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UNIVERSITY OF ALBERTA

HABITAT LIMITATIONS AND ECOTOPE STRUCTURE OF MIRE SPHAGNUM IN WESTERN CANADA.

BY

L. DENNIS GIGNAC

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

IN

PLANT ECOLOGY

DEPARTMENT OF BOTANY

EDMONTON, ALBERTA

SPRING 1990

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled HABITAT LIMITATIONS AND ECOTOPE STRUCTURE OF MIRE SPHAGNUM IN WESTERN CANADA submitted by L. DENNIS GIGNAC in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

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Abstract

Effects of four important gradients on the distribution and abundance of *Sphagnum* and other bryophyte genera were studied on 29 peatlands located along a gradient from the Queen Charlotte Islands, British Columbia to central Alberta. Data obtained from permanent weather stations were used to divide the climate in the study area into four zones: hyper-oceanic, oceanic, sub-oceanic, and sub-continental. Based on surface water chemistry, the peatlands studied varied from bogs to rich fens.

Sphagnum species can be divided into 4 groups based on their distribution and abundance along climatic and surface water chemistry gradients: oceanic bog and poor fen species, widespread poor fen species with sub-continental tendencies, widespread species, and moderate-rich fen species. The height of the moss above the water table and overstory shade did not affect the geographical distribution of most species. Height relative to the water table only affected the distribution of species found at either end of the microtopographic gradient.

Ecotope dimensions of 11 *Sphagnum* species were measured on climatic, water chemistry, height of the capitulum above the water table and overstory shade gradients. Dispersal of species optima indicate that climate and height relative to the water table are extensively partitioned by *Sphagnum* species. Only bog and poor fen habitats are partitioned on a complex water chemistry gradient that includes Ca, Mg, Na, K, Fe, Mn, and H concentrations in the surface waters . The overstory shade gradient was not partitioned by mire *Sphagnum* species.

Among 6 elements analysed (Ca, Mg, Na, k, Fe, Mn), only Ca and Mg concentrations in mire surface waters are significantly related to concentrations in hummock-forming *Sphagnum* species. Climatic conditions that produce moisture deficits increase effects of Ca and Mg in surface waters on concentrations of these elements in the moss plants.

Increases in length and weight of pool, lawn, and carpet *Sphagnum* species that were grown in waters collected from different climatic zones vary along corrected conductivity and amonium gradients. Lack of suitable habitats does not appear to limit the geographical distribution of such poor fen species as *Sphagnum lindbergii*, *S. papillosum*, and *S. jensenii*, since they grew significantly ($p<0.05$) in waters obtained from each of the climatic zones. However, growth of the moderate-rich fen species *Sphagnum teres* may be restricted on many hyperoceanic mires by low k_{corr} values (< 10 µS) and low NH_4^+ concentrations (< 2 mg/L) in the surface waters.

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I. Introduction

Mires or peatlands cover approximately 360 X 10^6 hectares of the world's surface (Moore and Bellamy 1974). By far the largest proportion of these are found in Northern Hemisphere boreal and arctic regions. Zoltai and Pollett (1983) estimate that approximately 12% of Canada's land mass is covered by peatlands and Vitt et al. (1975) suggest that 40% of boreal regions of Alberta are covered by these wetlands. The vegetation of most northern hemisphere mires is dominated by a single plant genus, Sphagnum (Moore and Bellamy 1974).

Peatlands are characterized by accumulations of dead organic matter (peat) and a water table that is close to the peat surface. Peat accumulations result when the rate of primary production exceeds the rate of decomposition. Peatlands are not very productive ecosystems and peat accumulations are mostly caused by extremely low decomposition rates (Clymo 1982). This is usually attributable to the inhibition of bacterial growth by anaerobic conditions due to a high water table, low pH, low temperatures, and low nutrient status (Clymo 1982, 1978). In boreal and sub-arctic peatlands, the peat is mainly composed of dead Sphagnum. In fact, Sphagnum is often over represented in peat because of its resistance to decomposition (Clymo & Hayward 1982). Clymo (1982, 1965) estimates that there is more carbon present in Sphagnum alive and dead, than is fixed by all terrestrial vegetation in one year.

Sphagnum initiates and controls many vegetation changes in peatland development (Crum 1988, Moore & Bellamy 1974). These changes usually result from the abilities of Sphagnum species to: 1) exchange H^+ ions for mineral cations, and 2) retain large quantities of water (Andrus 1986). By releasing H^+ into their environment as a result of ion exchange and organic acid production, Sphagnum plants can acidify their immediate surroundings thus affecting the adjacent vegetation. The ability to retain large quantities of water can elevate the peatland water table, effectively insulating mire vegetation from effects of the local ground water. This creates a nutrient poor ecosystem where the principal source of minerals and nutrients is from rainfall and aolian deposition (Damman 1986). By raising mire water tables, water may permanently flood the mineral soil surrounding the peatland, thus expanding the mire and radically changing the species composition of the previously dry land (Moore & Bellamy 1974).

Economically, Sphagnum is an important natural resource in many parts of the world. The high organic content, moisture retaining capacities and slow rate of decomposition make Sphagnum peat an excellent soil ameliorant. For this reason, the exploitation of Sphagnum peat is an annual multi-million dollar business. Peat has also been used as an energy source, either for domestic fuel or to power electricity generating stations.

The ecological and economic value of Sphagnum make it one of the most important moss genera in boreal and sub-arctic regions. For this reason, Sphagnum has been intensely studied both in Europe and North America. A large proportion of these studies have focused on the synecology of peatlands, and thus on Sphagnum but several other studies have examined the autecology of many species (Andrus 1986, Clymo & Hayward 1982). Effects of different types of pollutants on Sphagnum growth and distribution have also been studied (Gignac 1987a , b, Wilcox & Andrus 1987, Gignac and Beckett 1986, Wilcox 1984, Ferguson and Bell 1979, Ferguson et al. 1978, Gorham & Tilton 1978, Pakarinen & Tolonen 1977). However many facets of Sphagnum ecology remain largely undescribed. One such facet is the climate.

Climate is an important factor affecting plant distribution that has, as yet, not been accurately described for Sphagnum species. This study attempts to analyse the importance of climate relative to other gradients in limiting Sphagnum distribution, abundance, and ecotope (niche) dimensions in western Canada. This area provides a unique opportunity to study the effects of climate on Sphagnum. Because of a series of mountain ranges paralleling the coast, the entire climatic gradient is compressed within a relatively short distance when compared to eastern North America. The number and variety of peatlands are large in the area, although occasionally they are rare in some localities because of the rugged landscape.

In this first chapter, the following topics are introduced: 1) the structure, reproduction, and dispersal of Sphagnum; 2) descriptions of mire habitats and environmental gradients that affect peatland vegetation in general and Sphagnum in particular; 3) a review of the some of the problems in defining species ecotope (niche) dimensions and some possible approaches that will be used in this study to solve them. The second chapter examines the importance of climate, chemical, and physical gradients that limit the distribution of mire Sphagnum species in western Canada. In the third chapter, ecotope dimensions of some of the more abundant mire Sphagnum species in western Canada are defined. The fourth chapter examines effects of both climate and mire surface waters on the ecotope dimensions of hummock-forming Sphagnum species. Effects of surface water chemistry on the growth and geographical distribution of species found in wet hollows are examined in chapter five. Chapter six is a general discussion synthesizing the results of this study.

Morphology, reproduction, and dispersal

Like all mosses, Sphagnum are small plants, without roots and well differentiated vascular systems. Individual plants consist of a stem that varies from horizontal to upright in stature, depending on the species or the wetness of the microhabitat (Crum 1984). Branches occur in fascicles and are spirally arranged around the stem. At the tip of the stem, the branches are crowded together, forming a head-like tuft, the capitulum.

Leaves are typically dimorphic, with branch leaves differentiated from stem leaves. Branch leaves are crowded together and microscopically consist of large, dead, porose, hyaline cells, surrounded by smaller non porose living green cells. Hyaline cells usually have annular or helical thickenings (fibrils). Pores in the hyaline cells vary in size from 2.0 µm to over 20.0 µm, are more or less circular in shape, and are either simple or surrounded by a thickened ring (Daniels & Eddy 1985). Stem leaves are usually less crowded, but with the same cellular arrangement. The most common difference between branch and stem leaves is the partial and complete loss of hyaline cell fibrils in stem leaves, accompanied by resorption of the leaf surface. Resorption produces a thinning of the upper stem leaf surface margin or the leaf apex may become extensively resorbed and fringed with the remains of green cells (Daniels & Eddy 1985).

Stems are indeterminate in growth with the apical cell contained in a bud surrounded by tightly packed branches of the capitulum. Stems, branches, and leaves usually remain undecomposed for several decimeters into the peat. Peatland species normally have vertical growth; branching infrequently occurs and results from the apical bud equally splitting into two smaller buds.

Branch growth is determinate. Fascicles can be composed of from 2 to 12 branches of two different kinds. Hanging or pendent branches are relatively limp and lie along the stem. Spreading or divergent branches are sturdier and extend perpendicular from the stem. Ecologically, branches are important in maintaining water relations within hummocks and lawns. Small capillary spaces that form between the pendent branches and the stem enable water to move upward to the capitulum during periods of drought. Spreading branches permit water to transfer laterally, thus equilibrating water relations within the lawn or hummock (Hayward and Clymo 1983).

Sphagnum species possess a wide range of morphological variation. Most of the variability is genetic but may also be due to responses to environmental factors, particularly moisture stress. Some of the characters that vary extensively are: leaf shape and size, and the color of the capitulum and antheridial branches (Andrus 1980). The color variation is due mainly to light striking the capitulum and the air temperature (Andrus 1986).

Sphagnum species are mostly dioicous, with archegonia and antheridia on different plants. Spores are produced in capsules borne on a haploid pseudopodium and are dispersed when the operculum at the top of the capsule pops off. Spores are trilete, abundant, relatively large for mosses (25-45 μm) and wind dispersed (During 1979, Crum 1972). Spores germinate and produce a thalloid protonema from which a single gametophore is produced. However, the environmental conditions necessary for spore germination and the manner in which new plants establish from spores in the field largely remain a mystery. Fruiting occurs more or less frequently, depending on the species and environmental conditions. A few species produce several capsules yearly,that persist throughout the growing season. Some species, however, rarely produce capsules and these persist only for short periods of time. Sporophyte production appears to be controlled by day-length (Benson-Evans 1964, 1961) and perhaps by the balance of red and far red light (Clymo and Hayward 1982).

Asexual reproduction is inferred to be quite common in Sphagnum since some species do not fruit abundantly or regularly. Fragmentation followed by transportation by wind, water or animals, appears to be an important method of dispersal. However, little is known of the importance of asexual reproduction to the long range dispersal and geographic distribution of these mosses (Crum 1972).

Dichotomous branching is a phenomenon that is commonly observed in many Sphagnum species. The frequency with which the capitulum divides appears to be species specific (Clymo and Hayward 1982). Branching depends on the size of the capitulum (large capitula are more apt to branch than smaller ones) and the density of plants (Clymo and Hayward 1982). The probability that stems will fork is largest for populations that appear to be invading or colonizing a new area. Whether a plant has already branched or not has no effect on the probability that it will do so again. After a growing season, branches that have recently forked are usually for the most part functions physiologically independent of each other

Sphagnum only occurs in wet habitats. These wet areas may cover several hectares or a few square centimeters. Sphagnum species can colonize many types of substrate: seepage areas on cliffs, wet sand, bare peat, wet siliceous rocks, and stems of ericaceous shrubs. However, the majority of Sphagnum species are found in various types of mires.

Mire habitats

Peatland vegetation varies locally along three important gradients: 1) ombrotrophic to minerotrophic, 2) wet to dry, and 3) mire margin to mire expanse (Sjörs 1952, Malmer 1962). These gradients, or directions of variation, can be critically measured, and numerous studies have focused on the effects of these gradients on vegetation (Damman & French 1987, Vitt & Bayley 1984, Vitt & Slack 1984, Glaser et al. 1981, Gauthier 1980, Slack et al. 1980, Pakarinen & Ruuhijärvi 1978, Vitt et al. 1975, Sonesson 1970, Sjörs 1963, 1952, Malmer 1962, Persson 1961, Ruuhijärvi 1960). Snow cover and duration may also play a role in determining vegetation differences within a peatland (Sonesson 1970). The ombrotrophic to minerotrophic gradient; however, seems to be the most important factor limiting the vegetation on peatlands, and many peatland classification systems are based on this gradient (Zoltai 1988, Damman & French 1987, Damman 1977, Moore & Bellamy 1974, Gorham 1956, Du Rietz 1954, Sjörs 1952).

The ombrotrophic-minerotrophic gradient is based on the source of the supply of ions and elements to the peatland (Sjörs 1963). The supply of nutrients for ombrotrophic peatlands (or bogs) is derived entirely from precipitation or dustfall, while minerotrophic peatlands, or fens, are influenced by water that has been in contact with the mineral soil. The minerotrophic gradient is very complex, since the quantity of nutrients affecting the mire is variable, and depends on several factors: 1) the quantity of water flow through the mire, 2) the dilution effects of the precipitation, and 3) the nature of the mineral soil over which the water has flowed. The vegetation generally reflects the quantity and quality of nutrients contained in the system and varying from poor to rich (Du Rietz 1949).

Associated with the ombrotrophic-minerotrophic gradient and to a certain extent defining it, are several water chemistry gradients. The calcium and magnesium concentrations in mire waters increase from bogs to rich fens (whereas the concentration of hydrogen ions decreases) (Sjörs 1963). Thus, bogs will have very low concentrations of calcium and magnesium derived solely from precipitation and high concentrations of H^+ derived principally from the decomposition of organic matter, or from cation exchange by Sphagnum plants (Hemond 1980, Clymo 1964). Elemental and ionic concentrations in poor fen waters are similar or slightly higher than in bog waters, whereas rich fens have considerably greater concentrations of Ca and Mg and low amounts of hydrogen ions.

Sphagnum species are normally the dominant vegetation of bogs and poor fens and occupy the acidic end of the ombrotrophic-minerotrophic gradient (Sjörs 1963, 1952). Sphagnum species may also be prominent or at least present on some rich fens (Karlin & Bliss 1984, Slack et al. 1980). Since the genus Sphagnum is so prevalent on peatlands, it has attracted much interest, and numerous studies have dealt specifically with its ecology (Andrus 1986). Most of these studies have focused on the effects of cation concentrations in the surface water on local species distribution (Andrus 1986, Daniels & Eddy 1985, Karlin & Bliss 1984, Dierssen 1983, Sonesson et al. 1980, Vitt & Slack 1975). Several other studies have described, or tried to explain, the local distribution of species along the moisture gradient (Gignac 1987a, Titus & Wagner 1984, Wagner & Titus 1984, Andrus et al. 1983, Hayward & Clymo 1983, Titus et al. 1983, Vitt et al. 1975). A few studies have taken a more comprehensive approach to the limitations of species along the locally important gradients and the results of interspecific competition (Rydin 1986, 1985, Vitt & Slack 1984, Horton et al. 1979).

The habitat limitations of individual species along local gradients are generally overshadowed by a more important factor, the climate. It has been demonstrated that climate not only affects the distribution of mire species, but also the development of peatlands (Damman 1979, 1977, Moore & Bellamy 1974, Eurola 1962, Sjörs 1948). This factor is also important in limiting the ranges of individual Sphagnum species, and most taxonomic studies of the genus make note of the geographical distribution of each species (Daniels & Eddy 1985, Crum 1984, Andrus 1980, Vitt & Andrus 1977, Isoviita 1970, 1966). However, no direct measurements of the limitations imposed on each species by climate have specifically focused on Sphagnum.

Ecotope (niche) theory

One of the earliest usages of the term "niche" was to describe a species' role within a community. Hutchinson (1957) expanded this view by defining the niche as an n-dimensional hyper-volume differentiated into a fundamental niche or maximal space and a contracted space or realized niche. The fundamental niche measured a species' limitations relative to environmental factors and represented the genetic potential and physiological tolerances of that species. The inclusion of such biotic factors as predation, competition and limits to dispersal led to a contraction of the hyper-volume into the realized niche. Whittaker et al. (1973) distinguished the niche from an ecotope or habitat niche that included inter-community as well as intra-community factors. The ecotope had a spatial or landscape dimension that was absent from the niche. Since this study incorporates several different communities over a broad geographical area, the term "ecotope" is used rather than "niche", which is more appropriate for describing species' roles within one community.

Niche and ecotope theory have been applied in several bryophyte studies (Glime & Vitt 1987, Rydin 1986, Slack & Glime 1985, Vitt & Slack 1984, Slack 1982, 1977, Watson 1981, Lee & LaRoi 1979, Johnson 1977). Vitt and Slack (1984) examined ecotope dimensions of several Sphagnum species relative to such environmental gradients as cationic content of mire waters, height relative to the water table and shade. Rydin (1986) examined the niches of four Sphagnum species along a topographic gradient and Clymo and Reddaway (1974) and Clymo (1973) investigated the fundamental niches of several species along height, calcium and pH gradients, using growth and transplant experiments.

In several of these studies, the multidimensional hyper-volume had been reduced to a manageable number of axes representing ordered environmental gradients. These axes identified a limited number of factors that ensured niche and ecotope separation within a community or landscape. The reduction of the number of niche dimensions led to the inclusion of such complex environmental variables as elevation (Slack 1977, Lee & LaRoi 1979, Watson 1981), conductivity of mire waters (Vitt & Slack 1984), and substrate (Glime & Vitt 1987, Slack & Glime 1985), that summarized several environmental variables.

The exact relationship between each complex gradient and the environmental variables it summarized was determined either intuitively or indirectly through correlation analyses. The alternative to the use of a complex gradient was to analyse a large number of variables and quantify niche dimensions for each species along each gradient. The variables that separated species niches were judged to be the most important resources delimiting species niches. This method, however may prove limited if the gradients are not totally independent of each other.

The problem of the reduction of a large number of variables to a few highly significant axes can be solved by such ordination techniques as correspondence analysis (CA) (Hill & Gauch 1980) and canonical correspondence analysis (CCA) (ter Braak 1987a). These techniques maximize dispersal of species optima along ordination axes, thus improving niche or ecotope separation. Although both methods only project species optima, it is possible to fit Gaussian response curves by log-linear regression of species' abundances on the ordination axes (ter Braak 1985, ter Braak & Looman 1986). Gaussian response curves make possible quantitative measurements of niche or ecotope width and overlap (Gauch et al. 1974, Gauch & Chase 1974, Gauch & Whittaker 1972). When environmental variables are directly related to ordination axes, the axes become revised environmental gradients and species niche dimensions can be defined by fitting Gaussian curves on these synthetic gradients.

Canonical correspondence analysis in particular is useful in determining the effects of several variables on a complex gradient. This technique uses weighted environmental variables to calculate the ordination axes and ensures maximum species' dispersal (ter Braak 1987a & b). Several of the ordination axes may be influenced by complex gradients. The exact relationship between the component variables of the complex gradients and the ordination axes can be determined from the weight of each environmental variables. The effects of a large number of factors on the niche dimensions of several species can thus be determined from the ordination axes. The results also remain manageable by reducing all the variables to three or four axes.

Summary

Attempting to determine the principal factors limiting the geographical range of Sphagnum species and species distribution within that range is a complex problem. Crum (1972) synthesized this problem by defining four factors that could limit the geographical ranges and ecotope dimensions of bryophytes: i) lack of a suitable habitat; ii) effects of climate; iii) competition; iv) failure to disperse and/or establish in suitable habitats. The complexity is further increased by the multiplicity of variables that compose each of those factors. Few studies have examined all of those factors together in order to explain the distribution of a single moss species (Forman 1964) or of bryophytes in general (van Zanten & Pocs 1981, Crum 1966, 1972). Only a few studies have measured the effects of one or the other of the four factors on the geographical distributions of Sphagnum (McQueen 1987, Lane 1977, Boatman & Lark 1971, Green 1968). In this study, climate and lack of a suitable habitat will be examined as factors limiting the distribution of Sphagnum species in western Canada.

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II. Habitat limitations of Sphagnum along climatic, chemical and physical gradients in mires of western Canada[1]

Abstract

Sphagnum distribution was studied on twenty-seven peatlands found along a transect extending from the Queen Charlotte Islands, British Columbia, to central Alberta. Based on the dominant cations in the surface water, oceanic mires are either ombrotrophic bogs or poor fens, while in sub-continental areas, mires range from extreme-poor fens to moderate-rich fens. Species are grouped into five clusters; stands into ten. Species groups and stand dispersal are determined by climate and surface water chemistry, especially conductivity corrected to 20°C and for H^+ ions and calcium, magnesium and potassium concentrations.

Sphagnum species habitats are limited to mires having low cationic contents and corrected conductivities. Seven of eighteen species studied are limited by climatic factors to oceanic areas. Sphagnum fuscum is the most widespread of all the species studied, independent of climate and surface water chemistry. Only three Sphagnum species are present in moderate-rich fens. Most of the species height requirements along the hummock-hollow gradients are present on the mires studied, and the height relative to the water table does not limit the geographic distribution of these species. Height is limiting only for species found at either end of the topographic gradient. Tree and shrub produced shade does not limit the habitat of any of the species studied.

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Introduction

Peatlands, or mires, occupy approximately 360 x 10^6 hectares of the world's surface (Moore & Bellamy 1974). The largest proportion of these are found in boreal and subarctic regions of the Northern Hemisphere. Zoltai and Pollett (1983) estimated that approximately 12% of Canada's land mass is covered by peat. In western Canada, Vitt et al. (1975) judged that 40% of the boreal region of Alberta is covered by peatlands, and according to Banner et al. (1986), the surface area they cover is approximately equal to the area covered by closed forest in northwestern British Columbia.

Peatland vegetation varies locally along three important gradients: 1) ombrotrophic to minerotrophic, 2) wet to dry, and 3) mire margin to mire expanse (Malmer 1962, Sjörs 1952). These gradients, or directions of variation, can be critically measured, and numerous studies have focused on the effects of these gradients on vegetation (Damman & French 1987, Vitt & Bayley 1985, Vitt & Slack 1984, Glaser et al. 1981, Gauthier 1980, Slack et al. 1980, Pakarinen & Ruuhijärvi 1978, Vitt et al. 1975, Sonesson 1970, Sjörs 1963, 1952, Malmer 1962, Persson 1961, Ruuhijärvi 1960). Snow cover and duration may also play a role in determining vegetation differences within a peatland (Sonesson 1970). The ombrotrophic to minerotrophic gradient seems to be the most important factor limiting the vegetation on peatlands, and many peatland classification systems are based on this gradient (Zoltai 1988, Damman & French 1987, Damman 1977, Moore & Bellamy 1974, Du Rietz 1954, Sjörs 1952).

The ombrotrophic-minerotrophic gradient is based on the source of the supply of ions and elements to the peatland (Sjörs 1963). The supply of nutrients for ombrotrophic peatlands (or bogs) is derived entirely from precipitation or dustfall, while minerotrophic peatlands, or fens, are influenced by water that has been in contact with the mineral soil. The minerotrophic gradient is very complex, since the quantity of nutrients affecting the mire is variable, and depends on several factors: 1) the quantity of water flow through the mire, 2) the dilution effects of the precipitation, and 3) the nature of the mineral soil over which the water has flowed. The vegetation generally reflects the quantity and quality of nutrients contained in the system and varies from poor to rich (Du Rietz 1949).

Associated with the ombrotrophic-minerotrophic gradient and to a certain extent defining it, are several water chemistry gradients. The calcium and magnesium concentrations in mire waters increase from bogs to rich fens (whereas the concentration of hydrogen ions decreases) (Sjörs 1963). Thus, bogs will have very low concentrations of calcium and magnesium derived solely from precipitation and high concentrations of H^+ derived principally from the decomposition of organic matter or from cation exchange by Sphagnum plants (Hemond 1980, Clymo 1964). Elemental and ionic concentrations in poor fen waters are similar or slightly higher than in bog waters, whereas rich fens have considerably greater concentrations of Ca and Mg and low amounts of hydrogen ions.

Sphagnum species are normally the dominant vegetation of bogs and poor fens and occupy the acidic end of the ombrotrophic-minerotrophic gradient (Sjörs 1963, 1952). Sphagnum species may also be prominent or at least present on some rich fens (Karlin & Bliss 1984, Slack et al. 1980). Since the genus Sphagnum is so prevalent on peatlands, it has attracted much interest, and numerous studies have dealt specifically with its ecology (Andrus 1986). Most of these studies have focused on the effects of the cation concentrations in surface waters on local species distribution (Andrus 1986, Daniels & Eddy 1985, Karlin & Bliss 1984, Dierssen 1983, Sonesson et al. 1980, Vitt & Slack 1975). Several other studies have either described or tried to explain the local distribution of species along the moisture gradient (Gignac 1987, Wagner & Titus 1984, Titus & Wagner 1984, Andrus et al. 1983, Hayward & Clymo 1983, Titus et al. 1983, Vitt et al. 1975). A few studies have taken a more comprehensive approach to the limitations of species along the locally important gradients and the results of interspecific competition (Rydin 1987, 1985, Vitt & Slack 1984, Horton et al. 1979).

The habitat limitations of individual species along local gradients; however, are generally overshadowed by a more important factor, the climate. It has been demonstrated that the climate not only affects the distribution of mire species but also the development of peatlands (Damman 1979, 1977, Moore & Bellamy 1974, Eurola 1962, Sjörs 1948). This factor is also important in limiting the ranges of individual Sphagnum species, and most taxonomic studies of the genus make note of the geographical distribution of each species (Crum 1984, Daniels & Eddy 1985, Andrus 1980, Vitt & Andrus 1977, Isoviita 1970, 1966). However, no direct measurements of the limitations imposed on each species by climate have specifically focused on Sphagnum.

Western Canada provides a unique opportunity to study the effects of climate on Sphagnum. Because of a series of mountain ranges parallelling the coast, the entire climatic gradient is compressed within a relatively short distance when compared to eastern North America. The number and variety of peatlands is abundant in the area, although occasionally they are rare in some localities because of the rugged landscape.

The objectives of this study are to: 1) describe the climate as gradients determined from variables that include both hydric and temperature components, 2) determine the relationship between the climatic gradients and peatland types in western Canada and 3) delimit the habitats of mire Sphagnum species using climate, surface water chemistry and physical parameters.

Study Area

The study sites are located along a transect from the Pacific coast of British Columbia to central Alberta (Fig. II-1). The study area is dissected by a series of mountain ranges generally parallelling the coastline (Fig. II-2). The two largest ranges, the Coast Mountains and the Rocky Mountains are located on either side of British Columbia. Maximum elevations of the Coast Mountains vary between 1500 and 2500 m along the transect, and up to 3900 m in the Rocky Mountains (Holland 1964). Of the smaller ranges, only the Hazelton and Cariboo Mountains have a direct influence on the transect. Maximum elevations in these ranges varies between 1100 m in the Queen Charlotte, 2700 m in the Hazelton, and 3400 in the Cariboo Ranges.

The transect also intersects three major landforms that have a relatively flat topography. The Queen Charlotte Lowland east of the Queen Charlotte Mountains has elevations below 150 m. The Nechako Plateau and Plain are bounded by the Hazelton Mountains to the west and the Rocky and Cariboo Mountains to the east. The Plateau is an area of low relief with great expanses of flat and gently rolling terrain and lies between 1230 and 1500 m above sea level. East of the Rocky Mountain foothills, the Alberta Plain has a relatively even surface, with a few areas of widely separated hills. Elevations range from 610 to 914 m.

The climate ranges from maritime, temperate, humid with cool summer temperatures and no long periods of drought, to a sub-continental, boreal with cold winters, short cold summers and extended periods without summer precipitation. The climatic changes along the transect occur abruptly because of the effects of the various mountain ranges on the Pacific air masses as they move inland. The Coast Mountains have the greatest effects on the total precipitation and on the number of precipitation days (Figs. II-3 & II-4). These mountains reduce the precipitation from over 2400 mm to under 600 mm and the number of precipitation days from over 200 to under 150. The Queen Charlotte, Cariboo, and Rocky Mountains also affect the precipitation gradients, but to a much lesser degree. The mean daily temperatures are also affected by the mountain ranges (Fig. II-5). The Coast Mountains and Rocky Mountains create east-west temperature gradients that override the north-south gradient in parts of the study area. Mean daily temperatures range from above 7.5^{o}C in the coastal areas to below 2.5^{o}C for the greater portion of the study area east of the Hazelton Mountains. The annual total growing degree days calculated as the annual total of the positive difference between the mean daily temperature and $5^{o}C$ also show an east-west gradient, as well as a north-south gradient (Fig. II-6).

The transect passes through several wetland regions: the North Coast Pacific Oceanic, Central Coastal Mountain (Banner et al. 1988), Continental, Mid-Boreal Continental, and High-Boreal Regions (Zoltai, 1988). The peatland types occurring in these regions cover a wide range, from bogs to rich fens. The dominant Pacific Oceanic wetlands are slope and blanket bogs, with some basin and raised bogs that are more localized throughout the region (Banner et al. 1986). Banner et al. (1988) also reported the occurrences of domed bogs, sloped fens and stream and shore fens. Vitt et al. (1989) considered soligenous poor fens to be the dominant mire type along coastal British Columbia, with bogs being of rare occurrence.

The High-Boreal region is characterized by flat bogs and patterned fens with shore fens, floodplain fens and delta fens in suitable areas (Zoltai & Pollett 1983). Flat bogs and basin bogs sometimes associated with fens are common in the Mid-Boreal continental region. Poor fens, with treed bog islands, patterned fens, moderate-rich fens, and extreme-rich fens are the most common mire types in this region (Nicholson 1989, Slack et al. 1980, Vitt et al. 1975).

Materials and Methods

Study sites

Twenty-seven sites were selected for study along a climatic gradient from the Pacific Ocean to central Alberta (Fig. II-1). The transect oriented east-west was dissected by four shorter transects oriented north-south. These subsidiary, north south transects were positioned so as to sample more thoroughly the different climatic zones encountered along the east-west transect. Each site was chosen based on the following criteria: 1) covered by a minimum of 0.5 m of peat; 2) contained at least one Sphagnum species, and 3) was located within 10 km of a permanent meteorological station in mountainous areas and within 50 km in topographically homogenous areas.

Each site was divided into three physiognomic stands: a) a lagg or moat area along the edge of the peatland, b) an open area with trees shorter than 2 m, and c) a treed area, with a relatively dense growth of trees, most of which are taller than 2 m. The number of stands present on a site varied (Table II-1). Stands were studied during the months of July and August 1985, 1986 and 1987.

Meteorological variables

The data used to obtain the climatic variables were taken from 30 year means (1951 to 1980), measured at 27 permanent weather stations (Anonymous 1982 a & b, Anonymous 1986). The variables used can be divided into three groups: a) based only on temperature; b) based only on precipitation; and c) calculated as indices using both temperature and hydric measurements. The different variables calculated for each group are: group a are: 1) length of growing season (gs) calculated as the number of days having mean temperatures above 2°C; 2) effective temperature sum (w) which equals the summation of mean monthly temperatures minus 2°C; 3) biotemperature (bt) which is the summation of positive mean monthly temperatures divided by 12. Variables for group b are: 1) precipitation (precip) calculated as the total precipitation (mm) falling as rain during the growing season; 2) number of precipiation days (pdays) which equals the number of days with measurable rainfall during the growing season. Indices for group c include: 1) aridity index (ai) which equals the annual precipitation falling as rain divided by the annual mean temperature plus 10; 2) index of oceanity (o) that is calculated from the number of precipitation days, the number of days having mean temperatures between 0° and 10°C, and the annual temperature range (Tuhkanen 1984, 1980).

Vegetation sampling

At each site, a transect was established from one edge of the mire to the other. Each transect was oriented so that it traversed the different physiognomic stands on the peatland. The length of the transect was divided into 12 equidistant points. The nearest hummock-hollow complex to each point was selected for further study.

A 0.5 m^2 horizontal platform was suspended above the hummock-hollow complex on four posts. The platform was levelled using spirit levels. One metre-long welding rods were then dropped through holes drilled at 10 cm intervals in the board. The moss plant that lay below each rod was identified. Fifty individual measurements were taken at each hummock-hollow along the gradient; these measurements covered the complete height gradient from the hollow to the top of the hummock. This method is effective only for mosses of approximately the same size. Small mosses that were present on several hummocks often were not detected using this method because of the coarseness of the sampling grid. Abundances of these species were thus grossly underestimated for several stands and therefore, these species were not included in the data analysis. The lowest and highest points relative to the water table were measured and shade estimated for each stand on a scale from 0 to 10, where 0 indicates the absence of shade. With the exception of *Sphagnum austinii* (Andrus 1987), and *S. pacificum* (Flatberg 1989), nomenclature and authority names follow Ireland et al. (1987).

Water analyses

A water sample was collected from each stand either from the surface water or when no surface water could be found, from shallow pits dug in the peat. The water was collected in acid-washed (3% HCl) polyethylene bottles and kept refrigerated until the analyses could be performed. Each sample was filtered through a Whatman #42 filter paper and acidified by adding 1 ml of 4N HCl to 24 ml of water. The elemental concentrations in each water sample were measured on an inductively- coupled argon plasma spectrophotometer. The conductivity and pH were taken in the field. From these, the H^+ concentrations and corrected conductivity (k_{corr}) (Sjörs 1952) were calculated.

Data analyses

Species frequencies were calculated for each stand by dividing the number of occurrences for that species by the number of measurements taken in the stand. The frequencies were subjected to a TWINSPAN analysis, a divisive hierarchial method yielding a two-way classification of species and sites (Hill 1979). Detrended canonical correspondence analysis (DCCA) (ter Braak 1987) was used to simultaneously ordinate species frequencies and environmental variables. This analysis constrains the axis to optimize their relationship with a set of environmental variables, whose direction can be indicated by arrows.

Analysis of variance, Student Newman Keuls' means tests and Pearson product-moment correlations were computed with the Statistical Analysis System (SAS) package.

Results and Discussion

Climatic variables

All climatic variables exhibited strong gradients from oceanic to continental areas (Table II-2). Using precipitation falling as rain during the growing season (precip) and the aridity index (ai), the sites can be divided into three distinct groups. The first group, with the highest values for both variables, includes sites d through j. These sites are all found on the windward coastal areas and are characterized by having over 2000 mm of rain per year. The second group contains sites a through c, and sites k through p. Precipitation values for these sites range between 800 and 2000 mm of rain per year. All of these sites are separated from the coast by one mountain range. Sites a through c, are found along the leeward coast, while sites k through p are found several kilometres inland (Fig. II-1). These geographic differences do not produce large differences in the quantity of rainfall; however, they do create major differences in temperature as denoted by the length of growing season (gs) and biotemperature (bt). Sites a through c have higher values for these temperature variables than sites l through k. Group 3 includes all the remaining sites. These sites have precipitation values at or below 500 mm per year and are characterized by having at least two mountain ranges between themselves and the coast.

Using length of the growing season (gs), the sites can be divided into two groups. Sites a through j have growing seasons of approximately 300 days or more. None of these sites is separated from the coast by mountain ranges, and there are no clear differences between leeward and windward coasts when growing season, precipitation days and index of oceanity gradients are considered. Sites k - aa have growing seasons of less than 200 days. The number of precipitation days (pdays) and index of oceanity (o) also show this division between coastal and inland sites. However, these variables separate sites k through p from q - aa. The remaining temperature variables (w and bt) form fairly continuous gradients without distinct groups. The only important difference between these two variables is that w generally has higher values for coastal sites.

The groups described above, were formed by initial perusal of the data set; however, a one-way analysis of variance followed by Student-Newman-Keuls means test indicated that they are all significantly different ($p < 0.05$). Based on a combination of the climatic indices, four climatic zones can be distinguished along the transect. The first zone is on the windward coast and is characterized by more than 2000 mm of rain a year and a growing season of approximately 300 days or more. This zone (sites d through j) is classified as hyperoceanic. The second zone covers the leeward areas and is characterized by between 800 and 2000 mm of precipitation a year and a growing season longer than

300 days. It is classified as oceanic and contains sites a through c. The third zone is separated from the coast by an intervening mountain range and has between 800 and 2000 mm of precipitation a year and a growing season of approximately 250 days or less. Sites k through p are in this zone, and these are classified as sub-oceanic. Zone 4, which includes the remaining sites has less than 500 mm of rain a year and less than 250 days in the growing season. This zone has continental tendencies and is classified as sub-continental.

All of the climatic variables used in this study, with the exception of precipitation days, are highly correlated ($p > 0.001$ - Table II-3). Few differences between temperature and precipitation variables are evident. Although effective temperature sum (w) values are somewhat higher than for other temperature variables, these differences are not relevant because of small errors inherent in sampling site location.

Error within the measurements can be attributed to two factors. Firstly, the sites are not immediately adjacent to the weather stations, thus producing local variations in measurements. However, the distances between the weather stations and the sites are much smaller than distances between the sites. The variables can therefore be considered as a relatively accurate measurement of the macroclimate at each site. Secondly, the bryophytes may be affected by microclimates that are considerably different from those defined by the macroclimate at each site. But, when compared to the length of the transect, these differences are minor.

Environmental gradients and stand groups

The first TWINSPAN division separated stand groups 8, 9, and 10 from 1 - 7 (Fig. II-7). With the exception of group 10, this division is also reflected in the elemental concentrations of the surface waters (Table II-4). Calcium, magnesium, and potassium concentrations are distinctly higher in stand groups 8 and 9. These elevated elemental concentrations are also reflected by the higher corrected conductivity values which, along with the lower hydrogen ion concentration, are characteristic of moderate-rich fens (Sjörs 1952). Thus, the first TWINSPAN division separates moderate-rich fens from the remaining poor fens and bogs.

Stand group 10 contains only one stand (19) and it was separated from stand groups 8 and 9 in the next TWINSPAN division. Stand 19 is exceptional in several ways: 1) it is the only sub-oceanic site that had moderate-rich fen vegetation, 2) it was the southernmost of all the sub-oceanic and oceanic sites studied, and 3) it formed in a steep sided pothole and appeared to have been relatively recently covered by peat. The combination of these factors may explain the discrepancy between the elemental concentrations in stand group 10 and stand groups 8 and 9. The higher precipitation levels may have a dilution effect on the elemental concentrations normally found in moderate-rich fen surface waters. Conversely, the relative age of the peatland, combined with the steep sides of the pothole probably caused flooding of the peat surface by water that has flowed over mineral soil.

Stand groups 1,2 3, and 4 were separated from groups 5, 6 and 7 by the second TWINSPAN division. This division was parallelled by calcium concentrations and corrected conductivity of the surface waters. Stand groups 1, 2, and 3 have lower calcium concentrations and corrected conductivity that are indicative of extreme-poor fens and bogs. This TWINSPAN division separates extreme-poor fens and bogs from intermediate-poor fens and intermediate fens (Sjörs 1952).

The corrected conductivity and hydrogen ion concentration in the surface waters are significantly correlated ($p < 0.05$) with the concentrations of all of the elements, with the exception of iron (Table II-5). Calcium and magnesium concentrations are also significantly correlated with potassium concentrations. Shade is the only physical variable that is significantly correlated with most of the chemical variables. Corrected conductivity and calcium and magnesium concentrations are significantly correlated ($p < 0.05$) with the following climatic variables: growing season (gs), effective temperature sum (w), biotemperature (bt), precipitation (precip), and index of oceanity (o). None of the other elements is significantly correlated with more than one climatic variable.

The environmental and climatic variables that were used to determine the first three DCCA axes are plotted in Figures 8 and 9. The centroid for each variable is at the tip of the arrow. The direction and length of the arrows can be used to determine the relative weights of each variable in calculating the axes. Thus, growing season (gs) and index of oceanity (o), as indicated by the length and the close proximity of the arrows to the first axis (Fig. II-8), were the most influential climatic variables in determining this axis. However, precipitation (precip), biotemperature (bt), and aridity index (ai) were also important in calculating the first axis, as indicated by their significant correlation ($p < 0.05$) with the first axis (Fig. II-8). Corrected conductivity, calcium and magnesium are also significantly correlated with axis 1. These elements are also highly correlated amongst themselves as well with the climatic variables (Table II-5). The corrected conductivity and the calcium and magnesium concentrations generally increase as the climate changes from oceanic to continental areas.

The second DCCA axis is correlated only with chemical variables. These variables include corrected conductivity and hydrogen ion, calcium, magnesium and potassium concentrations in the surface waters. The directions of the arrows for each variable indicate that concentrations of all of the elements with the exception of hydrogen increase along the second axis. The hydrogen ion gradient is in the opposite direction to the other elements. Variation along the third axis is related to three physical variables: minimum and maximum heights above the water table and shade present on a stand. Of these three, the minimum height is the most important in determining this axis of variation.

This measurement indicates the lowest height relative to the water that is available as a habitat for the moss species.

The eigenvalues for the first three DCCA axes are 0.57, 0.41 and 0.30, respectively. These first three axes account for 56% of the variation of species distribution. A Monte Carlo permutation test showed that the first axis is statistically significant ($p > 0.01$).

Stands are generally arranged in ascending stand group order along the first DCCA axis, with stand groups 1, 2, 3, and 4 having low conductivity and calcium values mostly grouped on the negative side of the first axis (Fig. II-10). Groups 8 and 9, that have high calcium, magnesium, and potassium values are on the positive side of the first axis. Effects of the climate are also evident in the stand ordination since stands from groups 1, 2 and 3, mostly located in oceanic areas, are found in the negative side of the first axis. Groups 8 and 9, that are found in continental areas, are positioned on the positive side of the first axis. However, stand group 10, which occurs in a sub-oceanic area, is also on the positive side of the first axis. Therefore, the stand pattern groupings are more influenced by water chemistry than by climate, although both factors are important.

Variation between stands along the second axis exhibits two patterns. On the left side of the second axis, stands are positioned relatively close to the first axis, while on the right side, stands are dispersed farther away from the first axis. The second DCA axis is correlated with such water chemistry variables as H^+, calcium, magnesium, and potassium concentrations and corrected conductivity. The two stand patterns relative to the second axis indicate that there are wider variations in surface water chemistry in continental than in oceanic peatlands.

The DCCA stand ordination (Fig. II-10) can be related to the different peatland types using water chemistry components (Sjörs 1952). In oceanic regions, to the left of the ordination, there is relatively little variation along the second axis (Fig. II-10). This indicates that most of the peatlands are of one or two types and most of the variation along the water chemistry gradient is caused by the differences between the moat or lagg areas and the mire expanses. The low k_{corr} values and calcium concentrations of the stands are indicative of ombrotrophic bogs or extreme poor fens (Plate II-1).

A much broader spectrum of peatland types are found in continental areas. On the negative side of the second axis, stands from groups 5, 6 and 7 are either transitional poor fens or intermediate fens. On the positive side of the second axis, stands range from poor fens to moderate-rich fens (Plate II-2).

Species groups

The species groups are numbered according to the dendrogram in Figure II-7, and the distribution of species within these groups is shown in Table II-6.

Species group 1: Oceanic bog and extreme poor fen species. This group of seven species has oceanic or suboceanic tendencies and is associated with the left side of the species ordination (Fig. II-11). This group is also strongly associated with stand groups 2 through 4, which are characterized by low calcium and k_{corr} values (Table II-4).

Species group 2: Widespread poor fen species with continental tendencies. This group of 6 species is found in almost all of the stand groups but reached its greatest abundance in stand groups 5, 6 and 7. These stand groups have intermediate levels of Ca and k_{corr} and are poor fens. Sphagnum jensenii, S. majus, and S. russowii are the least widespread of the species within this group, being found only in one or two stand groups (Table II-6). Since this group is found on the right side of the ordination axis, they have greater continental tendencies than species group 1. Sphagnum capillifolium, S. angustifolium and S. magellanicum are the most widespread of the species in this group.

Sphagnum lindbergii is found on the most oceanic sites at the latitudes examined in this study. It has a more widespread distribution in more northerly latitudes and is occasionally found in northern Albertan poor fens (Horton et al. 1979, Vitt & Andrus 1977, Vitt et al. 1975). In these poor fens, it is most often found with S. jensenii and S. majus. Sphagnum lindbergii should be placed in group 2 rather than group 1, since it has a more widespread distribution than that shown in this study and should be considered as one of the more widespread poor fen species.

Species group 3: Widespread Sphagnum species. This is the only group occurring frequently in all of the stand groups, as indicated by the species occurrences in Figure III-6. The species in this group did not appear to have any preference either along the climatic gradient or for a specific peatland type. Sphagnum fuscum was the more common of the two species found in this group (Table II-6).

Species group 4: Widespread non-Sphagnum hummock species. The species in this group are abundant in stand groups 2, 6, 8 and 9. These groups have very different calcium concentrations and k_{corr} values and are located at different places along the climate gradient. These species are commonly found at the top of the driest hummocks on several peatlands.

Species group 5: Sub-continental and moderate-rich fen species. The species within this group are most abundant in stand groups 8 and 9. These stand groups have the greatest concentrations of Ca and the highest k_{corr} values and were indicative of a gradient from poor to moderate-rich fens. Almost all of the species within this group have continental tendencies. The exception is Sphagnum palustre, which is an oceanic or suboceanic species (as suggested by its position on the left side of the DCCA ordination). The most common species within this group are Tomenthypnum nitens and Sphagnum warnstorfii.

Species distributions

The DCCA biplots of axis 1 and 2, and 1 and 3 (Fig. II-12 & II-13) can be used to determine the effects of environmental gradients on the distribution of individual Sphagnum species. The distances between the arrows representing the environmental gradients and the species position on the ordination allows for an approximate determination of the importance of the variables in limiting the distribution of each species (Jongman et al. 1987). However, the distinction between highly correlated variables is too small to permit the separation of the effects of individual variables on the distribution of the species. For this reason, only representative gradients for each group of highly correlated variables are shown on the biplots. The chemical variables are represented by k_{corr}, which is significantly correlated with calcium and magnesium concentrations. The three physical variables that determine the third axis are plotted on Figure II-12.

Within western Canada, climate is not an important factor limiting the distribution of the Sphagnum species that are positioned around the 0 point of the first axis. Such species as S. fuscum, S. capillifolium, S. majus, S. pacificum, and S. magellanicum are widespread species that are found throughout the gradient. The position of each species relative to the 0 point can be used to indicate tendencies based on their abundance along the gradient. Thus, S. capillifolium and S. pacificum have slightly greater oceanic than continental tendencies. Conversely, S. majus, S. fuscum and S. magellanicum have more continental tendencies.

Sphagnum tenellum and S. austinii are found exclusively in oceanic and hyper-oceanic peatlands. These species are probably restricted to these sites by the climate, although they may also be affected to some extent by the low cationic contents of the mire waters. However, the water chemistry factor would appear to be much less important than climatic ones, since peatlands with very low cationic contents are also found in sub-continental areas.

Sphagnum palustre, S. papillosum, S. rubellum and S. pacificum all have intermediate positions on the DCCA biplot between the oceanic species and the widespread species. These species cover a wide portion of the climatic gradient from hyper-oceanic to sub-oceanic sites, but are excluded from sub-continental peatlands. These species also appear to be limited by climate, but their physiological tolerances along this gradient are wider than those of S. austinii and S. tenellum. Although S. centrale is also ordinated amongst the sub-oceanic species, it is occasionally found in the margins of sub-continental peatlands (Vitt & Andrus 1977). On these sites, it is more often found in forested areas of leaf litter, that were not sampled in this study. Thus, this species occupies habitats outside those included here, and it should be considered as a widespread species.

Sphagnum teres, S. angustifolium, S. russowii, S. squarrosum and S. jensenii are also widespread species, but they have much stronger continental tendencies than any of the other species. With the exception of S. angustifolium, none of these species is found in hyper-oceanic peatlands. However, the climate may not be limiting these species, particularly S. teres and S. squarrosum as much as the absence of stands in hyper-oceanic peatlands that have waters with high cationic contents. The same argument may also hold for S. warnstorfii, which according to the biplot was the most continentally distributed species.

The ecological amplitudes along the water chemistry gradient of the majority of the Sphagnum species encountered in this study have previously been described for eastern North America (Andrus 1986) and Europe (Daniels & Eddy 1985, Dierssen 1983). With a few exceptions, the DCCA ranking of the species along axis 2 correspond to ecological amplitudes that had been described in these studies. The exceptions are S. russowii, S. centrale, and S. fuscum. Sphagnum russowii and S. centrale are situated on the negative side of the second axis (Fig. II-2), indicating that they are found in mires having low cation and high H^+ concentrations. According to the biplot, S. russowii is found in habitats having the lowest cation concentrations of any other species studied. Based on the results from previous studies, both species should occur in habitats having lower H^+ and higher cation concentrations (Andrus 1986, Daniels & Eddy 1985, Dierssen 1983) and should thus be situated closer to the positive side of the second axis of the DCCA biplot. Both species grow along mire margins and are often found in wooded areas that would not be considered as part of a peatland (Vitt & Andrus 1977). These areas were not sampled, thus the cation and H^+ gradients are truncated and the ecological tolerances of both species are underestimated.

On the biplot of axis 1 and 2 (Fig. II-12), Sphagnum fuscum is situated at approximately the same distance from axis 1 as S. warnstorfii and should be considered a moderate-rich fen species. Although S. fuscum is found on moderate-rich fens along with S. warnstorfii, it also occurs in poor fens and ombrotrophic bogs. This may indicate that S. fuscum has very little contact with the surface water, and its habitat is unaffected by the cation concentrations and pH of the surface waters. Unlike any of the other Sphagnum species studied, S. fuscum may in fact form its own habitat, separated from the surface water cation concentrations. The same may hold for Racomitrium lanuginosum and Pleurozium schreberi, two widespread non-Sphagnum hummock species that are situated in close proximity to S. fuscum on the DCCA ordination.

The DCCA ordination of the species indicates that most Sphagnum species are restricted to peatlands that have low k_{corr} values and high H^+ concentrations. Among these species, distributions are more a function of the climate, rather than water chemistry. The biplot indicates that S. palustre, S. teres, S. fuscum, S. austinii, S. warnstorfii and S. squarrosum occur in stands having distinctly higher surface water cationic concentrations than the remaining species.

In continental areas, where the k_{corr} and pH gradients extend to high values, the DCCA ordination clearly demonstrates that Sphagnum species are replaced by other mosses. Poor fens are almost exclusively dominated by *Sphagnum*, while rich fens are dominated by such species as *Tomenthypnum nitens*, *Campylium stellatum*, *Meesia triquetra* and *Paludella squarrosa*. Only two *Sphagnum* species, *S. warnstorfii* and *S. fuscum* are abundant on mires having high k_{corr} values, *Sphagnum teres* is also occasionally found in this habitat.

Two physical parameters also limit species distribution: height relative to the water table and shade. Since the two gradients are oriented in the same direction, it is difficult to determine the effect of the individual variables on the distribution of species. In this case, the distance between the species position and the arrows may provide some indication as to which of these two gradients affect the distribution of individual species. Since none of the species was plotted along the shade gradient (Fig. II-13), it would appear that this environmental factor has little influence on species distribution. However, distribution of *S. capillifolium*, *S. majus*, *Racomitrium lanuginosum* and *Pleurozium schreberi* are limited by the minimum height present on a site.

Sphagnum species occupy specific zones along a topographic gradient (Gignac 1987, Vitt & Slack 1984, 1975, Andrus et al. 1983). Results indicate, however, that few species are limited to different stands by their height requirements. The height necessary for species to occur is already present on most of the mires studied and thus cannot limit the geographic distribution of these species. *Sphagnum rubellum*, for example which normally occupies a topographic zone between 15 and 40 cm above the water table (Andrus et al. 1983), is not limited to oceanic areas by the absence of this height zone in sub-continental mires. This height zone exists on all sites and if other factors were not limiting the distribution of *S. rubellum*, it could occupy this zone in sub-continental areas. Height becomes limiting only for such species as *S. capillifolium*, *Pleurozium schreberi* and *Racomitrium lanuginosum* that are normally found at the tops of the highest hummocks. This habitat may be absent from many sites and thus limit the distribution of these species. For *S. majus*, which occupies the lower end of the height gradient, its distribution may be limited by the absence of this habitat on some of the drier sites.

In conclusion, climate and water chemistry gradients are the most important factors limiting the distribution of individual *Sphagnum* species. The distributions of several species, including *S. austinii*, *S. pacificum*, *S. palustre*, *S. papillosum*, *S. rubellum*, and *S. tenellum* are restricted by the climate to oceanic habitats. All of the species, with the exception of *S. fuscum*, *S. palustre*, *S. squarrosum*, *S. teres* and *S. warnstorfii*, are limited to mires having low cationic concentrations and corrected conductivities. The distributions of *S. angustifolium*, *S. capillifolium*, *S. magellanicum*, and *S. majus* are limited by the surface water chemistry variables rather than the climate, since they occur in all of the climatic zones. *Sphagnum squarrosum*, *S. teres* and *S. warnstorfii* are limited to moderate-rich fen habitats and have continental tendencies, although it is not clear whether the climate or the absence of suitable habitats in oceanic areas that is limiting the geographic distribution of these species. *Sphagnum fuscum* is the most widely distributed of all the species studied and is found in all climatic zones and peatland types. Unlike the other *Sphagnum* species studied, *S. fuscum* seems to create its own habitat, unaffected by either climate or surface water chemistry.

Shade and height relative to the water table have little effect on species distributions. Only species found at either end of the height gradient are limited by the height parameter.

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Table II-1. Location of the 27 study sites in western Canada (indicated by letters) and the name of the nearest permanent weather station from which the climate data were obtained. Stands in each site are indicated by numbers.

Study site	Location	Weather Station	Stands
a	53°55'N 132°06'W	Masset BC	1,2
b	53°38'N 132°06'W	Port Clements BC	3,4
c	53°36'N 131°58'W	Tlell BC	5,6
d	54°17'N 130°21'W	Prince Rupert BC	7,8
e	54°14'N 130°16'W	Prince Rupert (airport)	9,10
f	54°18'N 130°15'W	Prince Rupert (Shawatlans)	11,12
g	54°16'N 130°16'W	Prince Rupert (park)	13
h	54°16'N 130°15'W	Prince Rupert (park)	14,15
i	54°14'N 130°09'W	Prince Rupert (mont circ)	16
j	54°14'N 129°51'W	Falls River BC	17,18
k	52°23'N 126°24'W	Bella Coola BC	19,20
l	55°06'N 128°40'W	Kitimat BC	21,22
m	54°08'N 120°40'W	Lakelse Lake BC	23
n	54°24'N 128°40'W	Terrace BC	24,25
o	54°26'N 128°38'W	Terrace (airport)	26,27
p	54°38'N 128°38'W	Rosswood BC	28,29
q	55°14'N 127°39'W	Hazelton BC	30,31
r	54°44'N 126°13'W	Topley Landing BC	32,33
s	54°24'N 122°22'W	Fort St-James BC	34,35
t	53°53'N 121°56'W	Prince George BC	36

u	53°42'N	121°06'W	Dome Creek BC	37,38
v	53°10'N	119°53'W	McBride BC	39
w	52°55'N	118°49'W	Mount Robson BC	40,41
x	53°32'N	117°58'W	Entrance AB	42,43
y	53°27'N	116°37'W	Robb AB	44,45
z	53°25'N	114°54'W	Glenevis AB	46,47,48
aa	55°54'N	112°01'W	Wandering River AB	49,50,51

Table II-2. Climatic variables for the 27 study sites in western Canada calculated from 30 year means measured at 26 permanent weather stations. gs = length of growing season; w = effective temperature sum; bt = biotemperature; precip = precipitation during growing season; pdays = number of precipitation days; ai = aridity index; o = index of oceanity. The lines in the table indicate the divisions between site groupings.

site	gs	w	bt	precip	pdays	ai	o
a	344	68.1	7.63	1353.0	200	81.47	68.45
b	313	67.0	7.45	1347.3	200	87.73	60.53
c	360	65.3	7.43	1091.2	203	66.22	71.13
d	346	71.0	7.44	2334.9	223	138.11	86.27
e	297	58.8	6.70	2369.0	218	151.09	69.59
f	346	71.0	7.44	2334.9	232	180.07	89.73
g	346	71.0	7.44	2334.9	232	180.07	89.73
h	346	71.0	7.44	2334.9	232	180.07	89.73
i	322	64.9	7.07	2846.5	227	178.62	79.12
j	297	74.5	7.81	3358.7	201	178.67	64.16
k	268	58.8	6.70	1423.9	170	92.25	26.44
l	242	66.4	6.98	1753.0	165	140.18	19.12
m	242	66.4	6.98	1253.9	152	99.56	20.17
n	232	65.5	6.78	934.3	150	82.60	16.69
o	240	67.7	7.08	945.5	158	70.83	18.31
p	240	63.7	6.61	814.9	149	69.20	20.30
q	225	59.8	6.16	395.0	87	37.17	6.35
r	196	48.7	5.23	285.8	78	41.03	6.25
s	216	51.5	5.46	290.3	80	40.20	5.85

t	204	56.2	5.85	409.8	104	47.24	7.80
u	222	53.4	5.62	529.9	107	64.11	6.72
v	213	61.8	6.32	406.7	92	44.05	7.35
w	201	54.5	5.71	366.7	91	49.24	6.37
x	198	49.4	5.30	345.5	56	42.80	3.65
y	189	45.2	4.90	416.3	69	54.44	5.27
z	190	55.9	5.84	389.2	76	48.88	3.20
aa	161	55.3	5.77	361.0	68	45.80	3.37

Table II-3. Correlation coefficients for climate variables calculated from data obtained from 26 weather stations in western Canada. See Table 2 for abbreviations. *** p > 0.001. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	gs	w	bt	precip	pdays	ai	o
gs	1.000						
w	0.752***	1.000					
bt	0.850***	0.968***	1.000				
precip	0.794***	0.625***	0.700***	1.000			
pdays	0.119	0.067	0.046	0.189	1.000		
ai	0.739***	0.613***	0.658***	0.968***	0.164	1.000	
o	0.969***	0.689***	0.785***	0.869***	0.164	0.828***	1.000

Table II-4. Mean elemental concentrations (mg L^{-1} ± s.e.) for surface waters collected from 51 stands in western Canada arranged in stand groups as delimited by TWINSPAN. Lines within the table distinguish the three major groupings based on water chemistry. Lines are drawn only for those elements that show major differences. n = number of stands per group.

Stand Groups	k_{corr} (µS)	H^+ (10^{-6})	Ca	Mg	Na	K	Fe	S	n
1	24.0 ± 13.7	9.7 ± 4.1	2.1 ±0.5	1.2 ± 0.1	7.9 ± 7.1	4.8 ± 0.1	4.8 ± 1.6	0.4 ± 0.2	2
2	20.0 ± 9.4	68.6 ± 11.2	1.0 ± 0.3	0.8 ± 0.2	7.2 ± 2.0	2.6 ± 0.7	3.5 ± 1.0	0.5 ± 0.1	6
3	11.0 ± 4.1	62.8 ± 16.2	0.6 ± 0.1	0.3 ± 0.1	2.2 ± 0.4	0.9 ± 0.3	1.2 ± 0.4	0.7 ± 0.2	5
4	58.2 ± 26.5	25.7 ± 9.1	4.9 ± 2.4	0.5 ± 0.2	2.5 ± 0.9	2.3 ± 0.3	1.5 ± 0.4	1.4 ± 0.6	5
5	63.1 ± 47.0	63.8 ± 20.0	12.4 ± 6.3	0.9 ± 0.3	5.8 ± 3.0	3.0 ± 0.9	1.6 ± 0.4	1.3 ± 0.6	7
6	52.5 ± 12.8	64.5 ± 11.2	3.6 ± 1.2	0.8 ± 0.3	3.0 ± 0.8	2.3 ± 0.7	3.1 ± 1.2	0.5 ± 0.1	9
7	73.2 ± 39.1	34.6 ± 30.5	7.6 ± 3.5	2.1 ± 1.6	7.2 ± 3.0	3.6 ± 0.3	2.7 ± 1.1	0.5 ± 0.1	4
8	430.7 ± 73.4	1.6 ± 1.4	71.4 ± 15.0	18.4 ± 3.5	10.4 ± 2.9	6.1 ± 1.5	1.8 ± 1.5	1.5 ± 0.8	7
9	421.5 ± 78.3	0.1 ± 0.03	84.9 ± 29.9	17.6 ± 2.4	7.3 ± 3.2	5.0 ± 3.0	6.0 ± 5.9	2.5 ± 0.7	5
10	30.9	2.7	6.1	0.7	3.3	2.4	0.8	0.4	1

Table II-5. Correlation coefficients between elemental concentrations of the surface water, climatic parameters, and environmental factors collected from 51 stands in western Canada. See table II-2 for abbreviations. min = minimum and max = maximum height above the water table. * $p > 0.05$, ** $p > 0.01$, *** $p > 0.001$. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	k_{corr}	H^+	Ca	Mg	Na	K	Fe	S
k_{corr}	1.000							
H^+	-0.546***	1.000						
Ca	0.925***	-0.470***	1.000					
Mg	0.919***	-0.506***	0.883***	1.000				
Na	0.423**	-0.495***	0.447***	0.407**	1.000			
K	0.498***	-0.308*	0.594***	0.520***	0.439**	1.000		
Fe	0.167	-0.082	0.440**	0.145	0.287*	0.557***	1.000	
S	0.356**	-0.308*	0.219	0.278*	0.239*	0.141	-0.104	1.000
min	-0.256*	0.144	-0.004	-0.089	0.184	0.137	0.104	0.142
max	-0.200	0.328*	-0.042	-0.012	-0.076	-0.040	0.026	0.224

shade	0.280*	-0.231*	0.264*	0.306*	0.298*	0.197	-0.004	0.229
gs	-0.415*	0.054	-0.393*	-0.454*	0.018	-0.218	-0.032	0.139
w	-0.591**	0.146	-0.598***	-0.591***	-0.164	-0.286	-0.102	0.044
bt	-0.610***	0.125	-0.600***	-0.685***	-0.107	-0.303	-0.090	0.005
precip	-0.428*	0.207	-0.396*	-0.480*	-0.200	-0.326	-0.158	0.066
pdays	-0.007	0.320	-0.008	-0.011	-0.132	-0.085	-0.108	-0.052
ai	-0.362	0.126	-0.352	-0.454*	-0.192	-0.283	-0.160	0.177
o	-0.381*	0.098	-0.358	-0.358*	-0.438*	0.267	-0.076	0.187

Table II-6. Mean frequency for bryophyte species groups within 10 stand groups as delimited by TWINSPAN.

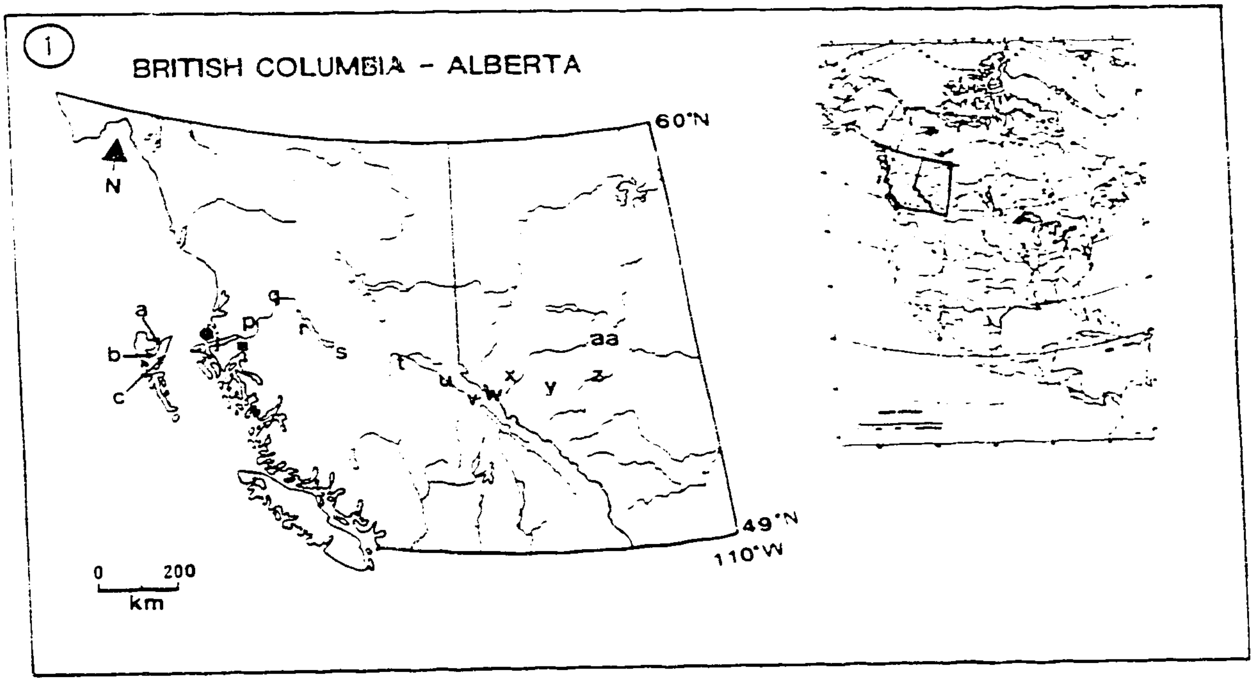
	Stand Groups									
	1	2	3	4	5	6	7	8	9	10
Species group 1										
Sphagnum lindbergii Lindb.		0.3	0.6	0.8			0.3			
Sphagnum papillosum Lindb.		0.3	0.8	1.0			0.3			
Sphagnum rubellum Wils.		0.2	1.0	0.8		0.1				
Sphagnum tenellum (Brid.) Brid.		0.4	0.4							
Sphagnum pacificum Flatb..	1.0	0.8		0.8		0.1				
Sphagnum austinii Aust.	0.5	0.8	0.8		0.1					
Sphagnum centrale C. Jens.	1.0									
Species group 2										
Sphagnum jensenii Lindb. f.					0.3					
Sphagnum magellanicum Brid.		0.2	0.8	0.8	0.6	1.0	0.8			
Sphagnum majus (Russ.) C. Jens.					0.4					
Sphagnum russowii Warnst.	0.3					0.1	1.0			

Sphagnum capillifolium (Ehrh.) Hedw.		0.8	0.8		0.4	0.4		0.3		
Sphagnum angustifolium (Russ.) C. Jens	0.5	0.7	0.8	1.0	0.9	0.2	0.5	0.6	0.8	
Species group 3										
Sphagnum fuscum (Schimp.) Klinggr.	0.5	0.7	0.8	1.0	0.9	0.2	0.5	0.6	0.8	
Sphagnum squarrosum Crome							0.5			1.0
Species group 4										
Pleurozium schreberi (Brid.) Mitt.		0.5	0.2			0.6		0.6	0.4	
Polytrichum juniperinum Hedw.						0.2		0.2		
Racomitrium lanuginosum (Hedw.) Brid.						0.1				
Species group 5										
Aulacomnium palustre (Hedw.) Schwaegr.						0.2				
Hylocomium splendens (Hedw.) B.S.G.		0.2						0.3	0.2	
Sphagnum palustre L.		0.2								
Sphagnum teres (Schimp.) C. Hartm.							0.2		1.0	
Sphagnum warnstorfii Russ.								0.7	0.6	
Tomenthypnum nitens (Hedw.) Loeske								1.0	0.6	

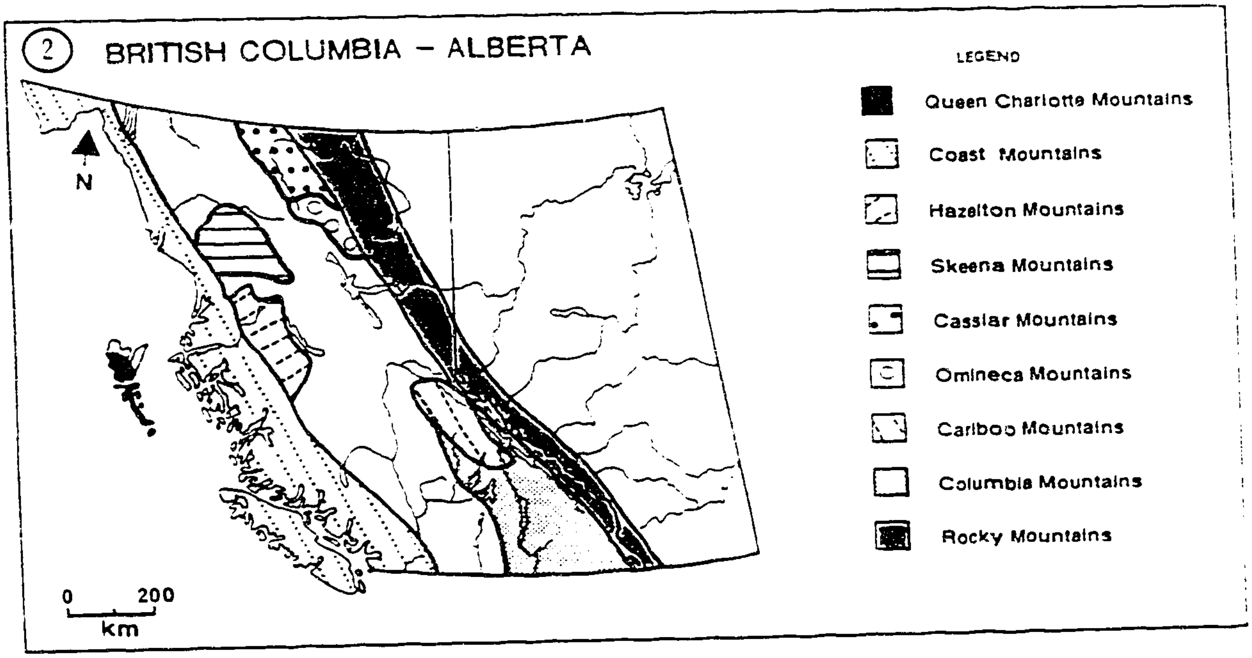
Paludella squarrosa (Hedw.) Brid.		0.[illegible]
Campylium stellatum (Hedw.) C. Jens.		0.6
Meesia triquetra (Richt.) Aongstr.	0.3	

Figures II-1/II-2. Study area. -- II-1. Location of the 27 peatlands studied along a transect from coastal British Columbia to central Alberta. ● indicates sites d-h; ■ indicates sites k-o. -- II-2. Map of British Columbia- Alberta, showing locations of the important mountain ranges.

①

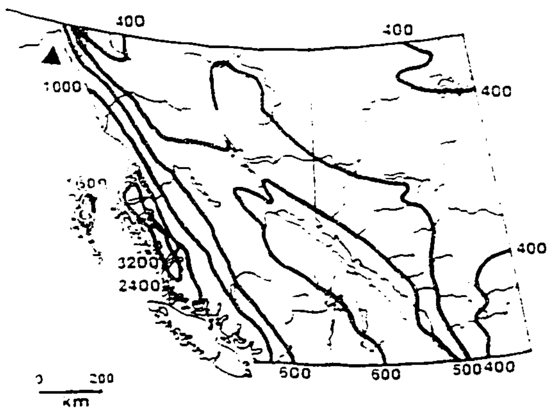

BRITISH COLUMBIA - ALBERTA
N
60°N
49°N
110°W
a
b
c
p
q
r
s
t
u
v
w
x
y
z
aa
0 200
km

②


BRITISH COLUMBIA - ALBERTA
N
0 200
km
LEGEND
Queen Charlotte Mountains
Coast Mountains
Hazelton Mountains
Skeena Mountains
Cassiar Mountains
Omineca Mountains
Cariboo Mountains
Columbia Mountains
Rocky Mountains

Figures II-3 - II-6. Isopleths of four climatic variables superimposed over the map of British Columbia-Alberta. -- II-3. Total precipitation. -- II-4. Number of precipitation days. -- II-5. Mean annual temperatures. -- II-6. annual total growing degree-days above 5°C.

