

# *Contents*

List of contributors .....	xviii
Preface .....	xxi
Foreword .....	xxiii

## BACKGROUND TO PALAEOENVIRONMENTAL CHANGES DURING HOLOCENE

1. Late-Quaternary biotic changes in terrestrial and lacustrine environments, with particular reference to north-west Europe .....	3
<i>H. J. B. Birks</i>	
Introduction — pattern, process and scale .....	3
Global glacial — interglacial patterns .....	9
Interglacial patterns — the interglacial cycle .....	10
Glacial patterns — the cryocratic phase .....	14
Late-glacial patterns — the protocratic phase .....	18
Postglacial forest development — the mesocratic phase .....	25
Postglacial forest retrogression — the oligocratic phase .....	37
Postglacial forest destruction — the <i>Homo sapiens</i> phase .....	41
Biotic crises and catastrophes .....	47
Coda .....	52
2. Lake sediments and palaeohydrological studies .....	67
<i>J. A. Dearing and I. D. L. Foster</i>	
Introduction .....	67
Lake-level fluctuations .....	67
Lake-sediment-derived sediment yields .....	76
Conclusions .....	85
3. Hydrological changes in mires .....	91
<i>P. D. Moore</i>	
Introduction .....	91
Mire classification and hydrology .....	92

Hydrological change and mire stratigraphy .....	94
Conclusions .....	105

## RESEARCH STRATEGY

<b>4. Palaeoecological reference areas and reference sites .....</b>	<b>111</b>
<i>B. E. Berglund</i>	
Introduction .....	111
Palaeoecological type regions and reference areas .....	112
Definition of reference areas .....	117
Recommendations for working methods .....	123
Research planning at a primary reference area .....	123
<b>5. Studies on past lake-level fluctuations</b>	
<i>G. Digerfeldt</i>	
Introduction .....	127
Sedimentary evidence of lake-level fluctuations .....	128
Method for reconstruction of past fluctuations .....	128
Fieldwork and laboratory analyses .....	131
<b>6. Palaeoecological studies of mires .....</b>	<b>145</b>
<i>B. Aaby</i>	
Introduction .....	145
Fieldwork .....	145
Laboratory work .....	147
Palaeoecological implications derived from mire investigations .....	152
Peat formation .....	153
Peat accumulation rates .....	155
The influence of humification and autocompaction on peat accumulation .....	157
Anthropogenic activity traced by ash content in peat deposits ...	160
<b>7. Palaeoecological studies of terrestrial soils .....</b>	<b>165</b>
<i>S. Th. Andersen</i>	
Introduction .....	165
Classification of terrestrial soils .....	165

Plant fossils in terrestrial soils .....	167
Field methods .....	169
Laboratory procedures .....	169
Microfossil analysis of soils .....	170
Dating of soil profiles .....	171
Modification of pollen diagrams from soils .....	171
Features of soil development recognized in soils .....	173

## SAMPLING AND MAPPING TECHNIQUES

8. Sampling techniques for lakes and bogs .....	181
<i>B. Aaby and G. Digerfeldt</i>	
Introduction .....	181
Chamber samplers .....	182
Piston samplers .....	184
Sampling from open sections .....	192
9. Geological survey mapping .....	195
<i>E. Daniel</i>	
Introduction .....	195
Classification of the Quaternary deposits .....	196
Field-mapping .....	197
Map compilation .....	198
10. Mapping present and past vegetation .....	203
<i>N. Malmer and G. Regnell</i>	
Introduction .....	203
Theoretical background .....	203
Mapping and reconstruction .....	206
Case study .....	209
11. Archaeological survey mapping .....	219
<i>L. Larsson</i>	
Introduction .....	219
Planning of survey mapping .....	220

Various elements in an inventory .....	221
Case studies .....	224

## STRATIGRAPHICAL METHODS

12. Characterization of peat and lake deposits .....	231
--	-----

### *B. Aaby and B. E. Berglund*

Introduction .....	231
Characterization of unconsolidated sediments .....	232
Deposit symbols .....	235
Modifications of the Troels-Smith system .....	238
Drawing procedure for Troels-Smith system .....	239
Microscopic sediment analysis .....	239
Photo documentation .....	245

13. Core correlation and total sediment influx .....	247
--	-----

### *J. A. Dearing*

Introduction .....	247
Considerations .....	248
Sampling .....	249
Core correlation methods .....	250
Total influx calculations .....	258
Case study of sediment influx .....	262
Final comments .....	265

