

Contents

PART I *Background*

CHAPTER 1: Introduction 1

Why Employ Molecular Genetic Markers? 5

- Molecular data are genetic 6
- Molecular methods open the entire biological world for genetic scrutiny 6
- Molecular methods access a nearly unlimited pool of genetic variability 7
- Molecular data can distinguish homology from analogy 8
- Molecular data provide common yardsticks for measuring divergence 9
- Molecular approaches facilitate mechanistic appraisals of evolution 14
- Molecular approaches are challenging and exciting 17

Why Not Employ Molecular Genetic Markers? 20

CHAPTER 2: The History of Interest in Genetic Variation 23

The Classical–Balance Debate 24

- Classical versus balance views of genome structure 24
- Molecular input to the debate 26
- Questions of empirical refinement 29

The Neutralist–Selectionist Debate 30

- Multi-locus allozyme heterozygosity and organismal fitness 36
- Single-locus allozyme variation and the vertical approach 40
- Selection at the level of DNA 41
- The unresolved status of the controversy 44

Must Molecular Markers Be Neutral To Be Informative? 47

The Molecule–Morphology Debate 48

Molecular Phylogenetics 49

CHAPTER 3: Molecular Techniques 55

Protein Immunology 55

Protein Electrophoresis 57

- Mendelian markers 59
- Idiosyncratic protein features 61

DNA–DNA Hybridization 63

Restriction Analyses	67
Animal mitochondrial DNA	70
Plant organelle DNA	78
Single-copy nuclear DNA	79
Moderately repetitive gene families	83
Minisatellites and DNA fingerprinting	84
Polymerase Chain Reaction	87
RAPDs	91
STRs (microsatellites)	92
AFLPs	94
SINEs	95
SSCPs	97
SNPs	97
HAPSTRs and SNPSTRs	98
DNA sequencing	98
Categorical Breakdowns of Molecular Methods	101
Protein versus DNA information	104
Discrete versus distance data	105
Detached versus connectable information	110
Single-locus versus multi-locus data	111
Utility of data along the phylogenetic hierarchy	111
CHAPTER FOUR: Philosophies and Methods of Molecular Data Analysis	115
<i>Cladistics versus Phenetics</i>	115
<i>Molecular Clocks</i>	120
History of clock calibrations and controversies	123
Absolute and relative rate comparisons	128
Closing thoughts on clocks	131
<i>Phylogenetic Reconstruction</i>	132
Distance-based approaches	134
Character-state approaches	139
Conclusions about phylogenetic procedures	142
<i>Gene Trees versus Species Trees</i>	143

PART II

Applications

CHAPTER FIVE: Individuality and Parentage 161

Human Forensics	161
History of laboratory approaches	162
History of controversies	165
Empirical examples	167
Ramets and Genets	169
Background	169
Spatial Distributions of Clones	172
Ages of clones	179
Clonal reproduction in microorganisms	183
Genetic chimeras	192
Gender Ascertainment	194
Genetic Parentage	196
Behavioral and evolutionary contexts	202
Selected empirical examples by taxa	204
Selected empirical examples by topic	221

CHAPTER SIX: Kinship and Intraspecific Genealogy 231

Close Kinship and Family Structure	231
Eusocial colonies	235
Non-eusocial groups	241
Kin recognition	244
Genetic relationships of specific individuals	245
Geographic Population Structure and Gene Flow	248
Autogamous mating systems	249
Gametic and zygotic dispersal	257
Direct estimates of dispersal distances	266
Vagility, philopatry, and dispersal scale	267
Non-neutrality of some molecular markers	277

Historical demographic events	279
Population assignments	280
Phylogeography	283
History and background	285
Case studies on particular populations or species	289
Genealogical concordance	301
Genealogical discordance	314
Microtemporal Phylogeny	316

CHAPTER SEVEN: Speciation and Hybridization 321

The Speciation Process	325
How much genetic change accompanies speciation?	325
Do founder-induced speciations leave definitive genetic signatures?	338
What other kinds of phylogenetic signatures do past speciations provide?	341
Are speciation rates and divergence rates correlated?	342
Can speciation occur sympatrically?	346
What are the temporal durations of speciation processes?	351
How prevalent is co-speciation?	353
Can morphologically cryptic species be diagnosed?	356
Should a phylogenetic species concept replace the BSC?	361

Hybridization and Introgression 363

Frequencies and geographic settings of hybridization	363
Sexual asymmetries in hybrid zones	367
More hybrid zone asymmetries	370
More hybrid zone phenomena	385
Speciation by hybridization	388

CHAPTER EIGHT: Species Phylogenies and Macroevolution	401
<i>Rationales for Phylogeny Estimation</i>	402

Phylogenetic character mapping	402
Biogeographic assessment	418
Academic pursuit of genealogical roots	431
Some Special Topics in Phylogeny Estimation	433
DNA hybridization and avian systematics	433
Mitochondrial DNA and the higher systematics of animals	434
Chloroplast DNA and the higher systematics of plants	438
Ribosomal gene sequences and deep phylogenies	443

Genomic Mergers, DNA Transfers, and Life's Early History 444

From ancient endosymbioses to recent intergenic transfers	448
Horizontal gene transfer	453
Relationships between retroviruses and transposable elements	459

Further Topics in Molecular Phylogenetics 460

Toward a global phylogeny and universal systematics	460
Molecular paleontology	466

CHAPTER NINE: Molecular Markers in Conservation Genetics 475

Within-Population Heterozygosity Issues	478
Molecular variability in rare and threatened species	479
Does reduced molecular variability matter?	484

Genealogy at the Microevolutionary Scale 491

Tracking individuals in wildlife management	491
Parentage and kinship	492
Gender identification	495
Estimating historical population size	495
Dispersal and gene flow	496

Population Structure and Phylogeography
497

- Genetics–demography connections 497
- Inherited versus acquired markers 500
- Mixed-stock assessment 502
- Shallow versus deep population structures 505
- Lessons from intraspecific phylogeography 510

Issues At and Beyond the Species Level
515

- Speciation and conservation biology 515

- Hybridization and introgression 527
- Species phylogenies and macroevolution 532
- Conclusion 540**

Literature Cited 543

Taxonomic Index 663

Subject Index 669