③ BRITISH COLUMBIA - ALBERTA



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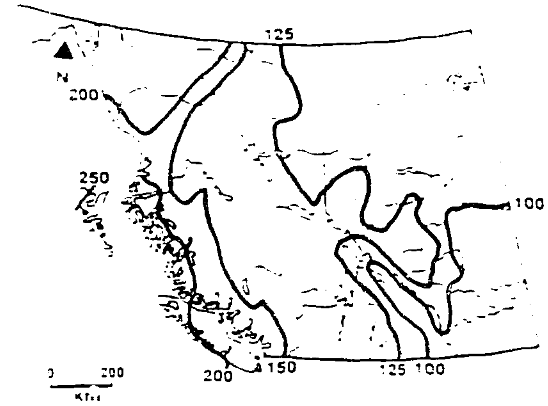

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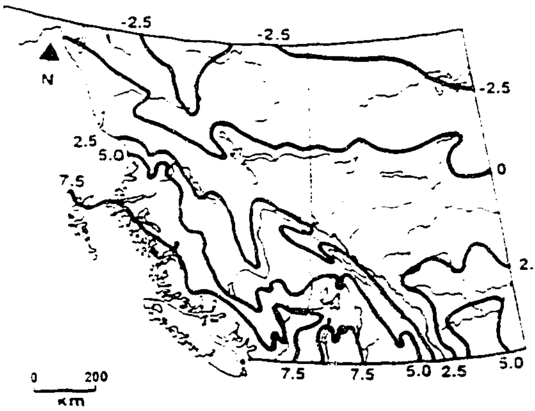


⑥ BRITISH COLUMBIA - ALBERTA

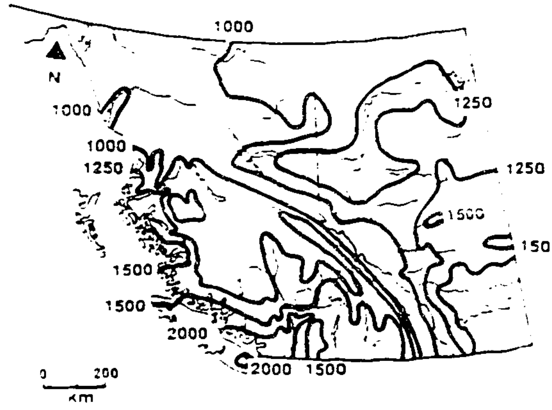
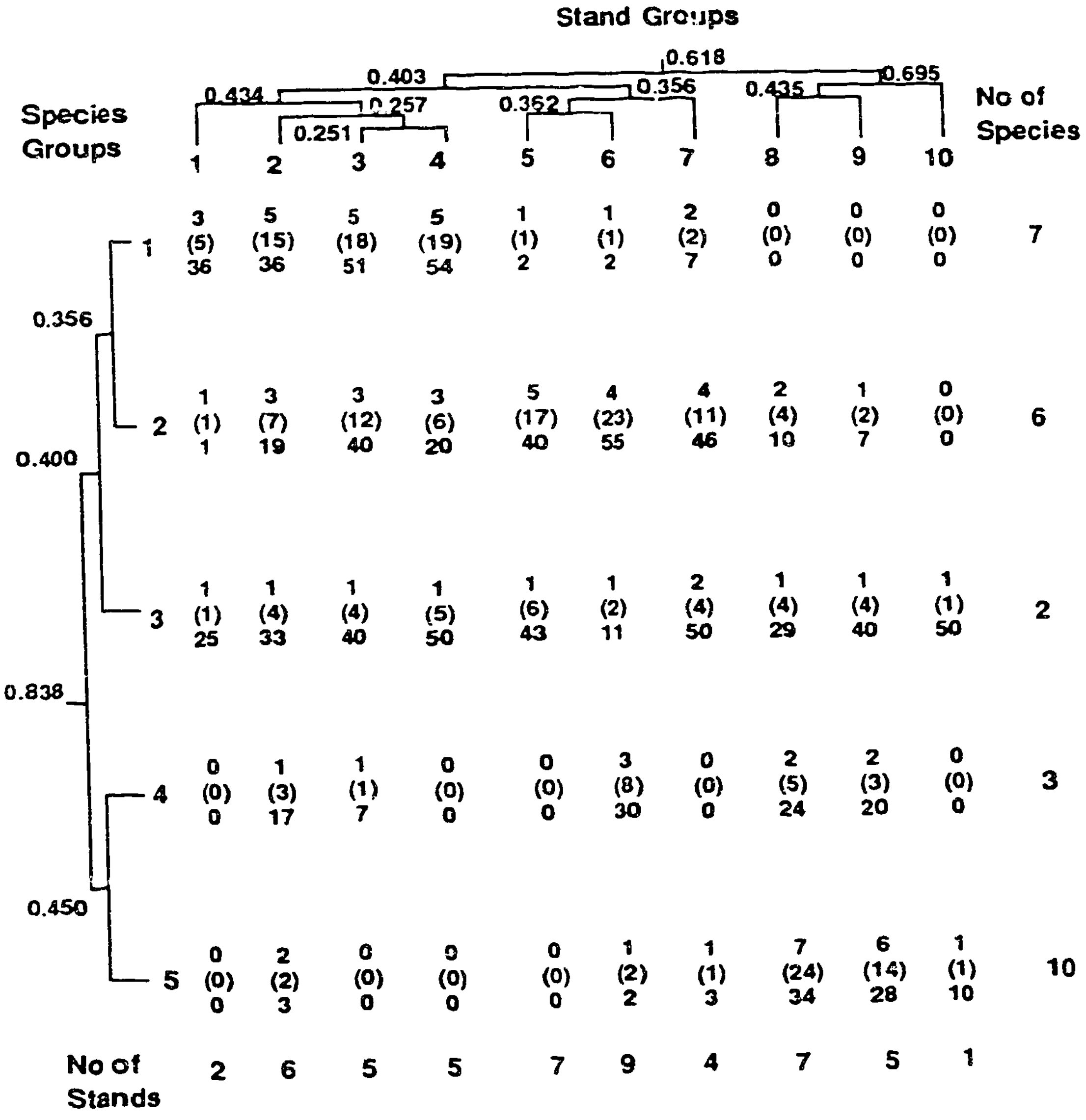


Figure II-7. Dendrograms of the stand groups and species groups as determined by TWINSPAN. The numbers within the dendrograms indicate the eigenvalues at each cut level. Upper numbers in the Table and the number of species occurrences within each stand group. Lower numbers are the number of species occurrences adjusted for equal block size [(number of occurrences in each block divided by the total possible occurrences in each block) X 100].

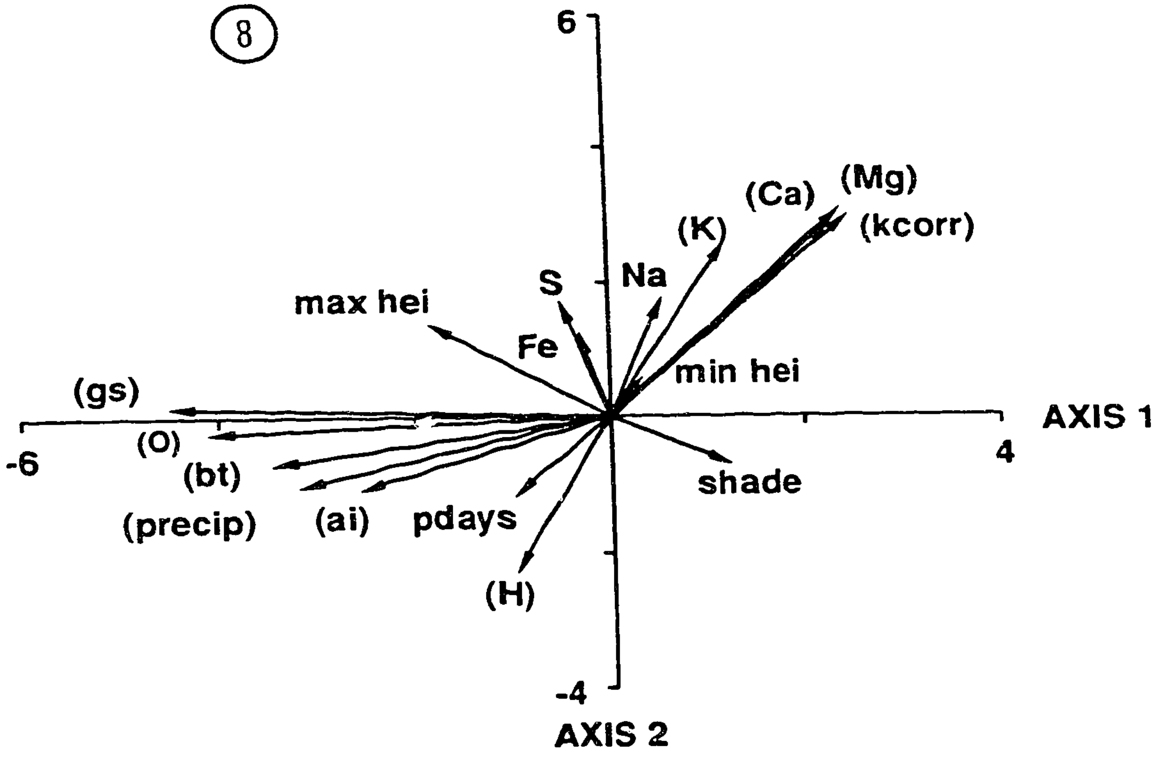


Species Groups	1	2	3	4	5	6	7	8	9	10	No of Species
1	3 (5) 36	5 (15) 36	5 (18) 51	5 (19) 54	1 (1) 2	1 (1) 2	2 (2) 7	0 (0) 0	0 (0) 0	0 (0) 0	7
2	1 (1) 1	3 (7) 19	3 (12) 40	3 (6) 20	5 (17) 40	4 (23) 55	4 (11) 46	2 (4) 10	1 (2) 7	0 (0) 0	6
3	1 (1) 25	1 (4) 33	1 (4) 40	1 (5) 50	1 (6) 43	1 (2) 11	2 (4) 50	1 (4) 29	1 (4) 40	1 (1) 50	2
4	0 (0) 0	1 (3) 17	1 (1) 7	0 (0) 0	0 (0) 0	3 (8) 30	0 (0) 0	2 (5) 24	2 (3) 20	0 (0) 0	3
5	0 (0) 0	2 (2) 3	0 (0) 0	0 (0) 0	0 (0) 0	1 (2) 2	1 (1) 3	7 (24) 34	6 (14) 28	1 (1) 10	10
No of Stands	2	6	5	5	7	9	4	7	5	1	

Figures II-8/II-9. DCCA ordinations of the environmental and climate variables measured at each study site in western Canada. The heads of the arrows indicate the coordinates of the variables. Abbreviations are as follows: min hei - minimum height; max hei - maximum height; kcorr - corrected conductivity; bt - biotemperature; gs - growing season; o - index of oceanity; precip - total precipitation falling as rain; ai - aridity index; pdays - number of precipitation days. The variables that are significantly correlated with the axis are indicated by parentheses.

-- II-8. Axes 1 and 2. -- II-9. Axes 1 and 3.

⑧


6
-4
-6
4
AXIS 1
AXIS 2
(Mg)
(Ca)
(kcorr)
(K)
Na
S
max hei
Fe
min hei
(gs)
(O)
(bt)
(precip)
(ai)
pdays
(H)
shade

⑨

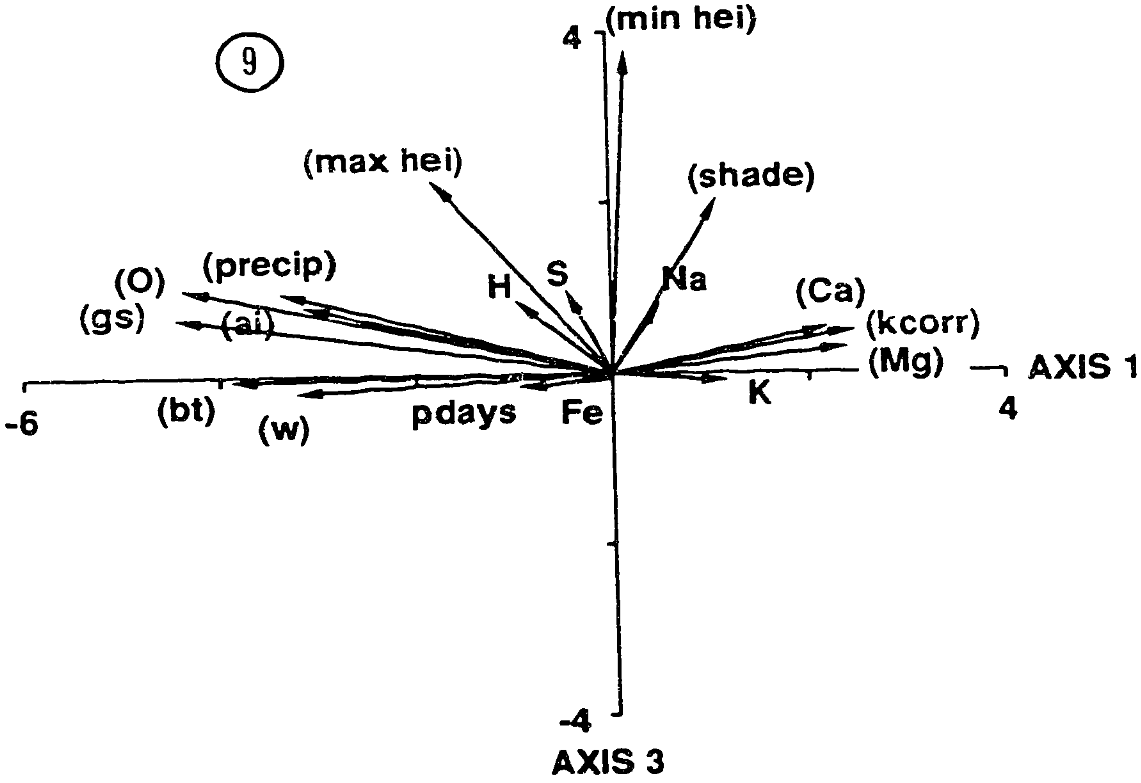

4
(min hei)
(max hei)
(shade)
(O)
(precip)
(gs)
(ai)
H
S
Na
(Ca)
(kcorr)
(Mg)
AXIS 1
K
4
-6
(bt)
(w)
pdays
Fe
-4
AXIS 3

Figure II-10. Stand pattern as determined by DCCA ordination. The stands are numbered according to the 10 groups delimited by TWINSPAN.

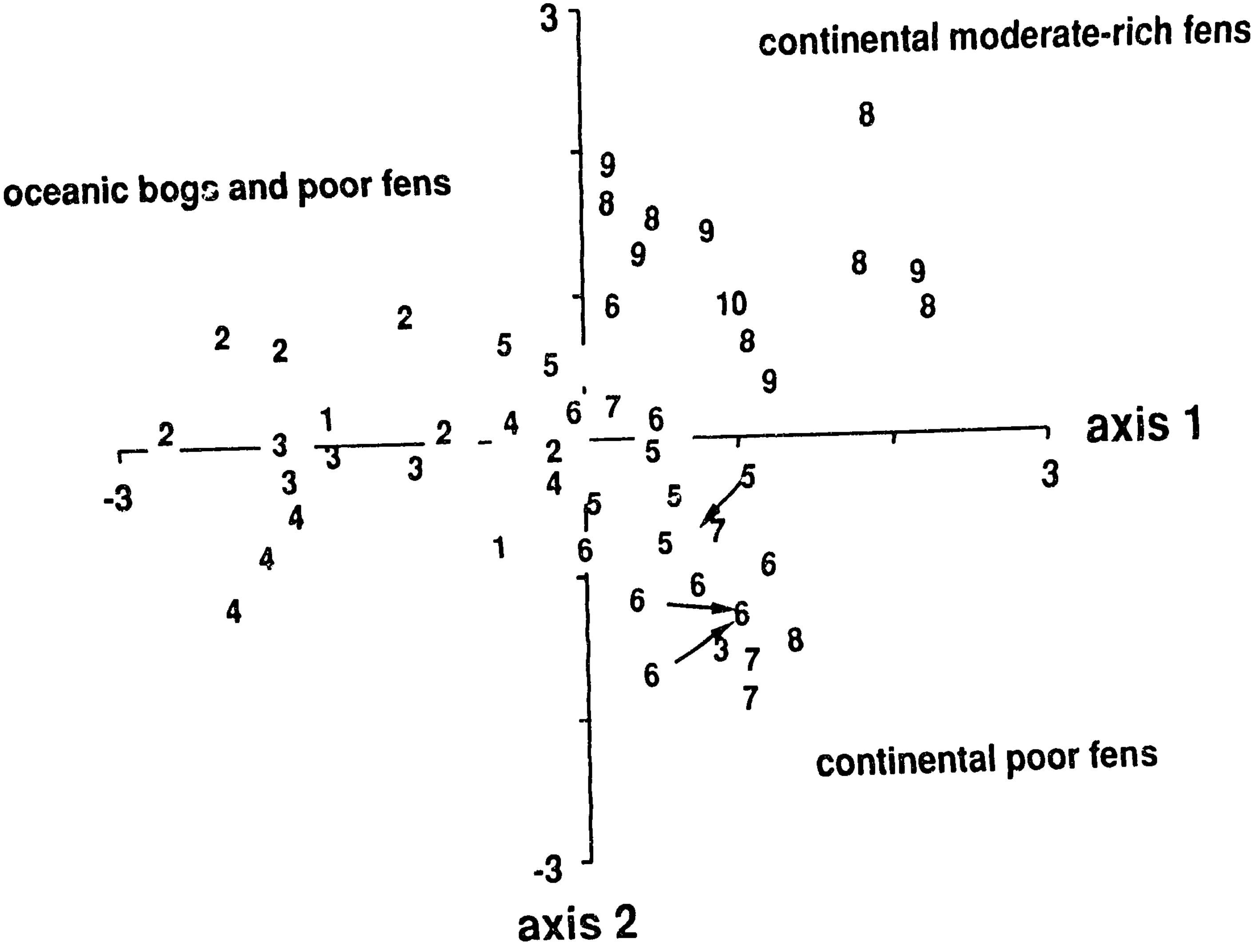
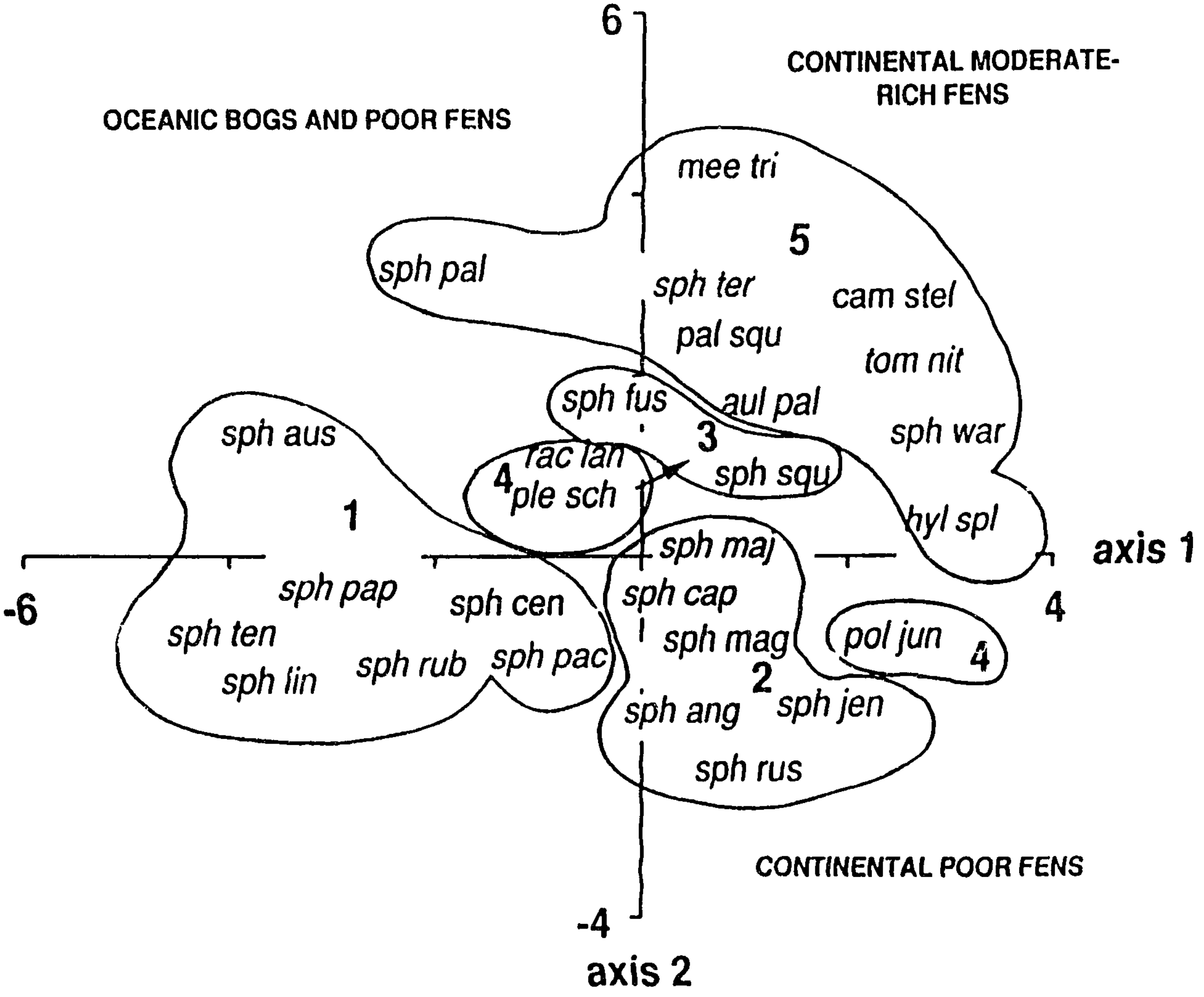
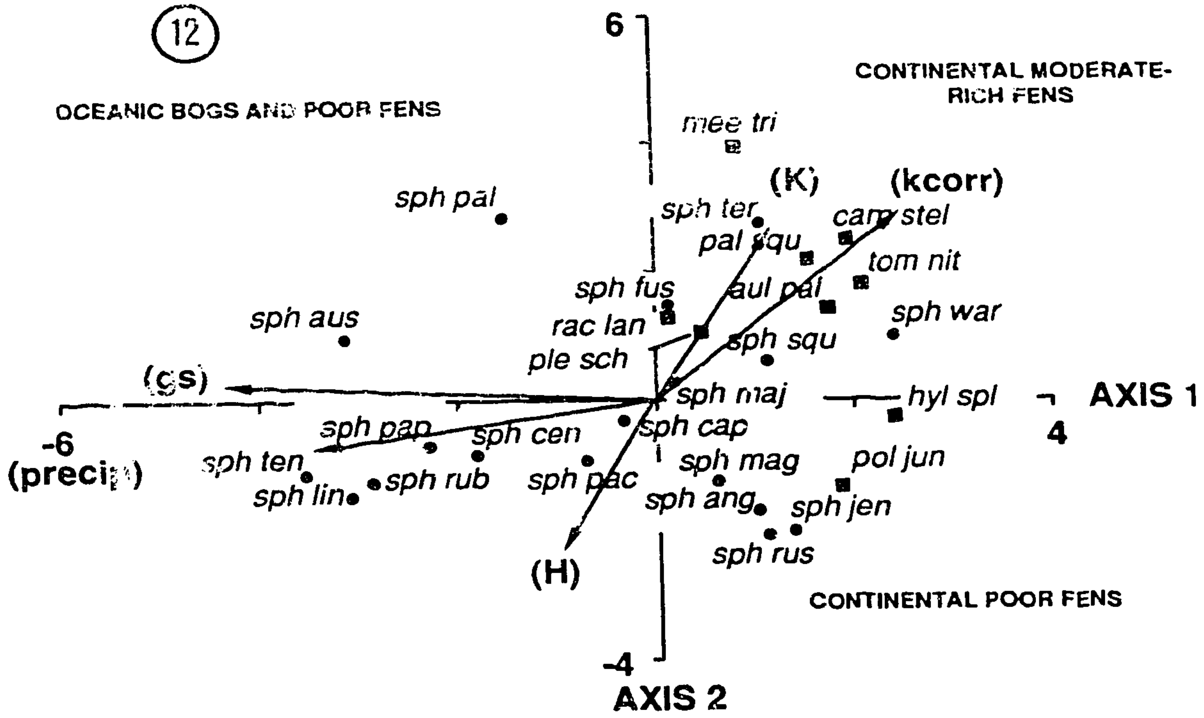

continental moderate-rich fens
oceanic bogs and poor fens
continental poor fens
axis 1
axis 2
3
-3
3
-3

Figure II-11. DCCA species ordination. The species groups are those delimited by TWINSPAN in Fig. II-7. Abbreviations correspond to the first three letters of the species names listed in Table II-6.


CONTINENTAL MODERATE-RICH FENS
OCEANIC BOGS AND POOR FENS
CONTINENTAL POOR FENS
6
-6
4
-4
axis 1
axis 2
1
2
3
4
4
4
5
mee tri
sph pal
sph ter
cam stel
pal squ
tom nit
sph fus
aul pal
sph war
sph aus
rac lan
ple sch
sph squ
hyl spl
sph maj
sph pap
sph cen
sph cap
sph ten
sph mag
pol jun
sph lin
sph rub
sph pac
sph ang
sph jen
sph rus

Figures II-12/II-13. DCCA biplot ordination of the species and variables. The environmental and climatic variables are shown by arrows and their abbreviations are as in Fig. II-8. The other abbreviations correspond to the first three letters of the species names listed in Table II-6. ● <u>Sphagnum</u> species, ■ other bryophyte genera. -- II-12. Axes 1 and 2. -- II-13. Axes 1 and 3.

⑫


OCEANIC BOGS AND POOR FENS
CONTINENTAL MODERATE-RICH FENS
CONTINENTAL POOR FENS
6
-4
AXIS 2
-6
4
AXIS 1
mee tri
(K)
(kcorr)
sph pal
sph ter
cam stel
pal squ
tom nit
sph fus
aul pal
rac lan
sph war
sph aus
sph squ
ple sch
(gs)
sph maj
hyl spl
sph pap
sph cen
sph cap
(precip)
sph ten
sph lin
sph rub
sph pac
sph mag
pol jun
sph ang
sph jen
sph rus
(H)

⑬

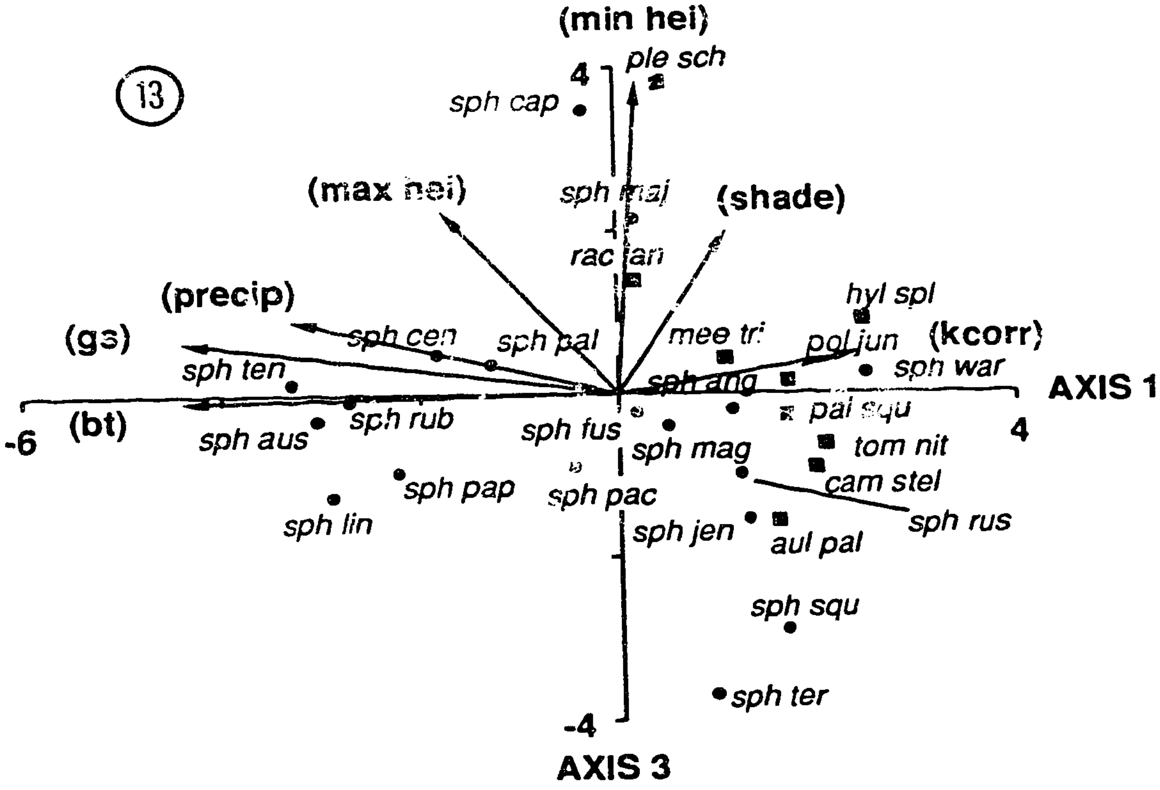
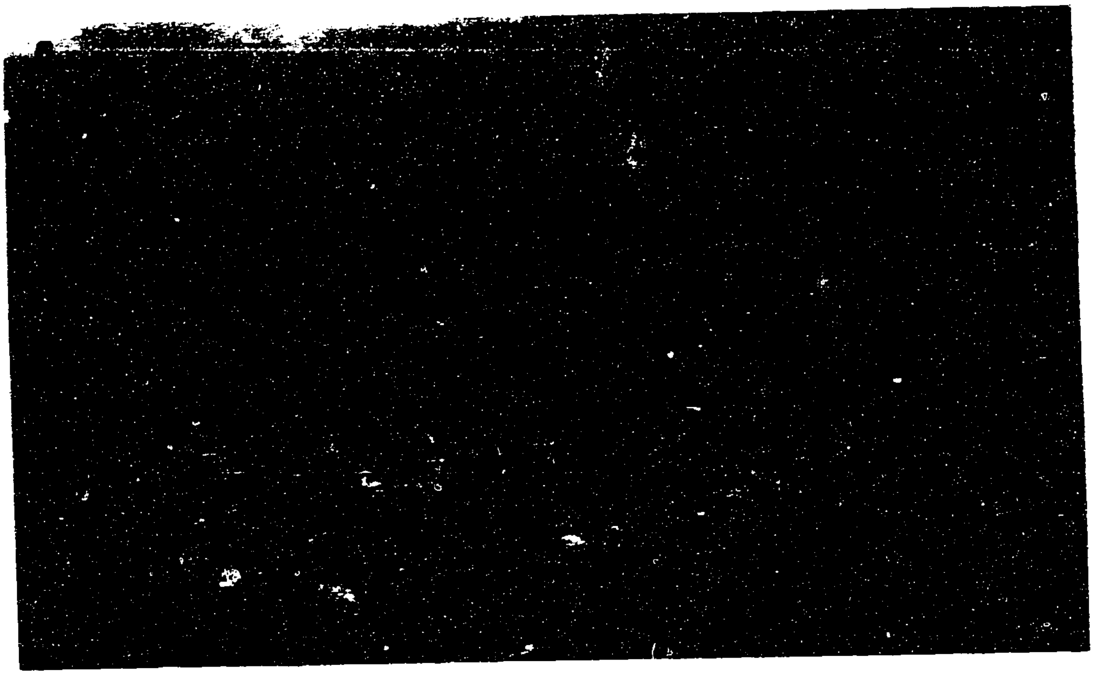

(min hei)
4
ple sch
sph cap
(max hei)
sph maj
(shade)
rac lan
(precip)
hyl spl
(gs)
sph cen
sph pal
mee tri
pol jun
(kcorr)
sph ten
sph war
sph ang
AXIS 1
(bt)
sph rub
pal squ
-6
sph aus
sph fus
sph mag
tom nit
4
sph pap
cam stel
sph pac
sph lin
sph jen
aul pal
sph rus
sph squ
sph ter
-4
AXIS 3

Plate II-1. Oceanic mires.--II-1-A. Domed ombrotrophic peatland (bog) near Prince Rupert, British Columbia. Trees in the background indicate the edge of the peatland (lagg). II-1-B. Poor fen near Port Edward British Columbia. Water movement is from the foreground to the background. The trees surrounding the mire are in the lagg.



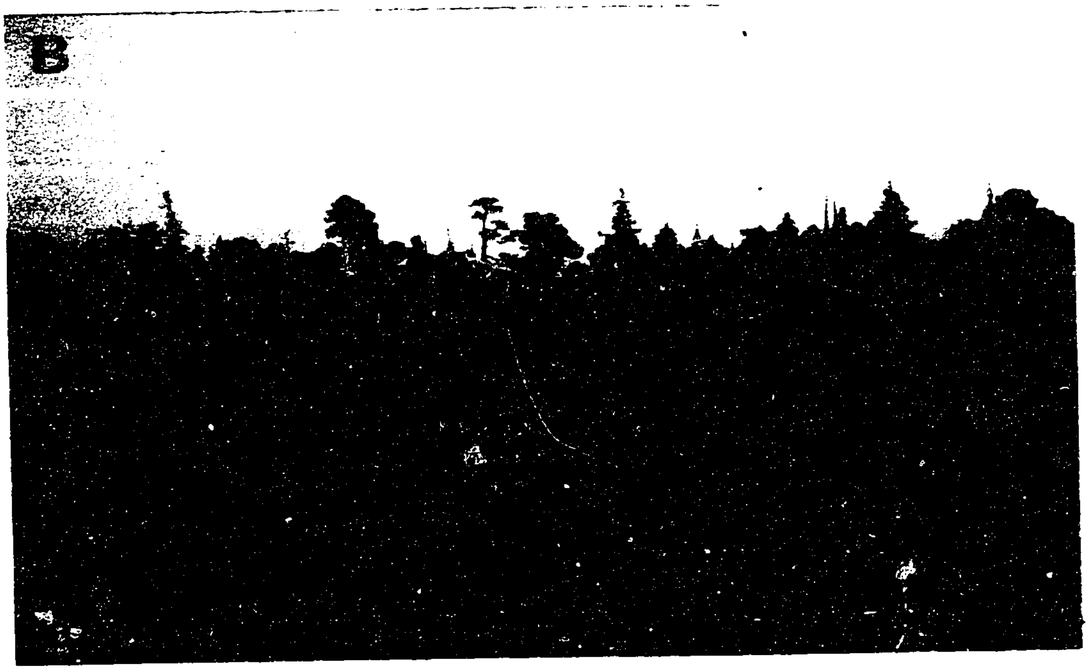

B

Plate II-2. Continental peatlands. II-2-A. Moderate-rich fen north of Hinton, Alberta. The peatland is forming by the terrestrialization of the small lake. Areas closer to the open water without any trees form a floating mat. II-2-B. Complex mire south of Fort McMurray, Alberta. The untreed area in the foreground is a poor fen. Water movement is from right to left. The treed area in the background is a bog.


A


B

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III. Ecotope structure of mire expanse Sphagnum along complex climatic, chemical, and physical gradients in western Canada

Abstract

The bryophyte component of mire vegetation was analysed on 27 peatlands located on a transect from the Queen Charlotte Islands, British Columbia to central Alberta. Ecotope dimensions for 11 Sphagnum species and 6 non-Sphagnum species were determined along four gradients. Climate and water chemistry were calculated as synthetic gradients, using 8 climate indices, cation concentrations, and corrected conductivity of mire waters. Canonical correspondence analysis was used to determine the weights of the variables used to construct the synthetic gradient. Log-linear regressions fitted to species abundance data were used to delimit ecotope dimensions. Dispersal of species optima and mean ecotope overlap values indicate that climate and height gradients are extensively partitioned by Sphagnum species. Only bog and poor fen habitats are partitioned on the synthetic water-chemistry gradient.

Introduction

Sphagnum is an important component of the vegetation of northern hemisphere boreal and sub-arctic mires. In western Canada, Sphagnum is dominant over all other bryophytes in oceanic and sub-continental bogs and poor fens (Gignac & Vitt 1990, Vitt et al. 1989, Banner et al. 1986, Horton et al. 1979, Vitt et al. 1975, Oswald 1933, Rigg 1925). Sphagnum species may also be present in sub-continental rich fens, but they are usually less important than other bryophyte genera, particularly the brown mosses (Karlin & Bliss 1983, Slack et al. 1980).

There are four important factors limiting Sphagnum habitats: mire water chemistry, height relative to the water table, shade, and climate. The chemical status of the surface waters is associated with and to some extent defines mire types and Sphagnum habitats (Damman 1987, Damman & French 1987, Moore & Bellamy 1974, Du Rietz 1954, Sjörs 1952). Calcium and magnesium concentrations, pH and conductivity are the most important variables that have been used to describe mire water chemistry (Vitt et al. 1989, Vitt & Bayley 1984, Vitt et al. 1975, Sonesson 1970, Sjörs 1963, 1952, Malmer 1962, Persson 1961, Gorham & Pearsall 1956, Gorham 1956). Surface waters of bogs and poor fens have low Ca, Mg, pH and conductivity values when compared to the levels in rich fens. Because calcium, magnesium, pH and conductivity gradients are highly correlated, it is difficult to determine the exact effect of the individual variables on Sphagnum habitats.

Some Sphagnum species have the capacity to build domes (hummocks) often to a height of one meter above the water table. These domes produce a very rugged surface, composed of hummocks and hollows that are sometimes only meters apart. These topographic differences form moisture gradients, where the lowest points are distinctly wetter than the higher areas. There is a general zonation of Sphagnum species from one type of hydrological condition to another and species' zones often overlap with those of its' neighbours (Gignac 1987, Andrus et al. 1983, Hayward & Clymo 1983, Vitt et al. 1975). Species distribution along this topographic gradient has been linked to differing abilities of each species to withstand desiccation (Rydin 1985, Rydin & McDonald 1985, Wagner & Titus 1984, Hayward & Clymo 1983, Titus et al. 1983, Clymo 1973, Green 1968), and to base saturation and uronic acid content of the cells (Vitt et al. 1975, Clymo 1970).

Sphagnum species can generally be divided into three groups along the shade gradient: shade tolerant, restricted shaded, and restricted non-shaded (Andrus 1980). Most of the species that are restricted to shaded areas are found in coniferous woodlands and are not abundant in mire habitats. Most mire species fall into the two remaining categories (Vitt & Slack 1984). The tree and shrub-produced or overstory shade gradient may also be affected by the topographic gradient. Trees normally grow in higher, drier areas of the peatland since they cannot tolerate having their roots submerged for long periods of time (Schwintzer 1979). Thus, the most shaded areas are often the highest and driest.

Sphagnum species are differentiated into three groups along a climatic gradient, extending from hyper-oceanic to sub-continental climates (Chapter II). Several species are limited to oceanic and hyper-oceanic areas by climatic factors, while others are widespread and are not limited by the climate. A few sub-continental species have limited distributions on the climate gradient, but it is not clear whether climate or the absence of suitable habitats in oceanic areas restrict the geographical distributions of these species.

One of the earliest usages of the term "niche" was to describe a species' role within a community. Hutchinson (1957) expanded this view by defining the niche as an n-dimensional hyper-volume differentiated into a fundamental niche or maximal space and a contracted space or realized niche. The fundamental niche measured a species' limitations relative to environmental factors and represented the genetic potential and physiological tolerances of that species. The inclusion of such biotic factors as predation, competition and limits to dispersal led to a contraction of the hyper-volume into the realized niche. Whittaker et al. (1973) distinguished the niche from an ecotope or habitat niche that included inter-community as well as intra-community factors. The ecotope had a spatial or landscape dimension that was absent from the niche. Since this study incorporates several different communities over a broad geographical area, the term "ecotope" is used rather than "niche", which is more appropriate for describing species' roles within one community.

Niche and ecotope theory have been applied in several bryophyte studies (Glime & Vitt 1987, Rydin 1986, Slack & Glime 1985, Vitt & Slack 1984, Slack 1982, 1977, Watson 1981, Lee & LaRoi 19[illegible], Johnson 1977). Vitt and Slack (1984) examined ecotope dimensions of several *Sphagnum* species relative to such environmental gradients as cationic content of mire waters, height relative to the water table and shade. Rydin (1986) examined the niches of four *Sphagnum* species along a topographic gradient and Clymo and Reddaway (1974) and Clymo (1973) investigated the fundamental niches of several species along height, calcium and pH gradients, using growth and transplant experiments.

In several of these studies, the multidimensional hyper-volume had been reduced to a manageable number of axes representing ordered environmental gradients. These axes identified a limited number of factors that ensured niche and ecotope separation within a community or landscape. The reduction of the number of niche dimensions led to the inclusion of such complex environmental variables as elevation (Watson 1981, Lee & LaRoi 1979, Slack 1977), conductivity of mire waters (Vitt & Slack 1984), and substrate (Glime & Vitt 1987, Slack & Glime 1985), that summarized several environmental variables.

The exact relationship between each complex gradient and the environmental variables it summarized was determined either intuitively or indirectly through correlation analyses. The alternative to using a complex gradient was to analyse a large number of variables and quantify niche dimensions for each species along each gradient. The variables that separated species niches were judged to be the most important resources delimiting species niches. This method, however may prove limited if the gradients are not totally independent of each other.

The problem of the reduction of a large number of variables to a few highly significant axes can be solved by such ordination techniques as correspondence analysis (CA) (Hill & Gauch 1980) and canonical correspondence analysis (CCA) (ter Braak 1987a). These techniques maximize dispersal of species optima along ordination axes, thus improving niche or ecotope separation. Although both methods only project species optima, it is possible to fit Gaussian response curves by log-linear regression of species' abundances on the ordination axes (ter Braak & Looman 1986, ter Braak 1985). Gaussian response curves make possible quantitative measurements of niche or ecotope width and overlap (Gauch & Chase 1974, Gauch et al. 1974, Gauch & Whittaker 1972). When environmental variables are directly related to ordination axes, the axes become revised environmental gradients and species niche dimensions can be defined by fitting Gaussian curves on these synthetic gradients.

Canonical correspondence analysis in particular is useful in determining the effects of several variables on a complex gradient. This technique uses weighted environmental variables to calculate the ordination axes and ensures maximum species' dispersal (ter Braak 1987a & b). Several of the ordination axes may be influenced by complex gradients. The exact relationship between the component variables of the complex gradients and the ordination axes can be determined from the weight of each environmental variable. The effects of a large number of factors on the niche dimensions of several species can thus be determined from the ordination axes. The results also remain manageable by reducing all the variables to three or four axes.

The purposes of this study are: 1) to quantify ecotope dimensions and niche overlap of Sphagnum species along four gradients: mire water chemistry, shade, height relative to the water table, and climate; 2) to reduce the large number of variables that compose such complex gradients as climate and water chemistry to two synthetic axes that maximize species' dispersions; 3) to determine the relative importance of each gradient in separating Sphagnum species ecotopes from each other; and 4) to determine the effects of the addition of other mire bryophyte species to the lengths of the gradients, the dispersion of species optima, and the quantity of ecotope overlap.

Materials and Methods

Study area and study sites

The Sphagnum component of mire vegetation was studied on 27 peatlands located along a transect extending from the Queen Charlotte Islands, British Columbia, to central Alberta (Fig. III-1). Site locations, peatland types, climate and geology were previously described in Chapter II. Sites were chosen using the following criteria: 1) covered by a minimum of 0.5 m of peat; 2) contained at least one Sphagnum species; 3) located within 10 km of a permanent meteorological station in mountainous areas and within 50 km in flat terrain.

Climatic variables

The data used to calculate climatic variables were obtained from 30 year means (1951 to 1980), measured at 26 permanent weather stations (Anonymous 1982a, b, Anonymous 1986). Formulas for the following climatic indices were obtained from Tukhanen (1980, 1984):

$$\text{Biotemperature (bt)} = \sum t_+/12$$

where t_+ = positive mean monthly temperature and summation is over 12 months.

Growing season (gs) = number of growing days having mean daily temperatures above 2^oC

The values are interpolated from monthly mean temperature. A threshold temperature of 2^oC was used to approximate the temperature at which mosses grow a measurable amount (Glime 1982).

$$\text{Effective temperature sum (w)} = \sum (t-t_k)$$

where t = monthly mean temperature during the growing season and t_k = threshold value (2^oC).

Precipitation (prec) = amount of rain (mm) falling during the growing season.

Precipitation days (pdays) = number of days with a measurable amount of rainfall during the growing season.

Aridity index (ai) = $\frac{p}{T+10^{\circ}}$

where p = annual precipitation falling as rain and T = mean annual temperature.

Index of oceanity (o) = $\frac{d(a-b)}{60 \cdot A \cdot \sin(\phi + 10^{\circ})}$

where d = number of days with measurable rainfall, a = number of days at 0°C or above, b = number of days at 10°C or above, A = annual temperature range and ø = latitude.

Conrad's index of continentality (c) = $\frac{1.7A}{\sin(\phi + 10^{\circ})} - 14$

where A = annual temperature range and ø = latitude.

Tuhkanen (1980, 1984) provided in-depth analyses of the relative merits of the variables used in this study.

Sampling

At each study site, a transect was established from one edge of the mire to the other. Transects were oriented so that they traversed the different vegetation zones present on each site. Twelve equi-distant hummock-hollow complexes were studied along each transect. The distance between sampling points depended on the size of each peatland and varied from 3 to 15 m.

A 0.5 m^2 horizontal platform was suspended above the hummock-hollow complex on four posts and levelled using spirit levels. One meter long, 2mm diameter welding rods were dropped through holes drilled at 10 cm intervals in the platform. The moss plant that lay below each rod was identified and the height relative to the water table measured. The standing water in the hollows that formed part of the hummock hollow complex was used to determine the height of the platform above the water level. At complexes where no standing water was present, shallow pits were dug and the water that accumulated in the hole was used as a measure of the water table. The distance between each moss and the platform was measured then subtracted from the distance between the water table and the platform. Fifty plants were measured at each hummock-hollow complex. Data were collected in July and August 1985, 1986, and 1987. Yearly, seasonal and daily variations in surface water chemistry or height above the water table were not measured at each hummock-hollow complex.

This method proved very effective only for mosses of approximately the same size. Such relatively small mosses as Drepanocladus spp. were not accurately sampled and were eliminated from the data set. With the exception of Sphagnum austinii (Andrus 1987) and Sphagnum pacificum (Flatberg 1989), nomenclature and authority names follow Ireland et al. (1987). Voucher specimens are deposited in ALTA.

Overstory shade was estimated at each hummock-hollow complex on a scale from 0 to 10, where 0 indicates the absence of shade and 10 total shade. A water sample was collected at each complex, either from the standing water or from the pits dug in the peat. The water was collected in acid-washed (3% HCl) polyethylene bottles and kept refrigerated until the analysis could be performed. The samples were filtered through a Whatman #42 filter paper and acidified using 1 ml of 4 N HCl to 24 ml of water. Calcium, magnesium, sodium, potassium, aluminum, manganese, iron and sulphur concentrations in the water were measured on an inductively- coupled argon plasma spectrophotometer. The conductivity and pH were measured in the field and from these the H^+ concentrations and corrected conductivity (k_{corr}), corrected to 20°C, were calculated (Sjörs 1952).

Data Analysis

Species abundances were calculated as: i) the number of plants per site on the climate gradient; ii) the number of plants at 5 unit intervals on the water chemistry gradient; iii) the number of plants occurring at 2 cm intervals on the height gradient; iv) the number of plants at each unit shade interval. Only species with enough data to satisfy the following criteria are analysed: i) present on a minimum of 5 sites, ii) found on 10 hummock-hollow complexes, and iii) have an overall total of 50 plants. Computations and all statistical analyses were performed on a personal computer using the Statistical Analysis System (SAS) package.

Ecotope Analysis

Gaussian response curves are fitted to species abundance data along four gradients: climate, surface water chemistry, height relative to the water table and shade. Gaussian curves are used to delimit ecotope dimensions and quantify niche widths (Gauch et al., 1974, Gauch & Whittaker 1972). Gaussian curves are expressed as:

$$y = C \exp [-0.5 (x-u)^2/t^2]$$

where y is the species abundance, c is the maximum abundance, u is the optimum, or the value of x that gives the maximum abundance (mode) and t is the standard deviation (Fig. III-2). The parameters c, u and t are calculated from the parameter estimates b_0, b_1 and b_2 of a quadratic curve of the form

$$\log y = b_o + b_1 x + b_2 x^2$$

where y is the species abundance (see Jongman et al., 1987 p. 42 for the methods used to calculate the parameters). An r^2 value is used as a measure of the goodness-of-fit of the quadratic regression fitted to the log abundance data. The value r^2 measures the fraction of variance accounted for by a regression line and is calculated as:

$$r^2 = 1 - (\text{residual variance/total variance})$$

The distance 4t approximately covers the range of species occurrences along a gradient and is used to measure [illegible] widths. This method creates a problem when widths are compared along two or more gradients since each gradient has a different range of values. This problem is solved by rescaling the gradients to the same range, between 0 and 1 and is accomplished by using the formula:

$$(x - x_{min})/(x_{max} - x_{min})$$

where x_{min} is the minimum value along a gradient and x_{max} is the maximum value.

Gradients for the complex variables, climate and water chemistry, were determined as the combination of variables that maximized the dispersion of species optima. In order to maximize dispersion, variables were standardized to mean = 0 and variance = 1 and weighted using the parameter estimates determined by multiple linear regression of environmental variables against site or hummock-hollow scores (ter Braak 1987a). Thus, weights for each environmental variable are equivalent to coefficients of linear transformation of the environmental variables to give the first CCA axis for the complex gradient. A two-way algorithm combining species abundances and site scores developed by Hill and Gauch (1980) and modified by ter Braak (1987a) was used to ensure absolute maximum dispersal. The dispersion is calculated as :

$$d_{k=1}^{m} = \Sigma (y_k \; u_k^2)/y{+}{+}$$

where y_k is the abundance of species k (out of m species), u_k is the optimum for species k and y_{++} is the overall abundance for all species. This technique is used to quantify the first CCA axes and is considered as best explaining the species data (Ter Braak 1987a).

Ecotope overlaps between pairs of species are calculated as the distance shared by each pair of species along a gradient. This distance is divided by the mean of the ecotope widths for the two species. All the overlaps between species are pooled for each gradient and arithmetic mean overlap calculated for each gradient. This single measure is a useful tool when comparing resource utilization by the species (Haefner 1988). Two methods are frequently used to produce a single overlap value that combines overlap values calculated for the separate axis: a) the arithmetic mean of all overlaps (the summation overlap); or 2) the product of the overlaps (the product overlap) (May 1975). The product overlap is selected in this study since it accurately represents the absence of overlap between two species on an axis by calculating the single overlap values as 0, thus indicating that there is no ecotope overlap between species. The arithmetic mean would calculate total overlap as a positive value indicating that ecotopes of the two species theoretically overlap, when realistically they do not (May 1975).

Separate analyses of ecotope dimensions along several gradients does not accurately explain species responses to two or more variables, particularly if the variables are correlated. Multiple regression analyses better express species responses to correlated variables by taking into account the effect of one variable on the values of another variable, i.e., interaction effects.

Bivariate and higher order models of species ecotope relationships are developed by fitting quadratic regressions to species log-abundance data along two gradients simultaneously. Quadratic surfaces of the form:

$$\log y = b_0 + b_1x_1 + b_2x_2 + b_3x_1^2 + b_4x_2^2 + b_5x_1x_2$$

are produced, that may be extended further by adding more variables. If the response is unimodal, the quadratic surface is an ellipoid that portrays a bivariate Gaussian response surface fitted to the original abundance data. The cross product term (x_1x_2) takes into account interaction effects between the two explanatory variables. This term, in effect, rotates the main axes of the ellipsoid so that they do not parallel either the x_1 or x_2 axes. Because regression analysis takes into account interaction effects, the area shared by two species ellipsoids represents intraspecific ecotope overlap more accurately than does the pooled overlap of these species along the gradients analysed separately. Height and water chemistry gradients are used to develop bivariate species response models at the hummock-hollow level. Attempts to build bivariate or trivariate models incorporating a climatic gradient failed because of the lack of a microclimatic gradient either at the individual plant level or at the hummock -hollow level.

Results

Gradient analyses

The area covered by the transect extending from the Queen Charlotte Islands to central Alberta can be divided into four zones (Chapter II), based on the climatic variables that characterize each site: hyper-oceanic, oceanic, sub-oceanic and sub-continental (Table III-1). Distinctions between hyper-oceanic and oceanic zones and other areas are based on the following criteria: growing season (gs)$\geq$300 days, number of days with measurable rainfall during the growing season (pdays)>200, index of oceanity (0)>60 and Conrad's index of continentality (C)<20. Hyper-oceanic areas are distinguished from oceanic areas by precipitation falling as rain during the growing season (precip)>2000mm and aridity index (ai)>140. The aridity index is calculated from precipitation and mean annual temperature, and since temperature values are approximately the same for both areas, the most important difference between the two zones is the precipitation.

Length of growing season between 230 and 300 days, number of precipitation days between 100 and 200, aridity index between 70 and 140, index of oceanity values between 20 and 30 separate the sub-oceanic zone from all other zones. Sub-continental areas have the lowest values for all climatic variables with the exception of the effective temperature sum (w) and the index of continentality. The index of continentality gradient is the reverse of the other gradients, therefore sub-continental areas have higher values than all other areas.

A synthetic gradient that maximizes the dispersion of species optima has been calculated from all the climatic variables. Weights for each standardized variable are shown in Figure III-3. Precipitation, number of precipitation days, and effective temperature sum are negatively weighted while the remaining variables are positively weighted. The synthetic gradient distinguishes, to some extent, reverse precipitation gradients from positive temperature gradients.

Site values on the synthetic climatic gradient indicate that hyper-oceanic and oceanic areas have values >40, sub-oceanic areas between -50 and 20 and sub-continental values <-50. Values for hyper-oceanic areas are smaller than those for oceanic areas because precipitation gradients are negatively weighted. Since hyper-oceanic sites have higher rainfall, and approximately the same temperature values as oceanic areas, they have smaller values on the synthetic gradient.

Cationic and hydrogen ion concentrations, and corrected conductivity (k_{corr}) values of the surface water collected at each of the 224 hummock- hollow complexes studied are listed in Appendix A. These data are summarized by site in Table III-2. Calcium and hydrogen ion concentrations, and k_{corr} values have relatively wide gradients: calcium values range from 0.01 to 201 mg/L, hydrogen ion concentrations from 0.02 X 10^6 to 110 x 10^6, and k_{corr} values from 0 to 869μS. Levels for the remaining cations generally range between 0.01 and 30mg/L. All gradients with the exception of the hydrogen ion gradient increase in the same direction.

Weights for the standardized water chemistry variables used to calculate the synthetic water chemistry gradient that maximizes the dispersion of species optima are shown in Figure III-4. The group composed of manganese, calcium, magnesium and sodium have positive weights, and are highly correlated ($p < 0.001$) (Table III-3). Corrected conductivity, potassium and sulphur form a second group of variables that are significantly correlated ($p < 0.01$) with each other and with the first group. Gradient direction for the elements of the second group is opposite to that of the first group. Iron and Aluminum also have negative weights but neither of these elements is significantly correlated ($p > 0.05$) with the majority of elements from the first and second groups. The water chemistry gradient is significantly correlated ($p < 0.05$) with all chemical variables. Elements from the first group, however, are more closely correlated with the synthetic water chemistry gradient than the others. Hummock-hollow complexes having the lowest Ca, Na and Mg and highest H^+ concentrations have the lowest values on the synthetic water chemistry axes. Low elemental concentrations and high H^+ levels are generally associated with ombrotrophic bogs and extreme poor fens (Sjörs 1952). Conversely, hummock-hollow complexes with the highest Ca, Mg, and Na and the lowest H^+ concentrations have the highest values along the water chemistry gradient. Elevated Ca, Mg and Na values and low H^+ concentrations usually describe moderate and extreme rich fens (Sjörs 1952).

All of the elements with the exception of Na and H are significantly negatively correlated ($p < 0.001$) with the synthetic climate gradient. Sodium and H^+ concentrations are positively correlated with the climate gradient. The synthetic water chemistry gradient is also negatively correlated with the climate axis. These results indicate that peatlands having low cationic and high H^+ and Na concentrations are found in oceanic areas. Thus, bogs and poor fens are generally a feature of oceanic zones.

The minimum height relative to the water table measured on the hummock-hollow complex is 8cm below the water table and the maximum height is 92cm. Height is not significantly correlated ($p > 0.05$) with any of the water chemistry variables. It is highly correlated ($p < 0.001$) with both the complex climate and shade gradients. Shade is significantly positively correlated ($p < 0.05$) with all of the chemical variables with the exception of Fe, Mn and H. It is significantly negatively correlated with hydrogen ion concentrations.

Ecotope dimensions

Bryophyte species can be divided into four groups, based on their ecotope dimensions on the complex climate gradient: restricted oceanic, widespread oceanic, widespread sub-continental, and restricted sub- continental species (Fig. III-5). Ecotopes of restricted oceanic species cover portions of the three oceanic habitats, but do not extend into sub-continental areas. Sphagnum austinii Sull. (7)*, S. tenellum (Brid.) Pers. (8), S. rubellum Wils. (4) and S. papillosum Lindb. (2) are included in this group. The ecotopes of S. rubellum and S. papillosum cover all three oceanic zones, while those of S. tenellum and S. austinii are limited to hyper-oceanic and oceanic (sensu stricto) habitats. With the exception of S. austinii, species optima are in the hyper-oceanic zone.

Widespread oceanic species found in all climatic zones include: Sphagnum pacificum Faltb., S. lindbergii Schimp. (1), S. capillifolium (Ehrh.) Hedw. (9), Pleurozium schreberi (Brid.) Mitt. (14) and Hylocomnium splendens (Hedw.) B.S.G. (16). Optima for these species are located either in sub-oceanic and hyper-oceanic areas. Such species as Sphagnum fuscum (Schimp.) Klinggr. (5), S. magellanicum Brid. (6) and S. angustifolium C. Jens. (11) that are also widespread have sub-continental tendencies since their optima are in sub-continental areas and they are not abundant in the oceanic zone. Numbers refer to species identifications in Figure III-5.

Ecotopes of sub-continental species are limited to subcontinental areas and portions of the sub-oceanic zone. Sub-continental species include Sphagnum warnstorfii Russ. (10), Tomenthypnum nitens (Hedw.) Loeske (13) and Aulacomnium palustre (Hedw.) Schwaegr. (15). With the exception of Sphagnum tenellum, species within this group have the narrowest ecotopes on the climate axes of any of the species studied.

Abundances for most species were totalled at 5 unit intervals on the synthetic water chemistry gradient Abundances for Sphagnum fuscum, S. warnstorfii, and S. angustifolium that have wide ecotope dimensions on this gradient were totalled at 50 unit intervals. Quadratic curves could not be fitted for these species using abundances calculated for 5 unit intervals. However, abundance data calculated for 50 unit intervals produced quadratic curves for these species.

The majority of Sphagnum species optima are tightly grouped on the complex surface water chemistry gradient (Fig. III-6). Ecotopes of most species are restricted to waters with low calcium, magnesium and high H^+ concentrations that are indicative of bogs and poor fens. With the exception of S. warnstorfii, species optima are limited to poor fen habitats. Ecotopes of S. fuscum and S. warnstorfii are the widest of any Sphagnum studies and cover portions of rich fen habitats.

Optima of other bryophyte species are spread over the entire length of the water chemistry gradient, increasing the overall dispersion of the species optima (Fig. III-6). The optima and ecotopes of Paludella squarrosa (Hedw.) Brid. (17) and Hylocomium splendens (16) occur at higher values on the complex gradient than any of the Sphagnum species. Ecotopes of Pleurozium schreberi (14) and Aulacomnium palustre (15) cover poor fen habitats and extend into bog habitats. Optima and ecotope dimensions for these two species are very close to those of the majority of Sphagnum species.

Species optima separate well in an ordered fashion from the surface of the water to the top of the hummocks on the topographic gradient (Fig. III-7). Sphagnum warnstorfii (10) and S. austinii (7) are the exceptions as their optima are superimposed on those of S. papillosum (2) and S. fuscum (5). As species optima increase on the topographic gradient, ecotopes become wider. Thus, such species as S. fuscum, S. austinii and S. capillifolium (9) that have optima situated more than 30 cm above the water table also have the widest ecotopes. Since the ecotopes of most hummock species extend to the water table, ecotopes of all species overlap between 8 and 14 cm above the water table. Dispersion of the species optima is intermediate between those of the climate and water chemistry gradients (Fig. III-7a).

Sphagnum lindbergii (1) is the only Sphagnum species studied that was commonly found below the surface of the water. Sphagnum papillosum (2) and S. tenellum (8) are occasionally found at or just below the surface of the water but are more often found with their capitula above the surface. Other species, when found in close proximity to standing water, are not emergent, but are found on the surface of the peat surrounding the pools. Sphagnum capillifolium is the only species that is not found close to the water table.

Ecotopes of non-Sphagnum species on the topographic gradient exhibit many of the same characteristics as those of Sphagnum species. Ecotope widths increase as the height of species optima increases. Ecotopes of most hummock species extend to the water table, thus creating an area between 12 and 15 cm above the water table, where all species ecotopes overlap. Campylium stellatum (Hedw.) C. Jens (12) occupies a similar ecotope as S. lindbergii, while Hylocomnium splendens (16) and S. capillifolium also share the same ecotope dimensions. These ecotope and optima similarities between Sphagnum and other bryophyte genera reduce the overall dispersion of species optima on the height gradient (Fig. III-7b).

Several species did not exhibit unimodal distributions on the tree and shrub-produced shade gradient (Fig. III-8). Abundances of these species are uniformly distributed along this gradient and the relationship between log-abundance and shade is best expressed as a straight line. Abundances of *Sphagnum lindbergii* (1), *S. warnstorfii* (10), *S. angustifolium*(11), *Aulacomnium palustre* (15) and *Hylocomium splendens* (16) decrease from non-shaded to shaded habitats. *Sphagnum capillifolium* (9) is the only species that shows a marginal increase from non-shaded to shaded habitats. Species exhibiting a unimodal response on the shade gradient can be divided in three groups, depending on their abundance in shaded habitats. Ecotopes of such species as *Sphagnum rubellum* (14), *S. pacificum* (3), *S. papillosum* (2) and *Paludella squarrosa* (17) do not extend into heavily shaded areas. *Sphagnum fuscum* (5), *S. austinii* (7), *S. magellanicum* (6), *Tomenthypnum nitens* (13) and *Pleurozium schreberi* (14) are found in all shade conditions but have optima towards the centre of the gradient. *Sphagnum tenellum* (8) forms the third group since it is restricted to relatively non-shaded habitats. The nonshaded habitat is the only one that is shared by all species.

With the exception of *S. warnstorfii*, ecotope widths of the *Sphagnum* species studied were narrower on the water chemistry gradient than any of the other gradients (Table III-4). Generally, species ecotope widths are narrower on the height gradient than on the climate gradient. Without exception, ecotope widths were the widest on the shade gradient for both *Sphagnum* species and other bryophyte genera. For the greater majority of non-*Sphagnum* species, the narrowest ecotope widths are not found on the water chemistry gradient Of the six non-*Sphagnum* species, two have their narrowest ecotope widths on each of the climate, water chemistry and height gradients.

Species ecotope dimensions relative to the height and water chemistry gradients are plotted on Figure 9. Ecotopes of several species show interaction effects where the height value depends on the value of the water chemistry variable. The height above the water table of *Sphagnum rubellum*, *S. lindbergii*, *S. austinii*, *S. capillifolium*, *S. angustifolium*, *S. warnstorfii*, *S. fuscum* and *Hylocomnium splendens* increases as values on the water chemistry gradient increase. Among the remaining species, only *Tomenthypnum nitens* shows an interaction effect where height values decrease as values on the water chemistry gradient increase.

Ecotope overlap

Overlap values for each pair of species on the four gradients studied are given in Table III-5. Values range from 0 to 1.00, where 0 indicates that portions of a gradient were not shared by two species and 1.00 indicates complete ecotope overlap. Overlap values for *Sphagnum* species range from 0 to 1 on the complex water chemistry and shade gradients, from 0.06 to 0.91 on the topographic gradient, and 0.49 to 1.00 on the shade gradient. Complete ecotope overlap between *Sphagnum* species does not occur on the climate, water chemistry and height gradients. Overlap values of 1.00 occur only twice on those axes and in both cases, non-*Sphagnum* species are involved. Overlap values greater than 0.90 among *Sphagnum* species are uncommon, particularly on the climate and topographic gradients. Conversely, overlap values of 0 among *Sphagnum* species are also infrequent and always involve *S. warnstorfii*. Overlap values less than 0.10 are relatively common when other bryophyte genera are included in the analysis.

Mean overlap values on the climate, water chemistry and height gradients are not significantly different ($p > 0.05$). The mean overlap value on the shade gradient, however, is significantly different from the others ($p < 0.05$), as determined by analysis of variance followed by Student-Newman-Kuels means test. The addition of non-*Sphagnum* species decreased mean ecotope overlaps on the climate and water chemistry gradients, but did not substantially change values on the shade and height gradients.

Total overlap values calculated as the product overlap (May 1975) are much higher between widespread species than restricted oceanic or sub-continental species (Table III-6). Generally, widespread oceanic species have greater overlap values than restricted oceanic species. *Sphagnum warnstorfii* is the most isolated of the *Sphagnum*, since it does not overlap with most oceanic species. *Sphagnum tenellum* has the lowest overlap values among poor fen species.

Among non-*Sphagnum* species, several species are isolated on the water chemistry and climate gradients. Such species as *Tomenthypnum nitens* and *Hylocomnium splendens* do not overlap with several *Sphagnum* species but produce relatively high overlap values with *S. warnstorfii*. These species are commonly associated with each other on moderately rich fens.

Discussion

Habitat partitioning

Species niche (ecotope) segregation on a gradient is usually taken as an indication of resource (habitat) partitioning (Vitt and Slack 1984, Watson 1981, Schoener 1974). Gradients providing the greatest amount of ecotope segregation are recognized as the most important axes, among the n dimensions that define species ecotopes or habitats. Important gradients are those that best explain how species coexist within a community or landscape. Two values are normally used to quantify ecotope segregation, and thus to determine the most important gradient: mean overlap of all pairwise overlaps (Pianka 1986), and dispersion of species optima (ter Braak 1987a).

Gradients having low mean ecotope values and high dispersion of species optima separate species ecotopes more than gradients having high mean overlap and low dispersion values. Based on these criteria, overstory shade does not segregate species ecotopes very well, since this gradient produces a relatively high mean overlap value

(Table III-5). Mean overlap values for the remaining gradients are similar, however dispersion of species optima on the complex climatic gradient is higher than those on the water chemistry and height gradients. This indicates that climate is the most important factor in segregating species ecotopes. The height gradient has a lower mean overlap and higher dispersion than the water chemistry gradient and is therefore the second most important ecotope dimension.

Closer examination of *Sphagnum* species ecotope parameters on the climate gradient provides information as to the effects of precipitation and temperature on species ecotope dimensions (Fig. III-5). Ecotopes of such species as *S. rubellum*, *S. papillosum* and *S. tenellum* which have optima in the hyper-oceanic zone and ecotope widths that do not extend into sub-continental areas appear to be limited by precipitation rather than the temperature range encountered in the study area. Precipitation during the growing season values (Table III-1) are highest in hyper-oceanic areas and decrease in sub-oceanic and oceanic areas. Log-linear regression of species abundances against the precipitation gradient produce the following r^2 values: *S. rubellum* = 0.94, *S. papillosum* = 0.95 and *S. tenellum* = 0.98. These r^2 values are higher than those describing relationships between these species and the synthetic climate gradient (Table III-4). Such temperature gradients as growing season (gs) and biotemperature (bt) increase linearly along the climatic gradient, achieving their highest values in oceanic areas rather than hyper-oceanic areas. Thus, precipitation rather than temperature are limiting restricted oceanic species at the latitudes covered by this study.

Such species as *S. lindbergii*, *S. capillifolium* and *S. pacificum*, with optima in hyper-oceanic areas and ecotopes that extend into sub- continental areas, have r^2 values of 0.16, 0.11, and 0.08 respectively for log-linear relationships between species abundances and precipitation. These r^2 values are much lower than r^2 values on the climatic gradient

(Table III-4). Thus it would appear that temperature rather than precipitation is limiting widespread oceanic species' ecotopes.

Effects of temperature on species ecotope dimensions are not clearly defined along the east-west transect used in this study. Effects of temperature, and particularly temperature extremes, could probably have been more accurately defined by expanding this study to extensive north-south transects in each climate zone. However, ecotope dimensions of the restricted oceanic species S. austinii on the climate gradient can somewhat be defined by the mean monthly minimum temperature. Monthly minimum temperatures > 0 are only found in hyper-oceanic and oceanic areas (Fig. III-10), and this range fits the ecotope width of S. austinii. A log linear regression of this species' abundance on the minimum monthly temperature produced an r^2 value of 0.65. This value could undoubtedly be improved by expanding this study to other coastal sites. It is unlikely that minimum temperature is limiting the distribution and abundance of widespread and sub-continental species, since their ecotopes extend into areas where minimum temperatures are below 0°C.

Andrus (1987) divided Sphagnum imbricatum in North America into three species: S. austinii, S. steerei, and S. affine. The distibution of S. austinii is restricted to hyper-oceanic and oceanic areas (Fig. III-11). These areas do not normally have minimum mean monthly temperatures below 0°C. Sphagnum steerei and S. affine however are found in arctic, sub-arctic, and sub-oceanic areas where minimum monthly temperatures are below 0°C for several months of the year. Results from this study indicate that S. austinii is limited to oceanic and hyper-oceanic areas by cold temperatures and support the segregation of S. austinii from S. steerei and S. affine.

With the exception of S. lindbergii, S. austinii and S. warnstorfii, species with optima relatively close to the water table on the topographic gradient (Fig. III-7) are limited by precipitation to oceanic areas. Species growing higher on the hummocks are all widespread and limited by temperature rather than precipitation. The height occupied by a species on the topographic gradient is directly related to its ability to move water vertically (Rydin & McDonald 1985, Hayward & Clymo 1983, Clymo 1973). Species found at the tops of hummocks have the ability to move water better than species restricted to hollows. The ability to move water reduces species dependence on precipitation as a source of moisture. Thus, morphological adaptations that permit species to grow on hummocks also enable them to expand their ecotopes into sub-continental areas by exploiting sources of water other than precipitation.

Such species as S. lindbergii that have optima very close to the water table and ecotopes that extend below the surface of the water do not need to move water vertically. These species can exploit permanent surface water supplies in all climatic zones and are not dependent on rainfall as a source of water. However, at the latitudes examined in this study, there are more permanent pools in hyper-oceanic areas as a result of frequent precipitation than in sub-continental areas. Thus, the optimum for S. lindbergii is in hyper-oceanic simply because there are more suitable habitats in that climatic zone.

The relatively low dispersion of Sphagnum species optima and high mean species overlap values on the synthetic water chemistry gradient, indicative of a poorly partitioned gradient, are misleading. With the exception of S. warnstorfii, Sphagnum species have their optima in poor fen habitats and their ecotopes cover most of that habitat. When poor fens and bogs alone are considered, dispersal of species optima increases to 0.219, indicating that those habitats are extensively partitioned.

The overstory shade gradient is not extensively partitioned among Sphagnum. The abundances of several species did not produce quadratic responses on this gradient and for this reason, dispersion of species optima could not be calculated. Fewer Sphagnum species occur in deeply shaded habitats. Sphagnum capillifolium is the notable exception, since its abundance increases in deep shade. This is misleading in that this species often occurs in unshaded areas in hyper-oceanic areas and it gradually shifts its ecotope to deeply shaded habitats in sub-continental areas. This ecotope shift may be caused by an avoidance of higher evapo-transpiration rates in unshaded sub-continental areas during the growing season.

