



Flora, chorology, biomass and productivity of the *Pinus albicaulis*-*Vaccinium scoparium* association
by Frank Forcella

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in BOTANY

Montana State University

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Abstract:

The *Pinus albicaulis* - *Vaccinium scoparium* association is restricted to noncalcareous sites in the subalpine zone of the northern Rocky Mountains (USA). The flora of the association changes clinally with latitude. Stands of this association may annually produce a total (above- and belowground) of 950 grams of dry matter per square meter and may obtain biomasses of nearly 60 kg per square meter. General productivity and biomass may be accurately estimated from simple measurements of stand basal area and median shrub coverage for the tree and shrub synusiae respectively. Mean cone and seed productivities range up to 84 and 25 grams per square meter per year respectively, and these productivities are correlated with percent canopy coverage (another easily measured stand parameter). Edible food production of typical stands of this association is sufficient to support 1000 red squirrels, 20 black bears or 50 humans on a square km basis. The spatial and temporal fluctuations of *Pinus albicaulis* seed production suggests that strategies for seed predator avoidance may have been selected for in this taxon.

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Date 31 May 1977

FLORA, CHOROLOGY, BIOMASS AND PRODUCTIVITY OF THE

PINUS ALBICAULIS - VACCINIUM SCOPARIUM

ASSOCIATION

by

FRANK FORCELLA

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Bozeman, Montana

May, 1977

PREFACE

This thesis has been divided into four segments or chapters. Though all chapters are interrelated, each has been written as an individual entity with its own Introduction, Methods etc. Such a format has been followed for the convenience of the reader. Plant taxonomists and geographers will be interested mostly in Chap. 1; interests of forest mensurationists lie entirely in Chap. 2; silviculturists and ecologists will find Chap. 3 useful, if not amusing; lastly, Chap. 4 is oriented toward wildlife biologists and general biologists. Within this thesis, retrieval of specific information by 'special interest groups' will be greatly facilitated by the format used.

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Beginning with my parents, there are several individuals who have greatly affected my personal development. Those who have contributed academically (and in other ways) include: Arthur Johnson, Fred A. Barkley, J.H. Rumely, H.N. Metcalf, S.J. Harvey and J. Major. I thank all these individuals. Of course in this same regard, T.W. Weaver deserves special mention. If I have any (good) scientific/analytic qualities, a very large proportion of them can be attributed to my association with Dr. Weaver. Though ones' initial boyhood enthusiasum in the natural sciences may often have been spontaneous, its maintainence into adulthood is

not necessarily self-perpetuating; Dr. Weaver has the uncanny ability to sustain, in another individual, an insatiable enthusiasm -- through his very own, perhaps.

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ABSTRACT

FLORA, CHOROLOGY, BIOMASS AND PRODUCTIVITY OF THE

PINUS ALBICAULIS - *VACCINIUM SCOPARIUM*

ASSOCIATION

The *Pinus albicaulis* - *Vaccinium scoparium* association is restricted to noncalcareous sites in the subalpine zone of the northern Rocky Mountains (USA). The flora of the association changes clinally with latitude. Stands of this association may annually produce a total (above- and belowground) of 950 grams of dry matter per square meter and may obtain biomasses of nearly 60 kg per square meter. General productivity and biomass may be accurately estimated from simple measurements of stand basal area and median shrub coverage for the tree and shrub synusiae respectively. Mean cone and seed productivities range up to 84 and 25 grams per square meter per year respectively, and these productivities are correlated with percent canopy coverage (another easily measured stand parameter). Edible food production of typical stands of this association is sufficient to support 1000 red squirrels, 20 black bears or 50 humans on a square km basis. The spatial and temporal fluctuations of *Pinus albicaulis* seed production suggests that strategies for seed predator avoidance may have been selected for in this taxon.

CHAPTER 1

THE FLORA AND CHOROLOGY OF THE *PINUS ALBICAULIS* -
VACCINIUM SCOPARIUM ASSOCIATION

INTRODUCTION

Floristic variation within a plant association may indicate that the habitat of the association is not uniform throughout, and that two or more plant associations are being considered as one, the extreme case being that each community is an individual, an association unto itself. Other interpretations exist; summaries can be found in Major and Pyott (1965) and in several texts dealing with vegetation. In this chapter I shall describe the compositional variation of the *Pinus albicaulis* - *Vaccinium scoparium* association, and relate some of the variation to one factor of vegetation formation (Major 1951), i.e., the flora from which the vegetation may have originated.

The suggestion that a single plant association varies according to the flora available to it suggests that this association may exist in more than one floristic region. If regional climate and events during historical time determine floristic regions, one might conclude that these factors could act differentially within the association and thereby affect its variation. Alternatively, if one assumes that a recurring mixture of plant species indicates a particular set of environmental conditions, and that the probability of two or more of these species concurrently evolving the same degree of ecotypic variation is low, then it follows that the

habitat within which this association of plant species exists is more or less equivalent throughout (if it is integrated over ecologic time). Thus floristic differences of communities with "identical" habitats must be a result of either the availability of their flora at the time of their establishment (Egler 1953) and/or through the remainder of their existence (Major 1951).

