

Contents

| | |
|---|-----------|
| ACKNOWLEDGMENTS | v |
| PREFACE TO THE SECOND EDITION | xxiii |
| PREFACE TO THE FIRST EDITION | xxvii |
| 1 Introduction | 1 |
| The Divisions of Plant Science | 1 |
| The Origin and Development of Living Things | 3 |
| The Classification of Plants | 5 |
| 2 Introduction to Algae; Cyanophycophyta | 9 |
| Algae, General Features | 9 |
| <i>Definition of Algae</i> | 9 |
| <i>Habitat</i> | 9 |
| <i>Organization of the Plant Body</i> | 10 |
| <i>Classification of Algae</i> | 10 |
| Division Cyanophycophyta | 10 |
| <i>General Features</i> | 10 |
| Illustrative Types | 13 |
| Unicellular Genera: <i>Chroococcus</i> , <i>Gloeocapsa</i> , and <i>Chamaesiphon</i> | 13 |
| Colonial Genera: <i>Polycystis</i> and <i>Merismopedia</i> | 16 |
| Filamentous Genera: <i>Oscillatoria</i> , <i>Lyngbya</i> , <i>Anabaena</i> , <i>Nostoc</i> , <i>Scytonema</i> , <i>Rivularia</i> , <i>Gloeotrichia</i> , <i>Calothrix</i> , and <i>Hapalosiphon</i> | 16 |
| Summary and Classification | 21 |
| 3 Division Chlorophycophyta | 24 |
| General Features | 24 |
| I. Motile Unicellular and Colonial Organisms | 26 |
| A. <i>Unicellular Types</i> | 26 |
| B. <i>Colonial Types</i> | 31 |

| | | |
|---|--|-----------|
| II. Nonmotile Unicellular and Colonial Organisms | 34 | |
| A. <i>Unicellular Types</i> | 34 | |
| 1. Zoospore Producers | 35 | |
| 2. Forms Lacking Zoospores | 39 | |
| B. <i>Nonmotile Colonial Organisms</i> | 39 | |
| 1. Zoospore Producers | 41 | |
| 2. Colonial Organisms Lacking Zoospores | 41 | |
| III. Filamentous Organisms | 42 | |
| A. <i>Filamentous Organisms with Flagellate Stages</i> | 42 | |
| B. <i>Filamentous Organisms Lacking Flagellate Reproductive Cells</i> | 49 | |
| Desmids | 51 | |
| IV. Membranous Organisms | 53 | |
| V. Coenocytic and Tubular Organisms | 54 | |
| Summary and Classification | 57 | |
| | | |
| 4 | Division Phaeophycophyta | 60 |
| | General Features | 60 |
| | Illustrative Genera | 60 |
| | <i>Filamentous Type: Ectocarpus</i> | 60 |
| | <i>The Kelps</i> | 62 |
| | Other Kelps | 65 |
| | <i>The Rockweeds: Fucus and Sargassum</i> | 66 |
| | Summary and Classification | 69 |
| | | |
| 5 | Division Rhodophycophyta | 71 |
| | General Features | 71 |
| | Illustrative Genera | 73 |
| | Summary and Classification | 82 |
| | | |
| 6 | Divisions Charophyta, Euglenophycophyta, and Pyrrhophycophyta | 84 |
| | Introduction | 84 |
| | Division Charophyta | 84 |
| | Division Euglenophycophyta | 88 |
| | Division Pyrrhophycophyta | 90 |

| | | |
|-----------|---|------------|
| 7 | Division Chrysophycophyta | 93 |
| | Introduction | 93 |
| | Class Xanthophyceae | 93 |
| | Class Chrysophyceae | 97 |
| | Class Bacillariophyceae | 99 |
| | Summary | 103 |
| 8 | The Algae: Recapitulation | 105 |
| | Classification | 105 |
| | Pigmentation and Storage Products | 106 |
| | Organization of the Plant Body | 106 |
| | Reproduction | 106 |
| | Economic Aspects of Algae | 107 |
| | Fossil Algae | 108 |
| 9 | Introduction to Fungi; Division Schizomycota | 112 |
| | Introduction | 112 |
| | Nutrition | 112 |
| | Division Schizomycota | 114 |
| | <i>Sexuality</i> | 118 |
| | The Actinomycetes | 119 |
| 10 | Division Myxomycota | 121 |
| | Introduction | 121 |
| | <i>Myxomycetes</i> | 121 |
| | Illustrative Genera | 121 |
| | <i>Acrasiomycetes</i> | 125 |
| | Summary and Classification | 125 |
| 11 | Division Phycomycota | 127 |
| | Introduction | 127 |
| | Illustrative Types | 127 |
| | Chytrids | 127 |
| | Allomyces | 130 |
| | The Water Molds | 133 |
| | Albrigo | 135 |
| | Rhizopus Stolonifer and Related Molds | 137 |
| | Summary and Classification | 140 |

