

# CONTENTS

<b>Preface to the Second Edition</b>	<b>xiii</b>
<b>Preface to the First Edition</b>	<b>xv</b>
<b>Chapter 1. Introduction</b>	<b>1</b>
Phylogenetic Propositions	3
Topics Covered	6
Terms and Concepts	7
Disciplines	8
Organisms and Grouping of Organisms	9
Phylogenetic History and Evolution	11
Attributes of Organisms	13
Classification	15
Philosophy and Systematics	16
The Form of Phylogenetic Hypotheses	19
Chapter Summary	21
<b>Chapter 2. Species and Speciation</b>	<b>23</b>
What Is It to Be a Species?	24
Species as Kinds	24
Species as Sets	26
Species as Individuals	27
Species Concepts	27
Process-Based Concepts	29
The Evolutionary Species Concept	30
Justifications for the ESC	32
Variations on the ESC	33

Process-Based Concepts Emphasizing Reproductive Isolation	34
Phylogenetic Species Concepts	36
Some Additional Species Concepts	37
Sorting through Species Concepts	38
Speciation: Modes and Patterns	39
Allopartic Speciation	41
Allopartic Mode I: Vicariance	42
Allopatric Speciation, Mode II Peripatric Speciation	44
Distinguishing between Allopatric Modes of Speciation	44
Parapatric Speciation	49
Sympatric Speciation	49
Identifying Modes of Speciation in the Fossil Record	50
The Evolutionary Species Concept, Speciation, and Ecology	54
Empirical Methods for Determining Species Limits	54
Nontree-Based Methods	55
Tree-Based Methods	61
Chapter Summary	65
<b>Chapter 3. Supraspecific Taxa</b>	<b>66</b>
Concepts of Naturalness and Supraspecific Taxa	67
The Natural Taxon	68
Monophyly, Paraphyly and Polyphyly	70
Hennig's Concepts Placed in History	72
Natural Higher Taxa as Monophyletic Groups <i>sensu</i> Hennig (1966)	73
Logical Consistency: The Hallmark of Proposed Natural Classifications	74
Paraphyletic Groups Misrepresent Character Evolution	80
Paraphyly and Polyphyly: Two Forms of Nonmonophyly	81
Node-Based and Stem-Based Monophyly: Same Concept Different Graphs	83
Chapter Summary	83
<b>Chapter 4. Tree Graphs</b>	<b>85</b>
Phylogenetic Trees	87
Stem-Based Phylogenetic Trees	87
Node-Based Phylogenetic Trees	89
Cyclic Graphs	91
Cladograms	92
Nelson Trees in Phylogenetics	92
From Nelson Trees to Phylogenetic Trees	93
Gene Trees	99
Individuals versus Sets of Individuals Used in an Analysis	99
Representing Character Evolution on Trees	100
Unrooted Trees and Their Relationship to Phylogenetic Trees	101
Node Rotation	102

Other Kinds of Tree Terminology	103
Concepts of Monophyly and Trees	104
Chapter Summary	106
<b>Chapter 5. Characters and Homology</b>	<b>107</b>
A Concept of Character	107
Character States as Properties	109
Shared Character States	110
Historical Character States as Properties	111
Ahistorical Kind Properties	112
Historical Groups and Natural Kinds	113
Homology	114
Haszprunar's Homology Synthesis	115
Concepts of Homology in Systematics	117
Phylogenetic Characters and Phylogenetic Homology: An Overview	118
Taxic Homologies as Properties of Monophyletic Groups	119
Transformational Homology: Linking Different Hypotheses of Qualitative Identity in a Transformation Series	121
Discovering and Testing Homology	122
Patterson's Tests	124
Similarity and Remane's Criteria	124
Similarity in Position: Morphology	124
Similarity in Position: Molecular Characters	125
Special or Intrinsic Similarity	129
Stacking Transformations: Intermediate Forms	131
Conjunction	132
Phylogenetic Homology (Forging Congruence between Hennig's and Patterson's Views)	136
Avoiding Circularity: How Congruence Works	136
Working with Characters	137
Qualitative versus Quantitative Characters: Avoiding Vague Characters	139
Morphometrics and Phylogenetics	140
Characters, Transformation Series, and Coding	144
Complex Characters or Separate Characters?	147
Missing Data	147
Homology and "Presence-Absence" Coding	149
Chapter Summary	150
<b>Chapter 6. Parsimony and Parsimony Analysis</b>	<b>152</b>
Parsimony	152
Parsimony: Basic Principles	153
Kinds of Parsimony	154
Classic Hennigian Argumentation	154
Polarization	156
Example 1. The Phylogenetic Relationships of <i>Leysera</i>	162

