Habitat History and the Decline of the Vancouver Island Marmot (*Marmota vancouverensis*)

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Abstract: Vegetation changes in subalpine and alpine habitats on Vancouver Island may have had a role in today's low numbers of Vancouver Island marmots (*Marmota vancouverensis*). We describe a fecal dietary analysis and approximately 2000 years of dynamic vegetation history of marmot habitat. Twelve fecal samples collected between May and August 2003 in the Mount Washington area were analyzed for pollen and spores to determine marmot diet. The main pollen types in the feces were derived from non-arboreal plants associated with open environments, including Ericaceae, Liliaceae, Rosaceae, and Cyperaceae family members. High-resolution pollen and spore analysis of wetland sediments collected at Heather Mountain, a locality presently inhabited by marmots, strongly suggest that subalpine forest vegetation is negatively correlated with early seral and meadow indicators, and early seral stages are positively correlated with meadow taxa. Eight times in the last 2000 years, open plant communities dominated the landscape. We infer that meadow/open parkland or transitional environments prevailed throughout approximately 78% of the sampling interval, with high percentages of alder, suggesting that this ecosystem was maintained by disturbances, likely fire. Our results demonstrate the importance of open heath and meadow habitats to marmot diet. We infer that subalpine landscapes on Heather Mountain were frequently much more open during the last two millennia than today, and were likely a complex mosaic of forested, transitional, and meadow plant communities.

Key Words: Vancouver Island marmot, *Marmota vancouverensis*, paleoecology, subalpine, habitat, meadow, fire, British Columbia

Introduction

One of the most endangered mammals in North America, *Marmota vancouverensis* (Vancouver Island marmot; herein marmot) is an endemic, burrowing rodent confined to subalpine and alpine habitats on Vancouver Island (Bryant and Janz 1996; Elner 2000). Marmot diet principally consists of a variety of forbs and graminoids found in high elevation meadows (Demarchi et al. 1996; Bryant 1997).

Vegetation changes may have had a role in today's low numbers of marmots. Alterations in plant species composition may have led to a reduction of preferred forage foods and a shifting of territorial structure (Nagorsen et al. 1996). In recent times, many subalpine meadows favored by marmots have been converted into forested stands, a situation likely leading to increased predation (Milko 1984). Historical fluctuations in climate, and disturbances such as fire, likely affected vegetation and influenced marmot survivorship.

We describe a fecal dietary analysis and approximately 2000 years of dynamic vegetation history of marmot habitat. Our findings strongly suggest that recent changes in landscape disturbance regimes contributed to present-day low populations.

Diet

Twelve fecal samples from the Mount Washington area were collected, but not necessarily deposited, between May and August 2003 (Fig. 1). We used standard pollen and spore analysis techniques (Faegri and Iversen 1989) to determine marmot diet. The main pollen types in the feces were derived from non-arboreal plants associated with open environments (Fig. 2). The presence of conifer pollen is likely by indirect ingestion or contamination of feces, both caused by conifer pollen rain.

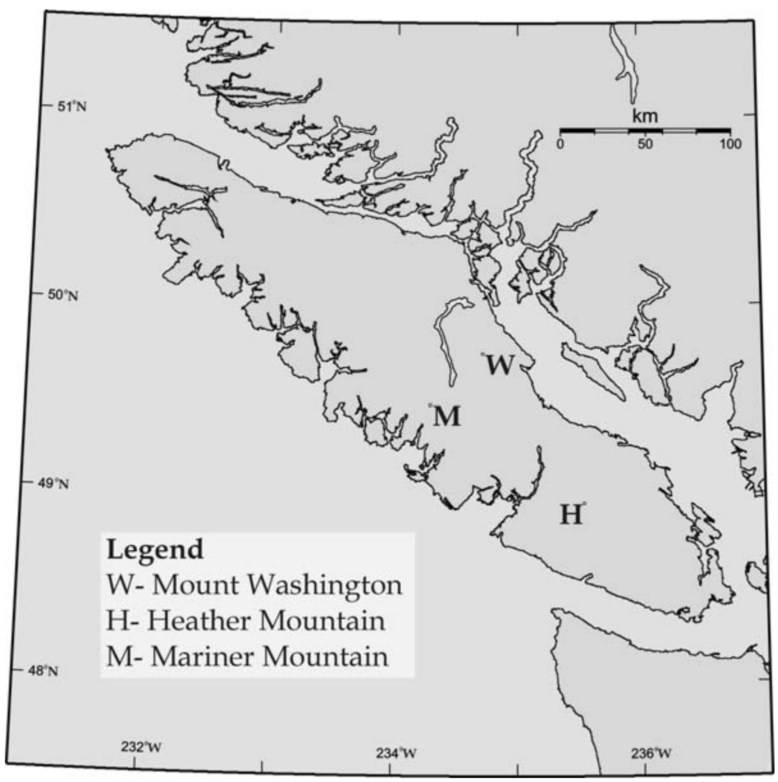

Figure 1. Site map of the study locations: Mount Washington and Heather Mountain, Vancouver Island. The discovery of abundant remains, including at least 23 individuals on Mariner Mountain aged at approximately 1000–1200 years old (Nagorsen et al. 1996), suggests that marmots were much more abundant in the last millennium.

