

BL-W-750

2769-1078

EXTREME ADAPTATIONS IN ANGIOSPERMOUS HYDROPHYTES

by

Professor Dr. ELIAS LANDOLT
Zürich

Dr. IRMGARD JÄGER-ZÜRN
Königstein

Professor Dr. R.A.A. SCHNELL
Paris

With 226 figures and 7 tables in the text

1998

GEBRÜDER BORNTRAEGER · BERLIN · STUTTGART

Contents

I. Anatomy of the Lemnaceae (duckweeds)

By E. LANDOLT, Zürich

| | |
|--|-----|
| Abbreviations | 1 |
| 1. Introduction | 1 |
| 1.1. History of the Lemnaceae investigations; literature | 1 |
| 1.2. Human importance of Lemnaceae | 2 |
| 1.3. Taxonomic organization | 4 |
| 1.4. Systematic position within the monocotyledons | 7 |
| 2. Organization and structure of the Lemnaceae | 8 |
| 2.1. Appearance and structure of the plant body | 8 |
| 2.2. Interpretation of the frond | 18 |
| 2.3. Mode of growth; growth rate | 23 |
| 2.4. Life-span and ageing; position and number of daughter fronds | 23 |
| 3. Growing fronds | 28 |
| 3.1. Shape, size, and weight | 28 |
| 3.2. Colour and brightness | 29 |
| 3.3. Elements of the normal cell | 31 |
| 3.4. Specialized cells | 37 |
| 3.5. Epidermis, stomata, and papules (papillae) | 40 |
| 3.6. Meristematic and parenchymatic tissue; air spaces | 49 |
| 3.7. Nerves and tracts of elongated cells; vascular and sieve elements | 56 |
| 3.8. Pouches (pockets) and cavities protecting daughter fronds | 64 |
| 3.9. Connection between mother and daughter frond (stipe) | 64 |
| 3.10. Devices of stabilization | 67 |
| 3.11. Roots | 69 |
| 3.12. Prophyllum in <i>Spirodela</i> | 76 |
| 4. Resting fronds | 77 |
| 4.1. Appearance, size and shape; anatomical features | 77 |
| 4.2. Tolerances of turions against environmental conditions | 80 |
| 4.3. Factors causing formation and germination of turions | 80 |
| 4.4. Ecological significance of resting fronds and turions | 81 |
| 5. Flowers and fruits | 82 |
| 5.1. Aspects of flowering fronds; position and number of flowers | 82 |
| 5.2. Flowering organs; formation of flowers | 85 |
| 5.3. Flower prophyllum | 88 |
| 5.4. Stamens | 89 |
| 5.5. Pistil | 92 |
| 5.6. Interpretation of the flowering organs | 94 |
| 5.7. Pollination | 95 |
| 5.8. Fruit development | 97 |
| 5.9. Fruits and seeds | 100 |

| | |
|--|-----|
| 5.10. Germination of seeds | 106 |
| 5.11. Ecological significance of seeds | 107 |
| 6. Ecology and distribution in relation to morphological and anatomical characters | 108 |
| 6.1. Ecological significance of morphological and anatomical features | 108 |
| 6.2. Ecology and distribution | 111 |
| Acknowledgements | 116 |
| Bibliography | 116 |

II. Anatomy of the Hydrostachyaceae

By I. JÄGER-ZÜRN, Königstein

| | |
|--|-----|
| Introduction | 129 |
| General plant structure | 130 |
| 1. Vegetative structures | 133 |
| 1.1. Germination | 133 |
| 1.2. Stem | 135 |
| 1.3. Leaves | 140 |
| 1.3.1. Anatomy of leaves | 144 |
| 1.3.2. Emergences of leaves | 148 |
| 1.3.3. Developmental morphology of leaves | 152 |
| 1.4. Roots | 154 |
| 1.4.1. Root tip | 158 |
| 1.4.2. Root-borne shoots | 158 |
| 2. Floral structures | 159 |
| 2.1. Inflorescences | 159 |
| 2.2. Flowers | 161 |
| 2.2.1. Female flower | 161 |
| 2.2.2. Male flower | 165 |
| 2.2.3. Bracts | 168 |
| 2.3. Embryology | 169 |
| 2.3.1. Female embryology | 169 |
| 2.3.2. Embryo | 175 |
| 2.3.3. Seed | 177 |
| 2.3.4. Male embryology | 177 |
| 3. The systematic position of the Hydrostachyaceae | 181 |
| 3.1. Points of view for a higher order classification of Hydrostachyaceae on account of new data | 183 |
| 3.1.1. Embryological data | 183 |
| 3.1.2. Flower morphological data | 184 |
| 3.1.3. Cladistics | 186 |
| 3.1.4. Myxospermy | 186 |
| 3.1.5. Palynological data | 186 |
| 3.1.6. Phytochemical data | 187 |

| | |
|---|-----|
| 3.1.7. Phylogenetic relationships based on molecular data | 188 |
| Addition in proof | 191 |
| Acknowledgement | 192 |
| Genus <i>Hydrostachys</i> : List of species and synonyms | 192 |
| References | 193 |

