

Contents

Preface	ix
Copyright Acknowledgements	xi
1 Introduction to Freshwater Algae	1
1.1 General introduction	1
1.1.1 Algae – an overview	1
1.1.2 Algae as primary producers	2
1.1.3 Freshwater environments	3
1.1.4 Planktonic and benthic algae	3
1.1.5 Size and shape	4
1.2 Taxonomic variation – the major groups of algae	5
1.2.1 Microscopical appearance	8
1.2.2 Biochemistry and cell structure	9
1.2.3 Molecular characterization and identification	9
1.3 Blue-green algae	12
1.3.1 Cytology	12
1.3.2 Morphological and taxonomic diversity	13
1.3.3 Ecology	15
1.3.4 Blue-green algae as bio-indicators	17
1.4 Green algae	17
1.4.1 Cytology	17
1.4.2 Morphological diversity	17
1.4.3 Ecology	18
1.4.4 Green algae as bioindicators	21
1.5 Euglenoids	21
1.5.1 Cytology	22
1.5.2 Morphological diversity	22
1.5.3 Ecology	23
1.5.4 Euglenoids as bioindicators	23
1.6 Yellow-green algae	23
1.6.1 Cytology	23
1.6.2 Morphological diversity	24
1.6.3 Ecology	24
1.6.4 Yellow-green algae as bioindicators	24

1.7	Dinoflagellates	25
1.7.1	Cytology	25
1.7.2	Morphological diversity	26
1.7.3	Ecology	27
1.8	Cryptomonads	28
1.8.1	Cytology	28
1.8.2	Comparison with euglenoid algae	29
1.8.3	Biodiversity	29
1.8.4	Ecology	30
1.8.5	Cryptomonads as bioindicators	30
1.9	Chrysophytes	31
1.9.1	Cytology	31
1.9.2	Morphological diversity	31
1.9.3	Ecology	32
1.9.4	Chrysophytes as bioindicators	32
1.10	Diatoms	33
1.10.1	Cytology	33
1.10.2	Morphological diversity	35
1.10.3	Ecology	38
1.10.4	Diatoms as bioindicators	39
1.11	Red algae	40
1.12	Brown algae	40
2	Sampling, Biomass Estimation and Counts of Freshwater Algae	41
A.	PLANKTONIC ALGAE	41
2.1	Protocol for collection	41
2.1.1	Standing water phytoplankton	42
2.1.2	River phytoplankton	46
2.2	Mode of collection	46
2.2.1	Phytoplankton trawl net	46
2.2.2	Volume samplers	48
2.2.3	Integrated sampling	49
2.2.4	Sediment traps	50
2.3	Phytoplankton biomass	51
2.3.1	Turbidity	51
2.3.2	Dry weight and ash-free dry weight	53
2.3.3	Pigment concentrations	53
2.4	Flow cytometry: automated analysis of phytoplankton populations	60
2.5	Microscope counts of species populations	61
2.5.1	Sample preservation and processing	61
2.5.2	Species counts	63
2.5.3	Conversion of species counts to biovolumes	70
2.5.4	Chemical cleaning of diatoms	75
2.6	Diversity within single-species populations	76
2.6.1	Molecular analysis	76
2.6.2	Analytical microscopical techniques	77

B. NON-PLANKTONIC ALGAE	82
2.7 Deep water benthic algae	82
2.7.1 Benthic–pelagic coupling	83
2.7.2 Benthic algae and sediment stability	84
2.7.3 Invertebrate grazing of benthic algae	84
2.8 Shallow water communities	84
2.8.1 Substrate	84
2.8.2 Algal communities	87
2.9 Algal biofilms	89
2.9.1 Mucilaginous biofilms	89
2.9.2 Biomass	89
2.9.3 Taxonomic composition	91
2.9.4 Matrix structure	93
2.10 Periphyton – algal mats	93
2.10.1 Inorganic substratum	93
2.10.2 Plant surfaces	95
 3 Algae as Bioindicators	 99
3.1 Bioindicators and water quality	99
3.1.1 Biomarkers and bioindicators	99
3.1.2 Characteristics of bioindicators	100
3.1.3 Biological monitoring versus chemical measurements	101
3.1.4 Monitoring water quality: objectives	102
3.2 Lakes	105
3.2.1 Contemporary planktonic and attached algae as bioindicators	105
3.2.2 Fossil algae as bioindicators: lake sediment analysis	106
3.2.3 Water quality parameters: inorganic and organic nutrients, acidity and heavy metals	110
3.3 Wetlands	119
3.4 Rivers	121
3.4.1 The periphyton community	121
3.4.2 River diatoms	121
3.4.3 Evaluation of the diatom community	122
3.4.4 Human impacts and diatom indices	123
3.4.5 Calculation of diatom indices	126
3.4.6 Practical applications of diatom indices	128
3.5 Estuaries	133
3.5.1 Ecosystem complexity	133
3.5.2 Algae as estuarine bioindicators	134
 4 A Key to the More Frequently Occurring Freshwater Algae	 137
4.1 Introduction to the key	137
4.1.1 Using the key	137
4.1.2 Morphological groupings	138
4.2 Key to the main genera and species	138

4.3	List of algae included and their occurrence in the key	241
4.4	Algal identification: bibliography	243
Glossary		245
References		255
Index		265