

Contents

Foreword

xiii

1	Taxonomy and Biogeography of Seagrasses	1–23
	<i>C. den Hartog and John Kuo</i>	
	I. Introduction	1
	II. Key to the Angiosperm Families Containing True Marine Species	2
	III. Seagrasses: General Taxonomy	3
	IV. Biogeography	16
	V. Conclusion and Outlook	18
	References	19
	Appendix: A List of the Seagrass Species of the World	22
2	Seagrass Evolution, Ecology and Conservation: A Genetic Perspective	25–50
	<i>Michelle Waycott, Gabriele Procaccini, Donald H. Les and Thorsten B. H. Reusch</i>	
	I. Introduction	25
	II. The Evolution of Seagrass Diversity	26
	III. Ecological and Reproductive Processes	35
	IV. Concluding Remarks	44
	Acknowledgments	45
	References	45
3	Seagrass Morphology, Anatomy, and Ultrastructure	51–87
	<i>J. Kuo and C. den Hartog</i>	
	I. Introduction	51
	II. General Morphology of Seagrasses—Size and Shape	52
	III. Vegetative Morphology and Anatomy	52
	IV. Reproductive Morphology and Anatomy	69
	V. Water Movement in Seagrass Leaves and Roots	81
	VI. Morphological, Anatomical and Ultrastructural Modifications in Relation to Environmental Conditions	82
	VII. Discussion and Concluding Remarks	83
	Acknowledgments	83
	References	83

4	Sexual Reproduction of Seagrasses: Pollination in the Marine Context	89–109
	<i>Josef Daniel Ackerman</i>	
	I. Introduction	89
	II. Defining Seagrasses	90
	III. Evolutionary Ecology	90
	IV. Morphological Patterns: Reproductive Organs	94
	V. Pollen	96
	VI. Reproductive Patterns	96
	VII. Pollination	98
	VIII. Post-Pollination: Pollen Tubes, Embryonic and Seedling Development	102
	IX. Evidence for Pollination Success	104
	X. Conclusions	105
	Acknowledgments	106
	References	106
5	Ecology of Seagrass Seeds and Dispersal Strategies	111–133
	<i>Robert J. Orth, Matthew C. Harwell and Graeme J. Inglis</i>	
	I. Introduction	111
	II. Seeds and Seed Production	112
	III. Seed Banks, Dormancy, and Seed Germination	113
	IV. Seed Dispersal	114
	V. Seed Recruitment and Seedling Establishment	122
	VI. Seagrass Conservation and Restoration: Utility of Seeds	123
	VII. Conclusions and Emerging Paradigms	126
	Acknowledgments	128
	References	128
6	Seagrass Beds and Coastal Biogeochemistry	135–157
	<i>Núria Marbà, Marianne Holmer, Esperança Gacia and Christina Barrón</i>	
	I. Introduction	135
	II. Role of Particulates and Dissolved Material	136
	III. Mineralization of Organic Matter and Nutrient Cycling in Seagrass Sediments	145
	IV. Summary and Future Work/Outlook	151
	Acknowledgments	153
	References	153
7	Carbon Flux in Seagrass Ecosystems	159–192
	<i>Miguel A. Mateo, Just Cebrián, Kenneth Dunton, and Troy Mutchler</i>	
	I. Introduction	159
	II. Seagrass Production	160
	III. The Fate of Seagrass Production	164
	IV. Ecosystem Carbon Budgets and Carbon Sinks	179
	V. Summary and Future Work	185
	Acknowledgments	186
	References	186

8	Fluid Dynamics in Seagrass Ecology—from Molecules to Ecosystems	193–225
	<i>Evamaria W. Koch, Joseph D. Ackerman, Jennifer Verduin and Michael van Keulen</i>	
	I. Introduction	193
	II. Fluid Dynamics: Fundamentals	194
	III. Micro-Scale Processes at the Molecular Level (μm)	198
	IV. Processes at the Shoot Level (mm–cm)	200
	V. Processes at the Canopy Level (m)	205
	VI. Hydrodynamically-Mediated Processes at the Landscape Level (100–1000 m)	212
	VII. Hydrodynamic Processes at the Meso-Scale Level (>1,000 m)	216
	VIII. Summary and Outlook	218
	Acknowledgments	219
	References	219
9	Nutrients Dynamics in Seagrass Ecosystems	227–254
	<i>Javier Romero, Kun-Seop Lee, Marta Pérez, Miguel A. Mateo, and Teresa Alcoverro</i>	
	I. Introduction	227
	II. Nutrient Economy: Acquisition, Transport, and Storage	228
	III. Nutrient Fluxes in Seagrass Ecosystems	235
	IV. Nutrient Limitation and Nutrient Imbalances	243
	V. Conclusion and Future Goals	247
	Acknowledgments	248
	References	248
10	Oxygen Movement in Seagrasses	255–270
	<i>Jens Borum, Kaj Sand-Jensen, Thomas Binzer, Ole Pedersen, and Tina Maria Greve</i>	
	I. General Introduction	255
	II. Measuring Oxygen Dynamics and Transport	256
	III. Oxygen Sources	257
	IV. Oxygen Sinks	260
	V. Internal Movement of Oxygen	263
	VI. <i>In Situ</i> Oxygen Variability in Seagrass	265
	VII. Anoxia and Seagrass Die-off	267
	VIII. Summary	267
	Acknowledgments	268
	References	268

