

Contents

1. The Golden Age	1
1.1 Biometricians, Saltationists and Mendelians	1
1.2 The Hardy-Weinberg Law	3
1.3 The Correlation Between Relatives	5
1.4 Evolution	9
1.5 Evolved Genetic Phenomena	26
1.6 Overall Evolutionary Theories	30
1.7 An End and a Beginning	33
2. Technicalities and Generalizations	35
2.1 Introduction	35
2.2 Random Union of Gametes	35
2.3 Dioecious Populations	36
2.4 Multiple Alleles.	40
2.5 Frequency-Dependent Selection.	45
2.6 Fertility Selection	46
2.7 Continuous-Time Models	48
2.8 A Remark on Average Effect and Average Excess	53
2.9 Two Loci.	55
2.10 Genetic Loads.	66
2.11 Finite Markov Chains	69
3. Discrete Stochastic Models	75
3.1 Introduction	75
3.2 Wright-Fisher Model: Two Alleles.	75
3.3 Moran Models: Two Alleles	84
3.4 Other “Exchangeable” Models	89
3.5 K-Allele Models	91
3.6 Infinitely Many Alleles.	93
3.7 Frequency-Dependent Selection.	98
3.8 Two Loci.	98
3.9 Effective Population Size	104
3.10 Age Properties and Retrospective Behavior.	112

4. Diffusion Theory	115
4.1 Introduction	115
4.2 The Forward and Backward Kolmogorov Equations.	115
4.3 Fixation Probabilities.	118
4.4 Absorption Time Properties	120
4.5 The Stationary Distribution	124
4.6 Conditional Processes.	125
4.7 Diffusion Theory.	127
4.8 Multidimensional Processes	134
4.9 Time Reversibility	136
4.10 Expectations of Functions of Diffusion Variables	136
5. Applications of Diffusion Theory	138
5.1 Introduction	138
5.2 No Selection or Mutation	140
5.3 Selection	146
5.4 Selection: Absorption Time Properties	148
5.5 One-Way Mutation	152
5.6 Two-Way Mutation	155
5.7 Diffusion Approximations and Boundary Conditions	156
5.8 Random Environments.	161
5.9 Time-Reversal and Age Properties.	164
5.10 Multi-allele Processes	167
6. Two Loci	176
6.1 Introduction	176
6.2 Evolutionary Properties of Mean Fitness	176
6.3 Equilibrium Points	183
6.4 Special Models	184
6.5 Modifier Theory	195
6.6 Two-Locus Diffusion Processes	200
6.7 Associative Overdominance and Hitch-hiking	204
6.8 The Evolutionary Advantage of Recombination	207
6.9 Summary.	211
7. Many Loci	213
7.1 Introduction	213
7.2 Notation	213
7.3 Recurrence Relations for Gametic Frequencies	216
7.4 Components of Variance	217
7.5 Particular Models	220
7.6 The Correlation Between Relatives	225
7.7 Summary.	230

8. Molecular Population Genetics	232
8.1 Introduction	232
8.2 Infinite Alleles and Infinite Sites Models	233
8.3 Genetic Variation Within and Between Populations	243
8.4 Genetic Distance	244
8.5 Constructing Phylogenetic Trees	247
9. The Neutral Theory	251
9.1 Introduction	251
9.2 Arguments Leading to the Neutral Theory: Loads	252
9.3 Arguments Leading to the Neutral Theory: Substitutions and Mutation Rates	255
9.4 Neutral Models	257
9.5 Charge-State Models	258
9.6 Infinite Allele Models	261
9.7 Infinite Allele Model: Generalized Neutrality	267
9.8 Infinite Site Models	275
9.9 Relations Between Models	278
9.10 Other Tests of Neutrality	281
10. Generalizations and Conclusions	283
10.1 Introduction	283
10.2 Mathematical Extensions	283
10.3 Geographical Structure	288
10.4 Age Structure	292
10.5 Random Environments	292
10.6 Ecological Considerations	296
10.7 Sociobiology	299
10.8 Concluding Remarks	300
Appendix A	303
Appendix B	305
Appendix C	306
Appendix D	307
References	308
Author Index	321
Subject Index	323