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Table III-1. Climatic variables for the 27 study sites calculated from 30 year means measured at 26 permanent weather stations. gs=length of growing season; w=effective temperature sum; bt=biotemperature; precip=precipitation during growing season; pdays=number of precipitation days; ai=aridity index; o=index of oceanity; C=Conrad's index of continentality: X_{clm}=site value on a complex climatic gradient that produces maximum dispersion of species optima.and was calculated using weights for each climate variable, standardized to mean=0 and variance=1. Lines in the table separate the four climatic zones

site	zone	gs	w	bt	precip	pdays	ai	o	C	X_{clm}
1		344	68.1	7.63	1353.0	200	81.47	68.45	10.68	177.5
2	oceanic	313	67.0	7.45	1347.3	200	87.73	60.53	13.47	127.9
3		360	65.3	7.43	1091.2	203	66.22	71.13	11.57	207.6
4		346	71.0	7.44	2334.9	223	138.11	86.27	7.94	105.9
5		297	58.8	6.70	2369.0	218	151.09	69.59	11.15	78.5
6	hyper-	346	71.0	7.44	2334.9	232	180.07	89.73	7.94	90.5
7	oceanic	346	71.0	7.44	2334.9	232	180.07	89.73	7.94	111.1
8		346	71.0	7.44	2334.9	232	180.07	89.73	7.94	111.1
9		322	64.9	7.07	2846.5	227	178.62	79.12	7.55	82.2
10		297	74.5	7.81	3358.7	201	178.67	64.16	11.15	48.5
11		268	58.8	6.70	1423.9	170	92.25	26.44	23.16	11.0
12		242	66.4	6.98	1753.0	165	140.18	19.12	28.95	-48.0
13	sub-	242	66.4	6.98	1253.9	152	99.56	20.17	28.91	-28.6
14	oceanic	232	65.5	6.78	934.3	150	82.60	16.69	27.60	-51.6

15		240	67.7	7.08	945.5	158	70.83	18.31	26.85	8.6
16		240	63.7	6.61	814.9	149	69.20	20.30	28.20	-38.4
17		225	59.8	6.16	395.0	87	37.17	6.35	34.23	-63.4
18		196	48.7	5.23	285.8	78	41.03	6.25	35.92	-79.0
19		216	51.5	5.46	290.3	80	40.20	5.85	39.70	-62.6
20		204	56.2	5.85	409.8	104	47.24	7.80	37.90	-77.6
21	sub-continental	222	53.4	5.62	529.9	107	64.11	6.72	37.13	-70.5
22		213	61.8	6.32	406.7	92	44.05	7.35	35.80	-71.2
23		201	54.5	5.71	366.7	91	49.24	6.37	39.04	-77.4
24		198	49.4	5.30	345.5	56	42.80	3.65	40.24	-74.6
25		189	45.2	4.90	416.3	69	54.44	5.27	38.55	-91.8
26		190	55.9	5.84	389.2	76	48.88	3.20	45.40	-102.6
27		161	55.3	5.77	361.0	68	45.80	3.37	52.50	-75.5

Table III-2. Pearson correlation coefficients for climate variables calculated from data obtained from 26 weather stations.and site values on a complex climate gradient (X_{clm}). The complex gradient that maximizes dispersion of the species optima. See Table 1 for abbreviations.

	w	bt	arid	gs	o	C	precip	pdays
w	1.000							
biot	0.961	1.000						
arid	0.556	0.605	1.000					
gs	0.728	0.839	0.693	1.000				
o	0.648	0.746	0.795	0.964	1.000			
C	-0.569	-0.690	-0.735	-0.887	-0.897	1.000		
precip	0.568	0.651	0.966	0.760	0.845	-0.787	1.000	
pdays	0.739	0.878	0.844	0.931	0.933	-0.855	0.876	1.000
X_{clm}	0.643	0.798	0.536	0.959	0.903	-0.811	0.626	0.860

Table III-3. Mean ± standard deviation for cation (mg/L) and hydrogen ion (10^6) concentrations, corrected conductivity (k_{corr}) values (µS), mean height relative to the water table (cm) and overstory shade for the 27 study sites. n=12.

Site	Ca	Mg	Na	K	Al	Fe	Mn	S	k_{corr}	H	height	shade
1	0.7±0.5	0.6±0.2	5.9±1.1	1.0±0.8	0.19±0.47	1.9±2.0	0.04±0.05	0.4±0.2	43.9±7.1	80.4±14.5	27.6±11.5	1.4±1.4
2	1.3±0.4	1.1±0.2	12.1±1.2	3.3±1.9	0.43±0.12	2.3±1.6	0.05±0.[illegible]	0.6±0.2	1.2±3.4	54.8±17.7	32.0±9.2	2.6±1.9
3	1.3±0.5	1.3±0.3	13.9±[illegible]	[illegible].0±1.3	0.30±0.12	3.2±1.9	0.07±0.04	0.7±0.3	2.0±2.9	39.9±13.0	33.8±10.5	3.5±1.9
4	0.6±0.9	0.3±0.1	2.8±1.8	1.6±3.0	0.05±0.08	0.8±0.4	0.02±0.01	0.8±0.4	5.5±4.4	74.8±19.0	18.5±11.1	2.9±2.3
5	0.5±0.3	0.2±0.1	2.7±0.6	0.8±0.7	0.08±0.18	1.6±0.7	0.03±0.02	0.7±0.3	20.1±12.7	68.7±3[illegible]	27.9±21.3	2.4±2.4
6	2.6±3.6	0.6±0.6	2.0±0.5	1.2±1.0	0.13±0.06	2.5±2.4	0.06±0.05	0.6±0.3	11.6±12.0	85.8±71.7	18.4±11.4	4.0±2.6
7	8.8±8.8	0.9±0.5	5.0±2.4	2.8±2.7	0.10±0.08	0.9±1.3	0.06±0.07	2.1±0.9	136.4±193.2	47.3±61.9	18.9±10.2	2.8±1.7
8	14.8±18.4	1.1±0.8	7.3±4.7	2.2±1.8	0.19±0.09	3.1±2.9	0.39±0.88	3.7±3.6	102.8±96.4	18.4±15.1	20.2±12.0	2.7±2.1
9	0.8±0.8	0.4±0.2	2.7±1.6	1.2±0.8	0.10±0.07	2.3±1.2	0.06±0.03	1.1±0.6	11.7±11.6	102.7±38.2	17.5±8.5	1.3±0.7
10	0.3±0.1	0.1±0.1	0.4±0.3	0.5±0.5	0.06±0.03	0.2±0.1	0.01±0.01	0.1±0.0	2.0±3.4	92.3±44.1	25.5±25.1	0.5±0.1
11	3.5±1.9	0.5±0.3	6.2±3.0	6.3±2.4	0.03±0.00	1.1±0.5	0.05±0.03	0.3±0.1	94.1±32.3	11.9±5.9	12.7±4.1	1.2±2.2
12	4.2±4.3	0.6±0.3	4.4±4.8	3.3±2.7	0.37±0.13	4.4±2.5	0.23±0.35	0.4±0.3	44.5±33.6	17.6±30.4	21.0±8.1	3.5±2.2
13	0.7±0.4	0.2±0.1	1.6±0.5	2.9±5.3	0.44±0.30	1.4±1.5	0.04±0.04	0.3±0.1	13.6±4.7	14.8±19.9	11.3±6.4	0.8±0.6

14	0.1±0.1	0.1±0.1	0.8±0.3	1.0±1.0	0.10±0.06	1.0±1.5	0.02±0.04	0.1±0.1	22.3±9.1	56.0±17.1	22.5±10.1	2.3±2.2
15	0.1±0.1	0.1±0.1	1.0±0.4	1.9±3.5	0.16±0.08	2.5±1.4	0.06±0.03	0.1±0.1	16.1±11.4	69.7±38.1	14.8±10.0	2.8±2.8
16	0.8±0.2	0.5±0.0	1.6±0.5	1.4±0.6	0.40±0.07	1.8±0.6	0.03±0.12	0.5±0.3	15.5±7.6	51.1±20.1	25.8±10.3	2.6±2.2
17	4.4±1.4	0.1±0.2	3.5±2.0	3.6±2.4	0.03±0.00	7.3±1.3	0.24±0.10	0.3±0.1	60.9±15.3	110.2±60.7	47.9±14.2	2.5±0.9
18	100.2±36.1	14.5±3.7	15.3±4.0	8.7±6.0	0.07±0.14	12.0±7.5	5.69±8.21	0.5±0.4	471.9±68.4	0.1±0.2	23.4±6.1	2.3±1.4
19	51.5±8.1	23.4±2.4	5.9±2.5	0.5±0.5	0.18±0.05	0.2±0.1	0.56±0.85	6.0±3.6	372.5±51.5	0.2±0.1	39.7±14.9	7.2±0.9
20	0.9±0.7	0.4±0.2	1.9±0.9	2.4±1.2	0.38±0.01	9.5±3.4	0.22±0.08	0.2±0.1	25.9±8.2	108.6±18.9	19.8±3.0	2.1±1.0
21	1.8±0.7	0.8±0.4	0.4±0.3	2.7±2.9	0.24±0.19	1.3±0.8	0.05±0.04	0.1±0.1	48.7±6.7	27.9±23.7	11.4±3.7	1.4±1.3
22	99.7±19.1	16.3±3.6	9.5±5.2	4.6±3.5	0.19±0.07	2.8±5.6	1.47±1.77	1.9±2.5	652.2±121.3	0.1±0.1	22.7±11.2	5.1±1.3
23	59.9±19.1	14.0±1.7	3.3±0.9	1.1±0.5	0.15±0.03	0.1±0.1	0.01±0.03	2.5±1.3	324.8±64.8	0.1±0.02	14.8±10.0	4.6±2.0
24	68.3±23.6	16.9±3.7	25.2±5.8	2.4±1.2	0.23±0.17	0.3±0.3	0.27±0.62	0.1±0.1	361.3±62.3	0.1±0.04	22.6±7.9	7.4±1.6
25	123.2±23.0	22.2±3.3	4.5±1.1	5.3±1.9	0.17±0.03	0.2±0.2	0.12±0.21	0.6±0.4	687.3±80.2	0.1±0.09	31.3±8.2	6.7±1.8
26	7.2±5.7	2.2±2.5	8.0±4.4	2.0±1.0	0.20±0.10	0.5±0.3	0.04±0.03	1.0±0.2	99.2±43.5	66.8±48.1	39.1±7.6	3.9±2.2
27	1.0±0.3	0.5±0.1	0.8±0.8	3.6±4.8	0.06±0.03	0.9±0.6	0.12±0.06	0.3±0.2	19.1±6.6	137.0±17.9	19.3±7.2	2.9±1.9

Table III-4. Pearson correlation coefficients for cation and hydrogen ion concentrations, corrected conductivity (k_{corr}) values, and hummock-hollow values along a complex surface water chemistry gradient (X_{che}) and climatic gradient (X_{clm}) that maximizes the dispersion of species optima, mean height relative to the water table and tree and shrub-produced shade. n=224. $p<0.05$, ** $p<0.01$, *** $p<0.0001$. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	Ca	Mg	Na	K	Al	Fe	Mn	S	k_{corr}	H	X_{che}	X_{clm}	height
Ca	1.00												
Mg	0.93***	1.00											
Na	0.43***	0.46***	1.00										
K	0.22***	0.26***	0.12**	1.00									
Al	-0.03	-0.02	0.15***	0.01	1.00								
Fe	0.11*	-0.03	0.10**	0.14***	0.08*	1.00							
Mn	0.37***	0.26***	0.18***	0.14***	-0.01	0.38***	1.00						
S	0.12***	0.25***	0.08	0.16***	-0.06	-0.11**	0.01	1.00					
k_{corr}	0.95***	0.91***	0.41***	0.24***	-0.08*	0.03	0.25***	0.23***	1.00				

H	-0.52***	-0.53***	-0.37***	-0.15***	-0.13***	0.04	-0.15***	-0.23***	-0.54***	1.00			
Xche	0.54***	0.48***	0.60***	0.11*	-0.07*	0.19***	0.82***	-0.12**	0.41***	-0.34***	1.00		
Xclm	-0.46***	-0.44***	0.38***	-0.26***	-0.49***	-0.28***	-0.20***	-0.28***	-0.39***	0.24***	0.12**	1.00	
height	-0.01	-0.01	-0.01	0.08	-0.01	0.03	-0.01	0.01	-0.01	0.05	0.02	-0.58***	1.00
shade	0.52***	0.60***	0.38***	0.13**	0.09*	-0.07	0.03	0.15***	0.54***	-0.33***	0.23***	0.09*	-0.53***

Table III-5. Species ecotope widths on complex climate and water chemistry gradients, and height and shade variables. n_{clm}=number of sites on which each species was found, n_{che}=number of hummock-hollow complexes on which each species was observed, n=overall number of plants measured on height and shade gradients, R^2=the fraction of variance accounted for by quadratic regressions fitted to species log-abundance data.

Species	climate			chemistry			height			shade	
	width	n_{clm}	R^2	width	n_{che}	R^2	width	n	R^2	width	R^2
Sphagnum lindbergii	0.63	8	0.40	0.35	27	0.14	0.35	340	0.81	1.00	0.02
Sphagnum papillosum	0.43	11	0.82	0.23	61	0.75	0.40	1051	0.88	0.47	0.77
Sphagnum pacificum	0.51	8	0.73	0.34	39	0.36	0.50	425	0.72	0.75	0.67
Sphagnum rubellum	0.40	12	0.54	0.19	51	0.41	0.31	624	0.94	0.70	0.44
Sphagnum fuscum	0.79	24	0.72	0.64	175	0.56	0.69	3798	0.90	0.91	0.72
Sphagnum magellanicum	0.60	14	0.90	0.44	118	0.30	0.57	1909	0.83	0.84	0.29
Sphagnum austinii	0.39	8	0.94	0.14	45	0.74	0.70	1221	0.67	1.00	0.98
Sphagnum tenellum	0.14	6	0.91	0.09	19	0.77	0.31	55	0.60	0.33	0.75
Sphagnum capillifolium	0.81	11	0.46	0.27	32	0.13	0.91	459	0.45	1.00	0.05
Sphagnum warnstorfii	0.16	7	0.72	0.40	27	0.41	0.34	499	0.90	1.00	0.29
Sphagnum angustifolium	0.77	18	0.64	0.31	117	0.69	0.49	2115	0.91	0.87	0.28
Campylium stellatum				0.23	18	0.64	0.40	52	0.33	0.69	0.29
Tomenthypnum nitens	0.15	6	0.49	0.46	64	0.58	0.40	899	0.88	0.87	0.58
Pleurozium schreberi	0.95	13	0.43	0.60	27	0.08	0.58	85	0.58	1.00	0.18
Aulacomnium palustre	0.15	6	0.99	0.38	22	0.29	0.54	106	0.49	1.00	0.26
Hylocomium splendens	0.50	5	0.69	0.56	10	0.99	0.29	50	0.29	1.00	0.15
Paludella squarrosa				0.58	11	0.48	0.33	104	0.60	1.00	0.67

Table III-6. Species ecotope overlaps among 17 mire bryophyte species on complex climate and water chemistry gradients, and height and shade gradients. Abbreviations correspond to the first three letters of species names for Sphagna and the first three letters of genus names for other bryophyte genera. lin=*Sphagnum lindbergii*. X_S=mean overlap ±standard deviation for *Sphagnum* species. X_+=mean ± standard deviation for all species.

Species	lin	pap	pac	rub	fus	mag	aus	ten	cap	war	ang	cam	tom	ple	aul	hyl
								CLIMATE								
Sphagnum papillosum	0.81															
Sphagnum pacificum	0.84	0.77														
Sphagnum rubellum	0.79	0.93	0.72					x_S=0.55±0.24								
Sphagnum fuscum	0.80	0.70	0.78	0.68												
Sphagnum magellanicum	0.52	0.40	0.64	0.34	0.79			X_+=0.49±0.28								
Sphagnum austinii	0.61	0.56	0.36	0.60	0.42	0.01										
Sphagnum tenellum	0.36	0.48	0.42	0.52	0.30	0.11	0.37									
Sphagnum capillifolium	0.86	0.69	0.77	0.67	0.94	0.72	0.50	0.29								
Sphagnum warnstorfii	0.35	0.67	0.50	0.00	0.38	0.47	0.00	0.00	0.37							
Sphagnum angustifolium	0.67	0.60	0.78	0.54	0.88	0.87	0.26	0.30	0.76	0.38						
Tomenthypnum nitens	0.08	0.00	0.18	0.00	0.32	0.39	0.00	0.00	0.31	0.31	0.33					
Pleurozium schreberi	0.80	0.62	0.70	0.60	0.91	0.72	0.58	0.25	0.92	0.32	0.83	0.12	0.27			

Aulacomnium palustre	0.08	0.00	0.18	0.00	0.32	0.39	0.00	0.00	0.31	0.31	0.33		1.00	0.27		
Hylocomium splendens	0.86	0.79	0.96	0.76	0.77	0.60	0.38	0.44	0.76	0.52	0.75		0.09	0.68	0.12	
	lin	pap	pac	rub	fus	mag	aus	ten	cap	war	ang	cam	tom	ple	aul	hyl

WATER CHEMISTRY

Xs=0.59±0.23

X_+=0.48±0.30

Sphagnum papillosum	0.78														
Sphagnum pacificum	0.93	0.78													
Sphagnum rubellum	0.70	0.90	0.70												
Sphagnum fuscum	0.70	0.51	0.69	0.45											
Sphagnum magellanicum	0.87	0.66	0.85	0.59	0.81										
Sphagnum austinii	0.56	0.74	0.58	0.82	0.36	0.48									
Sphagnum tenellum	0.40	0.56	0.40	0.64	0.24	0.33	0.50								
Sphagnum capillifolium	0.87	0.90	0.87	0.83	0.58	0.75	0.67	0.49							
Sphagnum warnstorfii	0.24	0.22	0.30	0.23	0.71	0.43	0.00	0.26	0.26						
Sphagnum angustifolium	0.91	0.83	0.93	0.76	0.64	0.81	0.61	0.45	0.93	0.33					
Campillium stellatum	0.17	0.13	0.24	0.14	0.52	0.41	0.16	0.00	0.54	0.84	0.30				
Tomenthypnum nitens	0.49	0.51	0.50	0.55	0.84	0.64	0.47	0.32	0.54	0.85	0.59	0.66			
Pleurozium schreberi	0.73	0.54	0.72	0.48	0.97	0.84	0.38	0.25	0.61	0.66	0.68	0.55	0.83		
Aulacomnium palustre	0.81	0.74	0.86	0.66	0.75	0.93	0.54	0.38	0.91	0.44	0.89	0.74	0.67	0.78	
Hylocomium splendens	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.46	0.00	0.23	0.33	0.26	0.00

Paludella squarrosa	0.00	0.00	0.00	0.00	0.36	0.05	0.00	0.00	0.00	0.49	0.00	0.27	0.38	0.30	0.04	0.98
	lin	pap	pac	rub	fus	mag	aus	ten	cap	war	ang	cam	tom	ple	aul	hyl

HEIGHT

Xs=0.52±0.21

X_+=0.53±0.18

Sphagnum papillosum	0.45															
Sphagnum pacificum	0.26	0.58														
Sphagnum rubellum	0.40	0.64	0.54													
Sphagnum fuscum	0.19	0.46	0.70	0.42												
Sphagnum magellanicum	0.30	0.59	0.78	0.52	0.73											
Sphagnum austinii	0.17	0.44	0.67	0.39	0.86	0.69										
Sphagnum tenellum	0.55	0.61	0.37	0.55	0.30	0.43	0.25									
Sphagnum capillifolium	0.06	0.27	0.48	0.23	0.68	0.53	0.69	0.13								
Sphagnum warnstorfii	0.46	0.70	0.50	0.70	0.40	0.54	0.38	0.61	0.22							
Sphagnum angustifolium	0.33	0.64	0.84	0.58	0.98	0.92	0.95	0.45	0.73	0.57						
Campillium stellatum	0.71	0.59	0.44	0.58	0.35	0.47	0.33	0.64	0.18	0.68	0.49					
Tomenthypnum nitens	0.32	0.68	0.67	0.66	0.54	0.65	0.51	0.49	0.34	0.62	0.70	0.52				
Pleurozium schreberi	0.35	0.42	0.63	0.40	0.79	0.69	0.81	0.40	0.67	0.44	0.91	0.48	0.50			
Aulacomnium palustre	0.27	0.57	0.80	0.56	0.66	0.75	0.63	0.38	0.46	0.51	0.81	0.45	0.67	0.59		
Hylocomium splendens	0.11	0.41	0.71	0.47	0.72	0.73	0.72	0.21	0.60	0.35	0.86	0.28	0.50	0.65	0.66	
Paludella squarrosa	0.32	0.68	0.60	0.66	0.49	0.56	0.46	0.47	0.39	0.62	0.61	0.51	0.69	0.42	0.63	0.44

SHADE

	lin	pap	pac	rub	fus	mag	aus	ten	cap	war	ang	cam	tom	ple	aul	hyl
Sphagnum papillosum	0.64															
Sphagnum pacificum	0.80	0.77														
Sphagnum rubellum	0.83	0.73	0.97													
Sphagnum fuscum	0.95	0.68	0.90	0.87												
Sphagnum magellanicum	0.91	0.72	0.94	0.91	0.96											
Sphagnum austinii	1.00	0.64	0.86	0.83	0.95	0.91										
Sphagnum tenellum	0.49	0.82	0.60	0.63	0.53	0.56	0.49									
Sphagnum capillifolium	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49								
Sphagnum warnstorfii	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49	1.00							
Sphagnum angustifolium	0.93	0.55	0.80	0.76	0.91	0.86	0.93	0.37	0.93	0.93						
Campillium stellatum	0.83	0.60	0.87	0.83	0.86	0.90	0.82	0.38	0.82	0.82	0.86					
Tomenthypnum nitens	0.94	0.69	0.92	0.88	0.99	0.97	0.94	0.54	0.94	0.94	0.89	0.88				
Pleurozium schreberi	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49	1.00	1.00	0.93	0.82	0.94			
Aulacomnium palustre	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49	1.00	1.00	0.93	0.82	0.94	1.00		
Hylocomium splendens	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49	1.00	1.00	0.93	0.82	0.94	1.00	1.00	
Paludella squarrosa	1.00	0.64	0.86	0.83	0.95	0.91	1.00	0.49	1.00	1.00	0.93	0.82	0.94	1.00	1.00	1.00

X_S=0.80±0.17

X_+=0.84±0.16

Pleurozium schreberi	0.20	0.09	0.27	0.10	0.66	0.38	0.18	0.01	0.38	0.09	0.69	0.11		
Aulacomnium palustre	0.02	0.00	0.11	0.00	0.15	0.25	0.00	0.00	0.13	0.07	0.22	0.42	0.14	
Hylocomium splendens	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.11	0.00

Table III-7. Total ecotope overlaps for paired combinations of 15 mire bryophyte species on four gradients. Abbreviations correspond to the first three letters of species names for Sphagna and the first three letters of genus names for other bryophyte genera. lin=*Sphagnum lindbergii*.

Species	lin	pap	pac	rub	fus	mag	aus	ten	cap	war	ang	tom	ple	aul
Sphagnum papillosum	0.18													
Sphagnum pacificum	0.16	0.27												
Sphagnum rubellum	0.18	0.39	0.26											
Sphagnum fuscum	0.10	0.11	0.34	0.11										
Sphagnum magellanicum	0.12	0.11	0.40	0.09	0.45									
Sphagnum austinii	0.06	0.12	0.12	0.16	0.12	0.01								
Sphagnum tenellum	0.04	0.13	0.06	0.12	0.01	0.01	0.02							
Sphagnum capillifolium	0.04	0.11	0.15	0.11	0.35	0.26	0.23	0.01						
Sphagnum warnstorfii	0.00	0.07	0.06	0.00	0.10	0.10	0.00	0.00	0.02					
Sphagnum angustifolium	0.19	0.18	0.42	0.19	0.50	0.59	0.14	0.02	0.48	0.07				
Tomenthypnum nitens	0.01	0.00	0.06	0.00	0.14	0.26	0.00	0.00	0.05	0.15	0.12			

Figure III-1. Map showing the location of the 27 mires studied along a transect from coastal British Columbia to central Alberta. ★ indicates sites 4 through 9, ☆ sites 11 through 14, and ■ sites 15 and 16.

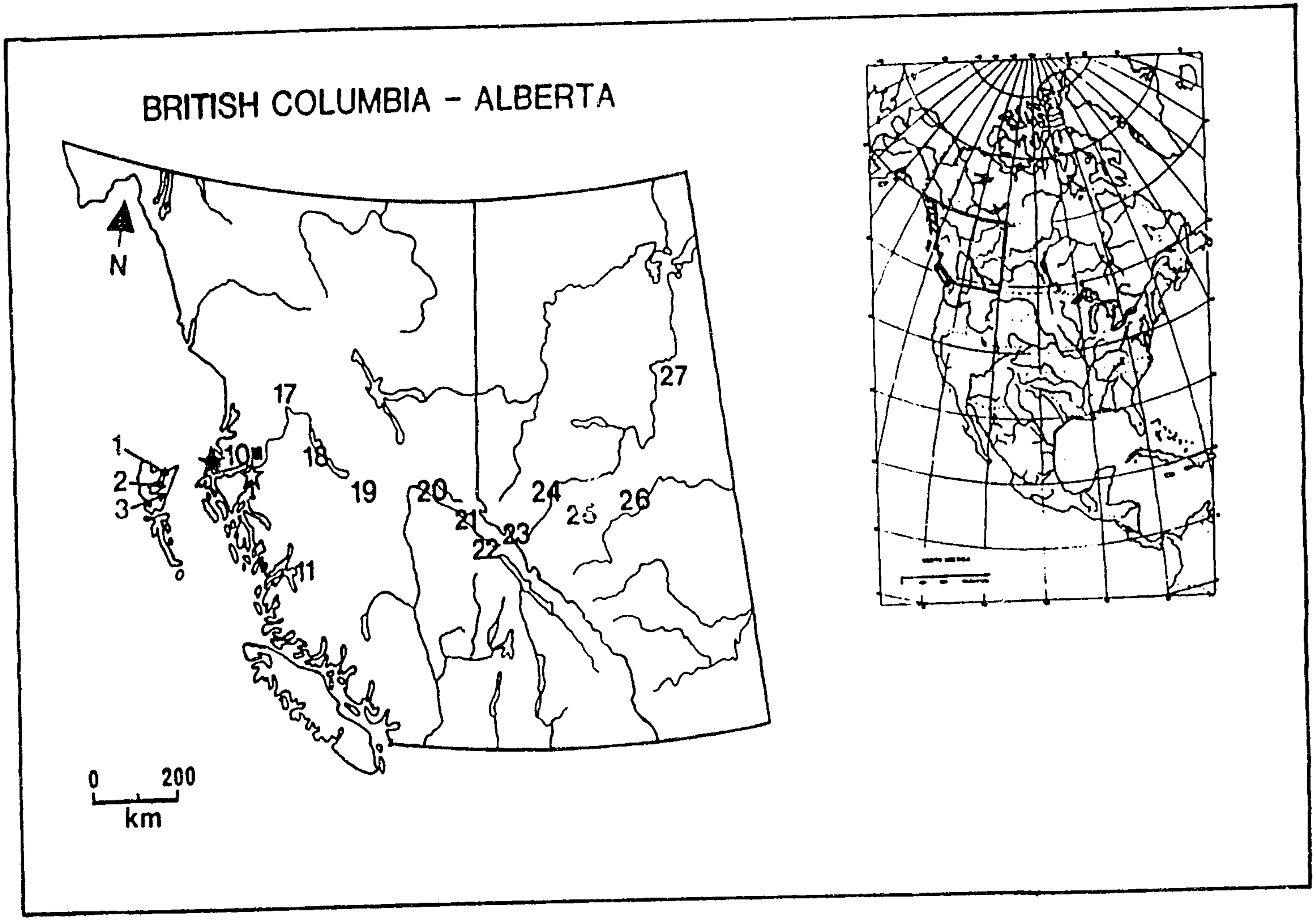
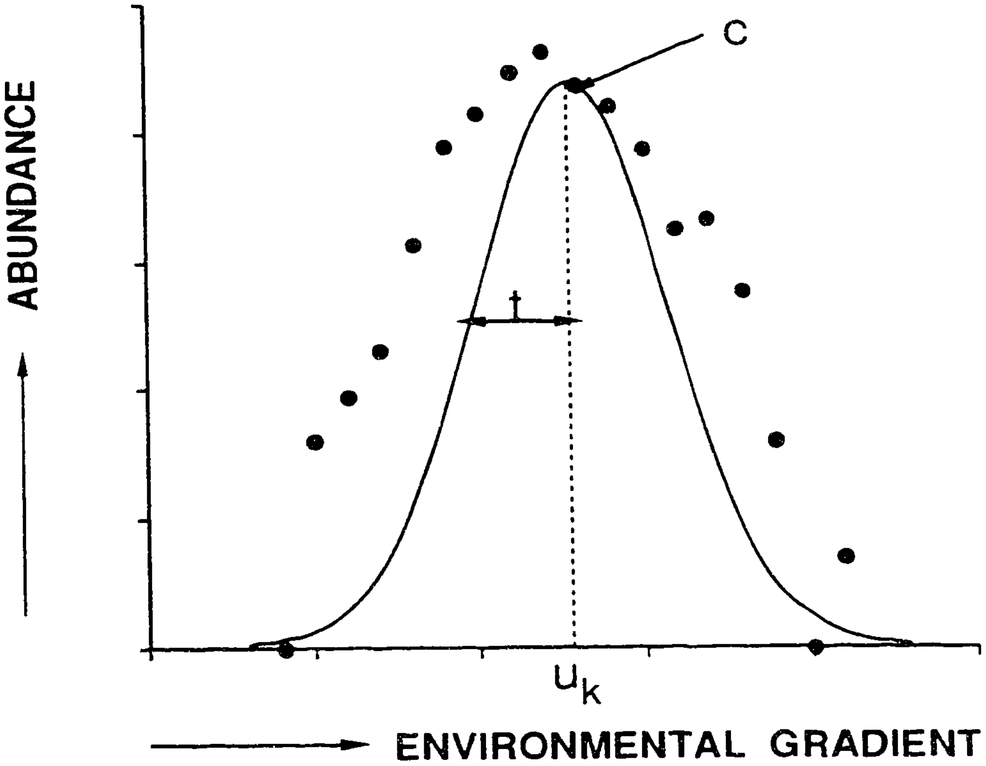
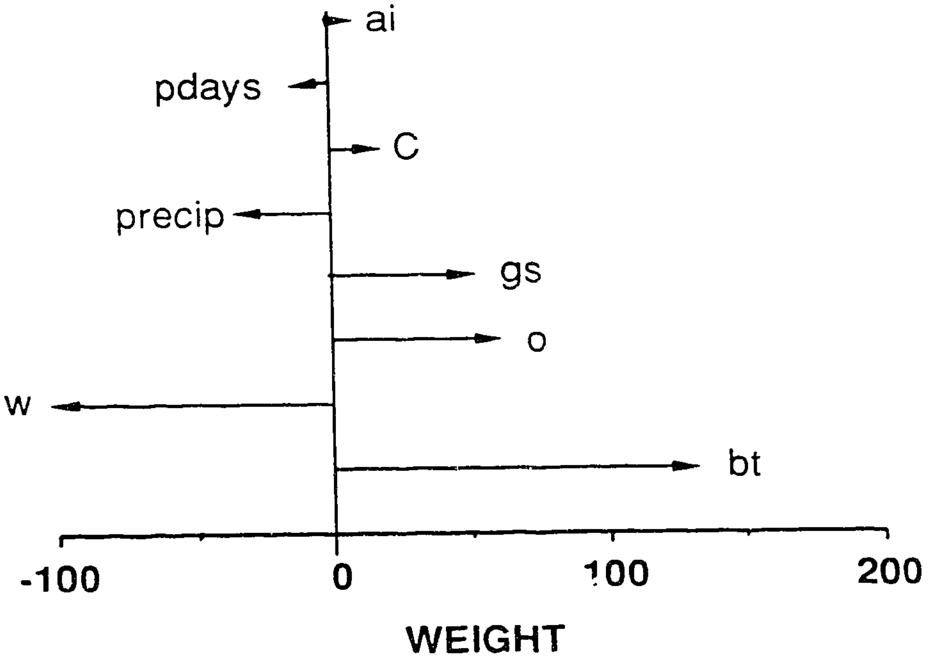

BRITISH COLUMBIA - ALBERTA
N
1
2
3
10
11
17
18
19
20
21
22
23
24
25
26
27
0
200
km

Figure III-2. Gaussian response curve fitted to abundance data showing three ecological parameters. c = maximum abundance (mode), u_k = optimum or value of x that gives maximum abundance, t = standard deviation.



C
t
ABUNDANCE
u_k
ENVIRONMENTAL GRADIENT

Figure III-3. Weights or coefficients (x100) of the linear transformations of climatic variables standardized to mean = 0 and variance =1 that were used to calculate the first canonical correspondence analysis axis that maximizes the dispersion of species optima on a complex climatic gradient. ai = aridity index, pdays = number of precipitation days, C = Conrad's index of continentality, prec. = rainfall during growing season, gs = growing season, o = index of oceanity, w = effective temperature sum, bt = biotemperature.


ai
pdays
C
precip
gs
o
w
bt
-100
0
100
200
WEIGHT

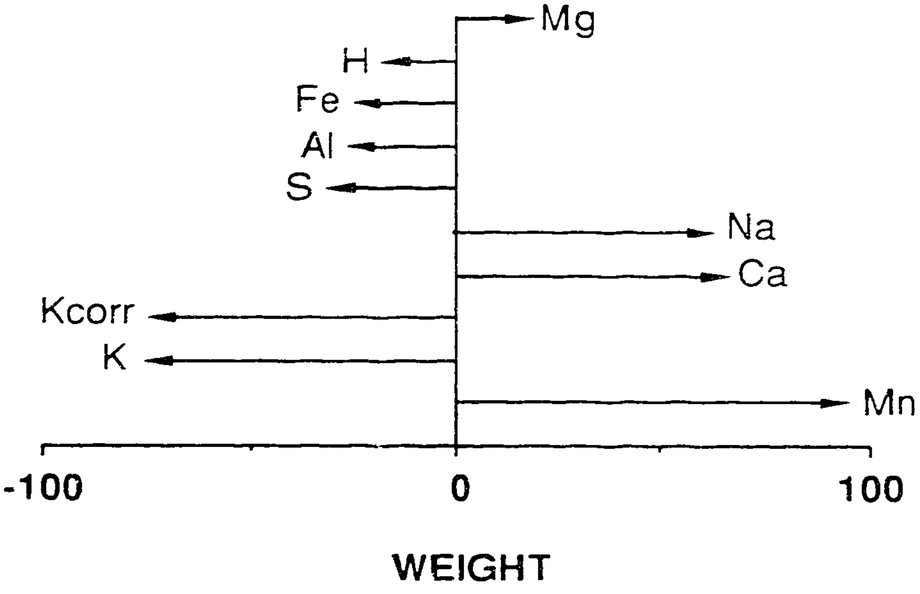
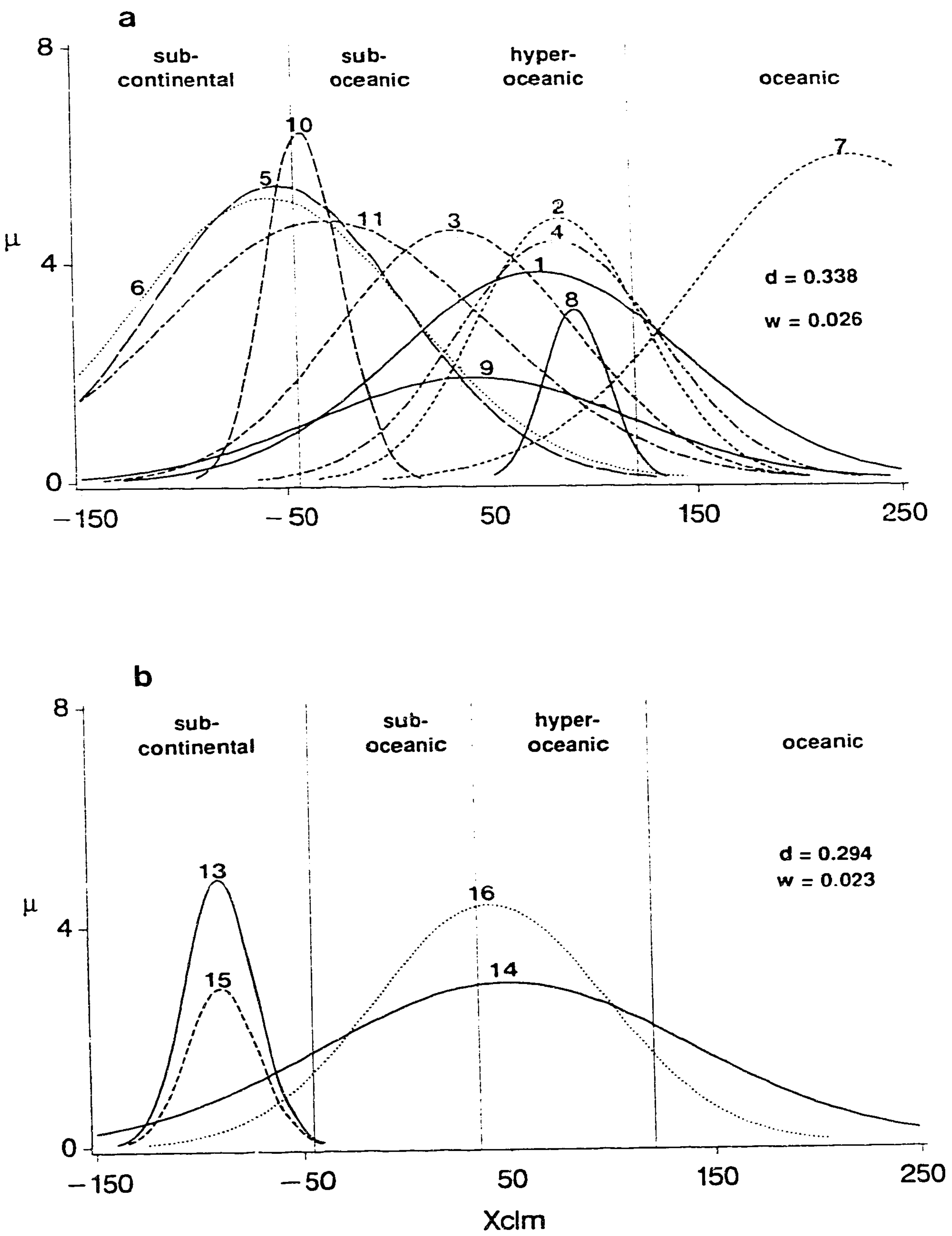
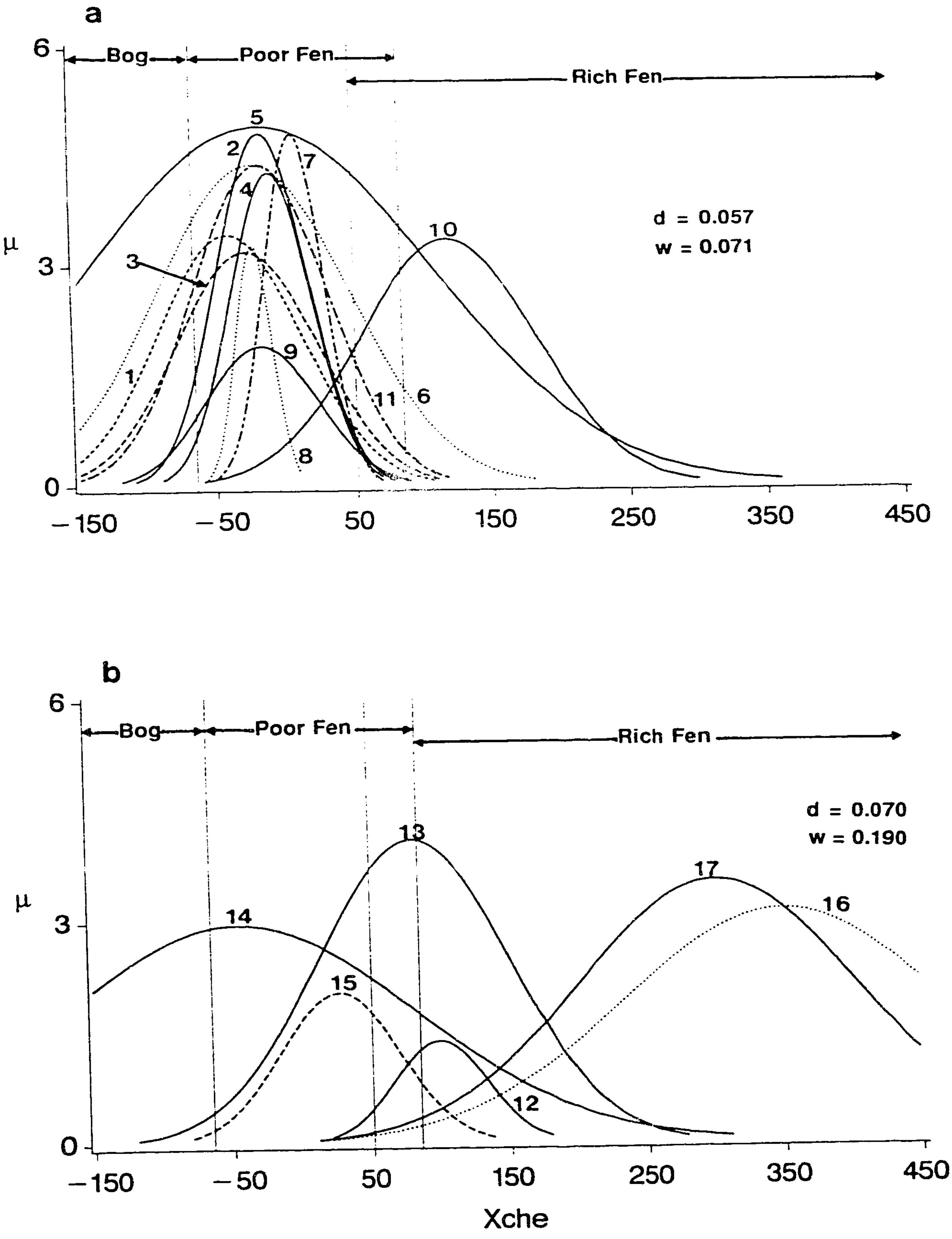

Mg
H
Fe
Al
S
Na
Ca
Kcorr
K
Mn
-100
0
100
WEIGHT

Figure III-4. Weights or coefficients (x100) of the linear transformations for elemental concentrations and corrected conductivity (k_{corr}) of mire surface waters standardized to mean = 0 and variance = 1 that were used to calculate the first canonical correspondence analysis axis that maximizes the dispersion of species optima on a complex surface water chemistry gradient.

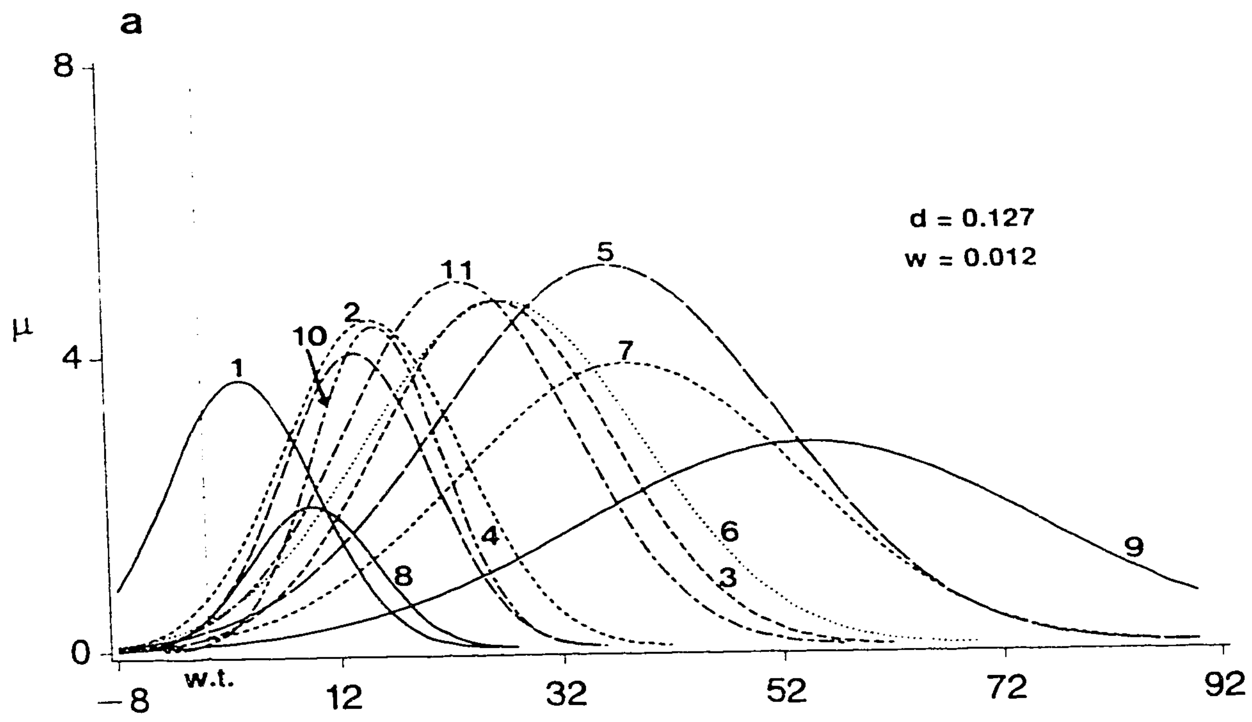
Figures III-5a) and b). Gaussian response curves for bryophyte species, fitted by log-linear regression of species abundance at each site on a synthetic climatic gradient (Xclm) divided into four climatic zones: a) *Sphagnum* species, μ = expected abundance. 1. = *S*. *lindbergii*, 2. = *S*. *papillosum*, 3. = *S*. *pacificum*, 4. = *S*. *rubellum*, 5. = *S*. *fuscum*, 6. = *S*. *magellanicum*, 7. = *S*. *austinii*, 8. = *S*. *tenellum*, 9. = *S*. *capillifolium*, 10. = *S*. *warnstorfii*, 11. = *S*. *angustifolium*. b) Non-*Sphagnum* species. 13. = *Tomenthypnum nitens*, 14. - *Pleurozium schreberi*, 15. = *Aulacomnium palustre*, 16. = *Hylocomium splendens*.

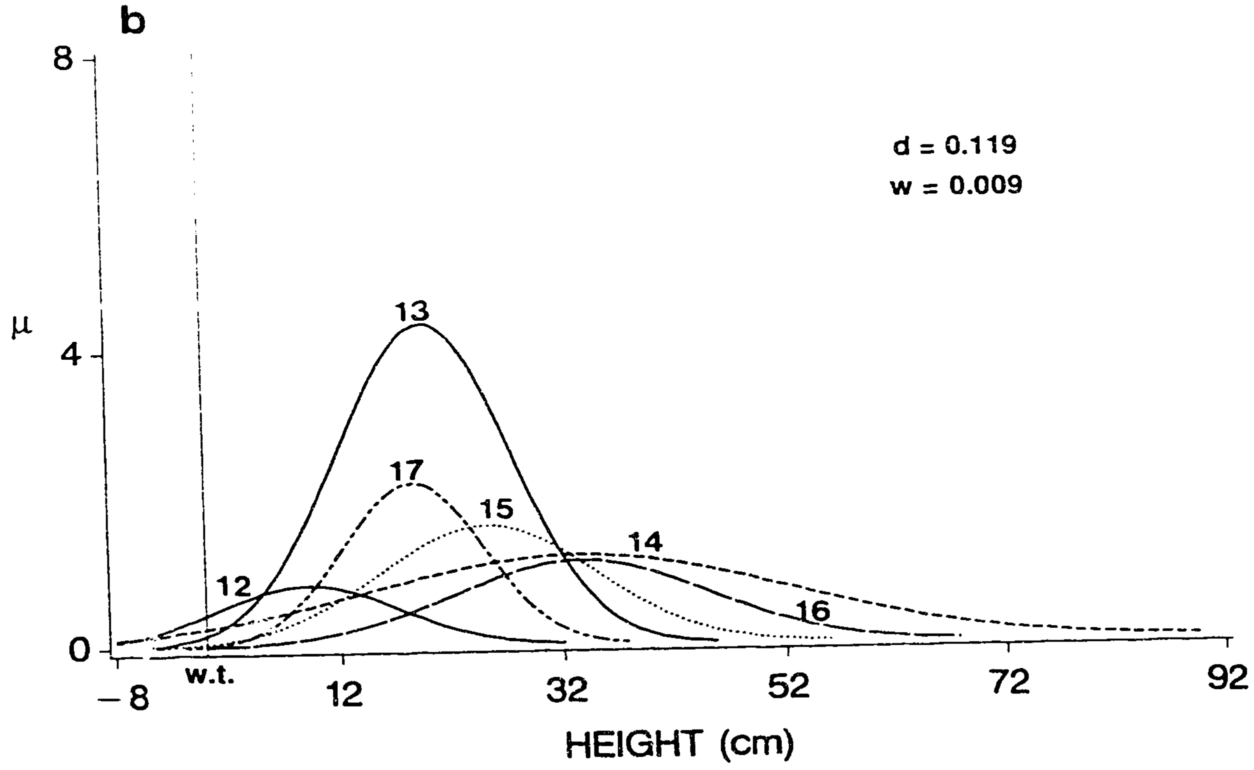

a
sub-
continental
sub-
oceanic
hyper-
oceanic
oceanic
8
4
0
μ
10
5
6
11
3
2
4
1
8
9
7
d = 0.338
w = 0.026
−150
−50
50
150
250
b
sub-
continental
sub-
oceanic
hyper-
oceanic
oceanic
8
4
0
μ
13
15
16
14
d = 0.294
w = 0.023
−150
−50
50
150
250
Xclm

Figures III-6a) and b). Gaussian response curves for bryophyte species fitted by log-linear regression of species abundances on a synthetic surface water chemistry gradient (Xche), μ = expected abundance. a) *Sphagnum* species, b) other bryophyte genera. See Figure III-5 for species names that are identified by the numbers. 12. = *Campylium stellatum*, 17. = *Paludella squarrosa*.

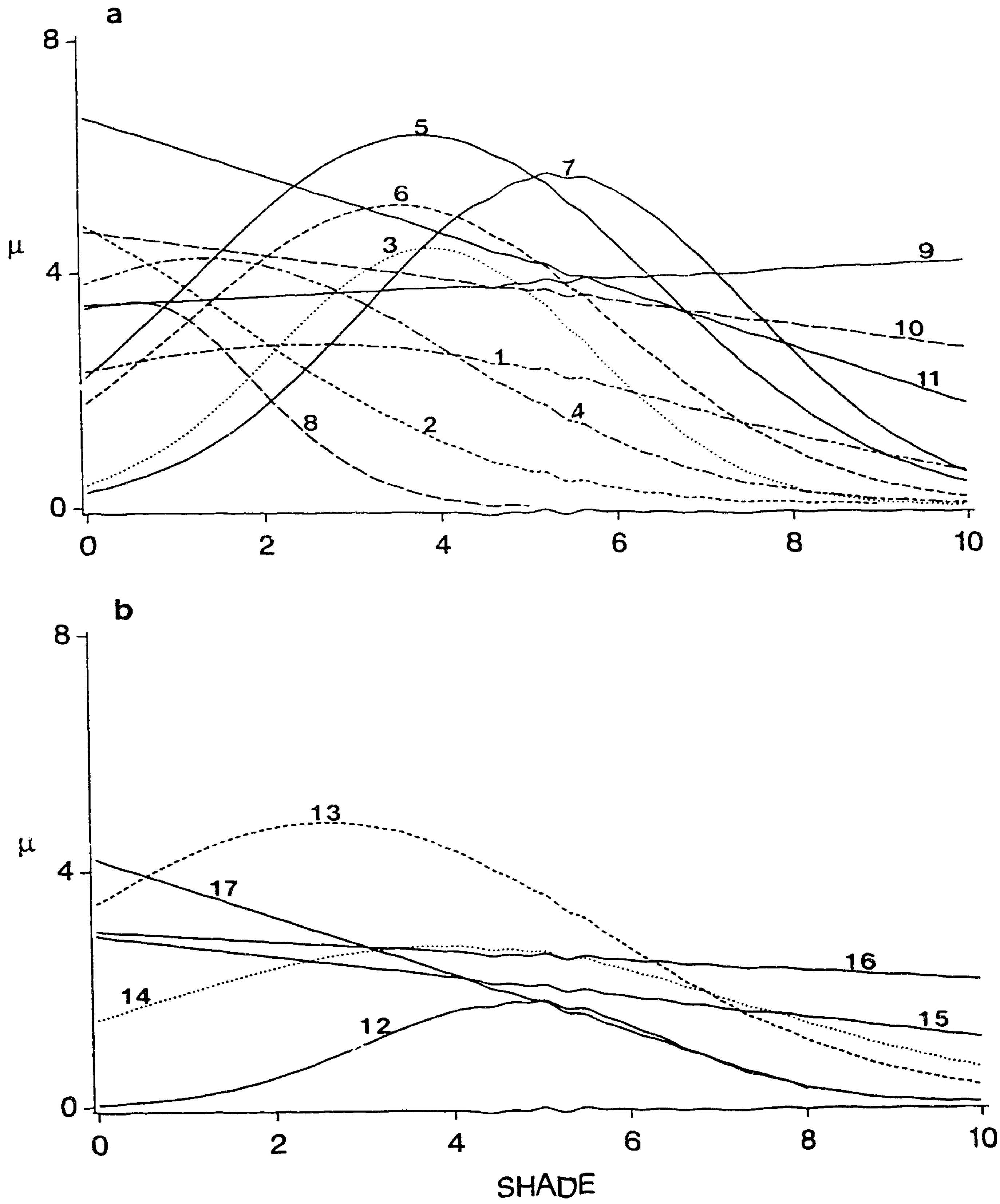
a
6
3
0
μ
Bog
Poor Fen
Rich Fen
1
2
3
4
5
6
7
8
9
10
11
d = 0.057
w = 0.071
−150
−50
50
150
250
350
450
b
6
3
0
μ
Bog
Poor Fen
Rich Fen
12
13
14
15
16
17
d = 0.070
w = 0.190
−150
−50
50
150
250
350
450
Xche

Figures III-7a) and b). Gaussian response curves for bryophyte species fitted by log-linear regression of species abundances on a topographic gradient measured as height relative to the water table (w.t.), μ = expected abundance, d = dispersion. a) Sphagnum species, b) other bryophyte genera. See Figure III-5 and III-6 for species names that are identified by the numbers.

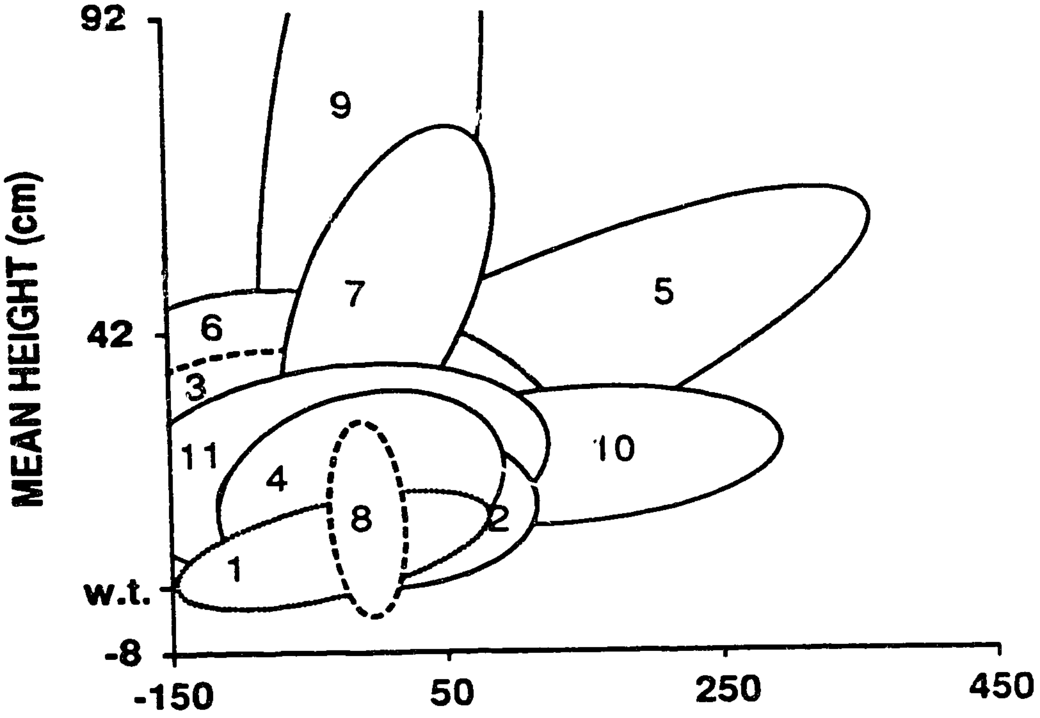

a
d = 0.127
w = 0.012
μ
8
4
0
−8
w.t.
12
32
52
72
92
1
2
3
4
5
6
7
8
9
10
11


b
d = 0.119
w = 0.009
μ
8
4
0
−8
w.t.
12
32
52
72
92
HEIGHT (cm)
12
13
14
15
16
17

Figures III-8a) and b). Gaussian response curves for bryophyte species on an overstory shade gradient, where 0 indicates the absence of shade and 10 indicates complete shade, μ = expected abundance. a) Sphagnum species, b) other bryophyte genera. See Figure III-5 and III-6 for species names that are identified by the numbers.


a
8
4
0
μ
0
2
4
6
8
10
1
2
3
4
5
6
7
8
9
10
11
b
8
4
0
μ
0
2
4
6
8
10
12
13
14
15
16
17
SHADE

Figures III-9a) and b). Bivariate Gaussian surfaces for bryophyte species on topographic and complex water chemistry gradients (Xche). w.t. = water table. a) *Sphagnum* species, b) other bryophyte genera. See Figure III-5 and III-6 for species names that are identified by the numbers.


92
42
w.t.
-8
MEAN HEIGHT (cm)
-150
50
250
450
1
2
3
4
5
6
7
8
9
10
11

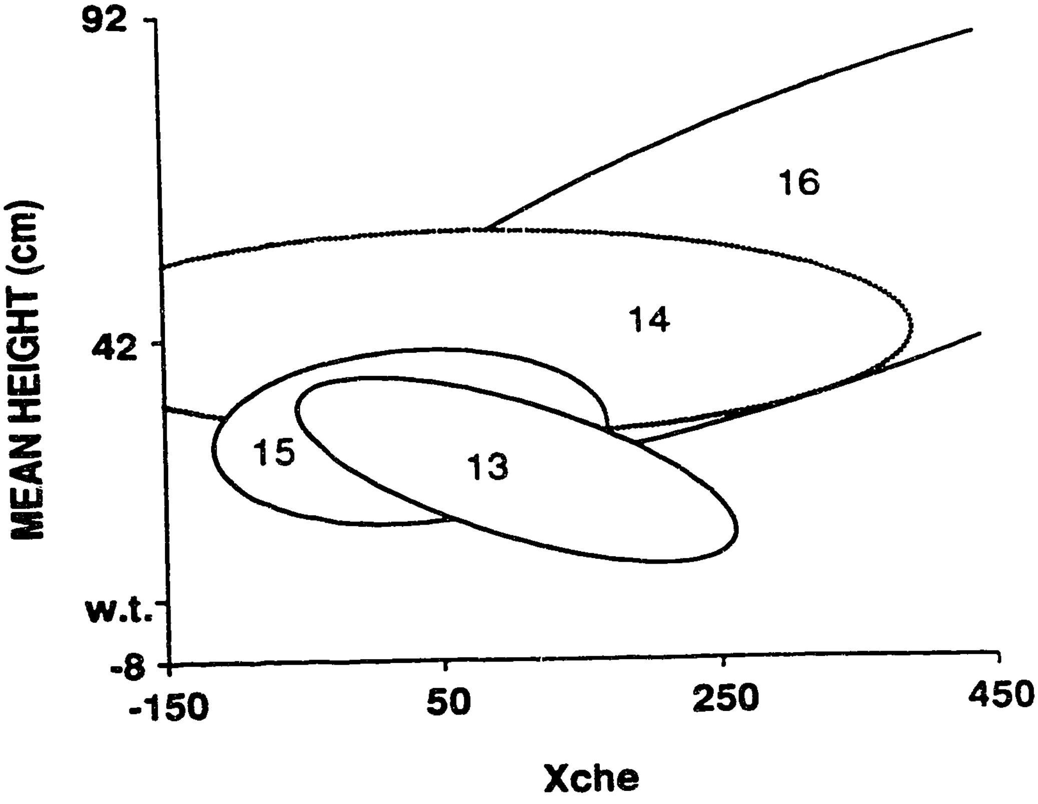

92
42
w.t.
-8
MEAN HEIGHT (cm)
-150
50
250
450
Xche
13
14
15
16

Figure III-10. Minimum mean monthly temperature of the coldest month for the 27 study sites on a synthetic climate gradient (xclm) divided into four climatic zones.

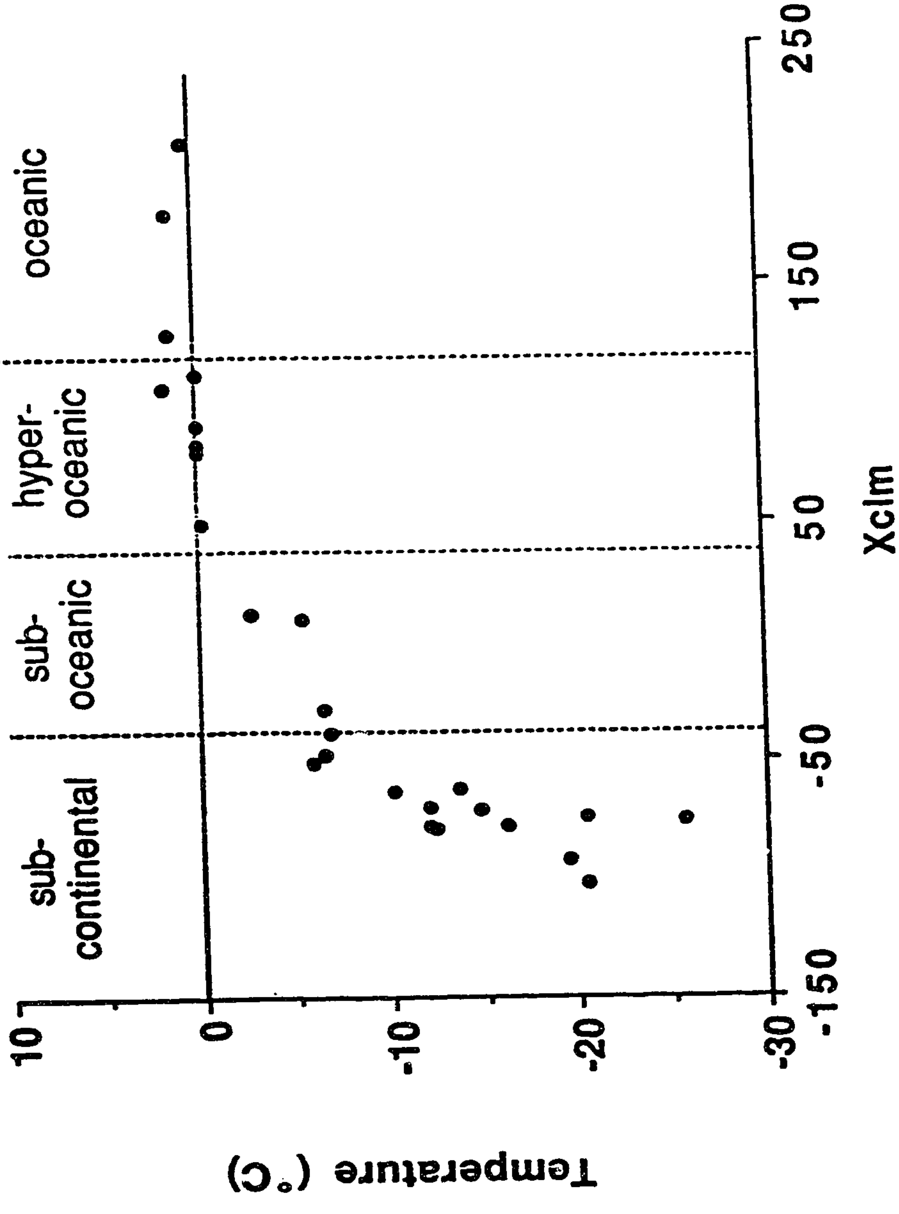

Temperature (°C)
10
0
-10
-20
-30
-150
-50
50
150
250
Xclm
sub-continental
sub-oceanic
hyper-oceanic
oceanic

Figure III-11. Distribution of *Sphagnum austinii*, *S*.*affine*, and *S*. *steerei* in North-America.


S. steerei
S. austinii
S. austinii
S. affine
NORTH AMERICA
0 200 400 600 800 1000 MILES
0 200 400 600 800 1000 KILOMETERS
LAMBERT AZIMUTHAL EQUAL AREA PROJECTION
120
110
100
90
80

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IV. Mineral content of mire surface waters and hummock-forming Sphagnum species in peatlands of western Canada[2]

Abstract

Concentrations of 6 elements (Ca, Mg, Na, K, Fe, S) were measured in surface cores of species of hummock growing Sphagnum, and in the water that accumulated below each core. Cores were taken from a wide variety of peatland types in four climatic zones in western Canada. Calcium, Mg, Fe, and Na concentrations in the cores increased or remained the same with increasing depth. Potassium and S concentrations decreased with depth. Only Ca and Mg levels in the surface waters are related to concentrations in the moss. Effects of Ca and Mg in the water on concentrations in the moss were greatest under conditions of moisture deficits that produced high evaporation rates. Maximum concentrations were related to the cation-exchange capacity for all species with the exception of Sphagnum angustifolium and S. austinii (S. imbricatum ssp. austinii)

Introduction

Many peatlands, particularly bogs and poor fens, have a rugged surface resulting from the presence of a large number of closely-spaced hummocks and hollows. Sphagnum species that form hummocks occupy different zones along the height gradient and each species zone often grades into those of adjacent species. The height zonation occupied by a species is a function of several morphological and physiological characters that include: 1) its ability to tolerate desiccation, 2) the rate of water loss from its hyaline cells, 3) its ability to photosynthesize under dry conditions, 4) the compactness and density of its growth form which allows water to move vertically through capillary spaces

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[2] A version of this chapter has been submitted for publication. Gignac, L.D. 1990. Lindbergia.

between its pendent branches, and 5) the number of binding sites on its cell walls (Rydin 1985, Rydin & McDonald 1985a,b, Wagner & Titus 1984, Titus & Wagner 1984, Titus et al. 1983, Hayward & Clymo 1983, Clymo & Hayward 1982, Vitt et al., 1975, Clymo 1973).

Mire surface water chemistry is a another gradient that limits Sphagnum distribution, abundance, and growth (Andrus 1986, Daniels & Eddy 1985, Karlin & Bliss 1984, Vitt & Slack 1984, Dierssen 1983, Clymo & Hayward 1982, Gauthier 1980, Horton et al. 1979, Moore & Bellamy 1974, Malmer 1962). Among the many variables that can be associated with surface water chemistry, pH, conductivity, and Ca concentrations have the greatest effect on Sphagnum distribution.

Peatland water chemistry, particularly pH, conductivity, and Ca and Mg concentrations, covers a wide gradient that depends on the source of water for the mire. The source of water for ombrotrophic mires (bogs) is entirely from precipitation resulting in low pH, conductivity, and Ca and Mg concentrations in the surface waters (Damman 1986, 1978, Sjörs 1963, 1952). In minerotrophic mires (fens), at least a portion of the water affecting the peatland has been in contact with the surrounding mineral soil (Sjörs 1963, 1952). The degree of minerotrophy of mire waters depends in part on the nature of the surrounding mineral soil. If the surrounding mineral soil is calcareous, the pH, conductivity, and Ca and Mg concentrations in the surface waters can be elevated compared to levels in bogs and poor fens and may produce rich fens (Sjörs 1952). The water in Sphagnum hummocks may have much lower pH, conductivity, and cation concentrations than the surrounding mire surface water that has circumneutral pH's (Karlin & Bliss 1984). Water within hummocks approach those of the surface water chemistry of bogs and thus hummocks are sometimes considered to be miniature ombrotrophic systems (Bellamy & Rieley 1967). As a result, the validity of using surface water chemistry parameters to define hummock forming Sphagnum species habitats or niche dimensions has been questionned (Andrus 1986, Karlin & Bliss 1984).

Results from other studies, however, suggest that mineral nutrients move vertically through the hummocks to the top of the Sphagnum moss (Damman 1986, 1978, Clymo 1982, Pakarinen 1978, 1977, Pakarinen & Tolonen 1977, Brehm 1971, Malmer 1962). Brehm (1971) demonstrated experimentally that in situations of high evapotranspiration and no precipitation, Na, K and Ca concentrations are greater in the apical portions of the plants, indicating that these elements moved upward in the capillary water. Damman (1986, 1978) and Pakarinen & Tolonen (1977), also found mineral nutrient enrichment in the apical portions of hummock forming Sphagnum plants and attributed this enrichment to the upward movement of elements in capillary water. None of these studies, however, has clearly demonstrated that the source of the elements is from the mire surface water. Damman (1986, 1978) suggested that these elements could come from the decomposition of Sphagnum and vascular plant, leaves, stems, and roots within the hummock. Pakarinen and Tolonen (1977) related the mineral nutrient content of Sphagnum to peatland water chemistry, but did not accurately account for effects of evaporation on the movement of the elements.

The objectives of this study are to determine: 1) the relationship between mineral nutrient concentrations in Sphagnum and the mineral content of mire waters from a broad spectrum of peatland types; 2) the effects of evaporation and height of the moss species above the water table on the relationship between mineral nutrient concentrations in the moss and in the mire waters; 3) the effects of surface water chemistry on the habitats of individual Sphagnum species.

Materials and Methods

Study sites

Surface cores were removed from 29 peatlands located along a transect from the Queen Charlotte Islands, British Columbia, to central Alberta (Table. IV-1). Mires were selected to cover the widest variety of peatland types and surface water chemistry gradients in the study area. Climate, geology and peatland types were previously described in Chapter II. The peatlands that were sampled were located within a 10 km radius of a weather station in mountainous areas and 50 km in more topographically homogenous areas. Two cores were taken for each Sphagnum species studied that was present on a site. Cores were collected in July and August 1985, 1986 and 1987.

Sampling Technique

Cores were cut from hummocks to a depth of 50 cm or to the water table, whichever came first, using a 17 cm diameter coring device. In this study, hummocks are defined as mounds or domes that project a minimum of 10 cm above the surface water, peat, or Sphagnum lawns or carpets. Hummock selection was based on the following criteria: 1) contained a relatively homogeneous area of at least one of the mosses studied, 2) were covered by few vascular plants, and 3) had moss capitula that were a minimum of 10 cm above the water table. Cores were placed in plastic bags, transported and stored upright to prevent contamination by water from the base of the core. Cores were frozen until they were analysed.

Samples were collected from the water that accumulated in the holes left by the corer. On hummocks where the cores did not reach the water table, the holes were dug deeper manually until water began flowing into the pit. Samples were collected in acid-washed (3% HCl) polyethylene bottles and refrigerated at 2°C until the analyses were performed.

Chemical Analyses

Conductivity and pH were measured in the field using a Radiometer conductivity meter and a Beckman portable pH meter. Conductivity was corrected to 20°C (Sjörs 1952). Samples were filtered through a Whatman #42 filter paper and acidified with 1 ml 4N HCl in 24 ml of water. Calcium, Mg, Na, K, Fe, and S concentrations in the water were measured on an inductively-coupled argon plasma spectrophotometer.

Between 12 and 15 cores were analysed for each *Sphagnum* species. Only species that form hummocks on several peatlands were selected for study. Cores were chosen to cover the widest possible range of elemental concentrations in the waters and the geographic range of each species. Only one core among those having approximately the same water chemistry and collected from sites having similar climates was analysed.

The *Sphagnum* species analysed in this study are: *S. angustifolium* Lindb., *S. pacificum* Flatb. (*S. fallax*), *S. rubellum* Wils. and *S. warnstorfii* Russ., *Sphagnum austinii* Sull. (*S. imbricatum* ssp austinii), *S. capillifolium* Hedw. (*S. nemoreum*), *S. fuscum* (Klingr.), *S. magellanicum* Brid., and *S. papillosum* Lindb. Nomenclature and authority names follow Flatberg (1989) for *S. pacificum*, Andrus (1987) for *S. austinii* and Ireland et al. (1987) for the remaining species. Voucher specimens are deposited at ALTA.

Individual moss stems were removed from the cores, cleaned but not washed of foreign particles and sectioned into capitulum and 5 cm stem increments to a maximum of 10 cm. The length of stem used in the analysis depended on the length of the shortest core for each species. Plant material was sectioned to a maximum of 5 cm for *S. angustifolium*, *S. pacificum*, *S.warnstorfii*, and *S. rubellum* that are found relatively close to the water table. The remaining species were sectioned to 10 cm lengths. Only unbroken stems having the required length were used in the analysis. Duplicates of the sectioned material of each species were analysed for total Ca, Mg, Na, K, Fe and S concentrations using a wet ashing method. Approximately 0.25g of oven-dried material (60-70°C) was digested in acid-washed (50% HNO_3) Kjeldahl flasks using 15 ml of concentrated HNO_3 and 3 ml of 60% $HClO_4$. The solution was evaporated until 1 or 2 ml remained. Two ml of concentrated HCl were added to the solution, heated for 15 minutes and filtered into 50 ml volumetric flasks using Whatman #42 filter paper. The sides of the flask were washed down with distilled deionized water into the flask then brought to volume with distilled deionized water. Total elemental concentrations were determined on an inductively coupled-Argon plasma spectrophotometer.

Climate Indices

Three climate indices were calculated from data obtained from the closest weather station to each site (Anonymous 1982 a, b, 1986). The indices are: 1) length of growing season (gs) calculated as the number of days with mean daily temperatures greater than 2°C; 2) precipitation (precip) which equals the total rainfall (mm) during the growing season; 3) water budget (H) calculated from the precipitation during the month prior to sampling (mm) and the monthly water need, which is based on the water vapour saturation pressure of the mean temperature for the month prior to sampling (Tuhkanen 1984, 1980, Malmström 1969). An H value of 1 indicates that precipitation balanced water loss through evapotranspiration. A value less than 1 indicates a water budget deficit. A period of one month was used to calculate H since it provides a long enough period of time for the plants to grow in response to the single water sample that was taken below each core. A longer period of time may introduce large scale seasonal variations in the water chemistry, thus increasing the error. A shorter period of time would not provide enough growth in response to the water chemistry.

