

Contents

Contributors	XV
Abbreviations	XVII

1 Cotton

M. Ulloa, C. Brubaker, P. Chee	1
1.1 Introduction	1
1.1.1 Origin and Domestication of Cotton	2
1.1.2 Evolution of Cotton	3
1.1.3 Morphology and Taxonomy of the Cotton Species	3
1.1.4 Domestication and Diffusion of Cotton	6
1.1.5 Traditional Breeding	9
1.1.6 Current Priorities for Breeding in Cotton	10
1.2 Construction of Genetic Linkage Maps	10
1.2.1 History of Genetic Linkage Mapping in Cotton	15
1.2.2 What Have We Learned from Genetic Linkage Mapping in Cotton?	16
1.2.3 What Is the Future for Genetic Linkage Mapping in Cotton? ..	18
1.3 Gene Mapping	19
1.3.1 Simple Phenotypes in <i>Gossypium</i> spp.	19
1.3.2 Simple Phenotypes Molecular Mapped in <i>Gossypium</i> spp.	20
1.3.3 Multigenic Qualitative Traits	24
1.4 Quantitative Trait Loci	24
1.4.1 History of QTLs	24
1.4.2 QTL Methodologies	25
1.4.3 QTLs Detected Using Interspecific Mapping Families	28
1.4.4 QTLs Detected Using Intraspecific Mapping Families	30
1.4.5 QTLs Detected on Mapping Population for Specific Gene(s) ..	31
1.4.6 Comparison of QTLs	33
1.5 Marker-Assisted Breeding	34
1.5.1 Challenges Facing MAB in Cotton	35
1.5.2 The Future of MAB in Cotton	35
1.5.3 Marker-Assisted Introgression	36
1.6 Map-Based Cloning	38
1.7 The Future	40
References	42

2 Forage Crops

M. Inoue, M. Fujimori, H. Cai	51
2.1 Introduction	51
2.1.1 Characteristics of Cross-Pollinated Forage Crops as Distinct from Those of Inbred Species	51
2.1.2 Botanical Descriptions	53
2.1.3 Economic Importance	54
2.1.4 Breeding Objectives	54
2.1.5 Classical Mapping Efforts	54
2.1.6 Classical Breeding Achievements	54

2.1.7	Limitations of Classical Endeavors and Utility of Molecular Mapping	54
2.2	Construction of Genetic Maps	55
2.2.1	Kinds of Mapping Population and Molecular Markers	55
2.2.2	Construction of First-Generation Maps	57
2.2.3	Construction of Second-Generation Maps	57
2.3	Gene Mapping	62
2.3.1	Crown-Rust Resistance	62
2.3.2	Blast Resistance	62
2.3.3	Incompatibility Mechanisms in Legumes and Grasses	63
2.3.4	Gene Mapping in Alfalfa	63
2.4	Quantitative Trait Loci Detected	63
2.5	Marker-Assisted Breeding	64
2.6	Map-Based Cloning	66
2.7	Future Scope of Works	67
2.7.1	Syteny Between Forage Crops and Other Well-Studied Grass Species	67
2.7.2	<i>Medicago truncatula</i> as a Model Plant for Legumes	68
2.7.3	Genetic Transformation	68
2.7.4	Endophytic Fungi	69
	References	69

3 Ornamentals

	M. Linde, Z. Yan, T. Debener	77
3.1	Introduction	77
3.2	Maps and Mapped Genes in Selected Ornamentals	78
3.2.1	Roses	78
3.2.2	Snapdragon	83
3.2.3	Petunia	85
3.3	Variety and Genotype Identification	86
3.3.1	Vegetatively Propagated Crops	86
3.3.2	Sexually Propagated Crops	86
3.3.3	Sports	87
3.4	Analysis of Genetic Relatedness	87
3.4.1	Methods of Classification	87
3.4.2	Studies of Genetic Relatedness of Genotypes	88
3.5	Future Prospects	89
	References	89

4 Oil Palm

	Z. Price, S. Mayes, N. Billotte, F. Hafeez, F. Dumortier, D. MacDonald	93
4.1	Introduction	93
4.1.1	Botanical Classification and Phylogeny	93
4.1.2	Geographical Distribution	94
4.1.3	Biology of Oil Palm	95
4.1.4	Economy	95
4.1.5	Oil Palm Products and Their Uses	97
4.2	Molecular Markers in Oil Palm Breeding	99
4.2.1	Fingerprinting and Linkage Studies	99
4.2.2	Potential Applications of Markers – Simple Traits	100
4.2.3	Potential Applications of Markers – Complex Traits	101

