

Contents

Acknowledgements xi

Preface xiii

Introduction 1

1 Topics 7

The biological approach to biogeography 8

The evolutionary approach to biogeography 10

The inductive approach to biogeography 12

Biased approaches to biogeography 14

Scales of variation 16

Conclusions 20

I Patterns of concordance 23

2 Qualitative and quantitative approaches 25

The qualitative approach 25

An example of the qualitative approach 26

The quantitative approach 27

An example of the quantitative approach 28

Conclusions 31

3 Methodology of quantitative biogeographical classification 32

A model of biogeographical classification 32

Criteria of biogeographical classification 32

Problems in the application of classification criteria 35

Endemism as a classification criterion 35

Effects of defining sampling areas 36

Procedures in biogeographical classification 39

Similarity coefficients 39

Effects of the number of shared taxa and of sampling area 41

viii *Contents*

Testing differences between similarity coefficients	43
Recommendations	44
Hierarchical cluster techniques	44
A generalized algorithm for agglomerative strategies	45
Some specific agglomerative cluster techniques	46
Recommendations	48
TWINSPAN, a divisive technique	48
Problems in the application of clustering algorithms	48
Area delimitation	48
Interlocation variation	49
Intralocation variation	50
Testing classifications	51
Conclusions	52
<i>4 Criticism of biogeographical classification</i>	54
Biogeographical classification and taxonomic level	54
Are biogeographical units homogeneous and stable?	55
Geographical discordance of ranges	56
How sharp are boundaries?	57
Why are biogeographical classifications hierarchical?	59
Conclusions	60
<i>5 Classification and ordination</i>	64
Efficiency of the models	65
Methodology of ordination	67
Scales of variation and concordant variation	69
Combinations of classification and ordination	70
Stability of ordinations	71
An application of classification and ordination	72
Conclusions	76
Summary of Part I	78
II Geographical trends in species richness and biological traits	81
<i>6 Geographical trends in species richness</i>	83
Latitudinal trends	83
Longitudinal trends	85
Continental trends in avian diversity	87
Continental trends in Holarctic plants	90
Explanations of broad-scale trends in species richness	92
Geographic nesting of species	94
The impact of ecological factors on European Silenoidae	98
The impact of historical factors on North American Polemoniaceae	100

Contents

ix

The impact of genetical factors on temperate wheats	101
Conclusions	102
7 Geographical trends in biological traits	103
Leaf form in plants	104
Life form in plants	105
Polyploidy and genome size in plants	106
Photosynthetic pathways	109
Shell morphology in marine molluscs	112
Alkaloid-bearing species	114
Conclusions	115
8 Intraspecific trends	116
Morphological traits	117
Physiological traits	119
Population genetic variation	120
Changes in population genetic structure	121
Discordant variation in man	122
Conclusions	124
Summary of Part II	125
III Areography: the analysis of species ranges	127
9 The anatomy of species ranges	129
Range structure	130
The range as an optimum-response surface	130
The distribution of vitality and dynamic behaviour	135
Latitudinal and altitudinal intensity distributions	140
Evaluations of the optimum-response model	142
Range shape	142
Range size	143
Range margins	148
Indirect approaches to range delimitation	148
Direct approaches to range delimitation	154
Risk assessment	157
Why study range margins?	159
The geography of species interactions	160
Potential ranges through monophagy	161
Changes in the general level of intensity	162
Invading species	165
Optimum-response surfaces and climatic reconstruction	166
Conclusions	168

10 The dynamic structure of species ranges 169

Good's Theories of Tolerance and Migration extended 169

Climatic release and dispersal in the spruce budworm 171

Climatic causes of range dynamics 174

Features of range dynamics 176

Seasonality and optimum-response surfaces 177

Extinction 180

Optimum surfaces and individualistic spatial behaviour 182

Conclusion: the range as a process 184

11 Population dynamic theories 185

Population control versus risk spreading 185

The balance of nature 186

Extinction probabilities explained by energy budgets and spatial dynamics 190

Conclusions 193

Summary of Part III 194**IV Species ranges and patterns of concordance 197****12 Discontinuous variation in space and time 199**

Biogeographical provinces and their dynamics 200

Glacials and interglacials 205

The analysis of scales of variation 208

The integration of scales of variation 210

Global unity of climatic variation 211

The representativity of our time 213

Conclusions 214

13 The future 216*References 219**Author index 239**Species index 244**Subject index 246*