III. Anatomie des Podostémacées [III. Anatomy of the Podostemaceae]

Par R. A. A. SCHNELL, Paris

| | |
|---|-----|
| 1. Introduction [Introduction] | 197 |
| 1.1. Généralités [General views] | 197 |
| 1.2. Historique [A historical recall] | 199 |
| 1.2.1. Les travaux anciens [Past works] | 199 |
| 1.2.2. Les travaux récents [Recent works] | 200 |
| 1.3. Aspects taxonomiques [Taxonomical features] | 202 |
| 1.3.1. La question des Hydrostachyacées [The Hydrostachyaceae question] | 202 |
| 1.3.2. Le cas des <i>Tristicha</i> [The case of <i>Tristicha</i>] | 202 |
| 1.3.3. Subdivisions des Podostémacées [Subdivisions in the Podostemaceae] | 203 |
| 1.4. Les affinités des Podostémacées [Affinities of Podostemaceae] | 203 |
| 1.4.1. Dans le cadre des flores actuelles [with the present floras] | 203 |
| 1.4.2. Une origine très ancienne? [An ancestral origin?] | 204 |
| 1.5. Traits morphologiques généraux [Main morphological features] | 205 |
| 2. Morphologie de l'appareil végétatif [Morphology of the vegetative body] | 207 |
| 2.1. Ontogénie. La »racine« [Ontogeny. The so-called root] | 207 |
| 2.2. Développement de la »racine« [Root development] | 211 |
| 2.3. Le thalle. Ses structures [The thallus and its structures] | 214 |
| 2.4. Les feuilles [The leaves] | 216 |
| 2.4.1. Divers types morphologiques [Various morphological types] | 216 |
| 2.4.2. Les feuilles de nature thalloïde [The thalloid-like leaves] | 216 |
| 2.4.3. La feuille de <i>Mourera fluviatilis</i> [The leaf in <i>Mourera fluviatilis</i>] | 220 |
| 2.4.4. Variations de la feuille au sein d'un même genre [Leaf variations within the genus frame] | 224 |
| 2.4.5. Les microphylls [The minute leaves] | 224 |
| 2.4.6. La feuille du <i>Tristicha</i> [The leaf in <i>Tristicha</i>] | 224 |
| 3. Anatomie de l'appareil végétatif [Anatomy of the vegetative body] | 224 |
| 3.1. Le tissu général [The fundamental tissue] | 224 |
| 3.2. Les éléments sécréteurs [The secreting cells] | 227 |
| 3.3. Les appendices du thalle [The thallus appendices] | 228 |
| 3.4. Les émergences des <i>Mourera</i> [The warts in <i>Mourera</i>] | 230 |
| 3.5. Interprétation des structures précédentes [Interpretation of the above structures] | 233 |

| | | |
|--------|--|------------|
| 3.6. | Les thalles très finement divisés [The carved thallus] | 237 |
| 3.7. | Les thalles très divisés issus de »racines thalloïdes« [The carved thallus from thalloid roots] | 238 |
| 3.8. | Feuilles à rôle absorbant chez les espèces à microphylls [Absorbing leaves by microphylls-bearing species] | 238 |
| 3.9. | Trifurcations et pseudo-dichotomies [Three-forked twigs and false dichotomies] | 238 |
| 3.10. | Les nodules de silice [The silice particles] | 240 |
| 3.11. | L'accumulation d'amidon [The starch storage] | 241 |
| 3.12. | Les stèles [The steles] | 242 |
| 3.13. | La gaine des stèles. Collenchyme et sclérenchyme [The sheath: collenchyme and sclerenchyme] | 243 |
| 3.14. | Les trachéides [The tracheids] | 244 |
| 3.15. | Le phloème. Historique [The phloem] | 248 |
| 3.16. | Les recloisonnements dans les stèles et le phloème [Cell partitions in steles and phloem] | 249 |
| 3.17. | Conclusion sur les stèles [Conclusion regarding the steles] | 251 |
| 4. | La fleur et le fruit [Flower and fruit] | 251 |
| 4.1. | La fleur [The flower] | 251 |
| 4.1.1. | Localisation des fleurs [Location of the flowers] | 251 |
| 4.1.2. | Structure générale de la fleur [General flower structure] | 252 |
| 4.1.3. | Le périanthe [The perianth] | 255 |
| 4.1.4. | L'androcée [The androcaemum] | 256 |
| 4.1.5. | Le gynécée [The gynecaemum] | 256 |
| 4.1.6. | L'anthèse et la pollinisation [Anthesis and pollination] | 260 |
| 4.2. | Le fruit [The fruit] | 263 |
| 4.3. | Les graines et leur dispersion [Seeds and their dispersal] | 263 |
| 4.4. | Le cycle annuel [Yearly cycle] | 270 |
| 5. | Les Podostémacées et le milieu [Podostemaceae and environment] | 271 |
| 5.1. | La nutrition [Nutrition] | 271 |
| 5.2. | Ecologie des Podostémacées [Ecology] | 272 |
| 5.3. | L'action de l'homme sur les Podostémacées [Man impact] | 273 |
| 5.4. | Biogéographie des Podostémacées [Biogeography] | 273 |
| 6. | Conclusion générale [General conclusions] | 274 |
| 6.1. | Les problèmes [The problems] | 274 |
| 6.2. | Les feuilles primordiales de la plantule [Seedling primitive leaves] | 275 |
| 6.3. | Le problème des plantes ancestrales [The question of ancestral plants] | 275 |
| 6.4. | Les faits chorologiques et l'hypothèse d'une origine gondwanienne [Chorology and supposed Gondwanian origin] | 276 |
| 6.5. | Le problème des relations possibles entre les formes à microphylls et les structures thalloïdes [Presumed relationships between microphylls stems and thalloid structures] | 277 |
| 6.6. | Résumé synthétique [Synthetic summary] | 278 |
| | Bibliographie [References] | 279 |
| | General Index | 285 |