
Contents

1	Introduction: invariants imply deeper symmetries	1
1.1	Introduction (with examples)	1
1.2	Population dynamics	6
1.3	Fitness and life history evolution	7
1.4	Inheritance and sex allocation	10
1.5	Relative timing (and body size) variables	12
1.6	Life history theory for the αM number	14
1.7	Allometry	17
1.8	Phylogenetic methods	21
1.9	Book layout: a short summary	22
2	Sex allocation	24
2.1	Introduction and overview	24
2.2	Sex allocation under the Fisher inheritance symmetry	29
2.3	Simultaneous hermaphroditism	30
2.4	Sex reversal: breeding sex ratio	35
2.5	Dioecy: population sex ratio with environmental sex determination	39
2.6	Summary	42
3	Alternative life histories, mostly about males	45
3.1	Introduction	45
3.2	Bluegill sunfish	46
3.3	Salmon	48
3.4	ESS theory: symmetric beginnings	50
3.5	ESS theory: asymmetric beginnings	51
3.6	One non-intuitive prediction	55
3.7	Summary	56
3.8	Appendix	56
4	Indeterminate growth	60
4.1	Introduction	60

xiv . Contents

4.2 Fish	63
Clupeomorpha	63
<i>M/k</i> for fish in general	64
Walleye and brown trout: violation of the Beverton-Holt invariance	66
4.3 Aquatic invertebrates	69
Sea urchins	69
Pandalid shrimp	71
4.4 Reptiles	76
4.5 A life history theory for the Beverton-Holt invariants	85
4.6 Summary	
5 Determinate growth, mostly about mammals	87
5.1 Introduction	87
5.2 Empirical patterns for female mammals	88
5.3 Theory: the basic 0.25 scaling	89
Stable demography	89
Growth versus body size	91
Offspring production versus adult body size	93
Natural selection on the age at maturity	95
Average immature mortality \bar{Z} follows directly from $R_0 = 1$	97
5.4 Theoretical interpretations	97
Eliminate adult body size	97
What if adult body size is held constant?	99
General theoretical interpretations	100
5.5 One special invariant: αM	101
What is the average value of δ ?	102
Is αM the same for primates?	102
Does αM change with δ ?	104
Phylogenetic contrasts and αM	106
What determines δ ?	107
5.6 A mortality cost of reproduction?	108
5.7 Sexual dimorphism in adult body size	109
5.8 Summary	112
6 Population dynamics	114
6.1 Introduction	114
6.2 r_{\max} allometry	114
The data	114
Why r_{\max} allometry?	115
How high is the mammal r_{\max} line?	117
	120

How high is the ectotherm r_{max} line?	121
Mammals once again: primates versus others	122
6.3 Fowler's rules	124
6.4 Summary	127
7 Senescence (ageing)	129
7.1 Introduction	129
7.2 Determinate versus indeterminate growth	130
7.3 Sex-changing fish	131
7.4 Pollen grains	133
7.5 Alternative male life histories	134
7.6 Summary	135
8 Finis	136
Glossary of major parameters and functions	146
References	147
Author index	161
Subject index	165