Statistical Analyses

Regression analyses are used to determine relationships between mineral concentrations in surface waters (independant variable) and concentrations in Sphagnum (dependant variable). Results of regression analyses are stated as r^2 values which indicate the proportion of the variation in the data that is explained by the linear regression rather than error and the significance level for F tests that test the hypothesis that the coefficient of regression is not 0. Significance levels for Pearson correlation coefficients (r) are used to determine relationships between mineral concentrations, pH, and corrected conductivity levels in surface waters. Computations and correlation and regression analyses were performed on a personal computer using the Statistical Analysis System package (SAS).

Results

Climate

The climate in the study area can be divided into four zones, based on the length of the growing season and the total rainfall during the growing season: hyper-oceanic, oceanic, sub-oceanic, and sub-continental. Hyper-oceanic sites have growing seasons > 290 days and precipitation during the growing season > 2000 mm of rain (Table IV-1). Oceanic sites also have long growing seasons (> 300 days), but have lower precipitation values (between 1000 and 2000 mm of rain) than hyper-oceanic areas. Sub-oceanic sites have approximately the same amount of rainfall as oceanic sites, but their growing seasons are shorter (with approximately 250 days). Sub-continental sites have less than 600 mm of rain during the growing season and less than 225 days in the growing season.

Water budget deficits (H < 1.00) mostly occur in sub-continental and sub-oceanic zones (Table IV-1). Some sub-continental and sub-oceanic sites, however have small moisture surpluses. Extremely high deficits (H < 0.75) do not occur in the study area. Extremely high surpluses (H > 2.00) only occurred in hyper-oceanic areas.

Mineral content of mire waters and Sphagnum

Results of the water analyses for each sampling site are shown in Table IV-2. Results of chemical analyses of surface waters and Sphagnum material for individual hummocks can be found in Appendix 2. Mires in hyper-oceanic, oceanic, and sub-oceanic areas have relatively low Ca, pH, and conductivity values. In sub-continental areas, Ca, pH, and conductivity show large variations. Calcium values range from 0.55 to 193 mg/L, pH from 3.98 to 7.7, and conductivity from 44 to 690 µS. Based on criteria from Sjörs (1952), peatlands in hyper-oceanic, oceanic and sub-oceanic areas are either bogs or poor fens. In sub-continental areas, mires range from bogs to extreme rich fens.

Calcium, Mg, K, S, pH, and conductivity comprise a group of variables that are significantly correlated ($p < 0.05$) (Table IV-3). Sodium and iron form a second group that is not significantly correlated with elements of the first group with the exception of Ca.

Calcium, Mg, Na, K, Fe and S concentrations in the plant material are shown in Fig. IV-1. Two patterns of mineral accumulation in the different moss sections are visible: 1) concentrations slightly increase or remain the same with depth (Ca, Na, Fe); 2) concentrations decrease with depth (K, S).

Relationships between moss chemistry and water chemistry

Results from regression analyses of elemental concentrations in the moss sections and levels in mire waters are shown in Table IV-4. Elemental concentrations in the surface waters [illegible] significantly related to concentrations in at least one section of the moss plants for each element. However, r^2 values are extremely low for all elements with the exceptions of Ca and Mg. These results suggest that surface water chemistry has an effect on Ca and Mg concentrations in hummock-forming Sphagnum species.

Effects of climate

For samples taken from hummocks higher than 15 cm above the water table, effects of Ca concentrations in the surface waters on concentrations in the moss is minimal under conditions of high moisture surpluses ($H > 1.5$) (Fig. IV-2). Under conditions of low moisture surpluses ($1.5 < H > 1.0$), the relationship between Ca concentrations in water and moss is not significant ($p > 0.05$) but is marginally higher than under conditions of high moisture surpluses. Effects of Ca in the surface water on concentrations in the moss are greatest under conditions of moisture deficits ($H < 1.0$).

The relationship between Mg concentrations in surface waters and concentrations in the moss sections obtained from smaller hummocks are significant only under conditions of high moisture surpluses (Fig. IV-3). Results for Mg are similar to those observed for Ca concentrations under those conditions (Fig. IV-2). For taller hummocks under humid conditions ($H > 1.0$), the relationship between Mg levels in water and moss is not significant ($p < 0.05$). Under conditions of low moisture surpluses and moisture deficits, the relationships between Mg concentrations in moss and water parallel those observed for Ca. Effects of Ca are more pronounced than those of Mg and probably result from tenfold greater Ca than Mg concentrations in surface waters.

Discussion

Patterns of elemental accumulations in hummocks are thought to reflect the location of each element relative to the cell walls of the Sphagnum species that form the hummocks (Damman 1986, 1978, Clymo 1982, Pakarinen & Tolonen 1977, Brehm 1971, 1968). Elements that increase or have constant concentrations with depth are thought to bind to the exterior of the dead hyaline "cells" on cation-exchange sites. The principal cation-exchangers in Sphagna are polygalcturonic acids (PGA) that exchange hydrogen ions for mineral cations (Richter & Dainty 1989, Spearing 1972, Clymo 1967, 1963, Craigie and Maass 1966). Elements that decrease with depth are thought to be actively taken up by the living cells that are largely surrounded by hyaline cells, rather than bound to the exterior of the walls.

Calcium and Fe are normally bound to the cell walls of dead hyaline cells and are not easily dislodged (Damman 1986, 1978, Clymo 1982, Pakarinen 1978). Sodium concentrations also increase with depth possibly indicating that most of the Na cations retained by the plants are bound to the cell walls. This element, however, can be relatively easily displaced by divalent and trivalent cations and is often leached from the hummocks (Damman 1978, Clymo 1963).

Potassium which shows a decrease in concentration with depth is actively taken up by the living chlorophyllous cells. Sphagnum grows vertically and thus the age of the moss increases with depth. When the cells die or become inactive, usually between 2 and 5 cm below the capitulum (Gignac 1987, Pakarinen 1978), cations are released or leached from the cells and become mobile. The cations are thought to move vertically along with capillary water to the capitulum. Cells in the capitulum have high demands that exceed inputs of these cations either from the surface water or from precipitation Cations that are relocated from the lower portions of the stem are rapidly taken up by the cells giving rise to high concentrations in the top sections of the plants and relatively low concentrations below. Sodium is also taken up by the living cells, however, quantities are low when compared to the amounts of K. Results from this study indicate that S concentrations increase with deph and suggest that most of the S accumulates in living cells, is not bound to the surface of dead hyaline cells and is recycled within hummocks.

Concentrations of Ca, Mg and Fe in hummock-forming Sphagna have been shown to be correlated with levels in mire waters (Aulio 1982, Pakarinen & Tolonen 1977). Of those three elements, only Fe has extremely low r^2 values for the relationship between concentrations in the mire waters and concentrations in the moss (Table IV-4).

Iron concentrations are extremely variable and usually reflect fluctuations in the water level. Water level fluctuations affect the redox potential of the substrate, which determines the solubility of Fe (Damman 1978). The variation in Fe solubility affects concentrations in the water, transport of the element in capillary water, and ultimately concentrations in the plants, particularly the lowest sections (Aulio 1982).

Surface waters have little effect on accumulation in Sphagnum of such elements as Na, K, and S that are actively taken up by living cells and released by dead chlorophyllous cells (Table IV-4). Results from other studies suggested that reactions involving uptake and release of Na and K by Sphagnum cells are independant of concentrations in surface waters (Aulio 1982, Pakarinen and Tolonen 1977). Two hypotheses are put forth to explain the lack of significant relationships for Na and K and the significant relationships for Ca, Mg, and Fe: 1) both Na and K are not tightly bound to hyaline cells and are easily displaced by such bivalent and trivalent cations as Ca, Mg, and Fe; 2) both Na and K are relatively easily leached from dead chlorophyllous cells and from hummocks by rain while such elements as Ca, Mg, and Fe are not (Damman 1986, 1978, Crum 1983, Pakarinen and Tolonen 1977).

Overall water movement in hummocks on sites with water surpluses ($H > 1.0$) is downward, since precipitation largely exceeds evaporation. Under those humid conditions, rainwater percolating downward provides an alternative source of ions, reducing the effects of surface water on mineral concentrations in the moss (Damman 1986). Under conditions of low precipitation and high evaporation ($H < 1.0$), Ca moves upward by capillary flow and has an effect on Ca concentrations in the plants. Under intermediate conditions where evaporation roughly matches precipitation, water can move both upward and downward, producing intermediate but still important effects on Ca concentrations on moss plants. Effects of surface water on concentrations in mosses occupying the taller hummocks is thus a function of evaporation at the surface of the hummocks.

Brehm (1971) demonstrated experimentally that Ca concentrations in the capitula of mosses increased with increasing evaporation. Other studies also indicate that Ca moves upward through hummocks, but suggest that hummock tops are isolated from the surface water (Karlin & Bliss 1984, Bellamy & Rieley 1967). Karlin and Bliss (1984) hypothesized that peat concentrations within hummocks removed Ca from capillary water as it moved upward. Elements in the water were thought to be exchanged for H^+ ions by unused binding sites present in the peat, reducing the pH and elemental concentrations in the water. The pH and elemental content of the capillary water when it reached the top of a hummock would thus be very low and would bear little relationship with concentrations in the surface water. Surface water chemistry would thus have little effect on the apical growth of the mosses.

Results from this study, however, indicate that Ca concentrations in the Sphagnum capitula at the tops of the tallest hummocks are affected by concentrations in the surface water particularly, in mires with high Ca levels and moisture deficits for relatively long periods of time. Those conditions are common in sub-continental mires and occasionally occur in sub-oceanic areas (Table IV-1). It would appear that such species as S. fuscum, S.magellanicum, S. capillifolium and S. papillosum that are found on the taller hummocks on those mires are not isolated from the surface water.

Species found on smaller hummocks (height < 15 cm above the water table) are never isolated from Ca concentrations in the surface water even under conditions of high moisture surpluses (Fig. IV-2). Under less humid conditions, effects of surface water on Ca concentrations in the plants are similar to those for taller hummocks. The upward movement of Ca through capillary water affects concentrations in hummock-forming species independently of the height of the hummock under conditions of low moisture surpluses and deficits.

Calcium concentrations in both taller and shorter hummocks are generally higher in the lower sections of the cores than those in the capitula. In small hummocks, this may simply indicate that the lower sections are more often submerged than the capitula at the surface of the hummocks. In taller hummocks, concentration increases with depth are similar to those observed by Karlin and Bliss (1984) and may indicate that the lower sections remove Ca from the capillary water as it moves upward.

Effects on species niche dimensions

Monthly moisture deficits occur in all climatic zones, but are rare in hyper-oceanic areas (Table IV-1). Since surface water affects Ca concentrations in Sphagna under conditions of moisture deficits, Ca levels in the surface water may affect the distribution and niche dimensions of all species with the possible exception of *S. austinii*. *Sphagnum austinii* is the only species among those studied that is found on taller hummocks and is restricted to areas that have high moisture surpluses (Chapter III). Under those conditions, surface water has little effect on Ca concentrations in mosses (Fig. IV-2). The remaining species are either found in areas where moisture deficits are relatively common or form smaller hummocks that are never completely isolated from the surface water.

Species occupy a wide range of niche dimensions on a Ca in surface water gradient (Fig. IV-4). Among the species studied, oceanic species have the narrowest niches on the Ca gradient. Niches of *S. rubellum* and *S. papillosum* appear to be truncated since they extend to the maximum Ca values measured in oceanic habitats. If Ca concentrations in mire waters reached higher levels in oceanic habitats, it is likely that niches of these species would also extend to higher levels. It would appear that the upper niche limits of *S. rubellum* and *S. papillosum* have not been determined in this study and niches of both species are not limited by the Ca gradient. Niches of the remaining oceanic species S. austinii and S. pacificum do not extend to the maximum Ca concentration measured in oceanic areas and niches of those species are limited along the Ca gradient. The same also applies to widespread and sub-continental species because the Ca in the surface water gradient extends beyond their upper niche limits.

High Ca concentrations combined with high pH values are lethal to Sphagna (Clymo 1973). Calcium concentrations in mire surface waters are highly positively correlated ($p < 0.001$) with pH values (Table IV-3). Surface waters having high Ca concentrations that move upward through hummocks as a result of moisture deficits should also have high pH levels. However, if Ca concentrations at high pH are to limit on the distribution of hummock-forming Sphagna effectively, surface waters must reach the capitula of the apically growing moss. Calcium and Mg ions that reach the capitulum are normally exchanged for H^+ ions by PGA at the surface of the hyaline cells, thus lowering the pH of the ambiant water (Killam 1982) and reducing the lethal effects of the surface water. Calcium will only become lethal if most of the cation-exchange sites become base saturated and the plants are incapable of reducing the pH. Thus, niche dimensions of Sphagnum on the Ca in surface water gradient should in some way reflect the cation-exchange capacity of each species.

Results from studies that examined the cation-exchange capacity can be used to rank the species examined in this study according to their cation-exchange capacity (Spearing 1972, Craigie & Maass 1966, Clymo 1963). Species are ranked as follows: S. fuscum > S. rubellum > S. capillifolium (S. nemoreum) > S. magellanicum > S. papillosum > S. austinii (S. imbricatum) > S. angustifolium > S. pacificum (S. fallax). There is no data available for S. warnstorfii. With the exception of S. rubellum and S. papillosum, species are ranked in the following order, according to their upper limits on the Ca in surface water gradients: S. warnstorfii > S. fuscum > S. capillifolium > S.

angustifolium > *S. magellanicum* > *S. austinii* > *S. pacificum* (Fig. IV-4). With the exception of *S. angustifolium*, both rankings are identical and suggest that the cation-exchange capacity is a factor in determining the upper limits of species niche dimensions. Those upper limits are only reached in sub-continental moderate rich fens. *Sphagnum rubellum* and *S. papillosum* were not included because their upper niche limits cannot be determined from the results of this study.

The maximum Ca concentrations in the moss capitula should also reflect both the species upper niche limits on the Ca gradient and the species cation-exchange capacity. Maximum concentrations in each *Sphagnum* species are ranked as follows: *S. angustifolium* > *S. warnstorfii* > *S. fuscum* > *S. capillifolium* > *S. magellanicum* > *S. pacificum* > *S. austinii* (Fig. IV-4.). With the exceptions of *S. angustifolium* and *S. austinii* rankings for upper niche limits, cation-exchange capacity, and maximum Ca concentrations are identical. Those results suggest, that with the exceptions of *S. angustifolium* and *S. austinii*, upper niche limits hummock-forming *Sphagnum* species on the Ca in surface water gradient is a function of concentrations in the capitula and base saturation which are determined by the cation-exchange capacity of the moss.

Results from this study show that *S. angustifolium* contains higher Ca concentrations in the capitulum than any of the other species studied. The cation-exchange capacity of *S. angustifolium* is close to that of *S. pacificum* (*S. fallax*) (Spearing 1974), but it has almost twice as much Ca in the capitulum than *S. pacificum* (Fig. IV-4). Perhaps *S. angustifolium* has evolved other mechanisms that permit it to withstand high Ca concentrations in the capitulum and thus reduce the effects of Ca on its niche dimensions. Vitt and Slack (1984) also demonstrated that surface water chemistry was not an important factor limiting the niche of *S. angustifolium*.

Sphagnum austinii has the lowest amounts of Ca in the capitulum than all of the species. Although Ca concentrations in the surface waters within its geographic range may reach 60 mg/L, it is resticted to waters having less than 5 mg/L (Fig. IV-4). In Chapter III it was hypothesized that this species is limited by the temperature to hyper-oceanic and oceanic areas that have mean minimum monthly temperatures above 0 °C. Results from this study suggest an alternative hypothesis. Sphagnum austinii may be very sensitive to Ca concentrations in the capitulum and cannot tolerate increased inputs from the surface water through capillary water resulting from moisture deficits. As a result of this, S. austinii is restricted to hyper-oceanic and oceanic peatlands where precipitation usually exceeds evaporation and there is relatively little upward movement of Ca compared to sub-oceanic and sub-continental mires. Sphagnum austinii is also limited to peatlands that have low Ca concentrations in surface waters by periods of moisture deficits that occasionally occur in hyper-oceanic and oceanic areas (Table IV-1).

Measurements of Ca levels in mire waters can be used to define hummock Sphagnum species niche dimensions. Corrected conductivity and pH levels in mire surface waters could also be used to quantify Sphagnum niches since these measurements are highly correlated with Ca concentrations. However, to determine species upper niche limits along the water chemistry gradient, measurements should be taken only in areas where monthly moisture deficits occur, since it is in those areas that Ca levels in the surface water have an effect on concentrations in the capitulum.

Further analyses by means of controlled experiments using radioactive tracers could be used to determine the effects of concentrations in surface water and evaporation rates on concentrations in several Sphagnum species. Results from this study indicate that such experiments could be useful in quantifying the source of various elements in hummock-forming species. Further experimentation would also be useful in determining the cation-exchange capacity, and maximum Ca concentrations in the moss capitula and relating those results to the upper niche dimensions of each species on a water chemistry gradient..

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Table IV-1. Location of the 28 sampling sites, the nearest weather station, sampling date (month / year) and species that were sampled at each site. (2) indicates that a species was sampled twice on a site. H = water budget for the month prior to sampling. prec = mean annual rainfall (mm). gs = growing season (days). pap = *Sphagnum papillosum*, pac = *S. pacificum*, aus = *S. austinii*, rub = *S. rubellum*, mag = *S. magellanicum*, cap = *S. capillifolium*, fus = *S. fuscum*, war = *S. warnstorfii*, ang = *S. angustifolium*.

Site	Location		Weather Station	date	H	prec	gs	species
1	53°21'N	132°15'W	Sandspit BC	7/87	1.12	1200	342	pap, pac
2	53°55'N	132°06'W	Masset BC	7/87	1.41	1353	344	aus(2), rub, pac
3	53°38'N	132°06'W	Port Clements BC	7/87	0.87	1347	313	aus(2)
4	53°38'N	132°03'W	Sewall Masset Inlet BC	7/87	1.41	1206	318	aus, rub, pap, pac
5	53°36'N	131°58'W	Tlell BC	7/87	1.30	1091	360	aus
6	54°17'N	130°21'W	Prince Rupert BC	7/86	2.38	2335	346	aus, rub
				7/87	0.87			aus, pac
7	54°14'N	130°16'W	Prince Rupert (airport)	7/85	2.22	2369	297	mag
				7/86	1.56			rub(2)
				7/87	0.85			aus(2), pac
8	54°18'N	130°15'W	Prince Rupert (Shawat.)	7/85	2.37	2958	346	pap, cap
				7/86	2.64			aus
9	54°16'N	130°15'W	Prince Rupert (park)	7/86	2.51	2335	346	rub, pap(2), mag
				7/87	0.89			cap(2), fus(2), pac(2)
10	54°14'N	130°09'W	Prince Rupert (mont)	7/86	2.51	2847	322	aus
				7/87	0.89			rub
11	54°14'N	129°51'W	Falls River BC	7/87	2.12	3359	297	rub(2), pap(2), mag, pac

12	52°23'N	126°24'W	Bella Coola BC	8/87	0.23	1424	268	war
13	55°06'N	128°40'W	Kitimat BC	7/86	1.11	1753	242	pap(2), mag, fus, ang
14	54°08'N	128°40'W	Terrace (airport) BC	7/86	1.09	946	232	mb(2), pap(2), fus, pac(2)
15	54°24'N	128°40'W	Terrace	7/86	0.89	934	240	cap(2), pac
16	54°38'N	128°[illegible]8'W	Rosswood BC	7/86	1.56	815	240	mag, cap(2), fus
17	55°14'N	127°39'W	Hazelton BC	7/86	1.07	395	225	mag(2), fus(2)
18	54°44'N	126°13'W	Topley Landing BC	7/86	1.20	286	196	war(2), fus(2)
19	54°24'N	122°[illegible]2'W	Fort St-James BC	7/86	0.66	290	216	fus
20	53°53'N	121°[illegible]'W	Prince George BC	7/86	0.94	410	204	mag, ang(2)
21	53°42'N	121°06'W	Dome Creek BC	7/86	1.96	530	222	mag, ang, pac
22	53°10'N	119°53'W	McBride BC	8/86	1.60	407	213	fus
23	52°55'N	118°49'W	Mount Robson BC	8/86	1.36	530	201	war(2), fus, ang(2)
24	53°32'N	117°58'W	Moberley AB	8/86	0.69	346	198	mag(2), war(2), fus, ang
25	53°27'N	116°37'W	Robb AB	8/86	0.37	416	189	cap(2), war(2)fus, ang
26	53°25'N	114°54'W	Glenevis AB	9/86	0.30	389	161	mag, ang
27	53°36'N	114°10'W	Stony Plain AB	9/86	0.40	391	198	war(2)
				7/87	0.84			war
28	55°54'N	112°01'W	Algar AB	9/86	0.50	361	190	cap(2), ang(2)

Table IV-2. Concentrations (mg L^{-1}) ± s.d. of 6 elements, pH, and corrected conductivity (k_{corr}) (μS) in waters collected from 28 peatlands in western Canada. Lines within the table separate sites having different climates as follows: 1 = hyper-oceanic; 2 = oceanic; 3 = sub-oceanic; 4 = sub-continental.

Site	Climate	Ca	Mg	Na	K	Fe	S	pH	k_{corr}	n
1	2	0.70 ± 0.30	0.38 ± 0.22	3.19 ± 0.53	0.49 ± 0.24	6.89 ± 1.26	0.31 ± 0.09	4.52 ± 0.05	7.6 ± 1.7	2
2	2	0.69 ± 0.46	0.91 ± 0.20	6.51 ± 0.55	1.57 ± 0.68	5.16 ± 3.22	0.54 ± 0.20	4.33 ± 0.10	63.6 ± 59.8	4
3	2	1.03 ± 0.37	0.82 ± 0.14	10.84 ± 1.07	1.68 ± 0.64	1.51 ± 1.37	0.82 ± 0.07	4.33 ± 0.13	16.1 ± 1.20	2
4	2	0.85 ± 0.72	0.69 ± 0.29	7.56 ± 0.49	0.39 ± 0.28	2.21 ± 3.38	0.63 ± 0.23	4.77 ± 1.59	16.1 ± 5.30	4
5	2	0.59	0.86	12.61	2.07	2.48	0.77	4.42	18.6	1
6	1	0.96 ± 1.69	0.17 ± 0.24	2.55 ± 2.05	0.95 ± 1.81	1.50 ± 1.52	0.03 ± 0.03	4.09 ± 0.05	22.2 ± 0.1	4
7	1	0.86 ± 1.49	0.15 ± 0.22	2.39 ± 1.65	0.69 ± 1.81	0.63 ± 0.45	0.46 ± 0.15	4.00 ± 0.20	32.2 ± 4.3	6
8	1	2.36 ± 3.71	0.36 ± 0.35	4.97 ± 5.96	2.43 ± 3.52	0.25 ± o.27	0.92 ± 0.58	3.90 ± 0.00	44.1 ± 16.8	3
9	1	2.57 ± 2.32	0.42 ± 0.23	3.35 ± 1.72	0.68 ± 0.25	0.57 ± 0.35	1.26 ± 0.77	4.62 ± 1.16	39.0 ± 11.9	10
10	1	0.36 ± 0.29	0.10 ± 0.11	2.68 ± 2.11	0.44 ± 0.31	3.73 ± 0.01	0.33 ± 0.00	4.34 ± 0.64	39.0 ± 24.0	2
11	1	0.27 ± 0.12	0.10 ± 0.09	0.51 ± 0.38	0.75 ± 0.65	0.20 ± 0.07	0.12 ± 0.03	4.24 ± 0.21	18.0 ± 3.5	6
12	3	2.49	0.25	3.88	1.70	3.69	0.32	4.89	57.6	1

13	3	0.98 ± 0.96	0.26 ± 0.17	2.82 ± 3.11	5.66 ± 8.92	1.69 ± 1.82	0.28 ± 0.18	5.26 ± 0.34	37.8 ± 30.2	5
14	3	0.31 ± 0.32	0.14 ± 0.13	1.64 ± 0.52	3.07 ± 4.72	1.96 ± 1.95	0.39 ± 0.09	4.68 ± 0.47	31.2 ± 19.0	7
15	3	0.07 ± 0.05	0.06 ± 0.04	0.82 ± 0.11	5.49 ± 8.66	2.81 ± 1.58	0.09 ± 0.10	4.00 ± 0.10	40.7 ± 16.7	3
16	3	0.57 ± 0.07	0.02 ± 0.00	1.32 ± 0.31	0.18 ± 0.10	1.34 ± 0.40	0.07 ± 0.10	4.55 ± 0.10	28.8 ± 2.0	4
17	4	5.34 ± 1.69	0.60 ± 0.72	3.45 ± 0.77	3.40 ± 1.96	7.12 ± 1.26	0.42 ± 0.18	3.98 ± 0.14	83.1 ± 12.3	4
18	4	108.12 ± 62.26	14.16 ± 6.44	19.49 ± 1.06	40.44 ± 66.28	16.41 ± 8.95	0.78 ± 0.55	6.78 ± 0.05	458.5 ± 53.6	4
19	4	50.10	22.57	4.35	3.85	0.19	7.23	7.3	352.5	1
20	4	0.55 ± 0.28	0.02 ± 0.00	0.40 ± 0.61	2.77 ± 3.47	9.63 ± 4.39	0.02 ± 0.00	4.08 ± 0.08	44.1 ± 13.2	3
21	4	1.89 ± 0.46	1.00 ± 0.19	0.70 ± 0.05	0.98 ± 0.67	0.66 ± 0.15	0.12 ± 0.04	5.00 ± 0.45	49.7 ± 4.89	3
22	4	95.21	12.68	4.47	2.97	0.19	1.58	7.19	584.0	1
23	4	74.9 ± 19.12	15.25 ± 1.93	2.55 ± 0.91	1.10 ± 0.66	0.13 ± 0.20	2.26 ± 0.78	7.21 ± 0.08	341.7 ± 62.5	5
24	4	49.24 ± 17.99	13.01 ± 3.61	17.54 ± 6.30	1.51 ± 0.62	0.16 ± 0.16	0.09 ± 0.05	6.83 ± 0.25	257.1 ± 70.4	6
25	4	124.54 ± 28.11	21.87 ± 3.54	4.63 ± 0.54	5.07 ± 2.37	0.35 ± 0.18	0.75 ± 0.57	7.03 ± 0.19	659.3 ± 103.5	6
26	4	11.60 ± 1.37	3.05 ± 0.28	3.98 ± 1.09	1.41 ± 0.47	0.40 ± 0.14	0.76 ± 0.12	5.06 ± 0.00	83.1 ± 0.00	2
27	4	192.48 ± 23.58	63.13 ± 3.16	23.21 ± 2.80	5.14 ± 1.18	1.82 ± 0.92	134.50 ± 24.21	7.70±0.50	690.2±121.3	3
28	4	1.23 ± 0.66	0.58 ± 0.31	1.51 ± 0.56	2.69 ± 0.28	2.21 ± 3.38	0.63 ± 0.23	4.77 ± 1.59	16.1± 5.4	4

Table IV-3. Pearson correlation coefficients for important elements, pH, and corrected conductivity (k_{corr}) of waters collected from 28 peatlands in western Canada. n = 108. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	Ca	Mg	Na	K	Fe	S	pH
Ca	1.00						
Mg	0.55 ***	1.00					
Na	-0.26 **	0.07	1.00				
K	0.34 **	0.32 **	-0.01	1.00			
Fe	0.28 **	0.13	-0.13	-0.01	1.00		
S	0.50 ***	0.11	0.07	0.42 **	0.07	1.00	
pH	0.71 ***	0.38 ***	-0.09	0.34 **	0.09	0.52 ***	1.00
k_{corr}	0.63 ***	0.26 **	-0.22 *	0.18 *	0.17	0.39 **	0.82 ***

Table IV-4. R^2 values and significance levels for F tests resulting from regression analyses of elemental content in three sections of *Sphagnum* cores (dependant variable) removed from 28 peatlands in western Canada and levels in mire waters (independant variable) collected below each core. 0 - 5 = top 5 cm of stem excluding the capitulum. 5 - 10 = length of stem between 5 and 10 cm below the capitulum. n = number of samples. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Section	Mineral nutrient						
	Ca	Mg	Na	K	Fe	S	n
capitulum	0.41***	0.17***	0.01	0.01	0.01	0.01	115
0 - 5	0.46***	0.25***	0.00	0.04**	0.00	0.05**	115
5 - 10	0.39***	0.23***	0.01	0.06**	0.01	0.07**	67

Figure IV-1. Total concentrations of Ca, Mg, Na, K, Fe, and S. (millimoles/kg dry weight) ± standard deviation in 9 hummock-forming Sphagnum species in western Canada. Plants were sectioned into capitulum, the uppermost 5 cm of stem (0-5) and for species forming hummocks greater than 15 cm above the water table, the next 5 cm of stem (5-10). Species abbreviations: S. pacificum = pc, S. rubellum = r, S. angustifolium = an, S. warnstorfii = w, S. austinii, = au, S. papillosum = pa, S. capillifolium = c, S. magellanicum = m, and S. fuscum = f.

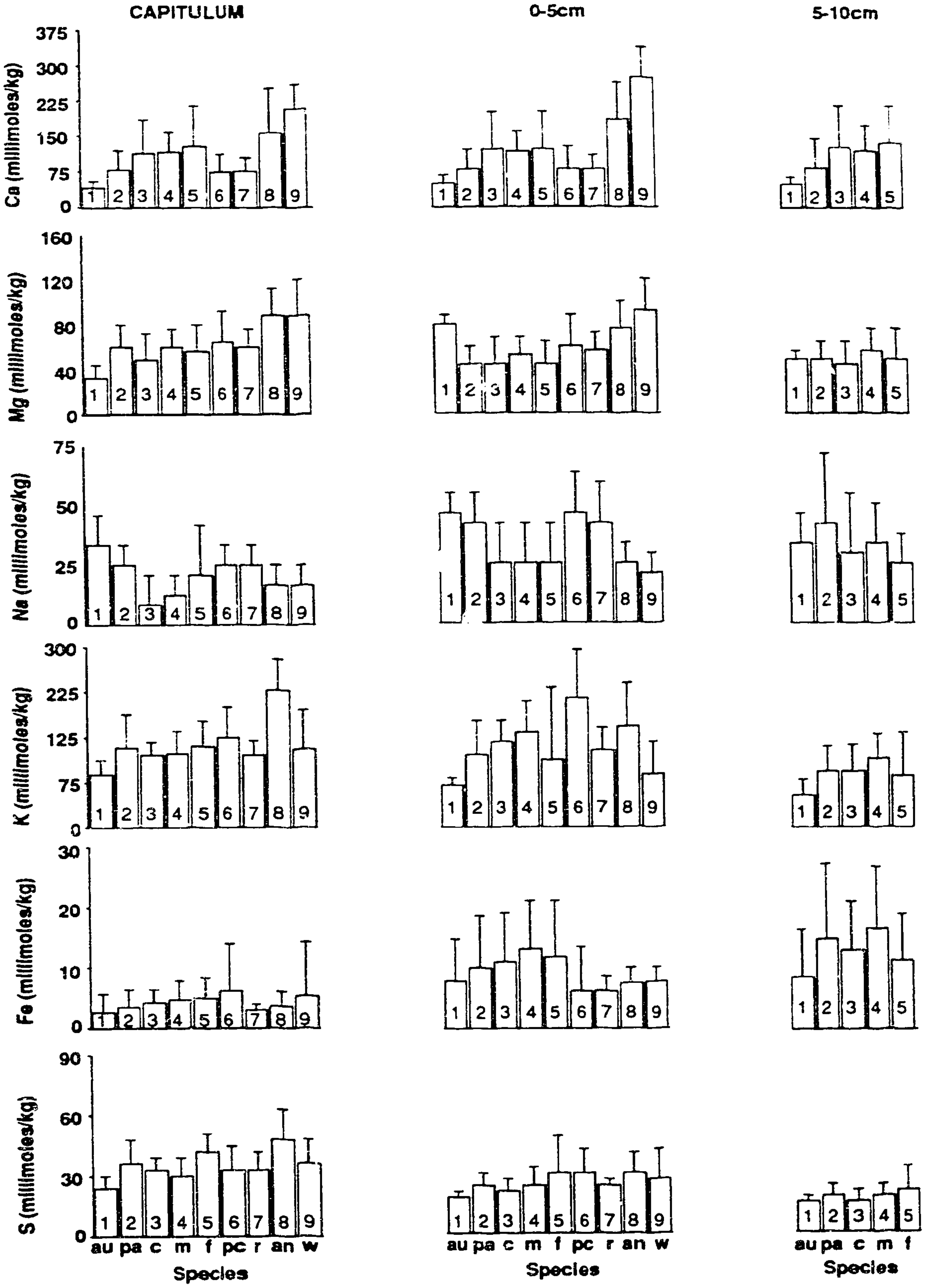

CAPITULUM
0-5cm
5-10cm
Ca (millimoles/kg)
375
300
225
150
75
0
Mg (millimoles/kg)
160
120
80
40
0
Na (millimoles/kg)
75
50
25
0
K (millimoles/kg)
300
225
125
75
0
Fe (millimoles/kg)
30
20
10
0
S (millimoles/kg)
90
60
30
0
1 2 3 4 5 6 7 8 9
au pa c m f pc r an w
Species
au pa c m f pc r an w
Species
au pa c m f
Species

Figure IV-2. Regression analyses for the relationships between Ca concentrations in mire surface waters and concentrations in two groups of Sphagnum species under three moisture regimes in western Canada. Species groups (a) and (b): species forming hummocks less than 15 cm and greater than 15 cm above the water table respectively. capitulum =cap ●——— , the uppermost 5 cm of stem = (0-5) ▲ ---- , and the next 5 cm of stem = (5-10) ■ ······ . Moisture regimes: high moisture surpluses ($H > 1.5$), low moisture surpluses ($1.5 < H > 1.0$) and moisture deficits ($H < 1.0$). R^2 values and significance levels are indicated for each section. * $p < 0.05$, .** $p < 0.01$, *** $p < 0.001$, n = number of samples.

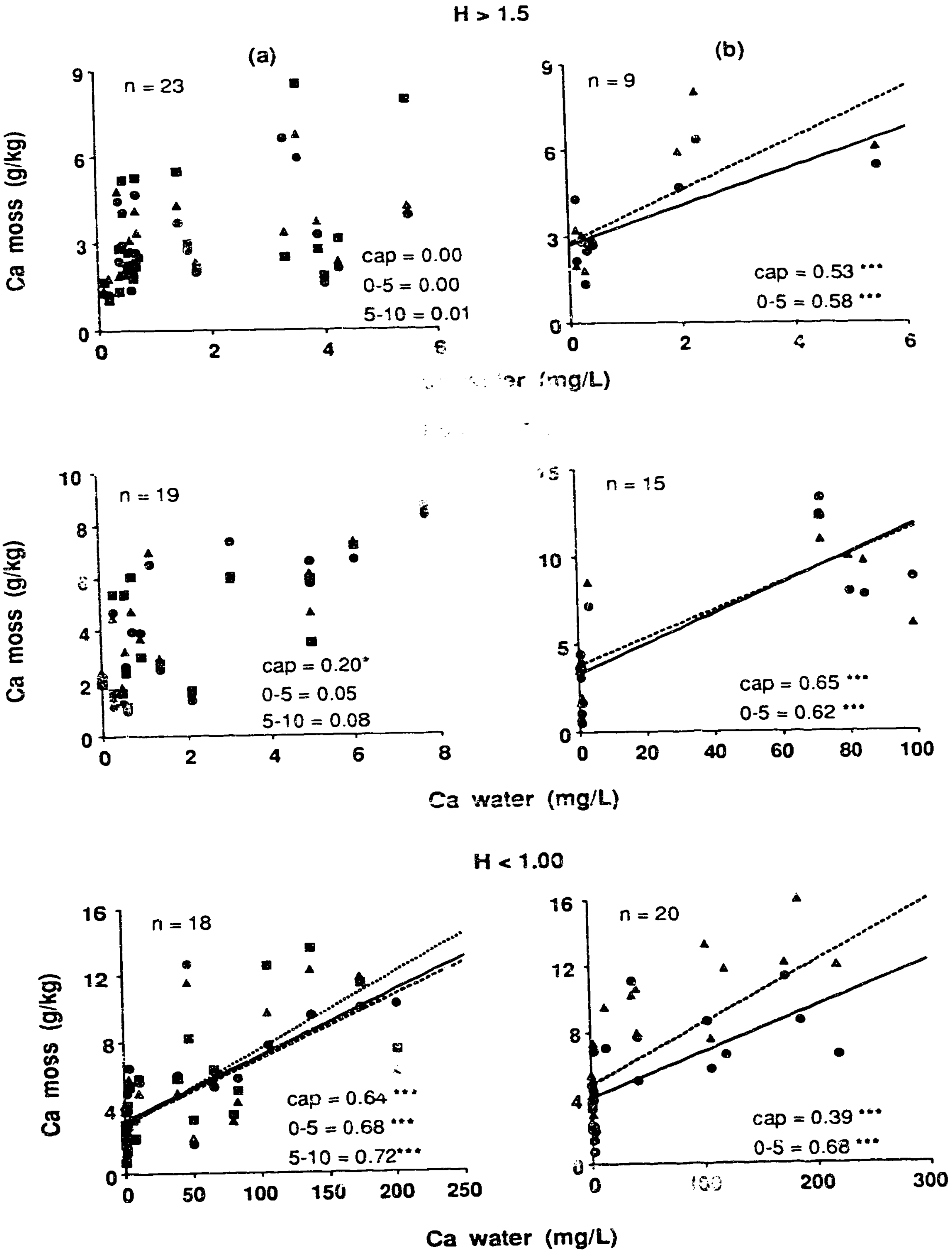

H > 1.5
(a)
(b)
n = 23
cap = 0.00
0-5 = 0.00
5-10 = 0.01
n = 9
cap = 0.53 ***
0-5 = 0.58 ***
Ca moss (g/kg)
0
3
6
9
0
2
4
6
Ca water (mg/L)
n = 19
cap = 0.20*
0-5 = 0.05
5-10 = 0.08
n = 15
cap = 0.65 ***
0-5 = 0.62 ***
Ca moss (g/kg)
0
2
4
6
8
10
0
5
10
15
0
20
40
60
80
100
Ca water (mg/L)
H < 1.00
n = 18
cap = 0.64 ***
0-5 = 0.68 ***
5-10 = 0.72***
n = 20
cap = 0.39 ***
0-5 = 0.68 ***
Ca moss (g/kg)
0
4
8
12
16
0
50
100
150
200
250
0
100
200
300
Ca water (mg/L)

Figure IV-3. Regression analyses for the relationships between Mg concentrations in mire surface waters and concentrations in two groups of Sphagnum species under three moisture regimes in western Canada. Species groups (a) and (b): species forming hummocks less than 15 cm and greater than 15 cm above the water table respectively. capitulum =cap ● ———, the uppermost 5 cm of stem = (0-5) ▲ ---- , and the next 5 cm of stem = (5-10) ■ ······ . Moisture regimes: high moisture surpluses ($H > 1.5$), low moisture surpluses ($1.5 < H > 1.0$) and moisture deficits ($H < 1.0$). R^2 values and significance levels are indicated for each section. * $p < 0.05$, .** $p < 0.01$, *** $p < 0.001$, n = number of samples.

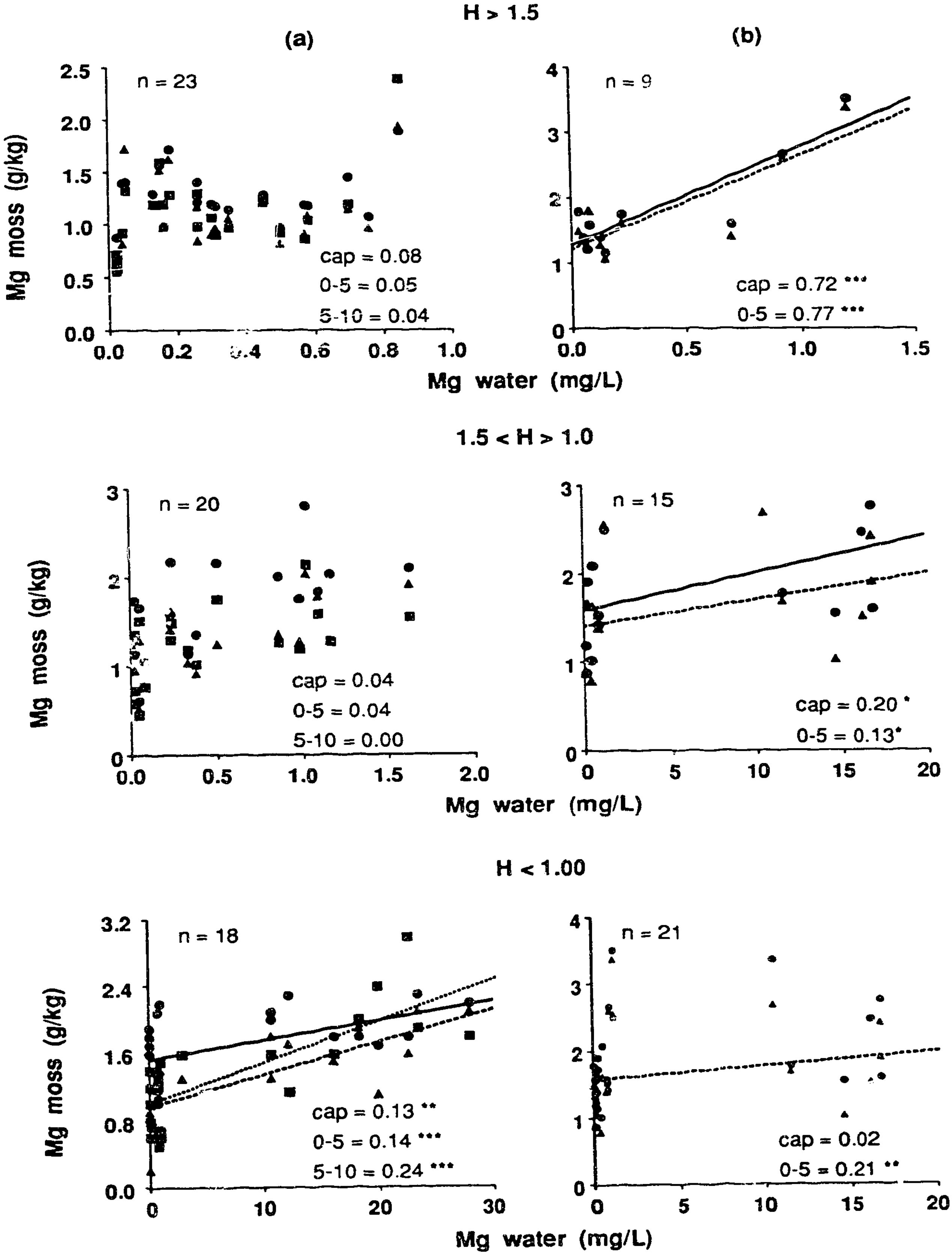
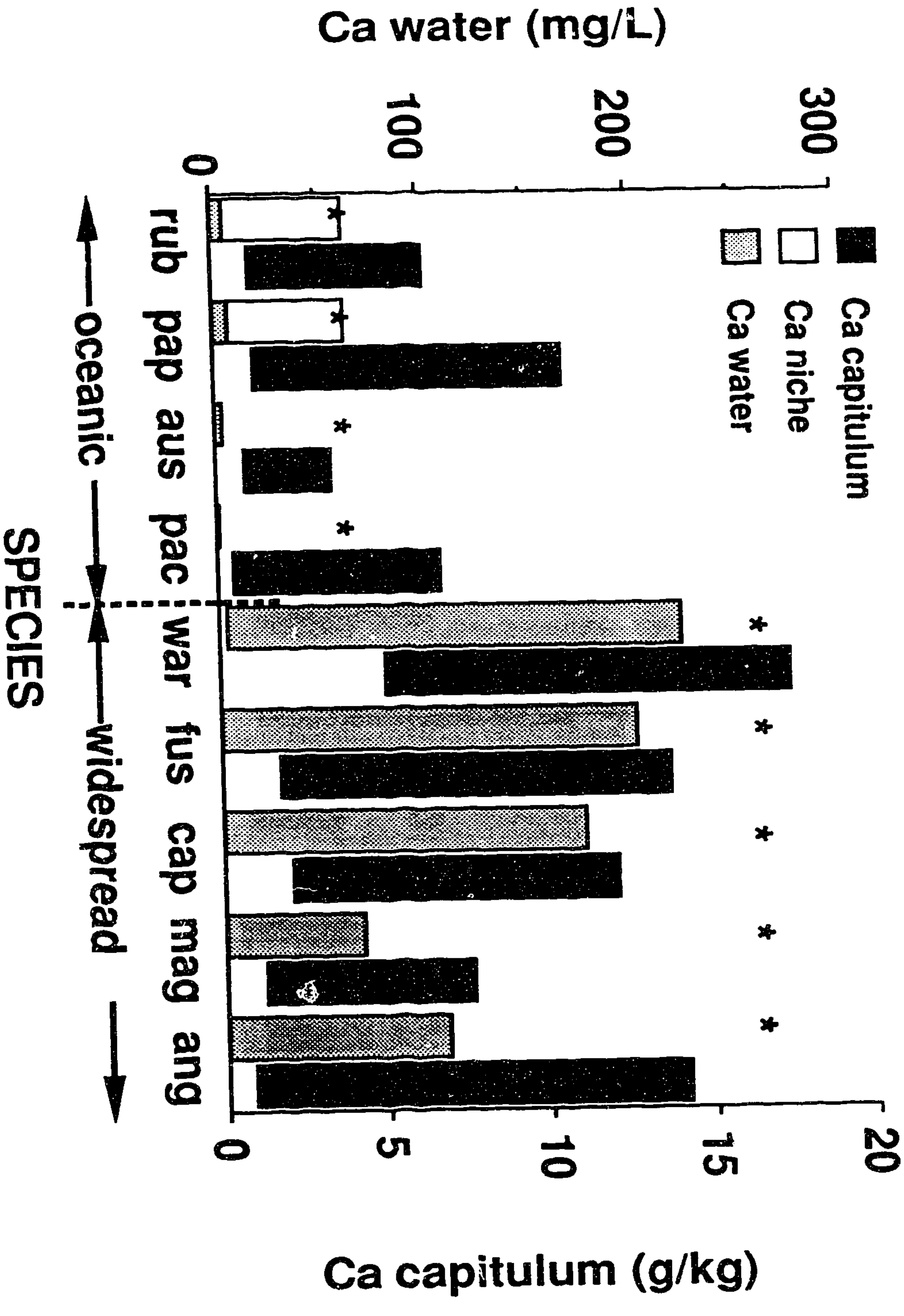

H > 1.5
(a)
(b)
n = 23
cap = 0.08
0-5 = 0.05
5-10 = 0.04
n = 9
cap = 0.72 ***
0-5 = 0.77 ***
Mg moss (g/kg)
Mg water (mg/L)
1.5 < H > 1.0
n = 20
cap = 0.04
0-5 = 0.04
5-10 = 0.00
n = 15
cap = 0.20 *
0-5 = 0.13*
Mg moss (g/kg)
Mg water (mg/L)
H < 1.00
n = 18
cap = 0.13 **
0-5 = 0.14 ***
5-10 = 0.24 ***
n = 21
cap = 0.02
0-5 = 0.21 **
Mg moss (g/kg)
Mg water (mg/L)

Figure IV-4. Niche dimensions and total Ca accumulations (g/kg dry weight) in the capitula of nine hummock-forming *Sphagnum* species along a Ca gradient in mire surface waters in western Canada. Ca water indicates the sampling range for each species on the Ca gradient in surface waters. Ca niche indicates the maximum species niche dimensions on the Ca gradient.

* = maximum Ca concentrations in surface waters for each habitat. Species are divided into two groups, based on their geographical distribution.

rub = *S. rubellum*, pap = *S. papillosum*, aus = *S. austinii*, pac = *S. pacificum*, fus = *S. fuscum*, cap = *S. capillifolium*, mag = *S. magellanicum*, ang = *S. angustifolium*, war = *S. warnstorfii*.


Ca water (mg/L)
0
100
200
300
Ca capitulum
Ca niche
Ca water
rub
pap
aus
pac
war
fus
cap
mag
ang
oceanic
widespread
SPECIES
0
5
10
15
20
Ca capitulum (g/kg)

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V. Effects of mire surface waters on the growth and geographical distribution of four Sphagnum species in western Canada.

Abstract

Sphagnum lindbergii, S. papillosum, S. jensenii, and S. teres that occur in pools, carpets, and/or lawns, on peatlands in western Canada were grown under controlled conditions in surface waters collected from mires located in widely separated geographical areas. The surface waters were obtained from a wide range of peatland types and contained large variations in the concentrations of mineral elements, sulphate, bicarbonate, and ammonium. Weight increases for all species were limited at both high and low corrected conductivities of the surface waters. Although the habitats of the four Sphagnum species studied were limited by the chemical attributes of mire waters, the lack of suitable habitats in different climate zones does not limit the geographic distributions of such bog and poor fen species as S. jensenii, S. papillosum, and S. lindbergii. However, species distributions within each climatic zone are limited by surface water chemistry. Weight increases for the moderate rich fen species S. teres that is mostly found in sub-continental areas in western Canada was significantly lower in waters collected from hyper-oceanic areas.

Introduction

The distribution of Sphagnum species along environmental gradients has been extensively studied (Andrus 1986). The four major gradients limiting habitats and niches of Sphagnum species are: 1) water chemistry that includes pH, conductivity, and Ca and Mg ions (Andrus 1986, Vitt & Slack 1984, Karlin and Bliss 1984, Dierssen 1983, Horton et al. 1979, Malmer 1962); 2) moisture (Gignac 1987, Andrus et al. 1983, Vitt et al.

1975); 3) shade (Vitt & Slack 1984); 4) climate (Chapter III, Gignac & Vitt 1990, Hayward & Clymo 1983).

Almost all of these studies have more or less defined the realized niches (sensu Hutchinson 1957) of many Sphagnum species. Only a few studies however have explored the fundamental niches of individual species by means of growth experiments (Rydin 1987, 1985, Rydin & McDonald 1985, Clymo 1973, Clymo & Reddaway 1971). Most of these studies have focused on the micro-topographical distribution of species from hummock to hollow rather than the distribution of each species over wider geographic areas.

The problem of explaining the geographic distribution of bryophyte species is complex. Crum (1972) reviewed this problem by defining four factors that could limit the geographical ranges and ecotope dimensions of bryophytes: i) lack of a suitable habitat; ii) effects of climate; iii) competition; iv) failure to disperse and/or establish in suitable habitats. Few studies have examined all of these factors together in order to explain the distribution of a single moss species (Forman 1964) or of bryophytes in general (van Zanten & Pocs 1981, Crum 1972, 1966). Only a few studies have measured the effects of one or the other of the four factors on Sphagnum distributions (McQueen 1987, Lane 1977, Boatman & Lark 1971).

In this study, lack of a suitable habitat is examined as a factor limiting the distribution of four Sphagnum species in western Canada. The four species studied are often found growing in carpets, lawns, and/or pools in mires (Sjörs 1983). These habitats are common features of most mires and are relatively easy to duplicate experimentally. Since tree and shrub-produced shade is usually absent and microtopographic gradients are small in wet carpets and hollows, habitat differences are largely confined to chemical and physical differences in the waters themselves. Waters obtained from different geographical and climatic zones can be used to measure the effects of habitat on the geographical distribution of each species. Furthermore, by growing the plants under uniform conditions, effects of climate can be separated from those of habitat.

Two experiments are used to determine the effects of waters from different geographical locations on the growth of *Sphagnum*. In the first experiment, the conductivity of each water treatment is kept constant in an attempt to determine the effects of a wide variety of chemical and physical factors on growth of two species. The two species selected are: *Sphagnum jensenii* Lindb. and *Sphagnum teres* (Schimp.) Aongstr. ex C. Hartm. Both species are largely sub-continental in distribution, but are usually not abundant in mires in western Canada (Gignac and Vitt 1990).

Monthly periods of moisture deficit where evaporation exceeds precipitation are common in sub-oceanic and sub-continental areas (Chapter IV). Moisture deficits often produce lower water levels in mires (drawdown) that result in higher elemental concentrations in mire waters (Sonesson et al. 1980, Chapman 1975, Pedersen 1975, Malmer 1963, 1962). Effects of drawdown may be particularly important in limiting the distribution of oceanic or more northerly distributed species, as moisture deficits and resulting drawdowns are not as extreme as those in sub-continental areas. In the second experiment, effects of drawdown and increased elemental concentrations on the growth of *Sphagnum lindbergii* Schimp. ex Lindb. and *Sphagnum papillosum* Lindb. are analysed. Both species are common in hyper-oceanic areas of western Canada, but decrease steadily in abundance as the climate becomes drier (Gignac & Vitt 1990).

The objectives of this study can be summarized as follows: 1) to determine the effects of chemical and physical variables of mire surface waters on the growth of four *Sphagnum* species that are found in hollows; 2) to determine the effects of drawdown on growth and distribution of two oceanic *Sphagnum* species; and 3) to determine the importance of habitat as a limiting factor on the geographic distribution of four *Sphagnum* species in western Canada.

Materials and methods

Two growth experiments were designed to determine the effects of mire surface water chemistry on the growth of Sphagnum species that occur in pools, carpets, and/or lawns: 1) corrected conductivity was kept constant throughout the experiment, and 2) corrected conductivity and mineral element concentrations were increased during the experiment. The following methods apply to both experiments.

Approximately 50 L of surface water were collected from mire pools in widely separated geographic areas. Plant material was collected at the same time and kept frozen until the experiment began. The water was kept refrigerated (2° C) until it was used. A Radiometer conductivity meter and an Electromate portable pH meter were used to measure conductivity and pH in the field. Conductivity and pH were also measured immediately before and after the experiment using the same instruments. Conductivity was corrected to 20° C and for H^+ concentrations (Sjörs 1952). Water samples were analysed for the mineral elements Ca, Mg, Na, K, Mn, Fe, and S on an inductively coupled argon plasma spectrophotometer before and after the experiments.

Precut lengths of ten Sphagnum stems were placed in 250 ml opaque plastic containers filled to the brim with water collected from one of the mires. To minimize any effects of the water in which the plants were previously growing on the experimental results, the stems were pretreated for approximately 20 minutes with three changes of the appropriate experimental water. Each container was replicated three to five times depending on the experiment. Containers were placed in 12 evenly spaced rows in a growth room under controlled conditions (Table V-1) and randomized on a weekly basis. Stems were harvested after 62 days and immediately frozen to prevent further growth.

Two types of growth measurements were taken for each stem. Growth as length was measured as the difference in stem length before and after the experiment. Growth as weight was measured using the capitulum correction method (Clymo 1970). Plants were cut into 5 cm or 10 cm lengths depending on the experiment and only the top sections of the plants were used. All of the branches were stripped from the bottom 4 or 9 cm of each stem, leaving the top 1 cm untouched. From among the precut plants for each species, 400 were used in the experiments and 50 were withheld.

Each of the fifty plants were sectioned into three parts as follows: 1) the bottom 1 cm of stem was cut and rejected; 2) the remaining 3 or 9 cm of stem from which all the branches had been removed was then sectionned from the top 1 cm (capitulum). The stem section and untouched capitulum were dried at 60°C for 24 hours, weighed and the results plotted. A linear equation was then calculated for the line of best fit for the relationship between stem and capitulum weights for each species

After harvesting, each plant was sectioned into three parts as described above. The initial capitulum weight for each plant was calculated from the dry weight of the 3 or 9 cm section of stem, using the previously generated linear equations. Growth was calculated as the actual capitulum weight minus the initial estimated capitulum weight.

Statistical analysis

Two-level nested analyses of variance, where replicates are nested within each water treatment (Sokal and Rolf 1981) were used to compare differences in growth between water treatments. Student-Newman-Keuls means tests were used to determine differences between individual water treatments. All statistics were computed with the SAS package on the MTS computer at the University of Alberta.

Experiment 1.

Locations of the 7 peatlands from which water was collected are shown in Table V-2. Each water was analysed for total Kjeldahl nitrogen (TKN), total phosphorus (TP), and bicarbonate concentrations, as well as color and turbidity following the methods of Bierhuizen and Prepas (1985). Water samples were also analysed for nitrite+nitrate, and ammonium on a Technicon AutoAnalyser II. Chloride and sulphate concentrations in the waters were determined by high performance liquid chromatography. All measurements were taken immediately before the experiment began and within a week after. Water samples were kept refrigerated (4° C) until they were analysed.

Water and *Sphagnum jensenii* and *Sphagnum teres* plants were collected within a two week period in October, 1988. Plants were sectioned into 5 cm lengths and ten randomly selected stems were placed in 5 replicates for each of the 7 water treatments. An eighth treatment consisting of distilled-deionized water was also added. Corrected conductivity was kept constant in each container by adding either distilled-deionized water or more of the same water that was already in the container to replace losses through evaporation. Conductivity and pH measurements were taken on a weekly basis; based on these measurements, distilled-deionized water was used to decrease the conductivity, or the appropriate mire water was added to increase the conductivity. In this manner, the corrected conductivity was kept within a 5% range of variation. After 31 days, the water in each container was changed with extra water that was collected from the same pools at the same time and kept refrigerated.

Experiment 2.

Locations of the 7 peatlands from which water was obtained from this experiment are shown in Table V-3. Water and *Sphagnum lindbergii* and *Sphagnum papillosum* material were collected within a two week period in July and August 1986. Stems were cut to 10 cm lengths instead of 5 cm lengths but otherwise follow the capitulum correction method (Clymo 1970). Ten randomly selected stems of each species were placed in three replicates for each of the seven water treatments.

Replicate containers were refilled on a weekly basis with the same water to replace losses through evaporation. Conductivity and pH were not measured on a weekly basis since no attempt was made to keep the corrected conductivity constant. The water was not replaced after 31 days.

Results

Experiment 1.

Waters used in this experiment cover a wide variety of peatland types ranging from bogs to extreme-rich fens (Table V-2). This diversity of peatland types is reflected in the water chemistry particularly in the pH, corrected conductivity (k_{corr}), and concentrations of the mineral elements Ca, Mg Na, K,and S (Tables V-4 and V-5). Sulphate, bicarbonate ammonium, total phosphorus, and total Kjeldahl nitrogen also show wide variation between waters. Concentrations and corrected conductivity (k_{corr}) is significantly correlated ($p<0.05$) with most mineral elements, SO_4^{--}, and (NH_4^+)-N (Table V-6). Total Kjeldahl nitrogen (TKN), (NO_2+NO_3)-N, Fe, $HCO_3^-$and Cl^- concentrations were not significantly ($p > 0.05$) correlated with k_{corr}. The distilled-deionized water had only trace amounts of all the water chemistry variables measured in this experiment.

Waters from different geographical areas can have similar water chemistry. Corrected conductivity, pH, mineral elements, HCO_3^-, and SO_4^{--} concentrations in particular are similar between waters from hyper-oceanic areas (waters 1 and 3) and from sub-continental areas (waters 2 and 4). Large variations between the four waters occur in TP, TKN, and (NH_4^+)-N levels. These variations however, do not reflect differences between sub-continental and hyper-oceanic mires, since variations also occur between waters 2 and 4 that were both obtained from sub-continental peatlands.

Analyses of variance of growth of both species indicate highly significant differences ($p < 0.001$) between water treatments (Table V-7). Student-Newman-Keuls means tests also indicate significant differences ($p < 0.05$) between waters (Fig. V-1). With the exception of water 7, both Sphagnum jensenii and Sphagnum teres grew in length and/or weight in all of the water treatments. All of the stems that were put into water 7 fell apart soon after they were put in the water and many had started to decompose by the end of the experiment. For this reason, growth both as length and weight in water 7 could not be measured and was considered to be 0.

Stems grew in two distinct forms. In the first form (etiolation), the stems grew very thin with relatively long internodes and bore little resemblance to the material that was originally collected in the field. The capitulum was much reduced in size and the growing point clearly visible, since it was surrounded by only a few leaves. Some stems produced innovations where one of the fascicular branches elongated to form a separate stem. Plants exhibiting the second growth form did not dramatically change their appearance and stem growth was relatively slow with no abnormally long internodes. The capitulum retained its size and shape and any branching that occurred was found at the growing point yielding two identical but smaller capitula.

Etiolation was observed in the distilled-deionized water treatment ($k_{corr} = 1$ µS). This water treatment produced significantly greater stem elongations ($p < 0.05$) for both species than several other water treatments (Fig. V-1). Etiolation is also associated with relatively large increases in weight for both species. With the exception of the distilled water treatment and water 7 where no growth occurred, all of the remaining waters produced plants having normal growth forms. Among these waters, water 2 ($k_{corr}= 5.1$ µS) produced significantly higher stem elongations than any of the other waters for both species. Waters 3, 4 (k_{corr} = 10 µS) and 6 (k_{corr} = 149 µS) also produced significantly greater increases in weight than any of the other waters for S. teres.

Disregarding the distilled water treatment, stem elongation and weight increase for both species increased from water 1 (k_{corr} = 4.9 µS) to an optimum in either water 2 (k_{corr} = 5.1 µS) or water 3 (k_{corr} = 5.7 µS). Growth then decreased from the optimum to 0 in water 6 (k_{corr} = 149 µS) for S. jensenii and in water 7 (k_{corr} = 540 µS) for S. teres. It also noteworthy that S. jensenii, a poor fen species did not grow significantly in weight or length in water 6 (k_{corr} = 149 µS), while S. teres, a moderate-rich fen species, had significant growth in length and weight in this water.

The geographic location of the mire waters did not cause major differences in the growth of S. jensenii. There were no significant differences ($p > 0.05$) in the weight increase for S. jensenii in waters 3 (k_{corr} = 5.7) and 4 (k_{corr} = 10 µS) from sub-continental poor fens, and water 5 (k_{corr} = 56 µS) from a hyper-oceanic fen (Fig. V-1). Stem elongation for S. teres is not significantly different between hyper-oceanic waters 2 and 3 and water 6 obtained from a sub-oceanic mire. Weight increase for Sphagnum teres however is significantly higher ($p < 0.05$) in waters obtained from sub-continental areas than waters from hyper-oceanic areas.

Experiment 2.

Corrected conductivity, pH, and mineral ion concentrations in waters used in this experiment are shown in Table V-8 and Figure V-2. Ionic concentrations increased by factors of 3 to 5 times from the beginning to the end of the experiment, as a result of refilling the containers with mire waters. The rate at which ions increased in concentration varied between water samples. However, the total ionic concentrations remained, with one exception, in the same order, with water 1 containing the least and water 7 the highest concentrations. The exception is water 5 in which the ions were concentrated at a faster rate than in water 6 giving marginally higher total cation concentrations in water 5. Hydrogen ion concentrations and k_{corr} also show the same effect. All mineral ion concentrations with the exception of Fe and Mn are significantly correlated ($p < 0.05$) with both pH and k_{corr} (Table V-9). The latter two ions are significantly negatively correlated. Waters 1 and 2 collected in hyper-oceanic areas have similar pH, corrected conductivity, and ionic concentrations to waters 5 and 6 from sub-continental areas.

Stem elongation and weight increase for S. lindbergii and S. papillosum are shown in Figure V-3. A two-level nested analysis of variance of the data showed significant differences ($p < 0.05$) in stem elongation only for S. papillosum (Table V-10). A Student-Newman-Keuls means test however did not reveal significant differences ($p > 0.05$) for stem elongation for either species (Fig. V-3). Analyses of variance for weight increase showed significant differences between water treatments for both species ($p < 0.01$). A Student-Newman-Keuls means test revealed that S. papillosum grew significantly more in four of the seven water treatments (Fig. V-3). Etiolation was observed in water 1.

Weight increase for S. lindbergii and S. papillosum shows the same relationship with the corrected conductivity of mire surface waters measured at the beginning of the experiment as did S. jensenii and S. teres in experiment 1. Growth increased significantly from water 2 ($k_{corr} = 10$ μS) to an optimum in either water 3 ($k_{corr} = 22$ μS) or water 4 ($k_{corr} = 23$ μS). Growth then decreased from the optimum to lower values in water 7 ($k_{corr} = 68$ μS).

There are no significant differences ($p > 0.05$) for stem elongation for both species between waters from different geographical areas (Fig. V-3). Waters 3 ($k_{corr} = 22$ μS) and 4 ($k_{corr} = 23$ μS) that have almost identical k_{corr} values produced approximately the same growth in weight for both species. These waters however were obtained from two different geographical areas. Water 3 was collected from a hyper-oceanic peatland while water 4 came from a sub-continental fen. The same relationship is also found between the weight increase in waters 5 (sub-continental, $k_{corr} = 52\ \mu S$) and water 6 (sub-oceanic, k_{corr} 53 μS).

Discussion

Stem elongation and weight increase

Increases in stem length may not provide an accurate measurement of stem growth in these experiments. Apical branching that produced two capitula was not accurately determined since only the length from the base of the stem to tip of the longest branch was measured. This measurement did not take into account the added growth produced by the second branch. Therefore, the stem elongation measurement may underestimate growth for species or waters where dichotomous branching was common. Of the two measurements used in this experiment, weight is probably more accurate than stem elongation for measuring growth.

Stem elongation was affected by the water treatments differently from weight gain. This is particularly evident for both species in experiment 2 (Fig. V-3). Growth as stem elongation would appear to respond differently from weight increase to the different water treatments. Clymo and Hayward (1982) also found that stem elongation and weight increase varied in different ways in response to different treatments.

The etiolated growth form that was observed in this sudy was also reported by Hayward and Clymo (1983), Boatman (1977), Clymo (1973), and Green (1968). The different growth forms appear to be linked to the quantity of water in which the plants were growing. Clymo & Hayward (1982) demonstrated that stems growing in a very wet habitat grew abnormally long or etiolated, while those growing in a drier habitat had a more normal growth form.

Results from this study suggest that it is not only the quantity but also the quality of water that produces abnormal growth. Waters having extremely low corrected conductivities (<1 μS) produced etiolated plants, while waters having higher corrected conductivities (>4.0 µS) produced plants that appeared normal. Growth of plants placed in waters having extremely low corrected conductivity levels invariably produced abnormally elongated and thin stems and this sometimes resulted in increases in weight. This point is demonstrated by the growth of *S. jensenii* and *S. teres* in the distilled-deionized water treatment in experiment 1 (Fig. V-1). In experiment 2 however, etiolation of the plants grown in water 1 ($k_{corr} = 0$) did not clearly produce an increase in weight in either *S. papillosum* or *S. lindbergii* (Fig. V-3). It would appear that plants etiolate under conditions of low moisture stress and high mineral and nutrient stresses whereas, low moisture stress accompanied by lower mineral and nutrient stresses results in plants that appear normal.

Etiolation may be the result of a pathological condition in which plants use their own resources to produce new growth. In the distilled-deionized water treatment, mineral and nutrient resources are in very short supply, but this water produced plants that increased significantly in both length and weight (Fig. V-1). Stem elongation may result from the translocation of minerals and nutrients that were originally located in the capitula to the new growth. No new leaves or branches are produced, and the distance between each branch (internodes) increases. This gradually reduces the size of the capitulum until it is only composed of a few leaves surrounding the apical growing point. Increases in weight may result from the translocation of resources to the new growth or from the loss of elements to the surrounding water. In both cases, the weight of the stem would be underestimated, resulting in an underestimation of the initial capitulum weight calculated from the regression equations for the relationship between stem and capitulum weights. The result of subtracting this underestimated initial capitulum weight from the actual capitulum weight would be to overestimate growth.

Effects of water chemistry on growth

Weight increase for such poor fen species as Sphagnum lindbergii, Sphagnum papillosum and Sphagnum jensenii produced the same response for all species to corrected conductivity levels in surface waters . At extremely low conductivity levels (≤ 1 µS) plants of all three species etiolated. At higher conductivity levels (> 4.0 µS) plants appeared normal. The growth of plants having a normal appearance for the three species increased to an optimum between 4.9 and 23 µS. Growth then decreased for all species to significantly lower values at conductivity levels > 60 µS. Thus, if etiolated plants are not considered, weight increase for poor fen Sphagnum species was related to the corrected conductivity levels in mire surface waters.

Several water chemistry variables were highly correlated ($p < 0.001$) to the corrected conductivity in surface waters. These variables included: Ca, Mg, Na, S, SO_4^{--}, HCO_3^-, and (NH_4^+)-N. It was impossible to determine from the results of these experiments which water chemistry variable or combination of variables limited the growth of poor fen Sphagnum species.

Growth of the moderate-rich fen species, S. teres, also appears to be related to the corrected conductivity levels in the surface waters (Fig. V-1). Etiolation occurred at extremely low k_{corr} levels (≤ 1 µS), while growth appeared to be normal at higher conductivity levels (> 4.0 µS). If etiolated plants are not considered, weight increase and stem elongation were significantly lower at low conductivity values, increased to an optimum at 5.7 µS and generally decreased to 0 at 540 µS. This species, however grew at higher k_{corr} levels (149 µS) than the poor fen species. The fundamental niche of this moderate-rich fen species is wider than those of the poor fen species along the k_{corr} gradient.

There appears to be another factor other than k_{corr} that limits the growth of

S. teres. This is indicated by the significantly lower growth in water 5 (k_{corr} = 56 µS) than in either water 4 (k_{corr} = 10 µS) or water 6 (k_{corr} = 149 µS) (Fig. V-1). If k_{corr} was the only variable related to growth, water 5 should have much greater increases in both length and weight. Among the variables analysed in the surface waters (Tables V-4 & V-5), (NH_4^+)-N concentrations vary the most between waters 4, 5, and 6. Ammonium concentrations are much lower in water 5 than either water 4 or water 6 (Table V-4). In fact, with the exception of water 7, growth is significantly lower in waters 2, 3 and 5 that have (NH_4^+)-N concentrations less than 1.0 µg/L than in waters 1, 4, and 6 that have concentrations >10.0 µg/L. It seems probable that low (NH_4^+)-N concentrations in the surface water is also an important factor limiting the growth of S. teres.

Three of the four species used in this study did not produce the greatest amount of growth in the waters from which they were collected. Sphagnum jensenii was obtained from site 3 but grew significantly more in weight in water from site 2 (k_{corr} = 5.1µS) where it did not occur (Fig. V-1). Sphagnum teres had both greater weight increase and stem elongation in waters from sites 3 and 4 where it was not found, than in water from site 6 where it did occur. Sphagnum lindbergii had greater weight increases in waters 3, 4, and 5 than in water 1 from which it was obtained (Fig. V-3). The only species that grew best in the water from which it was collected was S. papillosum.

Effects of drawdown on growth

Sonesson et al. (1980) found a four-fold increase in corrected conductivity during the summer drought. In a subarctic mire that containing S. riparium. Chapman (1975) measured a four-fold increase in cationic concentrations in waters that supported the growth of S. papillosum. Malmer (1962) measured increases in conductivity that were 2 and 4 times higher for sub-oceanic peatlands. Sphagnum papillosum was abundant in these areas. Malmer (1963) also found that the concentrations of such elements as Ca and

Na were closely correlated with conductivity. This suggests that both these elements were also concentrated in the water. Although Pedersen (1975) did not measure the conductivity of waters taken from a maritime mire, he did observe a drawdown of 8 cm of the water table caused by a summer drought. Sphagnum papillosum was found on this study site. In central Alberta, Chee (1988) measured increased elemental concentrations in surface waters as a result of drawdown on several peatlands. Thus, the twofold to fourfold increase in cationic concentrations and corrected conductivity of the waters measured during experiment 2 were quite similar to those observed in natural habitats where many of these species were found growing.

Increases in ionic concentrations as a result of water loss through evaporation did not appear to affect the survival of S. lindbergii and S. papillosum plants in the different water treatments. Increases in concentration did not clearly produce such negative effects as disintegration and decomposition of the plant material that was evident in the rich fen water treatment (water 7) used in experiment 1. Effects of increased elemental concentrations on the growth of each species could not be quantified in experiment 2.

Geographical distributions

The waters used in these experiments were collected from a wide range of geographical localities that include three climatic zones: hyper-oceanic, sub-oceanic, and sub-continental. Three of the species used in this study, S. jensenii, S. teres, and S. lindbergii,.are found throughout the geographical range from which the waters were collected. Sphagnum papillosum is not found in sub-continental areas.

