this second edition not only provides updates and extensions, it also offers R codes to run your analyses."
Anne Charmantier, Centre d'Écologie Fonctionnelle et Évolutive (CEFE), Montpellier

"For a long time biologists have inferred causation only from carefully designed experiments. Shipley's book broadens horizons by showing how to use observational data to infer whether a causal model is plausible, and to estimate the variation in response due to competing causes."
David Warton, University of New South Wales, Sydney

About the Author
Bill Shipley is a Professor in the Department of Biology at Université de Sherbrooke, Canada. His research interests centre upon plant ecophysiology, functional and community ecology, and statistical modelling. He is the author of From Plant Traits to Vegetation Structure: Chance and Selection in the Assembly of Ecological Communities, published by Cambridge University Press.

## Users Review

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**Shane Webb:**

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