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Physiological Ecology of the Alpine Timberline

Tree Existence at High Altitudes with Special Reference to the European Alps

With 67 Figures

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For explanation of the cover motive see legend to Fig. 61 (p. 110).

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In memory of Prof. A. Pisek,
a pioneer of alpine ecology

Preface

In the European Alps the importance of forests as protection against avalanches and soil erosion is becoming ever clearer with the continuing increase in population and development of tourism. The protective potential of the mountain forests can currently only be partially realised because a considerable proportion of high-altitude stands has been destroyed in historical times by man's extensive clearing of the forests. The forests still remaining are of limited effectiveness, due to inadequate density of trees and over-maturity. Considerable efforts, however, are now being made in the Alps and other mountains of the globe to increase the high-altitude forested area through reforestation, to raise depressed timberlines, and to restore remaining protection forests using suitable silvicultural methods to their full protective value.

This momentous task, if it is to be successful, must be planned on a sound foundation. An important prerequisite is the assembly of scientific facts concerning the physical environment in the protection forest zone of mountains, and the course of various life processes of tree species occurring there. Since the introduction of practical field techniques it has been possible to investigate successfully the reaction of trees at various altitudes to recorded factors, and the extent to which they are adapted to the measured situations. Such ecophysiological studies enable us to recognize the site requirements for individual tree species, and the reasons for the limits of their natural distribution.

During many years of research at alpine timberline in Tyrol, Austria, it has been possible for me to publish numerous articles on the ecophysiology of timberline trees. It is to one of the pioneers of experimental ecology, Professor A. Pisek, that I owe my introduction to this field of research and this book is dedicated with gratitude in his honour.

Colleagues at the Institute for Subalpine Forest Research in Innsbruck effectively supported my work and have brought together a mass of information on the ecology of timberline which has been drawn on in preparing this book. In the last 10 years students of the University of Innsbruck acted as valuable assistants and their dissertations stand as important contributions. It now appears useful to draw the numerous and diverse published research results together into a single volume.

In Europe I became familiar with the timberlines of the major mountain ranges besides the Alps and visited the main timberline investigations currently in progress. Discussions of the upper forest limits on mountains outside Europe are mainly based on an evaluation of the literature.

In treating the subject matter, particular emphasis has been placed on describing as completely as possible the interrelationship between site factors and the most important life processes, in order to elucidate the significance of such factors for the existence of trees at their upper limit. This approach is possible since site factors at timberline, as at other distinct vegetation limits, gain in significance, and clearly become limiting factors for vital plant processes. In contrast to this the importance of competition declines.

Although there are still gaps in our knowledge, an attempt has been made in the Synopsis (Chap. 6) to develop from numerous individual results a general picture of the life of trees at the limits of existence on mountains. The complex framework of interrelationships responsible for the occurrence of timberlines may thus be seen with greater clarity.

Much in the concepts presented remains unproven and hypothetical. Inevitably, the picture evolved here will not be valid everywhere, and other mechanisms may exist for formation of timberlines. The great diversity of environments and tree species on the earth's mountain ranges has been far too sparsely investigated for one to conclude otherwise. For the European Alps, however, as probably for other temperate mountains, this volume will hopefully form a valid contribution to the scientific foundation upon which reforestation and management of protection forests must be based.

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To the publishers I also wish to express my appreciation for their co-operation and willingness to consider all my requests.

Innsbruck, January 1979 W. TRANQUILLINI

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