MID-WISCONSINAN CLIMATE RECONSTRUCTION BASED ON FOSSIL BEETLES FROM SIX MILE CREEK, ITHACA, NEW YORK

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

The history of the Mid-Wisconsinan sub-stage in northeastern North America is one of large climatic oscillations. Fossil beetles were extracted from two horizons at the Six Mile Creek site, New York. A total of 738 individuals was identified, representing 16 species. The beetle fossils, as well as those of plants, indicate a range of habitats from well-drained uplands to moist boggy lowlands, indicative of a tundra environment. A modified Mutual Climatic Range (MCR) method was used for the paleoclimatic reconstruction. SAS and ArcGIS programs were used to construct 95% confidence ellipses from which mean July temperature was inferred to be in the range of 8.7 ºC to 11.4 ºC and mean January temperature in the range of -24.6 ºC to -15.3 ºC. The estimated mean July temperature is 9.0 °C to 11.7 °C cooler than in central New York State at present.

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I express my gratitude to my advisor Dr. Allan Ashworth for giving me the opportunity to pursue my dream of graduate studies, for providing samples, and for his technical help. I also thank Dr. Daniel E. Karig, Professor Emeritus, Department of Earth and Atmospheric Sciences, Cornell University for providing me samples that he collected from the Six Mile Creek valley.

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DEDICATION

I dedicate this thesis to my mother-in-law, late Mrs. Jamuna Devi Shrestha, who inspired and encouraged me in every step of my life.

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INTRODUCTION

The objective of the research is to quantify the paleotemperature of Mid-Wisconsinan-aged deposits at Six Mile Creek, Ithaca, New York using fossil beetle assemblages. Previously, a preliminary investigation had reported a tundra environment and mean summer temperature of 10 – 12 ºC (Ashworth and Willenbring, 1998). In this study, the fossils identified by Ashworth and Willenbring (1998) were included in the analysis. Additionally, new materials collected by Dr. Allan Ashworth but unused in the previous study, as well as new materials collected by Dr. Daniel Karig, Cornell University, New York, were used in the study.

New samples were processed, fossils isolated, and beetle species identified. Geographic information for each species identified as a fossil was compiled. For each location, pertinent physiographic and climatic information were obtained from modern climatic data sets to provide a base for paleoclimatic interpretation. The data were analyzed using a modified Mutual Climatic Range (MCR) approach using statistical routines within SAS and ArcGIS 10.1.

1. BACKGROUND AND LITERATURE RESEARCH

1.1. Paleoclimatic Proxies

Numerous types of proxy records, such as stable isotope data from ice cores, pollen from lake sediments, and planktonic Foraminifera from deep ocean cores have been used to infer past climate and environment (Lowe and Walker, 2015a). Ice core data have been used to obtain a continuous profile of $\delta^{18}O$ to infer past climate (Dansgaard et al., 1993, Augustin et al., 2004, Blockley et al., 2012). Tests of planktonic Foraminifera from deep ocean sediments have also been used to obtain profiles of $\delta^{18}O$ (Bond et al., 1993, Mudelsee and Raymo, 2005, Nace et al., 2014). Several other biological records have also been used as proxies to infer past climate and environmental changes, such as packrat middens (Thompson and Anderson, 2000), tree rings (Evans et al., 2013), and pollen (Bartlein et al., 2011).

Because insects are highly abundant and diverse, insect fossils can likewise be expected to occur in diverse fossil assemblages, which may make insect fossils important proxy data for the study of paleoclimate (Elias, 1994). Further, because of short life spans of insect species (e.g. compared to that of trees; fossil tree pollen may also be used as proxy data of paleoclimate), insect fossil data can help minimize time lags between environmental change and population adjustment to new conditions.

1.2. Fossil Beetles as Paleoclimatic Indicators

Beetles are robust insects. They make good fossils due to their heavily sclerotized exoskeletons (Ashworth, 2001, Smith et al., 2006). The most studied parts of beetle fossils, heads, pronota, and elytra, are made of chitin, a nitrogenous polysaccharide, which is stable in anaerobic environments (Ashworth, 2001). Pioneering work of Russell Coope in using fossil beetles in paleoclimatic reconstructions (Coope, 1970, Coope, 1977) led to their widespread use.

Several characteristics make fossil beetles an ideal form of biological proxy to reconstruct Quaternary terrestrial environments. Beetles are the most abundant and diverse of insects. More than 357,000 species of beetles are already identified (Bouchard et al., 2009), which is about 25% of 1.5 million species so far identified for the Earth (Stork et al., 2015). Beetles occupy almost every ecological habitat on land and fresh water. As ectotherms, beetle lifecycles are related to environmental temperatures (Ashworth, 2001, Colinet et al., 2015). This, combined with their high mobility in response to environmental change, makes study of their fossils suited to detect sudden climatic changes. Because many beetle species have narrow physiological tolerances, beetle fossils provide excellent environmental and paleoclimatic indicators (Elias, 2007). For example, *Diacheila polita*, *Amara alpina*, and *Helophorus glacialis* are found in cold climates, while *Bembidion grisvardi*, *Onthophagus massai*, and *Scolytus koenigi* are warm-adapted species (Epstein et al., 1998).

Perhaps the most important of all the characteristics of Quaternary fossil beetles data is that of species constancy (Ashworth, 2001, Coope, 2004). If fossils are from extinct species, their climatic and ecological requirements can only be guessed, rendering paleoclimatic interpretation difficult. Beetles demonstrate remarkable species constancy so that modern climatic data can be used to estimate paleoclimatic conditions.

As ectotherms, beetles are sensitive to the environment (Paaijmans et al., 2013) and respond to any climatic changes by dispersing to new places with suitable climatic conditions. Data from fossils from various parts of the world have provided evidence of large-scale dispersal of beetles in response to climatic oscillations, such as in Europe (Coope, 1973), North America (Schwert and Ashworth, 1988, Elias, 2015), South America (Hoganson and Ashworth, 1992), and Australia (Porch et al., 2009).

1.3. Mid-Wisconsinan Sub-stage in the Quaternary Period

1.3.1. Wisconsinan Glaciation

The duration of the Wisconsinan glaciation occurred between 75 to 10 kyr BP (Fulton et al., 1986), 115 to 21 kyr BP (Kleman et al., 2010), and ≈80 to 11.7 kyr BP (Syverson and Colgan, 2011). Generally it corresponds to marine isotope stages (MIS) 2–4, but may also include MIS sub-stages 5a to 5d (Lowe and Walker, 2015b, Karrow et al., 2000). Several episodes of glacial advances and retreats occurred during the Wisconsinan (Braun, 2004, Bromley et al., 2015). Also, the fossils of this stage are better preserved, and age relationships are better known than those of earlier Pleistocene stages. During the Wisconsinan stage, the Laurentide ice sheet advanced southward from northeastern Canada, and it covered the central region of New York State (Muller and Calkin, 1993). At its maximum extent, the ice reached northern Pennsylvania about 20 kyr BP (Muller and Calkin, 1993, Braun, 2004). The Wisconsinan is divided into three sub-stages in North America – Early, Middle, and Late Wisconsinan (Dreimanis and Karrow, 1972).

1.3.2. Mid-Wisconsinan Sub-stage

The Mid-Wisconsinan sub-stage spanned from 65 to 25 kyr BP (Dreimanis and Karrow, 1972). During this sub-stage, the margin of the Laurentide ice sheet retreated from southern to northern Canada in the Great Lakes region (Clark and Lea, 1986, Dredge and Thorleifson, 1987, Clark et al., 1993, Szabo and Chanda, 2004). As a result, most parts of the Great Lakes region were ice-free during the Mid-Wisconsinan sub-stage. Such changes in ice sheet coverage led to the shift in the composition of fossil beetle assemblages such as reported from Titusville, Pennsylvania (Cong et al., 1996).

The Mid-Wisconsinan sub-stage is a period of climatic oscillations (Fréchette and de Vernal, 2013, Heusser et al., 2015) divided on the basis of glacial stratigraphy – the Plum Point Interstade (25 – 32 kyr BP), the Cherrytree Stade (32 – 40 kyr BP), and Port Talbot Interstade (40 – 65 kyr BP) (Dreimanis and Karrow, 1972).

1.4. Six Mile Creek

Six Mile Creek is one of the tributaries of Cayuga Lake, which in turn is a part of high-level lakes collectively known as the Finger Lakes. It is situated in the west-central section of New York State (Figures 1 and 2). The Finger Lakes lie within the northern area of the Appalachian Uplands. The glacially eroded region that comprises the Finger Lakes was formed as a result of southward flowing ice from the Lake Ontario Lowlands encountering the higher terrain of the Appalachian Plateau (Clayton, 1965, Miller and Karig, 2010). The damming of the Finger Lakes is attributed to Mid-Wisconsinan ice spreading into the Allegheny Plateau (Muller and Calkin, 1993).

Glacial deposits at Six Mile Creek overlie Devonian-age deposits (Figure 3) (Miller and Karig, 2010, Karig and Miller, 2013). Within this part of the Appalachian plateau, there is evidence for at least four glacial advances (Miller and Karig, 2010). The most recent advance reached its maximum extent in most of northeastern North America about 21 kyr ago (Miller, 2009, Bromley et al., 2015).

Figure 1. The Finger Lakes and the surrounding physiographic region. The location of the Six Mile Creek site in relation to Cayuga Lake, and Ithaca.

Based on geomorphology, the Six Mile Creek valley is divided into upper and lower sections (Figure 2). The upper valley is higher in altitude and was oriented perpendicular to the north-south flow of glacial ice (Miller, 2009). The lower Six Mile Creek valley is lower in altitude, was parallel to the glacial flow, and thus was extensively scoured by ice that formed a trough (Figure 2). The upper valley was subjected to sub-glacial, glaciofluvial, glaciolacustrine, and post-glacial fluvial processes, while the lower valley was subjected to sub-glacial, deltaic, ice-contact, and glaciolacustrine processes (Miller and Karig, 2010).

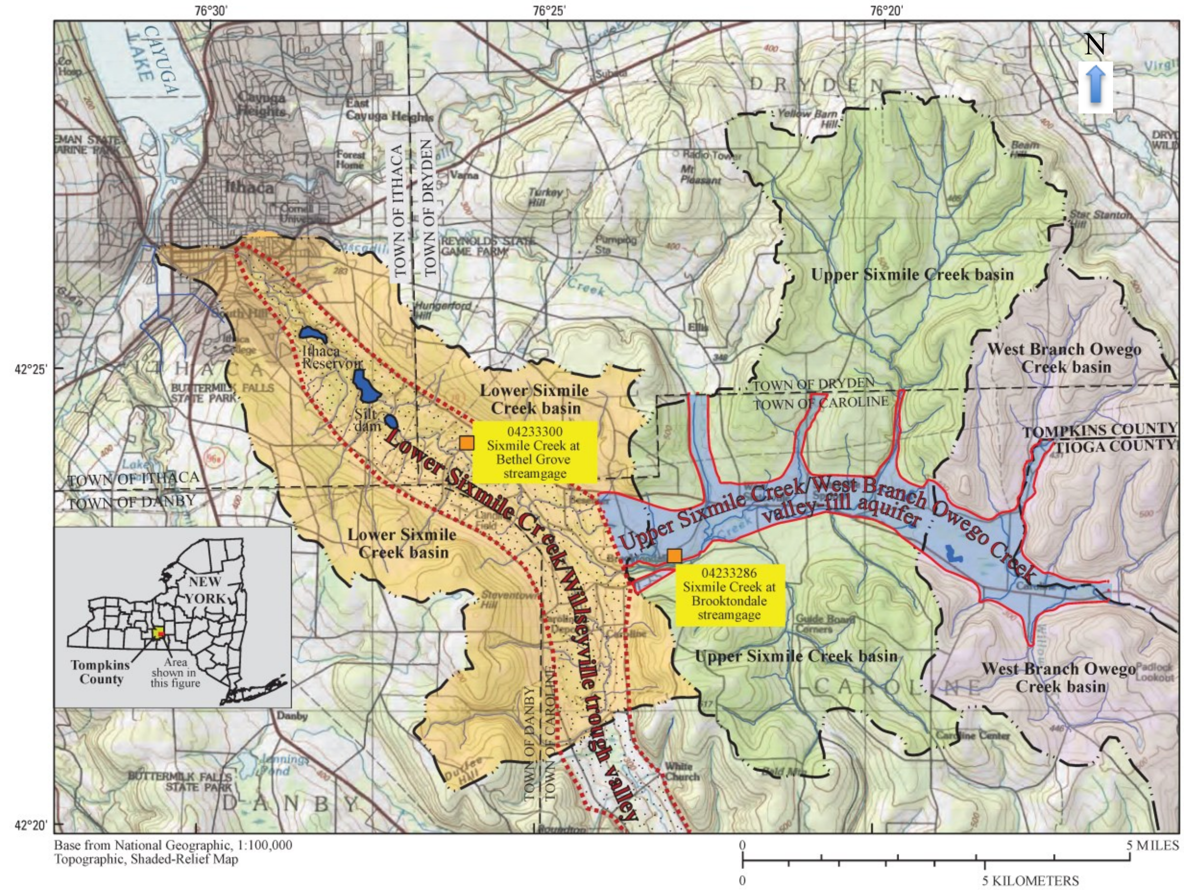


Figure 2. Orientation of the distinctive upper and lower Six Mile Creek valleys [Source: Miller, 2009; Figure courtesy of the U.S. Geological Survey].

Mid-Wisconsinan varved lacustrine clay sequences have been known to exist along the Six Mile Creek since the study of Schmidt (1947), who identified four series of Mid-Wisconsinan varved clay sequences. In a recent study, Karig and Miller (2013) divided the Six Mile Creek study area into four lithologic units, which are underlain by two lithologic units from Illinoian till and Devonian bedrock, respectively, and overlain by Late Wisconsinan till (Figure 3). Of these four Mid-Wisconsinan lithologic units, two (Unit 1 and 3) are dominantly clay-rich and one unit (Unit 2) consists of a sand and gravel unit containing exotic clasts. The remaining unit (Unit 4) consists of highly deformed sand, gravel and clay (Figure 3). For the purpose of my study, the lithologic divisions within the Mid-Wisconsinan follow those of Karig and Miller

(2013). Unit 1 is dominated by lacustrine clay, and is in part varved. Fossil plants and insects from organic beds within this unit have been analyzed in previous studies (Miller, 1996, Ashworth et al., 1997, Ashworth and Willenbring, 1998). Unit 2 is comprised of sand and gravel with a high fraction of exotic clasts that are roughly equant and round to sub-round, while local clasts are mostly tabular and less round (Karig and Miller, 2013). Strongly imbricated gravel clasts in the bedding with a low easterly dip, indicate flow from the west. Unit 3 consists primarily of lacustrine clay, but it contains gravels with very angular platy clasts, rounded cobble gravels with exotic clasts, and thin-bedded sands and silts. The exotic clasts indicate a glacial derivation. Unit 4 is a deformation till, mainly comprised of coarse-grained sand, with large irregular masses of silt, red clay, and gravel. Karig and Miller (2013) associate the formation of the deformation till with the advance of ice from the northwest which deformed sediments deposited in front of the ice margin (Karig and Miller, 2013).