| | | |
|-----------|--|-----|
| 12 | Division Ascomycota | 142 |
| | Introduction | 142 |
| | Illustrative Types | 142 |
| | <i>The Yeasts</i> | 142 |
| | <i>Brown, Green, and Pink Molds</i> | 143 |
| | <i>Powdery Mildews</i> | 148 |
| | <i>Cup Fungi</i> | 149 |
| | Summary and Classification | 153 |
| | | |
| 13 | Division Basidiomycota | 155 |
| | Introduction | 155 |
| | Illustrative Types | 155 |
| | <i>Rusts</i> | 155 |
| | <i>Smut Fungi</i> | 161 |
| | <i>Mushrooms</i> | 162 |
| | <i>Other Basidiomycota</i> | 165 |
| | Summary and Classification | 168 |
| | | |
| 14 | Deuteromycota; Predaceous Fungi; Lichens; Recapitulation of the Fungi | 170 |
| | Deuteromycota | 170 |
| | Predaceous Fungi | 170 |
| | Lichens | 173 |
| | Fossil Fungi | 177 |
| | Recapitulation of the Fungi | 179 |
| | | |
| 15 | Introduction to the Land Plants; Division Hepatophyta | 183 |
| | Introduction to the Land Plants | 183 |
| | Division Hepatophyta | 183 |
| | Class 1. Hepatopsida | 184 |
| | <i>Introduction</i> | 184 |
| | <i>Order 1. Marchantiales</i> | 184 |
| | Family 1. Ricciaceae | 184 |
| | Family 2. Marchantiaceae | 189 |

| | |
|-----------------------------------|------------|
| <i>Order 2. Sphaerocarpaceae</i> | 198 |
| Family 1. Sphaerocarpaceae | 198 |
| Family 2. Riellaceae | 201 |
| <i>Order 3. Jungermanniales</i> | 201 |
| Suborder 1. Metzgerineae | 202 |
| Family 1. Metzgeriaceae | 202 |
| Suborder 2. Jungermannineae | 207 |
| Family 1. Jungermanniaceae | 207 |
| <i>Order 4. Calobryales</i> | 212 |
| Family 1. Calobryaceae | 212 |
| <i>Order 5. Takakiales</i> | 213 |
| Family 1. Takakiaceae | 213 |
| Class 2. Anthocerotopsida | 213 |
| <i>Introduction</i> | 213 |
| <i>Order 1. Anthocerotales</i> | 214 |
| Family 1. Anthocerotaceae | 214 |
| Fossil Hepatophyta | 219 |
| Summary and Classification | 220 |

16 Division Bryophyta

225

| | |
|--|------------|
| Introduction | 225 |
| Class 1. Sphagnopsida | 225 |
| <i>Order 1. Sphagnales</i> | 225 |
| Family 1. Sphagnaceae | 225 |
| Summary | 229 |
| Class 2. Mnionopsida | 229 |
| Summary | 242 |
| Class 3. Andreaeopsida | 242 |
| <i>Order 1. Andreaeales</i> | 242 |
| Family 1. Andreaeaceae | 242 |
| Summary | 244 |
| The Relationship of Liverworts and Mosses | 244 |
| Fossil Bryophyta | 245 |
| Phylogenetic Considerations | 245 |
| Classification of Bryophyta | 246 |
| Theoretical Aspects of Alternation of Generations | 247 |

