Contents

Preface ix

Acknowledgements xi

1 Molecular genetics in Ecology 1

What is molecular ecology? 1
The emergence of molecular ecology 2
Protein allozymes 4
An unlimited source of data 9
Mutation and recombination 10
Polymerase chain reaction 16
Sources of DNA 20
Getting data from PCR 22
Overview 26
Chapter summary 27
Useful websites and software 28
Further reading 28
Review questions 29

2 Molecular Markers in Ecology 31

Understanding molecular markers 31
Modes of inheritance 31
Nuclear versus organelle 32
Haploid chromosomes 37
Uniparental markers: a cautionary note 41
Molecular markers 43
Co-dominant markers 44
Dominant markers 53
Overview 57
Chapter summary 57
Useful websites and software 59
Further reading 60
Review questions 60

3 Genetic Analysis of Single Populations **63**
Why study single populations? 63
What is a population? 63
Quantifying genetic diversity 67
Hardy–Weinberg equilibrium 67
Estimates of genetic diversity 72
Choice of marker 75
What influences genetic diversity? 77
Genetic drift 77
Population bottlenecks 89
Natural selection 94
Reproduction 98
Overview 103
Chapter summary 104
Useful websites and software 105
Further reading 105
Review questions 106

4 Genetic Analysis of Multiple Populations **109**
Why study multiple populations? 109
Quantifying population subdivision 109
Genetic distance 110
F-Statistics 112
Quantifying gene flow 117
Direct methods 117
Indirect methods 120
Assignment tests 121
Gene flow discrepancies 123
What influences gene flow? 123
Dispersal ability 127
Barriers to dispersal 129
Reproduction 131
Fragmented habitats and metapopulations 133
Interspecific interactions 136
Population differentiation: genetic drift and natural selection 138
Gene flow and genetic drift 139
Gene flow and local adaptation 142
Overview 151
Chapter summary 151
Useful websites and software 152
Further reading 153
Review questions 153

5 Phylogeography **155**
What is phylogeography? 155
Molecular markers in phylogeography 155

Molecular clocks 157
Bifurcating trees 160
The coalescent 164
Applying the coalescent 166
Networks 167
Nested clade phylogeographic analysis and statistical phylogeography 170
Distribution of genetic lineages 173
Subdivided populations 173
Lineage sorting 178
Hybridization 180
Comparative phylogeography 184
Regional concordance 185
Continental concordance 188
Introduced species 193
Overview 196
Chapter summary 196
Useful websites and software 198
Further reading 198
Review questions 199

6 Molecular Approaches to Behavioural Ecology 201
Using molecules to study behaviour 201
Mating systems 202
Monogamy, polygamy and promiscuity 202
Parentage analysis 204
Mate choice 212
Social breeding 216
Manipulation of sex ratio 221
Adaptive sex ratios 222
Sex ratio conflicts 224
Sex-biased dispersal 226
Nuclear versus mitochondrial markers 227
Relatedness 228
F_{ST} Values 228
Assignment tests 228
Concordant results 230
Foraging 232
Identifying prey 233
In search of food 238
Overview 241
Chapter summary 242
Useful websites and software 243
Further reading 243
Review questions 244

7 Conservation Genetics **247**
The need for conservation 247
Taxonomy 250
Species concepts 250
Genetic barcodes 252
Subspecies 254
Conservation units 255
Population size, genetic diversity and inbreeding 257
Inbreeding depression 258
Translocations 268
Outbreeding depression 273
Captive breeding 277
Maximizing genetic diversity 278
Genetic diversity banks 280
Overview 281
Chapter summary 282
Useful websites and software 283
Further reading 283
Review questions 284

8 Molecular Ecology in a Wider Context **287**
Applications of molecular ecology 287
Wildlife forensics 288
Poaching 288
Illegal trade 291
Non-human perpetrators 293
Agriculture 294
Pests and diseases 295
Law enforcement 296
Gene flow between genetically modified crops and wild relatives 297
Fishing 299
Overfishing 299
Stock enhancement 301
The future of molecular ecology 303
Chapter summary 304
Useful websites and software 305
Further reading 306
Review questions 306

Glossary **309**

Answers to Review Questions **327**

References **337**

Index **373**