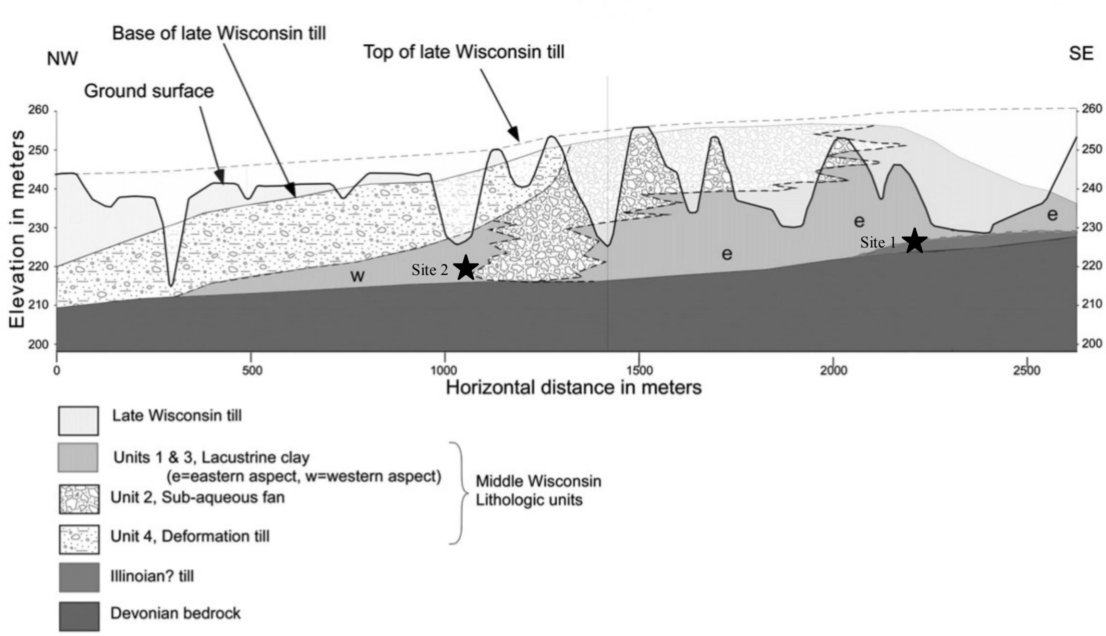


Figure 3. Longitudinal geologic section of the Mid-Wisconsinan deposits of Six Mile Creek, illustrating four Mid-Wisconsinan lithologic units. Symbol 'e' represents eastern aspect; symbol 'w' represents western aspect. Star symbols indicate Site 1 and 2. [Modified from Karig and Miller, 2013; base figure reproduced with permission].

1.5. Mid-Wisconsinan Chronostratigraphy of Northeastern North America

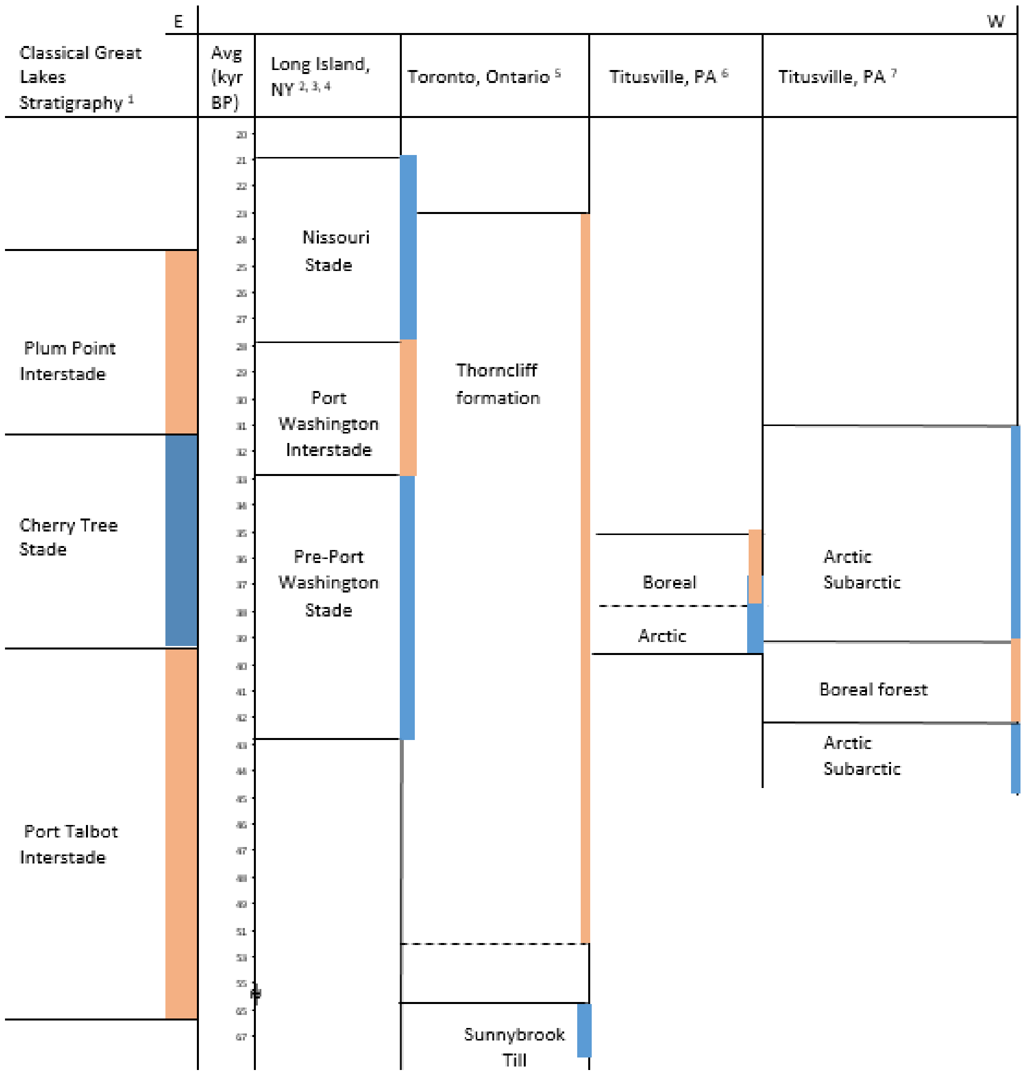
Ice advances and retreats characterize the history of the Mid-Wisconsinan in northeastern North America. During approximately 49 to 36.5 kyr BP, New York State and southwestern Ontario were ice-free (Young and Burr, 2006). However, by 35 kyr BP, the region was covered with ice (Mooers and Lehr, 1997).

Based on their investigation of the stratigraphic records and the apparent age of the glacial sequence on the western edge of the Finger Lakes region, Young and Burr (2006) concluded that the Mid-Wisconsinan ice advance was more than 30 km south of the Lake Ontario shoreline in west-central New York. Also, a study of proglacial lake sediments at the Novel Height site, Joffa, near St. Thomas, Ontario, showed the presence of glacial ice blocking eastern outflow from the Erie Basin during Mid-Wisconsinan time (Calkin and Barnett, 1990).

At its maximum extent, ice reached northern Pennsylvania about 23 to 24 kyr BP (Muller and Calkin, 1993, Mickelson and Colgan, 2003).

Mid-Wisconsinan chronostratigraphy based on various studies that used radiocarbon dating and other dating techniques, along with the classical interpretation of Dreimanis and Karrow (1972) for the eastern Great Lakes, is presented in Figure 4. In New York State, marine and freshwater sediments from the Long Island Platform provide evidence of climatic fluctuations (cold to warm to cold) during 43 to 21 kyr BP (Sirkin, 1991). Data from sand pits exposing peat, shells, and wood near Port Washington, Long Island, indicate a late Middle to early Late Wisconsinan succession (Sirkin and Stuckenrath, 1980, Sirkin, 1982). Using 29 radiocarbon ages, Sirkin and Stuckenrath (1980) constructed the following sequence:
(a) Nissouri Stade between 28 and 21 kyr BP, (b) Port Washington (Plum Point?) Interstade between 33 and 28 kyr BP, and (c) pre-Port Washingtonian (Nassauan) Stade between 43 and 33 kyr BP.

Studies of the lacustrine deposits containing detrital plant remains from Thorncliff Formation, Toronto, Canada, indicated Mid-Wisconsinan substrate, dated between 53 to about 39 kyr BP (Dredge and Thorleifson, 1987). The Thorncliff Formation rests on the Sunnybrook Till (Early Wisconsinan) and is overlain by Late Wisconsinan Halton Till (Dredge and Thorleifson, 1987). Thermoluminescence (TL) analysis of samples from upper sediments from the Thorncliff Formation yielded a TL date of 36 kyr BP (Berger, 1984). Based on conventional radiocarbon dates on peats and detrital organics, one AMS date, and a TL date of 36 kyr BP on the upper Thorncliff sediment, Dredge and Thorleifson (1987) suggested that interstadial conditions persisted between 47 and 23 kyr BP.



[1] Dremanis and Karrow (1972); [2] Sirkin and Stuckenrath (1980); [3] Sirkin (1982); [4] Sirkin (1991); [5] Dredge and Thorleifson (1987); [6] Berti (1975); [7] Cong et al. (1996)

Figure 4. Summary of Mid-Wisconsinan glacial and paleontological studies in eastern North America

1.6. Mid-Wisconsinan Climate Interpretation using Biological Proxies

1.6.1. Northeastern North America

Mid-Wisconsinan climate has been interpreted using various biological proxies such as pollen (Berti, 1975, Bajc et al., 2015), marine microfossils (Piper et al., 1978, Mudie and McCarthy, 2006, Mudie et al., 2010), plant macrofossils (Anderson, 1993, Anderson et al., 2000), vertebrate fossils (Shapiro et al., 2004, Burns, 2010), and beetles (Ashworth, 1979, Cong et al., 1996). Figure 4 summarizes some of the paleontological studies conducted in the northeastern North America using Mid-Wisconsinan biological proxies that are further described in the following paragraphs.

Pollen from the upper peat at Titusville, Pennsylvania, 35 and 39 kyr BP, indicates pine was dominant, while pollen from the lower peat (>37 and 40 kyr BP) indicates spruce was dominant (Berti, 1975). The shift in pollen was interpreted to indicate a shift from tundra forest to boreal forest (Berti, 1975). Fossil Coleoptera studies by Cong et al. (1996) indicate that from >37 and >42 kyr BP, the climate changed from arctic to subarctic. The fossil Coleoptera (40 kyr BP) were warmer adapted, indicating southern boreal forest. However, the beetle assemblages during 31 and 39 kyr BP indicate a return to forest-tundra vegetation and a subarctic climate.

At the Woodbridge site located west of the Humber River, Ontario, a dry, sparse tundra was present at 45 kyr BP (Karrow et al., 2001). Three coleopteran taxa were found at the Woodbridge site in the peaty lenses – a small carabid, *Trichocellus mannerheimi*; a rare weevil, *Vitavitus thulius*; and a staphylinid, *Tachinus*. *Trichocellus mannerheimi* has a circumpolar, high-northern and boreal-montane distribution from high altitudes in western North America. It is known to occur mostly on tundra, but also in the forest-tundra. The weevil *V. thulius* is a rare brachypterous weevil of dry tundra and steppe and is only known from Yukon and central Northwest Territories (Anderson, 1997). It has also been found in Mid-Wisconsinan samples from the Bell and Old Crow Basin in northern Yukon (Matthews Jr, 1975, Morlan and Matthews Jr, 1983). *Tachinus* is generally associated with leaf litter and/or animal droppings. Based on the habitat preferences of the taxa found, the Mid-Wisconsinan environment was inferred to be a dry, sparse tundra with a mean July temperature of about 10°C (Karrow et al., 2001).

Paleontological studies on the northwestern edge of the Allegheny Plateau, Ohio, indicate warm and cool climates during the Mid-Wisconsinan (Szabo, 1997). The deposits containing oak, ash and beech fossils indicate a warmer climate, while those containing spruce represented a cooler climate (Szabo, 1997).

Paleontological studies on Mid-Wisconsinan sediments from the Great Plains also indicate climate change (Baker et al., 2009). Studies from four locations that contained fossil plant indicated a change in habitat (Baker et al., 2009). At about 50 kyr BP, the upland vegetation of eastern Nebraska was prairie; between 39 and 37 kyr BP, scattered trees grew in mesic microhabitats in a parkland surrounded by prairie-like upland environment on the eastern plains. By about 29 kyr BP, spruce forest became widely established across the eastern Great Plains. At this time, spruce–sedge fens were the dominant wetland community (Baker et al., 2009). Sediments containing dwarf birch, spruce, and *Pinus* pollen are indicative of a forest-tundra environment deposited during a cool climate, while sediments containing oak, ash, and beech fossils are indicative of warm climate.

1.6.2. Previous Lithologic and Paleontological Studies at Six Mile Creek

Six Mile Creek deformation till has been correlated with 35 kyr BP till along the Genesee River that lies 125 km northwest (Karig and Miller, 2013). Based on the lithologic evidence, the authors suggested that the deformation till indicated the arrival of the ice front in the Finger Lakes region. Further, the coarseness of gravels interbedded with the lacustrine sequence indicated that the glacial margin was close to the Six Mile Creek site. They concluded that the ice advance was during the Cherrytree Stade. This glacial advance onto the Appalachian Plateau is much further south than has generally been accepted.

Earlier studies of plants and insects of Six Mile Creek associated with the Mid-Wisconsinan deposits (Miller, 1996, Ashworth and Willenbring, 1998, Karig and Miller, 2013) appear to be concentrated in the lithologic Unit 1 assigned by Karig and Miller (2013).