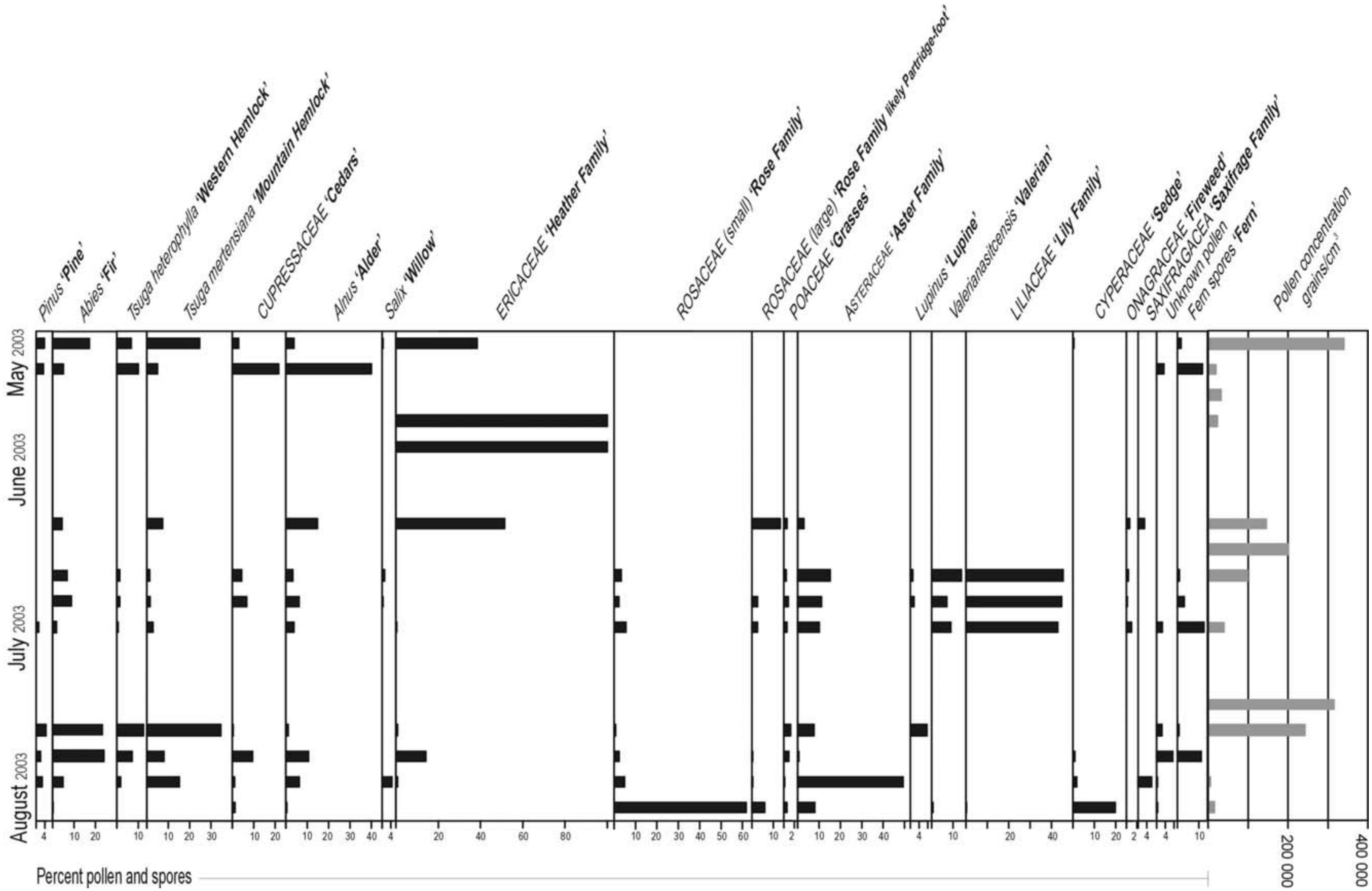

Figure 2. Pollen and spore content of marmot feces collected in the Mount Washington area, Vancouver Island. With the exception of incidental conifer ingestion, main pollen types were derived from non-arboreal plants associated with open environments.

May samples were dominated by Ericaceae pollen, including blueberry/huckleberry (*Vaccinium* spp.) and possibly kinnikinnick (*Arctostaphylos uva-ursi*) (Fig. 2). June samples were characterized by extremely high Ericaceae pollen concentrations, probably because marmots ate flowers of red heather (*Phyllodoce empetriformis*)[1]. July samples contained numerous Liliaceae pollen grains that strongly resemble false hellebore (*Veratrum viride*)[2]. Rosaceae and Cyperaceae pollen types dominate the August fecal sample. Rosaceae pollen is likely from partridge-foot (*Luetkea pectinata*), a ubiquitous low-growing sub-shrub of the alpine and subalpine zones.