11	Dynamics of Seagrass Stability and Change	271–294
	<i>Carlos M. Duarte, James W. Fourqurean, Dorte Krause-Jensen, and Birgit Olesen</i>	
	I. Introduction	271
	II. Components of Seagrass Meadows: from Apical Meristems to Meadows	272
	III. Shoot Dynamics	275
	IV. Clones and Patch Dynamics	281
	V. Gap Dynamics	283
	VI. Dynamics of Seagrass Meadows at Different Time Scales	284
	VII. Prospect: Forecasting Seagrass Dynamics	290
	Acknowledgement	290
	References	290
12	Aquatic Optics: Basic Concepts for Understanding How Light Affects Seagrasses and Makes them Measurable from Space	295–301
	<i>Richard C. Zimmerman and Arnold G. Dekker</i>	
	I. Introduction	295
	II. A Primer on Hydrologic Optics	295
	III. Radiative Transfer in Natural Waters	300
	References	301
13	Light and Photosynthesis in Seagrass Meadows	303–321
	<i>Richard C. Zimmerman</i>	
	I. Introduction	303
	II. Radiation Transfer and Light Interception	304
	III. Canopy Architecture and Leaf Orientation	304
	IV. Leaf Optical Properties	307
	V. Radiative Transfer and Submerged Plant Canopies	309
	VI. Irradiance Distributions Within the Seagrass Canopy	311
	VII. Productivity and Carbon Balance in Submerged Plant Canopies	312
	VIII. Leaf Orientation, Canopy Density, and Self-Shading	313
	IX. Effects of Water Quality on Seagrass Productivity and Distribution	315
	X. Potential Impacts of Climate Change on Seagrass Productivity	316
	XI. Effects of Epiphytes on Leaf Photosynthesis	316
	Acknowledgment	319
	References	319
14	Photosynthesis and Metabolism in Seagrasses at the Cellular Level	323–345
	<i>Anthony W. D. Larkum, Edward A. Drew, and Peter J. Ralph</i>	
	I. Introduction	323
	II. Photosynthetic Adaptations to Marine Submergence	324
	III. The Diffusive Boundary Layer (DBL)	324

IV.	Inorganic Carbon Uptake Mechanisms	325
V.	Rates of C _i Uptake	326
VI.	Photosynthetic Efficiency, Light-Harvesting and the Package Effect	328
VII.	Mechanisms of CO ₂ Fixation, CAM, Photorespiration and Oxygen Cycles	329
VIII.	Fluorescence Studies	330
IX.	Leaf Anatomy, Oxygen Effects and Depth Limitations in Seagrasses	337
X.	Initial Photosynthetic Products in Seagrass Leaves	338
XI.	Translocation and Exudation	338
XII.	Storage and Utilisation	339
XIII.	Secondary Metabolites and Chemotaxonomy	340
XIV.	Summary	341
	Acknowledgements	342
	References	342
15	Remote Sensing of Seagrass Ecosystems: Use of Spaceborne and Airborne Sensors	347–359
	<i>Arnold Dekker, Vittorio Brando, Janet Anstee, Suzanne Fyfe, Timothy Malthus and Evanthia Karpouzli</i>	
I.	Introduction	347
II.	Principles of Remote Sensing of Seagrass Ecosystems	350
III.	Optical Properties of the Overlying Water Column	351
IV.	Optically Deep and Shallow Waters: Physical Definitions	353
V.	Methodological Approaches to Assessing Seagrass Ecosystem Characteristics from Remote Sensing	355
VI.	Conclusions, Recommendations, and Outlook	357
	References	358
16	Zostera: Biology, Ecology, and Management	361–386
	<i>Kenneth A. Moore and Frederick T. Short</i>	
I.	Introduction	361
II.	Comparative Biology	361
III.	Ecology	370
IV.	Management and Restoration	372
V.	Future Research Needs	378
	References	378
17	Biology of Posidonia	387–408
	<i>Sylvie Gobert, Marion L. Cambridge, Branco Velimirov, Gérard Pergent, Gilles Lepoint, Jean-Marie Bouqueneau, Patrick Dauby, Christine Pergent-Martini, and Diana I. Walker</i>	
I.	Introduction	378
II.	Systematics	388
III.	Distribution of the Genus	388
IV.	Development of Meadows and Patches	391
V.	Biomass Dynamics and Production of the Plant	391