The three poor fen species, S. lindbergii, S. jensenii, and S. papillosum, grew both in weight and in length in surface waters collected from both hyper-oceanic and sub-continental mires. Sphagnum lindbergii and S. papillosum also grew in water collected from a sub-continental peatland. Thus, the chemistry of surface waters does not limit the growth and therefore the distribution of poor fen species to specific geographic areas. Sphagnum papillosum in particular is not limited to oceanic areas by the absence of habitats having siutable water chemistry in sub-continental areas. It grew significantly more in water 4 ($k_{corr} = 23\ \mu S$) that was collected from a sub-continental mire than in water 1 ($k_{corr} = 0\ \mu S$) that was obtained from a hyper-oceanic bog.

Growth of S. jensenii in waters obtained from hyper-oceanic peatlands varies according to the corrected conductivity levels in the water treatments. Growth both as length and weight in water 1 ($k_{corr} = 4.9\ \mu S$) is significantly lower than in water 2 ($k_{corr} = 1$). Growth in water 5 ($k_{corr} = 56\ \mu S$) is also significantly lower than in water 2. Weight increase for S. lindbergii also shows the same effects of water chemistry in waters that were obtained from sub-continental areas. These data demonstrate that, although the chemistry of mire surface waters does not limit the growth of poor fen species between climatic zones, it limits growth within climatic zones .

However, growth of the moderate-rich fen species, S. teres, is significantly lower ($p < 0.05$) in waters obtained from hyper-oceanic mires than in waters collected from sub-continental areas. In fact, growth of S. teres in waters obtained from hyper-oceanic areas was not significantly different ($p > 0.05$) than in water 7 ($k_{corr} = 540\ \mu S$) where there was no growth. Ammonium concentrations in waters obtained from hyper-oceanic areas are low compared to those in the sub-continental waters used in this sudy. This may indicate that low corrected conductivity levels and (NH_4^+)-N concentrations in the surface waters exclude S. teres from many hyper-oceanic mires.

Munger and Eisenreich (1983) found less (NH_4^+)-N in precipitation in coastal British Columbia (0.24 µg/L) than in sub-continental Alberta (0.35 µg/L). However, Malmer et al. (1990) determined that there is a greater yearly influx of (NH_4^+)-N through precipitation in hyper-oceanic areas (600 $mg/m^2/yr$) than in central Alberta

(170 mg/m^2/yr). This apparent discrepancy can be explained by the much greater volume of precipitation in hyper-oceanic areas (Chapter II). Although yearly (NH_4^+)-N inputs from precipitation are significantly higher in hyper-oceanic areas, concentrations in mire surface waters should be lower than in sub-continental Alberta because of the diluting effects of the large quantity of precipitation in coastal mires. It would appear that *S. teres* requires more (NH4+)-N for growth than is present at any time in the surface waters of hyper-oceanic peatlands that obtain most of their (NH_4^+)-N from precipitation.

In conclusion, growth of carpet and lawn *Sphagnum* species is limited by the chemistry of mire surface waters. Among the water chemistry variables measured corrected conductivity levels greater than 80 μS, and/or variables that are highly correlated to k_{corr} appear to be the most important in limiting *Sphagnum* growth. Ammonium concentrations of less than 2 mg/L in the surface waters may also limit the growth of *Sphagnum*, particularly *S. teres*. The fundamental niches of the three poor fen species used in this study are narrower on the k_{corr} gradient than that of the moderate-rich fen species *S. teres*.

The absence of suitable habitats along the water chemistry gradient does not limit the geographical distribution of poor fen *Sphagnum* species. Water chemistry however, is important in limiting species growth within climate zones. The oceanic species, *S. papillosum*, in particular is not limited to hyper-oceanic, oceanic, and sub-oceanic areas by the absence of suitable habitats in sub-continental areas. Growth of the moderate-rich fen species, *S. teres*, however may be limited in hyper-oceanic mires by low corrected conductivity levels and ammonium concentrations in surface waters found there.

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Table V-1. Environmental parameters prevailing in the growth room.

Parameter	Day	Night
Daylength	12 hours	12 hours
Light intensity	240 µmol m^{-2} sec^{-1}	
Temperature	16° to 19° C	8° to 16° C
Relative humidity	65 to 75%	85 to 95%

Table V-2. Location of 7 peatlands from which water samples and *Sphagnum* plants were collected for experiment 1. Plant material and water samples were both removed from the same pools at the sites indicated. Peatland types follow Sjörs (1952, 1963), species nomenclature Ireland et al. (1987), and climate zones Gignac and Vitt (1990).

Site	Locality	Peatland type	Species collected	Climate zone
1	54°18' N 130°17' W	bog (lagg)	none	hyper-oceanic
2	54°17' N 130°21' W	bog	none	hyper-oceanic
3	55°54' N 112°01' W	poor fen	*Sphagnum jensenii*	sub-continental
4	55°56' N 112°01' W	poor fen (discharge)	none	sub-continental
6	54°16' N 130°15' W	poor fen (lagg)	none	hyper-oceanic
5	55°54' N 112°01' W	moderate-rich fen	*Sphagnum teres*	sub-continental
7	50°35' N 114°44' W	extreme-rich fen	none	sub-continental

Table V-3. Location of 7 peatlands from which water samples and *Sphagnum* plants were collected for experiment 2. Plant material and water samples were both removed from the same pools at the sites indicated. Peatland types follow Sjörs (1952, 1963), species nomenclature Ireland et al. (1987), and climate zones Gignac and Vitt (1990).

Site	Locality	Peatland type	Species collected	Climate zone
1	54°14' N 129°51' W	bog	*Sphagnum lindbergii*	hyper-oceanic
2	55°54' N 112°01' W	poor fen	none	sub-continental
3	54°18' N 130°17' W	bog (lagg)	*Sphagnum papillosum*	hyper-oceanic
4	55°54' N 112°01' W	poor fen	none	sub-continental
5	46°39' N 81°31' W	poor fen	none	sub-oceanic
6	55°56' N 112°01' W	poor fen (discharge)	none	sub-continental
7	54°14' N 113°34' W	moderate-rich fen	none	sub-continental

Table V-4. PH, corrected conductivity (k_{corr}) (µS), color (mgPt/L), turbidity (NTU), (NO_2+NO_3)-N (µg/L), (NH_4^+)-N (µg/L), total phosphorus (TP) (µg/L), and total Kjeldahl nitrogen (TKN) (mg/L) ± standard deviation in the 7 mire waters used in experiment 1.

Water	pH	k_{corr}	Color	Turb	(NO_2+NO_3)-N	(NH_4^+)-N	TP	TKN
1	4.55	4.9	140	0.7	2.7 ± 0.2	0.9 ± 0.0	37.0 ± 10.3	0.23 ± 0.06
2	4.99	5.1	35	0.6	2.8 ± 0.3	<0.1	19.6 ± 1.2	0.09 ± 0.02
3	4.21	5.7	240	0.8	10.5 ± 0.2	12.2 ± 1.63	11.4 ± 2.1	0.79 ± 0.07
4	4.05	9.9	120	5.5	4.3 ± 0.0	20.4 ± 0.69	104.8 ± 15.6	2.08 ± 0.09
5	6.72	56.4	120	0.7	6.4 ± 0.2	1.3 ± 0.4	5.3 ± 1.0	0.44 ± 0.06
6	6.57	148.6	120	1.3	7.3 ± 0.4	162.1 ± 0.8	34.8 ± 5.6	0.68 ± 0.54
7	7.32	540.0	80	3.1	3.4 ± 0.0	1273.8 ± 4.4	13.4 ± 3.3	2.48 ± 0.02

Table V-5. Mineral element, chloride, sulphate, and bicarbonate concentrations (mg/L) ± standard deviation in the 7 mire waters used in experiment 1.

Water	Ca	Mg	Na	K	Fe	S	Cl^-	SO_4^{--}	HCO_3^-
1	1.79 ± 2.04	0.23 ± 0.08	1.18 ± 0.13	0.37 ± 0.01	0.31 ± 0.13	0.45 ± 0.12	3.06 ± 0.51	2.56 ± 0.37	0.6 ± 0.2
2	1.70 ± 1.02	0.22 ± 0.06	1.00 ± 0.13	0.20 ± 0.04	0.04 ± 0.02	0.33 ± 0.12	3.37 ± 0.15	1.92 ± 0.14	1.1 ± 0.1
3	2.12 ± 0.66	0.67 ± 0.07	1.00 ± 0.18	0.05 ± 0.06	1.94 ± 0.07	0.19 ± 0.15	4.03 ± 0.01	1.91 ± 0.16	1.8 ± 0.2
4	1.08 ± 0.41	0.49 ± 0.15	1.28 ± 0.13	6.99 ± 8.03	0.39± 0.00	0.98 ± 0.79	1.41 ± 0.02	2.76 ± 0.28	0.0± 0.0
5	18.30 ± 0.27	1.11 ± 0.10	4.67 ± 0.04	3.34 ± 2.03	0.41± 0.07	6.72 ± 0.91	5.67 ± 0.22	20.55 ± 0.68	17.2 ± 0.2
6	35.80 ± 2.47	7.61 ± 0.45	9.73 ± 0.41	8.27 ± 1.17	0.28 ± 0.09	5.48 ± 1.10	21.00 ± 0.48	14.48 ± 0.27	73.7 ± 0.5
7	140.00 ± 32.95	54.32 ± 9.18	68.90 ± 10.42	10.34 ± 1.42	0.26 ± 0.10	89.34 ± 14.28	7.47 ± 0.15	264.90 ± 2.00	378.0 ± 4.4

Table V-6. Spearman correlation coefficients for corrected conductivity (k_{corr}), pH, elemental, and nutrient concentrations in the 7 water treatments used in experiment 1. NO=(NO_2+NO_3)-N. * $p < 0.05$. *** $p < 0.001$. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	k_{corr}	pH	Ca	Mg	Na	K	Fe	S	Cl^-	SO_4^{--}	HCO_3^-	(NH_4^+)-N	NO
pH	0.60	1.00											
Ca	0.75 *	0.86 *	1.00										
Mg	0.75 *	0.64	0.54	1.00									
Na	0.96 ***	0.64	0.86 *	0.61	1.00								
K	0.89 **	0.71	0.71	0.75 *	0.85 *	1.00							
Fe	-0.04	-0.36	-0.36	-0.11	-0.07	-0.29	1.00						
S	0.82 *	0.79 *	0.79 *	0.53	0.86 *	0.93 **	0.25	1.00					
Cl^-	0.71	0.79 *	0.89 **	0.68	0.75 *	0.61	-0.21	0.57	1.00				
SO_4^{--}	0.90 **	0.72	0.67	0.64	0.84 *	0.95 **	0.04	0.94 **	0.57	1.00			
HCO_3^-	0.67	0.93**	0.96 ***	0.68	0.75 *	0.68	-0.39	0.71	0.93 **	0.63	1.00		
NH_4^+	0.89 **	0.29	0.57	0.64	0.86 *	0.71	0.04	0.57	0.54	0.67	0.46	1.00	
NO	0.39	-0.07	0.29	0.04	0.43	0.00	0.50	0.00	0.46	0.05	0.18	0.43	1.00
TKN	0.71	0.04	0.32	0.39	0.68	0.46	0.32	0.39	0.21	0.50	0.18	0.89 **	0.39

Table V-7. F values for two-level nested analyses of variance of the stem elongation and weight increase for *Sphagnum jensenii* and *S. teres* in 8 water treatments. * p > 0.05 ** p > 0.01 *** p > 0.001

Source of variation	df	*S. jensenii*		*S. teres*	
		length	weight	length	weight
Among groups (water)	7	70.22 ***	15.19 ***	34.18 ***	28.07 ***
Among subgroups within groups (replicates)	26	2.04 **	1.61 *	3.46 ***	2.39 ***

Table V-8. Hydrogen ion concentrations ($H^+ \times 10^{-6}$) and corrected conductivity (k_{corr}, μS) (Sjörs 1952) measured in the 7 water treatments used in experiment 2. Water samples were analysed before the experiment began (pre-experiment) and after it finished (post-experiment). Post-experiment data were calculated from three control replicates±standard deviation for each water treatment.

Water	Pre-experiment			Post-experiment (n = 3)	
	pH	H^+	k_{corr}	H^+ ± s.d	k_{corr} ± s.d.
1	3.80	158.5	0.0	20.5 ± 7.5	33.3 ± 5.5
2	3.88	130.9	10.0	64.4 ± 17.8	50.7 ± 11.9
3	4.05	89.1	22.0	190.6 ± 4.4	33.7 ± 1.2
4	4.10	78.8	23.0	279.4 ± 36.6	91.5 ± 37.4
5	3.65	218.8	52.0	77.0 ± 21.6	195.1 ± 10.2
6	4.16	69.2	53.0	1.5 ± 0.7	144.7 ± 25.5
7	4.88	13.3	68.0	0.3 ± 0.1	296.7 ± 19.3

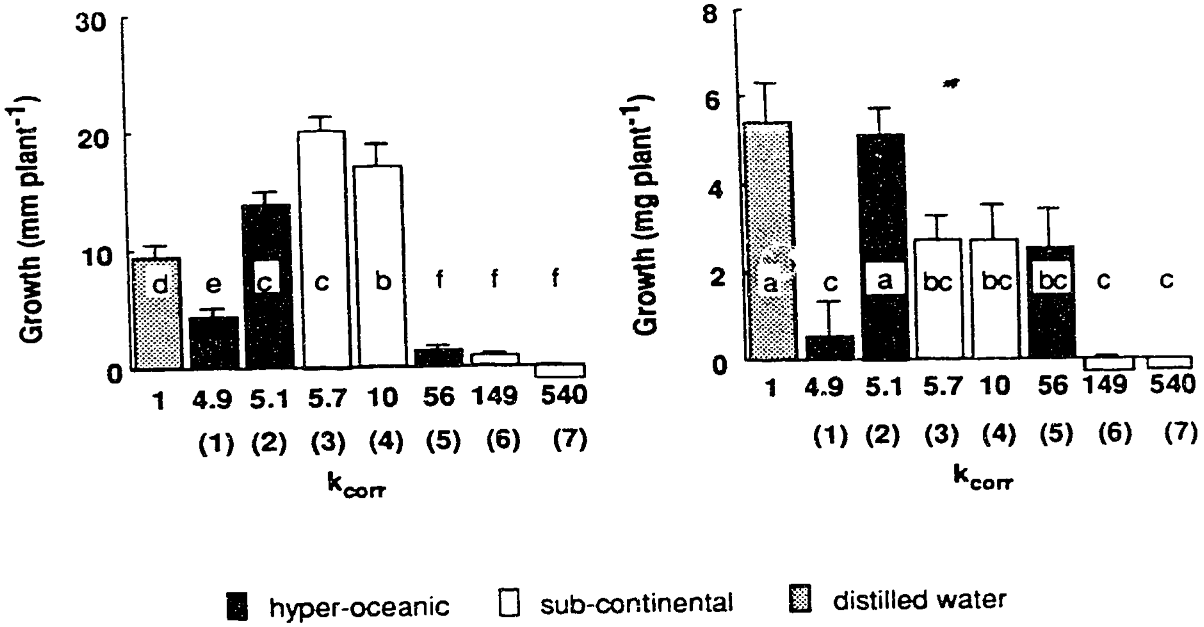
Table V-9. Spearman correlation coefficients for ionic concentrations (meq/L) and corrected conductivity (k_{corr}) measured in the 7 water treatments used in experiment 2. * $p > 0.05$ ** $p > 0.01$ *** $p > 0.001$. Lack of independance among these correlation coefficients means that the p values are actually larger than those reported in this table.

	Mg	Na	K	Fe	Mn	H^+	k_{corr}	Total
Ca	0.955 ***	0.527	0.943 ***	0.093	-0.331	-0.847**	0.518	0.928 ***
Mg	1.000	0.385	0.874 **	0.034	-0.293	-0.757 *	0.739 *	0.831 **
Na		1.000	0.360	0.022	0.137	0.107	0.862 **	0.788 *
K			1.000	0.171	-0.534	-0.699 *	0.660	0.838 **
Fe				1.000	0.241	-0.173	0.214	0.188
Mn					1.000	0.843 **	-0.582	-0.172
H^+						1.000	-0.360	-0.479
k_{corr}							1.000	0.985 ***

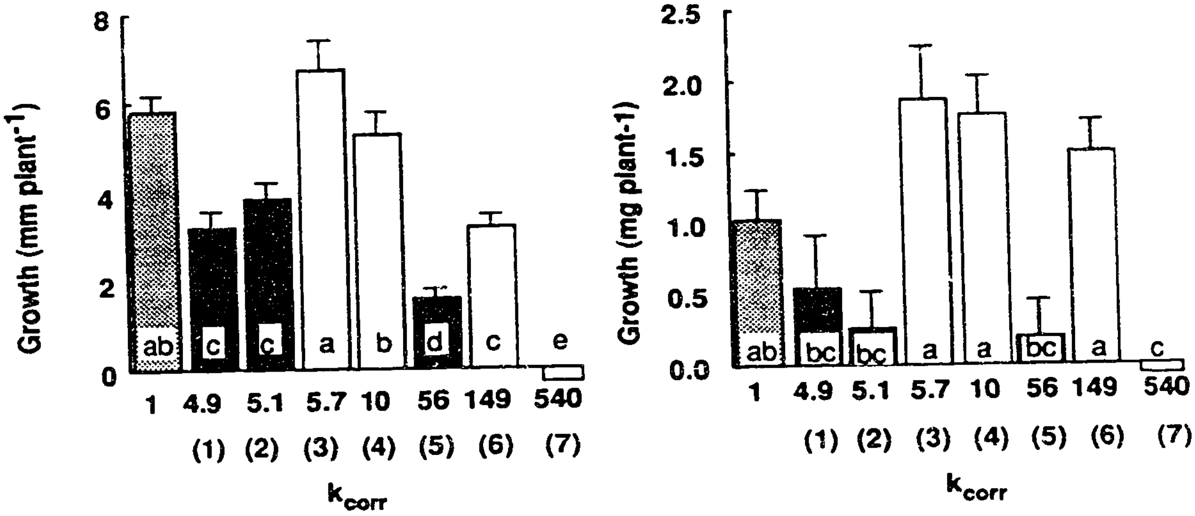
Table V-10. F values for two-level nested analyses of variance of the stem elongation and weight increase for *Sphagnum lindbergii* and *S. papillosum* in the 7 water treatments used in experiment 2. * p >0.05 ** p > 0.01 *** p > 0.001.

Source of variation	df	*S. lindbergii*		*S. papillosum*	
		length	weight	length	weight
Among groups (water)	6	1.60	2.92 *	2.24 *	11.60 ***
Among subgroups within groups (replicates)	13	1.79	1.96	2.67 **	2.97 **

Figure V-1. Growth as stem elongation (mm) and dry weight increase (mg) ± standard error for *Sphagnum jensenii* and *Sphagnum teres* in the 7 water treatments used in experiment 1. Hyper-oceanic = waters collected from hyper-oceanic sites. Sub-continental = waters collected from sub-continental peatlands (Gignac & Vitt 1990). Columns with the same letters are not significantly different ($p > 0.05$). Rectangles below the conductivity axes indicate the geographical area from which the water was obtained. Site numbers (Table V-2) are indicated in parentheses below k_{corr} values.



Sphagnum jensenii



Sphagnum teres

Figure V-2. Elemental concentrations in the 7 peatland waters used in experiment 2. The first column for each water shows concentrations before the experiment began and the second column indicates post-experiment concentrations.

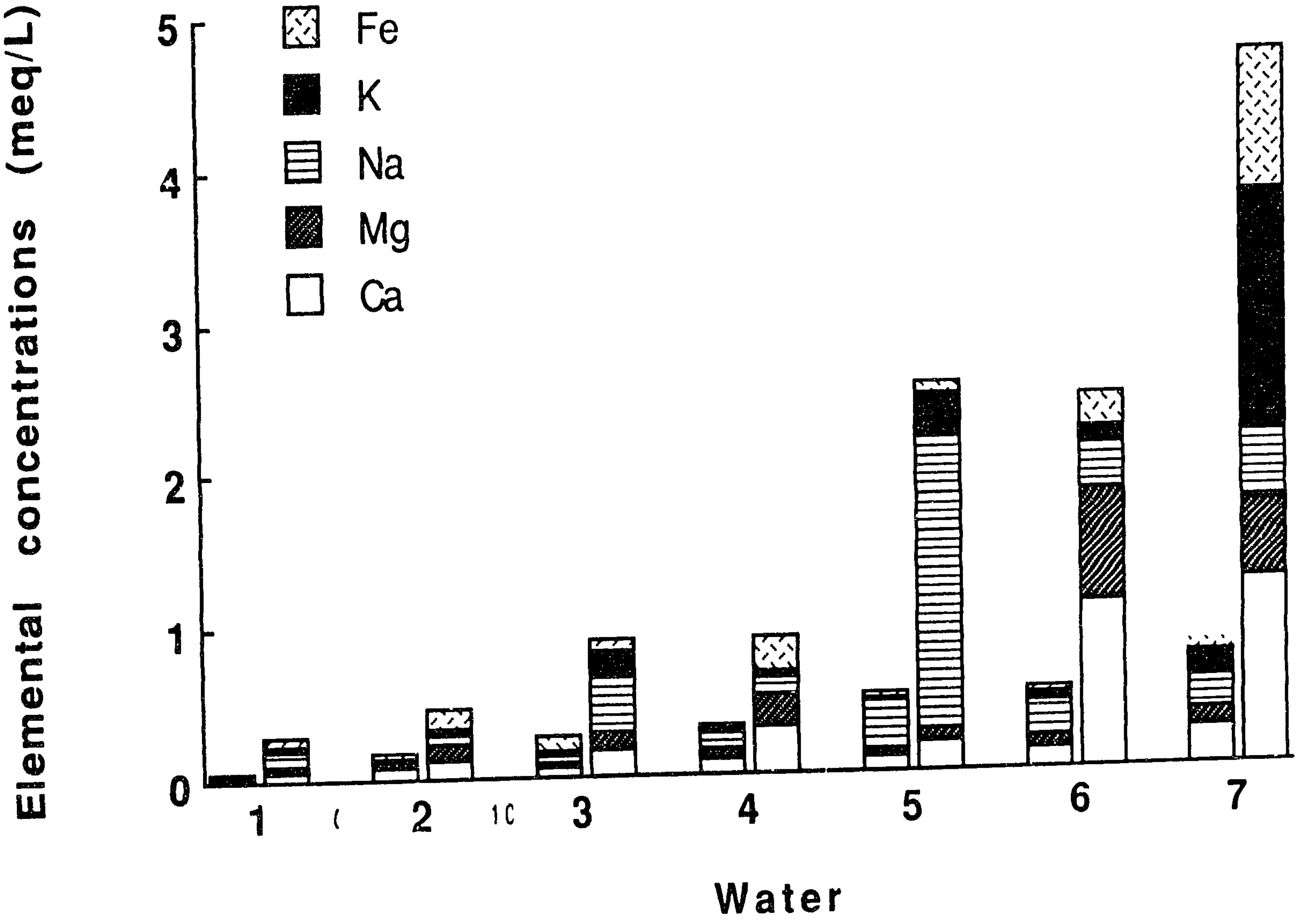
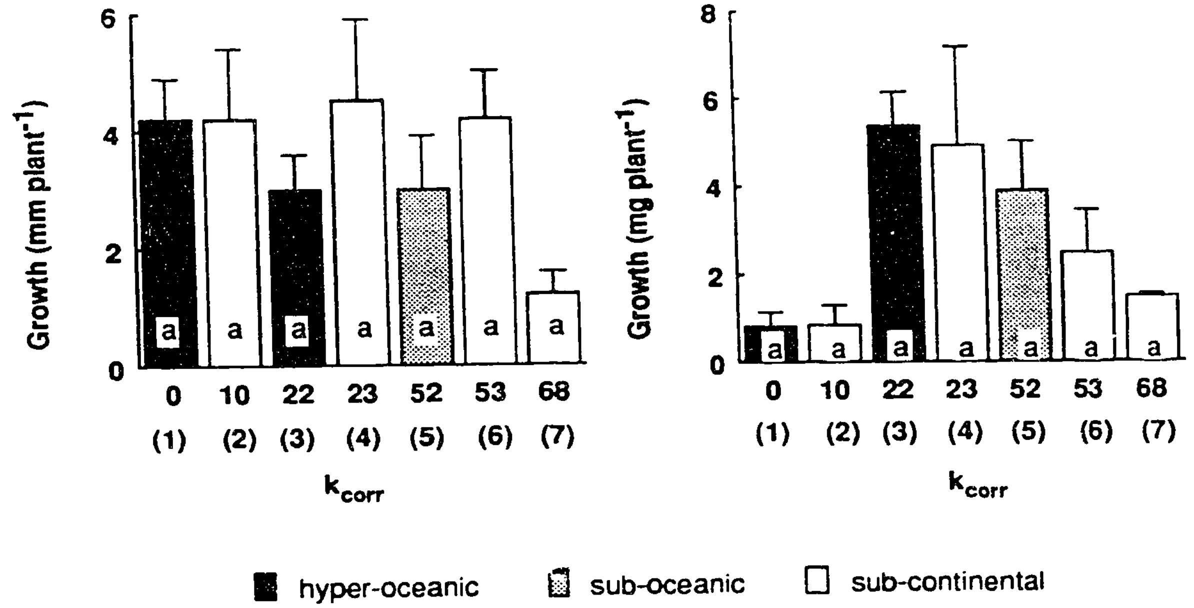
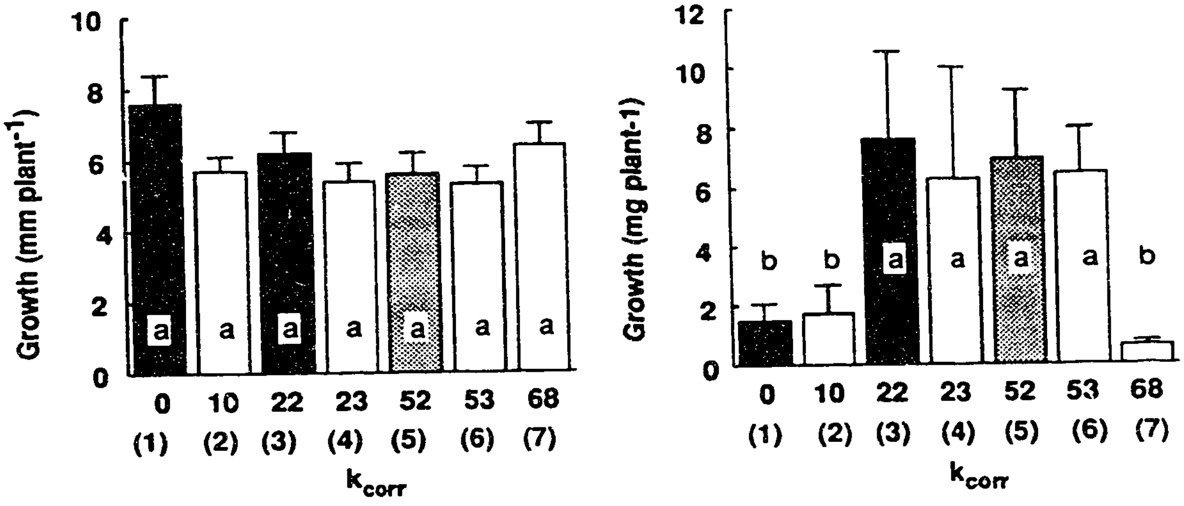

Elemental concentrations (meq/L)
5
4
3
2
1
0
Fe
K
Na
Mg
Ca
1
2
3
4
5
6
7
Water

Figure V-3. Growth as stem elongation (mm) and dry weight increase (mg) ± standard error for Sphagnum lindbergii and Sphagnum papillosum in the seven water treatments used in experiment 2. Columns with the same letters are not significantly different ($p > 0.05$). Hyper-oceanic = waters collected from hyper-oceanic sites. Sub-oceanic = water collected from a sub-oceanic sites. Sub-continental = waters collected from sub-continental sites (Gignac & Vitt 1990). Site numbers (Table V-3) are indicated in parentheses below k_{corr} values.



Sphagnum lindbergii



Sphagnum papillosum

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VI. General discussion

Twenty seven peatlands were studied along a transect from the Queen Charlotte Islands, British Columbia to central Alberta. Based on data obtained from permanent weather stations, the climate along the study transect can be divided into four zones: hyper-oceanic, oceanic, sub-oceanic, and sub-continental (Chapter I). Hyper-oceanic areas are characterized by a long growing season (> 200 days) and high precipitation falling as rain during the growing season (> 2000 mm). Both oceanic and sub-oceanic areas have between 800 and 2000 mm of rain during the growing seasom. Oceanic areas however have longer growing seasons (> 300 days) than sub-oceanic areas that have between 150 and 200 days. Sub-continental areas have the lowest amount of precipitation during the growing season (< 800 mm) and the shortest growing season (<100 days).

The 27 peatlands studied can be divided into bogs, poor fens, and rich fens based on vegetation and Ca, Mg, pH, and corrected conductivity levels in their surface waters (Sjörs 1963, 1952). The majority of hyper-oceanic, oceanic, and sub-oceanic peatlands are bogs and poor fens. These peatlands are characterised by low pH, corrected conductivity, Ca, and Mg values. In sub-continental areas, peatlands show wider variation, from extreme poor fens to moderate-rich fens. Moderate rich fens have higher pH, corrected conductivity, Ca, and Mg concentrations than either bogs or poor fens. Extreme-rich fens were excluded from this study, because Sphagnum species are not present on those peatlands.

The more abundant bryophytes that were found on the study sites are divided into 5 groups based on the results of a TWINSPAN analysis. A Detrended Cannonical Correspondence Analysis (DCCA) distributed these 5 groups along two principal axes: climate and surface water chemistry. Oceanic bog and poor fen Sphagnum species are found in hyper-oceanic, oceanic, and sub-oceanic mires. Widespread poor fen Sphagnum species are found in all climatic zones but are generally more abundant in sub-oceanic peatlands. Widespread Sphagnum species are not only found in all climatic zones, but also in all peatland types. All sub-continental moderate-rich fen species are, with the exception of Sphagnum palustre, restricted to sub-continental mires. Most moderate-rich fen species are not Sphagnum but brown mosses. Widespread non-Sphagnum species are found in all climatic zones and peatland types, and are generally restricted to the tops of the higher hummocks. However, brown moss dominated peatlands where these species occur near or at the water level were not included in this study.

Height relative to the water table and tree and shrub produced shade are not important gradients affecting the geographic distribution and abundance of most mire bryophyte species. Height is an important factor limiting habitats only for species found at either end of the topographic gradient. Species requirements along the height gradient would appear to be present on most of the sites even if a species is not present on a site. It is only species that are found on the tops of the highest hummocks and in wet hollows that are limited by the absence of those micro-habitats on some sites.

Analyses of the distribution and abundance of mire Sphagnum have clearly shown that climate and surface water chemistry gradients are the two most important factors limiting species habitats in western Canada. However, the high degree of correlation between water chemistry and climate gradients may lead to some confusion as to which of these two factors is more important in limiting species distributions. Results also do not clearly separate effects of such climatic variables as temperature and precipitation on the habitats of Sphagnum species. To clarify the relative importance of each of those factors on Sphagnum distributions, ecotopes (niches) of some of the more abundant species in the study area were analysed.

Analysis of the ecotope structure of eleven species reveals that complex climatic gradient is the most important factor segregating Sphagnum species in western Canada

(Chapter II). Results also show that such species as *S. rubellum*, *S. tenellum*, and *S.papillosum* that have optima in hyper-oceanic areas and have ecotopes that do not extend into sub-continental mires are limited by precipitation rather than temperature along the study transect. Distributions of the remaining species appear to be affected by temperature variables that, with the exception of *S. austinii*, are undetermined. *Sphagnum austinii* appears to be limited by long periods of cold temperatures to hyper-oceanic and oceanic mires where mean monthly temperatures of the coldest month are above freezing.

The second most important gradient segregating ecotopes of mire *Sphagnum* species is the height relative to the water table. With two exceptions, *S. warnstorfii* and *S. austinii*, species optima separate in ordered fashion on the height gradient. Ecotopes of *S. warnstorfii* and *S. austinii* are almost identical to those of *S. rubellum* and *S. fuscum*. Ecotopes of all species overlap between eight and fourteen cm above the water table. There is evidence that competition is an important factor segregating *Sphagnum* species ecotope dimensions on the height gradient, particularly at heights where ecotopes of most species overlap (Clymo and Reddaway 1971, Rydin 1986).

The complex surface water chemistry gradient is not extensively partitioned by mire *Sphagnum* species in western Canada. However, if only bog and poor fen habitats are analysed, the water chemistry gradient segregates *Sphagnum* ecotopes more than the height gradient but less than the climate gradient. Optima for most species are tightly grouped on the water chemistry gradient. With the exception of *S. warnstorfii*, species optima are all found in poor fen habitats. The optimum for *S. warnstorfii* is in moderate-rich fens. Ecotopes of all species that have optima in poor fens extend into bog habitats. With the exceptions of *S. angustifolium* and *S. fuscum*, ecotopes of poor fen species do not extend into rich fen habitats.

The overstory shade gradient is not extensively partitioned by the ecotopes of *Sphagnum* species within the range of habitats that were examined in this study. Several species ecotopes did not produce unimodal responses on the shade dimension and therefore dispersion of species optima could not be calculated. The mean ecotope overlap value however is very high, indicating that species ecotopes are not segregated on the shade gradient. Two factors may be responsible for the reduced importance of this gradient: i) many of the species that could be segregated along this gradient were not included in this study since most are found on shallow peat, in woodland habitats and those habitats were not not examined in this study; ii) trees and shrubs that produce overstory shade are ephemeral when compared to *Sphagnum*, and as a result, *Sphagnum* species may have to adapt to several changes in the amount shade over the lifespan of the plants.

Analysis of ecotope structure has clearly indicated that climate is more important than surface water chemistry in segregating *Sphagnum* species ecotopes. This suggests that climate rather than water chemistry is the most important factor limiting the distribution and abundance of *Sphagnum* species in western Canada. The analysis of ecotope structure has also separated the effects of temperature from those of precipitation on the distibution and abundance of several species. Results from both chapters I and II indicate that Ca, Mg, Na, pH and to some extent K and corrected conductivity levels in mire surface waters affect the habitats and ecotope dimensions of *Sphagnum* species. In chapter I, it is suggested that the hummock species, *S. fuscum*, found in a wide range of habitats along the water chemistry gradient was isolated from mire surface water. This conclusion leads to several questions relating to the affects of surface waters on ecotope dimensions of hummock *Sphagnum* species. 1) Is *S. fuscum* completely isolated from the surface water or is it simply able to withstand a wide range of elemental concentrations on the water chemistry gradient? 2) Is *Sphagnum fuscum* the only hummock-forming *Sphagnum* species that is isolated from surface water? 3) How does the surface water chemistry affect the ecotopes of hummock forming species, that often have their capitula several decimeters above the water's surface? 4) Which of the water chemistry variables is the most important in limiting ecotope dimensions of most hummock Sphagnum species?

In an attempt to answer these questions, concentrations of 6 mineral elements (Ca, Mg, Na, K, Fe, and S) are analysed in 9 hummock Sphagnum and in surface waters (Chapter IV). Plant material was obtained from cores cut into hummocks and water samples collected from the surface water that accumulated in the hole left by the coring device. Results show a relationship only between Ca and Mg concentrations in the water and concentrations in the moss. Relationships for other minerals were either not significant ($p > 0.05$) or not very important.

The relationship between Ca concentrations in Sphagnum and levels in surface waters increases in importance under conditions of monthly moisture deficits. Moisture deficits occur when evaporation is greater than precipitation (Malmström 1969). Monthly periods of moisture deficit occur in all climate zones, but are relative rare in hyper-oceanic areas. Conditions of high monthly moisture surpluses, where precipitation exceeds evaporation, are a common feature of hyper-oceanic areas and may occasionally occur in other climatic zones.

Under conditions of low precipitation and high evaporation, surface water and Ca ions in the water move upwards by capillary flow to the surface of the hummocks. Thus, Ca levels in the surface water affect Ca concentrations in the plants, particularly for species forming the taller hummocks. On sites with water surpluses, overall water movement in hummocks is downward, since precipitation exceeds evaporation. Under these humid conditions, rainwater provides an alternative source of Ca ions, reducing the effects of surface water on mineral concentrations in the moss (Damman 1986). Effects of surface water on concentrations in mosses occupying the taller hummocks is thus a function of evaporation at the surface of the hummocks.

High Ca concentrations combined with high pH values can be lethal to Sphagna (Clymo 1973). However, if Ca concentrations at high pHs are to limit the distribution of hummock-forming Sphagna effectively, surface waters must reach the capitula of the apically growing moss. Calcium concentrations in the capitula are affected by levels in the surface water for all species including S. fuscum, since moisture deficits occur in all climatic zones. Calcium and Mg ions that reach the capitulum are normally exchanged for H^+ ions at the surface of the dead hyaline cells, thus lowering the pH of the ambiant water (Killam 1982) and reducing the lethal effects of the surface water. Calcium will only become lethal if most of the cation-exchange sites are base saturated and the plants are incapable of reducing the pH of the ambiant water. Upper niche limits of Sphagnum on the Ca in surface water gradient reflect the cation-exchange capacity of each species and such species as S. fuscum and S. capillifolium that have high cation-exchange capacities also occupy wide niche dimensions on the Ca gradient. Results suggest, that with the exception of S. angustifolium, upper niche limits of hummock Sphagnum species on the Ca gradient are a function of concentrations in the capitula and of base saturation, which is determined by the cation-exchange capacity of the moss.

Ecotopes of hummock Sphagnum species are limited by mire surface water chemistry. However, surface water chemistry does not appear to limit the geographical distribution of those species, since all of the hummock species studied are found in waters having Ca concentrations of approximately 4 mg/L (Chapter III) and surface waters having these Ca concentrations occur in all climate zones (Chapter II). Monthly moisture deficits also occur in all climate zones in western Canada, thus all of the species studied are influenced by the upward movement of Ca in capillary waters. Surface water chemistry appears to be important in limiting the distribution of Sphagnum species within each climate zone (Chapter IV).

Growth of such species as S. jensenii, S. teres, S. lindbergii and S. papillosum that are found in pools, carpets, and/or lawns is also limited by the surface water chemistry (Chapter V). Several chemical variables are related to the growth of those species: corrected conductivity, pH, Ca, Mg, Na, K, SO_4^{--}, HCO_3^-, (NH_4^+)-N, and total phosphorus. However, effects of individual water chemistry variables on Sphagnum growth could not be determined from the experimental results.

The absence of suitable habitats in different climate zones does not affect the geographic distribution of mire Sphagnum species growing in pools, carpets, and/or lawns. Surface waters from different climate zones can have similar water chemistry, and growth for all species was not significantly different ($p > 0.05$) between waters having similar water chemistry, regardless of the geographic location from which the water was obtained. However, lack of suitable habitats on the water chemistry gradient may limit species within each climate zone.

In conclusion, climate is the most important environmental factor limiting Sphagnum ecotopes and habitats in western Canada. Surface water chemistry is also an important habitat and ecotope dimension of Sphagnum. However, water chemistry does not limit the geographical distribution of pool, carpet, lawn, or hummock species. Water chemistry would appear to be an important habitat limitation within each climate zone. The geographic distribution and habitats of Sphagna are not limited by the microtopographic gradient. Ecotopes of Sphagnum species however are limited by the height relative to the water table gradient. It would appear that peatlands in western Canada already have the necessary requirements on the height gradient to satisfy most Sphagnum species ecotope dimensions on this gradient. Overstory shade is not an important factor affecting the distribution and abundance of the mire Sphagnum species that were analysed in this study.

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VII. Appendix A.

Relative frequency of bryophyte species observed on twelve hummock-hollow complexes located on 27 peatlands in western Canada. Site numbering is the same as in Table II-1. Abbreviations correspond to the first three letters of the species names for Sphagnum, or the first three letters of the genus name for other bryophyte genera. Bryophyte nomenclature follows Table II-6. Variables measured at each complex include: distance (m) from margin (d), frequency for each species based on 50 measurements at each complex (frq), mean height (cm) above the water table (ht) ± standard deviation (sd), overstory shade (sh) measured on a scale from 0 to 10, where 0 indicates no shade and 10 indicates complete shade, and hydrogen ion concentrations (10^{-6}) (H), conductivity (μs) corrected to 20°C and for H ion concentrations (kc), elemental (Ca, Mg, Na, K, Al, Fe, Mn, Ni, S, P) concentrations (mg/L) in the surface water at the base of each complex. spa = Sphagnum palustre. pal = Paludella squarrosa.

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
1	1	5	cap	0.20	24.3	0.00	5.0	4.23	58.90	46.00	0.65
2	1	5	fus	0.84	32.3	5.00	5.0	4.23	58.90	46.00	0.65
3	1	10	aus	0.72	50.0	10.30	1.0	4.03	93.30	57.00	2.29
4	1	10	ple	0.02	52.9	0.00	1.0	4.03	93.30	57.00	2.29
5	1	15	fus	0.38	25.5	5.10	3.0	4.10	79.40	58.00	0.37
6	1	15	cap	0.02	33.2	0.00	3.0	4.10	79.40	58.00	0.37
7	1	15	aus	0.56	25.7	4.40	3.0	4.10	79.40	58.00	0.37
8	1	20	fus	0.32	25.7	3.20	1.0	4.19	64.60	43.00	0.45
9	1	20	aus	0.56	28.5	2.40	1.0	4.19	64.60	43.00	0.45
10	1	25	fus	0.10	33.5	3.90	3.0	4.11	77.60	37.00	0.35
11	1	25	aus	0.74	40.2	8.80	3.0	4.11	77.60	37.00	0.35
12	1	30	lin	0.14	7.2	3.30	0.5	4.20	63.10	41.00	0.61
13	1	30	aus	0.64	19.0	3.40	0.5	4.20	63.10	41.00	0.61
14	1	30	cap	0.08	20.5	3.10	0.5	4.20	63.10	41.00	0.61
15	1	30	fus	0.02	14.4	0.00	0.5	4.20	63.10	41.00	0.61
16	1	30	ple	0.02	19.1	0.00	0.5	4.20	63.10	41.00	0.61
17	1	35	aus	0.90	23.7	4.30	0.5	4.03	93.30	34.00	0.29
18	1	40	aus	1.00	42.7	10.20	0.5	4.03	93.30	45.00	1.37
19	1	45	aus	0.80	30.5	7.00	1.5	4.01	97.70	42.00	0.52
20	1	45	fus	0.04	40.7	0.30	1.5	4.01	97.70	42.00	0.52
21	1	50	lin	0.10	11.5	5.10	0.5	4.03	97.70	40.00	0.58
22	1	50	cap	0.04	14.0	4.20	0.5	4.03	97.70	40.00	0.58
23	1	50	fus	0.06	25.5	3.90	0.5	4.03	97.70	40.00	0.58
24	1	50	aus	0.80	29.9	7.90	0.5	4.03	97.70	40.00	0.58

OBS	MG	NA	K	AL	FE	MN	NI	S	P
1	0.83	5.46	0.38	0.14	7.14	0.16	0.85	0.54	0.03
2	0.83	5.46	0.38	0.14	7.14	0.16	0.85	0.54	0.03
3	0.66	9.23	3.16	1.83	2.08	0.05	0.23	0.80	0.24
4	0.66	9.23	3.16	1.83	2.08	0.05	0.23	0.80	0.24
5	0.48	6.31	2.06	0.06	0.43	0.01	0.09	0.28	0.03
6	0.48	6.31	2.06	0.06	0.43	0.01	0.09	0.28	0.03
7	0.48	6.31	2.06	0.06	0.43	0.01	0.09	0.28	0.03
8	0.32	5.07	0.46	0.04	0.53	0.01	0.07	0.65	0.06
9	0.32	5.07	0.46	0.04	0.53	0.01	0.07	0.65	0.06
10	0.30	4.50	0.64	0.10	1.41	0.03	0.20	0.46	0.03
11	0.30	4.50	0.64	0.10	1.41	0.03	0.20	0.46	0.03
12	0.64	5.57	0.80	0.03	1.21	0.03	0.15	0.19	0.03
13	0.64	5.57	0.80	0.03	1.21	0.03	0.15	0.19	0.03
14	0.64	5.57	0.80	0.03	1.21	0.03	0.15	0.19	0.03
15	0.64	5.57	0.80	0.03	1.21	0.03	0.15	0.19	0.03
16	0.64	5.57	0.80	0.03	1.21	0.03	0.15	0.19	0.03
17	0.64	6.26	0.97	0.06	3.16	0.07	0.41	0.35	0.03
18	1.16	7.13	1.31	0.08	5.07	0.11	0.58	0.63	0.03
19	0.60	5.87	0.56	0.04	4.19	0.11	0.62	0.34	0.03
20	0.60	5.87	0.56	0.04	4.19	0.11	0.62	0.34	0.03
21	0.79	5.62	0.71	0.03	0.51	0.01	0.07	0.27	0.03
22	0.79	5.62	0.71	0.03	0.51	0.01	0.07	0.27	0.03
23	0.79	5.62	0.71	0.03	0.51	0.01	0.07	0.27	0.03
24	0.79	5.62	0.71	0.03	0.51	0.01	0.07	0.27	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
25	1	45	pap	0.22	11.1	5.30	0.5	4.07	85.10	39.00	0.59
26	1	45	fus	0.02	27.3	0.00	0.5	4.07	85.10	39.00	0.59
27	1	45	aus	0.74	36.2	6.90	0.5	4.07	85.10	39.00	0.59
28	2	0	ang	0.18	27.1	2.10	7.0	4.79	16.20	11.30	2.02
29	2	0	aus	0.26	26.4	2.70	7.0	4.79	16.20	11.30	2.02
30	2	0	fus	0.50	28.5	2.80	7.0	4.79	16.20	11.30	2.02
31	2	0	cap	0.02	33.5	0.00	7.0	4.79	16.20	11.30	2.02
32	2	5	pal	0.16	42.4	9.10	3.0	4.35	44.70	1.00	1.30
33	2	5	fus	0.40	45.7	9.40	3.0	4.35	44.70	1.00	1.30
34	2	5	ple	0.14	49.7	1.90	3.0	4.35	44.70	1.00	1.30
35	2	5	hyl	0.30	58.5	3.50	3.0	4.35	44.70	1.00	1.30
36	2	15	pac	0.10	25.0	1.60	0.5	4.32	56.20	0.00	1.49
37	2	15	pap	0.10	30.4	6.80	0.5	4.32	56.20	0.00	1.49
38	2	15	aus	0.70	36.1	7.20	0.5	4.32	56.20	0.00	1.49
39	2	15	fus	0.10	37.0	5.30	0.5	4.32	56.20	0.00	1.49
40	2	10	pap	0.08	19.3	1.60	1.0	4.25	47.90	0.00	1.65
41	2	10	fus	0.26	21.3	1.90	1.0	4.25	47.90	0.00	1.65
42	2	10	pac	0.06	19.0	0.70	1.0	4.25	47.90	0.00	1.65
43	2	10	aus	0.60	22.4	2.20	1.0	4.25	47.90	0.00	1.65
44	2	20	pac	0.02	23.5	0.00	1.0	4.28	52.50	0.00	1.04
45	2	20	fus	0.80	25.8	3.60	1.0	4.28	52.50	0.00	1.04
46	2	20	aus	0.18	26.3	4.00	1.0	4.28	52.50	0.00	1.04
47	2	25	pac	0.12	25.9	4.40	5.0	4.20	60.00	0.00	0.89
48	2	25	fus	0.46	29.1	5.00	5.0	4.20	60.00	0.00	0.89

OBS	MG	NA	K	AL	FE	MN	NI	S	P
25	0.81	5.23	0.13	0.05	0.91	0.02	0.11	0.40	0.03
26	0.81	5.23	0.13	0.05	0.91	0.02	0.11	0.40	0.03
27	0.81	5.23	0.13	0.05	0.91	0.02	0.11	0.40	0.03
28	1.44	14.32	5.21	0.50	1.09	0.02	0.01	0.45	0.07
29	1.44	14.32	5.21	0.50	1.09	0.02	0.01	0.45	0.07
30	1.44	14.32	5.21	0.50	1.09	0.02	0.01	0.45	0.07
31	1.44	14.32	5.21	0.50	1.09	0.02	0.01	0.45	0.07
32	1.20	12.23	2.92	0.38	1.32	0.02	0.06	0.53	0.03
33	1.20	12.23	2.92	0.38	1.32	0.02	0.06	0.53	0.03
34	1.20	12.23	2.92	0.38	1.32	0.02	0.06	0.53	0.03
35	1.20	12.23	2.92	0.38	1.32	0.02	0.06	0.53	0.03
36	1.20	11.95	5.54	0.49	3.59	0.07	0.29	0.50	0.09
37	1.20	11.95	5.54	0.49	3.59	0.07	0.29	0.50	0.09
38	1.20	11.95	5.54	0.49	3.59	0.07	0.29	0.50	0.09
39	1.20	11.95	5.54	0.49	3.59	0.07	0.29	0.50	0.09
40	1.00	11.32	3.19	0.55	1.36	0.02	0.07	0.65	0.04
41	1.00	11.32	3.19	0.55	1.36	0.02	0.07	0.65	0.04
42	1.00	11.32	3.19	0.55	1.36	0.02	0.07	0.65	0.04
43	1.00	11.32	3.19	0.55	1.36	0.02	0.07	0.65	0.04
44	0.99	11.44	1.06	0.39	1.47	0.03	0.13	0.79	0.03
45	0.99	11.44	1.06	0.39	1.47	0.03	0.13	0.79	0.03
46	0.99	11.44	1.06	0.39	1.47	0.03	0.13	0.79	0.03
47	1.00	11.91	2.11	0.54	0.62	0.02	0.01	0.96	0.03
48	1.00	11.91	2.11	0.54	0.62	0.02	0.01	0.96	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
73	3	0	aus	0.30	31.1	4.90	8.0	4.86	13.80	10.20	1.64
74	3	0	fus	0.08	26.7	5.50	8.0	4.86	13.80	10.20	1.64
75	3	5	pac	0.14	27.6	8.70	4.0	4.56	27.50	3.90	1.89
76	3	5	aus	0.36	23.3	2.40	4.0	4.56	27.50	3.90	1.89
77	3	5	fus	0.42	29.2	9.20	4.0	4.56	27.50	3.90	1.89
78	3	5	cap	0.04	24.2	2.20	4.0	4.56	27.50	3.90	1.89
79	3	10	fus	0.32	29.7	4.00	5.0	4.47	33.90	1.30	1.42
80	3	10	aus	0.58	31.4	2.90	5.0	4.47	33.90	1.30	1.42
81	3	10	cap	0.06	29.2	3.40	5.0	4.47	33.90	1.30	1.42
82	3	15	fus	0.30	27.9	7.80	1.0	4.44	36.30	0.80	0.77
83	3	15	aus	0.66	33.7	8.10	1.0	4.44	36.30	0.80	0.77
84	3	20	pac	0.06	12.9	2.60	2.0	4.38	41.70	0.80	1.84
85	3	20	fus	0.02	36.1	0.00	2.0	4.38	41.70	0.80	1.84
86	3	20	aus	0.90	30.3	3.50	2.0	4.38	41.70	0.80	1.84
87	3	25	pac	0.08	40.3	1.60	2.0	4.39	40.70	0.80	1.14
88	3	25	fus	0.26	30.8	4.80	2.0	4.39	40.70	0.80	1.14
89	3	25	aus	0.66	31.8	6.10	2.0	4.39	40.70	0.80	1.14
90	3	30	fus	0.10	44.6	6.00	1.5	4.42	38.00	0.80	0.59
91	3	30	aus	0.90	36.2	7.30	1.5	4.42	38.00	0.80	0.59
92	3	35	fus	0.40	47.3	6.50	3.0	4.46	34.70	2.90	1.36
93	3	35	aus	0.54	45.4	7.40	3.0	4.46	34.70	2.90	1.36
94	3	35	hyl	0.02	58.4	0.00	3.0	4.46	34.70	2.90	1.36
95	3	35	ple	0.04	57.6	1.80	3.0	4.46	34.70	2.90	1.36
96	3	30	aus	0.98	39.1	12.30	4.0	4.30	50.10	0.00	1.07

OBS	MG	NA	K	AL	FE	MN	NI	S	P
73	1.11	15.07	4.88	0.57	6.41	0.14	0.71	0.66	0.23
74	1.11	15.07	4.88	0.57	6.41	0.14	0.71	0.66	0.23
75	1.75	13.46	3.22	0.31	4.27	0.10	2.53	0.55	0.03
76	1.75	13.46	3.22	0.31	4.27	0.10	2.53	0.55	0.03
77	1.75	13.46	3.22	0.31	4.27	0.10	2.53	0.55	0.03
78	1.75	13.46	3.22	0.31	4.27	0.10	2.53	0.55	0.03
79	1.60	12.58	0.27	0.38	2.22	0.07	0.19	0.48	0.03
80	1.60	12.58	0.27	0.38	2.22	0.07	0.19	0.48	0.03
81	1.60	12.58	0.27	0.38	2.22	0.07	0.19	0.48	0.03
82	0.74	12.17	2.33	0.22	3.30	0.07	0.32	0.65	0.03
83	0.74	12.17	2.33	0.22	3.30	0.07	0.32	0.65	0.03
84	1.74	14.77	1.49	0.44	2.56	0.04	0.14	0.85	0.03
85	1.74	14.77	1.49	0.44	2.56	0.04	0.14	0.85	0.03
86	1.74	14.77	1.49	0.44	2.56	0.04	0.14	0.85	0.03
87	1.41	13.68	1.21	0.29	0.53	0.01	0.02	1.14	0.03
88	1.41	13.68	1.21	0.29	0.53	0.01	0.02	1.14	0.03
89	1.41	13.68	1.21	0.29	0.53	0.01	0.02	1.14	0.03
90	0.86	12.61	2.07	0.24	2.48	0.06	0.04	0.47	0.05
91	0.86	12.61	2.07	0.24	2.48	0.06	0.04	0.47	0.05
92	1.55	13.74	0.73	0.23	0.67	0.02	0.17	0.76	0.03
93	1.55	13.74	0.73	0.23	0.67	0.02	0.17	0.76	0.03
94	1.55	13.74	0.73	0.23	0.67	0.02	0.17	0.76	0.03
95	1.55	13.74	0.73	0.23	0.67	0.02	0.17	0.76	0.03
96	1.24	15.81	3.35	0.30	1.95	0.04	0.17	0.76	1.16

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
97	3	30	pac	0.02	13.3	0.00	4.0	4.30	50.10	0.00	1.07
98	3	25	fus	0.54	37.4	11.40	2.0	4.27	53.70	0.00	0.53
99	3	25	aus	0.36	31.5	10.60	2.0	4.27	53.70	0.00	0.53
100	3	25	rub	0.10	25.8	4.40	2.0	4.27	53.70	0.00	0.53
101	3	20	ang	0.04	26.3	4.00	5.0	4.25	56.20	0.00	1.30
102	3	20	aus	0.64	34.2	5.80	5.0	4.25	56.20	0.00	1.30
103	3	20	fus	0.30	32.1	3.50	5.0	4.25	56.20	0.00	1.30
104	3	20	cap	0.02	46.6	0.00	5.0	4.25	56.20	0.00	1.30
105	3	15	fus	0.32	45.1	6.70	3.0	4.21	61.70	0.00	0.67
106	3	15	aus	0.68	45.0	4.60	3.0	4.21	61.70	0.00	0.67
107	4	0	rub	0.22	43.0	6.30	7.0	4.38	41.70	15.00	0.58
108	4	0	mag	0.88	40.7	9.90	7.0	4.38	41.70	15.00	0.58
109	4	10	pap	0.39	6.5	2.60	2.0	4.05	89.10	6.00	0.31
110	4	10	rub	0.49	6.5	3.50	2.0	4.05	89.10	6.00	0.31
111	4	10	fus	0.12	13.8	3.70	2.0	4.05	89.10	6.00	0.31
112	4	5	pap	0.39	10.9	4.90	2.0	4.18	66.10	9.00	0.23
113	4	5	lin	0.02	6.1	0.00	2.0	4.18	66.10	9.00	0.23
114	4	5	mag	0.49	13.9	4.20	2.0	4.18	66.10	9.00	0.23
115	4	5	rub	0.10	10.5	6.70	2.0	4.18	66.10	9.00	0.23
116	4	15	lin	0.04	2.4	6.90	1.0	4.32	47.90	5.00	0.12
117	4	15	pap	0.42	11.4	2.80	1.0	4.32	47.90	5.00	0.12
118	4	15	rub	0.26	10.3	2.50	1.0	4.32	47.90	5.00	0.12
119	4	15	mag	0.24	12.6	3.30	1.0	4.32	47.90	5.00	0.12
120	4	15	fus	0.04	16.5	0.90	1.0	4.32	47.90	5.00	0.12

OBS	MG	NA	K	AL	FE	MN	NI	S	P
97	1.24	15.81	3.35	0.30	1.95	0.04	0.17	0.76	1.16
98	0.76	13.89	1.90	0.11	4.93	0.11	0.58	0.10	1.16
99	0.76	13.89	1.90	0.11	4.93	0.11	0.58	0.10	1.16
100	0.76	13.89	1.90	0.11	4.93	0.11	0.58	0.10	1.16
101	1.48	14.46	1.74	0.25	5.39	0.13	0.58	0.60	0.03
102	1.48	14.46	1.74	0.25	5.39	0.13	0.58	0.60	0.03
103	1.48	14.46	1.74	0.25	5.39	0.13	0.58	0.60	0.03
104	1.48	14.46	1.74	0.25	5.39	0.13	0.58	0.60	0.03
105	1.13	13.82	1.34	0.20	2.52	0.05	0.25	1.38	0.03
106	1.13	13.82	1.34	0.20	2.52	0.05	0.25	1.38	0.03
107	0.22	4.15	1.40	0.03	1.50	0.05	0.23	1.08	0.14
108	0.22	4.15	1.40	0.03	1.50	0.05	0.23	1.08	0.14
109	0.28	1.97	0.26	0.03	0.80	0.02	0.10	0.81	0.11
110	0.28	1.97	0.26	0.03	0.80	0.02	0.10	0.81	0.11
111	0.28	1.97	0.26	0.03	0.80	0.02	0.10	0.81	0.11
112	0.26	2.41	0.65	0.03	1.05	0.03	0.19	0.71	0.05
113	0.26	2.41	0.65	0.03	1.05	0.03	0.19	0.71	0.05
114	0.26	2.41	0.65	0.03	1.05	0.03	0.19	0.71	0.05
115	0.26	2.41	0.65	0.03	1.05	0.03	0.19	0.71	0.05
116	0.13	1.97	0.18	0.03	0.66	0.03	0.09	0.87	0.03
117	0.13	1.97	0.18	0.03	0.66	0.03	0.09	0.87	0.03
118	0.13	1.97	0.18	0.03	0.66	0.03	0.09	0.87	0.03
119	0.13	1.97	0.18	0.03	0.66	0.03	0.09	0.87	0.03
120	0.13	1.97	0.18	0.03	0.66	0.03	0.09	0.87	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
121	4	25	lin	0.18	5.3	1.90	2.0	4.13	74.10	6.00	0.18
122	4	25	pap	0.49	6.1	3.50	2.0	4.13	74.10	6.00	0.18
123	4	25	rub	0.10	3.7	4.10	2.0	4.13	74.10	6.00	0.18
124	4	25	mag	0.23	8.3	2.20	2.0	4.13	74.10	6.00	0.18
125	4	30	cap	0.41	15.6	5.60	4.0	4.11	77.60	0.00	0.22
126	4	30	fus	0.18	21.6	6.50	4.0	4.11	77.60	0.00	0.22
127	4	30	aus	0.41	22.9	4.60	4.0	4.11	77.60	0.00	0.22
128	4	25	aus	0.31	24.3	5.10	1.0	4.16	69.20	3.00	1.51
129	4	25	mag	0.51	28.4	4.00	1.0	4.16	69.20	3.00	1.51
130	4	25	cap	0.18	24.3	4.40	1.0	4.16	69.20	3.00	1.51
131	4	0	ang	0.28	21.4	2.20	8.0	4.12	75.90	0.00	0.33
132	4	0	cap	0.72	40.4	10.10	8.0	4.12	75.90	0.00	0.33
133	4	30	rub	0.06	28.5	12.20	2.0	4.00	100.00	14.00	3.98
134	4	30	fus	0.28	27.5	5.20	2.0	4.00	100.00	14.00	3.98
135	4	35	rub	0.28	19.5	3.70	1.0	4.00	100.00	0.00	0.34
136	4	35	fus	0.06	24.5	4.90	1.0	4.00	100.00	0.00	0.34
137	4	35	aus	0.60	17.0	5.60	1.0	4.00	100.00	0.00	0.34
138	4	25	fus	0.24	34.1	13.10	6.0	4.00	100.00	6.00	0.45
139	4	25	aus	0.62	24.8	11.30	6.0	4.00	100.00	6.00	0.45
140	4	25	rub	0.02	27.2	0.00	6.0	4.00	100.00	6.00	0.45
141	4	25	lan	0.08	25.0	16.10	6.0	4.00	100.00	6.00	0.45
142	5	20	pap	0.80	6.7	3.20	2.0	3.97	107.20	3.00	0.22
143	5	20	rub	0.20	8.2	3.10	2.0	3.97	107.20	3.00	0.22
144	5	18	lin	0.66	4.7	3.40	2.0	4.75	17.80	19.00	1.20

OBS	MG	NA	K	AL	FE	MN	NI	S	P
121	0.18	2.16	0.25	0.03	1.19	0.03	0.16	0.71	0.03
122	0.18	2.16	0.25	0.03	1.19	0.03	0.16	0.71	0.03
123	0.18	2.16	0.25	0.03	1.19	0.03	0.16	0.71	0.03
124	0.18	2.16	0.25	0.03	1.19	0.03	0.16	0.71	0.03
125	0.53	1.79	0.12	0.03	0.05	0.01	0.02	1.37	0.03
126	0.53	1.79	0.12	0.03	0.05	0.01	0.02	1.37	0.03
127	0.53	1.79	0.12	0.03	0.05	0.01	0.02	1.37	0.03
128	0.23	7.31	10.69	0.03	0.22	0.01	0.01	1.79	0.03
129	0.23	7.31	10.69	0.03	0.22	0.01	0.01	1.79	0.03
130	0.23	7.31	10.69	0.03	0.22	0.01	0.01	1.79	0.03
131	0.02	1.50	0.01	0.03	1.53	0.03	0.17	0.29	0.03
132	0.02	1.50	0.01	0.03	1.53	0.03	0.17	0.29	0.03
133	0.57	6.18	4.17	0.36	0.61	0.02	0.03	0.84	0.44
134	0.57	6.18	4.17	0.36	0.61	0.02	0.03	0.84	0.44
135	0.26	1.70	0.40	0.07	0.38	0.01	0.02	0.41	0.03
136	0.26	1.70	0.40	0.07	0.38	0.01	0.02	0.41	0.03
137	0.26	1.70	0.40	0.07	0.38	0.01	0.02	0.41	0.03
138	0.30	1.85	1.49	0.05	0.61	0.03	0.02	0.34	0.03
139	0.30	1.85	1.49	0.05	0.61	0.03	0.02	0.34	0.03
140	0.30	1.85	1.49	0.05	0.61	0.03	0.02	0.34	0.03
141	0.30	1.85	1.49	0.05	0.61	0.03	0.02	0.34	0.03
142	0.31	1.98	0.12	0.11	2.06	0.05	0.24	0.34	0.03
143	0.31	1.98	0.12	0.11	2.06	0.05	0.24	0.34	0.03
144	0.30	1.75	1.19	0.05	2.42	0.08	0.26	0.91	0.05

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
145	5	18	ten	0.17	4.9	2.90	2.0	4.75	17.80	19.00	1.20
146	5	18	rub	0.17	11.3	0.80	2.0	4.75	17.80	19.00	1.20
147	5	0	lin	0.59	5.7	3.80	8.0	4.23	58.90	12.00	2.20
148	5	0	rub	0.39	12.3	4.90	8.0	4.23	58.90	12.00	2.20
149	5	0	pap	0.02	17.2	0.00	8.0	4.23	58.90	12.00	2.20
150	5	0	pac	0.69	29.6	1.90	2.0	3.90	125.90	0.00	0.09
151	5	0	cap	0.13	25.4	0.50	2.0	3.90	125.90	0.00	0.09
152	5	0	aus	0.19	28.8	1.80	2.0	3.90	125.90	0.00	0.09
153	5	70	lin	0.24	1.7	4.30	2.0	4.95	125.90	0.00	8.69
154	5	70	mag	0.42	16.5	5.20	2.0	4.95	11.20	29.00	8.69
155	5	70	rub	0.26	15.4	3.60	2.0	4.95	11.20	29.00	8.69
156	5	70	pap	0.02	11.8	0.00	2.0	4.95	11.20	29.00	8.69
157	5	70	fus	0.06	20.0	3.40	2.0	4.95	11.20	29.00	8.69
158	5	10	fus	0.08	35.4	3.60	7.0	3.70	11.20	29.00	0.03
159	5	10	pac	0.34	30.1	3.70	7.0	3.70	199.50	0.00	0.03
160	5	10	aus	0.30	32.3	5.50	7.0	3.70	199.50	0.00	0.03
161	5	10	cap	0.26	34.1	3.90	7.0	3.70	199.50	0.00	0.03
162	5	75	cap	1.00	34.9	6.30	6.0	3.90	199.50	0.00	0.35
163	6	0	rip	0.34	0.2	1.50	9.0	6.15	0.70	23.00	0.92
164	6	0	ang	0.62	10.0	5.60	9.0	6.15	0.70	23.00	0.92
165	6	0	rub	0.02	10.0	0.00	9.0	6.15	0.70	23.00	0.92
166	6	0	pap	0.02	17.0	0.00	9.0	6.15	0.70	23.00	0.92
167	6	5	ang	0.30	38.0	2.80	2.0	4.52	30.20	38.00	0.30
168	6	5	rub	0.18	38.7	2.40	2.0	4.52	30.20	38.00	0.30

OBS	MG	NA	K	AL	FE	MN	NI	S	P
145	0.30	1.75	1.19	0.05	2.42	0.08	0.26	0.91	0.05
146	0.30	1.75	1.19	0.05	2.42	0.08	0.26	0.91	0.05
147	1.92	2.61	2.20	0.24	3.62	0.11	0.16	0.54	0.08
148	1.92	2.61	2.20	0.24	3.62	0.11	0.16	0.54	0.08
149	1.92	2.61	2.20	0.24	3.62	0.11	0.16	0.54	0.08
150	0.16	2.11	0.70	0.11	0.02	0.00	0.01	0.67	0.03
151	0.16	2.11	0.70	0.11	0.02	0.00	0.01	0.67	0.03
152	0.16	2.11	0.70	0.11	0.02	0.00	0.01	0.67	0.03
153	1.01	2.44	2.40	0.15	6.03	0.13	0.40	0.89	0.21
154	1.01	2.44	2.40	0.15	6.03	0.13	0.40	0.89	0.21
155	1.01	2.44	2.40	0.15	6.03	0.13	0.40	0.89	0.21
156	1.01	2.44	2.40	0.15	6.03	0.13	0.40	0.89	0.21
157	1.01	2.44	2.40	0.15	6.03	0.13	0.40	0.89	0.21
158	0.08	1.42	0.24	0.14	0.02	0.00	0.01	0.19	0.03
159	0.08	1.42	0.24	0.14	0.02	0.00	0.01	0.19	0.03
160	0.08	1.42	0.24	0.14	0.02	0.00	0.01	0.19	0.03
161	0.08	1.42	0.24	0.14	0.02	0.00	0.01	0.19	0.03
162	0.15	0.97	0.10	0.06	0.23	0.00	0.01	0.51	0.05
163	0.14	2.11	0.14	0.17	1.24	0.03	0.07	0.42	0.06
164	0.14	2.11	0.14	0.17	1.24	0.03	0.07	0.42	0.06
165	0.14	2.11	0.14	0.17	1.24	0.03	0.07	0.42	0.06
166	0.14	2.11	0.14	0.17	1.24	0.03	0.07	0.42	0.06
167	0.13	2.91	2.17	0.03	2.37	0.04	0.13	0.61	0.03
168	0.13	2.91	2.17	0.03	2.37	0.04	0.13	0.61	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
169	6	5	mag	0.48	42.8	4.30	2.0	4.52	30.20	38.00	0.30
170	6	5	fus	0.04	36.3	0.40	2.0	4.52	30.20	38.00	0.30
171	6	10	aus	0.20	39.9	3.40	3.0	4.23	58.90	9.00	0.28
172	6	10	cap	0.80	46.2	7.80	3.0	4.23	58.90	9.00	0.28
173	6	15	pap	0.58	10.5	4.60	1.0	3.99	100.00	16.00	0.26
174	6	15	rub	0.42	11.9	3.00	1.0	3.99	100.00	16.00	0.26
175	6	20	rub	0.15	15.5	3.10	2.5	4.11	77.60	17.00	0.50
176	6	20	pap	0.77	17.4	4.60	2.5	4.11	77.60	17.00	0.50
177	6	20	fus	0.08	16.8	3.70	2.5	4.11	77.60	17.00	0.50
178	6	25	aus	1.00	74.9	6.10	2.0	4.10	79.40	21.00	0.34
179	6	30	lin	0.06	5.5	2.50	2.0	4.08	83.20	22.00	0.23
180	6	30	pap	0.73	13.0	5.90	2.0	4.08	83.20	22.00	0.23
181	6	30	rub	0.16	18.2	6.80	2.0	4.08	83.20	22.00	0.23
182	6	30	fus	0.04	26.1	1.80	2.0	4.08	83.20	22.00	0.23
183	6	25	cap	0.17	32.5	14.30	4.0	4.05	89.10	39.00	0.60
184	6	25	aus	0.83	36.6	12.40	4.0	4.05	89.10	39.00	0.60
185	6	20	lin	0.02	3.1	0.00	0.0	4.00	100.00	31.00	1.10
186	6	20	pap	0.70	12.9	5.90	0.0	4.00	100.00	31.00	1.10
187	6	20	rub	0.27	13.3	5.10	0.0	4.00	100.00	31.00	1.10
188	6	15	lin	0.39	10.1	2.80	1.0	4.10	79.40	2.00	0.42
189	6	15	rub	0.15	16.5	3.80	1.0	4.10	79.40	2.00	0.42
190	6	15	pap	0.31	13.9	2.60	1.0	4.10	79.40	2.00	0.42
191	6	15	fus	0.15	20.5	1.50	1.0	4.10	79.40	2.00	0.42
192	6	10	cap	1.00	69.9	9.20	1.0	4.31	49.00	14.00	0.50

