

contents

1 Evolution by natural selection 3

Darwin's theory 3

Evolution *in vitro* 4

Lamarck, Weismann, and the central dogma 8

Further reading 12

Problems 12

Computer projects 13

2 Models of populations 15

Models of population growth 15

Selection in an asexual population 17

The accuracy of replication 20

Genetic drift in finite populations 24

Further reading 27

Problems 27

Computer projects 28

3 Evolution in diploid populations 31

Gene frequencies and the Hardy–Weinberg ratio 31

The concept of fitness 36

The spread of a favourable gene 38

Further reading 45

Problems 45

Computer projects 46

4 The variability of natural populations 49

The evidence for genetic variability 49

Mutation 53

The maintenance of variation 64

Further reading 76

Problems 76

Computer projects 77

5 Evolution at more than one locus 81

Linkage disequilibrium 81

Heterostyly in plants 84

Mimicry in butterflies 85
 Linkage disequilibrium in natural populations 87
 Normalizing selection and linkage disequilibrium 88
 Further reading 90
 Problems 90
 Computer projects 91

6 Quantitative genetics 93

Nature and nurture 93
 The additive genetic model 95
 A more realistic model 108
 Experiments in artificial selection 113
 Quantitative variation and fitness 117
 The maintenance of genetic variation for quantitative traits 118
 Further reading 121
 Problems 121
 Computer projects 122

7 A model of phenotypic evolution 125

The hawk–dove game—a model of contest behaviour 125
 Asymmetric games 128
 More than two pure strategies 130
 Continuously varying strategies 131
 Will a sexual population evolve to an ESS? 134
 Further reading 135
 Problems 135
 Computer projects 136

8 Finite and structured populations 139

Inbreeding 139
 Genetic drift 143
 The rate of neutral molecular evolution 146
 Mitochondrial DNA 151
 Migration and differentiation between populations 154
 The establishment of a new favourable mutation 159
 Further reading 160
 Problems 160
 Computer projects 160

9 Evolution in structured populations 163

Selection in trait groups 163
 The evolution of co-operation: synergistic selection 164
 The evolution of co-operation: relatedness 167
 The group as the unit of evolution 173
 The shifting balance theory 179

14 Macroevolution 267

- Species and speciation 267
- Patterns of evolution 274
- Coevolution 285
- Further reading 296
- Problems 296
- Computer projects 297

15 Reconstructing evolutionary history 300

- How to construct a phylogenetic tree 300
- The reliability of trees 303
- What use are phylogenetic trees? 305
- Further reading 306

Answers to problems 307

References 315

Index 323