A description of the research project. If it is not obvious, state how the research is Quaternary-related (2 pages maximum [not including figures or reference list], single-spaced with a minimum of 11 pt font).

Fossil Cuticle Analysis of Graminoid Foliage in Beringia

The use of a well-described biological proxy for climatic and ecological conditions of the past has become instrumental in resolving the makeup of former terrestrial environments. The long-running correspondence of botanical species with their respective habitat type has provided paleo-inferences derived from fossil plant remains. I propose expanding the knowledge of Beringian paleoecology by identifying late-Pleistocene grasses and sedges to infer physical and ecological details of the past.

During lower sea levels of the last glaciation (75,000-12,000 calendar years before present; cal. yr BP) (Brigham-Grette 2001) Beringia supported a novel association of plants that is unrepresented in modern ecosystems (Hopkins 1982). A vague taxonomic view of this biome has caused this vegetation to be the target of considerable speculation regarding the local heterogeneity of floral communities in response to regional climate, edaphic and herbivore controls (Hopkins 1982 , Guthrie 1990, Elias et al. 1997) As a result, provocative debates and theories surround Beringia including the potential for warmer summer conditions in the sub arctic at the onset of a global glaciation (Elias et al. 1997, Kienast et al. 2005), regional variability of habitat quality for grazing herbivores (Guthrie 2001, Elias and Crocker 2008), and the causes of a highly productive and diverse ecosystem prevailing at high-latitudes (Guthrie 1990, Zimov et al. 1995). A detailed taxonomic account of the dominant primary producers (i.e. plants) in the past vegetation would provide a more informed discourse of Beringian issues.

Fossil evidence indicates grasses and sedges (graminoids) were the ecological keystone of Beringian vegetation by thriving in frequently disturbed soils and supporting a diverse assemblage of grazing mammals (Guthrie 1990, Anderson and Brubaker 1994, Ager 2003). Identification of fossil graminoids could significantly advance the understanding of Beringian paleoecology, however traditional techniques such as fossil pollen analysis has provided an indistinct makeup of Pleistocene vegetation because graminoid pollen can only be identified to family (e.g. Anderson and Brubaker 1994). High-latitude graminoid species are diverse in their habitat preferences, occurring in semi-aquatic to arid conditions (Hulten 1968) which makes fossil “grass” or “sedge” pollen vague in it’s ecological meaning.

Ancient plant remains (macrofossils such as seeds) buried and preserved in paleo soil surfaces and arctic ground squirrel (*Spermophilus parryii*) burrows have provided more detailed accounts (i.e. species) of local vegetation from Beringia’s vegetation (Fig 1; Goetcheus and Birks 2001, Zazula et al. 2005, Zazula et al. 2007). Fossil graminoid identification for these macrofossils have relied on the presence of seeds that are often shed or consumed prior to preservation. For instance, Goethchus et al. (2001) found *Kobresia myosuiroides* (sedge) seeds to predominate central Beringian paleoturfs dating to the LGM. However, fossil pollen deposited on the same turf indicates grasses were also abundant in the local area but are not represented in the macrofossil accounts. All late Pleistocene fossil plant assemblages are abundant in graminoid foliage, and with proper techniques can be identified to elaborate on the environmental inferences of pollen and seeds.

Plant cuticles, made up of unique polymers and waxes, encase the cell walls of leaves, and, in favorable taphonomic conditions, resist desiccation over geologic time (Martin and Juniper 1970, Wooller et al. 2000, Wooller et al. 2003). Much like macroscopic traits in botany, cell walls display microscopic characteristics consistent with taxonomic classification (Fig 2; Metcalfe et al. 1960, Martin and Juniper 1970, Palmer et al. 1981). With qualified inspection of modern and fossil cuticles, subfamily levels can be identified in the grass and sedge families, greatly enhancing vegetation histories (Ficken et al. 2002). For instance, grass cuticles preserved in lacustrine sediments indicate dynamic disturbance regimes, climatic forces and grassland composition in East Africa (Wooller et al. 2003, Street-Perrott et al. 2007).

