

CONTENTS

1. Introduction - Acknowledgements	7
2. Morphological characteristics: variability and function	13
2.1. General	13
2.2. Structure and organization of <u>Lemnaceae</u> plants; interpretation of different organs	13
2.2.1. Description of the frond	13
2.2.2. Interpretation of the frond	20
2.3. Growth and ageing of fronds; formation of daughter fronds	27
2.3.1. Mode of growth; growth rate	27
2.3.2. Lifespan and ageing	28
2.3.3. Number of daughter fronds	31
2.3.4. Position of daughter fronds	31
2.4. Characteristics of normal vegetative fronds	36
2.4. 1. Form, size and weight	36
2.4. 2. Elements of the cells	41
2.4. 3. Colour and brightness; pigment cells	46
2.4. 4. Epidermis, stomata and papillae (papules)	48
2.4. 5. Air spaces and parenchymatic tissue	54
2.4. 6. Nerves and tracts of elongated cells in the basal section of fronds; vascular and sieve cells	58
2.4. 7. Oxalate-crystal idioblasts	61
2.4. 8. Pouches (pockets) and cavities protecting daughter fronds	64
2.4. 9. Connection between mother and daughter frond (stipe)	66
2.4.10. Prophyllum in <u>Spirodela</u>	67
2.4.11. Roots	69
2.4.12. Organs of stabilization	77
2.5. Characteristics of resting fronds and turions	80
2.5.1. Different kinds of resting fronds	80
2.5.2. Factors causing formation of turions	84
2.5.3. Factors causing germination of turions	86
2.6. Characteristics of flowering and fruiting fronds	89
2.6.1. Aspects of flowering fronds	89
2.6.2. Morphology and interpretation of flowering organs	92
2.6.3. Development of flowers and fruits	105
2.6.4. Ripening of flowers	113
2.6.5. Fruits and seeds	115
2.6.6. Germination of seeds	123
2.7. Use of morphological features in taxonomy of <u>Lemnaceae</u> ; preparation of transparent slides	127
3. Karyology	129
3.1. Chromosome numbers	129
3.2. Morphological characteristics and DNA content of chromosomes	137
4. Habitat demands and ecological behaviour	138
4.1. General	138
4.2. Vegetative growth	139
4.2.1. Physical characteristics of the water body	139
4.2.2. Temperature conditions	142
4.2.3. Light condition	147