OBS	MG	NA	K	AL	FE	MN	NI	S	P
169	0.13	2.91	2.17	0.03	2.37	0.04	0.13	0.61	0.03
170	0.13	2.91	2.17	0.03	2.37	0.04	0.13	0.61	0.03
171	0.17	1.79	0.73	0.05	0.99	0.02	0.08	0.40	0.03
172	0.17	1.79	0.73	0.05	0.99	0.02	0.08	0.40	0.03
173	0.20	1.68	0.55	0.04	1.34	0.03	0.14	0.32	0.03
174	0.20	1.68	0.55	0.04	1.34	0.03	0.14	0.32	0.03
175	0.22	2.13	0.40	0.03	1.61	0.03	0.12	0.57	0.03
176	0.22	2.13	0.40	0.03	1.61	0.03	0.12	0.57	0.03
177	0.22	2.13	0.40	0.03	1.61	0.03	0.12	0.57	0.03
178	0.19	3.38	1.16	0.03	2.42	0.05	0.26	0.46	0.04
179	0.26	2.68	0.24	0.03	1.52	0.03	0.19	0.73	0.03
180	0.26	2.68	0.24	0.03	1.52	0.03	0.19	0.73	0.03
181	0.26	2.68	0.24	0.03	1.52	0.03	0.19	0.73	0.03
132	0.26	2.68	0.24	0.03	1.52	0.03	0.19	0.73	0.03
183	0.37	3.76	1.27	0.06	3.31	0.08	0.38	1.10	0.03
184	0.37	3.76	1.27	0.06	3.31	0.08	0.38	1.10	0.03
185	0.61	3.32	1.63	0.03	1.78	0.09	0.22	1.12	0.03
186	0.61	3.32	1.63	0.03	1.78	0.09	0.22	1.12	0.03
187	0.61	3.32	1.63	0.03	1.78	0.09	0.22	1.12	0.03
188	0.28	3.11	0.24	0.09	0.89	0.02	0.08	0.73	0.03
189	0.28	3.11	0.24	0.09	0.89	0.02	0.08	0.73	0.03
190	0.28	3.11	0.24	0.09	0.89	0.02	0.08	0.73	0.03
191	0.28	3.11	0.24	0.09	0.89	0.02	0.08	0.73	0.03
192	0.23	2.97	0.56	1.08	1.59	0.02	0.04	1.41	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
193	6	5	cap	0.58	77.2	6.50	1.0	3.99	100.00	0.00	0.49
194	6	5	aus	0.42	71.1	3.10	1.0	3.99	100.00	0.00	0.49
195	7	10	cap	0.25	35.4	0.35	4.0	6.29	0.50	548.00	22.98
196	7	10	ang	0.19	36.5	5.50	4.0	6.29	0.50	548.00	22.98
197	7	10	fus	0.42	40.1	5.20	4.0	6.29	0.50	548.00	22.98
198	7	10	pap	0.15	46.0	1.60	4.0	6.29	0.50	548.00	22.98
199	7	12	pap	0.38	8.1	3.40	4.0	6.24	0.60	400.00	17.37
200	7	12	rub	0.63	13.8	3.20	4.0	6.24	0.60	400.00	17.37
201	7	17	lin	0.28	12.7	1.90	2.0	5.36	4.40	81.44	7.75
202	7	17	pap	0.41	16.3	5.60	2.0	5.36	4.40	81.44	7.75
203	7	17	rub	0.20	1.5	2.20	2.0	5.36	4.40	81.44	7.75
204	7	17	fus	0.11	23.2	1.10	2.0	5.36	4.40	81.44	7.75
205	7	22	pap	0.60	12.0	4.70	2.5	5.15	7.10	61.00	5.93
206	7	22	rub	0.38	19.3	3.60	2.5	5.15	7.10	61.00	5.93
207	7	22	fus	0.02	25.3	0.00	2.5	5.15	7.10	61.00	5.93
208	7	27	rub	0.39	26.2	4.90	4.0	5.12	7.60	73.00	5.85
209	7	27	fus	0.47	26.0	3.90	4.0	5.12	7.60	73.00	5.85
210	7	27	pap	0.14	25.4	5.60	4.0	5.12	7.60	73.00	5.85
211	7	32	pap	0.50	13.7	3.30	7.0	5.04	9.10	67.21	25.11
212	7	32	rub	0.50	14.6	2.60	7.0	5.04	9.10	67.21	25.11
213	7	40	ten	0.02	12.6	0.00	3.0	4.30	50.10	16.00	2.26
214	7	40	rub	0.66	12.5	4.00	3.0	4.30	50.10	16.00	2.26
215	7	40	fus	0.12	13.9	1.20	3.0	4.30	50.10	16.00	2.26
216	7	55	ten	0.22	10.6	3.40	1.0	3.90	125.90	10.00	0.46

OBS	MG	NA	K	AL	FE	MN	NI	S	P
193	0.03	2.12	0.01	0.03	0.35	0.01	0.03	0.66	0.03
194	0.03	2.12	0.01	0.03	0.35	0.01	0.03	0.66	0.03
195	1.18	9.5[illegible]	7.96	0.03	0.21	0.00	0.05	3.13	0.03
196	1.18	9.55	7.96	0.03	0.21	0.00	0.05	3.13	0.03
197	1.18	9.55	7.96	0.03	0.21	0.00	0.05	3.13	0.03
198	1.18	9.55	7.96	0.03	0.21	0.00	0.05	3.13	0.03
199	1.21	7.16	5.11	0.03	0.20	0.00	0.01	3.08	0.03
200	1.21	7.16	5.11	0.03	0.20	0.00	0.01	3.08	0.03
201	0.84	6.43	0.72	0.03	0.34	0.19	0.02	2.46	0.03
202	0.84	6.43	0.72	0.03	0.34	0.19	0.02	2.46	0.03
203	0.84	6.43	0.72	0.03	0.34	0.19	0.02	2.46	0.03
204	0.84	6.43	0.72	0.03	0.34	0.19	0.02	2.46	0.03
205	0.84	3.48	1.84	0.09	0.85	0.05	0.04	2.26	0.03
206	0.84	3.48	1.84	0.09	0.85	0.05	0.04	2.26	0.03
207	0.84	3.48	1.84	0.09	0.85	0.05	0.04	2.26	0.03
208	0.70	4.60	4.81	0.11	1.39	0.17	0.04	3.25	0.13
209	0.70	4.60	4.81	0.11	1.39	0.17	0.04	3.25	0.13
210	0.70	4.60	4.81	0.11	1.39	0.17	0.04	3.25	0.13
211	2.47	5.31	3.71	0.34	5.51	0.08	0.12	1.62	0.14
212	2.47	5.31	3.71	0.34	5.51	0.08	0.12	1.62	0.14
213	0.41	2.46	0.74	0.11	0.76	0.02	0.02	0.45	0.03
214	0.41	2.46	0.74	0.11	0.76	0.02	0.02	0.45	0.03
215	0.41	2.46	0.74	0.11	0.76	0.02	0.02	0.45	0.03
216	0.49	2.69	0.24	0.15	0.40	0.01	0.02	1.45	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
217	7	55	rub	0.06	13.3	2.00	1.0	3.90	125.90	10.00	0.46
218	7	55	pap	0.30	15.3	1.40	1.0	3.90	125.90	10.00	0.46
219	7	55	fus	0.38	14.0	2.80	1.0	3.90	125.90	10.00	0.46
220	7	50	ten	0.18	4.4	3.50	0.5	3.80	158.50	4.00	0.95
221	7	50	pap	0.04	5.9	2.10	0.5	3.80	158.50	4.00	0.95
222	7	50	rub	0.42	13.7	3.20	0.5	3.80	158.50	4.00	0.95
223	7	50	fus	0.30	17.0	1.40	0.5	3.80	158.50	4.00	0.95
224	7	50	lan	0.04	16.1	0.00	0.5	3.80	158.50	4.00	0.95
225	8	0	pac	0.09	50.6	0.50	7.0	6.64	0.20	345.00	45.57
226	8	0	fus	0.31	57.8	3.60	7.0	6.64	0.20	345.00	45.57
227	8	0	cap	0.60	59.7	3.80	7.0	6.64	0.20	345.00	45.57
228	8	5	pap	0.08	7.7	7.80	5.0	4.68	20.90	60.00	2.89
229	8	5	rub	0.18	16.5	4.00	5.0	4.68	20.90	60.00	2.89
230	8	5	pac	0.33	22.1	3.80	5.0	4.68	20.90	60.00	2.89
231	8	5	fus	0.41	25.6	1.90	5.0	4.68	20.90	60.00	2.89
232	8	15	pap	0.53	14.6	3.80	2.0	5.17	6.80	49.00	3.55
233	8	15	rub	0.47	14.8	3.30	2.0	5.17	6.80	49.00	3.55
234	8	20	lin	0.56	3.0	2.80	1.0	4.29	51.30	64.00	1.81
235	8	20	pap	0.33	9.8	4.60	1.0	4.29	51.30	64.00	1.81
236	8	20	rub	0.10	16.8	2.50	1.0	4.29	51.30	64.00	1.81
237	8	20	fus	0.02	25.9	0.00	1.0	4.29	51.30	64.00	1.81
238	8	25	pap	0.36	21.0	6.80	3.0	4.42	38.00	45.00	1.83
239	8	25	ang	0.20	12.7	6.80	3.0	4.42	38.00	45.00	1.83
240	8	25	rub	0.37	21.3	6.80	3.0	4.42	38.00	45.00	1.83

OBS	MG	NA	K	AL	FE	MN	NI	S	P
217	0.49	2.69	0.24	0.15	0.40	0.01	0.02	1.45	0.03
218	0.49	2.69	0.24	0.15	0.40	0.01	0.02	1.45	0.03
219	0.49	2.69	0.24	0.15	0.40	0.01	0.02	1.45	0.03
220	0.54	3.51	1.30	0.08	0.46	0.02	0.02	1.55	0.03
221	0.54	3.51	1.30	0.08	0.46	0.02	0.02	1.55	0.03
222	0.54	3.51	1.30	0.08	0.46	0.02	0.02	1.55	0.03
223	0.54	3.51	1.30	0.08	0.46	0.02	0.02	1.55	0.03
224	0.54	3.51	1.30	0.08	0.46	0.02	0.02	1.55	0.03
225	2.11	19.95	6.78	0.16	3.29	0.21	0.06	7.72	0.06
226	2.11	19.95	6.78	0.16	3.29	0.21	0.06	7.72	0.06
227	2.11	19.95	6.78	0.16	3.29	0.21	0.06	7.72	0.06
228	0.48	5.17	1.25	0.21	1.01	0.09	0.08	2.63	0.08
229	0.48	5.17	1.25	0.21	1.01	0.09	0.08	2.63	0.08
230	0.48	5.17	1.25	0.21	1.01	0.09	0.08	2.63	0.08
231	0.48	5.17	1.25	0.21	1.01	0.09	0.08	2.63	0.08
232	0.49	3.93	1.86	0.14	2.38	0.05	0.09	0.77	0.03
233	0.49	3.93	1.86	0.14	2.38	0.05	0.09	0.77	0.03
234	0.61	3.85	1.46	0.12	4.04	0.09	0.30	1.89	0.08
235	0.61	3.85	1.46	0.12	4.04	0.09	0.30	1.89	0.08
236	0.61	3.85	1.46	0.12	4.04	0.09	0.30	1.89	0.08
237	0.61	3.85	1.46	0.12	4.04	0.09	0.30	1.89	0.08
238	0.41	4.54	1.19	0.20	3.11	0.05	0.15	1.97	0.05
239	0.41	4.54	1.19	0.20	3.11	0.05	0.15	1.97	0.05
240	0.41	4.54	1.19	0.20	3.11	0.05	0.15	1.97	0.05

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
241	8	25	fus	0.06	25.6	3.10	3.0	4.42	38.00	45.00	1.83
242	8	30	pap	0.21	11.7	3.30	1.0	4.69	20.40	37.00	15.61
243	8	30	rub	0.31	14.8	3.30	1.0	4.69	20.40	37.00	15.61
244	8	30	fus	0.48	17.0	2.50	1.0	4.69	20.40	37.00	15.61
245	8	25	lin	0.93	9.5	18.20	1.0	4.81	15.50	53.00	1.76
246	8	25	pap	0.07	7.4	3.40	1.0	4.81	15.50	53.00	1.76
247	8	10	pap	0.54	17.1	5.60	2.0	5.12	7.60	56.00	3.04
248	8	10	rub	0.36	18.7	4.70	2.0	5.12	7.60	56.00	3.04
249	8	10	fus	0.09	24.9	2.30	2.0	5.12	7.60	56.00	3.04
250	8	10	rub	0.54	26.0	2.30	0.5	5.20	6.30	268.00	56.41
251	8	10	fus	0.02	27.3	0.00	0.5	5.20	6.30	268.00	56.41
252	8	10	pap	0.38	25.6	2.40	0.5	5.20	6.30	268.00	56.41
253	8	10	mag	0.02	27.2	0.00	0.5	5.20	6.30	268.00	56.41
254	8	5	rub	0.32	16.6	3.30	1.0	5.10	7.90	114.00	19.26
255	8	5	ang	0.08	18.3	2.30	1.0	5.10	7.90	114.00	19.26
256	8	5	pap	0.38	17.2	2.90	1.0	5.10	7.90	114.00	19.26
257	8	5	fus	0.02	22.0	0.00	1.0	5.10	7.90	114.00	19.26
258	8	5	mag	0.08	20.1	1.60	1.0	5.10	7.90	114.00	19.26
259	8	0	lin	0.18	12.6	7.90	5.0	4.70	20.00	49.00	7.40
260	8	0	rub	0.18	13.5	3.00	5.0	4.70	20.00	49.00	7.40
261	8	0	ang	0.02	9.1	0.00	5.0	4.70	20.00	49.00	7.40
262	8	0	pac	0.34	11.3	3.70	5.0	4.70	20.00	49.00	7.40
263	8	0	mag	0.10	14.6	2.30	5.0	4.70	20.00	49.00	7.40
264	8	30	mag	0.06	19.3	2.00	2.0	4.00	3.00	30.00	3.98

OBS	MG	NA	K	AL	FE	MN	NI	S	P
241	0.41	4.54	1.19	0.20	3.11	0.05	0.15	1.97	0.05
242	1.94	4.96	1.33	0.33	12.27	0.20	0.15	1.16	0.05
243	1.94	4.96	1.33	0.33	12.27	0.20	0.15	1.16	0.05
244	1.94	4.96	1.33	0.33	12.27	0.20	0.15	1.16	0.05
245	0.46	4.64	2.15	0.20	5.04	0.10	0.34	2.99	0.10
246	0.46	4.64	2.15	0.20	5.04	0.10	0.34	2.99	0.10
247	0.48	6.61	0.92	0.09	1.52	0.07	0.05	0.15	0.03
248	0.48	6.61	0.92	0.09	1.52	0.07	0.05	0.15	0.03
249	0.48	6.61	0.92	0.09	1.52	0.07	0.05	0.15	0.03
250	2.91	14.16	4.89	0.14	3.56	2.99	0.10	12.90	0.03
251	2.91	14.16	4.89	0.14	3.56	2.99	0.10	12.90	0.03
252	2.91	14.16	4.89	0.14	3.56	2.99	0.10	12.90	0.03
253	2.91	14.16	4.89	0.14	3.56	2.99	0.10	12.90	0.03
254	1.24	8.03	1.39	0.11	0.97	0.06	0.08	4.63	0.03
255	1.24	8.03	1.39	0.11	0.97	0.06	0.08	4.63	0.03
256	1.24	8.03	1.39	0.11	0.97	0.06	0.08	4.63	0.03
257	1.24	8.03	1.39	0.11	0.97	0.06	0.08	4.63	0.03
258	1.24	8.03	1.39	0.11	0.97	0.06	0.08	4.63	0.03
259	0.89	4.76	1.12	0.35	1.32	0.16	0.05	2.63	0.03
260	0.89	4.76	1.12	0.35	1.32	0.16	0.05	2.63	0.03
261	0.89	4.76	1.12	0.35	1.32	0.16	0.05	2.63	0.03
262	0.89	4.76	1.12	0.35	1.32	0.16	0.05	2.63	0.03
263	0.89	4.76	1.12	0.35	1.32	0.16	0.05	2.63	0.03
264	0.57	6.18	4.17	0.36	0.61	0.02	0.03	0.84	0.44

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
265	9	15	fus	0.18	34.2	2.50	1.0	4.11	77.60	4.00	0.22
266	9	15	mag	0.60	34.7	2.40	1.0	4.11	77.60	4.00	0.22
267	9	15	aus	0.22	39.0	1.70	1.0	4.11	77.60	4.00	0.22
268	9	20	ten	0.21	15.1	1.00	2.0	3.79	162.20	28.00	0.67
269	9	20	rub	0.31	20.3	2.70	2.0	3.79	162.20	28.00	0.67
270	9	20	fus	0.43	20.7	2.70	2.0	3.79	162.20	28.00	0.67
271	9	20	aus	0.05	16.9	1.30	2.0	3.79	162.20	28.00	0.67
272	9	25	pap	0.69	9.3	1.50	1.0	4.05	89.10	21.00	0.41
273	9	25	ten	0.02	9.4	0.00	1.0	4.05	89.10	21.00	0.41
274	9	25	rub	0.29	10.1	2.10	1.0	4.05	89.10	21.00	0.41
275	9	35	ten	0.12	20.0	3.60	2.5	4.35	44.70	24.00	0.19
276	9	35	rub	0.20	24.3	3.80	2.5	4.35	44.70	24.00	0.19
277	9	35	pap	0.02	24.2	0.00	2.5	4.35	44.70	24.00	0.19
278	9	35	fus	0.65	24.9	2.40	2.5	4.35	44.70	24.00	0.19
279	9	40	pap	0.52	7.9	3.90	1.0	3.87	134.90	1.00	0.25
280	9	40	ten	0.25	8.7	2.70	1.0	3.87	134.90	1.00	0.25
281	9	40	rub	0.23	9.5	2.10	1.0	3.87	134.90	1.00	0.25
282	9	45	pap	0.54	10.3	2.20	1.0	3.97	107.20	6.00	0.52
283	9	45	rub	0.22	11.4	0.90	1.0	3.97	107.20	6.00	0.52
284	9	45	fus	0.24	11.2	1.20	1.0	3.97	107.20	6.00	0.52
285	9	50	rub	0.38	19.2	1.80	0.5	4.10	79.40	0.00	1.94
286	9	50	ang	0.02	11.2	0.00	0.5	4.10	79.40	0.00	1.94
287	9	50	pap	0.56	16.4	3.00	0.5	4.10	79.40	0.00	1.94
288	9	55	ang	0.06	14.6	2.00	0.5	3.90	125.90	0.00	2.31

OBS	MG	NA	K	AL	FE	MN	NI	S	P
265	0.11	1.97	0.01	0.03	1.32	0.03	0.13	0.35	0.03
266	0.11	1.97	0.01	0.03	1.32	0.03	0.13	0.35	0.03
267	0.11	1.97	0.01	0.03	1.32	0.03	0.13	0.35	0.03
268	0.54	6.05	2.42	0.10	2.17	0.05	0.26	1.37	0.17
269	0.54	6.05	2.42	0.10	2.17	0.05	0.26	1.37	0.17
270	0.54	6.05	2.42	0.10	2.17	0.05	0.26	1.37	0.17
271	0.54	6.05	2.42	0.10	2.17	0.05	0.26	1.37	0.17
272	0.46	3.28	0.91	0.07	2.09	0.05	0.25	1.40	0.05
273	0.46	3.28	0.91	0.07	2.09	0.05	0.25	1.40	0.05
274	0.46	3.28	0.91	0.07	2.09	0.05	0.25	1.40	0.05
275	0.11	2.38	1.61	0.03	2.30	0.06	0.30	0.67	0.14
276	0.11	2.38	1.61	0.03	2.30	0.06	0.30	0.67	0.14
277	0.11	2.38	1.61	0.03	2.30	0.06	0.30	0.67	0.14
278	0.11	2.38	1.61	0.03	2.30	0.06	0.30	0.67	0.14
279	0.29	2.28	1.12	0.03	2.53	0.06	0.32	1.09	0.04
280	0.29	2.28	1.12	0.03	2.53	0.06	0.32	1.09	0.04
281	0.29	2.28	1.12	0.03	2.53	0.06	0.32	1.09	0.04
282	0.48	2.68	1.39	0.13	5.19	0.11	0.58	1.39	0.04
283	0.48	2.68	1.39	0.13	5.19	0.11	0.58	1.39	0.04
284	0.48	2.68	1.39	0.13	5.19	0.11	0.58	1.39	0.04
285	0.68	1.77	1.67	0.18	2.38	0.03	0.01	0.52	0.03
286	0.68	1.77	1.67	0.18	2.38	0.03	0.01	0.52	0.03
287	0.68	1.77	1.67	0.18	2.38	0.03	0.01	0.52	0.03
288	0.79	0.45	0.30	0.22	0.70	0.09	0.01	2.48	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
289	9	55	rub	0.20	15.3	2.60	0.5	3.90	125.90	0.00	2.31
290	9	55	pap	0.56	15.8	4.10	0.5	3.90	125.90	0.00	2.31
291	10	0	mag	0.04	89.7	0.60	0.5	4.00	100.00	0.00	0.21
292	10	0	cap	0.86	87.6	2.30	0.5	4.00	100.00	0.00	0.21
293	10	0	myl	0.02	83.8	0.00	0.5	4.00	100.00	0.00	0.21
294	10	0	ple	0.08	80.7	0.20	0.5	4.00	100.00	0.00	0.21
295	10	5	ang	0.14	71.6	4.00	0.5	4.00	39.80	7.00	0.21
296	10	5	cap	0.32	74.0	3.70	0.5	4.00	39.80	7.00	0.21
297	10	5	mag	0.06	77.8	0.90	0.5	4.00	39.80	7.00	0.21
298	10	5	ple	0.48	68.7	9.70	0.5	4.00	39.80	7.00	0.21
299	10	10	lin	0.06	11.0	4.30	0.5	4.40	158.50	0.00	0.13
300	10	10	rub	0.46	16.2	2.80	0.5	4.40	158.50	0.00	0.13
301	10	10	ang	0.22	16.8	1.90	0.5	4.40	158.50	0.00	0.13
302	10	10	pap	0.04	15.8	2.30	0.5	4.40	158.50	0.00	0.13
303	10	10	ple	0.02	22.7	0.00	0.5	4.40	158.50	0.00	0.13
304	10	10	myl	0.06	14.7	2.40	0.5	4.40	158.50	0.00	0.13
305	10	15	rub	0.38	15.3	1.70	0.5	3.80	158.50	0.00	0.42
306	10	15	pap	0.52	14.8	3.00	0.5	3.80	158.50	0.00	0.42
307	10	20	rub	0.12	20.2	2.00	0.5	4.20	63.10	0.00	0.35
308	10	20	mag	0.10	20.7	1.80	0.5	4.20	63.10	0.00	0.35
309	10	20	pap	0.70	20.7	0.90	0.5	4.20	63.10	0.00	0.35
310	10	20	poh	0.06	21.1	0.90	0.5	4.20	63.10	0.00	0.35
311	10	25	lin	0.08	4.7	2.30	0.5	4.20	63.10	0.00	0.21
312	10	25	ang	0.24	5.6	4.70	0.5	4.20	63.10	0.00	0.21

OBS	MG	NA	K	AL	FE	MN	NI	S	P
289	0.79	0.45	0.30	0.22	0.70	0.09	0.01	2.48	0.03
290	0.79	0.45	0.30	0.22	0.70	0.09	0.01	2.48	0.03
291	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
292	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
293	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
294	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
295	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
296	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
297	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
298	0.14	0.39	0.57	0.05	0.31	0.01	0.05	0.09	0.04
299	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
300	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
301	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
302	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
303	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
304	0.08	0.36	0.25	0.09	0.16	0.00	0.01	0.08	0.17
305	0.26	1.01	1.62	0.10	0.31	0.01	0.05	0.13	0.03
306	0.26	1.01	1.62	0.10	0.31	0.01	0.05	0.13	0.03
307	0.04	0.80	1.28	0.06	0.13	0.00	0.02	0.16	0.03
308	0.04	0.80	1.28	0.06	0.13	0.00	0.02	0.16	0.03
309	0.04	0.80	1.28	0.06	0.13	0.00	0.02	0.16	0.03
310	0.04	0.80	1.28	0.06	0.13	0.00	0.02	0.16	0.03
311	0.07	0.02	0.21	0.03	0.12	0.00	0.02	0.06	0.03
312	0.07	0.02	0.21	0.03	0.12	0.00	0.02	0.06	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
313	10	25	mag	0.16	8.6	2.20	0.5	4.20	63.10	0.00	0.21
314	10	25	rub	0.24	13.0	2.80	0.5	4.20	63.10	0.00	0.21
315	10	25	pap	0.26	9.7	3.70	0.5	4.20	63.10	0.00	0.21
316	10	30	lin	0.32	5.5	4.40	0.5	4.00	100.00	0.00	0.29
317	10	30	pap	0.18	6.1	3.70	0.5	4.00	100.00	0.00	0.29
318	10	30	mag	0.40	6.6	3.60	0.5	4.00	100.00	0.00	0.29
319	10	30	rub	0.08	11.5	1.70	0.5	4.00	100.00	0.00	0.29
320	10	30	fus	0.02	14.9	0.00	0.5	4.00	100.00	0.00	0.29
321	10	35	lin	0.14	4.2	2.20	1.0	3.80	158.50	0.00	0.16
322	10	35	pap	0.46	9.1	2.90	1.0	3.80	158.50	0.00	0.16
323	10	35	mag	0.36	8.8	4.10	1.0	3.80	158.50	0.00	0.16
324	10	35	rub	0.04	7.7	2.40	1.0	3.80	158.50	0.00	0.16
325	10	40	fus	1.00	26.1	1.10	0.5	4.10	79.40	0.00	0.34
326	10	45	myl	0.16	21.6	4.30	0.5	4.30	50.10	7.90	0.15
327	10	45	fus	0.68	28.6	2.70	0.5	4.30	50.10	7.90	0.15
328	10	45	cap	0.14	25.7	3.20	0.5	4.30	50.10	7.90	0.15
329	10	45	mag	0.02	30.2	0.00	0.5	4.30	50.10	7.90	0.15
330	10	50	fus	0.76	20.8	4.50	0.5	4.10	79.40	0.00	0.24
331	10	50	rub	0.08	18.4	1.20	0.5	4.10	79.40	0.00	0.24
332	10	50	mag	0.06	19.5	2.10	0.5	4.10	79.40	0.00	0.24
333	10	55	ang	0.38	12.9	4.40	0.5	4.30	50.10	8.00	0.46
334	10	55	mag	0.16	14.1	3.40	0.5	4.30	50.10	8.00	0.46
335	10	55	rub	0.02	16.3	0.00	0.5	4.30	50.10	8.00	0.46
336	10	55	pap	0.38	16.2	3.30	0.5	4.30	50.10	8.00	0.46

OBS	MG	NA	K	AL	FE	MN	NI	S	P
313	0.07	0.02	0.21	0.03	0.12	0.00	0.02	0.06	0.03
314	0.07	0.02	0.21	0.03	0.12	0.00	0.02	0.06	0.03
315	0.07	0.02	0.21	0.03	0.12	0.00	0.02	0.06	0.03
316	0.11	0.05	1.15	0.06	0.19	0.01	0.03	0.13	0.03
317	0.11	0.05	1.15	0.06	0.19	0.01	0.03	0.13	0.03
318	0.11	0.05	1.15	0.06	0.19	0.01	0.03	0.13	0.03
319	0.11	0.05	1.15	0.06	0.19	0.01	0.03	0.13	0.03
320	0.11	0.05	1.15	0.06	0.19	0.01	0.03	0.13	0.03
321	0.05	0.26	0.21	0.03	0.15	0.00	0.03	0.08	0.03
322	0.05	0.26	0.21	0.03	0.15	0.00	0.03	0.08	0.03
323	0.05	0.26	0.21	0.03	0.15	0.00	0.03	0.08	0.03
324	0.05	0.26	0.21	0.03	0.15	0.00	0.03	0.08	0.03
325	0.09	0.65	0.34	0.07	0.15	0.01	0.01	0.14	0.03
326	0.02	0.44	0.02	0.03	0.04	0.00	0.01	0.08	0.03
327	0.02	0.44	0.02	0.03	0.04	0.00	0.01	0.08	0.03
328	0.02	0.44	0.02	0.03	0.04	0.00	0.01	0.08	0.03
329	0.02	0.44	0.02	0.03	0.04	0.00	0.01	0.08	0.03
330	0.03	0.61	0.12	0.04	0.15	0.00	0.02	0.18	0.06
331	0.03	0.61	0.12	0.04	0.15	0.00	0.02	0.18	0.06
332	0.03	0.61	0.12	0.04	0.15	0.00	0.02	0.18	0.06
333	0.25	0.41	0.33	0.12	0.14	0.01	0.03	0.10	0.03
334	0.25	0.41	0.33	0.12	0.14	0.01	0.03	0.10	0.03
335	0.25	0.41	0.33	0.12	0.14	0.01	0.03	0.10	0.03
336	0.25	0.41	0.33	0.12	0.14	0.01	0.03	0.10	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
337	12	0	ang	0.54	16.1	3.10	6.0	5.90	1.30	54.00	17.04
338	12	0	fus	0.42	29.4	7.80	6.0	5.90	1.30	54.00	17.04
339	12	0	squ	0.04	16.8	4.00	6.0	5.90	1.30	54.00	17.04
340	12	5	squ	0.02	12.4	0.00	2.0	5.90	1.30	55.00	5.90
341	12	5	fus	0.42	25.6	4.00	2.0	5.90	1.30	55.00	5.90
342	12	5	ple	0.02	31.9	0.00	2.0	5.90	1.30	55.00	5.90
343	12	5	ang	0.54	17.6	4.70	2.0	5.90	1.30	55.00	5.90
344	12	10	ang	0.50	13.8	6.50	3.5	4.90	12.60	19.00	1.41
345	12	10	fus	0.50	20.4	7.60	3.5	4.90	12.60	19.00	1.41
346	12	15	fus	1.00	23.7	3.20	4.0	5.30	5.00	60.00	4.75
347	12	20	ang	0.64	20.0	5.60	6.0	5.50	2.60	23.00	2.55
348	12	20	pap	0.10	23.7	2.00	6.0	5.50	2.60	23.00	2.55
349	12	20	lin	0.02	0.6	0.00	6.0	5.50	2.60	23.00	2.55
350	12	20	fus	0.20	25.0	3.90	6.0	5.50	2.60	23.00	2.55
351	12	25	ang	0.10	11.1	5.90	4.0	5.00	10.00	22.00	1.67
352	12	25	pap	0.16	19.1	3.90	4.0	5.00	10.00	22.00	1.67
353	12	25	fus	0.74	18.9	7.40	4.0	5.00	10.00	22.00	1.67
354	12	28	ang	0.08	18.7	2.30	1.0	5.50	2.60	17.00	1.41
355	12	28	pap	0.60	14.4	17.00	1.0	5.50	2.60	17.00	1.41
356	12	28	fus	0.26	16.2	4.40	1.0	5.50	2.60	17.00	1.41
357	12	25	pap	0.16	21.9	2.90	0.5	5.00	10.00	28.00	2.89
358	12	25	mag	0.02	23.3	0.00	0.5	5.00	10.00	28.00	2.89
359	12	25	fus	0.80	22.3	2.60	0.5	5.00	10.00	28.00	2.89
360	12	20	ang	0.06	28.9	3.70	6.0	5.00	10.00	37.00	4.53

OBS	MG	NA	K	AL	FE	MN	NI	S	P
337	1.41	3.09	4.04	0.31	9.05	1.35	0.70	0.31	0.13
338	1.41	3.09	4.04	0.31	9.05	1.35	0.70	0.31	0.13
339	1.41	3.09	4.04	0.31	9.05	1.35	0.70	0.31	0.13
340	0.66	2.18	5.18	0.21	4.87	0.12	0.58	0.89	0.03
341	0.66	2.18	5.18	0.21	4.87	0.12	0.58	0.89	0.03
342	0.66	2.18	5.18	0.21	4.87	0.12	0.58	0.89	0.03
343	0.66	2.18	5.18	0.21	4.87	0.12	0.58	0.89	0.03
344	0.24	2.03	1.18	0.24	5.04	0.12	0.60	0.84	0.03
345	0.24	2.03	1.18	0.24	5.04	0.12	0.60	0.84	0.03
346	0.76	4.41	7.59	0.55	5.08	0.14	0.54	0.30	0.[illegible]
347	0.39	1.36	0.47	0.31	5.51	0.14	0.69	0.14	0.03
348	0.39	1.36	0.47	0.31	5.51	0.14	0.69	0.14	0.03
349	0.39	1.36	0.47	0.31	5.51	0.14	0.69	0.14	0.03
350	0.39	1.36	0.47	0.31	5.51	0.14	0.69	0.14	0.03
351	0.35	1.79	0.76	0.57	4.43	0.12	0.48	0.62	0.03
352	0.35	1.79	0.76	0.57	4.43	0.12	0.48	0.62	0.03
353	0.35	1.79	0.76	0.57	4.43	0.12	0.48	0.62	0.03
354	0.29	1.42	0.37	0.39	2.59	0.06	0.31	0.20	0.03
355	0.29	1.42	0.37	0.39	2.59	0.06	0.31	0.20	0.03
356	0.29	1.42	0.37	0.39	2.59	0.06	0.31	0.20	0.03
357	0.56	4.09	3.09	0.33	0.88	0.01	0.01	0.16	0.04
358	0.56	4.09	3.09	0.33	0.88	0.01	0.01	0.16	0.04
359	0.56	4.09	3.09	0.33	0.88	0.01	0.01	0.16	0.04
360	0.65	4.73	4.08	0.29	0.79	0.23	0.03	0.15	0.69

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
361	12	20	mag	0.32	31.0	4.80	6.0	5.00	10.00	37.00	4.53
362	12	20	fus	0.34	26.7	2.70	6.0	5.00	10.00	37.00	4.53
363	12	20	pap	0.28	26.4	4.00	6.0	5.00	10.00	37.00	4.53
364	12	15	ang	0.10	32.9	1.40	2.0	4.00	100.00	125.00	2.05
365	12	15	mag	0.40	30.3	2.30	2.0	4.00	100.00	125.00	2.05
366	12	15	fus	0.36	29.3	2.40	2.0	4.00	100.00	125.00	2.05
367	12	15	pap	0.14	32.3	3.10	2.0	4.00	100.00	125.00	2.05
368	12	10	lin	0.02	-0.6	0.00	1.5	4.80	15.80	18.00	1.87
369	12	10	ang	0.36	12.3	4.90	1.5	4.80	15.80	18.00	1.87
370	12	10	rus	0.46	16.6	4.80	1.5	4.80	15.80	18.00	1.87
371	12	10	mag	0.02	17.7	0.00	1.5	4.80	15.80	18.00	1.87
372	12	5	ang	0.64	24.5	4.50	7.0	5.00	10.00	81.00	3.99
373	12	5	rus	0.38	25.5	3.60	7.0	5.00	10.00	81.00	3.99
374	13	0	pac	0.24	6.4	4.50	0.5	4.80	15.80	12.00	0.60
375	13	0	pap	0.56	9.1	2.20	0.5	4.80	15.80	12.00	0.60
376	13	0	rub	0.20	11.7	2.40	0.5	4.80	15.80	12.00	0.60
377	13	5	lin	0.48	7.3	3.50	1.0	4.90	12.60	12.00	0.55
378	13	5	pac	0.42	12.7	3.20	1.0	4.90	12.60	12.00	0.55
379	13	5	mag	0.10	14.6	1.40	1.0	4.90	12.60	12.00	0.55
380	13	16	lin	0.22	5.9	3.90	1.0	5.20	6.30	16.00	1.36
381	13	16	ang	0.52	14.3	4.20	1.0	5.20	6.30	16.00	1.36
382	13	16	mag	0.26	22.4	4.00	1.0	5.20	6.30	16.00	1.36
383	13	18	mag	0.02	19.0	0.00	1.5	5.00	10.00	25.00	1.25
384	13	18	fus	0.58	17.0	3.20	1.5	5.00	10.00	25.00	1.25

OBS	MG	NA	K	AL	FE	MN	NI	S	P
361	0.65	4.73	4.08	0.29	0.79	0.23	0.03	0.15	0.69
362	0.65	4.73	4.08	0.29	0.79	0.23	0.03	0.15	0.69
363	0.65	4.73	4.08	0.29	0.79	0.23	0.03	0.15	0.69
364	0.45	16.98	8.70	0.53	5.98	0.15	0.71	0.63	0.99
365	0.45	16.98	8.70	0.53	5.98	0.15	0.71	0.63	0.99
366	0.45	16.98	8.70	0.53	5.98	0.15	0.71	0.63	0.99
367	0.45	16.98	8.70	0.53	5.98	0.15	0.71	0.63	0.99
368	0.34	1.83	1.02	0.45	6.69	0.17	0.83	0.49	0.03
369	0.34	1.83	1.02	0.45	6.69	0.17	0.83	0.49	0.03
370	0.34	1.83	1.02	0.45	6.69	0.17	0.83	0.49	0.03
371	0.34	1.83	1.02	0.45	6.69	0.17	0.83	0.49	0.03
372	0.63	8.98	4.08	0.71	0.77	0.03	0.01	0.37	0.03
373	0.63	8.98	4.08	0.71	0.77	0.03	0.01	0.37	0.03
374	0.23	1.57	20.20	0.46	2.60	0.05	0.23	0.33	0.03
375	0.23	1.57	20.20	0.46	2.60	0.05	0.23	0.33	0.03
376	0.23	1.57	20.20	0.46	2.60	0.05	0.23	0.33	0.03
377	0.13	1.39	0.29	0.69	0.39	0.03	0.01	0.39	0.03
378	0.13	1.39	0.29	0.69	0.39	0.03	0.01	0.39	0.03
379	0.13	1.39	0.29	0.69	0.39	0.03	0.01	0.39	0.03
380	0.29	3.11	2.39	1.31	0.74	0.13	0.01	0.28	0.03
381	0.29	3.11	2.39	1.31	0.74	0.13	0.01	0.28	0.03
382	0.29	3.11	2.39	1.31	0.74	0.13	0.01	0.28	0.03
383	0.40	1.59	1.65	0.51	0.24	0.02	0.01	0.50	0.03
384	0.40	1.59	1.65	0.51	0.24	0.02	0.01	0.50	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
385	13	20	ang	0.08	12.8	6.30	2.0	5.10	7.90	20.00	1.02
386	13	20	fus	0.92	12.8	6.30	2.0	5.10	7.90	20.00	1.02
387	13	26	lin	0.16	0.3	0.60	1.0	4.30	50.10	21.00	0.01
388	13	26	pac	0.22	6.5	4.80	1.0	4.30	50.10	21.00	0.01
389	13	26	mag	0.08	5.4	3.50	1.0	4.30	50.10	21.00	0.01
390	13	26	fus	0.54	15.2	5.50	1.0	4.30	50.10	21.00	0.01
391	13	30	lin	0.28	3.7	2.80	1.0	5.10	7.90	10.00	0.82
392	13	30	pac	0.22	10.5	2.00	1.0	5.10	7.90	10.00	0.82
393	13	30	mag	0.36	13.7	2.80	1.0	5.10	7.90	10.00	0.82
394	13	30	fus	0.14	13.3	2.70	1.0	5.10	7.90	10.00	0.82
395	13	20	fus	0.82	15.3	7.00	3.0	4.00	100.00	8.00	0.48
396	13	15	lin	0.04	-0.8	0.40	0.5	4.80	15.80	13.00	0.31
397	13	15	pap	0.30	16.4	7.90	0.5	4.80	15.80	13.00	0.31
398	13	15	mag	0.56	21.2	6.20	0.5	4.80	15.80	13.00	0.31
399	13	15	fus	0.06	23.7	2.20	0.5	4.80	15.80	13.00	0.31
400	13	10	lin	0.04	-2.7	2.50	0.5	6.20	0.60	10.00	0.59
401	13	10	pap	0.64	7.4	5.60	0.5	6.20	0.60	10.00	0.59
402	13	10	pac	0.10	11.1	3.60	0.5	6.20	0.60	10.00	0.59
403	13	10	mag	0.18	13.7	2.00	0.5	6.20	0.60	10.00	0.59
404	13	10	fus	0.02	13.5	0.00	0.5	6.20	0.60	10.00	0.59
405	13	5	pap	0.72	5.3	3.10	0.0	5.30	5.00	10.00	0.73
406	13	5	pac	0.04	5.8	6.60	0.0	5.30	5.00	10.00	0.73
407	13	5	mag	0.14	9.5	2.60	0.0	5.30	5.00	10.00	0.73
408	13	5	fus	0.10	12.4	2.80	0.0	5.30	5.00	10.00	0.73

OBS	MG	NA	K	AL	FE	MN	NI	S	P
385	0.26	1.81	1.81	0.35	5.25	0.02	0.01	0.30	0.03
386	0.26	1.81	1.81	0.35	5.25	0.02	0.01	0.30	0.03
387	0.06	1.42	4.26	0.48	0.00	0.00	0.01	0.40	0.03
388	0.06	1.42	4.26	0.48	0.00	0.00	0.01	0.40	0.03
389	0.06	1.42	4.26	0.48	0.00	0.00	0.01	0.40	0.03
390	0.06	1.42	4.26	0.48	0.00	0.00	0.01	0.40	0.03
391	0.24	1.47	0.73	0.40	0.00	0.02	0.01	0.34	0.03
392	0.24	1.47	0.73	0.40	0.00	0.02	0.01	0.34	0.03
393	0.24	1.47	0.73	0.40	0.00	0.02	0.01	0.34	0.03
394	0.24	1.47	0.73	0.40	0.00	0.02	0.01	0.34	0.03
395	0.52	2.06	1.88	0.47	1.21	0.03	0.10	0.28	0.03
396	0.14	1.97	0.71	0.36	1.52	0.01	0.01	0.23	0.03
397	0.14	1.97	0.71	0.36	1.52	0.01	0.01	0.23	0.03
398	0.14	1.97	0.71	0.36	1.52	0.01	0.01	0.23	0.03
399	0.14	1.97	0.71	0.36	1.52	0.01	0.01	0.23	0.03
400	0.25	1.44	0.95	0.22	2.17	0.05	0.25	0.50	0.03
401	0.25	1.44	0.95	0.22	2.17	0.05	0.25	0.50	0.03
402	0.25	1.44	0.95	0.22	2.17	0.05	0.25	0.50	0.03
403	0.25	1.44	0.95	0.22	2.17	0.05	0.25	0.50	0.03
404	0.25	1.44	0.95	0.22	2.17	0.05	0.25	0.50	0.03
405	0.21	1.32	0.73	0.20	3.34	0.10	0.38	0.33	0.03
406	0.21	1.32	0.73	0.20	3.34	0.10	0.38	0.33	0.03
407	0.21	1.32	0.73	0.20	3.34	0.10	0.38	0.33	0.03
408	0.21	1.32	0.73	0.20	3.34	0.10	0.38	0.33	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	Pr.	H	KC	CA
409	13	0	pac	0.02	5.1	0.00	0.5	5.70	2.00	11.00	0.64
410	13	0	mag	0.26	14.3	8.50	0.5	5.70	2.00	11.00	0.64
411	13	0	fus	0.70	23.3	6.70	0.5	5.70	2.00	11.00	0.64
412	14	0	ang	0.76	30.5	2.10	6.0	4.10	79.40	32.00	0.30
413	14	0	mag	0.20	30.4	3.00	6.0	4.10	79.40	32.00	0.30
414	14	0	ple	0.04	29.7	0.40	6.0	4.10	79.40	32.00	0.30
415	14	4	ang	0.38	31.4	2.00	4.0	4.20	63.10	40.00	0.05
416	14	4	mag	0.52	29.9	1.90	4.0	4.20	63.10	40.00	0.05
417	14	4	ple	0.10	27.3	1.00	4.0	4.20	63.10	40.00	0.05
418	14	8	ang	0.04	37.9	1.10	3.0	4.20	63.10	25.00	0.04
419	14	8	mag	0.96	35.0	2.00	3.0	4.20	63.10	25.00	0.04
420	14	12	ang	0.26	20.7	5.40	3.0	4.40	39.80	16.00	0.00
421	14	12	mag	0.60	26.0	5.60	3.0	4.40	39.80	16.00	0.00
422	14	12	fus	0.14	34.1	5.70	3.0	4.40	39.80	16.00	0.00
423	14	16	ang	0.32	33.6	3.30	1.0	4.10	79.40	27.00	0.00
424	14	16	mag	0.70	34.3	2.80	1.0	4.10	79.40	27.00	0.00
425	14	20	ang	0.26	24.2	3.40	6.0	4.20	63.10	17.00	0.00
426	14	20	mag	0.74	24.3	3.70	6.0	4.20	63.10	17.00	0.00
427	14	24	ang	0.88	16.9	4.50	0.5	4.20	63.10	24.00	0.37
428	14	24	mag	0.12	14.0	3.20	0.5	4.20	63.10	24.00	0.37
429	14	28	ang	0.02	9.2	0.00	0.0	4.60	25.10	11.00	0.00
430	14	28	fus	0.92	19.1	4.40	0.0	4.60	25.10	11.00	0.00
431	14	32	ang	0.02	2.5	0.00	0.5	4.30	50.10	13.00	0.00
432	14	32	mag	0.04	4.5	0.80	0.5	4.30	50.10	13.00	0.00

OBS	MG	NA	K	AL	FE	MN	NI	S	P
409	0.19	1.23	0.35	0.13	0.00	0.00	0.01	0.10	0.03
410	0.19	1.23	0.35	0.13	0.00	0.00	0.01	0.10	0.03
411	0.19	1.23	0.35	0.13	0.00	0.00	0.01	0.10	0.03
412	0.21	0.98	0.74	0.18	0.71	0.01	0.08	0.20	0.19
413	0.21	0.98	0.74	0.18	0.71	0.01	0.08	0.20	0.19
414	0.21	0.98	0.74	0.18	0.71	0.01	0.08	0.20	0.19
415	0.02	1.01	0.91	0.03	1.22	0.03	0.12	0.12	0.31
416	0.02	1.01	0.91	0.03	1.22	0.03	0.12	0.12	0.31
417	0.02	1.01	0.91	0.03	1.22	0.03	0.12	0.12	0.31
418	0.02	0.77	0.41	0.03	0.58	0.01	0.04	0.24	0.30
419	0.02	0.77	0.41	0.03	0.58	0.01	0.04	0.24	0.30
420	0.04	0.38	1.12	0.09	0.16	0.00	0.01	0.06	0.24
421	0.04	0.38	1.12	0.09	0.16	0.00	0.01	0.06	0.24
422	0.04	0.38	1.12	0.09	0.16	0.00	0.01	0.06	0.24
423	0.02	1.07	0.46	0.03	0.87	0.02	0.09	0.03	0.03
424	0.02	1.07	0.46	0.03	0.87	0.02	0.09	0.03	0.03
425	0.04	1.01	0.41	0.20	0.19	0.00	0.09	0.28	0.17
426	0.04	1.01	0.41	0.20	0.19	0.00	0.09	0.28	0.17
427	0.17	1.37	2.32	0.07	0.57	0.02	0.04	0.11	0.88
428	0.17	1.37	2.32	0.07	0.57	0.02	0.04	0.11	0.88
429	0.08	0.42	0.66	0.10	0.34	0.01	0.01	0.09	0.13
430	0.08	0.42	0.66	0.10	0.34	0.01	0.01	0.09	0.13
431	0.02	0.43	0.17	0.05	0.06	0.00	0.01	0.08	0.03
432	0.02	0.43	0.17	0.05	0.06	0.00	0.01	0.08	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
433	14	32	fus	0.82	18.3	4.40	0.5	4.30	50.10	13.00	0.00
434	14	32	myl	0.04	10.3	0.06	0.5	4.30	50.10	13.00	0.00
435	14	36	ang	0.10	20.8	1.70	1.0	4.20	63.10	13.00	0.00
436	14	36	mag	0.10	21.6	2.00	1.0	4.20	63.10	13.00	0.00
437	14	36	fus	0.68	21.0	3.40	1.0	4.20	63.10	13.00	0.00
438	14	40	fus	1.00	19.8	2.00	0.0	4.50	31.60	25.00	0.10
439	14	44	ang	0.20	3.4	1.90	0.5	4.50	31.60	25.00	0.00
440	14	44	fus	0.80	8.9	4.80	0.5	4.50	31.60	25.00	0.00
441	15	0	pac	0.02	62.8	0.00	9.0	3.80	158.50	13.00	0.11
442	15	0	cap	0.98	58.6	5.60	9.0	3.80	158.50	13.00	0.11
443	15	2	pac	0.04	34.8	3.10	8.0	4.00	100.00	7.00	0.09
444	15	4	pac	0.04	35.8	4.00	6.0	4.00	100.00	11.00	0.19
445	15	4	mag	0.74	40.4	7.30	6.0	4.00	100.00	11.00	0.19
446	15	4	cap	0.22	33.0	1.90	6.0	4.00	100.00	11.00	0.19
447	15	6	pac	0.02	35.2	0.00	5.0	3.90	125.90	17.00	0.16
448	15	6	mag	0.30	34.3	1.20	5.0	3.90	125.90	17.00	0.16
449	15	6	fus	0.68	32.8	2.10	5.0	3.90	125.90	17.00	0.16
450	15	8	pac	0.70	14.1	4.10	4.0	4.20	63.10	9.00	0.00
451	15	8	mag	0.18	19.0	3.10	4.0	4.20	63.10	9.00	0.00
452	15	10	pac	0.66	17.5	2.70	2.5	4.10	79.40	11.00	0.00
453	15	10	mag	0.12	22.4	2.10	2.5	4.10	79.40	11.00	0.00
454	15	10	fus	0.22	20.6	1.70	2.5	4.10	79.40	11.00	0.00
455	15	12	pac	0.28	13.6	2.40	1.5	4.30	50.10	13.00	0.00
456	15	12	mag	0.24	15.4	4.00	1.5	4.30	50.10	13.00	0.00

OBS	MG	NA	K	AL	FE	MN	NI	S	P
433	0.02	0.43	0.17	0.05	0.06	0.00	0.01	0.08	0.03
434	0.02	0.43	0.17	0.05	0.06	0.00	0.01	0.08	0.03
435	0.03	1.04	3.47	0.19	4.98	0.13	0.59	0.19	0.40
436	0.03	1.04	3.47	0.19	4.98	0.13	0.59	0.19	0.40
437	0.03	1.04	3.47	0.19	4.98	0.13	0.59	0.19	0.40
438	0.04	0.50	1.00	0.09	0.34	0.01	0.01	0.08	0.16
439	0.03	0.77	0.31	0.09	0.21	0.00	0.01	0.08	0.05
440	0.03	0.77	0.31	0.09	0.21	0.00	0.01	0.08	0.05
441	0.11	0.92	0.96	0.26	3.05	0.07	0.36	0.20	0.04
442	0.11	0.92	0.96	0.26	3.05	0.07	0.36	0.20	0.04
443	0.04	0.85	15.48	0.15	4.26	0.10	0.49	0.04	0.03
444	0.09	0.53	0.15	0.37	0.68	0.01	0.03	0.11	0.03
445	0.09	0.53	0.15	0.37	0.68	0.01	0.03	0.11	0.03
446	0.09	0.53	0.15	0.37	0.68	0.01	0.03	0.11	0.03
447	0.06	0.79	0.47	0.16	5.64	0.13	0.65	0.17	0.03
448	0.06	0.79	0.47	0.16	5.64	0.13	0.65	0.17	0.03
449	0.06	0.79	0.47	0.16	5.64	0.13	0.65	0.17	0.03
450	0.03	0.71	0.03	0.12	1.12	0.02	0.11	0.02	0.03
451	0.03	0.71	0.03	0.12	1.12	0.02	0.11	0.02	0.03
452	0.02	1.05	1.48	0.12	1.83	0.04	0.19	0.10	0.03
453	0.02	1.05	1.48	0.12	1.83	0.04	0.19	0.10	0.03
454	0.02	1.05	1.48	0.12	1.83	0.04	0.19	0.10	0.03
455	0.02	0.82	1.44	0.09	2.49	0.06	0.27	0.14	0.03
456	0.02	0.82	1.44	0.09	2.49	0.06	0.27	0.14	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
457	15	12	fus	0.44	19.4	4.20	1.5	4.30	50.10	13.00	0.00
458	15	12	pap	0.02	20.8	0.00	1.5	4.30	50.10	13.00	0.00
459	15	14	pac	0.52	14.9	2.40	1.0	4.20	63.10	8.00	0.00
460	15	14	mag	0.16	15.7	2.20	1.0	4.20	63.10	8.00	0.00
461	15	14	fus	0.32	15.3	1.50	1.0	4.20	63.10	8.00	0.00
462	15	16	pap	0.12	11.0	1.50	0.5	4.30	50.10	17.00	0.08
463	15	16	pac	0.64	10.2	2.70	0.5	4.30	50.10	17.00	0.08
464	15	16	mag	0.06	9.3	2.20	0.5	4.30	50.10	17.00	0.08
465	15	16	fus	0.18	9.1	2.80	0.5	4.30	50.10	17.00	0.08
466	15	18	pap	0.20	8.7	4.40	0.5	4.40	39.80	4.00	0.04
467	15	18	pac	0.12	7.4	3.80	0.5	4.40	39.80	4.00	0.04
468	15	18	mag	0.68	11.3	3.20	0.5	4.40	39.80	4.00	0.04
469	15	20	pac	0.40	13.7	6.30	1.0	4.30	50.10	32.00	0.02
470	15	20	mag	0.46	20.2	5.50	1.0	4.30	50.10	32.00	0.02
471	15	20	fus	0.10	23.9	0.90	1.0	4.30	50.10	32.00	0.02
472	15	22	pac	0.30	6.8	1.80	0.5	5.20	6.30	45.00	0.02
473	15	22	mag	0.40	5.9	1.70	0.5	5.20	6.30	45.00	0.02
474	15	22	fus	0.16	7.9	0.90	0.5	5.20	6.30	45.00	0.02
475	16	0	ang	0.28	45.2	4.80	8.0	4.60	25.10	21.00	0.82
476	16	0	cap	0.72	49.6	3.20	8.0	4.60	25.10	21.00	0.82
477	16	5	ang	0.28	40.6	2.90	3.0	4.60	25.10	24.00	0.35
478	16	5	mag	0.72	40.1	2.80	3.0	4.60	25.10	24.00	0.35
479	16	10	ang	0.74	19.1	4.40	3.5	4.60	25.10	25.00	0.96
480	16	10	mag	0.26	29.5	4.90	3.5	4.60	25.10	25.00	0.96

OBS	MG	NA	K	AL	FE	MN	NI	S	P
457	0.02	0.82	1.44	0.09	2.49	0.06	0.27	0.14	0.03
458	0.02	0.82	1.44	0.09	2.49	0.06	0.27	0.14	0.03
459	0.02	0.87	0.75	0.18	2.36	0.06	0.61	0.06	0.03
460	0.02	0.87	0.75	0.18	2.36	0.06	0.61	0.06	0.03
461	0.02	0.87	0.75	0.18	2.36	0.06	0.61	0.06	0.03
462	0.19	1.20	1.41	0.09	1.55	0.07	0.13	0.03	0.03
463	0.19	1.20	1.41	0.09	1.55	0.07	0.13	0.03	0.03
464	0.19	1.20	1.41	0.09	1.55	0.07	0.13	0.03	0.03
465	0.19	1.20	1.41	0.09	1.55	0.07	0.13	0.03	0.03
466	0.08	0.23	0.26	0.08	1.81	0.06	0.21	0.02	0.03
467	0.08	0.23	0.26	0.08	1.81	0.06	0.21	0.02	0.03
468	0.08	0.23	0.26	0.08	1.81	0.06	0.21	0.02	0.03
469	0.08	2.10	3.48	0.17	4.00	0.07	0.32	0.11	0.03
470	0.08	2.10	3.48	0.17	4.00	0.07	0.32	0.11	0.03
471	0.08	2.10	3.48	0.17	4.00	0.07	0.32	0.11	0.03
472	0.08	1.05	0.41	0.22	2.25	0.06	0.26	0.07	0.03
473	0.08	1.05	0.41	0.22	2.25	0.06	0.26	0.07	0.03
474	0.08	1.05	0.41	0.22	2.25	0.06	0.26	0.07	0.03
475	0.50	2.75	1.30	0.41	2.59	0.02	0.17	0.21	0.38
476	0.50	2.75	1.30	0.41	2.59	0.02	0.17	0.21	0.38
477	0.50	1.74	1.65	0.41	2.50	0.02	0.17	0.18	0.04
478	0.50	1.74	1.65	0.41	2.50	0.02	0.17	0.18	0.04
479	0.50	2.10	1.26	0.41	1.64	0.02	0.17	0.18	0.38
480	0.50	2.10	1.26	0.41	1.64	0.02	0.17	0.18	0.38

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
481	16	15	ang	0.26	18.9	6.00	3.0	4.10	79.40	8.00	0.92
482	16	15	mag	0.28	24.5	2.50	3.0	4.10	79.40	8.00	0.92
483	16	15	fus	0.46	27.4	2.40	3.0	4.10	79.40	8.00	0.92
484	16	20	ang	0.56	19.2	3.00	1.5	4.30	50.10	25.00	0.63
485	16	20	mag	0.38	21.8	3.90	1.5	4.30	50.10	25.00	0.63
486	16	20	fus	0.06	23.1	0.10	1.5	4.30	50.10	25.00	0.63
487	16	25	myl	0.22	14.9	1.00	1.0	4.20	63.10	12.00	0.94
488	16	25	ang	0.08	23.3	8.80	1.0	4.20	63.10	12.00	0.94
489	16	25	fus	0.66	31.4	3.60	1.0	4.20	63.10	12.00	0.94
490	16	30	fus	0.58	34.2	5.30	1.0	4.40	39.80	19.00	0.49
491	16	35	exa	0.02	13.3	0.00	1.5	4.10	79.40	8.00	0.79
492	16	35	ang	0.38	12.8	4.20	1.5	4.10	79.40	8.00	0.79
493	16	35	mag	0.46	19.2	4.30	1.5	4.10	79.40	8.00	0.79
494	16	35	fus	0.14	26.0	6.30	1.5	4.10	79.40	8.00	0.79
495	16	40	ang	0.16	15.1	10.00	0.5	4.20	63.10	18.00	0.32
496	16	40	mag	0.82	20.8	5.20	0.5	4.20	63.10	18.00	0.32
497	16	45	ang	0.16	15.1	10.00	0.5	4.40	39.80	12.00	0.94
498	16	45	mag	0.82	20.[illegible]	5.20	0.5	4.40	39.80	12.00	0.94
499	16	50	ang	0.60	8.4	4.40	2.0	4.40	39.80	2.00	0.56
500	16	50	mag	0.40	16.2	4.80	2.0	4.40	39.80	2.00	0.56
501	16	55	ang	0.50	32.5	3.00	6.0	4.30	50.10	16.00	1.08
502	16	55	mag	0.50	35.4	2.60	6.0	4.30	50.10	16.00	1.08
503	11	0	squ	0.98	6.8	2.40	9.0	5.57	2.70	32.00	6.14
504	11	0	ter	0.02	7.9	0.00	9.0	5.57	2.70	32.00	6.14

OBS	MG	NA	K	AL	FE	MN	NI	S	P
481	0.50	2.19	1.08	0.41	2.11	0.03	0.17	0.40	0.38
482	0.50	2.19	1.08	0.41	2.11	0.03	0.17	0.40	0.38
483	0.50	2.19	1.08	0.41	2.11	0.03	0.17	0.40	0.38
484	0.50	1.42	1.05	0.41	1.37	0.02	0.17	0.51	0.44
485	0.50	1.42	1.05	0.41	1.37	0.02	0.17	0.51	0.44
486	0.50	1.42	1.05	0.41	1.37	0.02	0.17	0.51	0.44
487	0.50	1.17	1.05	0.41	1.54	0.02	0.17	0.18	0.38
488	0.50	1.17	1.05	0.41	1.54	0.02	0.17	0.18	0.38
489	0.50	1.17	1.05	0.41	1.54	0.02	0.17	0.18	0.38
490	0.50	1.67	1.27	0.03	1.44	0.02	1.12	0.18	0.38
491	0.50	1.08	1.05	0.41	2.52	0.03	0.17	0.18	0.38
492	0.50	1.08	1.05	0.41	2.52	0.03	0.17	0.18	0.38
493	0.50	1.08	1.05	0.41	2.52	0.03	0.17	0.18	0.38
494	0.50	1.08	1.05	0.41	2.52	0.03	0.17	0.18	0.38
495	0.50	1.43	3.11	0.41	0.78	0.02	0.17	0.33	0.64
496	0.50	1.43	3.11	0.41	0.78	0.02	0.17	0.33	0.64
497	0.50	1.28	1.46	0.41	1.84	0.02	0.17	0.18	0.38
498	0.50	1.28	1.46	0.41	1.84	0.02	0.17	0.18	0.38
499	0.50	1.00	1.05	0.41	1.26	0.04	0.17	0.18	0.38
500	0.50	1.00	1.05	0.41	1.26	0.04	0.17	0.18	0.38
501	0.50	1.24	2.36	0.41	1.99	0.02	0.17	0.18	0.38
502	0.50	1.24	2.36	0.41	1.99	0.02	0.17	0.18	0.38
503	0.66	3.36	2.43	0.03	0.80	0.11	0.07	0.43	0.99
504	0.66	3.36	2.43	0.03	0.80	0.11	0.07	0.43	0.99

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
505	11	3	ter	0.22	5.5	0.80	0.5	5.18	6.60	50.00	0.80
506	11	3	cal	0.74	4.9	0.80	0.5	5.18	6.60	50.00	0.80
507	11	3	aul	0.04	5.4	0.90	0.5	5.18	6.60	50.00	0.80
508	11	6	ter	0.16	8.4	1.80	0.5	5.13	7.40	81.00	0.73
509	11	6	aul	0.80	8.7	1.30	0.5	5.13	7.40	81.00	0.73
510	11	3	cal	0.02	8.6	0.00	0.5	5.13	7.40	81.00	0.73
511	11	9	ter	0.06	8.2	1.20	0.5	5.16	6.90	112.00	2.90
512	11	9	adu	0.72	7.4	1.40	0.5	5.16	6.90	112.00	2.90
513	11	9	cal	0.22	7.6	1.00	0.5	5.16	6.90	112.00	2.90
514	11	12	ter	0.12	10.4	1.40	0.5	5.17	6.80	104.00	2.04
515	11	12	adu	0.38	8.8	1.20	0.5	5.17	6.80	104.00	2.04
516	11	12	tom	0.20	8.8	1.30	0.5	5.17	6.80	104.00	2.04
517	11	12	cal	0.28	8.7	1.20	0.5	5.17	6.80	104.00	2.04
518	11	15	ter	0.04	12.1	0.10	0.5	4.90	12.60	115.00	3.87
519	11	15	tom	0.96	13.4	1.30	0.5	4.90	12.60	115.00	3.87
520	11	18	ter	0.02	13.4	0.00	0.5	5.14	7.20	113.00	3.87
521	11	18	tom	0.70	14.1	1.10	0.5	5.14	7.20	113.00	3.87
522	11	18	war	0.26	14.1	1.10	0.5	5.14	7.20	113.00	3.87
523	11	21	ter	0.02	12.9	0.00	1.0	4.87	13.50	132.00	5.66
524	11	21	tom	0.82	13.3	2.50	1.0	4.87	13.50	132.00	5.66
525	11	21	aul	0.12	16.4	0.80	1.0	4.87	13.50	132.00	5.66
526	11	21	ple	0.04	12.6	0.10	1.0	4.87	13.50	132.00	5.66
527	11	24	tom	0.56	15.0	1.10	1.0	4.63	23.40	79.00	4.60
528	11	24	ter	0.20	21.7	4.90	1.0	4.63	23.40	79.00	4.60

OBS	MG	NA	K	AL	FE	MN	NI	S	P
505	0.25	3.19	12.71	0.03	0.79	0.09	0.06	0.31	0.95
506	0.25	3.19	12.71	0.03	0.79	0.09	0.06	0.31	0.95
507	0.25	3.19	12.71	0.03	0.79	0.09	0.06	0.31	0.95
508	0.20	7.91	6.38	0.03	0.76	0.05	0.06	0.31	0.50
509	0.20	7.91	6.38	0.03	0.76	0.05	0.06	0.31	0.50
510	0.20	7.91	6.38	0.03	0.76	0.05	0.06	0.31	0.50
511	1.09	7.52	5.84	0.00	0.83	0.12	0.05	0.28	1.37
512	1.09	7.52	5.84	0.00	0.83	0.12	0.05	0.28	1.37
513	1.09	7.52	5.84	0.00	0.83	0.12	0.05	0.28	1.37
514	0.46	5.82	5.94	0.03	0.95	0.04	0.07	0.20	1.32
515	0.46	5.82	5.94	0.03	0.95	0.04	0.07	0.20	1.32
516	0.46	5.82	5.94	0.03	0.95	0.04	0.07	0.20	1.32
517	0.46	5.82	5.94	0.03	0.95	0.04	0.07	0.20	1.32
518	0.93	7.26	8.27	0.03	1.21	0.09	0.10	0.26	2.33
519	0.93	7.26	8.27	0.03	1.21	0.09	0.10	0.26	2.33
520	0.77	7.31	6.87	0.03	1.72	0.08	0.16	0.39	1.36
521	0.77	7.31	6.87	0.03	1.72	0.08	0.16	0.39	1.36
522	0.77	7.31	6.87	0.03	1.72	0.08	0.16	0.39	1.36
523	0.77	9.60	7.05	0.03	0.63	0.03	0.04	0.34	1.89
524	0.77	9.60	7.05	0.03	0.63	0.03	0.04	0.34	1.89
525	0.77	9.60	7.05	0.03	0.63	0.03	0.04	0.34	1.89
526	0.77	9.60	7.05	0.03	0.63	0.03	0.04	0.34	1.89
527	0.38	3.09	6.46	0.03	0.64	0.03	0.04	0.28	1.87
528	0.38	3.09	6.46	0.03	0.64	0.03	0.04	0.28	1.87

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OBS SI  D SP   FRQ   HT    SD  SHA  PH       H      KC     CA
529 11 24 aul 0.24 22.6  5.60 1.0 4.63  23.40   79.00   4.60
530 11 21 tom 0.98 13.8  1.20 0.5 4.92  12.00   84.00   1.65
531 11 18 tom 0.98 13.4  1.30 0.5 4.89  15.50   49.00   1.32
532 11 18 ter 0.02 12.3  0.00 0.5 4.89  15.50   49.00   1.32
533 11 15 tom 0.84 12.7  1.50 0.5 4.89  12.90  117.00   1.55
534 17  0 ang 0.90 26.4  4.80 2.0 4.70  20.00   82.00   8.80
535 17  0 ple 0.04 12.2  2.20 2.0 4.70  20.00   82.00   8.80
536 17  7 ang 0.46 31.3  4.60 4.0 4.00 100.00   61.00   4.95
537 17  7 mag 0.30 37.6  3.90 4.0 4.00 100.00   61.00   4.95
538 17  7 rus 0.14 36.0  2.60 4.0 4.00 100.00   61.00   4.95
539 17  7 cap 0.06 42.0  1.90 4.0 4.00 100.00   61.00   4.95
540 17  7 ple 0.02 46.3  0.00 4.0 4.00 100.00   61.00   4.95
541 17 13 ang 0.56 39.5  5.30 3.0 5.40   4.00   84.00   3.08
542 17 13 mag 0.08 52.9 10.20 3.0 5.40   4.00   84.00   3.08
543 17 13 fus 0.32 51.7  7.50 3.0 5.40   4.00   84.00   3.08
544 17 13 ple 0.02 41.8  0.00 3.0 5.40   4.00   84.00   3.08
545 17 13 aul 0.02 42.5  0.00 3.0 5.40   4.00   84.00   3.08
546 17 18 mag 0.08 56.2  9.60 2.5 3.80 158.50   62.00   4.94
547 17 18 fus 0.94 56.1  5.40 2.5 3.80 158.50   62.00   4.94
548 17 25 mag 0.08 56.3  4.30 2.0 3.90 125.90   80.00   3.15
549 17 25 fus 0.94 58.8  6.60 2.0 3.90 125.90   80.00   3.15
550 17 30 mag 0.30 51.0  6.60 4.0 4.00 100.00   42.00   4.12
551 17 30 fus 0.70 54.4  6.30 4.0 4.00 100.00   42.00   4.12
552 17 35 mag 0.22 43.4  8.10 2.0 3.80 158.50   51.00   4.42

OBS   MG    NA     K     AL     FE     MN    NI     S      P
529  0.38  3.09  6.46  0.03   0.64   0.03  0.04  0.28  1.87
530  0.05  3.01  4.78  0.03   0.85   0.02  0.06  0.33  2.31
531  0.02  1.88  2.55  0.03   1.87   0.04  0.18  0.28  0.98
532  0.02  1.88  2.55  0.03   1.87   0.04  0.18  0.28  0.98
533  0.05 11.03  4.15  0.03   2.15   0.05  0.22  0.23  1.04
534  1.01  5.50  1.19  0.03   5.35   0.37  0.53  0.39  0.03
535  1.01  5.50  1.19  0.03   5.35   0.37  0.53  0.39  0.03
536  0.23  4.19  2.64  0.03   5.64   0.14  0.55  0.40  0.03
537  0.23  4.19  2.64  0.03   5.64   0.14  0.55  0.40  0.03
538  0.23  4.19  2.64  0.03   5.64   0.14  0.55  0.40  0.03
539  0.23  4.19  2.64  0.03   5.64   0.14  0.55  0.40  0.03
540  0.23  4.19  2.64  0.03   5.64   0.14  0.55  0.40  0.03
541  0.02  3.17  6.72  0.03   6.06   0.14  0.57  0.26  0.03
542  0.02  3.17  6.72  0.03   6.06   0.14  0.57  0.26  0.03
543  [illegible]  3.17  6.72  0.03   6.06   0.14  0.57  0.26  0.03
544  [illegible]  3.17  6.72  0.03   6.06   0.14  0.57  0.26  0.03
545  [illegible]  3.17  6.72  0.03   6.06   0.14  0.57  0.26  0.03
546  0.02  2.30  3.61  0.03   8.66   0.26  0.91  0.39  0.77
547  0.02  2.30  3.61  0.03   8.66   0.26  0.91  0.39  0.77
548  0.25  5.16 10.01  0.03   7.32   0.30  0.76  0.42  0.85
549  0.25  5.16 10.01  0.03   7.32   0.30  0.76  0.42  0.85
550  0.02  2.44  1.69  0.03   8.37   0.19  0.85  0.27  0.60
551  0.02  2.44  1.69  0.03   8.37   0.19  0.85  0.27  0.60
552  0.02  0.89  0.95  0.03   8.84   0.45  0.96  0.14  0.03
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OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA	MG	NA	K	AL	FE	MN	NI	S	P
553	17	35	fus	0.74	52.5	5.10	2.0	3.80	158.50	51.00	4.42	0.02	0.89	0.95	0.03	8.84	0.45	0.96	0.14	0.03
554	17	35	cap	0.04	44.8	0.70	2.0	3.80	158.50	51.00	4.42	0.02	0.89	0.95	0.03	8.84	0.45	0.96	0.14	0.03
555	17	40	mag	0.04	67.9	3.40	2.0	3.90	125.90	53.00	4.44	0.02	1.15	1.83	0.03	8.61	0.33	0.89	0.33	1.33
556	17	40	fus	0.96	68.4	4.90	2.0	3.90	125.90	53.00	4.44	0.02	1.15	1.83	0.03	8.61	0.33	0.89	0.33	1.33
557	17	40	ang	0.42	38.3	5.00	2.0	3.80	158.50	56.00	4.92	0.02	7.89	3.41	0.03	8.53	0.22	0.92	0.38	1.51
558	17	40	mag	0.18	44.6	5.30	2.0	3.80	158.50	56.00	4.92	0.02	7.89	3.41	0.03	8.53	0.22	0.92	0.38	1.51
559	17	40	fus	0.40	44.6	5.20	2.0	3.80	158.50	56.00	4.92	0.02	7.89	3.41	0.03	8.53	0.22	0.92	0.38	1.51
560	17	35	ang	0.02	32.7	0.00	2.0	3.90	125.90	51.00	3.16	0.02	4.19	3.19	0.03	6.79	0.18	0.58	0.43	0.55
561	17	35	mag	0.16	48.6	4.50	2.0	3.90	125.90	51.00	3.16	0.02	4.19	3.19	0.03	6.79	0.18	0.58	0.43	0.55
562	17	35	fus	0.82	44.0	7.40	2.0	3.90	125.90	51.00	3.16	0.02	4.19	3.19	0.03	6.79	0.18	0.58	0.43	0.55
563	17	30	mag	0.04	87.0	1.40	1.5	3.80	158.50	49.00	4.62	0.02	1.80	3.00	0.03	8.00	0.30	0.85	0.29	1.42
564	17	30	fus	0.96	74.7	7.30	1.5	3.80	158.50	49.00	4.62	0.02	1.80	3.00	0.03	8.00	0.30	0.85	0.29	1.42
565	17	25	mag	0.02	39.7	0.00	1.5	3.70	199.50	37.00	4.72	0.02	2.00	3.00	0.03	8.02	0.26	0.76	0.30	1.48
566	17	25	fus	0.98	46.0	6.60	1.5	3.70	199.50	37.00	4.72	0.02	2.00	3.00	0.03	8.02	0.26	0.76	0.30	1.48
567	18	0	tom	0.02	27.4	0.00	6.0	6.80	0.20	554.00	201.34	23.80	17.96	16.53	0.50	29.71	17.70	1.79	0.43	0.95
568	18	0	fus	0.78	40.1	3.20	6.0	6.80	0.20	554.00	201.34	23.80	17.96	16.53	0.50	29.71	17.70	1.79	0.43	0.95
569	18	0	ple	0.10	38.3	1.70	6.0	6.80	0.20	554.00	201.34	23.80	17.96	16.53	0.50	29.71	17.70	1.79	0.43	0.95
570	18	5	tom	0.06	26.5	2.60	3.0	6.75	0.20	537.00	75.08	11.04	17.96	4.55	0.03	14.21	0.37	1.67	0.79	0.38
571	18	5	fus	0.94	34.1	6.90	3.0	6.75	0.20	537.00	75.08	11.04	17.96	4.55	0.03	14.21	0.37	1.67	0.79	0.38
572	18	10	tom	0.54	25.9	4.30	2.0	7.00	0.10	578.00	76.36	11.04	14.52	22.69	0.03	12.30	0.34	1.45	1.10	0.38
573	18	10	fus	0.28	31.1	3.70	2.0	7.00	0.10	578.00	76.36	11.04	14.52	22.69	0.03	12.30	0.34	1.45	1.10	0.38
574	18	10	war	0.18	30.1	3.10	2.0	7.00	0.10	578.00	76.36	11.04	14.52	22.69	0.03	12.30	0.34	1.45	1.10	0.38
575	18	15	tom	0.34	27.0	2.90	3.5	7.00	0.10	578.00	90.59	13.10	23.54	11.76	0.03	13.45	0.34	1.58	0.18	0.38
576	18	15	war	0.66	26.6	5.30	3.5	7.00	0.10	578.00	90.59	13.10	23.54	11.76	0.03	13.45	0.34	1.58	0.18	0.38