A Beringian photo-reference guide of cuticle features for 38 graminoid species from eastern Beringia has recently been developed for identifying fossil graminoid foliage (Gaglioti and Wooller, in prep). These 38 species proved to be common in Beringia during the mid and late Wisconsin period (the period of the fossil sites discussed above) by their seed presence and/or abundance in modern analogues of Beringian vegetation (Hopkins 1982 , Yurtsev 2001, Swanson 2006, Zazula et al. 2007). The guide has proven to be a viable identification tool for fossil foliage (e.g. Fig 3). The species list in the guide is not exhaustive for steppe-tundra, however it does encompass nearly all genera that presumably occurred there. These genera display sub-family characters that can be narrowed down to the species as the modern guide is also being expanded. Scanning electron microscopy has been used for this and other guides (e.g. Palmer et al 1981), and due to the minute epidermal features unable to be observed with compound light microscopy, the SEM is the optimum tool for fossil identification as well.

The goal of this work is to identify fossil graminoid leaves derived from a paleoturf retrieved from the Fox Permafrost tunnel (~30,000 cal. yr. BP; Wooller et al. in prep.) and squirrel nest material from near Dawson City, Yukon Territory (25,000-35,000 cal yr. BP; Zazula et al. 2007). Forty separate leaf fragments from each site will be mounted, scanned and identified using the SEM. Fossil samples will be taken, washed in deionized water, freeze dried, and gold palladium coated as a standard preparation for the SEM in the Advanced Instrumentation Lab (AIL). SEM images will be taken at 100-2,000x magnification and compared and identified with the modern database of images.

Environmental inferences made from the results of this work will be based on modern habitat preferences for the species found (e.g. Hulten 1968, Cody and National Research Council of Canada. 2000). Local environmental conditions such as moisture, temperature, substrate, disturbances and community type will be inferred based on results. In addition a literature survey of forage quality of found species will indicate nutritional variability for herbivores at site locations. Conclusions will be compared with other paleoecological information from Eastern/Central Beringia. Inter-site results will be used to judge the variability of local vegetation at specific sites and times. Site comparison of species composition in macrofossils will test the hypothesis of Swanson (2006) regarding the proposed graminoids dominating eastern Beringia. I have already received training for proficiently running the Advanced Instrumentation Laboratory’s (AIL; located at UAF) SEM, however am in need of funding for operation time to identify fossil foliage. All other portions of this work is in line for implementation (i.e. C14 dates, sampling, and training) making it a feasible and suitable study for the fellowship award.

