

|  |          |
|--|----------|
| Preface.....   | V        |
| Abbreviations and Technical Remarks.....                                   | X        |
| <b>Introduction.....</b>   | <b>1</b> |
| <b>1 The Evolution of Plant Stems in the Earth's History</b>               |          |
| The Landscape in the Paleozoic.....  | 4        |
| Plant Body of Vascular Plants.....   | 6        |
| The Evolution of a Stabilization System.....                               | 8        |
| The Contemporary Fossil <i>Psilotum Nudum?</i> .....                       | 9        |
| Diversification of Plants Containing Tracheids                             |          |
| The Lycopods.....  | 10       |
| The Horsetails.....  | 11       |
| The Fossil and Contemporary Ferns.....                                     | 12       |
| Contemporary Ferns.....  | 14       |
| Trees Grow Taller and Bigger.....  | 16       |
| Successful Seed Plants with Naked Seeds                                    |          |
| Ginkgos and Cycads.....  | 18       |
| Gnetophytes ( <i>Ephedra</i> , <i>Gnetum</i> and <i>Welwitschia</i> )..... | 20       |
| The Most Successful Seed Plants with Naked Seeds: Conifers.....            | 22       |
| Successful Plants with Seeds Enclosed in a Carpel: Angiospermae.....       | 24       |
| Systematic of Plant Life.....  | 26       |
| <b>2 The Structure of the Plant Body</b>                                   |          |
| Life Forms in Different Vegetation Zones.....                              | 28       |
| Principal Growth Forms of Stems.....                                       | 30       |
| Principal Construction of Roots and Shoots.....                            | 32       |
| Principal Construction of the Xylem and Phloem                             |          |
| Cell Types, Cell Walls and Cell Contents.....                              | 34       |
| <b>3 Secondary Growth: Advantages and Risks</b>                            |          |
| Primary and Secondary Growth.....  | 40       |
| Principle Structure of Plants with Secondary Growth.....                   | 42       |
| Physiological Ageing in Plants with Secondary Growth.....                  | 43       |
| The Risks of Water Transport:  |          |
| Stabilized and Permeable Cell Walls.....                                   | 44       |
| The Risks of Stem Thickening:  |          |
| Dilatation and Phellem Formation.....                                      | 46       |
| The Risks of Over-Production:  |          |
| Programmed Cell Death.....   | 50       |
| The Risks of Instability:  |          |
| Eccentricity.....  | 52       |
| Reaction Wood.....   | 54       |
| Formation of Lignin and Thick Cell Walls.....                              | 56       |
| Internal Optimization.....   | 58       |
| The Risk of Decomposition:   |          |
| Natural Boundaries and Protection Systems.....                             | 60       |
| Defence Barriers Around Wounds.....  | 62       |
| The Risk of Shedding Plant Parts:  |          |
| Abscission.....  | 64       |
| <b>4 Modification of the Stem Structure</b>                                |          |
| The Primary Stage of Growth:   |          |
| The Construction of Vascular Bundles.....                                  | 70       |
| The Arrangement of Vascular Bundles in Mosses, Lycopods and Ferns.....     | 72       |

|   |     |
|---|-----|
| The Arrangement of Vascular Bundles in Conifer and Dicotyledonous Plant Shoots.....     | 74  |
| The Secondary Stage of Growth:  |     |
| Conifer Xylem .....   | 76  |
| The Xylem of Dicotyledonous Angiosperms .....   | 78  |
| The Primary and Secondary Stages of Growth of Monocotyledons:                           |     |
| Macroscopic View.....   | 82  |
| Microscopic View.....   | 84  |
| The Secondary Stage of Growth:  |     |
| Conifer Phloem .....  | 86  |
| The Phloem of Dicotyledonous Angiosperms .....  | 88  |
| Cambial Growth Variants and Successive Cambia .....                                     | 90  |
| The Third Stage of Growth: The Periderm.....  | 92  |
| <b>5 Modification of the Xylem Within a Plant</b>                                       |     |
| Modification of the Xylem Within a Plant  |     |
| Conifer: Root, Twig and Stem .....  | 96  |
| Deciduous Tree: Root, Twig and Stem.....  | 98  |
| From Root to Stem Structure.....  | 99  |
| Modification by Aging:  |     |
| Changing Growth Forms .....   | 100 |
| Changing Growth and Leaf Forms .....  | 101 |
| Changing Wood Anatomical Structures .....   | 102 |
| Change of Phloem and Periderm Structures.....   | 104 |
| <b>6 Modification of the Xylem and Phloem by Ecological Factors</b>                     |     |
| Intra-Annual Density Fluctuations, Phenolic and Crystal Deposits.....                   | 108 |
| Intra-Annual Cell Collapse, Callous Tissue and Ducts.....                               | 110 |
| Interannual Variation of Latewood Zones.....  | 112 |
| Long Term Variations: Sudden Growth Changes .....                                       | 113 |
| Inter- and Intra-Annual Variations of the Phloem.....                                   | 114 |
| <b>7 Modification of Organs</b>   |     |
| Modification of Shoots:   |     |
| Long and Short Shoots.....  | 118 |
| Shedding Needles, Male and Female Flowers.....  | 121 |
| Thorns and Spines .....   | 122 |
| Vertical, Horizontal and Drooping Twigs.....  | 124 |
| Latent and Adventitious Shoots.....   | 126 |
| The Lateral Modification of Stems.....  | 128 |
| <b>8 Anatomical Plasticity</b>  |     |
| Wood Structural Variability   |     |
| In Different Families .....   | 132 |
| In Different Growth Forms.....  | 134 |
| Under Different Site Conditions .....   | 136 |
| Modification Caused by Different Shoot and Root Functions .....                         | 140 |
| <b>9 Modifications Caused by Weather and Climate</b>                                    |     |
| Major Wood Anatomical Types in Different Climatic Regions .....                         | 144 |
| Modification of the Annual Tree-Ring Formation Caused By Seasonal Climatic Changes..... | 148 |
| Modification of the Annual Tree-Ring Formation Caused By Seasonal Climatic Changes:     |     |
| The Genetic Component.....  | 150 |
| Modification of the Xylem due to Intra-Seasonal Variations:                             |     |
| Ecological, Climatic and Individual Components.....                                     | 152 |