Preliminary investigations of fossil Coleoptera from Six Mile Creek, conducted in the Quaternary Entomology Laboratory of NDSU, indicated the presence of several species of tundra and arctic-alpine beetle species. The species included *Agonum quinquepunctatum*, *Carabus chamissonis*, *Diacheila polita*, *Pterostichus pinguedineus*, *Pterostichus ventricosus* (ground beetles), *Helophorus arcticus* (water scavenger beetle), *Olophrum boreale*, *Olophrum rotundicolle*, and *Eucnecosum brunnescens* (or *Eucnecosum brachypterum)* (rove beetles), and *Thanatophilus sagax* (carrion beetle) (Ashworth and Willenbring, 1998). None of these species occur in New York State today. However, these species are currently found inhabiting the tundra of Alaska and arctic Canada. A few species (e.g., *Carabus chamissonis* and *Pterostichus pinguedineus*) also inhabit alpine tundra on Mount Washington, New Hampshire, and other high peaks in New England and Quebec.

Age of the different stratigraphic units at Six Mile Creek are summarized in Table 1. The young age of 21,820 ± 390 ^{14}C yr BP is based on insect chitin, and is probably in error. Radiocarbon and corresponding calibrated ages (Stuiver et al., 2017) of various paleontological samples at Six Mile Creek are listed in Table 2.

Table 1. Age of different stratigraphic units at Six Mile Creek

	^{14}C yr BP		**Cal. yr BP**	
Unit 1	21,820 ± 390	43,000 ± 1,600	25,710 – 26,504 (26,112)	44,838 – 47,929 (46,398)
Unit 3	41,900 ± 900		44,455 – 46,043 (45,262)	
Sub-unit 3	40,100 ± 630	43,800 ± 4900	43,177 – 44,268 (43,744)	44,081 - [>50,000] (45,764)

Table 2. Radiocarbon ages and associated calendar years from plant macrofossils and beetles at Six Mile Creek site

Description of sample	^{14}C Age (yr BP)	Calibrated cal. year[1,2] (yr BP)	Source	Site description
Organic debris	>39,900		Bloom (1972)	Unit 1, Base varve series 1
Dryas integrifolia leaf	27,000 ± 360	30,832 – 31,264 (31,045)	Miller (1996)	„
Salix twig	33,900 ± 710	37,230 – 39,114 (38,209)	Miller (1996)	„
Beetle chitin	21,820 ± 390	25,710 – 26,504 (26,112)	Ashworth and Willenbring (1998)	„
Plant macrofossils	38,350 ± 980	41,738 – 43,151 (42,451)	Karig and Miller (2013)	„
9 *Salix herbacea* leaves	41,000 ± 1900	42,885 – 46,072 (44,623)	Karig and Miller (2013)	„
6 *Dryas integrifolia* leaves	38,790 ± 930	42,059 – 43,421 (42,780)	Karig and Miller (2013)	„
9 *Claytonia* seeds	43,000 ± 1600	44,838 – 47,929 (46,398)	Karig and Miller (2013)	„
Beetle chitin	34,510 ± 960	37,870 – 40,197 (38,948)	Karig and Miller (2013)	„
Conifer twigs	33,950 ± 220	38,246 – 38,715 (38,459)	Karig and Miller (2013)	Unit 1, Base varve series 4
Conifer twigs	35,190 ± 240	39,452 – 40,069 (39,751)	Karig and Miller (2013)	„
Plant macrofossils	37,200 ± 500	41,313 – 42,081 (41,672)	Karig and Miller (2013)	„
Picea wood	41,900 ± 900	44,455 – 46,043 (45,262)	Bloom (1972)	Unit 3
Plant macrofossils	42,300 ± 1500	44,241 – 47,092 (45,717)	Karig and Miller (2013)	Deposit below Unit 3
Plant macrofossils	43,800 ± 4900	44,081 - [>50,000] (45,764)	Karig and Miller (2013)	„
Dryas integrifolia leaves and *Salix* bud	40,100 ± 630	43,177 – 44,268 (43,744)	Karig and Miller (2013)	„

[1] Value in parenthesis indicates median probability value for one standard deviation; [2] Values obtained using CALIB 7.1, Stuvier et al. (2017)

1.7. Climate Reconstruction using Biological Proxies

1.7.1. Most Commonly Used Approaches in Paleoecology

In the last half-century, quantitative methods for reconstructing paleoclimate have used a range of biological proxies such as pollen, plant macrofossils, and insects, to name a few (Berti, 1975, Atkinson et al., 1987, Thompson and Anderson, 2000, Elias, 2015). Three basic approaches that are generally used to infer past climate using fossil biological proxies are (a) the indicator species approach; (b) the assemblage or analog approach; and (c) the multivariate calibration function approach. All these approaches employ a space-for-time substitution by using information about the modern climatic tolerances of the taxa found as fossils. For all the identified taxa, data are obtained by exploring the distribution of organisms in relation to environmental variables of interest (e.g., maximum summer temperature and minimum winter temperature) in the modern world as an analog to their expected distribution in relation to the environmental variable of interest in the past ('space-for-time' substitution) (Jackson and Williams, 2004). Also known as bioclimate-envelope modeling, the approach in paleoclimatic reconstruction involves representing the modern distributions of the representative taxa with contemporary climate variables (Birks et al., 2010).

In the indicator species approach, 'thermal limits' of a single species is used as the basis to infer past climate from fossil remains (Iversen, 1944). Atkinson et al. (1987) expanded on the concept of bioclimatic envelopes and developed the mutual climatic range approach (MCR). This method has been extensively used for fossil beetle assemblages (Atkinson et al., 1987, Elias, 1999), as well for plant macrofossils (Sinka and Atkinson, 1999) and pollen (Zheng et al., 2011). In this method, climate data correlated with geographic location of species are plotted with T_{max} (average July temperature) on the Y-axis and T_{min} (average January temperature) on the X-axis. For each species, T_{max} and T_{min} points for all the locations of their modern distribution are plotted that identify "climatic space" for the individual species. The resulting envelopes are then overlain to show the mutual climatic range for the selected species (Elias, 1994). Kühl et al. (2002) provided a potentially more rigorous approach using probability density functions (pdfs) for monthly mean July and January temperature, as bivariate ellipses conditional on the present day occurrence of the identified taxa. The strengths of the above methods are that they are simple to use, given reliable data on the modern distribution of the taxa and the climate. The weaknesses are that they only use the 'presence/absence' data without any weight of abundance to relate the species with the climate data. Also, the MCR method assumes a uniform probability of occurrence of a given taxa in the climate space, and the MCR method does not provide means for deriving model performance statistics (Birks et al., 2010). However, strengths of MCR probably outweigh the weaknesses, as manifested by its extensive use for beetles and macrofossils.

In the assemblage or analog approach, in contrast to the indicator-species approach, the fossil assemblage is considered as a whole along with the relative abundances of all the different fossil taxa, and not the 'presence' or 'absence' of a taxa (Birks et al., 2010). In recent years, the assemblage approach has evolved more quantitatively giving rise to the 'modern analog technique,' where a dissimilarity measure is used to numerically compare a fossil assemblage with modern assemblages (Overpeck et al., 1985). According to Birks et al. (2010), the weaknesses of this approach are that they are sensitive to spatial autocorrelation, data demanding, and in finding appropriate analogs. Another method under this approach is the 'response surface' approach, which involves the construction of modern taxon-climate response surfaces to summarize patterns of modern taxon abundances along major climate gradients

(Huntley, 1994). The limitations of the response surface approach are due to local fitting, and the difficulty in deriving unbiased estimates of model performance (Birks et al., 2010). Different methods using analog approach have been used for paleoclimatic reconstruction using plant macrofossils and pollen.

In the multivariate calibration-function approach, statistical models are used with global estimation of parametric functions for all the taxa present. In common with the assemblage approach, it considers modern quantitative assemblages at many sites. It links with the modern climatic data using linear or non-linear regression and calibration (ter Braak and Juggins, 1993). Some of the strengths of this approach are its robustness to spatial autocorrelation, global parameter estimation, and possibility to extrapolate to some degree, while its weaknesses are its sensitivity to sample distribution in modern data and the possibility of overfitting (Birks et al., 2010).

1.7.2. Use of GIS in Paleoecological Reconstructions

Little has been published about the direct use of GIS in paleoclimatic reconstruction using fossil assemblage data. Nevertheless, GIS has been used considerably as an aid in the overall investigation of paleoclimate. Whitmore et al. (2005) used GIS to identify spatial duplicates of pollen data in the development of modern pollen data for multi-scale paleoenvironmental applications. DeVogel et al. (2004), in their study of a GIS-based reconstruction of paleohydrology of Lake Eyre in central Australia, used GIS to virtually fill the lake from selective basins connected by channels or spillovers. GIS has also been used to calculate direct incoming solar radiation and mean annual air temperature using a digital elevation model (DEM) and meteorological data in the reconstruction of Younger Dryas permafrost distribution patterns in the Err-Julier area in the Swiss Alp (Frauenfelder et al., 2001).

Napieralski (2007) used GIS to test output from a numeric ice sheet model against a suite of geomorphic data to evaluate paleo-ice sheet evaluation. Gyllencreutz et al. (2007) used a GIS-based reconstruction to describe and document the deglaciation of the large ice-sheets in northwest Eurasia (Scandinavian, British-Irish, and Barents-Kara). For this, they compiled digitized ice margins and other published relevant information in GIS and coupled that to a database with dates (such as ^{14}C, clay-varve, etc). Kalm (2012) studied ice-flow pattern and extent of the last Scandinavian Ice Sheet southeast of the Baltic Sea using a GIS-based approach. Ice-flow pattern, ice streams and lobes, and ice-marginal positions in the area between the Last Glacial Maximum (LGM) and the Baltic Sea were reconstructed. Information on glacial landscapes, such as original maps, figures, sketches, and unpublished drawings were draped over a DEM and displayed against regional topography, whereby the results of glacial modeling results could be overlaid. Such information on spatial pattern and timing of deglaciation is useful to accurately reconstruct the ice sheet history which is subsequently important in paleoclimate modeling (Kalm, 2012).

For paleoclimatic reconstruction using fossil assemblages, GIS is mostly used to develop climate range distributions for each species using climate surfaces and the database of the present day distribution locations for each identified fossil species (Marra et al., 2006). Viau et al. (2008) reconstructed temperature and precipitation for the past 25,000 years in eastern Beringia using July temperature and precipitation anomalies.

2. MATERIAL AND METHODS

2.1. Sample Collection

Samples from Six Mile Creek study site containing peat and silt-bearing Mid-Wisconsinan sediments were collected from two sites at four different times. Figure 5 and Table 3 present the detail on the sample collection sites.

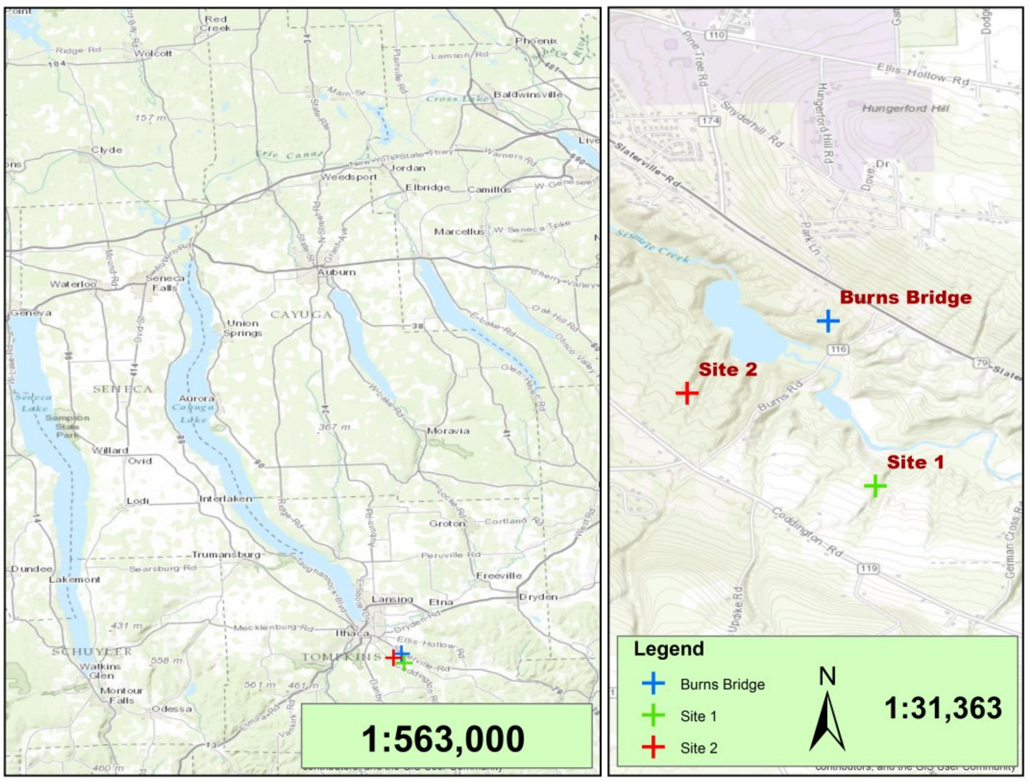


Figure 5. Sample collection sites at the Six Mile Creek study site.

Samples from a fossiliferous horizon in Site 1 (Figure 5) that consisted of a 2-3 cm thick peat layer within a varved lacustrine sequence (Unit 1, Figure 3) were collected during 1996 – 1997 by Ashworth and Willenbring. A preliminary study using some of these samples was also published (Ashworth and Willenbring, 1998). Unidentified fossil beetle parts from those samples were identified as a part of this study. Additionally, about 40 kg of peat and silt from Site 2 (Figure 5), collected by Daniel Karig (Professor Emeritus, Cornell University) in 2012 and 2013, was processed for fossil Coleoptera. At Site 2, samples were collected from pits dug through the colluvial cover (Figure 6) and have a mean AMS age of 41 to 43 ^{14}C kyr BP (Daniel Karig, pers. comm.). Sites 1 and 2 are about 1.5 km apart (Figure 5).

