

Contents

List of contributors page xii

Preface xv

Acknowledgments xviii

Part I Development and morphogenesis

1 Photoresponses in fern gametophytes 3

MASAMITSU WADA

- 1.1 Introduction 3
- 1.2 Spore germination 7
- 1.3 Cell growth 9
- 1.4 Phototropism and polarotropism 12
- 1.5 Cell division 16
- 1.6 Apical cell bulging 19
- 1.7 Chloroplast movement 20
- 1.8 Nuclear movement 30
- 1.9 Reproductive organs 31
- 1.10 Photoreceptors for photomorphogenesis 31
- 1.11 Concluding remarks 39
- References 40

2 Alternation of generations 49

ELIZABETH SHEFFIELD

- 2.1 Introduction 49
- 2.2 "The" fern life cycle 51
- 2.3 Historical summary 52
- 2.4 Variations on a theme 55
- 2.5 Sporogenesis 61
- References 68

3 Meristem organization and organ diversity 75

RYOKO IMAICHI

- 3.1 Introduction 75
- 3.2 Stem 76
- 3.3 Leaf 82
- 3.4 Shoot branching, dichotomous versus monopodial 86
- 3.5 Roots 90
- 3.6 Psilotalean rhizomes (subterranean axes) 94
- 3.7 Root-producing organs, rhizophores and rhizomorphs 95
- 3.8 Summary and future goals 97
- References 98

Part II Genetics and reproduction

4 Population genetics 107

TOM A. RANKER AND JENNIFER M. O. GEIGER

- 4.1 Introduction 107
- 4.2 Population genetics and reproductive biology 108
- 4.3 Genetic structure of populations 121
- 4.4 Gene flow and divergence 122
- 4.5 Population genetics of dispersal and colonization 123
- 4.6 Summary and future prospects 124
- References 125

5 Antheridiogens 134

JAKOB J. SCHNELLER

- 5.1 Introduction 134
- 5.2 History of discovery 134
- 5.3 General effect of antheridiogen 135
- 5.4 Occurrence of different antheridiogens and their chemical structure 138
- 5.5 Experiments under laboratory conditions 140
- 5.6 Dark germination: a further influence of antheridiogen 143
- 5.7 Antheridiogen in nature 145
- 5.8 Biological and evolutionary implications of the antheridiogen system 149
- 5.9 Future goals 150
- References 151

6 Structure and evolution of fern plastid genomes 159

PAUL G. WOLF AND JESSIE M. ROPER

- 6.1 Introduction 159
- 6.2 The golden age of fern chloroplast genomics 161

6.3	The age of complete plastid genome sequences	162
6.4	PCR mapping of fern plastid genomes	164
6.5	Conclusions and prospects	171
	References	171
7	Evolution of the nuclear genome of ferns and lycophytes	175
	TAKUYA NAKAZATO, MICHAEL S. BARKER, LOREN H. RIESEBERG, AND GERALD J. GASTONY	
7.1	Introduction	175
7.2	Historical summary	177
7.3	Review of critical recent advances	180
7.4	Synthesis of current perspectives	188
7.5	Future goals and directions	189
	References	193
Part III Ecology		
8	Phenology and habitat specificity of tropical ferns	201
	KLAUS MEHLTRETER	
8.1	Introduction	201
8.2	Historical summary	201
8.3	Review of critical recent advances	203
8.4	Synthesis of current perspectives	215
8.5	Future goals and directions	216
8.6	Importance of long-term studies	216
	References	217
9	Gametophyte ecology	222
	DONALD R. FARRAR, CYNTHIA DASSLER, JAMES E. WATKINS, JR., AND CHANDA SKELTON	
9.1	Introduction	222
9.2	Ecomorphology	225
9.3	Ecophysiology	233
9.4	Ecovalidation	242
9.5	Summary	250
	References	251
10	Conservation biology	257
	NAOMI N. ARCAND AND TOM A. RANKER	
10.1	Introduction	257
10.2	Conservation importance of ferns and lycophytes	258
10.3	Threats to global fern and lycophyte diversity	260
10.4	Life cycle challenges for conservation	264

- 10.5 *Ex situ* propagation of ferns and lycophytes 265
- 10.6 Regional and ecosystem-level conservation 265
- 10.7 Conservation of fern and lycophyte taxa 268
- 10.8 Genetics in fern and lycophyte conservation strategies 269
- 10.9 Protection and restoration 270
- 10.10 Future directions in fern and lycophyte conservation 272
- References 273
- 11 *Ex situ* conservation of ferns and lycophytes – approaches and techniques 284
VALERIE C. PENCE
 - 11.1 Introduction 284
 - 11.2 Methods for *ex situ* conservation 285
 - 11.3 *In vitro* cultures and collections 290
 - 11.4 *Ex situ* cryostorage of gametophytes 291
 - 11.5 *Ex situ* cryostorage of sporophytes 292
 - 11.6 *In vitro* collecting for *ex situ* conservation 293
 - 11.7 Current status and future perspectives 294
 - References 296

Part IV Systematics and evolutionary biology

- 12 Species and speciation 303
CHRISTOPHER H. HAUFLER
 - 12.1 Introduction 303
 - 12.2 Species concepts and definitions 304
 - 12.3 Speciation 311
 - 12.4 Summary and future prospects 322
 - References 324
- 13 Phylogeny and evolution of ferns: a paleontological perspective 332
GAR W. ROTHWELL AND RUTH A. STOCKEY
 - 13.1 Introduction 332
 - 13.2 Nature of the fossil record 335
 - 13.3 Systematic relationships among ferns, fern-like plants, and other euphyllophytes 335
 - 13.4 Moniliforms – the most ancient fern-like plants 337
 - 13.5 Ophioglossid ferns 343
 - 13.6 Marattioid ferns 345
 - 13.7 Patterns of diversification among leptosporangiate ferns 346
 - 13.8 Historical context, popular practices, and the upward outlook 358
 - References 360

14	Diversity, biogeography, and floristics	367
	ROBBIN C. MORAN	
14.1	Introduction	367
14.2	Historical review	367
14.3	Diversity	368
14.4	Long-distance dispersal	372
14.5	Vicariance	378
14.6	Floristics	379
14.7	Important questions	381
14.8	Future directions	382
	References	383
15	Fern phylogeny	395
	ERIC SCHUETTPELZ AND KATHLEEN M. PRYER	
15.1	Introduction	395
15.2	Early vascular plant divergences	396
15.3	Early fern divergences	399
15.4	Early leptosproangiate divergences	403
15.5	Early polypod divergences	405
15.6	Divergences within eupolypods I	406
15.7	Divergences within eupolypods II	407
15.8	Future prospects	408
	References	409
16	Fern classification	417
	ALAN R. SMITH, KATHLEEN M. PRYER, ERIC SCHUETTPELZ, PETRA KORALL, HARALD SCHNEIDER, AND PAUL G. WOLF	
16.1	Introduction and historical summary	417
16.2	Review of critical recent advances	420
16.3	Synthesis of current perspectives: the classification of ferns	421
16.4	Synthesis: lessons learned from morphology and molecular systematics, and unexpected surprises	445
16.5	Future goals and directions	448
	References	448
	Appendix A: Familial names applied to extant ferns	460
	Appendix B: Index to genera	462