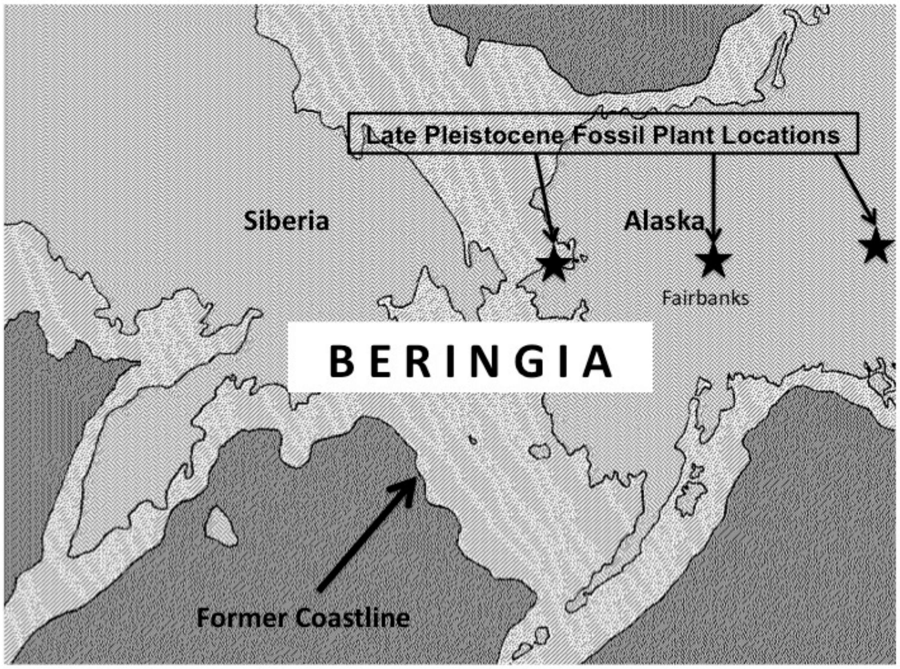

Figure 1 Map of Beringia with fossil plant locations from left to right Seward Peninsula site (~18,000 cal yrs. BP), Fox Permafrost Tunnel (~30,000 cal. yrs. BP) and Squirrel Nest location (~25-35,000 cal. yrs. BP).

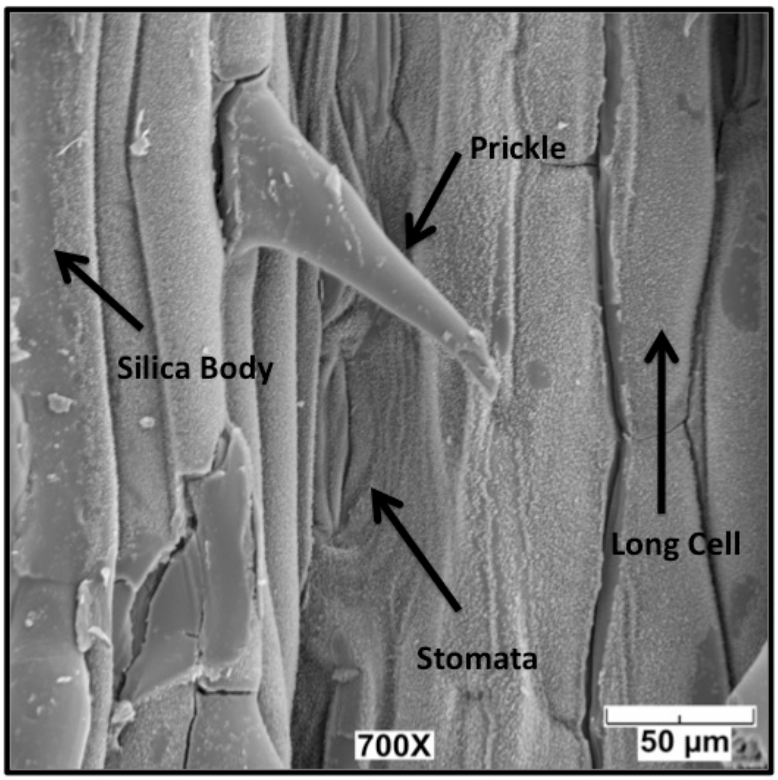

Figure 2 Closeup SEM image of modern leaf displaying cuticle features used for fossil identification.