Table 3. Radiocarbon ages and associated calendar years of samples at the Six Mile Creek site

Site	Location	Collection year	Radiocarbon age (kyr BP)	Calibrated cal. year (kyr BP)	Collected by
Site 1	42º 24' 17.7 " N 76º 27' 0.3 " W	1996; 1998	34 – 39	38 – 43	Ashworth & Willenbring
Site 2	42º 24' 32.6 " N 76º 27' 50.9 " W	2012; 2013	41 – 43	44 – 46	Daniel Karig

Figure 6. Fossiliferous horizon at Site 2, Six Mile Creek, Ithaca, New York. Fossiliferous silt overlain by coarse gravel (Photographs courtesy of D. Karig)

2.2. Fossil Extraction and Preparation

The fossil beetles were separated from the sediment matrix using the flotation method described by Elias (1994). The sediments were boiled in water, and then mixed with sodium carbonate to help disaggregate clays. The sediments were then washed through a 300 μm sieve. Remaining sieve contents were transferred to a plastic bowl, covered with kerosene and hand stirred for about five minutes. After filling the bowl with cold water, the mixture was allowed to settle for fifteen minutes. The floating contents, which contained light chitinous material (beetle exoskeletons), other insects and mite carapaces, and plant material were decanted. The float was washed in detergent to remove the kerosene and stored in ethanol. Subsequently, the specimens were sorted under a binocular microscope, dried and mounted on micropaleontological slides using water soluble glue.

2.3. Fossil Identification

A total of 1,109 fossil beetle fragments were extracted from the sediments. The mounted specimens were studied microscopically to identify the fossils to various taxonomic levels. An example of fossil beetle parts used for identification is shown in Figure 7. Species identifications were made using modern specimens in the Quaternary Fossil Beetle Laboratory, Department of Geosciences, NDSU, and also using entomological keys, line drawings and images of either complete specimens or of prominent sclerites in the literature.

Non-Coleoptera insect parts were also identified as far as possible. Fossil plant materials were sent to Dr. Dorothy Peteet, Lamont-Doherty Earth Observatory, Columbia University for identification.

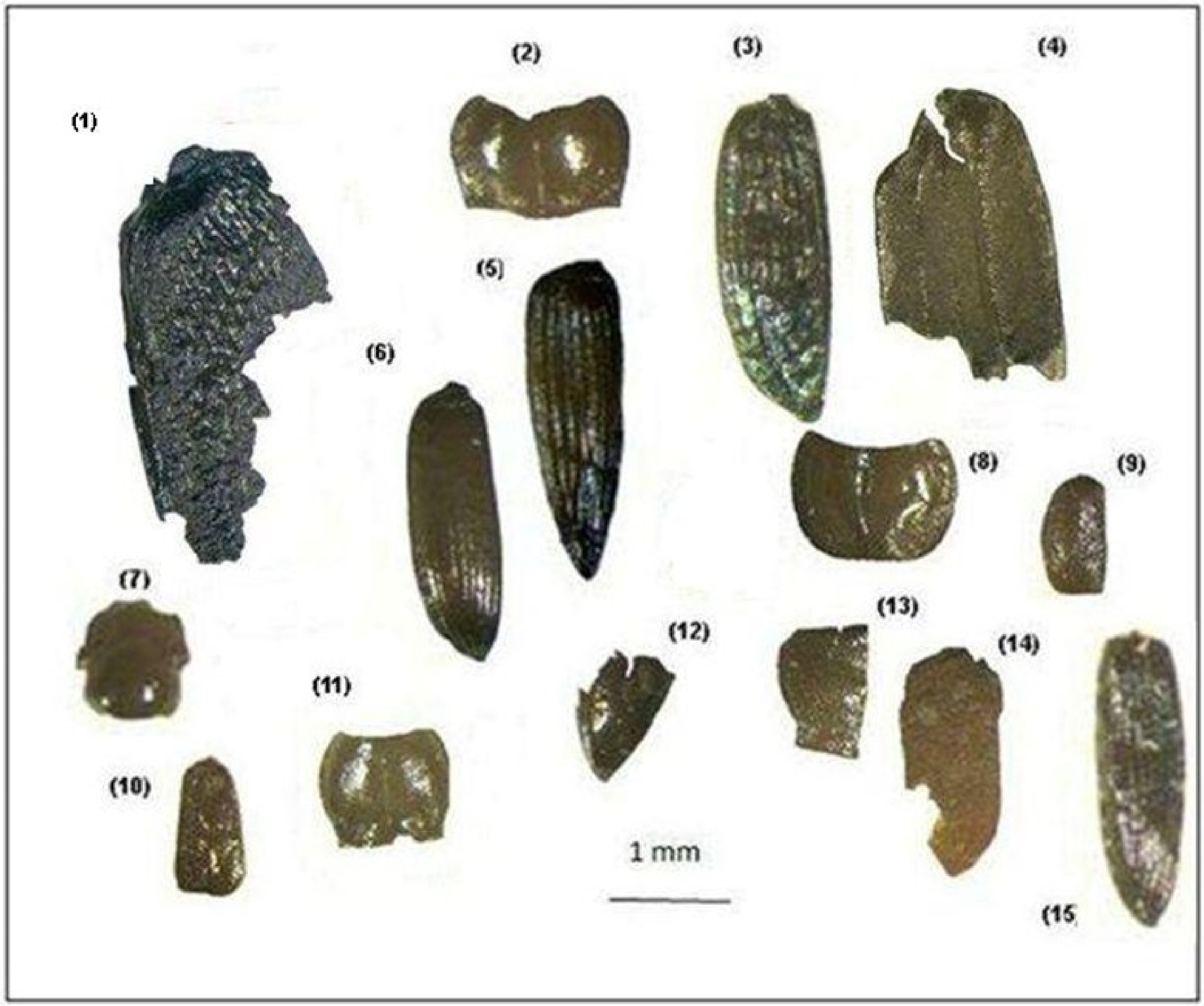


Figure 7. Some of the Coleoptera fossils used in the study. (1) left elytron, *Carabus chamissonis*, (2) pronotum, *Amara glacialis*, (3) left elytron, *Agonum quinquepunctatum*, (4) right elytron, *Thanatophilus sagax*, (5) left elytron, *Amara glacialis*, (6) left elytron, *Pterostichus pinguedineus*, (7) head, *Pterostichus (Cryobius) sp*., (8) pronotum, *Agonum quinquepunctatum*, (9) left elytron, *Olophrum sp*., (10) right elytron, *Olophrum sp*., (11) pronotum, *Pterostichus pinguedineus*, (12) elytron fragment, *Agabus sp*., (13) pronotum, *Diacheila polita*, (14) right elytron, Chrysomelidae gen.sp., (15) right elytron, *Diacheila polita*

2.4. Similarity Analysis of Site 1 and Site 2 Samples

A similarity analysis was used to see if specimens from the two sample sites represent the same or different faunal assemblages. The Dice coefficient was used for the analysis (Bergolc, 2004, Jackson et al., 1989). The formula to calculate the Dice coefficient is given below:

$$D = \frac{2a}{2a + b + c}$$

where,

D = Dice coefficient

a = number of species present in both units

b = number of species found only in unit one

c = number of species found only in unit two

A value of zero for the Dice coefficient indicates that the samples from the two sites are from completely different assemblages. A value of one, on the other hand, indicates they are from the same assemblage. Due to the possibility of some variation of species year by year in any given site, a value of one may be unlikely. To accommodate this variation, a value of 0.8 was adopted as the threshold to indicate similarity/dissimilarity (Bergolc, 2004). A value less than 0.8 indicated that the units were from separate assemblages. A value of 0.8 or higher indicated that the two units were from a related assemblage.

2.5. Paleoclimatic Analysis

Paleoclimatic reconstructions were made using sequential steps which started with assembling modern distributions for each Coleopteran species identified in the fossil assemblage. Modern distributions were obtained from the literature. Additional information was available online, from the E. H. Strickland Entomological Museum, University of Alberta. Also, data from the pinned specimens in the Quaternary Entomology Laboratory, North Dakota State University, were used. Modern distribution maps for the Six Mile Creek Coleoptera species were prepared in ArcGIS (Figures 8 through 23).

Climate data tables were constructed in Excel spreadsheets for each species (Appendices: Table A-1 through A-16). To accomplish this, meteorological stations were selected as close as possible to beetle collecting localities. For most localities, the distance of separation was tens of kilometers but for remote parts of the Arctic, the distances could be up to 200 km. Mean July and January temperatures were tabulated for each collecting locality. Corrections were made for differences in elevation between collecting locality sites and meteorological stations using standard adiabatic lapse rate.

The following relationship was used for the adiabatic corrections in the temperature data.

$$\textit{Corrected temperature} = \textit{Station temperature} \pm 0.005 \square \textit{elevation difference (m)}$$

Climate data for Canadian modern beetle location were obtained from Canadian Climate Normals, Government of Canada (http://climate.weather.gc.ca/climate_normals/index_e.html). These data are based on measurements from 1971 to 2000. For the United States, climate data were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) (http://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals). The NCDC means are based on a record from 1971-2000.

Two different approaches were used for paleoclimatic analysis. Both were based on the concept of Mutual Climatic Range (MCR) technique of Atkinson et al. (1987). The MCR method constructs a climatic envelope within which a species can theoretically survive. In this method, mean July temperature (T_{max}) is plotted on the Y-axis and mean January temperature (T_{min}) on the X-axis. Individual plots are overlaid to determine the mutual climatic range which is the area of overlap.

The first approach, a slightly modified method of original MCR was employed using SAS (Statistical Analysis System) to generate bivariate ellipses from bivariate scatter plots of the climate data (Rock, 2009). The SAS ELLIPSES macro was developed by Michael Friendly at

York University, Toronto (Friendly, 2011). Using this approach, the area formed by overlapping the ellipses represents the climatic envelope for the site.

The second approach used GIS software ArcMap 10.1 to analyze the data. The statistical tool called 'directional distribution' was used to analyze the selected features to generate the confidence ellipses. However, instead of summarizing the spatial characteristics of geographic features (which is more general in a typical GIS application), the function was instead used to analyze non-geographical features in the data set. Mean July temperatures and mean January temperatures for each of the species were used as bivariate variables.

The parameters to the function "DirectionalDistribution_stats" were (1) 'input feature class', (2) 'output ellipse feature class', (3) 'ellipse size', (4) 'weight field', and (5) 'case field'. The parameter 'input feature class' contains a distribution of features for which the spatial statistics are calculated. The parameter 'output ellipse feature class' contains the ellipse output feature, namely, the 'Standard Distance' that describes the compactness of the data points around their geometrical mean center. The standard distance provides values for X and Y directions, which define the major and minor axis of an ellipse that encompasses the distribution of features. The size of the output ellipse is based on one, two, or three standard deviations (68%, 95%, and 99% of the distributions, respectively) (Wang et al., 2015). In this study, a two standard deviation (95%) ellipse was used.

The overlapping area of the probability ellipses represents the climatic envelope, which was used to analyze the paleoclimate.

3. RESULTS AND DISCUSSION

3.1. Fossil Beetle Assemblages

The samples from locations 1 and 2 from the Six Mile Creek site probably come from two stratigraphic horizons. The sample from Site 1 dated between 38-43 kyr BP, and that from Site 2 between 44-46 kyr BP (Table 3). Site 1 and Site 2 samples are from eastern (lithologic Unit 1) and western (lithologic Unit 3) aspects, respectively (Figure 3). Both sites are from a lacustrine clay formation that represents the varved clay series 1 – a sequence of Mid-Wisconsinan varved clays first recognized by Schmidt (1947). From all samples, a total of 738 individuals were identified from representing 8 families, 21 genera, and 16 species (Tables 4 and 5).

Similarities between the two sites were analyzed using the Dice coefficient. The value for the parameter is shown in Table 6. The Dice coefficient was calculated to be 0.83. A value greater than 0.8 indicates that samples from the two sites represent the same assemblage. Hence it was concluded that both sites represent the same assemblage.

Carabids (ground beetles) are well represented in both sites in Six Mile Creek. Many members of the family are known for their predatory behavior and are regarded as sensitive indicators of climate change (Koivula, 2011).

Table 7 summarizes the habitat preferences of beetles identified in the Six Mile Creek fossil assemblage.

Hydrophilids and dytiscids are aquatic. Most of the remaining species identified in the samples may be classified as either water-marginal, such as *Bembidion sordidum* Kirby that prefers shady or gravely banks (Lindroth, 1966), or three species of *Olophrum* which prefer proximity to water bodies (Campbell, 1983).

Table 4. Coleoptera identified from Site 1 at Six Mile Creek (1997 sample)

Identified insect taxa	Skeletal Part				MNI
	h	p	le	re	
INSECTA					
COLEOPTERA					
Carabidae					
Agonum quinquepunctatum Motschulsky	0	9	4	3	9
Carabus chamissonis Fischer	0	0	3	0	3
Diacheila polita Faldermann	1	5	1	10	10
Pterostichus pinguedineus Motschulsky	0	3	0	0	3
Amara glacialis Mannerheim	0	1	1	1	1
Amara quenseli Schönherr	0	1	0	0	1
Bembidion sordidum Kirby	0	2	0	0	2
Bembidion spp.	1	8	13	15	15
Dyschirius spp.	0	4	12	12	12
Agonum sp.	2	2	7	3	7
Pterostichus (Cryobius) spp.	2	1	2	3	3
Pterostichus spp.	4	5	8	7	8
Staphylinidae					
Eucnecosum brachypterum (Gravenhorst) / *Eucnecosum brunnescens* (J. Sahlberg)	0	33	0	0	33
Eucnecosum spp.	0	0	25	24	25
Olophrum rotundicolle (C.R.Sahlberg)	0	4	0	0	4
Olophrum boreale (Paykull)	0	2	0	0	2
Olophrum latum Maklin	0	8	0	0	8
Olophrum spp.	0	0	18	15	18
Aleocharinae spp.	0	13	11	13	13
Stenus spp.	0	1	1	1	1
Tachyporinae sp.	0	0	1	0	1
Byrrhidae					
Byrrhidae gen. spp.	0	6	9	12	12
Hydrophilidae					
Helophorus arcticus Brown	2	2	2	4	4
Helophorus parasplendidus Angus	0	9	4	4	9
Helophorus spp.	1	2	1	1	2
Chrysomelidae					
Chrysomelidae gen. spp.	1	0	3	6	6
Dytiscidae					
Agabus bipustulatus Linnaeus	0	0	1	1	1
Curculionidae					
Curculionidae gen. spp.	0	1	2	1	2
Silphidae					
Thanatophilus sagax (Mannerheim)	0	0	0	1	1

h = head(s); p = pronotum(a); le = left elytron(a); re = right elytron(a); MNI = minimum number of individuals

Table 5. Coleoptera identified from Site 2 at Six Mile Creek (2013 sample)