A Posteriori Character Argumentation	166
Algorithmic versus Optimality Approaches	166
Optimality-Driven Parsimony	168
Determining Tree Length	169
Finding Trees	171
Random Addition Searches	172
Rearranging Tree Topologies	173
The Parsimony Ratchet	175
Simulated Annealing	176
Optimizing Characters on Trees	176
ACCTRAN Optimization	177
DELTRAN Optimization	178
Summary Tree Measures	179
Example 2: Olenelloid Trilobites	184
Evaluating Support	188
Using Consensus Techniques to Compare Trees	193
Statistical Comparisons of Trees	195
Weighting Characters in Parsimony	196
A Priori Weighting	196
Weighting by Performance	198
Weighting by Character Elimination	199
Weighting: Concluding Remarks	199
Phylogenetics Without Transformation?	199
Chapter Summary	202
<b>Chapter 7. Parametric Phylogenetics</b>	<b>203</b>
Maximum Likelihood Techniques	205
Simplicity	209
Likelihood in Phylogenetics: An Intuitive Introduction	210
Likelihood in Phylogenetics: A More Formal Introduction	212
Selecting Models	218
Bayesian Analysis	219
Interpreting Models in a Phylogenetic Context	226
Chapter Summary	227
<b>Chapter 8. Phylogenetic Classification</b>	<b>229</b>
Classifications: Some General Types	230
Classification of Natural Kinds	230
Historical Classifications (Systematizations)	231
Convenience Classifications	233
Biological Classifications	233
Constituents and Grouping in Phylogenetic Classifications	233
The Linnean Hierarchy	234
Definition of Linnean Higher Categories	235
Conventions for Annotated Linnean Classifications	236
Ancestors in Phylogenetic Classification	241
Species and Higher Taxa of Hybrid Origin	244

Alternative Methods of Classifying in the Phylogenetics Community	245
The PhyloCode	248
PhyloCode Controversies	250
Stability of Names Relative to Clade Content	253
Proper Names of Taxa	255
The Future of Linnean Nomenclature	257
Alternative “Schools” and Logical Consistency	258
Chapter Summary	258
<b>Chapter 9. Historical Biogeography</b>	<b>260</b>
The Distinction between Ecological and Phylogenetic Biogeography and the Importance of Congruence	261
Hierarchies of Climate and Geological Change and Their Relationship to Phylogenetic Biogeographic Patterns and Processes	264
The Importance of Vicariance in the Context of Evolutionary Theory	265
The Importance of “Dispersal” in Phylogenetic Biogeography	265
Geodispersal: Not Dispersal	266
Historical Perspective on Geodispersal and the Cyclical Nature of Oscillations between Vicariance and Geodispersal	270
Areas and Biotas	271
“Area” as It Relates to Phylogenetic Biogeographic Analysis	274
The Boundaries of Biotic Areas and Comparing the Geographic Ranges of Taxa	277
Conclusions	278
Analytical Methods in Phylogenetic Biogeography	278
Historical Biogeography Using Modified Brooks Parsimony Analysis	280
Overview of MBPA	282
Steps 1 and 2: Fitch Optimization of Area States on a Phylogeny	285
Area Distributions	288
Step 3.1: The Vicariance Matrix	288
Step 3.2: The Dispersal Matrix	289
Steps 4 and 5: MBPA Analyses and Comparison	290
Alternative Biogeographic Methods	293
How Extinction Affects Our Ability to Study Biogeographic Patterns in the Extant Biota	297
Statistical Approaches to Biogeographic Analysis	301
Tracking Biogeographic Change within a Single Clade	305
Phylogeography: Within Species Biogeography	307
The Biogeography of Biodiversity Crises	308
A Brief History of the Events Influencing Our Present Concepts of Historical Biogeography	310

Fundamental Divisions in Biogeography, a Pre-Evolutionary Context, or What Causes Biogeographic Patterns, Vicariance or Dispersal?	310
The Growing Evolutionary Perspective and the Continued Debate About Vicariance and Dispersal	312
Chapter Summary	314
<b>Chapter 10. Specimens and Curation</b>	<b>316</b>
Specimens, Vouchers, and Samples	316
The Need for Voucher Specimens	317
Access to Specimens	318
Previous Literature	318
Systematic Collections	318
Access to Specimens in the Age of the Internet	318
Collecting and Collection Information	319
Field Data	321
The Systematics Collection	322
Loans and Exchanges	322
Curation	323
Receipt of Specimens, Accessing the Collections, and Initial Sorting	323
Sorting and Identifying	324
Cataloging	324
Storage	324
Arrangements of Collections	324
Type Specimens	324
Catalogs	325
What Is in a Catalog?	325
The Responsibility of Curators	326
The Importance of Museum Collections	326
Integrating Biodiversity and Ecological Data	327
A Simple Example: Range Predictions	328
Predicting Species Invasions	329
Global Climate Change	329
Chapter Summary	329
<b>Chapter 11. Publication and Rules of Nomenclature</b>	<b>331</b>
Kinds of Systematic Literature	331
Descriptions of New Species	331
Revisionary Studies	332
Keys	332
Faunistic and Floristic Works	332
Atlases	333
Catalogs	333
Checklists	333
Handbooks and Field Guides	334
Taxonomic Scholarship	334

Phylogenetic Analyses	334
Access to the Literature	334
Literature in Zoology	334
Literature in Botany	335
Publication of Systematic Studies	337
Major Features of the Formal Taxonomic Work	338
Name Presentation	338
Synonomies	339
Material Examined	340
The Diagnosis	340
The Description	341
Illustrations and Graphics	341
Comparisons and Discussion	342
Distributional Data	342
Etymology	343
Keys	343
Indented Key	344
Bracket Key	344
The Rules of Nomenclature	345
Basic Nomenclatural Concepts	346
Priority	346
Correct Name and Valid Name	346
Synonyms	347
Homonyms	347
Conserved Names ( <i>Nomen conservandum</i> )	347
Limits of Priority	347
Names and Name Endings	347
Types	347
Chapter Summary	348
<b>Literature Cited</b>	<b>349</b>
<b>Index</b>	<b>390</b>