1805

67563

Quercus

4.2.4. Chemical composition of the water	149
4.3. Sexual reproduction	167
4.3.1. Flowering conditions	167
4.3.2. Pollination and fruit setting	178
4.4. Dispersal and survival	181
4.4.1. Dispersal	181
4.4.2. Survival during unfavourable conditions	183
5. Position within the ecosystem	186
5.1. Ecosystems with <u>Lemnaceae</u>	186
5.2. Specific abiotic factors in ecosystems with <u>Lemnaceae</u>	189
5.3. Relationship of <u>Lemnaceae</u> to other organisms	192
5.3.1. Herbivores and parasites	192
5.3.2. Mutualists, commensalists, and amensalists	195
5.3.3. Competitors	201
5.4. Relationship between members of the family of <u>Lemnaceae</u> and other small, free-floating, vascular plant species	204
5.5. Plant communities with <u>Lemnaceae</u>	207
5.5.1. Characteristics of <u>Lemnaceae</u> communities and principles of classification	207
5.5.2. Survey of <u>Lemnaceae</u> communities	215
5.5.3. Influence on <u>Lemnaceae</u> communities by human activities	228
6. Geographic distribution; distribution patterns	229
6.1. Geographic distribution	229
6.1.1. Procedure and methods	229
6.1.2. Distribution of the family; species diversity	233
6.1.3. Distribution of the different species	238
6.1.3. 1. <u>Spirodela intermedia</u>	238
6.1.3. 2. <u>S. polyrrhiz</u>	243
6.1.3. 3. <u>S. punctata</u>	255
6.1.3. 4. <u>Lemna gibba</u>	262
6.1.3. 5. <u>L. disperma</u>	273
6.1.3. 6. <u>L. minor</u>	275
6.1.3. 7. <u>L. japonica</u>	283
6.1.3. 8. <u>L. ecuadoriensis</u>	284
6.1.3. 9. <u>L. obscura</u>	284
6.1.3.10. <u>L. turionifera</u>	287
6.1.3.11. <u>L. trisulca</u>	292
6.1.3.12. <u>L. perpusilla</u>	301
6.1.3.13. <u>L. aequinoctialis</u>	303
6.1.3.14. <u>L. tenera</u>	320
6.1.3.15. <u>L. valdiviana</u>	321
6.1.3.16. <u>L. minuscula</u>	327
6.1.3.17. <u>Wolffiella hyalina</u>	335
6.1.3.18. <u>W. repanda</u>	336
6.1.3.19. <u>W. rotunda</u>	337
6.1.3.20. <u>W. neotropica</u>	337
6.1.3.21. <u>W. Welwitschii</u>	339
6.1.3.22. <u>W. lingulata</u>	343
6.1.3.23. <u>W. oblonga</u>	347
6.1.3.24. <u>W. gladiata</u>	352
6.1.3.25. <u>W. denticulata</u>	353
6.1.3.26. <u>Wolffia microscopica</u>	355
6.1.3.27. <u>W. elongata</u>	355
6.1.3.28. <u>W. brasiliensis</u>	357
6.1.3.29. <u>W. borealis</u>	362

6.1.3.30. <u>W. australiana</u>	363
6.1.3.31. <u>W. angusta</u>	365
6.1.3.32. <u>W. arrhiza</u>	366
6.1.3.33. <u>W. columbiana</u>	371
6.1.3.34. <u>W. globosa</u>	377
6.2. Altitudinal distribution	381
6.3. Relationship between ecological demands, climatic factors, and geographic distribution	392
6.3.1. Local factors interfering with the general distribution	392
6.3.2. General climatic factors limiting the distribution of <u>Lemnaceae</u>	395
6.3.3. Distribution within the Climate zones	402
6.4. Dispersal and threat by man	406
7. Systematic position, taxonomical relations, species differentiation	410
7.1. Paleobotanical records	410
7.2. Position within the plant kingdom	412
7.3. Taxonomical relationship within the family	417
7.3.1. Differentiation of the genera	417
7.3.2. Differentiation within the genera	421
7.3.3. Differentiation within the species	429
8. Nomenclature	436
8.1. Typification and validity of names	436
8.1.1. General remarks	436
8.1.2. Names of family, subfamilies, genera and species	437
8.2. List of names and synonyms	455
9. Description of family, genera, and species of <u>Lemnaceae</u> with key for determination	461
9.1. Description of the family of <u>Lemnaceae</u> with key to the subfamilies	461
9.2. Subfamily of <u>Lemnoideae</u>	463
9.2.1. Description of the subfamily of <u>Lemnoideae</u> with key to the genera	463
9.2.2. Genus <u>Spirodela</u> Schleiden	466
9.2.3. Genus <u>Lemna</u> L.	471
9.3. Subfamily of <u>Wolffioideae</u>	530
9.3.1. Description of the subfamily of <u>Wolffioideae</u> with key to the genera	530
9.3.2. Genus <u>Wolffiella</u> Hegelmaier	532
9.3.3. Genus <u>Wolffia</u> Horkel	544
References. All the references and a complete survey of the <u>Lemnaceae</u> bibliography are given in vol. 2	
Abbreviations (especially chemical substances)	553
List of the figures in vol. 1	555
List of the tables in vol. 1	558
Index of subjects and names of plants	559
Contents of vol. 2 (E. LANDOLT and R. KANDELER, 1987. Veröff.Geobot.Inst.ETH,Stiftung Rübél,Zürich, 95)	565