Identified Coleoptera taxa	Skeletal Parts				MNI
	h	p	le	re	
Carabidae					
Agonum quinquepunctatum Motschulsky		4		1	4
Carabus chamissonis Fischer			2		2
Diacheila polita Faldermann		3		4	4
Pterostichus pinguedineus Motschulsky		2			2
Amara quenseli Schönherr		1			1
Bembidion sordidum Kirby		1			1
Stereocerus haematopus Dejan		1			1
Bembidion spp.			7	6	7
Dyschirius spp.			3	2	3
Agonum sp.		2	3		3
Pterostichus (Cryobius) spp.	1	1			1
Pterostichus spp.	1	2	7	6	7
Staphylinidae					
Eucnecosum brachypterum (Gravenhorst) / *Eucnecosum brunnescens* (J. Sahlberg)		5			5
Eucnecosum spp.			3	1	3
Olophrum rotundicolle (C.R.Sahlberg)		1			1
Olophrum boreale (Paykull)		1			1
Olophrum latum Maklin		1			1
Olophrum spp.			3	8	8
Aleocharinae spp.		2	5	6	6
Stenus spp.		1	1		1
Tachyporinae sp.			1		1
Byrrhidae					
Byrrhidae gen. spp.		1	1	2	2
Chrysomelidae					
Chrysomelidae sp.				1	1

h = head(s); p = pronotum(a); le = left elytron(a); re = right elytron(a); MNI = minimum number of individuals

Table 6. Analysis for similarity/dissimilarity between Site 1 and Site 2 using the Dice coefficient

Parameter	Value
Number of species present in both sites (a)	17
Number of species present only in Site 1 (b)	6
Number of species present only in Site 2 (c)	1
Dice coefficient: D = 2a/(2a+b+c)	0.83

Table 7. Summary of habitat preferences of beetles identified in the Six Mile Creek fossil assemblage

Species	**Habitat preferences**
Carabus chamissonis Fischer	Open, dry regions of tundra.
Agonum quinquepunctatum Motschulsky	Peat-boggy areas of tundra, taiga and boreal forest.
Diacheila polita Faldermann	Among sedges on moist and soft soils, and peaty soil of tundra.
Pterostichus pinguedineus Motschulsky	Under leaves near rivers with rich vegetation in tundra and taiga habitats.
Stereocerus haematopus Dejean	Usually on sandy soils on arctic tundra boreal forest habitats.
Amara glacialis Mannerheim	Flat, barren, dry, sandy banks of rivers with scattered vegetation of *Chamerion latifolium* on tundra to boreal forest habitats.
Amara quenseli Schönherr	A xerophilous species of tundra and the alpine zone.
Bembidion sordidum Kirby	Shaded river banks in tundra and forested habitats.
Eucnecosum brachypterum (Gravenhorst) *Eucnecosum brunnescens (*J. Sahlberg)	Margins of lakes and rivers in alpine tundra and boreal habitats.
Olophrum rotundicolle (C. R. Sahlberg)	*Carex* (sedges) and moss at the edges of the lakes, bogs in tundra, alpine and forested habitats.
Olophrum boreale (Paykull)	*Salix* (willow) and *Alnus* (alder) leaf litter in tundra, alpine and forested habitats.
Olophrum latum Mäklin	*Salix* (willow) and *Alnus* (alder) leaf litter in tundra, alpine and forested habitats.
Helophorus arcticus Brown	Tundra and taiga habitats.
Helophorus parasplendidus Angus	Tundra, alpine and forested habitats.
Thanatophilus sagax (Mannerheim)	Tundra and boreal habitats under carrion along shores of lakes and rivers.

Ecological information for each species is described in the subsequent paragraphs (e.g., Lindroth, 1961-69, Anderson and Peck, 1976, Campbell, 1983).

Agonum quinquepunctatum Motschulsky is an arctic species, known to inhabit bogs (Lindroth, 1966) (Figure 8).

Figure 8. Distribution map of *Agonum quinquepunctatum* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Amara glacialis Mannerheim occurs in the arctic and subarctic regions of North America. It inhabits flat, barren, sandy ba nks of rivers where the soil is dry, mostly with scattered plants of *Chamerion latifolium* (Figure 9) (Lindroth, 1968).

Amara quenseli Schönherr is a circumpolar species which occurs in xerophilous habitats (Lindroth, 1968) (Figure 10).

Figure 9. Distribution map of *Amara glacialis* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

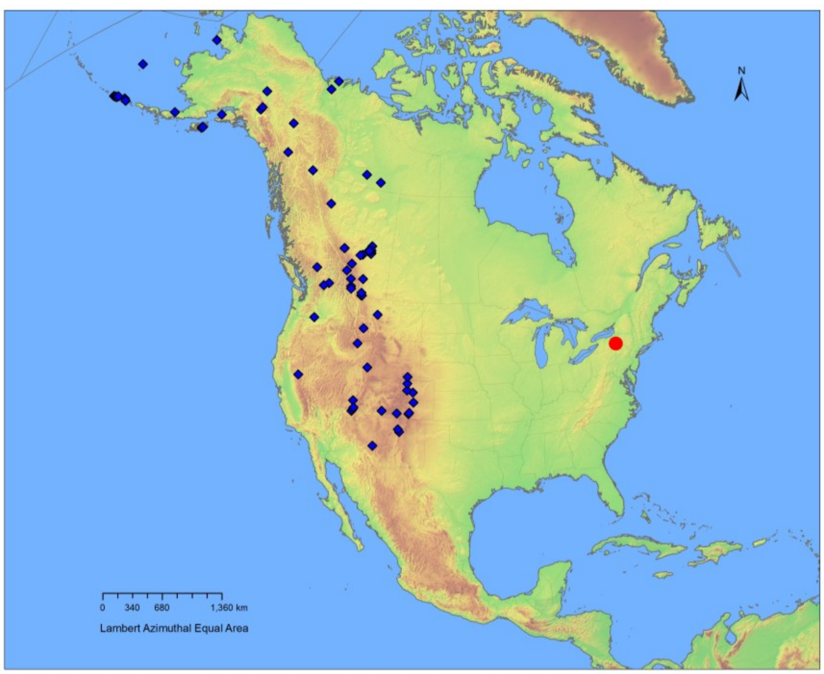


Figure 10. Distribution map of *Amara quenseli* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Bembidion is the most abundant species among the carabids found in the Six Mile Creek assemblage. Most species are hygrophilous, found near water with habitats ranging from gravel banks of rivers to marshlands. *Bembidion sordidum* Kirby was the only identified species from the assemblage. The species is confined to shaded river banks (Lindroth, 1963) with a geographic range shown in Figure 11.

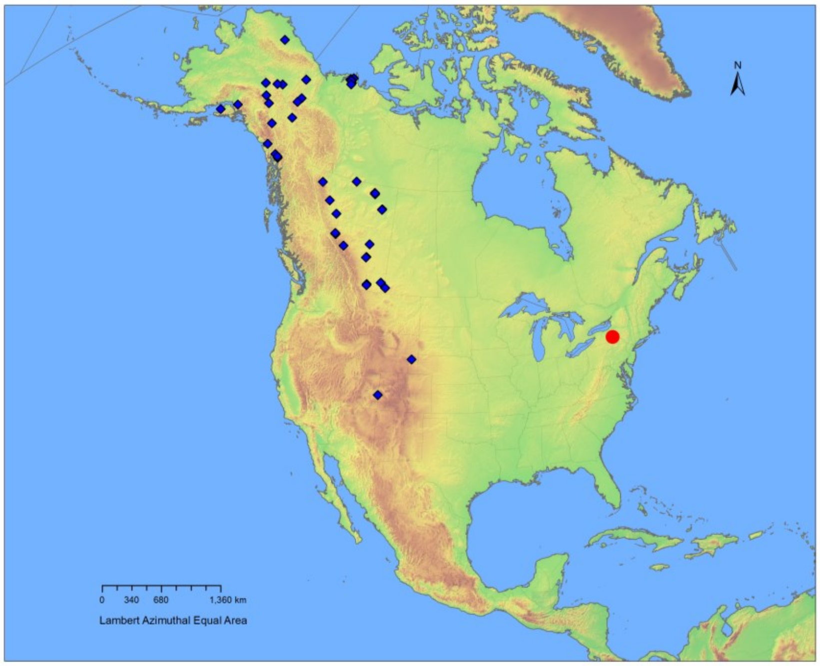


Figure 11. Distribution map of *Bembidion sordidum* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Carabus chamissonis Fischer has a transcontinental range restricted to high latitudes. The species occurs in open, dry tundra (Lindroth, 1966). Its modern distribution is shown in Figure 12.

Diacheila polita Faldermann is a circumpolar species. In North America, it is restricted to the northwest part of the continent in the Northwest Territories and Alaska (Figure 13). It inhabits tundra on moist and soft soils with sedges (Lindroth, 1961).

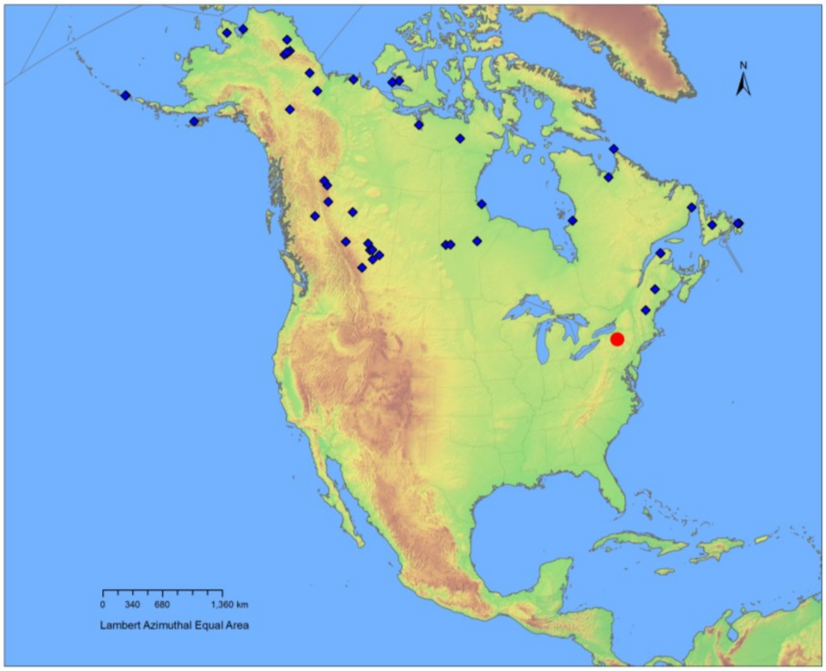


Figure 12. Distribution map of *Carabus chamissonis* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

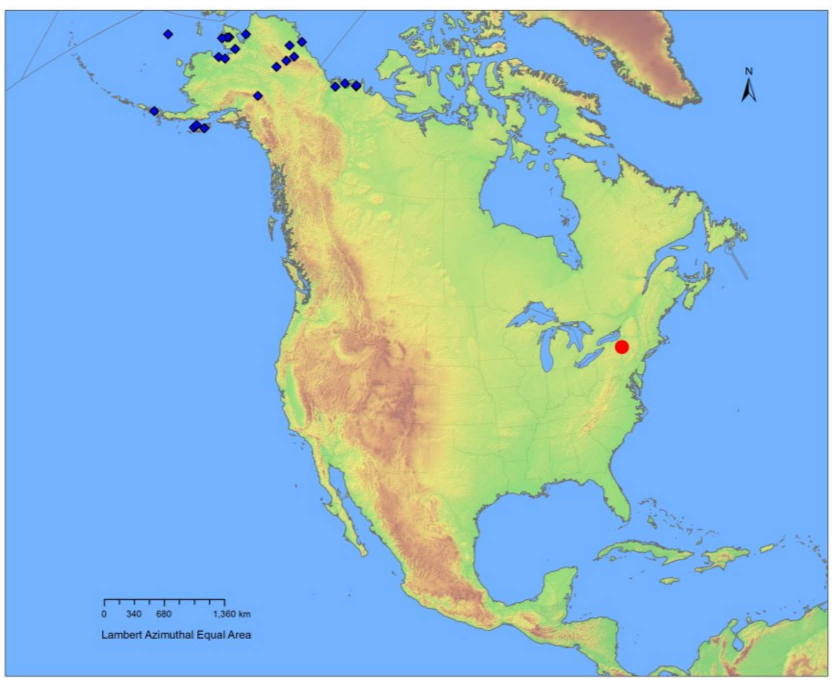


Figure 13. Distribution map *of Diacheila polita* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Pterostichus pinguedineus Motschulsky was identified from its pronota. The species belongs to the *Cryobius* group. *Cryobius* almost exclusively inhabits tundra and forest tundra habitats. *P. pinguedineus* occurs under leaves on riverbanks with rich vegetation (Lindroth, 1966) with a geographic range shown in Figure 14.

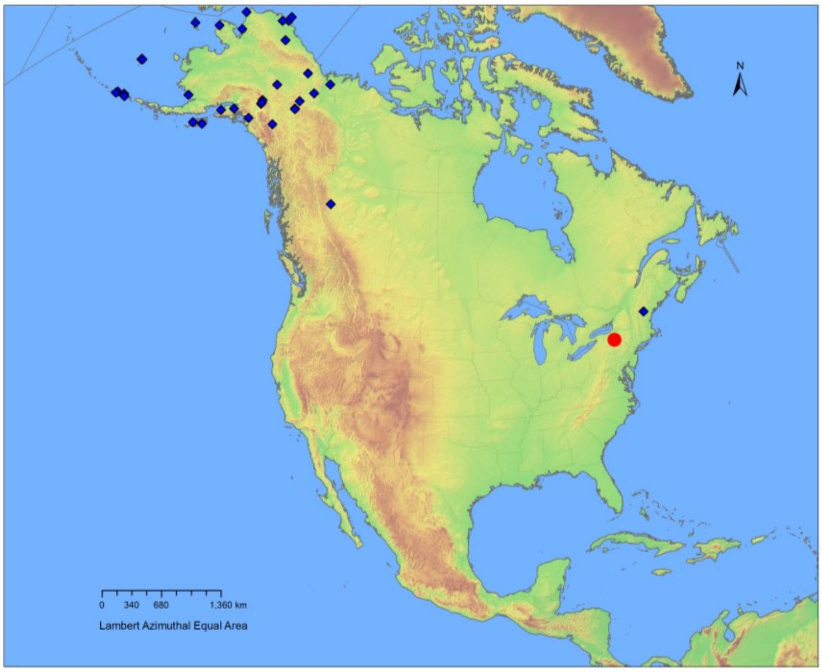


Figure 14. Distribution map of *Pterostichus pinguedineus* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Stereocerus haematopus Dejean, formerly known as *Pterostichus haematopus,* was only represented in the fossil collected from Site 2. In North America, it occurs in tundra habitats, usually on sandy soil with *Empetrum*. It also occurs in the alpine zone of the mountains of New England and Wyoming (Lindroth, 1966) (Figure 15).