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
577	18	20	tom	0.20	20.2	3.00	3.0	6.70	0.20	429.00	74.40
578	18	20	war	0.70	21.4	2.90	3.0	6.70	0.20	429.00	74.40
579	18	25	tom	0.28	22.0	4.10	2.0	6.80	0.20	461.00	78.06
580	18	25	war	0.64	21.6	4.00	2.0	6.80	0.20	461.00	78.06
581	18	30	tom	0.06	18.6	0.20	2.0	6.80	0.20	408.00	99.51
582	18	30	war	0.66	20.1	3.00	2.0	6.80	0.20	408.00	99.51
583	18	35	tom	0.08	20.0	3.00	1.0	6.95	0.10	447.00	98.80
584	18	35	war	0.38	18.4	3.10	1.0	6.95	0.10	447.00	98.80
585	18	40	tom	0.24	19.8	4.20	1.0	7.05	0.08	462.00	91.39
586	18	40	war	0.26	15.3	3.70	1.0	7.05	0.08	462.00	91.39
587	18	45	tom	0.08	20.9	2.70	1.0	7.05	0.08	453.00	91.39
588	18	45	war	0.74	22.8	2.80	1.0	7.05	0.08	453.00	91.39
589	18	35	tom	0.10	17.6	1.70	1.5	6.95	0.10	380.00	123.90
590	18	35	war	0.54	17.4	1.60	1.5	6.95	0.10	380.00	123.90
591	18	5	fus	0.98	28.7	5.30	2.5	7.00	0.10	356.00	71.02
592	19	0	tom	0.08	15.5	1.60	6.0	6.60	0.30	485.00	65.86
593	19	0	fus	0.76	42.4	12.40	6.0	6.60	0.30	485.00	65.86
594	19	5	tom	0.06	15.6	1.70	9.0	6.70	0.20	388.00	56.14
595	19	5	fus	0.94	39.0	8.70	9.0	6.70	0.20	388.00	56.14
596	19	10	tom	0.04	31.5	0.80	7.0	6.70	0.20	341.00	44.39
597	19	10	fus	0.96	61.7	8.90	7.0	6.70	0.20	341.00	44.39
598	19	15	tom	0.12	27.0	2.90	7.5	6.90	0.10	364.00	42.39
599	19	15	fus	0.88	55.6	11.60	7.5	6.90	0.10	364.00	42.39
600	19	20	fus	1.00	58.1	3.80	7.0	6.90	0.10	369.00	47.11

OBS	MG	NA	K	AL	FE	MN	NO	S	P
577	10.63	16.58	6.71	0.02	12.58	0.33	1.47	0.18	0.38
578	10.63	16.58	6.71	0.02	12.58	0.33	1.47	0.18	0.38
579	12.26	18.99	3.56	0.03	14.08	0.35	1.65	0.18	0.38
580	12.26	18.99	3.56	0.03	14.08	0.35	1.65	0.18	0.38
581	14.32	17.05	8.46	0.03	13.28	6.47	1.59	0.30	0.38
582	14.32	17.05	8.46	0.03	13.28	6.47	1.59	0.30	0.38
583	14.00	14.14	4.56	0.03	2.34	0.18	0.21	1.01	0.38
584	14.00	14.14	4.56	0.03	2.34	0.18	0.21	1.01	0.38
585	15.19	13.94	7.83	0.03	1.50	24.25	0.13	0.18	0.38
586	15.19	13.94	7.83	0.03	1.50	24.25	0.13	0.18	0.38
587	15.36	10.70	2.68	0.03	5.33	0.17	0.55	1.42	0.38
588	15.36	10.70	2.68	0.03	5.33	0.17	0.55	1.42	0.38
589	18.16	9.70	6.06	0.04	14.00	9.86	1.80	0.35	0.38
590	18.16	9.70	6.06	0.04	14.00	9.86	1.80	0.35	0.38
591	12.18	5.81	7.63	0.03	14.78	1.69	1.77	0.18	0.93
592	26.30	10.93	13.66	0.12	0.22	1.14	0.01	1.06	1.30
593	26.30	10.93	13.66	0.12	0.22	1.14	0.01	1.06	1.30
594	25.46	5.16	6.27	0.20	0.14	0.46	0.05	5.50	0.45
595	25.46	5.16	6.27	0.20	0.14	0.46	0.05	5.50	0.45
596	20.83	4.31	4.51	0.17	0.11	0.01	0.05	7.26	0.23
597	20.83	4.31	4.51	0.17	0.11	0.01	0.05	7.26	0.23
598	19.90	3.82	3.59	0.18	0.22	0.02	0.05	4.94	0.13
599	19.90	3.82	3.59	0.18	0.22	0.02	0.05	4.94	0.13
600	22.49	4.86	4.06	0.17	0.13	0.02	0.05	5.64	0.08

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
601	19	30	fus	0.82	50.9	3.20	7.0	7.00	0.10	354.00	52.46
602	19	30	ple	0.18	50.1	3.30	7.0	7.00	0.10	354.00	52.46
603	19	35	fus	1.00	52.8	13.40	8.0	7.00	0.10	397.00	48.01
604	19	40	aul	0.16	23.3	6.40	7.0	7.00	0.10	360.00	54.54
605	19	40	fus	0.84	33.9	8.30	7.0	7.00	0.10	360.00	54.54
606	19	45	fus	1.00	50.0	3.50	7.0	6.90	0.10	336.00	43.78
607	19	40	fus	1.00	48.0	6.50	8.0	6.90	0.10	345.00	47.17
608	19	35	tom	0.24	32.2	4.90	8.0	6.00	0.10	336.00	57.14
609	19	35	fus	0.74	47.2	4.50	8.0	6.00	0.10	336.00	57.14
610	20	0	ang	0.60	19.3	2.40	3.0	3.90	125.90	22.00	1.38
611	20	0	mag	0.40	20.6	1.80	3.0	3.90	125.90	22.00	1.38
612	20	5	ang	0.54	23.4	3.80	1.0	3.50	125.90	24.00	2.89
613	20	5	mag	0.44	23.3	3.40	1.0	3.50	125.90	24.00	2.89
614	20	10	ang	0.38	23.2	3.80	3.5	3.90	125.90	36.00	1.02
615	20	10	mag	0.62	20.2	3.40	3.5	3.90	125.90	36.00	1.02
616	20	15	ang	0.74	26.0	3.40	2.0	4.00	125.90	33.00	0.32
617	20	15	mag	0.26	22.9	4.10	2.0	4.00	125.90	33.00	0.32
618	20	20	ang	0.50	20.9	3.80	1.0	3.90	125.90	25.00	0.58
619	20	20	mag	0.50	19.7	3.10	1.0	3.90	125.90	25.00	0.58
620	20	25	ang	0.70	18.4	3.90	4.0	4.10	79.40	29.00	0.59
621	20	25	mag	0.30	23.3	6.60	4.0	4.10	79.40	29.00	0.59
622	20	30	ang	0.30	16.5	4.20	3.0	4.05	89.10	13.00	0.90
623	20	30	mag	0.64	18.6	4.50	3.0	4.05	89.10	13.00	0.90
624	20	35	ang	0.46	14.4	2.40	2.0	4.00	100.00	17.00	0.62

OBS	MG	NA	K	AL	FE	MN	NI	S	P
601	24.93	4.63	4.59	0.20	0.21	0.03	0.07	14.23	0.12
602	24.93	4.63	4.59	0.20	0.21	0.03	0.07	14.23	0.12
603	22.95	4.27	4.19	0.18	0.12	0.00	0.05	3.23	0.13
604	24.52	8.77	5.96	0.28	0.29	0.81	0.07	6.56	0.17
605	24.52	8.77	5.96	0.28	0.29	0.81	0.07	6.56	0.17
606	20.96	6.56	4.98	0.19	0.12	0.02	0.06	8.61	0.14
607	21.64	4.25	4.19	0.14	0.23	0.01	0.03	1.18	0.11
608	25.80	4.38	4.71	0.18	0.19	2.78	0.06	7.23	0.13
609	25.80	4.38	4.71	0.18	0.19	2.78	0.06	7.23	0.13
610	0.05	1.61	2.34	0.38	6.06	0.14	0.55	0.18	0.38
611	0.05	1.61	2.34	0.38	6.06	0.14	0.55	0.18	0.38
612	0.05	3.31	2.34	0.39	5.00	0.12	0.38	0.18	0.38
613	0.05	3.31	2.34	0.39	5.00	0.12	0.38	0.18	0.38
614	0.48	3.65	2.18	0.39	14.08	0.33	1.41	0.18	0.38
615	0.48	3.65	2.18	0.39	14.08	0.33	1.41	0.18	0.38
616	0.48	1.23	2.63	0.39	5.48	0.13	0.43	0.20	0.38
617	0.48	1.23	2.63	0.39	5.48	0.13	0.43	0.20	0.38
618	0.48	2.36	3.34	0.39	6.25	0.14	0.53	0.18	0.62
619	0.48	2.36	3.34	0.39	6.25	0.14	0.53	0.18	0.62
620	0.48	1.64	4.57	0.39	13.12	0.32	1.27	0.18	0.55
621	0.48	1.64	4.57	0.39	13.12	0.32	1.27	0.18	0.55
622	0.48	1.02	1.04	0.39	10.53	0.25	1.03	0.18	0.38
623	0.48	1.02	1.04	0.39	10.53	0.25	1.03	0.18	0.38
624	0.48	1.14	1.07	0.39	8.62	0.20	0.78	0.18	0.38

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
625	20	35	mag	0.50	15.3	2.60	2.0	4.00	100.00	17.00	0.62
626	20	35	myl	0.04	13.3	0.10	2.0	4.00	100.00	17.00	0.62
627	20	40	ang	0.52	17.1	3.80	1.5	4.00	100.00	31.00	0.54
628	20	40	mag	0.48	16.7	3.40	1.5	4.00	100.00	31.00	0.54
629	20	45	ang	0.82	22.4	2.50	1.0	4.10	79.40	28.00	0.66
630	20	45	mag	0.16	21.2	2.50	1.0	4.10	79.40	28.00	0.66
631	20	45	myl	0.02	13.1	0.00	1.0	4.10	79.40	28.00	0.66
632	20	50	ang	0.56	17.3	5.00	1.5	3.90	125.90	39.00	0.47
633	20	50	mag	0.30	17.8	3.50	1.5	3.90	125.90	39.00	0.47
634	20	50	myl	0.14	11.2	4.20	1.5	3.90	125.90	39.00	0.47
635	20	55	ang	0.46	20.6	2.80	2.0	4.00	100.00	14.00	0.89
636	20	55	mag	0.32	16.4	7.80	2.0	4.00	100.00	14.00	0.89
637	21	0	pac	0.66	16.9	8.10	6.0	5.20	6.30	28.00	2.80
638	21	0	rus	0.08	24.1	2.40	6.0	5.20	6.30	28.00	2.80
639	21	5	pac	0.54	13.7	4.70	5.0	5.30	5.00	46.00	2.41
640	21	5	cen	0.28	15.1	3.50	5.0	5.30	5.00	46.00	2.41
641	21	5	poh	0.02	16.8	0.00	5.0	5.30	5.00	46.00	2.41
642	21	10	ang	0.42	14.3	1.10	1.0	5.10	0.30	48.00	1.78
643	21	10	mag	0.58	15.3	2.30	1.0	5.10	0.30	48.00	1.78
644	21	15	ang	0.60	11.3	1.60	1.0	4.20	0.30	48.00	1.55
645	21	15	mag	0.40	12.0	2.10	1.0	4.20	0.30	48.00	1.55
646	21	15	ang	0.18	15.4	3.10	1.0	4.20	63.10	43.00	1.55
647	21	15	mag	0.82	14.3	1.30	1.0	4.20	63.10	43.00	1.55
648	21	20	ang	0.20	14.1	1.60	1.0	4.70	20.00	56.00	1.45

OBS	MG	NA	K	AL	FE	MN	NI	S	P
625	0.48	1.14	1.07	0.39	8.62	0.20	0.78	0.18	0.38
626	0.48	1.14	1.07	0.39	8.62	0.20	0.78	0.18	0.38
627	0.48	1.50	1.04	0.39	7.61	0.17	0.64	0.38	0.94
628	0.48	1.50	1.04	0.39	7.61	0.17	0.64	0.38	0.94
629	0.48	1.71	3.18	0.39	13.60	0.32	1.29	0.18	0.49
630	0.48	1.71	3.18	0.39	13.60	0.32	1.29	0.18	0.49
631	0.48	1.71	3.18	0.39	13.60	0.32	1.29	0.13	0.49
632	0.48	2.42	3.91	0.39	9.60	0.22	0.88	0.18	0.27
633	0.48	2.42	3.91	0.39	9.60	0.22	0.88	0.18	0.27
634	0.48	2.42	3.91	0.39	9.60	0.22	0.88	0.18	0.27
635	0.48	1.02	1.04	0.39	13.48	0.32	1.32	0.18	0.38
636	0.48	1.02	1.04	0.39	13.48	0.32	1.32	0.18	0.38
637	1.29	0.63	1.60	0.78	2.32	0.10	0.02	0.17	0.03
638	1.29	0.63	1.60	0.78	2.32	0.10	0.02	0.17	0.03
639	1.31	0.82	7.92	0.76	3.89	0.13	0.11	0.17	0.04
640	1.31	0.82	7.92	0.76	3.89	0.13	0.11	0.17	0.04
641	1.31	0.82	7.92	0.76	3.89	0.13	0.11	0.17	0.04
642	0.79	0.02	0.45	0.19	0.55	0.02	0.01	0.11	0.03
643	0.79	0.02	0.45	0.19	0.55	0.02	0.01	0.11	0.03
644	0.64	0.56	1.52	0.15	0.67	0.04	0.75	0.19	0.10
645	0.64	0.56	1.52	0.15	0.67	0.04	0.75	0.19	0.10
646	0.64	0.56	1.52	0.15	0.67	0.04	0.75	0.19	0.10
647	0.64	0.56	1.52	0.15	0.67	0.04	0.75	0.19	0.10
648	0.59	0.76	3.01	0.17	0.81	0.11	0.01	0.11	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
649	21	20	mag	0.80	14.3	1.90	1.0	4.70	20.00	56.00	1.45
650	21	30	ang	0.36	4.6	6.00	1.0	4.30	50.10	49.00	2.58
651	21	30	mag	0.44	11.7	3.70	1.0	4.30	50.10	49.00	2.58
652	21	35	ang	0.54	5.6	3.60	1.0	5.00	10.00	53.00	2.29
653	21	35	mag	0.44	9.1	2.10	1.0	5.00	10.00	53.00	2.29
654	21	40	ang	0.32	6.2	4.30	1.0	4.85	14.10	45.00	2.83
655	21	40	mag	0.68	10.1	3.20	1.0	4.85	14.10	45.00	2.83
656	21	45	ang	0.52	9.0	2.10	1.0	4.35	44.70	54.00	1.24
657	21	45	mag	0.48	8.7	1.90	1.0	4.35	44.70	54.00	1.24
[illegible]	21	50	ang	0.56	17.6	2.10	1.0	4.20	63.10	45.00	1.35
	21	50	mag	0.44	11.7	2.00	1.0	4.20	63.10	45.00	1.35
660	21	45	ang	0.52	7.9	1.90	1.0	4.45	35.50	58.00	0.40
661	21	45	mag	0.48	7.6	2.40	1.0	4.45	35.50	58.00	0.40
662	22	0	cam	0.08	8.9	2.20	6.0	7.63	0.02	584.00	76.72
663	22	0	tom	0.50	17.7	5.60	6.0	7.63	0.02	584.00	76.72
664	22	0	fus	0.30	25.8	4.40	6.0	7.63	0.02	584.00	76.72
665	22	0	ple	0.02	24.5	0.00	6.0	7.63	0.02	584.00	76.72
666	22	0	rev	0.04	9.0	0.60	6.0	7.63	0.02	584.00	76.72
667	22	5	rev	0.14	6.9	2.60	4.0	7.31	0.04	544.00	85.82
668	22	5	tom	0.38	14.8	9.30	4.0	7.31	0.04	544.00	85.82
669	22	5	fus	0.42	30.1	5.20	4.0	7.31	0.04	544.00	85.82
670	22	5	str	0.04	30.5	0.70	4.0	7.31	0.04	544.00	85.82
671	22	10	cam	0.04	14.7	0.10	4.0	7.25	0.05	559.00	95.21
672	22	10	tom	0.20	18.4	4.20	4.0	7.25	0.05	559.00	95.21

OBS	MG	NA	K	AL	FE	MN	NI	S	P
649	0.59	0.76	3.01	0.17	0.81	0.11	0.01	0.11	0.03
650	1.22	0.24	0.09	0.20	1.09	0.05	0.02	0.10	0.03
651	1.22	0.24	0.09	0.20	1.09	0.05	0.02	0.10	0.03
652	1.20	0.18	0.64	0.25	2.18	0.13	0.02	0.09	0.03
653	1.20	0.18	0.64	0.25	2.18	0.13	0.02	0.09	0.03
654	1.32	0.11	0.34	0.45	1.86	0.06	0.05	0.16	0.14
655	1.32	0.11	0.34	0.45	1.86	0.06	0.05	0.16	0.14
656	0.61	0.23	1.97	0.16	0.95	0.03	0.01	0.13	0.03
657	0.61	0.23	1.97	0.16	0.95	0.03	0.01	0.13	0.03
658	0.22	0.94	8.60	0.14	1.29	0.02	0.01	0.24	0.60
659	0.22	0.94	8.60	0.14	1.29	0.02	0.01	0.24	0.60
660	0.08	0.05	6.76	0.06	0.73	0.02	0.01	0.07	0.24
661	0.08	0.05	6.76	0.06	0.73	0.02	0.01	0.07	0.24
662	15.07	8.12	6.29	0.18	16.67	3.76	0.02	0.24	0.03
663	15.07	8.12	6.29	0.18	16.67	3.76	0.02	0.24	0.03
664	15.07	8.12	6.29	0.18	16.67	3.76	0.02	0.24	0.03
665	15.07	8.12	6.29	0.18	16.67	3.76	0.02	0.24	0.03
666	15.07	8.12	6.29	0.18	16.67	3.76	0.02	0.24	0.03
667	12.49	3.71	2.42	0.16	3.79	3.42	0.01	0.11	0.03
668	12.49	3.71	2.42	0.16	3.79	3.42	0.01	0.11	0.03
669	12.49	3.71	2.42	0.16	3.79	3.42	0.01	0.11	0.03
670	12.49	3.71	2.42	0.16	3.79	3.42	0.01	0.11	0.03
671	12.86	4.47	2.97	0.31	0.19	0.23	0.01	1.59	0.03
672	12.86	4.47	2.97	0.31	0.19	0.23	0.01	1.59	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
673	22	10	fus	0.76	39.5	8.50	4.0	7.25	0.05	559.00	95.21
674	22	15	rev	0.12	9.9	1.70	6.0	6.97	0.10	472.00	84.06
675	22	15	tom	0.24	17.3	4.00	6.0	6.97	0.10	472.00	84.06
676	22	15	fus	0.61	43.4	7.20	6.0	6.97	0.10	472.00	84.06
677	22	20	tom	0.02	17.0	0.00	5.0	6.90	0.10	477.00	78.70
678	22	20	fus	0.96	36.3	12.20	5.0	6.90	0.10	481.00	78.70
679	22	20	str	0.02	60.1	0.00	5.0	6.90	0.10	481.00	78.70
680	22	25	tom	0.50	22.8	5.20	7.0	7.29	0.05	632.00	120.69
681	22	25	fus	0.36	34.8	3.00	7.0	7.29	0.05	632.00	120.69
682	22	30	tom	0.10	18.0	4.10	5.0	7.21	0.06	630.00	101.26
683	22	30	fus	0.90	38.3	6.80	5.0	7.21	0.06	630.00	101.26
684	22	35	tom	0.90	21.3	5.00	4.0	7.03	0.09	703.00	112.14
685	22	30	tom	0.62	16.7	4.40	4.0	6.91	0.10	712.00	104.33
686	22	30	fus	0.34	24.8	3.20	4.0	6.91	0.10	712.00	104.33
687	22	30	cam	0.02	6.4	0.00	4.0	6.91	0.10	712.00	104.33
688	22	25	tom	0.32	26.8	5.40	7.0	7.58	0.03	772.00	88.55
689	22	25	fus	0.56	28.0	4.10	7.0	7.58	0.03	772.00	88.55
690	22	25	myl	0.04	31.9	5.70	7.0	7.58	0.03	772.00	88.55
691	22	25	ple	0.06	28.2	0.60	7.0	7.58	0.03	772.00	88.55
692	22	20	cam	0.06	12.2	3.50	3.0	6.81	0.20	759.00	119.83
693	22	20	rev	0.10	13.7	7.70	3.0	6.81	0.20	759.00	119.83
694	22	20	tom	0.06	9.3	1.90	3.0	6.81	0.20	759.00	119.83
695	22	20	fus	0.74	46.9	13.40	3.0	6.81	0.20	759.00	119.83
696	22	20	myl	0.04	48.2	1.10	3.0	6.81	0.20	759.00	119.83

OBS	MG	NA	K	AL	FE	MN	NI	S	P
673	12.86	4.47	2.97	0.31	0.19	0.23	0.01	1.59	0.03
674	12.02	3.88	1.11	0.13	0.05	0.00	0.01	1.20	0.03
675	12.02	3.88	1.11	0.13	0.05	0.00	0.01	1.20	0.03
676	12.02	3.88	1.11	0.13	0.05	0.00	0.01	1.20	0.03
677	11.23	3.83	1.99	0.16	0.19	0.01	0.01	7.98	0.03
678	11.23	3.83	1.99	0.16	0.19	0.01	0.01	7.98	0.03
679	11.23	3.83	1.99	0.16	0.19	0.01	0.01	7.98	0.03
680	17.43	5.10	6.09	0.19	0.37	5.32	0.03	0.86	0.03
681	17.43	5.10	6.09	0.19	0.37	5.32	0.03	0.86	0.03
682	18.83	15.00	2.96	0.21	0.07	0.01	0.02	0.92	0.03
683	18.83	15.00	2.96	0.21	0.07	0.01	0.02	0.92	0.03
684	16.39	15.30	2.35	0.16	0.65	0.30	0.08	2.34	0.03
685	15.53	16.63	3.31	0.20	0.10	0.11	0.01	1.48	0.03
686	15.53	16.63	3.31	0.20	0.10	0.11	0.01	1.48	0.03
687	15.53	16.63	3.31	0.20	0.10	0.11	0.01	1.48	0.03
688	18.21	14.16	10.24	0.18	0.54	2.29	0.01	0.13	0.03
689	18.21	14.16	10.24	0.18	0.54	2.29	0.01	0.13	0.03
690	18.21	14.16	10.24	0.18	0.54	2.29	0.01	0.13	0.03
691	18.21	14.16	10.24	0.18	0.54	2.29	0.01	0.13	0.03
692	18.70	15.96	0.20	0.03	0.10	0.02	0.02	6.70	0.03
693	18.70	15.96	0.20	0.03	0.10	0.02	0.02	6.70	0.03
694	18.70	15.96	0.20	0.03	0.10	0.02	0.02	6.70	0.03
695	18.70	15.96	0.20	0.03	0.10	0.02	0.02	6.70	0.03
696	18.70	15.96	0.20	0.03	0.10	0.02	0.02	6.70	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
697	22	15	cam	0.04	4.2	0.80	6.0	7.34	0.05	869.00	136.19
698	22	15	tom	0.26	7.8	3.00	6.0	7.34	0.05	869.00	136.19
699	22	15	fus	0.70	26.4	8.20	6.0	7.34	0.05	869.00	136.19
700	23	0	tom	0.18	11.2	11.50	4.0	7.19	0.06	427.00	98.79
701	23	0	ple	0.16	18.1	12.60	4.0	7.19	0.06	427.00	98.79
702	23	0	myl	0.02	21.1	0.00	4.0	7.19	0.06	427.00	98.79
703	23	0	fus	0.62	20.6	8.00	4.0	7.19	0.06	427.00	98.79
704	23	5	mee	0.08	-4.9	3.30	5.5	7.13	0.07	420.00	84.67
705	23	5	tom	0.36	8.6	7.30	5.5	7.13	0.07	420.00	84.67
706	23	5	war	0.54	11.7	4.80	5.5	7.13	0.07	420.00	84.67
707	23	5	fus	0.02	23.0	0.00	5.5	7.13	0.07	420.00	84.67
708	23	10	ang	0.86	9.9	4.80	6.0	7.28	0.05	395.00	72.20
709	23	10	tom	0.08	6.2	6.50	6.0	7.28	0.05	395.00	72.20
710	23	10	war	0.02	12.0	0.00	6.0	7.28	0.05	395.00	72.20
711	23	15	ang	0.36	10.3	3.00	6.0	7.29	0.05	364.00	71.93
712	23	15	tom	0.26	12.6	5.70	6.0	7.29	0.05	364.00	71.93
713	23	15	fus	0.38	18.5	4.60	6.0	7.29	0.05	364.00	71.93
714	23	20	fus	1.00	26.7	9.80	3.0	7.28	0.05	261.00	46.90
715	23	25	fus	0.96	19.3	7.70	1.5	7.22	0.06	300.00	46.90
716	23	30	cam	0.06	-9.9	0.90	7.0	7.06	0.09	270.00	46.48
717	23	30	ang	0.02	-0.4	0.00	7.0	7.06	0.09	270.00	46.48
718	23	30	tom	0.20	18.6	4.30	7.0	7.06	0.09	270.00	46.48
719	23	30	fus	0.72	24.7	7.80	7.0	7.06	0.09	270.00	46.48
720	23	35	fus	0.96	32.7	4.90	7.0	6.89	0.10	272.00	46.65

OBS	MG	NA	K	AL	FE	MN	NI	S	P
697	23.77	6.62	10.76	0.32	1.26	1.12	0.02	0.42	0.03
698	23.77	6.62	10.76	0.32	1.26	1.12	0.02	0.42	0.03
699	23.77	6.62	10.76	0.32	1.26	1.12	0.02	0.42	0.03
700	14.56	2.11	2.26	0.11	0.02	0.00	0.01	1.29	0.03
701	14.56	2.11	2.26	0.11	0.02	0.00	0.01	1.29	0.03
702	14.56	2.11	2.26	0.11	0.02	0.00	0.01	1.29	0.03
703	14.56	2.11	2.26	0.11	0.02	0.00	0.01	1.82	0.03
704	16.68	1.78	0.68	0.20	0.04	0.00	0.01	1.82	0.03
705	16.68	1.78	0.68	0.20	0.04	0.00	0.01	1.82	0.03
706	16.68	1.78	0.68	0.20	0.04	0.00	0.01	1.82	0.03
707	16.68	1.78	0.68	0.20	0.04	0.00	0.01	1.82	0.03
708	16.13	2.35	0.92	0.20	0.11	0.00	0.02	2.34	0.03
709	16.13	2.35	0.92	0.20	0.11	0.00	0.02	2.34	0.03
710	16.13	2.35	0.92	0.20	0.11	0.00	0.02	2.34	0.03
711	16.72	2.40	0.78	0.18	0.48	0.01	0.05	2.41	0.03
712	16.72	2.40	0.78	0.18	0.48	0.01	0.05	2.41	0.03
713	16.72	2.40	0.78	0.18	0.48	0.01	0.05	2.41	0.03
714	12.30	3.93	0.81	0.14	0.01	0.00	0.01	3.42	0.03
715	12.17	4.13	0.84	0.13	0.02	0.00	0.71	3.39	0.03
716	12.54	4.01	0.81	0.11	0.01	0.00	0.01	3.49	0.03
717	12.54	4.01	0.81	0.11	0.01	0.00	0.01	3.49	0.03
718	12.54	4.01	0.81	0.11	0.01	0.00	0.01	3.49	0.03
719	12.54	4.01	0.81	0.11	0.01	0.00	0.01	3.49	0.03
720	12.79	3.97	1.62	0.15	0.02	0.01	0.01	3.46	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
721	23	40	tom	0.20	19.4	5.10	6.0	7.23	0.06	309.00	43.75
722	23	40	fus	0.78	16.3	5.80	6.0	7.23	0.06	308.94	43.75
723	23	45	cam	0.04	-9.9	1.30	4.0	6.98	0.10	276.00	45.69
724	23	45	ang	0.10	11.9	13.50	4.0	6.98	0.10	276.00	45.69
725	23	45	tom	0.14	18.7	8.80	4.0	6.98	0.10	276.00	45.69
726	23	45	fus	0.62	25.7	6.30	4.0	6.98	0.10	276.00	45.69
727	23	45	ple	0.08	26.7	2.00	4.0	6.98	0.10	276.00	45.69
728	23	50	cam	0.04	3.2	0.60	2.0	7.01	0.10	276.00	46.95
729	23	50	fus	0.88	20.7	5.90	2.0	7.01	0.10	276.00	46.95
730	23	55	war	0.44	6.4	4.60	1.0	7.05	0.09	263.00	46.04
731	23	55	ang	0.02	20.6	0.00	1.0	7.05	0.09	263.00	46.04
732	23	55	fus	0.22	23.6	2.90	1.0	7.05	0.09	263.00	46.04
733	24	0	ang	0.62	30.5	5.80	8.0	6.98	0.10	412.00	113.12
734	24	0	hyl	0.18	37.8	8.90	8.0	6.98	0.10	412.00	113.12
735	24	0	war	0.08	23.8	2.90	8.0	6.98	0.10	412.00	113.12
736	24	0	aul	0.10	28.0	3.30	8.0	6.98	0.10	412.00	113.12
737	24	0	tom	0.02	22.5	0.00	8.0	6.98	0.10	412.00	113.12
738	24	5	tom	0.12	25.8	6.80	9.0	7.03	0.10	382.00	67.19
739	24	5	ang	0.54	28.6	4.60	9.0	7.03	0.10	382.00	67.19
740	24	5	hyl	0.14	31.6	5.60	9.0	7.03	0.10	382.00	67.19
741	24	5	cap	0.10	24.5	2.90	9.0	7.03	0.10	382.00	67.19
742	24	5	aul	0.08	33.0	5.00	9.0	7.03	0.10	382.00	67.19
743	24	10	bry	0.02	2.3	0.00	7.5	7.00	0.10	330.00	86.91
744	24	10	ang	0.94	24.9	4.70	7.5	7.00	0.10	330.00	86.91

OBS	MG	NA	K	AL	FE	MN	NI	S	P
721	12.17	3.91	0.65	0.12	0.02	0.00	0.01	3.22	0.03
722	12.17	3.91	0.65	0.12	0.02	0.00	0.01	3.22	0.03
723	13.41	4.14	1.06	0.16	0.09	0.00	0.01	3.55	0.03
724	13.41	4.14	1.06	0.16	0.09	0.00	0.01	3.55	0.03
725	13.41	4.14	1.06	0.16	0.09	0.00	0.01	3.55	0.03
726	13.41	4.14	1.06	0.16	0.09	0.00	0.01	3.55	0.03
727	13.41	4.14	1.06	0.16	0.09	0.00	0.01	3.55	0.03
728	12.87	4.05	1.84	0.17	0.05	0.15	0.02	3.29	0.03
729	12.87	4.05	1.84	0.17	0.05	0.15	0.02	3.29	0.03
730	12.63	3.99	0.96	0.14	0.07	0.00	0.01	0.03	0.03
731	12.63	3.99	0.96	0.14	0.07	0.00	0.01	0.03	0.03
732	12.63	3.99	0.96	0.14	0.07	0.00	0.01	0.03	0.03
733	23.22	33.95	4.02	0.54	0.83	1.99	0.07	0.15	0.73
734	23.22	33.95	4.02	0.54	0.83	1.99	0.07	0.15	0.73
735	23.22	33.95	4.02	0.54	0.83	1.99	0.07	0.15	0.73
736	23.22	33.95	4.02	0.54	0.83	1.99	0.07	0.15	0.73
737	23.22	33.95	4.02	0.54	0.83	1.99	0.07	0.15	0.73
738	16.71	23.73	2.60	0.18	0.13	0.04	0.02	0.06	0.20
739	16.71	23.73	2.60	0.18	0.13	0.04	0.02	0.06	0.20
740	16.71	23.73	2.60	0.18	0.13	0.04	0.02	0.06	0.20
741	16.71	23.73	2.60	0.18	0.13	0.04	0.02	0.06	0.20
742	16.71	23.73	2.60	0.18	0.13	0.04	0.02	0.06	0.20
743	20.97	26.80	3.70	0.03	0.40	0.26	0.04	0.02	0.62
744	20.97	26.80	3.70	0.03	0.40	0.26	0.04	0.02	0.62

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
745	24	10	aul	0.02	35.4	0.00	7.5	7.00	0.10	330.00	86.91
746	24	10	war	0.02	23.9	0.00	7.5	7.00	0.10	330.00	86.91
747	24	15	cal	0.04	1.2	0.10	7.0	7.09	0.09	425.00	64.99
748	24	15	tom	0.02	8.3	0.00	7.0	7.09	0.09	425.00	64.99
749	24	15	fus	0.72	32.7	8.40	7.0	7.09	0.09	425.00	64.99
750	24	15	war	0.04	15.7	2.10	7.0	7.09	0.09	425.00	64.99
751	24	15	poh	0.02	18.0	0.00	7.0	7.09	0.09	425.00	64.99
752	24	15	hyl	0.12	27.1	6.00	7.0	7.09	0.09	425.00	64.99
753	24	15	aul	0.04	31.3	0.10	7.0	7.09	0.09	425.00	64.99
754	24	20	tom	0.30	17.1	5.20	6.5	7.07	0.09	438.00	92.35
755	24	20	war	0.44	20.7	2.30	6.5	7.07	0.09	438.00	92.35
756	24	20	fus	0.20	24.4	3.80	6.5	7.07	0.09	438.00	92.35
757	24	20	aul	0.06	27.0	1.20	6.5	7.07	0.09	438.00	92.35
758	24	25	ang	0.58	23.2	2.90	8.0	7.07	0.09	377.00	69.02
759	24	25	tom	0.02	21.6	0.00	8.0	7.07	0.09	377.00	69.02
760	24	25	fus	0.18	30.3	6.20	8.0	7.07	0.09	377.00	69.02
761	24	25	hyl	0.18	35.0	4.60	8.0	7.07	0.09	377.00	69.02
762	24	25	ple	0.04	29.2	0.70	8.0	7.07	0.09	377.00	69.02
763	24	30	ang	0.64	17.2	3.90	9.0	7.11	0.08	341.00	51.54
764	24	30	war	0.18	15.2	1.90	9.0	7.11	0.08	341.00	51.54
765	24	30	tom	0.04	15.7	3.00	9.0	7.11	0.08	341.00	51.54
766	24	30	ple	0.06	16.7	1.80	9.0	7.11	0.08	341.00	51.54
767	24	30	fus	0.08	29.9	2.50	9.0	7.11	0.08	341.00	51.54
768	24	35	ang	0.86	16.5	3.50	8.0	6.98	0.10	382.00	66.92

OBS	MG	NA	K	AL	FE	MN	NI	S	P
745	20.97	26.80	3.70	0.03	0.40	0.26	0.04	0.02	0.62
746	20.97	26.80	3.70	0.03	0.40	0.26	0.04	0.02	0.62
747	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
748	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
749	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
750	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
751	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
752	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
753	16.75	23.67	0.38	0.02	0.00	0.00	0.01	0.46	0.35
754	21.82	32.22	4.06	0.40	0.00	0.03	0.05	0.06	0.70
755	21.82	32.22	4.06	0.40	0.00	0.03	0.05	0.06	0.70
756	21.82	32.22	4.06	0.40	0.00	0.03	0.05	0.06	0.70
757	21.82	32.22	4.06	0.40	0.00	0.03	0.05	0.06	0.70
758	16.55	29.66	2.36	0.29	0.00	0.00	0.01	0.13	0.03
759	16.55	29.66	2.36	0.29	0.00	0.00	0.01	0.13	0.03
760	16.55	29.66	2.36	0.29	0.00	0.00	0.01	0.13	0.03
761	16.55	29.66	2.36	0.29	0.00	0.00	0.01	0.13	0.03
762	16.55	29.66	2.36	0.29	0.00	0.00	0.01	0.13	0.03
763	13.68	24.37	1.42	0.16	0.39	0.01	0.05	0.14	0.03
764	13.68	24.37	1.42	0.16	0.39	0.01	0.05	0.14	0.03
765	13.68	24.37	1.42	0.16	0.39	0.01	0.05	0.14	0.03
766	13.68	24.37	1.42	0.16	0.39	0.01	0.05	0.14	0.03
767	13.68	24.37	1.42	0.16	0.39	0.01	0.05	0.14	0.03
768	16.50	25.52	2.68	0.13	0.51	0.03	0.06	0.11	0.26

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
769	24	35	war	0.08	14.6	3.20	8.0	6.98	0.10	382.00	66.92
770	24	35	tom	0.02	21.2	0.00	8.0	6.98	0.10	382.00	66.92
771	24	35	fus	0.04	20.0	0.20	8.0	6.98	0.10	382.00	66.92
772	24	40	ang	0.88	15.7	3.80	7.0	6.82	0.20	276.00	21.28
773	24	40	war	0.10	14.2	4.00	7.0	6.82	0.20	276.00	21.28
774	24	40	tom	0.02	18.3	0.00	7.0	6.82	0.20	276.00	21.28
775	24	45	ang	0.84	27.2	7.20	7.0	6.80	0.20	280.00	52.88
776	24	50	mee	0.02	3.7	0.00	4.0	6.71	0.20	252.00	40.96
777	24	50	war	0.60	14.1	3.90	4.0	6.71	0.20	252.00	40.96
778	24	50	tom	0.30	16.6	3.80	4.0	6.71	0.20	252.00	40.96
779	24	50	cam	0.04	1.5	0.00	4.0	6.71	0.20	252.00	40.96
780	24	55	war	0.26	9.5	3.40	3.0	6.70	0.20	220.00	52.88
781	24	55	tom	0.60	18.1	4.30	3.0	6.70	0.20	220.00	52.88
782	25	0	cap	0.74	44.9	5.60	8.0	6.88	0.10	867.00	174.99
783	25	0	ple	0.18	37.7	2.50	8.0	6.88	0.10	867.00	174.99
784	25	0	hyl	0.04	27.9	0.10	8.0	6.88	0.10	867.00	174.99
785	25	4	tom	0.06	25.2	15.40	7.0	6.89	0.10	712.00	138.33
786	25	4	fus	0.80	45.5	4.10	7.0	6.89	0.10	712.00	138.33
787	25	4	ple	0.02	37.2	0.00	7.0	6.89	0.10	712.00	138.33
788	25	4	aul	0.04	43.9	4.00	7.0	6.89	0.10	712.00	138.33
789	25	8	tom	0.26	28.3	2.30	7.0	7.12	0.08	794.00	147.33
790	25	8	fus	0.74	41.7	5.60	7.0	7.12	0.08	794.00	147.33
791	25	12	tom	0.06	33.7	3.40	9.5	7.28	0.05	744.00	146.08
792	25	12	fus	0.84	41.6	5.60	9.5	7.28	0.05	744.00	146.08

OBS	MG	NA	K	AL	FE	MN	NI	S	P
769	16.50	25.52	2.68	0.13	0.51	0.03	0.06	0.11	0.26
770	16.50	25.52	2.68	0.13	0.51	0.03	0.06	0.11	0.26
771	16.50	25.52	2.68	0.13	0.51	0.03	0.06	0.11	0.26
772	11.20	17.99	1.60	0.16	0.21	0.00	0.02	0.15	0.05
773	11.20	17.99	1.60	0.16	0.21	0.00	0.02	0.15	0.05
774	11.20	17.99	1.60	0.16	0.21	0.00	0.02	0.15	0.05
775	14.25	17.37	1.61	0.48	0.00	0.05	0.01	0.13	0.05
776	11.42	13.24	1.60	0.16	0.21	0.28	0.01	0.12	0.03
777	11.42	13.24	1.60	0.16	0.21	0.28	0.01	0.12	0.03
778	11.42	13.24	1.60	0.16	0.21	0.28	0.01	0.12	0.03
779	11.42	13.24	1.60	0.16	0.21	0.28	0.01	0.12	0.03
780	14.25	17.37	1.61	0.48	0.00	0.05	0.01	0.13	0.05
781	14.25	17.37	1.61	0.48	0.00	0.05	0.01	0.13	0.05
782	27.88	5.45	7.52	0.21	0.22	0.56	0.01	0.02	0.19
783	27.88	5.45	7.52	0.21	0.22	0.56	0.01	0.02	0.19
784	27.88	5.45	7.52	0.21	0.22	0.56	0.01	0.02	0.19
785	23.42	4.86	7.91	0.16	0.50	0.12	0.06	0.25	0.15
786	23.42	4.86	7.91	0.16	0.50	0.12	0.06	0.25	0.15
787	23.42	4.86	7.91	0.16	0.50	0.12	0.06	0.25	0.15
788	23.42	4.86	7.91	0.16	0.50	0.12	0.06	0.25	0.15
789	26.81	4.84	4.72	0.18	0.93	0.04	0.11	0.26	0.03
790	26.81	4.84	4.72	0.18	0.93	0.04	0.11	0.26	0.03
791	27.76	6.67	5.30	0.23	0.26	0.64	0.02	1.05	0.03
792	27.76	6.67	5.30	0.23	0.26	0.64	0.02	1.05	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
793	25	12	aul	0.04	33.7	4.90	9.5	7.28	0.05	744.00	146.08
794	25	16	war	0.08	24.2	2.10	8.0	7.11	0.08	712.00	119.57
795	25	16	tom	0.20	31.4	3.70	8.0	7.11	0.08	712.00	119.57
796	25	16	fus	0.72	47.9	4.70	8.0	7.11	0.08	712.00	119.57
797	25	20	war	0.50	26.5	6.70	9.0	7.17	0.08	712.00	119.57
798	25	20	tom	0.44	31.7	5.90	9.0	7.17	0.07	694.00	119.99
799	25	20	fus	0.10	37.7	3.00	9.0	7.17	0.07	694.00	119.99
800	25	24	tom	0.10	29.5	2.20	7.0	7.17	0.07	694.00	119.99
801	25	24	fus	0.82	38.1	5.30	7.0	7.25	0.06	746.00	139.61
802	25	24	war	0.04	30.3	1.80	7.0	7.25	0.06	746.00	139.61
803	25	24	aul	0.04	32.2	1.00	7.0	7.25	0.06	746.00	139.61
804	25	28	war	0.42	26.5	3.30	4.0	7.12	0.06	746.00	139.61
805	25	28	ang	0.32	28.1	3.30	4.0	7.12	0.08	651.00	115.12
806	25	28	aul	0.04	29.3	4.00	4.0	7.12	0.08	651.00	115.12
807	25	28	tom	0.18	28.5	4.10	4.0	7.12	0.08	651.00	115.12
808	25	32	war	0.38	25.4	2.00	7.0	7.27	0.08	651.00	115.12
809	25	32	ang	0.28	26.3	2.50	7.0	7.27	0.05	610.00	101.99
810	25	32	tom	0.16	24.8	1.70	7.0	7.27	0.05	610.00	101.99
811	25	32	fus	0.12	35.4	1.70	7.0	7.27	0.05	610.00	101.99
812	25	32	aul	0.06	27.1	3.10	7.0	7.27	0.05	610.00	101.99
813	25	36	tom	0.44	29.3	2.40	5.0	7.25	0.05	610.00	101.99
814	25	36	war	0.10	33.7	3.90	5.0	7.25	0.05	636.00	100.26
815	25	36	ang	0.22	36.6	6.70	5.0	7.25	0.05	636.00	100.26
816	25	36	fus	0.24	46.5	2.00	5.0	7.25	0.05	636.00	100.26

OBS	MG	NA	K	AL	FE	MN	NI	S	P
793	27.76	6.67	5.30	0.23	0.26	0.64	0.02	1.05	0.03
794	21.82	5.46	4.19	0.17	0.07	0.00	0.01	0.90	0.03
795	21.82	5.46	4.19	0.17	0.07	0.00	0.01	0.90	0.03
796	21.82	5.46	4.19	0.17	0.07	0.00	0.01	0.90	0.03
797	22.01	4.01	6.00	0.18	0.29	0.18	0.03	0.76	0.03
798	22.01	4.01	6.00	0.18	0.29	0.18	0.03	0.76	0.03
799	22.01	4.01	6.00	0.18	0.29	0.18	0.03	0.76	0.03
800	24.63	4.71	8.28	0.21	0.15	0.09	0.01	0.04	0.03
801	24.63	4.71	8.28	0.21	0.15	0.09	0.01	0.04	0.03
802	24.63	4.71	8.28	0.21	0.15	0.09	0.01	0.04	0.03
803	24.63	4.71	8.28	0.21	0.15	0.09	0.01	0.04	0.03
804	20.22	2.06	4.43	0.20	0.18	0.01	0.03	0.34	0.05
805	20.22	2.06	4.43	0.20	0.18	0.01	0.03	0.34	0.05
806	20.22	2.06	4.43	0.20	0.18	0.01	0.03	0.34	0.05
807	20.22	2.06	4.43	0.20	0.18	0.01	0.03	0.34	0.05
808	18.46	4.14	2.83	0.15	0.11	0.00	0.01	0.83	0.12
809	18.46	4.14	2.83	0.15	0.11	0.00	0.01	0.83	0.12
810	18.46	4.14	2.83	0.15	0.11	0.00	0.01	0.83	0.12
811	18.46	4.14	2.83	0.15	0.11	0.00	0.01	0.83	0.12
812	18.46	4.14	2.83	0.15	0.11	0.00	0.01	0.83	0.12
813	19.37	4.35	3.64	0.14	0.11	0.00	0.01	0.84	0.03
814	19.37	4.35	3.64	0.14	0.11	0.00	0.01	0.84	0.03
815	19.37	4.35	3.64	0.14	0.11	0.00	0.01	0.84	0.03
816	19.37	4.35	3.64	0.14	0.11	0.00	0.01	0.84	0.03

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
817	25	40	tom	0.54	16.5	4.60	6.0	7.12	0.08	574.00	98.47
818	25	40	war	0.36	19.5	3.20	6.0	7.12	0.08	574.00	98.47
819	25	40	ang	0.04	22.2	0.10	6.0	7.12	0.08	574.00	98.47
820	25	40	aul	0.04	24.6	0.40	6.0	7.12	0.08	574.00	98.47
821	25	44	rev	0.06	0.6	1.50	2.5	7.39	0.04	608.00	98.15
822	25	44	war	0.48	16.4	2.50	2.5	7.39	0.04	608.00	98.15
823	25	44	tom	0.46	17.2	3.50	2.5	7.39	0.04	608.00	98.15
824	26	0	rus	0.28	19.2	7.00	6.0	6.73	0.20	257.00	26.33
825	26	0	ang	0.54	29.2	4.00	6.0	6.73	0.20	257.00	26.33
826	26	0	mag	0.14	32.5	1.50	6.0	6.73	0.20	257.00	26.33
827	26	5	aul	0.04	30.3	1.10	6.0	5.37	4.30	107.00	5.50
828	26	5	ang	0.90	29.0	2.00	6.0	5.37	4.30	107.00	5.50
829	26	10	ang	0.28	35.4	6.50	2.5	5.78	1.70	87.00	5.25
830	26	10	mag	0.70	41.6	3.10	2.5	5.78	1.70	87.00	5.25
831	26	15	ang	0.08	41.0	4.10	2.0	5.07	8.50	68.00	1.89
832	26	15	mag	0.16	45.3	4.50	2.0	5.07	8.50	68.00	1.89
833	26	15	fus	0.72	45.3	5.20	2.0	5.07	8.50	68.00	1.89
834	26	20	ang	0.28	46.0	2.30	3.0	4.42	38.00	84.00	2.87
835	26	20	mag	0.18	45.7	7.50	3.0	4.42	38.00	84.00	2.87
836	26	20	fus	0.52	48.1	3.30	3.0	4.42	38.00	84.00	2.87
837	26	25	ang	0.06	37.0	0.30	2.0	4.05	89.10	110.00	3.71
838	26	25	mag	0.70	44.9	8.20	2.0	4.05	89.10	110.00	3.71
839	26	25	aul	0.10	35.6	0.80	2.0	4.05	89.10	110.00	3.71
840	26	30	ang	0.06	29.7	3.30	3.0	4.06	109.60	78.00	2.82

OBS	MG	NA	K	AL	FE	MN	NI	S	P
817	18.80	4.50	5.60	0.14	0.06	0.01	0.06	1.06	0.03
818	18.80	4.50	5.60	0.14	0.06	0.01	0.06	1.06	0.03
819	18.80	4.50	5.60	0.14	0.06	0.01	0.06	1.06	0.03
820	18.80	4.50	5.60	0.14	0.06	0.01	0.06	1.06	0.03
821	20.91	4.63	2.42	0.21	0.18	0.00	0.02	1.24	0.03
822	20.91	4.63	2.42	0.21	0.18	0.00	0.02	1.24	0.03
823	20.91	4.63	2.42	0.21	0.18	0.00	0.02	1.24	0.03
824	11.65	18.87	5.20	0.18	0.11	0.11	0.01	0.90	1.28
825	11.65	18.87	5.20	0.18	0.11	0.11	0.01	0.90	1.28
826	11.65	18.87	5.20	0.18	0.11	0.11	0.01	0.90	1.28
827	1.78	12.88	0.93	0.13	0.33	0.01	0.01	0.86	0.59
828	1.78	12.88	0.93	0.13	0.33	0.01	0.01	0.86	0.59
829	1.48	16.08	1.60	0.13	0.26	0.01	0.01	0.97	0.60
830	1.48	16.08	1.60	0.13	0.26	0.01	0.01	0.97	0.60
831	0.48	10.65	1.44	0.11	0.65	0.01	0.05	0.91	0.44
832	0.48	10.65	1.44	0.11	0.65	0.01	0.05	0.91	0.44
833	0.48	10.65	1.44	0.11	0.65	0.01	0.05	0.91	0.44
834	1.13	9.87	1.90	0.14	0.32	0.02	0.01	1.05	0.32
835	1.13	9.87	1.90	0.14	0.32	0.02	0.01	1.05	0.32
836	1.13	9.87	1.90	0.14	0.32	0.02	0.01	1.05	0.32
837	1.81	8.15	2.94	0.14	1.08	0.04	0.11	0.81	0.43
838	1.81	8.15	2.94	0.14	1.08	0.04	0.11	0.81	0.43
839	1.81	8.15	2.94	0.14	1.08	0.04	0.11	0.81	0.43
840	1.22	5.99	2.08	0.44	0.39	0.02	0.01	0.84	0.59

OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
841	26	30	mag	0.02	33.0	0.00	3.0	4.06	109.60	78.00	2.82
842	26	30	fus	0.70	32.5	4.40	3.0	4.06	109.60	78.00	2.82
843	26	30	aul	0.04	21.3	9.10	3.0	4.06	109.60	78.00	2.82
844	26	35	ang	0.24	41.3	2.40	3.0	3.96	109.60	78.00	10.63
845	26	35	mag	0.70	44.7	2.60	3.0	3.96	109.60	78.00	10.63
846	26	35	fus	0.06	48.1	0.80	3.0	3.96	109.60	78.00	10.63
847	26	40	mag	0.04	44.5	3.00	2.5	3.88	131.80	101.00	8.76
848	26	40	fus	0.86	53.7	4.30	2.5	3.88	131.80	101.00	8.76
849	26	40	aul	0.06	44.0	1.60	2.5	3.88	131.80	101.00	8.76
850	26	40	ang	0.02	42.2	0.00	2.5	3.88	131.80	101.00	8.76
851	26	45	ang	0.20	42.5	6.00	3.0	4.05	89.10	67.00	5.68
852	26	45	mag	0.28	44.7	5.40	3.0	4.05	89.10	67.00	5.68
853	26	45	fus	0.26	53.3	2.60	3.0	4.05	89.10	67.00	5.68
854	26	45	poh	0.04	51.5	1.40	3.0	4.05	89.10	67.00	5.68
855	26	45	aul	0.12	39.5	5.60	3.0	4.05	89.10	67.00	5.68
856	26	50	ang	0.46	36.0	7.00	8.0	4.08	83.20	129.00	8.98
857	26	50	mag	0.44	32.5	5.00	8.0	4.08	83.20	129.00	8.98
858	26	50	ple	0.02	30.4	0.00	8.0	4.08	83.20	129.00	8.98
859	26	50	poh	0.02	33.4	0.00	8.0	4.08	83.20	129.00	8.98
860	26	55	ang	0.34	29.6	5.40	9.0	5.06	8.70	89.00	12.57
861	26	55	mag	0.64	39.2	9.70	9.0	5.06	8.70	89.00	12.57
862	27	5	ang	0.53	32.4	2.10	2.0	4.00	144.00	15.00	0.90
863	27	5	poh	0.02	33.2	0.00	2.0	4.00	144.00	15.00	0.90
864	27	5	mag	0.43	34.5	1.50	2.0	4.00	144.00	15.00	0.90