| | | |
|-----------|---|------------|
| 17 | Introduction to Vascular Plants | 250 |
| | I. Classification of Vascular Plants | 250 |
| | II. Organization of the Vascular Plant Body | 251 |
| | A. <i>The Stem</i> | 251 |
| | (1) Ontogeny of the Primary Stem | 251 |
| | (2) Nodal Anatomy | 258 |
| | (3) Steles | 259 |
| | (4) Secondary Growth | 261 |
| | B. <i>The Root</i> | 262 |
| | C. <i>The Leaf</i> | 263 |
| | | |
| 18 | Psilophyta | 268 |
| | <i>Order 1. Psilotales</i> | 268 |
| | Family 1. Psilotaceae | 268 |
| | Summary | 275 |
| | <i>Order 2. Psilophytales</i> | 275 |
| | Family 1. Psilophytaceae | 275 |
| | Family 2. Asteroxylaceae | 276 |
| | Family 3. Rhyniaceae | 277 |
| | | |
| 19 | Division Microphyllphyta | 280 |
| | Class 1. Aglossopsida | 281 |
| | <i>Order 1. Lycopodiales</i> | 281 |
| | Family 1. Lycopodiaceae | 281 |
| | Summary | 286 |
| | Class 2. Glossopsida | 287 |
| | <i>Order 1. Selaginellales</i> | 287 |
| | Family 1. Selaginellaceae | 287 |
| | <i>Order 2. Isoetales</i> | 297 |
| | Family 1. Isoetaceae | 297 |
| | Summary | 301 |
| | Fossil Microphyllphyta | 302 |
| | <i>Order 1. Protolpidodendrales</i> | 302 |
| | <i>Order 2. Lycopodiales</i> | 303 |
| | <i>Order 3. Lepidodendrales</i> | 303 |
| | <i>Order 4. Selaginellales</i> | 307 |
| | <i>Order 5. Isoetales</i> | 307 |
| | <i>Order 6. Pleuromeiales</i> | 308 |
| | Summary | 308 |

| | | |
|-----------|---|------------|
| 20 | Division Arthrophyta | 310 |
| | <i>Order 1. Equisetales</i> | 310 |
| | Family 1. Equisetaceae | 310 |
| | Summary | 319 |
| | Fossil Arthrophyta | 320 |
| | <i>Order 1. Hyeniales</i> | 320 |
| | <i>Order 2. Calamitales</i> | 321 |
| | <i>Order 3. Sphenophyllales</i> | 323 |
| | <i>Order 4. Equisetales</i> | 324 |
| | Summary of Fossil Arthrophyta | 324 |
| | | |
| 21 | Division Pterophyta—I | 326 |
| | Introduction | 326 |
| | Class 1. Eusporangiospida | 326 |
| | <i>Order 1. Ophioglossales</i> | 326 |
| | Family 1. Ophioglossaceae | 326 |
| | <i>Order 2. Marattiales</i> | 330 |
| | Family 1. Marattiaceae | 330 |
| | Summary and Classification | 333 |
| | | |
| 22 | Division Pterophyta—II | 335 |
| | Class 2. Leptosporangiopsida | 335 |
| | <i>Order 1. Filicales</i> | 335 |
| | Family 1. Polypodiaceae | 335 |
| | <i>Other Filicales</i> | 347 |
| | Family 2. Osmundaceae | 347 |
| | Family 3. Schizaeaceae | 353 |
| | Family 4. Hymenophyllaceae | 353 |
| | Families 5 and 6. Cyatheaceae and Dicksoniaceae | 354 |
| | Summary of Filicales | 355 |
| | The Fern Life Cycle | 356 |
| | | |
| 23 | Division Pterophyta—III | 360 |
| | <i>Order 2. Marsileales</i> | 360 |
| | Family 1. Marsileaceae | 360 |