Species of Staphylinidae (rove beetle) are found associated with dung, carrion, ants and termite nests. A species of *Eucnecosum* Reitter was identified in the Six Mile Creek assemblage. It could be either *E. brachypterum* (Gravenhorst) or *E. brunnescens (*J. Sahlberg). Both have northern distributions in North America (Campbell, 1984) (Figures 16 and 17).

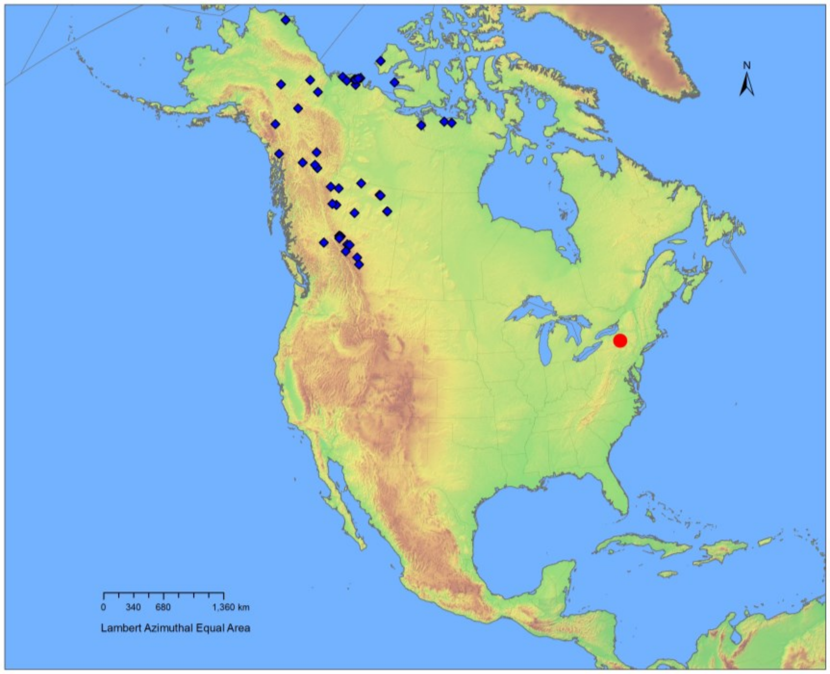


Figure 15. Distribution map of *Stereocerus haematopus* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Figure 16. Distribution map of *Eucnecosum brachypterum* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

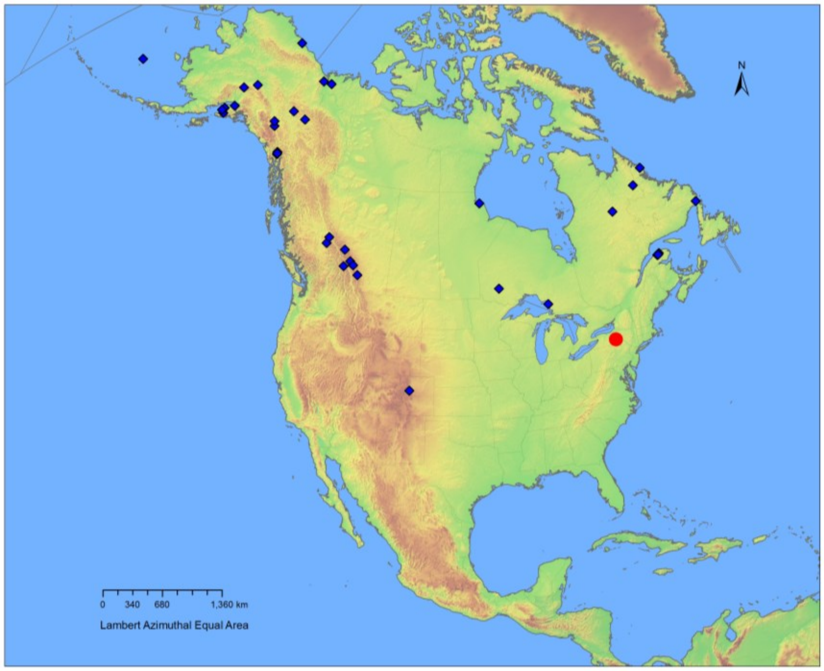


Figure 17. Distribution map of *Eucnecosum brunnescens* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Three species of *Olophrum* Erichson were identified in the samples of the fossil assemblage. *O. boreale* (Paykull) is a Holarctic species. In North America, it occurs mostly in arctic and alpine habitats (Campbell, 1983) (Figure 18). *O. latum* Maklin is an arctic species (Figure 19). The species inhabits clumps of emergent, sub-aquatic vegetation, as well as in moist organic litter associated with *Salix* (willow) and *Alnus* (alder) (Campbell, 1983). *O. rotundicolle* (C. R. Sahlberg) is a circumpolar species. In North America, it occurs in arctic and alpine areas and northern boreal regions ranging from Alaska to Newfoundland. It also occurs in southern Quebec and British Columbia (Figure 20). The species occurs in clumps of *Carex* (sedges) or moss at the margins of lakes, bogs and slow moving streams (Campbell, 1983).

Figure 18. Distribution map of *Olophrum boreale* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Figure 19. Distribution map of *Olophrum latum* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

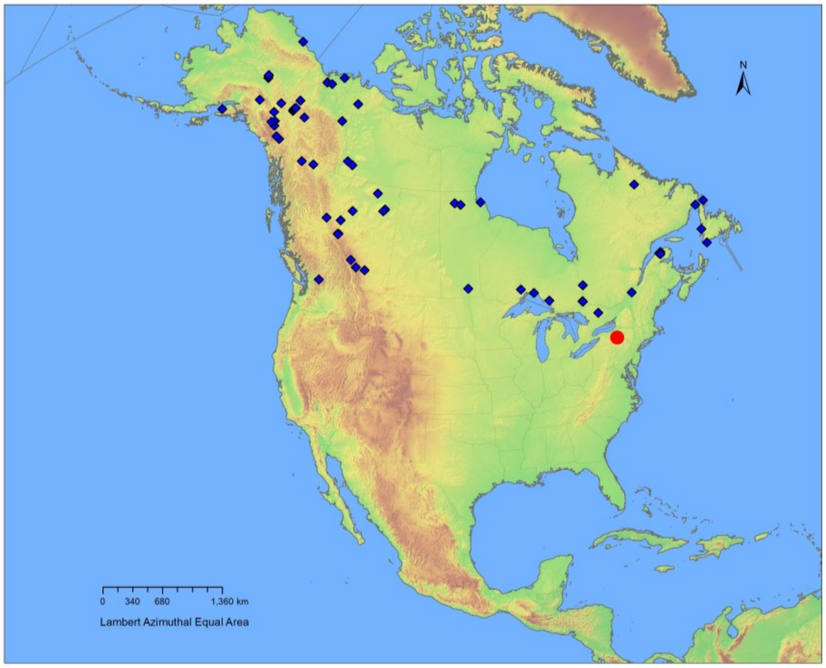


Figure 20. Distribution map of *Olophrum rotundicolle* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Two species of Hydrophilidae were identified in the Six Mile Creek assemblage. In North America, *Helophorus arcticus* Brown is associated with the treeline vegetation at Kuujjuaq, northern Québec (Ashworth, 2000) (Figure 21). *H. parasplendidus* Angus is found in the Canadian arctic from Churchill, Manitoba, westward to northern Yukon, and at high elevations in the Rocky Mountains of Colorado westwards to the eastern slopes of Sierra Nevada in California (Figure 22).

Thanatophilus sagax (Mannerheim) is a northern species. Most adults of the species live under debris or carrion along shores of lakes, rivers, and alkaline sloughs (Anderson and Peck, 1976) (Figure 23).

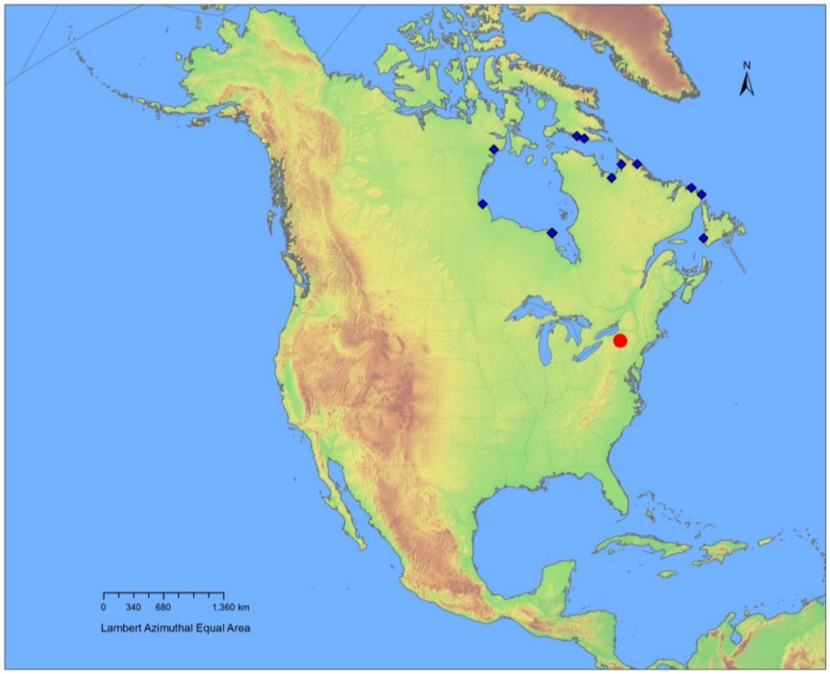


Figure 21. Distribution map of *Helophorus arcticus* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

Figure 22. Distribution map of *Helophorus parasplendidus* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

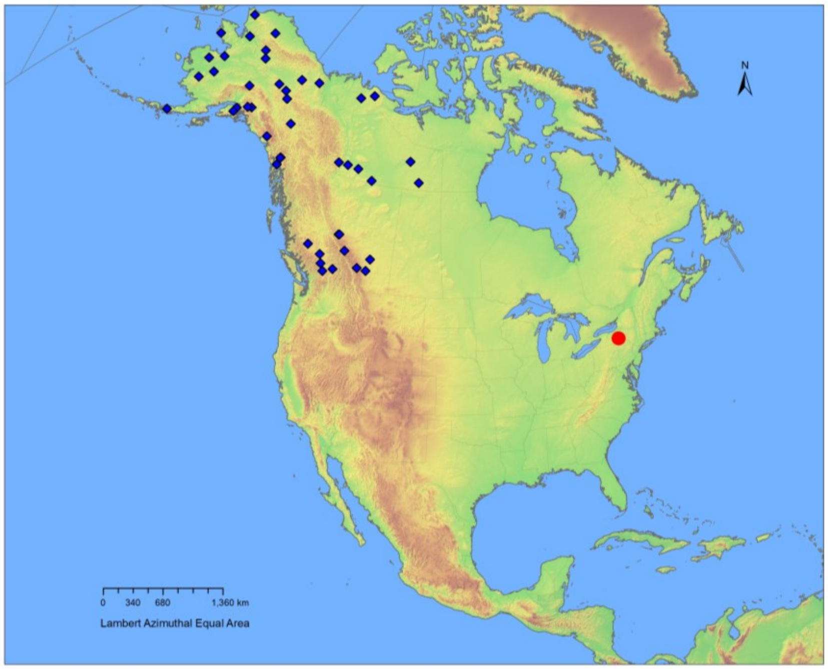


Figure 23. Distribution map of *Thanatophilus sagax* in North America (blue diamonds). The location of Six Mile Creek is shown by the red circle.

3.2. Macrofossil Analyses

Macroscopic plan remains from Six Mile Creek were identified by Dr. D. M. Peteet, Lamont-Doherty Earth Observatory, Columbia University, New York (personal communication, 2014). They include specimens of *Salix* (willow) buds, *Dryas integrifolia* (entireleaf mountain-avens) leaves, and *Claytonia caroliniana* (Carolina springbeauty). These are plants of stream, wetland, and drier upland habitats of tundra and alpine habitats. *C. caroliniana* is a flowering plant currently found in northern forests. Mosses were represented by *Drepanocladus* and *Polytrichum juniperum*. *Cenococcus* fungal bodies were also present, which indicate soil disturbance and frost action (Birks, 2000). Earlier plant studies at Six Mile Creek area (Miller, 1996; Karig and Miller, 2013) identified *Salix, Dryas integrifolia, Claytonia caroliniana,* and *Polytrichum juniperum* and *Drepanocladus*.

3.3. Synthesis of Paleoenvironment

The habitat preferences of the identified beetles in the Six Mile Creek fossil assemblages ranged from those associated with (a) peat or peaty wet tundra, to (b) dry tundra, to (c) dry, sandy river banks, and (d) shaded river banks (Table 7). Similarly, the associated fossil plant assemblages are those of tundra and alpine habitats.

All of the modern localities for the Six Mile Creek fossils are plotted on an Ecological Regions map of North America (Figure 24). This clearly shows the preference for tundra and northern forested habitats. The number of localities within each of the ecological regions is summarized in Table 8. Out of the total recorded occurrences for the modern distribution of the Six Mile Creek fossil beetle species, majority was associated with forested mountains, tundra, and taiga ecoregions.