OBS	MG	NA	K	AL	FE	MN	NI	S	P
841	1.22	5.99	2.08	0.44	0.39	0.02	0.01	0.84	0.59
842	1.22	5.99	2.08	0.44	0.39	0.02	0.01	0.84	0.59
843	1.22	5.99	2.08	0.44	0.39	0.02	0.01	0.84	0.59
844	2.85	4.75	1.74	0.31	0.30	0.08	0.01	0.84	0.19
845	2.85	4.75	1.74	0.31	0.30	0.08	0.01	0.84	[illegible]
846	2.85	4.75	1.74	0.31	0.30	0.08	0.01	0.84	[illegible]
847	1.56	5.45	2.27	0.18	0.19	0.05	0.01	1.25	[illegible]
848	1.56	5.45	2.27	0.18	0.19	0.05	0.01	1.25	[illegible]
849	1.56	5.45	2.27	0.18	0.19	0.05	0.01	1.25	[illegible]
850	1.56	5.45	2.27	0.18	0.19	0.05	0.01	1.25	0.20
851	1.32	3.90	1.27	0.16	0.66	0.02	0.50	0.82	0.21
852	1.32	3.90	1.27	0.16	0.66	0.02	0.50	0.82	0.21
853	1.32	3.90	1.27	0.16	0.66	0.02	0.50	0.82	0.21
854	1.32	3.90	1.27	0.16	0.66	0.02	0.50	0.82	0.21
855	1.32	3.90	1.27	0.16	0.66	0.02	0.50	0.82	0.21
856	2.24	5.76	1.91	0.20	0.58	0.05	0.05	0.94	0.42
857	2.24	5.76	1.91	0.20	0.58	0.05	0.05	0.94	0.42
858	2.24	5.76	1.91	0.20	0.58	0.05	0.05	0.94	0.42
859	2.24	5.76	1.91	0.20	0.58	0.05	0.05	0.94	0.42
860	3.24	3.21	1.08	0.15	0.50	0.03	0.05	1.67	0.14
861	3.24	3.21	1.08	0.15	0.50	0.03	0.05	1.67	0.14
862	0.35	2.87	3.99	0.11	1.52	0.06	0.01	0.49	0.37
863	0.35	2.87	3.99	0.11	1.52	0.06	0.01	0.49	0.37
864	0.35	2.87	3.99	0.11	1.52	0.06	0.01	0.49	0.37

```
OBS SI   D SP    FRQ    HT    SD  SHA  PH          H      KC     CA
865 27  10 ang 0.34  19.8   2.70 2.0 4.00 144.00   15.00   0.53
866 27  10 mag 0.56  24.7   4.30 2.0 4.00 144.00   15.00   0.53
867 27  10 maj 0.10  16.0   0.80 2.0 4.00 144.00   15.00   0.53
868 27  15 ang 0.66   6.0   3.40 1.0 4.00 144.00   15.00   1.40
869 27  15 mag 0.34   9.1   7.50 1.0 4.00 144.00   15.00   1.40
870 27  25 mag 0.46  17.6   4.00 1.5 4.00 144.00   15.00   0.82
871 27  25 ang 0.54  17.3   3.40 1.5 4.00 144.00   15.00   0.82
872 27  45 ang 0.58  14.9   6.40 1.5 4.00 144.00   15.00   0.82
873 27  45 mag 0.32  26.8   8.10 1.5 4.00 144.00   15.00   0.82
874 27  45 fus 0.10  24.8   1.60 1.5 4.00 144.00   15.00   0.82
875 27  55 ang 0.56  18.3   7.50 2.0 4.00 144.00   15.00   0.93
876 27  55 mag 0.44  23.5   6.70 2.0 4.00 144.00   15.00   0.93
877 27  65 ang 0.14  16.6   2.20 1.0 4.00 144.00   15.00   0.69
878 27  65 mag 0.10  19.6   4.90 1.0 4.00 144.00   15.00   0.69
879 27  65 fus 0.76  33.8   7.00 1.0 4.00 144.00   15.00   0.69
880 27  85 maj 0.10  -0.6   5.10 2.0 3.84 144.50   13.00   0.73
881 27  85 ang 0.24  12.3   6.40 2.0 3.84 144.50   13.00   0.73
882 27  85 mag 0.06   6.9   3.80 2.0 3.84 144.50   13.00   0.73
883 27  85 fus 0.60  20.0   5.60 2.0 3.84 144.50   13.00   0.73
884 27  90 myl 0.04   1.0   2.00 3.0 4.05   89.10   34.00   1.41
885 27  90 maj 0.34   3.9   3.20 3.0 4.05   89.10   34.00   1.41
886 27  90 mag 0.12  10.2   4.50 3.0 4.05   89.10   34.00   1.41
887 27  90 ang 0.18  13.2   5.50 3.0 4.05   89.10   34.00   1.41
888 27  90 fus 0.32  22.3   2.70 3.0 4.05   89.10   34.00   1.41

OBS     MG      NA      K      AL      FE       MN      NI      S       P
865    0.23   1.00   2.74   0.03   0.29     0.08   0.01   0.34   0.16
866    0.23   1.00   2.74   0.03   0.29     0.08   0.01   0.34   0.16
867    0.23   1.00   2.74   0.03   0.29     0.08   0.01   0.34   0.16
868    0.56   1.38   1.98   0.03   0.42     0.10   0.01   0.28   0.03
869    0.56   1.38   1.98   0.03   0.42     0.10   0.01   0.28   0.03
870    0.42   1.07   3.68   0.03   0.60     0.25   0.01   0.46   0.04
871    0.42   1.07   3.68   0.03   0.60     0.25   0.01   0.46   0.04
872    0.52   1.04   3.77   0.03   0.87     0.13   0.01   0.64   0.26
873    0.52   1.04   3.77   0.03   0.87     0.13   0.01   0.64   0.26
874    0.52   1.04   3.77   0.03   0.87     0.13   0.01   0.64   0.26
875    0.51   1.25   2.53   0.03   1.24     0.10   0.01   0.69   0.31
876    0.51   1.25   2.53   0.03   1.24     0.10   0.01   0.69   0.31
877    0.67   0.57  17.27   0.03   2.09     0.11   0.01   0.39   0.03
878    0.67   0.57  17.27   0.03   2.09     0.11   0.01   0.39   0.03
879    0.67   0.57  17.27   0.03   2.09     0.11   0.01   0.39   0.03
880    0.55   1.41   1.94   0.12   0.17     0.08   0.01   0.24   0.03
881    0.55   1.41   1.94   0.12   0.17     0.08   0.01   0.24   0.03
882    0.55   1.41   1.94   0.12   0.17     0.08   0.01   0.24   0.03
883    0.55   1.41   1.94   0.12   0.17     0.08   0.01   0.24   0.03
884    0.62   0.20   0.94   0.04   1.24     0.21   0.01   0.19   0.03
885    0.62   0.20   0.94   0.04   1.24     0.21   0.01   0.19   0.03
886    0.62   0.20   0.94   0.04   1.24     0.21   0.01   0.19   0.03
887    0.62   0.20   0.94   0.04   1.24     0.21   0.01   0.19   0.03
888    0.62   0.20   0.94   0.04   1.24     0.21   0.01   0.19   0.03
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OBS	SI	D	SP	FRQ	HT	SD	SHA	PH	H	KC	CA
889	27	93	ang	0.70	19.3	4.30	6.5	3.91	123.00	24.00	1.55
890	27	93	mag	0.14	17.8	2.70	6.5	3.91	123.00	24.00	1.55
891	27	95	myl	0.02	-0.1	0.00	5.0	3.88	131.80	23.00	1.48
892	27	95	ang	0.30	19.1	5.70	5.0	3.88	131.80	23.00	1.48
893	27	95	mag	0.12	17.6	4.70	5.0	3.88	131.80	23.00	1.48
894	27	95	maj	0.02	1.7	0.00	5.0	3.88	131.80	23.00	1.48
895	27	95	fus	0.50	20.8	4.90	5.0	3.88	131.80	23.00	1.48
896	27	99	fus	0.44	28.3	8.80	6.0	3.81	154.90	25.00	1.11
897	27	99	ang	1.32	15.7	5.60	6.0	3.81	154.90	25.00	1.11
898	27	99	mag	0.20	18.6	4.80	6.0	3.81	154.90	25.00	1.11

OBS	MG	NA	K	AL	FE	MN	NI	S	P
889	0.56	0.17	0.63	0.09	0.92	0.08	0.01	0.19	0.03
890	0.56	0.17	0.63	0.09	0.92	0.08	0.01	0.19	0.03
891	0.59	0.04	0.42	0.11	0.79	0.08	0.01	0.19	0.03
892	0.59	0.04	0.42	0.11	0.79	0.08	0.01	0.19	0.03
893	0.59	0.04	0.42	0.11	0.79	0.08	0.01	0.19	0.03
894	0.59	0.04	0.42	0.11	0.79	0.08	0.01	0.19	0.03
895	0.59	0.04	0.42	0.11	0.79	0.08	0.01	0.19	0.03
896	0.48	0.02	1.27	0.08	0.59	0.18	0.01	0.19	0.03
897	0.48	0.02	1.27	0.08	0.59	0.18	0.01	0.19	0.03
898	0.48	0.02	1.27	0.08	0.59	0.18	0.01	0.19	0.03

VIII. Appendix B

Elemental concentrations in 9 Sphagnum species and surface waters collected from 28 peatlands in western Canada Peatlands are indicated by sites (si) which correspond to the localities listed in Table IV-1. Species names (sp) are abbreviated to the first three letters as indicated in table IV-1. Plants were cut into three sections (sec), where section 1 is the top 5cm of the plants, section 2 is between 5 and 10 cm from the tops of the capitula, and section 3 is between 10 and 15cm from the tops of the plants. Concentrations of 6 elements (Ca, Mg, Na, K, Fe, S) were measured in both plant material (g/kg) and surface water (mg/L). Elemental abbreviations having 'w' at the end indicate concentrations in the surface waters...Rep = replicate.

OBS	SI	S P	SEC	REP	CA	MG	NA	K	FE	S
1	2	aus	1	1	2.54	2.04	0.89	4.37	0.12	0.83
2	2	aus	1	2	2.50	2.02	0.88	4.30	0.11	0.89
3	2	aus	2	1	2.95	1.28	1.08	3.65	0.15	0.58
4	2	aus	2	2	2.90	1.27	1.03	3.62	0.14	0.61
5	2	aus	3	1	2.76	1.28	0.57	1.96	0.20	0.45
6	2	aus	3	2	2.71	1.28	0.57	1.91	0.20	0.43
7	6	aus	1	1	2.66	1.58	0.49	4.00	0.17	1.05
8	6	aus	1	2	2.54	1.52	0.51	3.81	0.14	0.97
9	6	aus	2	1	2.34	0.89	0.87	2.44	0.32	0.69
10	6	aus	2	2	2.38	0.89	0.88	2.49	0.32	0.69
11	6	aus	3	1	2.77	0.76	0.61	2.27	0.28	0.53
12	6	aus	3	2	2.80	0.76	0.59	2.31	0.28	0.54
13	3	aus	1	1	1.47	2.13	0.87	4.58	0.10	0.90
14	3	aus	1	2	1.41	2.07	0.85	4.60	0.08	0.81
15	3	aus	2	1	1.30	1.35	1.20	2.49	0.11	0.58
16	3	aus	2	2	1.38	1.39	1.20	2.44	0.20	0.56
17	3	aus	3	1	1.37	1.34	0.82	1.45	0.09	0.53
18	3	aus	3	2	1.33	1.31	0.85	1.48	0.09	0.51
19	6	aus	1	1	1.61	1.18	0.50	3.41	0.60	1.04
20	6	aus	1	2	1.61	1.16	0.48	3.42	0.26	0.99
21	6	aus	2	1	1.88	0.91	1.11	2.68	0.46	0.81
22	6	aus	2	2	1.92	0.88	1.23	2.78	0.43	0.78
23	6	aus	3	1	1.88	0.86	0.65	2.44	0.37	0.61
24	6	aus	3	2	1.90	0.86	0.62	2.48	0.35	0.59

OBS	CAW	MGW	NAW	KW	FEW	SW
1	1.37	1.16	7.13	1.31	5.07	0.63
2	1.37	1.16	7.13	1.31	5.07	0.63
3	1.37	1.16	7.13	1.31	5.07	0.63
4	1.37	1.16	7.13	1.31	5.07	0.63
5	1.37	1.16	7.13	1.31	5.07	0.63
6	1.37	1.16	7.13	1.31	5.07	0.63
7	0.20	0.02	1.65	0.09	4.11	0.30
8	0.20	0.02	1.65	0.09	4.11	0.30
9	0.20	0.02	1.65	0.09	4.11	0.30
10	0.20	0.02	1.65	0.09	4.11	0.30
11	0.20	0.02	1.65	0.09	4.11	0.30
12	0.20	0.02	1.65	0.09	4.11	0.30
13	0.76	0.72	10.08	1.22	2.48	0.77
14	0.76	0.72	10.08	1.22	2.48	0.77
15	0.76	0.72	10.08	1.22	2.48	0.77
16	0.76	0.72	10.08	1.22	2.48	0.77
17	0.76	0.72	10.08	1.22	2.48	0.77
18	0.76	0.72	10.08	1.22	2.48	0.77
19	3.98	0.57	6.18	4.17	0.61	0.84
20	3.98	0.57	6.18	4.17	0.61	0.84
21	3.98	0.57	6.18	4.17	0.61	0.84
22	3.98	0.57	6.18	4.17	0.61	0.84
23	3.98	0.57	6.18	4.17	0.61	0.84
24	3.98	0.57	6.18	4.17	0.61	0.84

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
25	8	aus	1	1	1.30	0.98	0.70	2.62	0.40	0.71
26	8	aus	1	2	1.37	0.97	0.85	2.04	0.87	0.51
27	8	aus	2	1	1.37	0.97	0.89	3.15	0.76	0.51
28	8	aus	2	2	1.67	1.18	1.07	2.60	1.13	0.44
29	8	aus	3	1	1.69	1.19	1.11	2.66	1.06	0.45
30	8	aus	3	2	1.63	1.16	1.08	2.74	1.03	0.41
31	5	aus	1	1	0.95	2.01	1.05	3.65	0.07	0.69
32	5	aus	1	2	0.97	1.95	1.07	3.39	0.07	0.71
33	5	aus	2	1	[illegible]	1.35	1.28	2.64	0.11	0.52
34	5	aus	2	2	1.16	1.33	1.30	2.60	0.12	0.52
35	5	aus	3	1	1.15	1.26	1.09	1.63	0.10	0.50
36	5	aus	3	2	1.19	1.24	1.08	1.63	0.11	0.48
37	3	aus	1	1	1.18	2.20	1.03	3.51	0.06	0.75
38	3	aus	1	2	1.18	2.22	1.07	3.45	0.06	0.73
39	3	aus	2	1	1.24	1.41	1.42	1.95	0.13	0.52
40	3	aus	2	2	1.23	1.40	1.40	1.93	0.12	0.52
41	[illegible]	aus	3	1	1.48	1.47	0.89	1.82	0.12	0.46
42	[illegible]	aus	3	2	1.42	1.45	0.85	1.79	0.12	0.46
43	7	aus	1	1	2.14	1.68	0.74	4.21	0.07	1.07
44	7	aus	1	2	1.93	1.56	0.63	4.03	0.06	1.11
45	7	aus	2	1	2.19	0.99	1.22	3.02	0.25	0.60
46	7	aus	2	2	2.06	0.95	1.13	2.82	0.24	0.57
47	7	aus	3	1	2.54	1.15	0.58	1.80	0.37	0.41
48	7	aus	3	2	2.61	1.19	0.59	1.84	0.37	0.46

OBS	CAW	MGW	NAW	KW	FEW	SW
25	0.09	0.16	2.11	0.70	0.00	0.67
26	0.09	0.16	2.11	0.70	0.00	0.67
27	0.09	0.16	2.11	0.70	0.00	0.67
28	0.09	0.16	2.11	0.70	0.00	0.67
29	0.09	0.16	2.11	0.70	0.00	0.67
30	0.09	0.16	2.11	0.70	0.00	0.67
31	0.59	0.86	12.61	2.07	2.48	0.77
32	0.59	0.86	12.61	2.07	2.48	0.77
33	0.59	0.86	12.61	2.07	2.48	0.77
34	0.59	0.86	12.61	2.07	2.48	0.77
35	0.59	0.86	12.61	2.07	2.48	0.77
36	0.59	0.86	12.61	2.07	2.48	0.77
37	1.29	0.92	11.60	2.13	0.54	0.87
38	1.29	0.92	11.60	2.13	0.54	0.87
39	1.29	0.92	11.60	2.13	0.54	0.87
40	1.29	0.92	11.60	2.13	0.54	0.87
41	1.29	0.92	11.60	2.13	0.54	0.87
42	1.29	0.92	11.60	2.13	0.54	0.87
43	0.10	0.02	1.89	0.05	0.33	0.47
44	0.10	0.02	1.89	0.05	0.33	0.47
45	0.10	0.02	1.89	0.05	0.33	0.47
46	0.10	0.02	1.89	0.05	0.33	0.47
47	0.10	[illegible]	1.89	0.05	0.33	0.47
48	0.10	0.02	1.89	0.05	0.33	0.47

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
49	2	aus	1	1	2.67	1.76	0.39	5.27	0.16	0.87
50	2	aus	1	2	2.54	1.69	0.39	5.11	0.13	0.82
51	2	aus	2	1	3.19	1.27	1.20	3.35	0.88	0.60
52	2	aus	2	2	3.34	1.32	1.23	3.39	1.11	0.65
53	2	aus	3	1	2.40	1.19	1.49	2.48	1.33	0.50
54	2	aus	3	2	2.33	1.12	1.53	5.90	0.96	0.50
55	7	aus	1	1	1.70	1.93	0.59	3.74	0.05	1.01
56	7	aus	1	2	1.66	1.89	0.59	3.76	0.05	0.97
57	7	aus	2	1	2.04	1.39	1.04	2.87	0.24	0.67
58	7	aus	2	2	2.07	1.45	1.13	3.04	0.37	0.75
59	7	aus	3	1	2.20	1.43	0.35	0.54	0.41	0.45
60	7	aus	3	2	2.13	1.39	0.31	2.82	0.38	0.44
61	10	aus	1	1	1.42	[illegible]	0.48	3.58	0.20	0.92
62	10	aus	1	2	1.37	[illegible]	[illegible]	3.62	0.19	0.94
63	10	aus	2	1	1.84	[illegible]	[illegible]	2.63	1.39	0.69
64	10	aus	2	2	1.79	[illegible]	[illegible]	2.61	1.28	0.67
65	10	aus	3	1	2.27	[illegible]	0.34	0.79	1.58	0.46
66	10	aus	3	2	2.18	1.23	0.35	0.78	1.46	0.36
67	4	aus	1	1	1.25	2.17	1.07	2.88	0.06	0.65
68	4	aus	1	2	1.25	2.16	1.07	2.92	0.03	0.69
69	4	aus	2	1	1.56	1.62	1.36	1.99	0.09	0.56
70	4	aus	2	2	1.43	1.58	1.36	1.94	0.09	0.51
71	4	aus	3	1	1.65	1.76	0.76	1.31	0.11	0.43
72	4	aus	3	2	1.82	1.92	0.85	1.43	0.12	0.45

OBS	CAW	MGW	NAW	KW	FEW	SW
49	0.55	0.98	6.56	1.51	8.58	0.25
50	0.55	0.98	6.56	1.51	8.58	0.25
51	0.55	0.98	6.56	1.51	8.58	0.25
52	0.55	0.98	6.56	1.51	8.58	0.25
53	0.55	0.98	6.56	1.51	8.58	0.25
54	0.55	0.98	6.56	1.51	8.58	0.25
55	0.09	0.02	1.97	0.18	0.42	0.40
56	0.09	0.02	1.97	0.18	0.42	0.40
57	0.09	0.02	1.97	0.18	0.42	0.40
58	0.09	0.02	1.97	0.18	0.42	0.40
59	0.09	0.02	1.97	0.18	0.42	0.40
60	0.09	0.02	1.97	0.18	0.42	0.40
61	0.56	0.18	4.17	0.66	3.72	0.33
62	0.56	0.18	4.17	0.66	3.72	0.33
63	0.56	0.18	4.17	0.66	3.72	0.33
64	0.56	0.18	4.17	0.66	3.72	0.33
65	0.56	0.18	4.17	0.66	3.72	0.33
66	0.56	0.18	4.17	0.66	3.72	0.33
67	0.47	0.50	7.24	0.42	0.21	0.64
68	0.47	0.50	7.24	0.42	0.21	0.64
69	0.47	0.50	7.24	0.42	0.21	0.64
70	0.47	0.50	7.24	0.42	0.21	0.64
71	0.47	0.50	7.24	0.42	0.21	0.64
72	0.47	0.50	7.24	0.42	0.21	0.64

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
73	6	rub	1	1	2.80	1.79	0.41	4.28	0.20	1.14
74	6	rub	1	2	2.75	1.81	0.41	4.42	0.20	1.14
75	6	rub	2	1	3.03	1.48	0.62	4.69	0.32	0.80
76	6	rub	2	2	2.95	1.46	0.62	4.47	0.36	0.78
77	6	rub	1	1	2.54	1.73	0.45	3.87	0.15	1.19
78	6	rub	1	2	2.42	1.68	0.52	3.79	0.14	1.20
79	6	rub	2	1	2.56	1.60	0.82	4.21	0.40	0.79
80	6	rub	2	2	2.62	1.63	0.83	4.30	0.42	0.80
81	7	rub	1	1	2.69	1.39	0.46	5.42	0.32	1.24
82	7	rub	1	2	2.58	1.42	0.53	5.25	0.34	1.23
83	7	rub	2	1	2.91	1.27	1.22	5.47	0.46	0.93
84	7	rub	2	2	2.95	1.27	1.29	5.57	0.45	0.97
85	7	rub	1	1	2.71	1.16	0.80	4.36	0.15	1.19
86	7	rub	1	2	2.71	1.13	0.81	4.36	0.12	1.16
87	7	rub	2	1	2.93	1.05	1.10	4.04	0.33	0.85
88	7	rub	2	2	2.85	1.03	1.01	3.86	0.32	0.81
89	9	rub	1	1	5.48	1.59	0.53	4.22	0.17	1.06
90	9	rub	1	2	5.62	1.58	0.56	4.25	0.18	1.17
91	9	rub	2	1	6.11	1.40	0.68	4.49	0.47	0.86
92	9	rub	2	2	6.58	1.49	0.68	4.40	0.51	0.96
93	11	rub	1	1	4.31	1.57	0.29	4.05	0.12	0.85
94	11	rub	1	2	4.22	1.58	0.31	3.78	0.17	0.85
95	11	rub	2	1	3.23	1.48	0.49	3.83	0.27	0.60
96	11	rub	2	2	3.22	1.49	0.48	3.59	0.25	0.60

OBS	CAW	MGW	NAW	KW	FEW	SW
73	0.23	0.03	2.17	0.01	1.17	0.95
74	0.23	0.03	2.17	0.01	1.17	0.95
75	0.23	0.03	2.17	0.01	1.17	0.95
76	0.23	0.03	2.17	0.01	1.17	0.95
77	0.31	0.22	1.35	0.48	0.26	0.43
78	0.31	0.22	1.35	0.48	0.26	0.43
79	0.31	0.22	1.35	0.48	0.26	0.43
80	0.31	0.22	1.35	0.48	0.26	0.43
81	0.43	0.12	1.42	0.48	0.45	0.34
82	0.43	0.12	1.42	0.48	0.45	0.34
83	0.43	0.12	1.42	0.48	0.45	0.34
84	0.43	0.12	1.42	0.48	0.45	0.34
85	0.42	0.14	1.52	1.05	0.24	0.35
86	0.42	0.14	1.52	1.05	0.24	0.35
87	0.42	0.14	1.52	1.05	0.24	0.35
88	0.42	0.14	1.52	1.05	0.24	0.35
89	5.50	0.70	5.23	0.80	1.03	2.22
90	5.50	0.70	5.23	0.80	1.03	2.22
91	5.50	0.70	5.23	0.80	1.03	2.22
92	5.50	0.70	5.23	0.80	1.03	2.22
93	0.13	0.08	0.36	0.25	0.16	0.17
94	0.13	0.08	0.36	0.25	0.16	0.17
95	0.13	0.08	0.36	0.25	0.16	0.17
96	0.13	0.08	0.36	0.25	0.16	0.17

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
97	14	rub	1	1	3.67	1.20	0.77	6.27	0.22	1.72
98	14	rub	1	2	3.44	1.06	0.53	5.57	0.21	1.61
99	14	rub	2	1	3.47	0.89	1.40	7.82	0.47	1.10
100	14	rub	2	2	3.70	0.93	1.47	8.32	0.49	1.15
101	14	rub	1	1	3.15	0.88	0.81	8.01	0.22	1.60
102	14	rub	1	2	3.29	0.91	0.82	5.79	0.24	1.61
103	14	rub	2	1	3.47	0.87	1.35	7.71	0.62	0.98
104	14	rub	2	2	3.78	0.92	1.37	8.23	0.62	1.04
105	10	rub	1	1	3.43	1.50	0.42	4.68	0.19	0.86
106	10	rub	1	2	3.21	1.55	0.41	4.70	0.19	0.90
107	10	rub	2	1	3.39	1.29	0.76	4.29	0.35	0.74
108	10	rub	2	2	3.43	1.31	0.79	4.34	0.35	0.78
109	4	rub	1	1	1.69	2.51	0.87	4.59	0.08	0.81
110	4	rub	1	2	1.89	2.39	0.85	4.52	0.08	0.76
111	4	rub	2	1	1.91	2.56	1.20	5.42	0.11	0.71
112	4	rub	2	2	1.74	2.31	1.09	5.08	0.09	0.62
113	2	rub	1	1	1.09	1.55	0.75	4.23	0.20	0.91
114	2	rub	1	2	1.45	1.57	0.72	4.71	0.20	0.90
115	2	rub	2	1	1.71	1.53	1.49	4.23	0.28	0.62
116	2	rub	2	2	1.74	1.59	1.59	4.38	0.31	0.65
117	4	pap	1	1	1.35	2.81	0.84	4.76	0.08	0.78
118	4	pap	1	2	1.30	2.72	0.86	4.67	0.06	0.79
119	4	pap	2	1	1.61	2.04	0.97	4.86	0.11	0.61
120	4	pap	2	2	1.58	2.04	0.98	4.81	0.09	0.60

OBS	CAW	MGW	NAW	KW	FEW	SW
97	0.06	0.05	1.63	1.29	0.42	0.53
98	0.06	0.05	1.63	1.29	0.42	0.53
99	0.06	0.05	1.63	1.29	0.42	0.53
100	0.06	0.05	1.63	1.29	0.42	0.53
101	0.20	0.05	2.41	1.52	4.76	0.39
102	0.20	0.05	2.41	1.52	4.76	0.39
103	0.20	0.05	2.41	1.52	4.76	0.39
104	0.20	0.05	2.41	1.52	4.76	0.39
105	0.15	0.02	1.18	0.21	3.74	0.33
106	0.15	0.02	1.18	0.21	3.74	0.33
107	0.15	0.02	1.18	0.21	3.74	0.33
108	0.15	0.02	1.18	0.21	3.74	0.33
109	0.60	1.17	8.46	0.96	9.81	0.21
110	0.60	1.17	8.46	0.96	9.81	0.21
111	0.60	1.17	8.46	0.96	9.81	0.21
112	0.60	1.17	8.46	0.96	9.81	0.21
113	0.48	0.74	5.79	0.93	0.86	0.69
114	0.48	0.74	5.79	0.93	0.86	0.69
115	0.48	0.74	5.79	0.93	0.86	0.69
116	0.48	0.74	5.79	0.93	0.86	0.69
117	2.11	1.02	8.07	0.01	4.39	0.48
118	2.11	1.02	8.07	0.01	4.39	0.48
119	2.11	1.02	8.07	0.01	4.39	0.48
120	2.11	1.02	8.07	0.01	4.39	0.48

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
121	4	pap	3	1	1.73	2.15	0.82	4.29	0.12	0.52
122	4	pap	3	2	1.73	2.22	0.85	4.38	0.12	0.52
123	1	pap	1	1	1.17	1.67	0.75	7.90	0.19	0.88
124	1	pap	1	2	1.15	1.63	0.75	8.67	0.19	0.88
125	1	pap	2	1	1.47	1.29	1.04	7.57	0.48	0.64
126	1	pap	2	2	1.49	1.29	1.04	7.60	0.48	0.64
127	1	pap	3	1	1.70	1.52	0.77	5.06	0.96	0.73
128	1	pap	3	2	1.73	1.51	0.79	5.13	0.93	0.72
129	13	pap	1	1	6.54	1.36	0.91	5.91	0.16	1.45
130	13	pap	1	2	6.23	1.33	0.96	6.16	0.13	1.45
131	13	pap	2	1	6.99	0.91	1.48	5.68	0.57	0.90
132	13	pap	2	2	6.90	0.91	1.51	5.10	0.63	0.89
133	13	pap	3	1	9.64	1.03	1.34	3.75	1.50	0.77
134	13	pap	3	2	9.75	1.03	1.21	3.42	1.57	0.86
135	13	pap	1	1	3.95	1.15	0.63	7.45	0.12	1.71
136	13	pap	1	2	4.04	1.15	0.62	7.86	0.12	1.72
137	13	pap	2	1	3.69	0.72	0.67	5.74	0.33	1.03
138	13	pap	2	2	3.71	0.74	0.67	5.55	0.33	0.99
139	13	pap	3	1	3.00	0.59	0.00	4.98	0.40	0.43
140	13	pap	3	2	3.13	0.63	0.00	4.65	0.58	0.37
141	14	pap	1	1	5.37	2.18	0.76	9.14	0.30	1.61
142	14	pap	1	2	5.30	2.19	0.88	9.33	0.32	1.71
143	14	pap	2	1	5.32	1.62	1.20	9.65	0.70	1.14
144	14	pap	2	2	5.12	1.57	1.23	9.34	0.69	1.06

OBS	CAW	MGW	NAW	KW	FEW	SW
121	2.11	1.02	8.07	0.01	4.39	0.48
122	2.11	1.02	8.07	0.01	4.39	0.48
123	0.25	0.05	2.39	0.14	5.00	0.18
124	0.25	0.05	2.39	0.14	5.00	0.18
125	0.25	0.05	2.39	0.14	5.00	0.18
126	0.25	0.05	2.39	0.14	5.00	0.18
127	0.25	0.05	2.39	0.14	5.00	0.18
128	0.25	0.05	2.39	0.14	5.00	0.18
129	1.17	0.38	9.84	23.75	0.88	0.51
130	1.17	0.38	9.84	23.75	0.88	0.51
131	1.17	0.38	9.84	23.75	0.88	0.51
132	1.17	0.38	9.84	23.75	0.88	0.51
133	1.17	0.38	9.84	23.75	0.88	0.51
134	1.17	0.38	9.84	23.75	0.88	0.51
135	0.93	0.02	1.19	0.01	4.96	0.15
136	0.93	0.02	1.19	0.01	4.96	0.15
137	0.93	0.02	1.19	0.01	4.96	0.15
138	0.93	0.02	1.19	0.01	4.96	0.15
139	0.93	0.02	1.19	0.01	4.96	0.15
140	0.93	0.02	1.19	0.01	4.96	0.15
141	0.55	0.24	1.75	11.47	0.04	0.35
142	0.55	0.24	1.75	11.47	0.04	0.35
143	0.55	0.24	1.75	11.47	0.04	0.35
144	0.55	0.24	1.75	11.47	0.04	0.35

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
145	14	pap	3	1	5.42	1.49	1.13	6.89	1.31	0.91
146	14	pap	3	2	5.48	1.48	1.14	7.07	1.28	0.86
147	14	pap	1	1	3.97	1.14	0.43	4.26	0.56	1.51
148	14	pap	1	2	3.98	1.14	0.46	4.12	0.57	1.49
149	14	pap	2	1	4.72	1.04	1.32	5.91	1.94	1.13
150	14	pap	2	2	4.72	1.03	1.29	5.73	1.95	1.09
151	14	pap	3	1	6.05	1.19	1.80	5.18	2.91	0.70
152	14	pap	3	2	5.83	1.14	1.67	5.13	2.67	0.64
153	8	pap	1	1	3.29	1.07	0.54	3.12	0.54	0.75
154	8	pap	1	2	3.28	1.04	0.51	3.18	0.47	0.76
155	8	pap	2	1	3.37	0.96	0.59	2.06	1.15	0.59
156	8	pap	2	2	3.25	0.93	0.60	2.12	1.18	0.56
157	8	pap	3	1	2.53	0.90	0.38	1.46	1.10	0.42
158	8	pap	3	2	2.50	0.91	0.35	1.52	1.07	0.42
159	9	pap	1	1	2.55	1.18	0.60	3.95	0.15	1.20
160	9	pap	1	2	2.22	1.05	0.58	3.41	0.13	1.05
161	9	pap	2	1	2.36	0.91	1.13	2.74	0.44	0.72
162	9	pap	2	2	2.09	0.82	0.97	2.47	0.39	0.62
163	9	pap	3	1	2.18	1.06	3.32	3.34	0.67	0.68
164	9	pap	3	2	2.20	1.10	1.15	3.37	0.67	0.69
165	9	pap	1	1	2.03	1.20	0.77	5.15	0.13	1.46
166	9	pap	1	2	1.71	1.03	0.68	4.30	0.10	1.23
167	9	pap	2	1	1.88	0.82	1.35	3.27	0.34	0.93
168	9	pap	2	2	1.60	0.72	1.23	3.11	0.28	0.82

OBS	CAW	MGW	NAW	KW	FEW	SW
145	0.55	0.24	1.75	11.47	0.04	0.35
146	0.55	0.24	1.75	11.47	0.04	0.35
147	0.73	0.33	1.45	0.80	1.55	0.28
148	0.73	0.33	1.45	0.80	1.55	0.28
149	0.73	0.33	1.45	0.80	1.55	0.28
150	0.73	0.33	1.45	0.80	1.55	0.28
151	0.73	0.33	1.45	0.80	1.55	0.28
152	0.73	0.33	1.45	0.80	1.55	0.28
153	6.65	0.76	11.82	6.48	0.53	1.58
154	6.65	0.76	11.82	6.48	0.53	1.58
155	6.65	0.76	11.82	6.48	0.53	1.58
156	6.65	0.76	11.82	6.48	0.53	1.58
157	6.65	0.76	11.82	6.48	0.53	1.58
158	6.65	0.76	11.82	6.48	0.53	1.58
159	0.69	0.31	2.18	0.50	0.29	1.15
160	0.69	0.31	2.18	0.50	0.29	1.15
161	0.69	0.31	2.18	0.50	0.29	1.15
162	0.69	0.31	2.18	0.50	0.29	1.15
163	0.69	0.31	2.18	0.50	0.29	1.15
164	0.69	0.31	2.18	0.50	0.29	1.15
165	1.73	0.30	4.12	0.93	0.45	0.79
166	1.73	0.30	4.12	0.93	0.45	0.79
167	1.73	0.30	4.12	0.93	0.45	0.79
168	1.73	0.30	4.12	0.93	0.45	0.79

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
169	9	pap	3	1	1.38	0.92	1.28	2.78	0.28	0.60
170	9	pap	3	2	1.47	1.02	1.61	3.42	0.29	0.68
171	11	pap	1	1	2.96	1.41	0.38	3.19	0.11	0.69
172	11	pap	1	2	2.92	1.41	0.37	3.15	0.10	0.70
173	11	pap	2	1	2.35	1.17	0.66	2.97	0.34	0.62
174	11	pap	2	2	2.55	1.18	0.61	2.96	0.33	0.62
175	11	pap	3	1	1.96	1.30	0.45	1.71	0.36	0.56
176	11	pap	3	2	2.11	1.40	0.53	1.83	0.38	0.61
177	11	pap	1	1	2.43	1.40	0.44	2.90	0.11	0.75
178	11	pap	1	2	2.43	1.46	0.48	3.05	0.11	0.77
179	11	pap	2	1	2.05	1.17	0.81	2.67	0.24	0.54
180	11	pap	2	2	2.07	1.15	0.83	2.69	0.24	0.53
181	11	pap	3	1	2.16	1.21	0.48	1.34	0.41	0.49
182	11	pap	3	2	1.92	1.10	0.40	1.16	0.35	0.45
183	9	mag	1	1	5.96	1.28	0.76	4.71	0.40	1.54
184	9	mag	1	2	7.11	1.56	0.94	5.51	0.50	1.82
185	9	mag	2	1	6.77	1.20	1.01	3.97	1.99	1.26
186	9	mag	2	2	6.97	1.26	1.08	4.18	1.99	1.31
187	9	mag	3	1	9.05	1.23	1.11	3.66	2.61	1.01
188	9	mag	3	2	8.56	1.12	0.96	3.50	2.28	0.89
189	11	mag	1	1	1.28	1.41	0.64	4.34	0.11	0.93
190	11	mag	1	2	0.83	0.93	0.65	2.74	0.09	0.61
191	11	mag	2	1	1.83	1.71	1.38	6.59	0.59	1.08
192	11	mag	2	2	1.29	1.22	0.98	4.59	0.38	0.75

OBS	CAW	MGW	NAW	KW	FEW	SW
169	1.73	0.30	4.12	0.93	0.45	0.79
170	1.73	0.30	4.12	0.93	0.45	0.79
171	0.42	0.26	1.01	1.62	0.31	0.13
172	0.42	0.26	1.01	1.62	0.31	0.13
173	0.42	0.26	1.01	1.62	0.31	0.13
174	0.42	0.26	1.01	1.62	0.31	0.13
175	0.42	0.26	1.01	1.62	0.31	0.13
176	0.42	0.26	1.01	1.62	0.31	0.13
177	0.35	0.04	0.80	1.28	0.13	0.13
178	0.35	0.04	0.80	1.28	0.13	0.13
179	0.35	0.04	0.80	1.28	0.13	0.13
180	0.35	0.04	0.80	1.28	0.13	0.13
181	0.35	0.04	0.80	1.28	0.13	0.13
182	0.35	0.04	0.80	1.28	0.13	0.13
183	3.54	0.45	3.69	1.60	0.67	0.20
184	3.54	0.45	3.69	1.60	0.67	0.20
185	3.54	0.45	3.69	1.60	0.67	0.20
186	3.54	0.45	3.69	1.60	0.67	0.20
187	3.54	0.45	3.69	1.60	0.67	0.20
188	3.54	0.45	3.69	1.60	0.67	0.20
189	0.16	0.05	0.26	0.26	0.21	0.09
190	0.16	0.05	0.26	0.26	0.21	0.09
191	0.16	0.05	0.26	0.26	0.21	0.09
192	0.16	0.05	0.26	0.26	0.21	0.09

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
193	11	mag	3	1	1.08	1.32	1.53	4.78	0.48	0.58
194	11	mag	3	2	1.27	1.39	1.44	5.22	0.61	0.57
195	13	mag	1	1	4.69	1.21	0.54	5.54	0.14	1.53
196	13	mag	1	2	4.91	1.24	0.52	5.38	0.14	1.54
197	13	mag	2	1	4.10	0.84	1.08	7.57	0.31	1.14
198	13	mag	2	2	4.55	0.94	1.22	8.44	0.36	1.28
199	13	mag	3	1	5.29	0.98	1.80	8.60	0.43	0.93
200	13	mag	3	2	5.14	0.96	1.63	7.72	0.44	0.91
201	16	mag	1	1	2.71	0.89	0.12	5.24	0.07	0.97
202	16	mag	1	2	2.61	0.82	0.14	4.99	0.07	0.92
203	16	mag	2	1	2.51	0.60	0.36	8.38	0.14	0.72
204	16	mag	2	2	2.37	0.56	0.34	8.22	0.13	0.72
205	16	mag	3	1	2.24	0.61	0.64	4.29	0.16	0.52
206	16	mag	3	2	2.23	0.58	0.64	4.13	0.18	0.35
207	17	mag	1	1	6.07	1.59	0.00	6.45	0.34	0.53
208	17	mag	1	2	6.37	1.63	0.00	6.85	0.33	0.57
209	17	mag	2	1	6.15	1.42	0.00	8.48	0.71	0.29
210	17	mag	2	2	5.95	1.39	0.00	8.28	0.69	0.28
211	17	mag	3	1	5.97	1.30	0.00	6.20	0.71	0.22
212	17	mag	3	2	6.29	1.36	0.00	6.32	0.75	0.26
213	17	mag	1	1	6.70	1.84	0.24	6.15	0.37	0.84
214	17	mag	1	2	6.66	1.85	0.20	6.15	0.73	0.88
215	17	mag	2	1	7.34	1.78	0.49	5.29	0.86	0.72
216	17	mag	2	2	7.22	1.75	0.44	8.28	0.81	0.71

OBS	CAW	MGW	NAW	KW	FEW	SW
193	0.16	0.05	0.26	0.26	0.21	0.09
194	0.16	0.05	0.26	0.26	0.21	0.09
195	0.67	0.26	1.99	0.74	0.52	0.45
196	0.67	0.26	1.99	0.74	0.52	0.45
197	0.67	0.26	1.99	0.74	0.52	0.45
198	0.67	0.26	1.99	0.74	0.52	0.45
199	0.67	0.26	1.99	0.74	0.52	0.45
200	0.67	0.26	1.99	0.74	0.52	0.45
201	0.65	0.02	1.01	0.21	0.91	0.02
202	0.65	0.02	1.01	0.21	0.91	0.02
203	0.65	0.02	1.01	0.21	0.91	0.02
204	0.65	0.02	1.01	0.21	0.91	0.02
205	0.65	0.02	1.01	0.21	0.91	0.02
206	0.65	0.02	1.01	0.21	0.91	0.02
207	4.95	0.23	4.19	2.64	5.64	0.40
208	4.95	0.23	4.19	2.64	5.64	0.40
209	4.95	0.23	4.19	2.64	5.64	0.40
210	4.95	0.23	4.19	2.64	5.64	0.40
211	4.95	0.23	4.19	2.64	5.64	0.40
212	4.95	0.23	4.19	2.64	5.64	0.40
213	6.01	1.09	3.46	2.07	7.87	0.73
214	6.01	1.09	3.46	2.07	7.87	0.73
215	6.01	1.09	3.46	2.07	7.87	0.73
216	6.01	1.09	3.46	2.07	7.87	0.73

OBS	SI	SP	S_D	REP	CA	MG	NA	K	FE	S
217	17	mag	3	1	7.21	1.59	0.68	5.89	0.92	0.54
218	17	mag	3	2	6.98	1.54	0.62	6.14	0.73	0.67
219	20	mag	1	1	3.98	1.42	0.35	4.16	0.24	0.99
220	20	mag	1	2	4.27	1.32	0.30	3.73	0.28	0.90
221	20	mag	2	1	3.75	1.19	0.61	8.74	1.05	0.78
222	20	mag	2	2	3.27	1.06	0.43	5.86	0.86	0.68
223	20	mag	3	1	3.02	1.03	0.51	3.73	1.04	0.47
224	20	mag	3	2	3.02	1.02	0.54	3.65	0.96	0.48
225	21	mag	1	1	3.72	1.90	0.23	6.42	0.19	0.90
226	21	mag	1	2	3.81	1.90	0.23	6.84	0.18	0.89
227	21	mag	2	1	4.29	1.94	0.53	9.12	0.56	0.55
228	21	mag	2	2	4.22	1.98	0.56	9.15	0.60	0.52
229	21	mag	3	1	5.50	2.40	0.56	5.14	1.66	0.37
230	21	mag	3	2	5.87	2.49	0.54	5.15	1.74	0.39
231	24	mag	1	1	5.25	1.77	0.16	5.53	0.18	1.13
232	24	mag	1	2	5.54	1.84	0.26	5.93	0.20	1.19
233	24	mag	2	1	5.55	1.52	0.48	5.75	0.88	0.83
234	24	mag	2	2	5.49	1.51	0.45	5.62	0.88	0.80
235	24	mag	3	1	6.34	1.56	0.67	3.63	0.91	0.60
236	24	mag	3	2	6.02	1.49	0.74	3.82	0.85	0.56
237	24	mag	1	1	6.39	2.12	0.22	4.62	0.24	1.12
238	24	mag	1	1	6.04	2.00	0.27	4.34	0.23	1.07
239	24	mag	2	1	5.73	1.78	0.43	5.56	1.06	0.69
240	24	mag	2	2	5.70	1.77	0.46	5.37	1.00	0.68

OBS	CAW	MGW	NAW	KW	FEW	SW
217	6.01	1.09	3.46	2.07	7.87	0.73
218	6.01	1.09	3.46	2.07	7.87	0.73
219	0.29	0.02	0.02	1.14	12.09	0.02
220	0.29	0.02	0.02	1.14	12.09	0.02
221	0.29	0.02	0.02	1.14	12.09	0.02
222	0.29	0.02	0.02	1.14	12.09	0.02
223	0.29	0.02	0.02	1.14	12.09	0.02
224	0.29	0.02	0.02	1.14	12.09	0.02
225	1.40	0.85	0.74	0.80	0.64	0.15
226	1.40	0.85	0.74	0.80	0.64	0.15
227	1.40	0.85	0.74	0.80	0.64	0.15
228	1.40	0.85	0.74	0.80	0.64	0.15
229	1.40	0.85	0.74	0.80	0.64	0.15
230	1.40	0.85	0.74	0.80	0.64	0.15
231	65.61	16.03	24.01	1.77	0.05	0.14
232	65.61	16.03	24.01	1.77	0.05	0.14
233	65.61	16.03	24.01	1.77	0.05	0.14
234	65.61	16.03	24.01	1.77	0.05	0.14
235	65.61	16.03	24.01	1.77	0.05	0.14
236	65.61	16.03	24.01	1.77	0.05	0.14
237	38.37	10.57	14.07	1.49	0.09	0.07
238	38.37	10.57	14.07	1.49	0.09	0.07
239	38.37	10.57	14.07	1.49	0.09	0.07
240	38.37	10.57	14.07	1.49	0.09	0.07

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
241	24	mag	3	1	5.27	1.60	0.62	2.76	1.00	0.47
242	24	mag	3	2	5.28	1.60	0.64	2.95	1.01	0.50
243	26	mag	1	1	5.61	1.59	0.03	1.20	0.69	1.00
244	26	mag	1	2	5.24	1.55	0.02	1.22	0.64	0.95
245	26	mag	2	1	4.94	1.34	0.40	3.60	1.17	1.00
246	26	mag	2	2	5.02	1.35	0.43	3.45	1.19	0.99
247	26	mag	3	1	5.80	1.65	0.89	2.60	1.55	0.84
248	26	mag	3	2	5.52	1.57	0.88	2.51	1.51	0.78
249	7	mag	1	1	3.30	1.18	0.32	4.24	0.14	0.95
250	7	mag	1	2	3.12	1.19	0.33	4.46	0.14	0.96
251	7	mag	2	1	3.72	1.09	1.07	3.12	0.45	0.66
252	7	mag	2	2	3.59	1.03	1.06	3.06	0.43	0.65
253	7	mag	3	1	2.79	1.05	1.07	3.62	0.51	0.52
254	7	mag	3	2	3.76	1.00	1.14	3.58	0.49	0.51
255	8	cap	1	1	4.47	1.57	0.26	4.57	0.26	1.02
256	8	cap	1	2	4.61	1.62	0.43	4.59	0.29	1.01
257	8	cap	2	1	4.80	1.51	0.71	4.33	0.81	0.75
258	8	cap	2	2	4.91	1.56	0.72	4.37	0.88	0.78
259	8	cap	3	1	2.86	1.60	1.79	4.96	0.81	0.71
260	8	cap	3	2	3.20	1.81	2.15	5.35	0.94	0.83
261	9	cap	1	1	4.10	1.30	0.48	4.67	0.13	1.09
262	9	cap	1	2	4.07	1.35	0.44	4.90	0.13	1.06
263	9	cap	2	1	4.05	1.18	1.10	6.26	0.36	0.89
264	9	cap	2	2	4.01	1.19	1.11	5.88	0.40	0.87

OBS	CAW	MGW	NAW	KW	FEW	SW
241	38.37	10.57	14.07	1.49	0.09	0.07
242	38.37	10.57	14.07	1.49	0.09	0.07
243	10.63	2.85	4.75	1.74	0.30	0.84
244	10.63	2.85	4.75	1.74	0.30	0.84
245	10.63	2.85	4.75	1.74	0.30	0.84
246	10.63	2.85	4.75	1.74	0.30	0.84
247	10.63	2.85	4.75	1.74	0.30	0.84
248	10.63	2.85	4.75	1.74	0.30	0.84
249	3.89	0.58	5.72	2.37	0.94	0.75
250	3.89	0.58	5.72	2.37	0.94	0.75
251	3.89	0.58	5.72	2.37	0.94	0.75
252	3.89	0.58	5.72	2.37	0.94	0.75
253	3.89	0.58	5.72	2.37	0.94	0.75
254	3.89	0.58	5.72	2.37	0.94	0.75
255	0.35	0.15	0.97	0.10	0.23	0.51
256	0.35	0.15	0.97	0.10	0.23	0.51
257	0.35	0.15	0.97	0.10	0.23	0.51
258	0.35	0.15	0.97	0.10	0.23	0.51
259	0.35	0.15	0.97	0.10	0.23	0.51
260	0.35	0.15	0.97	0.10	0.23	0.51
261	0.44	0.13	1.92	0.27	0.37	0.46
262	0.44	0.13	1.92	0.27	0.37	0.46
263	0.44	0.13	1.92	0.27	0.37	0.46
264	0.44	0.13	1.92	0.27	0.37	0.46

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
265	9	cap	3	1	5.22	1.19	1.06	3.18	0.38	0.55
266	9	cap	3	2	4.90	1.13	1.00	3.15	0.35	0.52
267	9	cap	1	1	2.77	1.14	0.98	4.32	0.12	1.29
268	9	cap	1	2	2.70	1.05	0.83	4.05	0.12	1.21
269	9	cap	2	1	2.94	1.05	1.62	5.22	0.29	0.81
270	9	cap	2	2	2.86	1.00	1.60	5.22	0.28	0.77
271	9	cap	3	1	3.01	0.97	1.27	2.23	0.31	0.51
272	9	cap	3	2	3.71	1.14	1.55	2.55	0.37	0.61
273	15	cap	1	1	2.32	1.01	0.00	4.36	0.45	1.09
274	15	cap	1	2	2.51	1.01	0.02	4.61	0.56	1.08
275	15	cap	2	1	2.35	0.93	0.31	5.82	0.49	0.69
276	15	cap	2	2	2.37	0.95	0.21	5.81	0.49	0.68
277	15	cap	3	1	1.84	0.73	0.23	1.43	1.11	0.36
278	15	cap	3	2	1.79	0.71	0.24	1.53	1.04	0.29
279	15	cap	1	1	2.07	0.65	0.06	3.66	0.21	0.94
280	15	cap	1	2	2.00	0.63	0.00	3.67	0.19	0.90
281	15	cap	2	1	2.12	0.66	0.51	3.89	0.50	0.47
282	15	cap	2	2	1.80	0.55	0.45	3.64	0.44	0.42
283	15	cap	3	1	1.81	0.59	0.21	1.81	0.85	0.31
284	15	cap	3	2	1.79	0.57	0.30	1.77	0.84	0.31
285	16	cap	1	1	2.19	0.57	0.26	3.77	0.16	0.82
286	16	cap	1	2	2.15	0.62	0.25	3.82	0.17	0.92
287	16	cap	2	1	1.94	0.69	0.50	4.24	0.35	0.52
288	16	cap	2	2	1.93	0.68	0.55	4.13	0.38	0.53

OBS	CAW	MGW	NAW	KW	FEW	SW
265	0.44	0.13	1.92	0.27	0.37	0.46
266	0.44	0.13	1.92	0.27	0.37	0.46
267	1.57	0.35	1.41	0.78	0.30	0.73
268	1.57	0.35	1.41	0.78	0.30	0.73
269	1.57	0.35	1.41	0.78	0.30	0.73
270	1.57	0.35	1.41	0.78	0.30	0.73
271	1.57	0.35	1.41	0.78	0.30	0.73
272	1.57	0.35	1.41	0.78	0.30	0.73
273	0.11	0.11	0.92	0.96	3.05	0.20
274	0.11	0.11	0.92	0.96	3.05	0.20
275	0.11	0.11	0.92	0.96	3.05	0.20
276	0.11	0.11	0.92	0.96	3.05	0.20
277	0.11	0.11	0.92	0.96	3.05	0.20
278	0.11	0.11	0.92	0.96	3.05	0.20
279	0.09	0.04	0.85	15.48	4.26	0.04
280	0.09	0.04	0.85	15.48	4.26	0.04
281	0.09	0.04	0.85	15.48	4.26	0.04
282	0.09	0.04	0.85	15.48	4.26	0.04
283	0.09	0.04	0.85	15.48	4.26	0.04
284	0.09	0.04	0.85	15.48	4.26	0.04
285	0.50	0.02	1.74	0.25	1.87	0.02
286	0.50	0.02	1.74	0.25	1.87	0.02
287	0.50	0.02	1.74	0.25	1.87	0.02
288	0.50	0.02	1.74	0.25	1.87	0.02

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
289	16	cap	3	1	2.24	0.73	0.42	2.11	0.37	0.30
290	16	cap	3	2	2.70	0.89	0.68	2.73	0.43	0.37
291	16	cap	1	1	2.08	0.69	0.13	4.41	0.13	1.13
292	16	cap	1	2	2.56	0.91	0.23	4.68	0.15	1.37
293	16	cap	2	1	2.26	0.55	0.55	6.04	0.23	0.75
294	16	cap	2	2	2.25	0.56	0.49	6.23	0.22	0.75
295	16	cap	3	1	2.70	0.59	0.71	6.68	0.35	0.55
296	16	cap	3	2	2.65	0.57	0.79	7.09	0.33	0.54
297	17	cap	1	1	8.35	2.11	0.00	7.38	0.32	0.58
298	17	cap	1	2	9.38	2.26	0.00	6.53	0.36	0.65
299	17	cap	2	1	8.58	1.92	0.00	8.95	0.54	0.33
300	17	cap	2	2	8.49	1.88	0.00	8.64	0.56	0.33
301	17	cap	3	1	8.78	1.56	0.00	4.24	0.70	0.19
302	17	cap	3	2	8.85	1.57	0.00	4.18	0.71	0.21
303	25	cap	1	1	10.00	2.20	0.08	5.24	0.51	1.44
304	25	cap	1	2	10.32	2.26	0.12	5.73	0.47	1.60
305	25	cap	2	1	11.77	2.07	0.54	6.73	1.95	1.27
306	25	cap	2	2	11.12	2.01	0.49	6.52	2.06	1.25
307	25	cap	3	1	11.45	1.84	0.70	7.21	1.75	1.01
308	25	cap	3	2	10.83	1.77	0.71	6.82	1.76	0.58
309	25	cap	1	1	7.81	1.81	0.09	5.35	0.24	1.32
310	25	cap	1	2	8.27	1.84	0.07	5.47	0.26	1.52
311	25	cap	2	1	9.68	1.89	0.22	7.33	1.22	1.00
312	25	cap	2	2	9.56	1.84	0.26	6.90	1.18	0.99

OBS	CAW	MGW	NAW	KW	FEW	SW
289	0.50	0.02	1.74	0.25	1.87	0.02
290	0.50	0.02	1.74	0.25	1.87	0.02
291	0.52	0.02	1.35	0.21	1.21	0.02
292	0.52	0.02	1.35	0.21	1.21	0.02
293	0.52	0.02	1.35	0.21	1.21	0.02
294	0.52	0.02	1.35	0.21	1.21	0.02
295	0.52	0.02	1.35	0.21	1.21	0.02
296	0.52	0.02	1.35	0.21	1.21	0.02
297	7.70	1.62	4.11	1.98	7.37	0.32
298	7.70	1.62	4.11	1.98	7.37	0.32
299	7.70	1.62	4.11	1.98	7.37	0.32
300	7.70	1.62	4.11	1.98	7.37	0.32
301	7.70	1.62	4.11	1.98	7.37	0.32
302	7.70	1.62	4.11	1.98	7.37	0.32
303	174.99	27.88	5.45	7.52	0.22	0.02
304	174.99	27.88	5.45	7.52	0.22	0.02
305	174.99	27.88	5.45	7.52	0.22	0.02
306	174.99	27.88	5.45	7.52	0.22	0.02
307	174.99	27.88	5.45	7.52	0.22	0.02
308	174.99	27.88	5.45	7.52	0.22	0.02
309	105.35	18.29	3.97	2.74	0.15	1.63
310	105.35	18.29	3.97	2.74	0.15	1.63
311	105.35	18.29	3.97	2.74	0.15	1.63
312	105.35	18.29	3.97	2.74	0.15	1.63

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
313	25	cap	3	1	12.62	1.96	0.33	3.58	1.69	0.65
314	25	cap	3	2	12.60	1.95	0.33	3.58	1.70	0.66
315	28	cap	1	1	2.83	0.67	0.14	5.36	0.20	1.15
316	28	cap	1	2	2.86	0.65	0.07	5.17	0.22	1.20
317	28	cap	2	1	3.74	0.64	0.41	5.14	0.60	0.74
318	28	cap	2	2	3.51	0.59	0.23	4.89	0.56	0.69
319	28	cap	3	1	4.23	0.60	0.29	4.05	0.55	0.51
320	28	cap	3	2	4.16	0.60	0.26	3.79	0.58	0.51
321	28	cap	1	1	4.87	1.01	0.11	5.04	0.22	1.27
322	28	cap	1	2	4.73	0.96	0.15	4.81	0.22	1.19
323	28	cap	2	1	5.22	0.73	0.42	5.12	0.56	0.80
324	28	cap	2	2	5.12	0.70	0.36	5.12	0.53	0.77
325	28	cap	3	1	3.89	0.53	0.55	2.82	0.39	0.64
326	28	cap	3	2	3.86	0.52	0.49	2.81	0.37	0.60
327	18	war	1	1	8.04	1.78	0.73	4.14	0.26	1.44
328	18	war	1	2	8.17	1.82	0.80	4.02	0.33	1.45
329	18	war	2	1	9.98	1.69	0.66	0.96	0.23	0.83
330	18	war	2	2	9.55	1.65	0.59	0.81	0.25	0.81
331	18	war	1	1	12.39	3.37	0.83	2.70	1.15	1.51
332	18	war	1	2	12.02	3.52	0.67	1.78	2.59	1.30
333	18	war	2	1	12.28	2.69	0.81	0.30	0.59	0.95
334	18	war	2	2	11.89	2.61	0.78	0.27	0.49	0.91
335	23	war	1	1	8.83	1.56	0.40	10.99	0.27	1.13
336	23	war	1	2	7.86	1.38	0.27	9.97	0.23	1.09

OBS	CAW	MGW	NAW	KW	FEW	SW
313	105.35	18.29	3.97	2.74	0.15	1.63
314	105.35	18.29	3.97	2.74	0.15	1.63
315	1.88	0.93	1.79	2.36	4.08	0.41
316	1.88	0.93	1.79	2.36	4.08	0.41
317	1.88	0.93	1.79	2.36	4.08	0.41
318	1.88	0.93	1.79	2.36	4.08	0.41
319	1.88	0.93	1.79	2.36	4.08	0.41
320	1.88	0.93	1.79	2.36	4.08	0.41
321	1.72	0.72	2.16	1.98	0.02	0.65
322	1.72	0.72	2.16	1.98	0.02	0.65
323	1.72	0.72	2.16	1.98	0.02	0.65
324	1.72	0.72	2.16	1.98	0.02	0.65
325	1.72	0.72	2.16	1.98	0.02	0.65
326	1.72	0.72	2.16	1.98	0.02	0.65
327	80.24	11.50	20.06	3.49	11.75	.
328	80.24	11.50	20.06	3.49	11.75	.
329	80.24	11.50	20.06	3.49	11.75	.
330	80.24	11.50	20.06	3.49	11.75	.
331	71.66	10.46	20.31	139.39	10.64	1.35
332	71.66	10.46	20.31	139.39	10.64	1.35
333	71.66	10.46	20.31	139.39	10.64	1.35
334	71.66	10.46	20.31	139.39	10.64	1.35
335	98.79	14.56	2.11	2.26	0.02	1.29
336	98.79	14.56	2.11	2.26	0.02	1.29

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
337	23	war	2	1	6.14	1.03	0.40	7.29	0.39	0.61
338	23	war	2	2	6.42	1.04	0.45	7.31	0.40	0.61
339	23	war	1	1	7.83	1.60	0.18	6.60	0.13	1.20
340	23	war	1	2	7.14	1.44	0.24	6.48	0.15	1.20
341	23	war	2	1	9.77	1.90	0.27	3.81	0.36	0.54
342	23	war	2	2	10.12	1.94	0.37	4.00	0.37	0.55
343	24	war	1	1	11.10	4.28	0.61	3.76	0.21	1.02
344	24	war	1	2	10.48	3.73	0.68	3.41	0.17	1.06
345	24	war	2	1	10.24	3.39	0.60	1.83	0.56	0.68
346	24	war	2	2	10.27	3.45	0.60	1.88	0.55	0.59
347	24	war	1	1	5.15	2.23	0.20	7.48	0.16	1.05
348	24	war	1	2	5.37	2.37	0.50	8.24	0.16	1.04
349	24	war	2	1	10.58	3.25	0.71	2.36	0.66	0.70
350	24	war	2	2	10.18	3.18	0.71	2.23	0.66	0.67
351	25	war	1	1	6.56	1.50	0.25	7.33	0.15	1.36
352	25	war	1	2	7.30	1.63	0.27	8.10	0.17	1.42
353	25	war	2	1	11.80	2.11	0.38	6.60	0.56	0.90
354	25	war	2	2	11.93	2.20	0.40	6.89	0.57	0.97
355	25	war	1	1	8.72	1.65	0.17	3.79	0.14	1.37
356	25	war	1	2	9.03	1.69	0.20	3.94	0.17	1.27
357	25	war	2	1	13.31	2.27	0.43	4.39	0.56	0.85
358	25	war	2	2	12.46	2.16	0.43	4.17	0.55	0.81
359	27	war	1	1	6.57	1.45	0.23	4.05	0.21	1.01
360	27	war	1	2	6.16	1.37	0.24	4.01	0.19	1.03

OBS	CAW	MGW	NAW	KW	FEW	SW
337	98.79	14.56	2.11	2.26	0.02	1.29
338	98.79	14.56	2.11	2.26	0.02	1.29
339	84.67	16.68	1.78	0.68	0.04	1.82
340	84.67	16.68	1.78	0.68	0.04	1.82
341	84.67	16.68	1.78	0.68	0.04	1.82
342	84.67	16.68	1.78	0.68	0.04	1.82
343	36.88	11.29	11.19	0.58	0.47	0.09
344	36.88	11.29	11.19	0.58	0.47	0.09
345	36.88	11.29	11.19	0.58	0.47	0.09
346	36.83	11.29	11.19	0.58	0.47	0.09
347	40.96	11.42	13.24	1.60	0.21	0.12
348	40.96	11.42	13.24	1.60	0.21	0.12
349	40.96	11.42	13.24	1.60	0.21	0.12
350	40.96	11.42	13.24	1.60	0.21	0.12
351	119.99	22.01	4.77	6.00	0.29	0.76
352	119.99	22.01	4.77	6.00	0.29	0.76
353	119.99	22.01	4.77	6.00	0.29	0.76
354	119.99	22.01	4.77	6.00	0.29	0.76
355	102.34	18.65	4.09	2.97	0.62	0.88
356	102.34	18.65	4.09	2.97	0.62	0.88
357	102.34	18.65	4.09	2.97	0.62	0.88
358	102.34	18.65	4.09	2.97	0.62	0.88
359	218.82	66.78	20.90	4.04	2.28	162.38
360	218.82	66.78	20.90	4.04	2.28	162.38

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
361	27	war	2	1	12.01	1.86	0.35	4.14	0.54	0.90
362	27	war	2	2	11.64	1.83	0.33	3.98	0.52	0.86
363	27	war	1	1	11.37	2.34	0.46	0.99	0.18	2.15
364	27	war	1	2	11.18	2.34	0.43	0.90	0.18	2.43
365	27	war	2	1	12.20	2.48	0.91	1.70	0.34	2.47
366	27	war	2	2	13.94	2.79	1.03	2.41	0.41	2.37
367	12	war	1	1	6.86	2.18	0.16	5.49	0.15	0.40
368	12	war	1	2	6.59	2.03	0.19	5.23	0.14	0.42
369	12	war	2	1	7.33	1.98	0.18	5.72	0.18	0.37
370	12	war	2	2	7.21	1.93	0.18	5.69	0.17	0.28
371	27	war	1	1	8.70	2.43	0.26	5.35	0.12	1.19
372	27	war	1	2	8.64	2.40	0.25	5.27	0.13	1.06
373	27	war	2	1	15.98	3.17	0.33	2.33	0.59	0.92
374	27	war	2	2	16.07	3.14	0.35	3.55	0.59	0.78
375	13	ang	1	1	7.22	2.09	0.61	8.66	0.08	1.91
376	13	ang	1	2	7.23	2.05	0.57	9.04	0.09	1.99
377	13	ang	2	1	8.57	1.63	0.86	7.76	0.18	1.08
378	13	ang	2	2	8.16	1.59	0.84	0.19	0.17	1.12
379	20	ang	1	1	4.55	2.66	0.40	10.54	0.21	1.44
380	20	ang	1	2	4.66	2.59	0.42	10.36	0.26	1.44
381	20	ang	2	1	5.13	1.74	0.73	6.13	0.41	0.59
382	20	ang	2	2	4.90	1.68	0.66	6.49	0.56	0.62
383	20	ang	1	1	4.83	2.18	0.36	10.49	0.17	1.54
384	20	ang	1	2	4.68	2.09	0.49	10.75	0.18	1.48

OBS	CAW	MGW	NAW	KW	FEW	SW
361	218.82	66.78	20.90	4.04	2.28	162.38
362	218.82	66.78	20.90	4.04	2.28	162.38
363	173.34	61.15	26.33	6.38	2.42	118.67
364	173.34	61.15	26.33	6.38	2.42	118.67
365	173.34	61.15	26.33	6.38	2.42	118.67
366	173.34	61.15	26.33	6.38	2.42	118.67
367	2.49	0.25	3.88	1.70	3.69	0.32
368	2.49	0.25	3.88	1.70	3.69	0.32
369	2.49	0.25	3.88	1.70	3.69	0.32
370	2.49	0.25	3.88	1.70	3.69	0.32
371	185.29	61.47	22.41	4.99	0.76	122.45
372	185.29	61.47	22.41	4.99	0.76	122.45
373	185.29	61.47	22.41	4.99	0.76	122.45
374	185.29	61.47	22.41	4.99	0.76	122.45
375	3.02	0.52	2.02	1.72	2.18	0.03
376	3.02	0.52	2.02	1.72	2.18	0.03
377	3.02	0.52	2.02	1.72	2.18	0.03
378	3.02	0.52	2.02	1.72	2.18	0.03
379	0.85	0.02	1.10	0.42	4.57	0.02
380	0.85	0.02	1.10	0.42	4.57	0.02
381	0.85	0.02	1.10	0.42	4.57	0.02
382	0.85	0.02	1.10	0.42	4.57	0.02
383	0.51	0.02	0.07	6.75	12.24	0.02
384	0.51	0.02	0.07	6.75	12.24	0.02

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
385	20	ang	2	1	5.36	1.46	0.62	5.38	0.57	0.61
386	20	ang	2	2	5.43	1.52	0.61	5.70	0.56	0.63
387	21	ang	1	1	4.70	2.66	0.57	14.57	0.41	1.51
388	21	ang	1	2	3.91	2.26	0.49	11.83	0.41	1.46
389	21	ang	2	1	5.94	2.60	0.71	11.94	0.63	0.89
390	21	ang	2	2	5.02	3.22	0.56	11.82	0.55	0.75
391	23	ang	1	1	13.39	2.47	0.45	10.08	0.16	2.69
392	23	ang	1	2	13.57	2.52	0.47	9.96	0.17	2.71
393	23	ang	2	1	10.96	1.52	0.44	7.38	0.38	1.76
394	23	ang	2	2	10.30	1.41	0.46	6.87	0.35	1.62
395	23	ang	1	1	12.31	2.77	0.31	9.26	0.11	2.39
396	23	ang	1	2	11.73	2.66	0.31	8.31	0.11	2.26
397	23	ang	2	1	13.39	2.42	0.41	5.22	0.35	0.98
398	23	ang	2	2	12.86	2.25	0.36	4.61	0.32	1.39
399	24	ang	1	1	7.67	3.18	0.34	10.23	0.20	1.40
400	24	ang	1	2	7.03	2.89	0.36	9.10	0.19	1.27
401	24	ang	2	1	7.85	2.28	0.50	5.64	0.42	0.66
402	24	ang	2	2	7.52	2.27	0.35	5.49	0.37	0.64
403	25	ang	1	1	5.84	1.87	0.09	7.04	0.14	1.44
404	25	ang	1	2	5.64	1.92	0.12	7.29	0.14	1.38
405	25	ang	2	1	7.56	1.84	0.24	7.73	0.39	1.01
406	25	ang	2	2	7.54	1.82	0.27	8.00	0.42	1.03
407	26	ang	1	1	7.11	2.15	0.38	8.92	0.57	1.34
408	26	ang	1	2	7.80	2.47	0.35	9.99	0.56	1.37

OBS	CAW	MGW	NAW	KW	FEW	SW
385	0.51	0.02	0.07	6.75	12.24	0.02
386	0.51	0.02	0.07	6.75	12.24	0.02
387	1.98	0.93	0.65	1.73	0.52	0.07
388	1.98	0.93	0.65	1.73	0.52	0.07
389	1.98	0.93	0.65	1.73	0.52	0.07
390	1.98	0.93	0.65	1.73	0.52	0.07
391	72.20	16.13	2.35	0.92	0.11	2.34
392	72.20	16.13	2.35	0.92	0.11	2.34
393	72.20	16.13	2.35	0.92	0.11	2.34
394	72.20	16.13	2.35	0.92	0.11	2.34
395	71.93	16.72	2.40	0.78	0.48	2.46
396	71.93	16.72	2.40	0.78	0.48	2.46
397	71.93	16.72	2.40	0.78	0.48	2.46
398	71.93	16.72	2.40	0.78	0.48	2.46
399	41.28	11.20	17.99	1.05	0.21	0.15
400	41.28	11.20	17.99	1.05	0.21	0.15
401	41.28	11.20	17.99	1.05	0.21	0.15
402	41.28	11.20	17.99	1.05	0.21	0.15
403	106.25	20.97	4.65	3.26	0.31	0.94
404	106.25	20.97	4.65	3.26	0.31	0.94
405	106.25	20.97	4.65	3.26	0.31	0.94
406	106.25	20.97	4.65	3.26	0.31	0.94
407	12.57	3.24	3.21	1.08	0.50	0.67
408	12.57	3.24	3.21	1.08	0.50	0.67

OBS	GI	SP	SEC	REP	CA	MG	NA	K	FE	S
409	26	ang	2	1	9.47	2.60	0.65	10.52	0.74	1.19
410	26	ang	2	2	9.35	2.52	0.61	10.10	0.68	1.15
411	28	ang	1	1	0.76	0.79	0.18	6.36	0.10	0.94
412	28	ang	1	2	0.75	0.77	0.10	6.15	0.10	0.90
413	28	ang	1	1	1.52	1.50	0.66	5.90	0.27	1.06
414	28	ang	1	2	1.51	1.46	0.66	5.77	0.28	1.03
415	28	ang	2	1	1.47	1.21	0.59	3.26	0.53	0.78
416	28	ang	2	2	1.42	1.13	0.64	3.05	0.50	0.72
417	11	pac	1	1	1.36	1.38	0.39	7.01	0.10	1.42
418	11	pac	1	2	1.46	1.45	0.37	6.80	0.08	1.36
419	11	pac	2	1	1.79	1.34	0.65	6.85	0.12	0.88
420	11	pac	2	2	1.97	1.44	0.78	7.37	0.13	0.92
421	13	pac	1	1	3.69	1.91	0.85	8.97	0.67	1.67
422	13	pac	1	2	3.82	2.03	0.95	9.31	0.55	1.78
423	13	pac	2	1	4.12	1.66	1.14	12.13	0.65	1.24
424	13	pac	2	2	3.92	1.62	1.05	12.08	0.67	1.25
425	13	pac	1	1	4.43	1.02	0.74	7.84	0.10	1.95
426	13	pac	1	2	4.09	0.94	0.72	7.50	0.11	1.96
427	13	pac	2	1	4.49	0.79	1.71	14.02	0.14	1.95
428	13	pac	2	2	4.61	0.74	1.90	12.98	0.14	1.90
429	15	pac	1	1	3.67	2.27	0.61	7.31	0.09	1.14
430	15	pac	1	2	3.67	2.28	0.48	7.50	0.07	1.25
431	15	pac	2	1	4.01	2.07	0.81	10.97	0.15	0.88
432	15	pac	2	2	4.78	2.38	1.00	12.70	0.19	1.00

OBS	CAW	MGW	NAW	KW	FEW	SW
409	12.57	3.24	3.21	1.08	0.50	0.67
410	12.57	3.24	3.21	1.08	0.50	0.67
411	0.82	0.42	1.07	3.68	0.60	0.47
412	0.82	0.42	1.07	3.68	0.60	0.47
413	0.53	0.23	1.00	2.74	0.29	0.34
414	0.53	0.23	1.00	2.74	0.29	0.34
415	0.53	0.23	1.00	2.74	0.29	0.34
416	0.53	0.23	1.00	2.74	0.29	0.34
417	0.27	0.05	0.12	0.35	0.19	0.09
418	0.27	0.05	0.12	0.35	0.19	0.09
419	0.27	0.05	0.12	0.35	0.19	0.09
420	0.27	0.05	0.12	0.35	0.19	0.09
421	0.54	0.24	1.75	11.47	0.04	0.39
422	0.54	0.24	1.75	11.47	0.04	0.39
423	0.54	0.24	1.75	11.47	0.04	0.39
424	0.54	0.24	1.75	11.47	0.04	0.39
425	0.24	0.35	1.46	1.38	3.09	0.15
426	0.24	0.35	1.46	1.38	3.09	0.15
427	0.24	0.35	1.46	1.38	3.09	0.15
428	0.24	0.35	1.46	1.38	3.09	0.15
429	0.02	0.03	0.71	0.03	1.12	0.02
430	0.02	0.03	0.71	0.03	1.12	0.02
431	0.02	0.03	0.71	0.03	1.12	0.02
432	0.02	0.03	0.71	0.03	1.12	0.02

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
433	9	pac	1	1	2.31	0.88	0.59	3.43	0.17	1.14
434	9	pac	1	2	.	.	.	.	.	.
435	9	pac	2	1	2.37	0.77	1.08	4.07	0.27	0.90
436	9	pac	2	2	2.31	0.76	1.06	3.76	0.28	1.16
437	21	pac	1	1	6.37	3.51	0.31	7.79	0.55	1.14
438	21	pac	1	2	5.80	3.31	0.40	7.94	0.57	1.13
439	21	pac	2	1	8.04	3.37	0.31	8.33	1.59	0.66
440	21	pac	2	2	7.94	3.38	0.42	5.64	1.67	0.67
441	6	pac	1	1	2.35	1.17	0.34	5.08	0.04	0.78
442	6	pac	1	2	2.34	1.17	0.36	5.21	0.04	0.80
443	6	pac	2	1	3.04	1.19	0.88	10.55	0.08	0.82
444	6	pac	2	2	2.89	1.13	0.80	9.77	0.09	0.75
445	2	pac	1	1	0.53	1.43	0.77	3.97	0.16	0.81
446	2	pac	1	2	0.55	1.43	0.78	3.96	0.15	0.83
447	2	pac	2	1	0.86	1.39	1.69	10.87	0.17	0.85
448	2	pac	2	2	0.82	1.36	1.58	10.57	0.19	0.89
449	1	pac	1	1	3.88	1.64	0.34	5.17	0.94	0.69
450	1	pac	1	2	3.79	1.62	0.36	4.91	0.94	0.94
451	1	pac	2	1	4.30	1.83	0.98	8.39	1.66	0.91
452	1	pac	2	2	4.29	1.82	0.91	8.69	1.64	0.68
453	9	pac	1	1	2.04	0.91	0.52	3.81	0.12	0.97
454	9	pac	1	2	2.09	0.89	0.51	3.90	0.11	1.05
455	9	pac	2	1	2.62	0.90	1.38	6.26	0.26	1.05
456	9	pac	2	2	2.57	0.89	1.37	6.69	0.25	1.17

OBS	CAW	MGW	NAW	KW	FEW	SW
433	0.77	0.05	2.87	0.22	0.65	1.23
434	0.77	0.05	2.87	0.22	0.65	1.23
435	0.77	0.05	2.87	0.22	0.65	1.23
436	0.77	0.05	2.87	0.22	0.65	1.23
437	2.30	1.21	0.70	0.42	0.82	0.13
438	2.30	1.21	0.70	0.42	0.82	0.13
439	2.30	1.21	0.70	0.42	0.82	0.13
440	2.30	1.21	0.70	0.42	0.82	0.13
441	0.25	0.02	1.79	0.01	1.41	0.47
442	0.25	0.02	1.79	0.01	1.41	0.47
443	0.25	0.02	1.79	0.01	1.41	0.47
444	0.25	0.02	1.79	0.01	1.41	0.47
445	0.36	0.75	6.58	2.53	6.14	0.57
446	0.36	0.75	6.58	2.53	6.14	0.57
447	0.36	0.75	6.58	2.53	6.14	0.57
448	0.36	0.75	6.58	2.53	6.14	0.57
449	0.85	0.49	3.45	0.61	7.52	0.35
450	0.85	0.49	3.45	0.61	7.52	0.35
451	0.85	0.49	3.45	0.61	7.52	0.35
452	0.85	0.49	3.45	0.61	7.52	0.35
453	2.26	0.43	5.48	0.32	5.34	1.86
454	2.26	0.43	5.48	0.32	5.34	1.86
455	2.26	0.43	5.48	0.32	5.34	1.86
456	2.26	0.43	5.48	0.32	5.34	1.86

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
457	4	pac	1	1	1.54	1.50	0.67	4.01	0.09	0.67
458	4	pac	1	2	1.53	1.49	0.62	3.94	0.08	0.71
459	4	pac	2	1	1.86	1.47	1.59	5.88	0.33	0.76
460	4	pac	2	2	1.84	1.48	1.38	5.57	0.34	0.74
461	6	pac	1	1	2.10	1.20	0.34	3.76	0.18	0.76
462	6	pac	1	2	2.13	1.23	0.34	3.71	0.18	0.79
463	6	pac	2	1	2.29	1.16	0.87	6.29	0.26	0.42
464	6	pac	2	2	1.99	0.99	0.77	5.14	0.22	0.64
465	9	fus	1	1	3.96	1.45	0.90	4.64	0.18	1.20
466	9	fus	1	2	3.36	1.25	0.53	4.20	0.15	1.29
467	9	fus	2	1	4.22	1.14	0.83	3.38	0.31	0.66
468	9	fus	2	2	4.89	1.28	0.88	3.58	0.36	0.81
469	9	fus	3	1	8.00	1.20	0.83	2.17	0.47	0.55
470	9	fus	3	2	8.61	1.32	1.11	2.21	0.59	0.77
471	13	fus	1	1	4.76	1.06	0.59	5.11	0.17	1.86
472	13	fus	1	2	4.66	1.02	0.61	5.01	0.19	1.78
473	13	fus	2	1	4.48	0.77	0.76	3.95	0.43	0.72
474	13	fus	2	2	4.51	0.80	0.85	3.94	0.42	0.74
475	13	fus	3	1	5.41	0.77	0.92	4.47	0.42	0.62
476	13	fus	3	2	5.52	0.80	0.94	4.57	0.44	0.64
477	14	fus	1	1	2.29	0.61	0.46	3.28	0.31	1.52
478	14	fus	1	2	2.16	0.61	0.32	3.20	0.28	1.51
479	14	fus	2	1	2.41	0.51	0.49	1.36	0.67	0.64
480	14	fus	2	2	2.41	0.51	0.38	1.34	0.67	0.62

OBS	CAW	MGW	NAW	KW	FEW	SW
457	2.11	1.02	8.07	0.01	4.39	1.11
458	2.11	1.02	8.07	0.01	4.39	1.11
459	2.11	1.02	8.07	0.01	4.39	1.11
460	2.11	1.02	8.07	0.01	4.39	1.11
461	0.10	0.02	1.41	0.01	1.33	0.37
462	0.10	0.02	1.41	0.01	1.33	0.37
463	0.10	0.02	1.41	0.01	1.33	0.37
464	0.10	0.02	1.41	0.01	1.33	0.37
465	5.50	0.70	5.23	0.80	1.03	2.22
466	5.50	0.70	5.23	0.80	1.03	2.22
467	5.50	0.70	5.23	0.80	1.03	2.22
468	5.50	0.70	5.23	0.80	1.03	2.22
469	5.50	0.70	5.23	0.80	1.03	2.22
470	5.50	0.70	5.23	0.80	1.03	2.22
471	0.27	0.08	1.48	0.54	0.16	0.26
472	0.27	0.08	1.48	0.54	0.16	0.26
473	0.27	0.08	1.48	0.54	0.16	0.26
474	0.27	0.08	1.48	0.54	0.16	0.26
475	0.27	0.08	1.48	0.54	0.16	0.26
476	0.27	0.08	1.48	0.54	0.16	0.26
477	0.00	0.04	0.98	0.26	3.04	0.39
478	0.00	0.04	0.98	0.26	3.04	0.39
479	0.00	0.04	0.98	0.26	3.04	0.39
480	0.00	0.04	0.98	0.26	3.04	0.39

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
481	14	fus	3	1	2.03	0.46	0.47	0.74	0.68	0.57
482	14	fus	3	2	2.08	0.47	0.45	0.73	0.68	0.60
483	16	fus	1	1	1.97	0.67	0.09	4.99	0.08	1.46
484	16	fus	1	2	1.90	0.62	0.06	4.83	0.08	1.30
485	16	fus	2	1	2.19	0.63	0.35	5.30	0.23	0.68
486	16	fus	2	2	2.27	0.66	0.43	5.87	0.23	0.82
487	16	fus	3	1	1.81	0.61	0.54	4.41	0.25	0.41
488	16	fus	3	2	1.78	0.61	0.56	4.35	0.26	0.43
489	17	fus	1	1	7.39	1.74	0.00	6.43	0.50	0.81
490	17	fus	1	2	7.25	1.72	0.00	6.35	0.51	0.84
491	17	fus	2	1	5.94	1.32	0.00	6.71	0.52	0.22
492	17	fus	2	2	6.28	1.40	0.00	6.91	0.52	0.25
493	17	fus	3	1	6.07	1.37	0.00	8.21	0.60	0.17
494	17	fus	3	2	5.68	1.29	0.00	7.63	0.56	0.14
495	17	fus	1	1	5.78	1.27	0.05	4.44	0.38	0.72
496	17	fus	1	2	5.70	1.31	0.01	4.44	0.40	0.72
497	17	fus	2	1	4.64	0.95	0.23	6.07	0.68	0.37
498	17	fus	2	2	4.57	0.95	0.18	5.89	0.61	0.35
499	17	fus	3	1	3.54	0.73	0.29	4.00	0.58	0.27
500	17	fus	3	2	4.41	0.92	0.40	4.93	0.70	0.33
501	18	fus	1	1	10.22	2.26	0.07	6.22	0.45	2.00
502	18	fus	1	2	9.45	2.06	0.09	5.79	0.47	1.94
503	18	fus	2	1	6.11	1.07	0.71	2.83	1.94	2.61
504	18	fus	2	2	6.05	1.08	0.77	2.81	2.25	2.77

OBS	CAW	MGW	NAW	KW	FEW	SW
481	0.00	0.04	0.98	0.26	3.04	0.39
482	0.00	0.04	0.98	0.26	3.04	0.39
483	0.60	0.02	1.18	0.03	1.38	0.21
484	0.60	0.02	1.18	0.03	1.38	0.21
485	0.60	0.02	1.18	0.03	1.38	0.21
486	0.60	0.02	1.18	0.03	1.38	0.21
487	0.60	0.02	1.18	0.03	1.38	0.21
488	0.60	0.02	1.18	0.03	1.38	0.21
489	3.08	0.02	3.17	6.72	6.06	0.38
490	3.08	0.02	3.17	6.72	6.06	0.38
491	3.08	0.02	3.17	6.72	6.06	0.38
492	3.08	0.02	3.17	6.72	6.06	0.38
493	3.08	0.02	3.17	6.72	6.06	0.38
494	3.08	0.02	3.17	6.72	6.06	0.38
495	4.94	0.02	2.30	3.61	8.66	0.26
496	4.94	0.02	2.30	3.61	8.66	0.26
497	4.94	0.02	2.30	3.61	8.66	0.26
498	4.94	0.02	2.30	3.61	8.66	0.26
499	4.94	0.02	2.30	3.61	8.66	0.26
500	4.94	0.02	2.30	3.61	8.66	0.26
501	201.34	23.80	17.96	16.53	29.71	0.25
502	201.34	23.80	17.96	16.53	29.71	0.25
503	201.34	23.80	17.96	16.53	29.71	0.25
504	201.34	23.80	17.96	16.53	29.71	0.25

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
505	18	fus	3	1	7.46	1.44	0.48	10.49	0.48	1.45
506	18	fus	3	2	8.11	1.56	0.44	10.99	0.44	1.51
507	18	fus	1	1	3.51	0.84	0.37	4.22	0.34	1.86
508	18	fus	1	2	3.47	0.80	0.36	4.25	0.32	1.88
509	18	fus	2	1	3.16	0.69	0.60	3.42	0.33	1.02
510	18	fus	2	2	3.14	0.69	0.58	3.13	0.30	1.00
511	18	fus	3	1	3.58	0.64	0.58	0.15	0.65	1.08
512	18	fus	3	2	3.62	0.65	0.69	0.17	0.70	1.05
513	23	fus	1	1	12.75	2.30	0.52	9.62	0.13	1.74
514	23	fus	1	2	12.83	2.34	0.51	9.44	0.15	1.78
515	23	fus	2	1	11.55	1.71	0.54	7.73	0.32	1.57
516	23	fus	2	2	11.16	1.68	0.53	7.48	0.33	1.57
517	23	fus	3	1	8.21	1.14	0.52	4.23	0.53	1.34
518	23	fus	3	2	8.11	1.10	0.45	4.21	0.50	1.34
519	24	fus	1	1	5.80	1.68	2.08	8.60	0.19	1.36
520	24	fus	1	2	4.83	1.40	1.72	7.94	0.18	1.21
521	24	fus	2	1	4.26	1.06	1.61	4.32	0.49	0.64
522	24	fus	2	2	4.13	1.04	1.61	4.16	0.49	0.64
523	24	fus	3	1	4.97	2.37	1.31	2.13	0.56	0.55
524	24	fus	3	2	5.08	2.50	1.31	2.14	0.56	0.55
525	25	fus	1	1	9.55	2.25	0.12	5.76	0.50	1.62
526	25	fus	1	2	10.10	2.31	0.13	5.82	0.54	1.60
527	25	fus	2	1	12.35	2.14	0.49	6.08	1.73	1.38
528	25	fus	2	2	11.65	2.10	0.44	5.89	1.82	1.35

OBS	CAW	MGW	NAW	KW	FEW	SW
505	201.34	23.80	17.96	16.53	29.71	0.25
506	201.34	23.80	17.96	16.53	29.71	0.25
507	79.25	10.88	19.64	2.35	13.53	0.74
508	79.25	10.88	19.64	2.35	13.53	0.74
509	79.25	10.88	19.64	2.35	13.53	0.74
510	79.25	10.88	19.64	2.35	13.53	0.74
511	79.25	10.88	19.64	2.35	13.53	0.74
512	79.25	10.88	19.64	2.35	13.53	0.74
513	46.97	12.17	4.13	0.84	0.02	3.39
514	46.97	12.17	4.13	0.84	0.02	3.39
515	46.97	12.17	4.13	0.84	0.02	3.39
516	46.97	12.17	4.13	0.84	0.02	3.39
517	46.97	12.17	4.13	0.84	0.02	3.39
518	46.97	12.17	4.13	0.84	0.02	3.39
519	83.20	19.96	28.18	2.58	0.01	0.02
520	83.20	19.96	28.18	2.58	0.01	0.02
521	83.20	19.96	28.18	2.58	0.01	0.02
522	83.20	19.96	28.18	2.58	0.01	0.02
523	83.20	19.96	28.18	2.58	0.01	0.02
524	83.20	19.96	28.18	2.58	0.01	0.02
525	138.33	23.43	4.86	7.91	0.50	0.25
526	138.33	23.43	4.86	7.91	0.50	0.25
527	138.33	23.43	4.86	7.91	0.50	0.25
528	138.33	23.43	4.86	7.91	0.50	0.25

OBS	SI	SP	SEC	REP	CA	MG	NA	K	FE	S
529	25	fus	3	1	13.58	1.93	0.51	2.45	2.31	0.89
530	25	fus	3	2	13.62	1.87	0.52	2.30	2.02	0.86
531	9	fus	1	1	2.13	0.98	0.80	2.84	0.35	1.18
532	9	fus	1	2	2.27	1.01	0.75	2.97	0.38	1.21
533	9	fus	2	1	2.34	0.81	0.94	1.67	0.85	0.66
534	9	fus	2	2	2.50	0.90	0.77	1.80	0.94	0.70
535	9	fus	3	1	3.15	0.93	0.59	0.52	1.13	0.60
536	9	fus	3	2	3.10	0.93	0.65	0.55	1.11	0.58
537	22	fus	1	1	2.50	0.65	0.74	5.58	0.58	1.49
538	22	fus	1	2	2.58	0.66	0.69	5.28	0.57	1.44
539	22	fus	2	1	3.12	0.60	0.66	4.12	0.77	0.98
540	22	fus	2	1	3.10	0.60	0.65	4.16	0.80	1.02
541	22	fus	3	1	4.07	0.65	0.55	1.58	0.77	0.58
542	22	fus	3	2	3.86	0.64	0.55	1.53	0.76	0.57
543	19	fus	1	1	1.81	1.85	0.39	5.42	0.13	1.47
544	19	fus	1	2	1.90	1.88	0.39	5.73	0.15	1.53
545	19	fus	2	1	2.07	1.60	0.72	5.28	0.23	0.88
546	19	fus	2	2	2.01	1.58	0.73	5.18	0.32	0.90
547	19	fus	3	1	3.25	2.97	0.64	1.38	0.20	0.81
548	19	fus	3	2	3.30	2.93	0.71	1.35	0.21	0.78

OBS	CAW	MGW	NAW	KW	FEW	SW
529	138.33	23.43	4.86	7.91	0.50	0.25
530	138.33	23.43	4.86	7.91	0.50	0.25
531	4.24	0.45	7.57	2.25	1.01	1.02
532	4.24	0.45	7.57	2.25	1.01	1.02
533	4.24	0.45	7.57	2.25	1.01	1.02
534	4.24	0.45	7.57	2.25	1.01	1.02
535	4.24	0.45	7.57	2.25	1.01	1.02
536	4.24	0.45	7.57	2.25	1.01	1.02
537	95.21	12.68	4.47	2.97	0.19	1.58
538	95.21	12.68	4.47	2.97	0.19	1.58
539	95.21	12.68	4.47	2.97	0.19	1.58
540	95.21	12.68	4.47	2.97	0.19	1.58
541	95.21	12.68	4.47	2.97	0.19	1.58
542	95.21	12.68	4.47	2.97	0.19	1.58
543	50.13	22.57	4.35	3.85	0.19	7.23
544	50.13	22.57	4.35	3.85	0.19	7.23
545	50.13	22.57	4.35	3.85	0.19	7.23
546	50.13	22.57	4.35	3.85	0.19	7.23
547	50.13	22.57	4.35	3.85	0.19	7.23
548	50.13	22.57	4.35	3.85	0.19	7.23