Changes in the Landscape

To assess the impact of historic habitat changes on marmots, we conducted a high-resolution paleoecological study of wetland sediments adjacent to the summit of Heather Mountain, a site where marmots live today. The base of Heather Mountain is located at the northwestern end of Lake Cowichan, on Vancouver Island (Fig. 1). The sampling location was in the Mountain Hemlock biogeoclimatic zone, described in Meidinger and Pojar (1991).

We used relative pollen and spore percentages and radiocarbon dates to reconstruct the historic plant assemblages of this area. The presence or absence of forested vs. open vegetation was inferred on the basis of the relative abundance of mountain hemlock (*Tsuga mertensiana*) and true fir (*Abies* spp.) compared to alder (*Alnus* spp.), an indicator of disturbances, and non-arboreal types such as Poaceae and members of the Asteraceae family, which we used as meadow indicators.

Forested vegetation had a strong negative relationship with alder (n = 34, r^2 = -0.814, P = 0.000) and meadow vegetation (n = 34, r^2 = -0.627, P = 0.000). A strong positive relationship was detected between alder and meadow vegetation (n = 34, r^2 = 0.613, P = 0.000), indicating that disturbance agents are correlated with the renewal of meadow ecosystems (Fig. 3).

A preliminary pollen diagram indicates that eight times in the last 2000 years open plant communities dominated the landscape. Preliminary analysis suggests that meadow/open parkland or transitional environments prevailed throughout approximately 78% of the sampling interval, with high percentages of alder suggesting that this ecosystem was maintained by disturbances, likely fire. Heavily forested plant communities, which predominate today, occurred only 22% of the time.

[1]Currently, the BC Species and Ecosystems Explorer (September 2004) lists this species as pink mountain-heather.
[2]The BC Species and Ecosystems Explorer (September 2004) now lists this species as Indian hellebore.

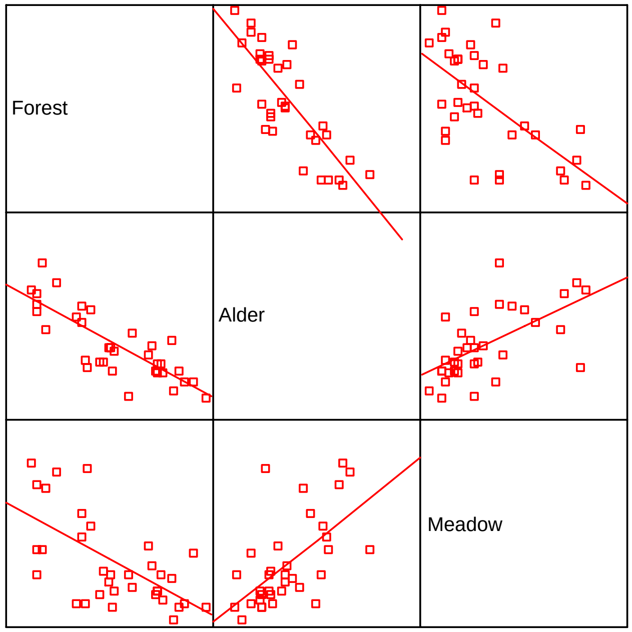

Figure 3. Scatter-plot matrix of forest, alder, and meadow pollen, analyzed from Heather Mountain, Vancouver Island. Forest pollen correlated negatively with alder and meadow vegetation; alder and meadow pollen were positively correlated.

Future Work and Conclusions

Fecal analyses merit further study. Our results illustrate the importance of open heather and meadow habitats to marmot diet. Originally, our interest focused on forb- and grass-dominated ecosystems, which are reported as constituting critical marmot habitat (Martell and Milko 1986). Though our paleoecological results show that such communities have been much more abundant in the recent past, preliminary fecal analysis points to a wider use of the landscape for food. A systematic study of seasonal pollen variability within feces would complement foraging observations made in the field.

Disturbances, such as fire, likely played an important role in maintaining marmot habitat. Preliminary work in various historic marmot localities indicates that charcoal, an indicator of fire, is abundant throughout some of the samples. It is critical to determine the ecological role of fire in the past because of its potential application in managing future marmot habitat. It is particularly important to understand the effects of fire in comparison to logging as a disturbance agent, especially as marmots have not faired well in logged areas (Bryant 1996).

Results from Heather Mountain suggest that the decline in the extent of suitable habitat may have been a significant contributing factor to marmot population decline. Subalpine landscapes on Heather Mountain were much more open during the last two millennia than today, and were likely a complex mosaic of forested, transitional, and meadow plant communities.

This study is part of a larger investigation of historic marmot habitat in subalpine environments on Vancouver Island. Additional analysis of fecal samples collected from present-day and past marmot localities will be completed to provide a more complete picture of historic habitat changes and the possible implications of climate change.

Acknowledgments

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