Table 8. Modern occurrences of the beetles from Six Mile Creek fossil assemblages in North American ecological regions

Ecoregion	Occurrences
Arctic Cordillera	4
Tundra	53
Taiga	37
Hudson Plains	6
Northern Forests	41
Northwestern Forested Mountains	77
Marine West Coast Forests	11

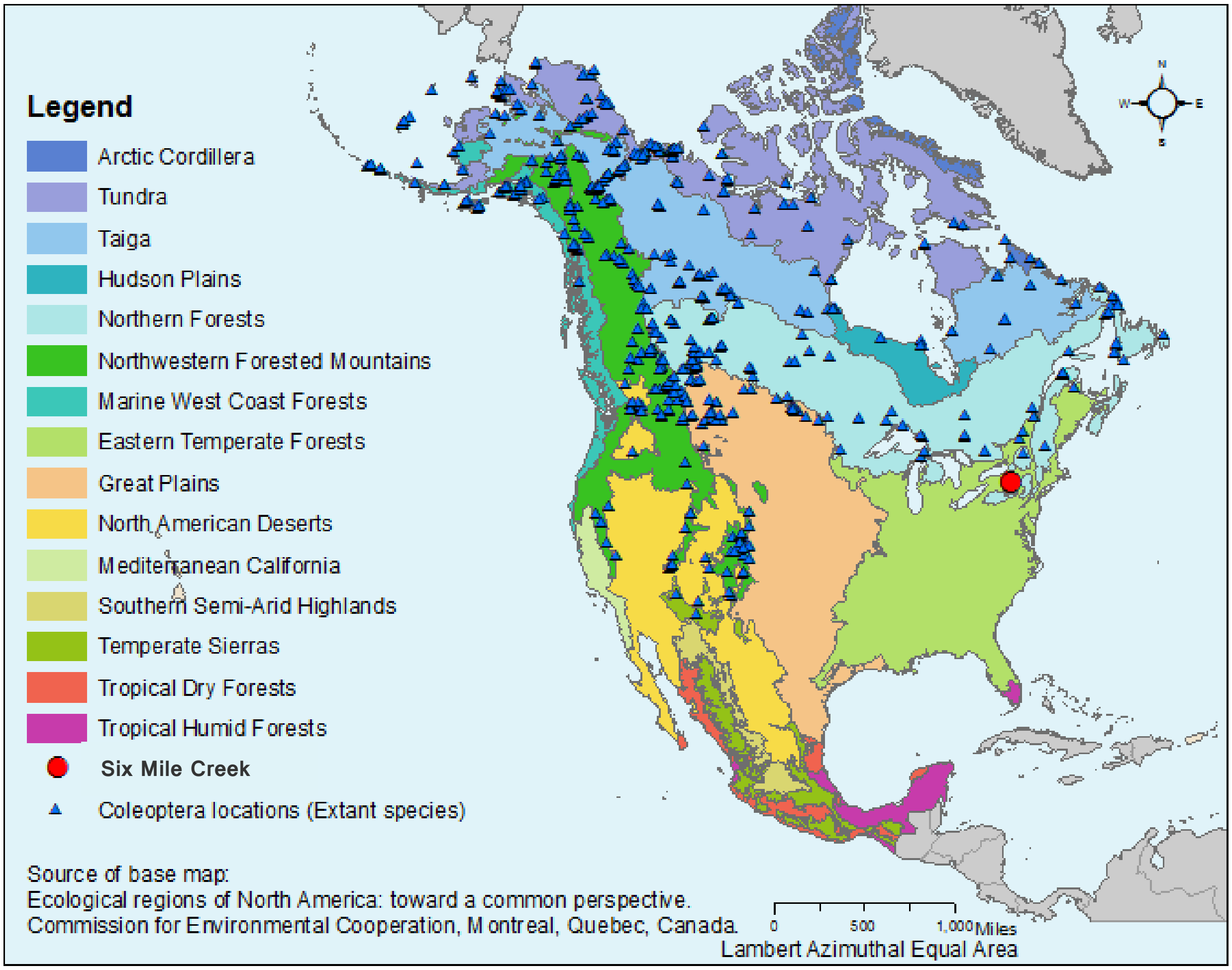


Figure 24. Modern North American distribution of Six Mile Creek taxa (blue triangles). The Six Mile Creek location is marked by a red circle.

3.4. Paleoclimatic Reconstruction

The MCR approach assumes data on mean July and mean January temperature are normally distributed in developing confidence ellipses. The plots for *Amara quenseli* support this assumption (Figure 25).

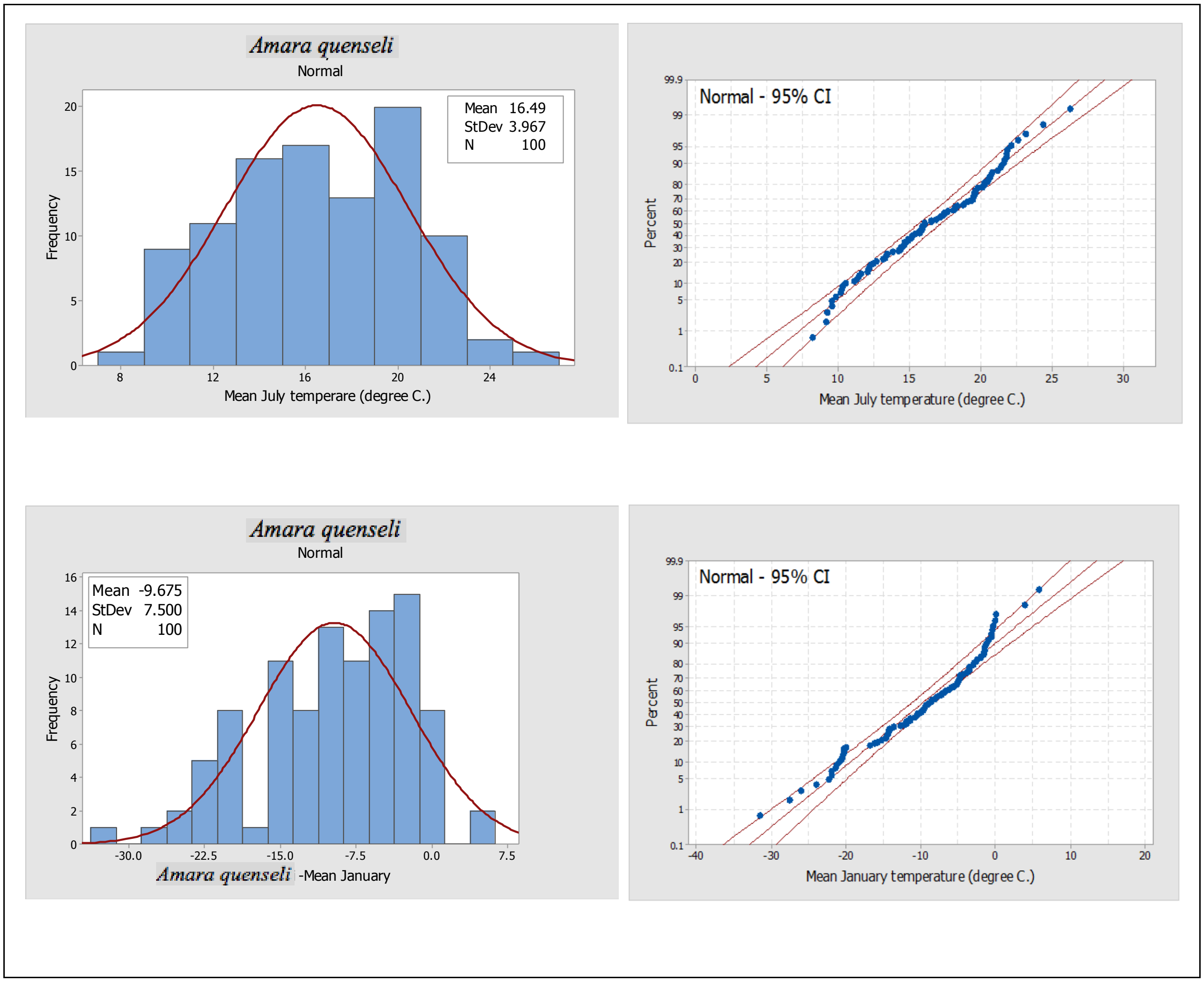


Figure 25. Distribution of average July and average January temperatures for *Amara quenseli*.

The Mutual Climatic Range (MCR) for the Six Mile Creek assemblage was determined first by creating a 95% confidence ellipse for each species using bivariate scatter data (mean July and mean December temperature), and then by stacking the ellipses for the species identified in the Six Mile Creek assemblage on top of each other. Figure 26 shows an example of a 95% confidence ellipse using bivariate data of mean January temperature and mean July temperature for *Amara quenseli*.

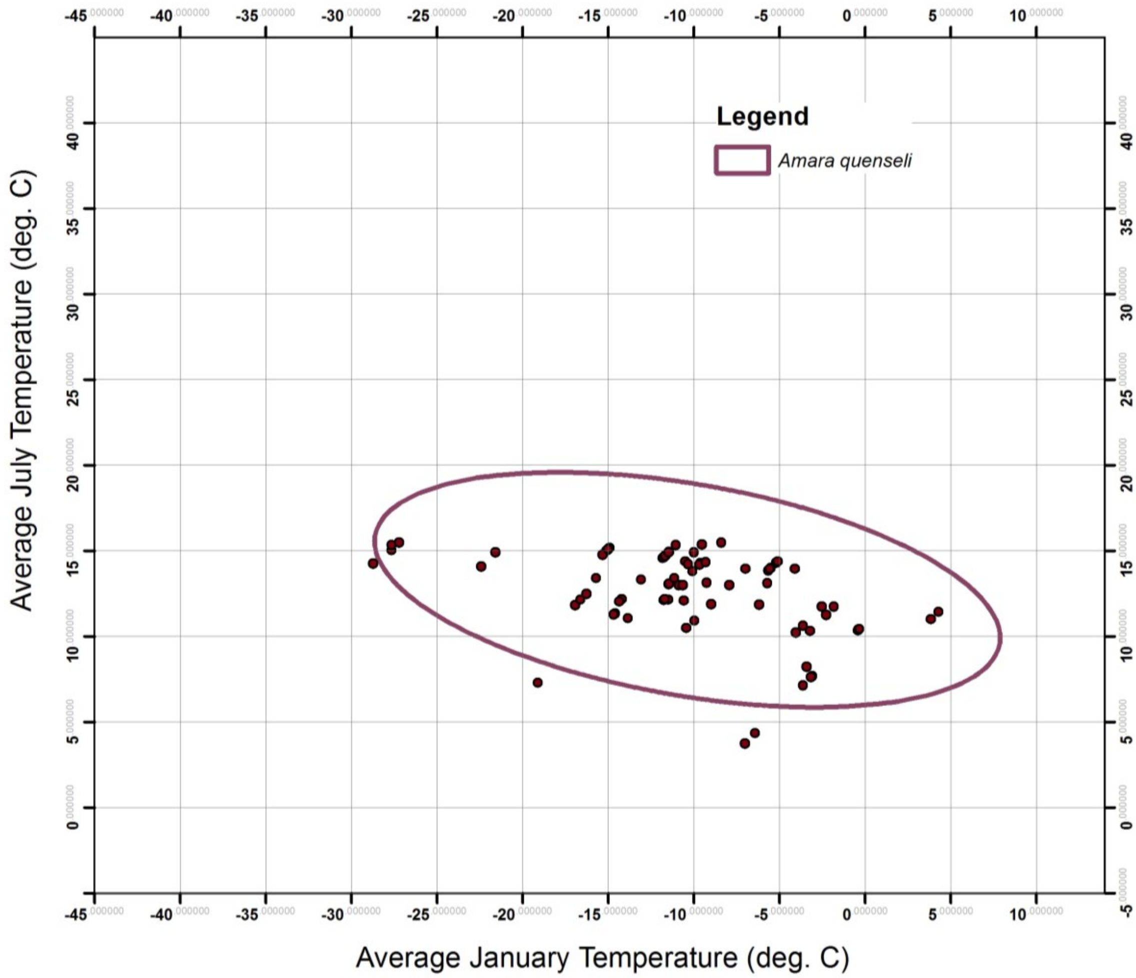


Figure 26. Bivariate data plot of average July temperature and average January temperature for *Amara quenseli* and construction of a 95% confidence ellipse for the species.

The paleoclimatic reconstruction with 95% confidence ellipses using ArcGIS is shown in Figure 27. The average mean July temperature, defined by the overlap region, was estimated to be 8.7 ºC to 11.4 ºC. Similarly, the average mean January temperature was -15.3 ºC to -24.6 ºC.

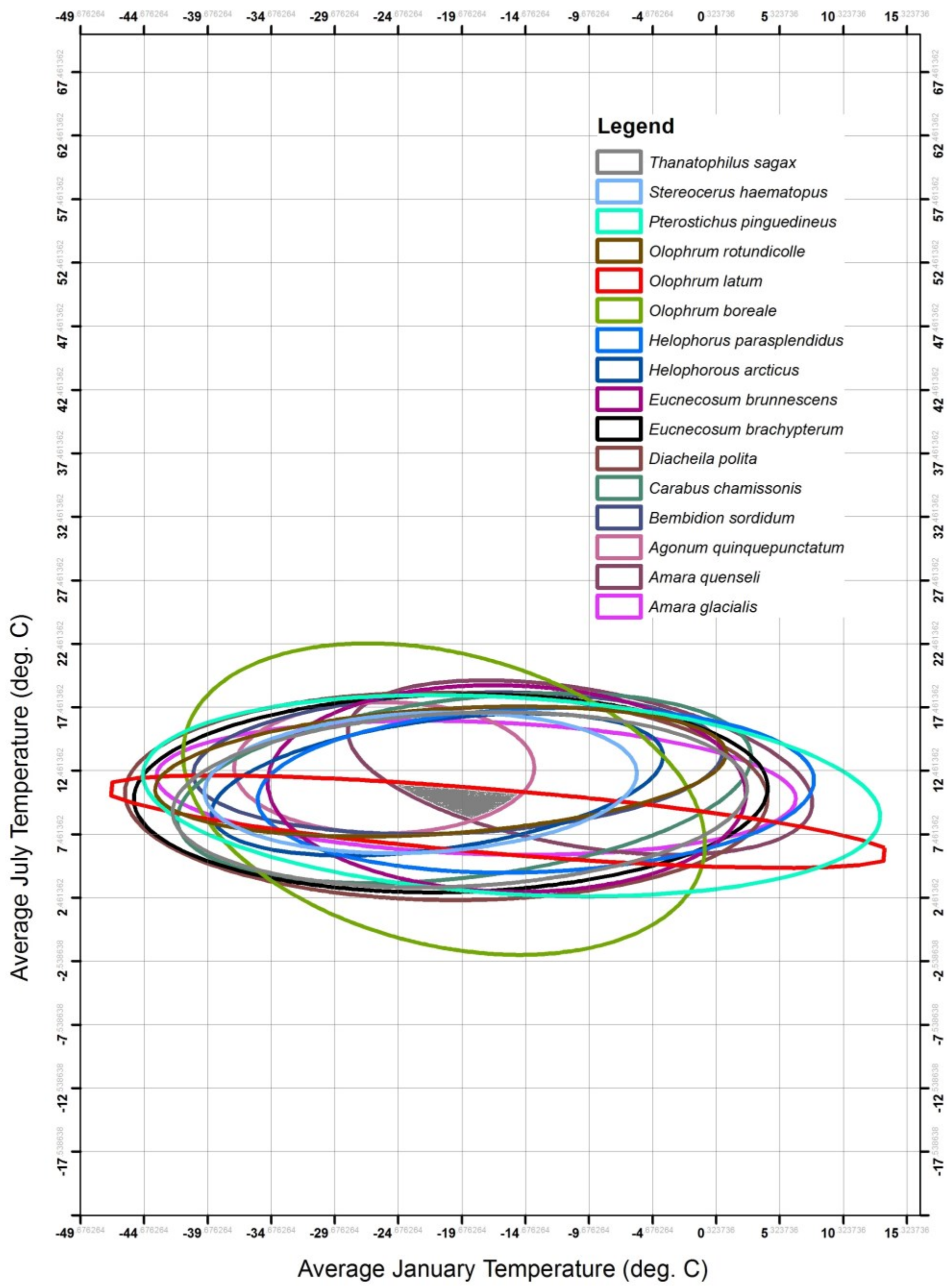


Figure 27. Overlapping probability ellipses (95% confidence interval) for n =16 Six Mile Creek taxa drawn using ArcGIS. The shaded area indicates a region of climatic overlap for the identified beetle species.