METHODS

Stands in Wyoming, Idaho and Montana (U.S.A.) with overstories dominated by *Pinus albicaulis*, understories dominated by *Vaccinium scoparium* and lacking conspicuous populations of *Abies lasiocarpa* seedlings and/or layered shoots (i.e., *Abies* reproduction less than that of *P. albicaulis*), and soils not stony or rocky (Soil Survey Staff 1976) enough to obviously affect the growth and distribution of plants, were sampled. Within a 600 m² area (three, 6.67 x 30 m) in each of 29 stands, all vascular plant species were collected (identified and filed at the Herbarium, Montana State University; Bozeman, Montana); and within ninety 2 x 5 dm frames in each 600 m² area, the coverage of each vascular plant taxon was estimated. Foliose arboreal lichens were also collected, but not systematically. Nomenclature follows that of Hitchcock and Cronquist (1973) for the Pacific

Northwest vascular plants, Munz and Keck (1968) for other vascular plants, and Hale (1969) for lichens. Taxonomic authorities not in the text are listed in Table 1.

RESULTS

Four species other than *Pinus albicaulis* and *Vaccinium scoparium* were nearly ubiquitous in the sampled stands: the widespread *Carex rossii*, *Abies lasiocarpa* and *Poa nervosa* with constancies of 80, 90 and 70% respectively, and *Arnica latifolia* (80% constancy, though absent from most Wyoming stands). The presence of these taxa lends some support (or degrees of freedom in a statistical sense) to the initial assumption of the improbability of two or more species concurrently evolving associated ecotypes.

In Table 1, the flora and some other stand characteristics are provided in relevé form. This table lists the stands in a latitudinal sequence, with adjustments to accommodate latitudinally-similar stands with widely separated longitudinal ordinates (cf. Fig. 1). Stands have not been sorted according to their floristic similarities as is usually done in relevé analyses (Mueller-Dombois and Ellenberg 1974). However, the taxa have been arranged to give the maximum impression of latitudinal change to

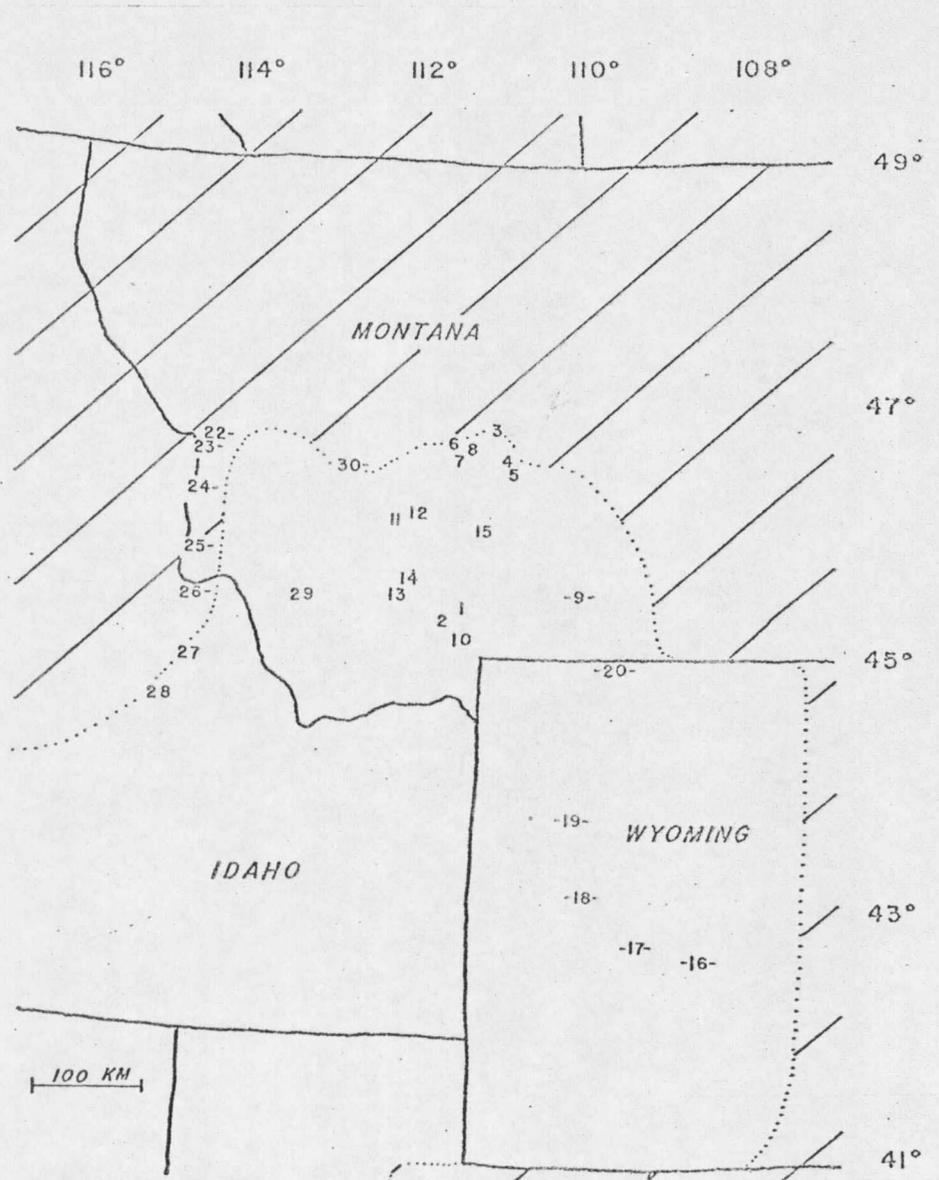


Figure 1. The distribution of the *Pinus albicaulis* - *Vaccinium scoparium* association. The numbers and their associated characters (e.g. n-, -n-) represent stand numbers and the three geographic/floristic regions referred to in the text. The geographical extent of the stands is thought to represent the range of the association. The unshaded area inside the dotted line represents the gap in the distribution of *Pinus ponderosa* (from Little 1971). (There is no Stand 21.)