| | | |
|-----------|--|------------|
| | Summary of Marsileales | 366 |
| | <i>Order 3. Salviniiales</i> | 367 |
| | Fossil Pterophyta | 368 |
| | <i>Order 1. Protopteridiales</i> | 369 |
| | <i>Order 2. Cladoxylales</i> | 369 |
| | <i>Order 3. Coenopteridales</i> | 371 |
| | <i>Order 4. Marattiales</i> | 372 |
| | <i>Orders 5, 6. Filicales and Salviniiales</i> | 372 |
| | Classification and Summary of Pterophyta | 374 |
| 24 | The Vascular Cryptogams: Recapitulation | 378 |
| | The Life Cycle | 378 |
| | <i>The Sporophyte</i> | 380 |
| | Vegetative Organs | 380 |
| | Sporogenous Tissue | 381 |
| | <i>The Gametophyte</i> | 382 |
| | <i>The Embryo</i> | 382 |
| | Phylogenetic Considerations | 383 |
| 25 | Introduction to Seed Plants; Division Cycadophyta | 388 |
| | Introduction to Seed Plants | 388 |
| | Class 1. Cycadopsida | 389 |
| | <i>Order 1. Cycadales</i> | 389 |
| | Family 1. Cycadaceae | 389 |
| | Summary of Extant Cycadopsida | 403 |
| | Some Primitive Fossil Seed Plants | 404 |
| | Class 1. Pteridospermopsida | 404 |
| | Class 2. Cycadeoidopsida | 408 |
| | Class 3. Cycadopsida | 409 |
| | Classification | 410 |
| 26 | Division Ginkgophyta | 413 |
| | Class 1. Ginkgopsida | 413 |
| | <i>Fossil Precursors of Ginkgo</i> | 422 |
| | Summary and Classification | 422 |

| | | |
|-----------|--|-----|
| 27 | Division Coniferophyta | 424 |
| | Class 1. Coniferopsida | 424 |
| | <i>Order 1. Coniferales</i> | 425 |
| | Family 1. Abietaceae | 425 |
| | <i>Other Abietaceae</i> | 438 |
| | Family 2. Taxodiaceae | 439 |
| | Family 3. Cupressaceae | 440 |
| | Family 4. Araucariaceae | 440 |
| | Family 5. Podocarpaceae | 441 |
| | Class 2. Taxopsida | 441 |
| | <i>Order 1. Taxales</i> | 441 |
| | Class 3. Cordaitopsida | 442 |
| | Classification and Summary | 447 |
| | | |
| 28 | Division Gnetophyta | 449 |
| | Class 1. Gnetophyta | 449 |
| | <i>Order 1. Ephedrales</i> | 449 |
| | <i>Orders 2 and 3. Gnetales and Welwitschiales</i> | 458 |
| | Summary and Classification | 461 |
| | | |
| 29 | Gymnosperms: Recapitulation | 463 |
| | Comparison of Vegetative Attributes | 463 |
| | Reproduction in the Gymnosperms | 464 |
| | | |
| 30 | Division Anthophyta—I | 466 |
| | The Vegetative Organization of Anthophyta | 466 |
| | <i>The Leaf</i> | 466 |
| | <i>The Stem</i> | 467 |
| | <i>The Root</i> | 468 |
| | Reproduction | 468 |
| | <i>Gross Morphology of the Flower</i> | 468 |
| | <i>The Reproductive Process</i> | 476 |
| | (1) Microsporogenesis | 477 |
| | (2) Megasporogenesis | 478 |
| | (3) Development of the Male Gametophyte | 479 |
| | (4) Development of the Female Gametophyte | 480 |
| | (5) Pollination and Fertilization | 483 |
| | (6) Development of the Embryo, Seed, and Fruit | 485 |

| | |
|-----------------------------|-----|
| I. <i>Simple Fruits</i> | 490 |
| A. Dry Fruits | 490 |
| B. Fleshy Fruits | 490 |
| II. <i>Aggregate Fruits</i> | 490 |
| III. <i>Multiple Fruits</i> | 491 |
| Summary | 493 |

31 Division Anthophyta—II 495

| | |
|--|-----|
| The Origin and Fossil Record of Angiosperms | 495 |
| The Origin of Angiospermy | 498 |
| The Nature of Primitive Flowers | 500 |
| The Origin of Other Angiospermous Attributes | 502 |

32 General Summary 504

| | |
|---|-----|
| Introduction | 504 |
| Vegetative Organization | 504 |
| <i>Form and Growth</i> | 504 |
| <i>Differentiation</i> | 506 |
| <i>Nutrition and Habitat</i> | 507 |
| <i>Reproduction</i> | 508 |
| The Fossil Record, Classification and Phylogeny | 511 |
| Glossary | 519 |
| Index | 531 |