4.2.4	Potential Applications of Markers – Disease Resistance	101
4.3	Genome Organization	102
4.4	Uses of Conserved Synteny	102
4.5	Vegetative Propagation of Oil Palm	102
4.6	Transformation Technology	103
4.7	Conclusions – the Future of Genetic Improvement in Oil Palm	104
4.7.1	Molecular Genetics	104
4.7.2	Models and Comparative Genetics	104
4.7.3	Transgenics and Tissue Culture	104
	References	105
5 Coffee		
	P. Lashermes, F. Anthony	109
5.1	Introduction	109
5.2	Genome Structure and Molecular Diversity	110
5.2.1	An Allotetraploid Species	110
5.2.2	An Extremely Low Genetic Diversity	111
5.3	Breeding Strategies	111
5.3.1	Introgression Assessment	112
5.3.2	Factors Controlling Gene Introgression	112
5.4	Genetic Mapping	113
5.5	Gene Tagging	113
5.6	Genomics	115
5.7	Conclusions and Perspectives	115
	References	116
6 Tea		
	J. Tanaka, F. Taniguchi	119
6.1	Introduction	119
6.1.1	Tea in a Botanical Context	119
6.1.2	<i>Camellia sinensis</i> as a Beverage Crop	119
6.1.3	Breeding Objectives for Tea	120
6.1.4	Challenges for Tea Breeding and Significance of MAS	121
6.2	Use of Markers and Genetic Analysis with DNA Markers	121
6.2.1	Use of DNA Markers for Nongenetic Analyses	121
6.2.2	Genetic Analysis with DNA Markers	121
6.3	MAS for Mulberry Scale Resistance	124
6.4	Advanced Works	124
	References	124
7 Cacao		
	R. Bhattacharjee, P. L. Kumar	127
7.1	Introduction	127
7.1.1	History and Distribution	127
7.1.2	General Characteristics of Cacao	128
7.1.3	Botany	129
7.1.4	Self-Incompatibility	132
7.1.5	Importance and Uses of Cacao	132
7.1.6	Production Constraints	133
7.2	Cacao Breeding	134
7.2.1	Clone Selection	134
7.2.2	Hybrid Selection	134

7.2.3	Recurrent Selection and Prebreeding	135
7.3	Genetic Linkage and Gene Mapping	135
7.4	Marker-Assisted Selection	136
7.5	Application of Genomic Tools and Gene Discovery	137
7.6	Genetic Transformation	137
7.7	Future Prospects	138
	References	138

8 Rubber

P.M. Priyadarshan	143	
8.1	Introduction	143
8.1.1	Commercial Importance	143
8.1.2	Botanical Aspects	144
8.1.3	Historical Aspects	144
8.1.4	Propagation Systems	146
8.1.5	Breeding Objectives	146
8.1.6	Genetic Resources and Variability	147
8.1.7	Breeding Methodologies and Achievements	148
8.2	Application of in Vitro Culture	157
8.2.1	Anther Culture	159
8.2.2	Somatic Embryogenesis and Meristem Culture	159
8.3	Molecular Genetics and Breeding	161
8.3.1	Molecular Diversity	161
8.3.2	Gene Linkage Maps and QTLs	163
8.3.3	Laticifer-Specific Gene Expression	167
8.3.4	Direct Gene Transfer	167
8.3.5	Conclusions and Future Outlook	168
	References	169

9 Medicinal and Aromatic Plants

A. K. Shasany, A. K. Shukla, S. P. S. Khanuja	175	
9.1	Introduction	175
9.2	Metabolic Profiles and Significance of Some Prominent Medicinal and Aromatic Plants	175
9.2.1	<i>Catharanthus roseus</i>	175
9.2.2	<i>Mentha</i> spp.	177
9.2.3	<i>Papaver somniferum</i>	181
9.2.4	<i>Ocimum</i> spp.	182
9.2.5	<i>Artemisia annua</i>	183
9.2.6	<i>Capsicum</i> spp.	184
9.2.7	<i>Vetiveria zizanioides</i>	186
9.2.8	<i>Taxus wallichiana</i>	186
9.2.9	<i>Phyllanthus</i> spp.	187
9.2.10	<i>Pelargonium graveolens</i>	188
9.2.11	<i>Cymbopogon</i> spp.	188
9.2.12	<i>Bacopa monnieri</i>	189
9.2.13	<i>Aloe</i>	190
9.3	Concluding Remarks	190
	References	191

Subject Index