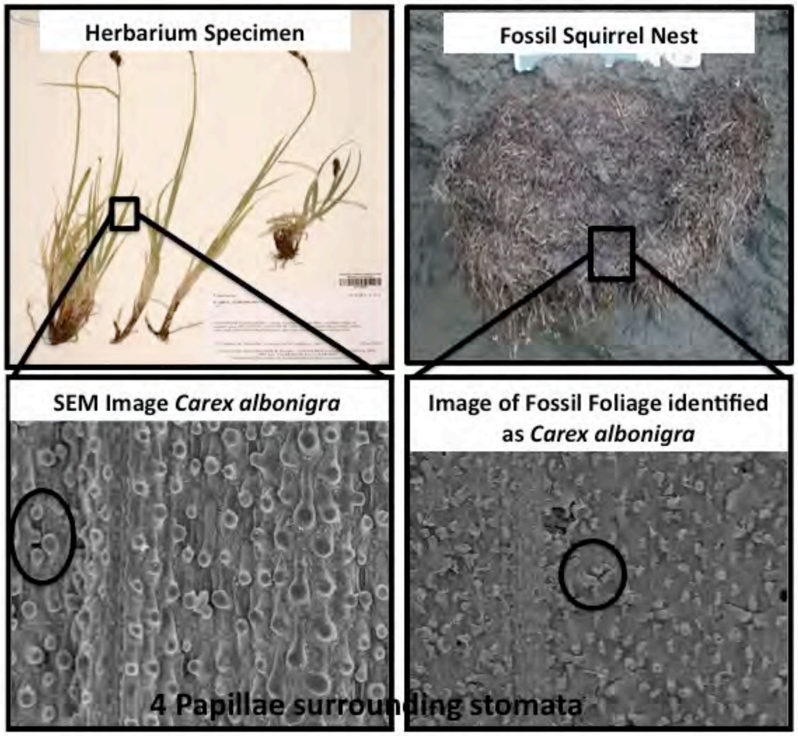

Figure 3 Modern herbarium specimen of *Carex albonigra* with corresponding SEM image (left) compared to a SEM image of fossil nest marerial (right) from ~30,000 cal yrs. BP displaying the same distinct feature of 4 papillae overarching stomata. No other modern specimen in the reference guide exhibits these characters.

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Research Interests:
Paleoecology of high-latitude terrestrial ecosystems, especially details of Beringian vegetation at a regional scale. I am investigating this topic by alternating research between modern and paleoecology for a better understanding of long-term change's implications in the north.

Education:
2008-Present. Pursuing a Masters of Science degree at The University of Alaska Fairbanks,Biology and Wildlife Grad Program.
2007. Field Course in Arctic Science offered by University of Alaska Fairbanks.
-This was a 3 credit field course at Toolik Lake Research Station on the North Slope of Alaska. Sections of the class included Permafrost, Snow Ecology, Hibernation, Climate Change, Mammal Ecology.
2003-2007. Bachelors of Arts Degree in Circumpolar Studies from The Center for Northern Studies at Sterling College, Craftsbury Common, VT.
-Sterling is a small liberal arts college with an environmental focus, exposing students to both traditional and experiential education. Here I have focused on Boreal Natural History, and Paleoecology, as well as the social sciences of the North.
2006. Senior thesis study at Northern Arizona University's Laboratory of Paleoecology, Flagstaff, AZ. Study titled: "*Modern Pollen and Vegetation Relationships along an Elevation Gradient in Northern Arizona*."
2002. High School Diploma, Cleveland Heights High School, Cleveland Heights OH

Student Awards:
2008. Advanced Instrumentation Laboratory- Seed Grant Award to produce SEM images and a data base of modern grasses and sedges from Alaska.
2008. Institute of Arctic Biology Summer Graduate Student Research Fellowship, UAF.
Conference Presentations:
2009. Arctic Workshop Conference, Oral Presentation: New Accounts of Beringia's Steppe-Tundra: Technique Developments.
2009. Arctic Workshop Conference, Poster Presentation: A Scanning Electron Microscope Guide of Grass and Sedge Cuticle Micromorphologies From Eastern Beringia.
Relevant Experience:
2009 to present. Research Assistant with Dr. Matthew Wooller, Alaska Stable Isotope Facility.
2003-2006. Botany Technician, Cleveland Museum of Natural History Botany Department, Cleveland, OH.
2008. Teaching Assistant for Wildlife Management Techniques (Wildlife 310), Professor Falk Heuttmann, University of Alaska Fairbanks, Fairbanks Alaska 2008.

Budget

Please include an itemized budget and budget justification being as detailed as possible (add or delete rows as needed):		
Description	**Amount**	**Source of Funding**
SEM Instrument Time (25 hours)	$1,200.00	Hopkins Fellowship
SEM Instrument Time (100 hours)	$4,500.00	Pending CGC, and IAB Fellowships.
Amount requested from AQC (max $1200)	**$1,200.00**	**Hopkins Fellowship**
TOTAL Project:	**$5,700.00**	

Budget Justification (use as much space as needed):

SEM instrument time is $45.00 per hour (Source: http://www.uaf.edu/AIL/services.html). Which makes ~26 hours from this funding source. **I would like to note that regardless of pending funding sources (CGC and IAB Fellowships) I would be able to produce a significant amount of data from the funds of the Hopkins fellowship award as a sole funding source.**