## DATING METHODS

14. Radiometric dating .....	273
------------------------------	-----

### *I. U. Olsson*

I. Radiocarbon dating .....	275
Introduction .....	275
Radiocarbon years and conventional years .....	276
Isotopic fractionation .....	281
Influence of contaminants .....	283
Pretreatment .....	287
Apparent ages of lake sediments — reservoir effect and contamination .....	290

Apparent age of sea-water, marine plants, marine mammals and fish-eating animals .....	292
Low-activity regions .....	293
Other uncertainties .....	293
Size of the sample .....	296
II. Methods for late Holocene deposits .....	298
The c.i.c. and c.r.s. models for $^{210}\text{Pb}$ dating .....	299
Some complications with $^{210}\text{Pb}$ dating .....	303
Related isotopes .....	303
$^{137}\text{Cs}$ , $^{239,240}\text{Pu}$ and $^{241}\text{Am}$ dating .....	303
$^{32}\text{Si}$ and $^{39}\text{Ar}$ dating .....	304
General remarks on some dating errors .....	305
15. Palaeomagnetic dating .....	313
 <i>R. Thompson</i>	
Introduction .....	313
Field methods and equipment .....	314
Laboratory work .....	315
Correlation .....	317
Dating .....	318
Appendix .....	320
16. Tephrochronology .....	329
 <i>Th. Einarsson</i>	
Introduction .....	329
Distribution of tephra .....	330
Fieldwork .....	331
Laboratory work .....	335
Absolute dating of tephra layers .....	336
Relative dating of tephra layers .....	337
Tephrochronological 'systems' .....	338
Applications of tephrochronology .....	339
17. Annually laminated lake sediments .....	343
 <i>M. Saarnisto</i>	
Introduction .....	343
Characteristics of lakes .....	345

Types of laminations .....	346
The freezing technique .....	353
Laboratory techniques .....	355
Applications of annually laminated sediments .....	362
 18. Dendrochronology applied to mire environments .....	371
<i>A. V. Munaut</i>	
Introduction .....	371
Fieldwork .....	372
Laboratory work .....	375
Applications .....	381
 19. Dendrochronology applied in mountain regions .....	387
<i>W. Bircher</i>	
Introduction .....	387
Obtaining the material .....	389
Laboratory work .....	392
Data processing .....	393
Applications of dendrochronology and radiodensitometry .....	398
 <b>PHYSICAL AND CHEMICAL METHODS</b>	
 20. Stable oxygen and carbon isotope analyses .....	407
<i>U. Siegenthaler and U. Eicher</i>	
Principle of the method .....	407
Experimental methods .....	408
Results from lake carbonates .....	410
$\delta^{18}\text{O}$ and $\delta\text{D}$ in organic matter .....	419
 21. Chemical analysis .....	423
<i>L. Bengtsson and M. Enell</i>	
Introduction .....	423
Sampling, subsampling and storing .....	424
Physical analysis .....	425
Solution preparation .....	428
Phosphorus content .....	433

Nitrogen content .....	436
Sedimentary plant pigments .....	440
Metals .....	443
Presentation of results .....	448

## BIOLOGICAL METHODS

22. Pollen analysis and pollen diagrams .....	455
<i>B. E. Berglund and M. Ralska-Jasiewiczowa</i>	
Introduction .....	455
Laboratory technique .....	456
Identifications—nomenclature and accuracy .....	457
Calculation of results .....	462
Pollen diagrams .....	463
Pollen-analytical correlations and syntheses .....	479
23. Charred particle analysis .....	485
<i>K. Tolonen</i>	
Introduction .....	485
Choice of study sites .....	486
Laboratory work .....	488
Interpretation, application and recommendations .....	490
24. Application of fungal and algal remains and other microfossils in palynological analyses .....	497
<i>B. van Geel</i>	
Introduction .....	497
Laboratory studies .....	498
Presentation of results .....	500
Interpretations .....	500
25. Blue-green algae, green algae and chrysophyceae in sediments ....	507
<i>G. Cronberg</i>	
Review .....	507
Methods .....	511
Case study .....	516