VI. Reproduction	393
VII. Dynamics of Carbon and Nitrogen	395
VIII. Food Webs	397
IX. Species Status and Anthropogenic Impact	400
X. Summary	401
References	401
18 The Biology of <i>Thalassia</i>: Paradigms and Recent Advances in Research	409–439
<i>Brigitta I. van Tussenbroek, Jan A. Vonk, Johan Stapel, Paul L. A. Erftemeijer, Jack J. Middelburg, and Jay C. Zieman</i>	
I. Introduction	409
II. Basic Environmental Requirements	410
III. Historical Development in Research	411
IV. <i>Thalassia</i> –Sediment Interactions	412
V. Nutrient Dynamics	412
VI. Plant Development	416
VII. Population Dynamics	422
VIII. Community Ecology	423
IX. Conclusions	430
Acknowledgments	431
References	431
19 Epiphytes of Seagrasses	441–461
<i>Michael A. Borowitzka, Paul S. Lavery, and Mike van Keulen</i>	
I. Introduction	441
II. The Role of the Epiphytic Organisms	441
III. Distribution and Abundance of Epiphytic Organisms	443
IV. Factors Affecting Distribution and Abundance	450
V. Conclusions	456
References	456
20 The Central Role of Grazing in Seagrass Ecology	463–501
<i>John F. Valentine and J. Emmett Duffy</i>	
I. Introduction	463
II. Philosophy of the Review	465
III. An Evolutionary Perspective on Seagrasses and their Grazers	466
IV. The Modern Seagrass Community Interaction Web	467
V. Direct Grazing on Seagrasses	468
VI. Indirect Effects of Grazing on Seagrass Communities: A Delicate Balance	481
VII. Bottom-Up and Top-Down Control in Seagrass Communities	485
VIII. Alternate Stable States in Seagrass Ecosystems?	488
IX. Questions and Recommendations for Future Research	489
X. Summary	491
Acknowledgments	492
References	492

21 Seagrasses, Fish, and Fisheries	503–536
<i>Bronwyn M. Gillanders</i>	
I. Introduction	503
II. Use of Seagrass Beds by Fish Species	503
III. Comparison of Abundance, Diversity, Growth, and Survival of Fish in Seagrass Habitats, with Other Nearshore Habitats	505
IV. Spatial Scales—Factors Influencing Abundance of Fish in Seagrass Beds	509
V. Temporal Scales—Factors Influencing Abundance of Fish in Seagrass Beds	516
VI. Links Between Seagrass and Fisheries	517
VII. Conservation and Management Issues	524
VIII. Future Research Directions	527
Acknowledgments	530
References	530
22 Predation in Seagrass Beds	537–550
<i>Kenneth L. Heck and Robert J. Orth</i>	
I. Introduction	537
II. Effects of Seagrasses on Predator–Prey Interactions in Ecological Time	537
III. Effects of Seagrass on Predator–Prey Interactions in Evolutionary Time	545
IV. Summary	546
References	547
23 Decline and Recovery of Seagrass Ecosystems—The Dynamics of Change	551–565
<i>Diana I. Walker, Gary A. Kendrick, and Arthur J. McComb</i>	
I. Introduction	551
II. Changes in Seagrass Distributions	551
III. Loss of Seagrass Beds	552
IV. Case Study 1: Why did We Lose Seagrasses in Cockburn Sound Whereas Seagrass Area has Expanded on Neighbouring Parmelia and Success Banks?	556
V. Case Study 2: Florida Bay	560
VI. Species-Specific Recruitment and Growth Characteristics	560
VII. Can Seagrass Management be Proactive?	562
References	562
24 Human Impacts on Seagrasses: Eutrophication, Sedimentation and Contamination	567–593
<i>Peter J. Ralph, David Tomasko, Kenneth Moore, Stephanie Seddon, and Catriona M. O. Macinnis-Ng</i>	
I. Introduction	567
II. Anthropogenic Stressors	568
III. Management of Anthropogenic Pollutants	584
IV. Recommended Research Directions	586
V. Summary	587
References	587

25	Seagrass Conservation Biology: An Interdisciplinary Science for Protection of the Seagrass Biome	595–623
	<i>W. Judson Kenworthy, Sandy Wyllie-Echeverria, Robert G. Coles, Gérard Pergent and Christine Pergent-Martini</i>	
	I. Introduction	595
	II. The State of Seagrass Science Relative to Conservation Biology	604
	III. Seagrasses Conservation Biology: An Approach for the Future	605
	IV. Science-Based Protection Approaches	610
	V. Implementing Conservation Tools: Two Examples	612
	VI. Summary and Outlook	617
	Acknowledgments	617
	References	617
26	Seagrass Ecology: New Contributions from a Landscape Perspective	625–645
	<i>Susan S. Bell, Mark S. Fonseca, and Nathaniel B. Stafford</i>	
	I. Introduction	625
	II. The Landscape Approach	626
	III. Historical Overview	629
	IV. Terrestrial vs. Marine Landscapes	635
	V. Landscape Dynamics	636
	VI. Boundaries and Seagrass Landscapes	638
	VII. Conceptual and Methodological Improvements	639
	VIII. Future Directions	640
	IX. Summary	641
	Acknowledgments	641
	References	641
	Epilogue	647
	Index	649

Seagrasses: Biology, Ecology and Conservation

Larkum, A.W.D.; Orth, R.J.; Duarte, C. (Eds.)

2006, XVI, 676 p., Hardcover

ISBN: 978-1-4020-2942-4