Conclusions .....	520
Recommended taxonomic literature .....	521
26. Diatom analysis .....	527
<i>R. W. Battarbee</i>	
Introduction .....	527
Methods .....	528
Representativity .....	539
Environmental reconstruction .....	541
27. Analysis of fossil fruits and seeds .....	571
<i>K. Wasylkowa</i>	
Introduction .....	571
Fieldwork .....	571
Laboratory techniques .....	573
Identification of fruits and seeds .....	575
Presentation and interpretation of results .....	578
28. Analysis of vegetative plant macrofossils .....	591
<i>G. Grosse-Brauckmann</i>	
Introduction .....	591
Deposition and preservation of macrofossils in peat .....	592
Laboratory techniques .....	596
Quantitative assessments in macrofossil investigations .....	599
General remarks on identification of plant remains .....	600
Some notes on phytoliths .....	602
Determination of vegetative macrofossils: literature, reference collections .....	603
Presentation of macrofossil records .....	605
Significance of macrofossil investigations .....	608
29. Wood and charcoal analysis .....	619
<i>W. Schoch</i>	
Introduction .....	619
Fieldwork .....	619
Laboratory work .....	623

Types of analysis and findings .....	623
Applications .....	626
Interpretation .....	626
30. Bryophyte analysis .....	627
<i>J. H. Dickson</i>	
Introduction .....	627
Spores .....	627
Macroscopic remains .....	629
Bryogeographical inferences .....	634
Palaeoclimatic and palaeoenvironmental inferences .....	634
Appendix .....	638
31. Rhizopod analysis .....	645
<i>K. Tolonen</i>	
Introduction .....	645
Rhizopod analysis of mire deposits .....	646
Rhizopod analysis of lake deposits .....	656
Identification of species .....	660
Autecological and taxonomical notes .....	660
32. Cladocera analysis .....	667
<i>D. G. Frey</i>	
Introduction .....	667
Preparation of slides .....	669
Examination of slides .....	675
Interpretation of results .....	677
Conclusions .....	686
33. Ostracod analysis .....	693
<i>H. Löffler</i>	
Introduction .....	693
Sampling methods .....	693
Preservation and identification .....	694
Presentation of results .....	695
Results obtained by ostracod studies in lake sediments .....	697

34. Coleoptera analysis .....	703
<i>G. R. Coope</i>	
Introduction .....	703
Field techniques .....	703
Laboratory techniques .....	705
Preservation of fossil insects .....	707
Identification .....	708
Interpretation .....	708
Palaeoclimatology and fossil coleoptera: some results .....	711
35. Chironomid analysis .....	715
<i>W. Hofmann</i>	
Introduction .....	715
Laboratory work .....	716
Presentation of results .....	719
Interpretations .....	723
36. Mollusca analysis .....	729
<i>V. Ložek</i>	
Introduction .....	729
Fieldwork .....	730
Laboratory work .....	731
Presentation of results .....	733
Interpretation .....	735
NUMERICAL TREATMENT OF BIOSTRATIGRAPHICAL DATA	
37. Numerical zonation, comparison and correlation of Quaternary pollen-stratigraphical data .....	743
<i>H. J. B. Birks</i>	
Introduction .....	743
Approaches to presentation, zonation, comparison and correlation of pollen-stratigraphical data .....	746
Computer methods for constructing pollen diagrams .....	750
Numerical methods for zonation of pollen-stratigraphical data .....	751
Numerical methods for comparing pollen-stratigraphical data .....	757
Additional numerical methods .....	761

Comparison of stratigraphical data sets from the same sequence .....	764
Computer programs .....	766
<b>38. Multivariate methods for data analysis .....</b>	<b>775</b>
<i>I. C. Prentice</i>	
Introduction .....	775
Principles .....	777
Examples .....	784
Programs .....	791
A note on canonical analysis .....	794
<b>39. Forest-composition calibration of pollen data .....</b>	<b>799</b>
<i>I. C. Prentice</i>	
Introduction .....	799
Surface pollen and vegetation data for calibration .....	800
The analog method .....	803
Andersen's method .....	805
Extended R-value method .....	805
Further notes .....	816
<b>40. Climatic calibration of pollen data: an example and annotated computing instructions .....</b>	<b>817</b>
<i>R. Arigo, S. E. Howe and T. Webb, III</i>	
Introduction .....	817
Selection of sampling sites and pollen types .....	819
Computing instructions .....	821
Discussion .....	846
<b>41. Climatic calibration of coleopteran data .....</b>	<b>851</b>
<i>T. C. Atkinson, K. R. Briffa, G. R. Coope, M. J. Joachim and D. W. Perzy</i>	
Introduction .....	851
Mutual Climatic Range Method .....	852
Worked example .....	856
Conclusion .....	858
<b>Index .....</b>	<b>859</b>