The SAS output for the paleoclimatic reconstruction for Six Mile Creek using a confidence interval of 95% is shown in Figure 28. The average July temperature was estimated to be 9.0 ºC to 11.3 ºC and average January temperature was in the range of -15.2 ºC to -23.2 ºC.

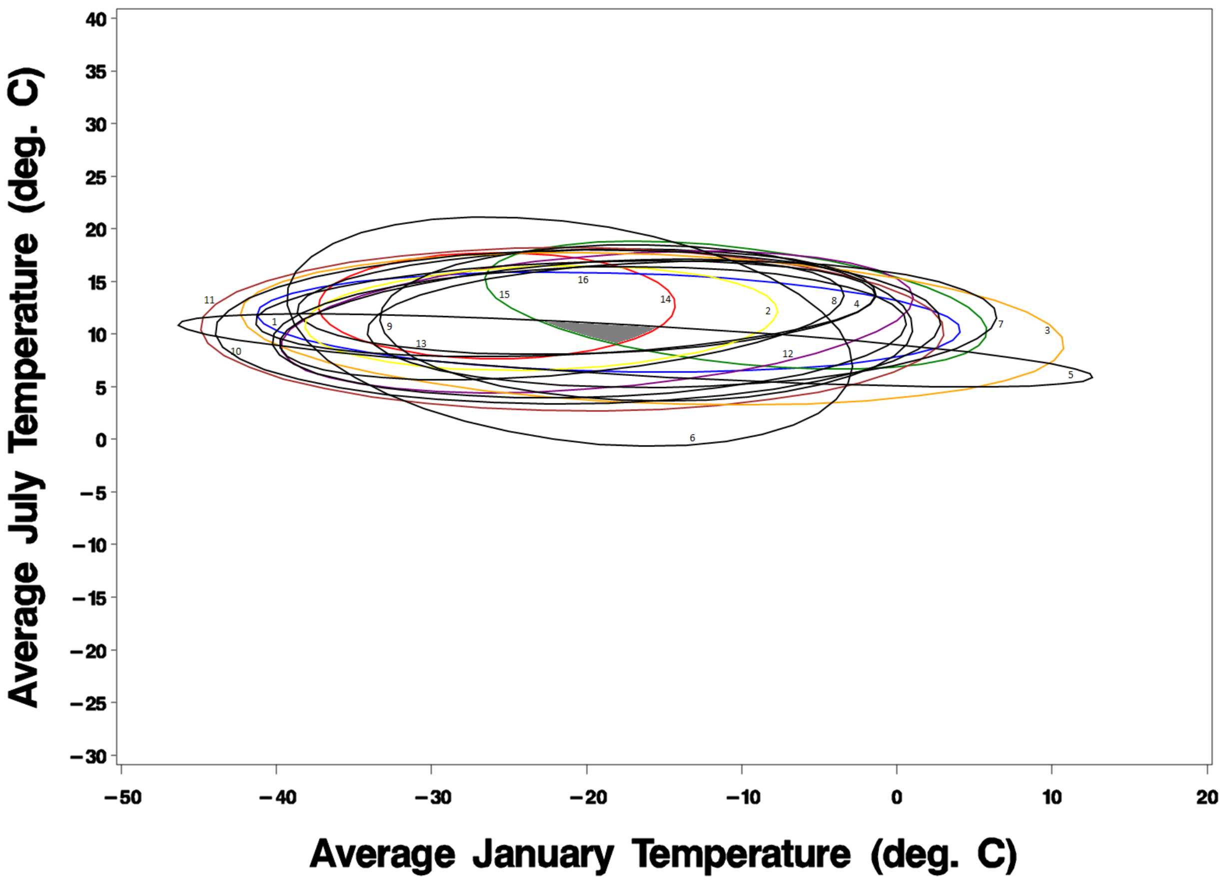


Figure 28. Overlapping probability ellipses (95% confidence interval) for n =16 Six Mile Creek taxa drawn using SAS. The shaded area indicates region of climatic overlap for the identified beetle species. Numbers associated with the ellipses represent species 1: *Thanatophillus sagax*; 2: *Stereocerus haematopus*; 3: *Pterostichus pinguedineus*; 4: *Olophrum rotundicolle*; 5: *Olophrum latum*; 6: *Olophrum boreale*; 7: *Helophorus parasplendidus*; 8: *Helophorus arcticus;* 9: *Eucnecosum brunnescens*; 10: *Eucnecosum brachypterum*; 11: *Diacheila polita*; 12: *Carabus chamissonis*; 13: *Bembidion sordidum*; 14: *Agonum quinquepunctatum*; 15: *Amara quenseli*; 16: *Amara glacialis*.

The summarized results from the SAS and ArcGIS analyses for the study site at Six Mile Creek are presented in Table 9, along with the results from a previous study of Ashworth and Willenbring (1998).

Table 9. Comparison of the paleoclimate for the Six Mile Creek site obtained from analyses of probability ellipses constructed using SAS, ArcGIS and from the preliminary study of Ashworth and Willenbring (1998)

Climate Value	SAS[1]	ArcGIS[1]	Ashworth and Willenbring (1998)
Average July Temperature, low	9.0	8.7	10.0
Average July Temperature, high	11.3	11.4	12.0
Average January Temperature, low	-23.2	-24.6	-26.0
Average January Temperature, high	-15.2	-15.3	-20.0

[1]This study

It is noted that both methods provide very close estimates for both average July and January temperatures. Slight differences between the two results may be due to the computational formulae used to derive the ellipses. The SAS macro used in this study employs the approach of understanding statistical methods through elliptical geometry (Friendly et al., 2013), while the 'directional distribution' or standard deviational ellipse tool in the Spatial Statistics Toolbox of ArcGIS 10.1 is based on Lefever (1926) (Wang et al., 2015).

The only other quantitative estimate of the Mid-Wisconsinan paleoclimate condition at Six Mile Creek is from Ashworth and Willenbring (1998). The authors used MCR method for the paleoclimate reconstruction, but they did not employ statistical methods such as confidence ellipses and instead used a graphical method to obtain the climatic envelope. Most of the Mutual Climatic Range analyses in the literature (Elias, 1999) have employed hand-drawn graphical methods.

The only other study to use SAS to generate confidence ellipses for interpreting the paleoclimate was by Rock (2009). She used a fossil beetle assemblage to interpret the climate of the Moorhead Low Water Phase of Lake Agassiz. The GIS approach of quantitative paleoclimatic interpretation in the present study using fossil beetle assemblage with MCR approach is perhaps the first time, even though the use of standard deviational ellipses in GIS can be found in many other research fields (Baojun et al., 2008, Wang et al., 2015, Wong, 1998, Eryando et al., 2012).

3.5. Discussion

During the interval 38-46 cal kyr BP, $\delta^{18}O$ fluctuations recorded in the NGRIP ice core are interpreted to represent four cold-warm climate cycles with an amplitude between the coldest and warmest phases of about 11°C (NorthGRIP Members, 2004; British Antarctic Survey, 2014). The Six Mile Creek insect and plant fossils provide an unambiguous interpretation of a tundra landscape in northern New York State during the same interval. Based on radiocarbon dating, the record is discontinuous with deposits ranging in age from 38-43 and 44-46 cal kyr BP. The similarity of the fossil biota during both intervals indicates a climate too cold to preclude tree growth.

There are no Mid-Wisconsinan terrestrial records with the completeness of ice-core records. There are a number of problems which prevent detailed correlation between terrestrial records like those of Six Mile Creek with the ice cores of Greenland not the least of which is that the chronologies were developed using different methods. Even comparisons between Mid-Wisconsinan sites using radiocarbon methodology is difficult because of the uncertainties in the reliability of the method near the limits of its use.

The paleoclimatic interpretation from Six Mile Creek is simple compared to that of the Greenland NGRIP ice core. There is no evidence at Six Mile Creek of warmer intervals as indicated in Greenland. However, there are paleontological and glacial geological records in eastern North America which indicate that the Mid-Wisconsinan was a time of fluctuating climatic conditions (Berti, 1975; Sirkin and Stuckenrath, 1980; Sirkin, 1982; Dredge and Thorleifson, 1987; Sirkin, 1991; Cong et al., 1996)

Regional paleontological and glacial geological evidence indicates that northern New York State would have experienced oscillating climatic conditions during the Mid-Wisconsinan. Absence of any evidence supporting a warmer interval or warmer intervals at Six Mile Creek is most likely the result of the incompleteness of the stratigraphic record demonstrated by a discontinuity in the range of radiocarbon ages. Future discoveries of Mid-Wisconsinan deposits in the Six Mile Creek drainage could change this picture.

One of the objectives of this study was to experiment with more automated assessments of paleoclimate based on the Mutual Climate Range (MCR) methodology (Atkinson et al., 1987). The MCR technique assumes that climate is the primary control of species distributions. Scott Elias has published several MCR studies in North America (Elias, 1996; Elias 1999; Elias 2000; Elias and Matthews Jr., 2002; Elias, 2015). All are based on plotting data by hand. The reason for experimenting with more automated systems is to decrease error and also to increase reproducibility. Rock (2009) demonstrated that algorithms were available within SAS to produce probability ellipses of species climate data which could be then layered on one another to produce an area of maximum overlap.

In my study, I was able to use standard algorithms within ArcGIS to achieve similar results. A comparison of the results of the SAS and ArcGIS studies showed that they produced very similar results. Probability ellipses using different values are easily constructed within ArcGIS which is not possible by drawing by hand. The advantage of using ArcGIS is that it is widely available software with an online version. Data collection, which involves converting sets of coordinates for locations within a species range, is still a very time-consuming proposition. In future, conversion of coordinates to climate data using modeled climate datasets should also be possible speeding up the process and making it more likely that MCR-like methods are employed in paleoclimatic analysis.

4. CONCLUSIONS

The different samples from the Six Mile Creek site probably come from two stratigraphic horizons. The sample from Site 1 dated between 38-43 kyr BP, and that from Site 2 between 44-46 kyr BP. Both samples represent similar fossil beetle assemblages. The stratigraphic horizons represent the deposits of terrestrial habitats which existed in a non-glacial interval between glaciations. The surface was a vegetated tundra with both moist and dry areas, based on the modern-day habitat preferences of the beetle and plant species identified from the Six Mile Creek deposits.

The average July temperature based on MCR analysis using both SAS and ArcGIS was in range of 8.7 ºC to 11.4 ºC, while the mean January temperature was -15.2 ºC to -24.6 ºC. The Mid-Wisconsinan environment at the Ithaca, New York, was 9.0 ºC to 11.7 ºC colder in July compared to the present 30-yr average July temperature of 20.4 ºC.

5. REFERENCES

Anderson, R.S., 1993, A 35,000 year vegetation and climate history from Potato Lake, Mogollon Rim, Arizona: Quaternary Research, v. 40(3), p. 351-359.

Anderson, R.S., 1997, Weevils (Coleoptera: Curculionoidea, excluding Scolytinae and Platypodinae) of the Yukon, *in* Danks, H.V., and Downes, H.V., eds., Insects of the Yukon: Biological Survey of Canada (Terrestrial Arthropods), Ottawa, Ontario, p. 523-562.

Anderson, R.S., Betancourt, J.L., Mead, J.I., Hevly, R.H., and Adam, D.P., 2000, Middle-and late-Wisconsin paleobotanic and paleoclimatic records from the southern Colorado Plateau, USA: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 155(1), p. 31-57.

Anderson, R.S., and Peck, S.B., 1976, The carrion beetles of Canada and Alaska. Coleoptera: Silphidae and Agyrtidae, *in* Insects and Arachnids of Canada, Part 13: Agriculture Canada, p. 121.

Ashworth, A.C., 1979, Quaternary Coleoptera studies in North America: past and present, *in* Erwin, T.L., Ball, G.E., Whitehead, D.R., and Halpern, A.L., eds., Carabid Beetles: Springer, Dordrecht, p. 395-406.

Ashworth, A.C., 2000, The ecology of *Helophorus arcticus* Brown (Coleoptera: Hydrophilidae) reconsidered: The Coleopterists Bulletin, v. 54(3), p. 370-378.

Ashworth, A.C., 2001, Perspectives on Quaternary beetles and climate change, in Gerhard, L.C., Harrison, W.E., and Hanson, B.M., eds., Geological Perspectives of Global Climate Change, p. 153-168: The American Association of Petroleum Geologists (AAPG Studies in Geology 47)

Ashworth, A.C., Miller, N.G., Schmidt, V.E., and Willenbring, J., 1997, The Sixmile Creek site, Ithaca, New York, and potential problems with Mid-Wisconsin regional paleoclimatic interpretations: GSA Annual Meeting, Abstracts with Programs, Salt Lake City, p. 37.

Ashworth, A.C., and Willenbring, J.K., 1998, Fossil beetles and climate change at the Sixmile Creek site, Ithaca, New York: American Paleontologist, v. 6, p. 2-3.

Atkinson, T.C., Briffa, K.R., and Coope, G.R., 1987, Seasonal temperatures in Britain during the past 22,000 years, reconstructed using beetle remains: Nature, v. 325(6105), p. 587-592.

Augustin, L., Barbante, C., Barnes, P.R., Barnola, J.M., Bigler, M., Castellano, E., Cattani, O., Chappellaz, J., Dahl-Jensen, D., Delmonte, B., and Dreyfus, G., 2004, Eight glacial cycles from an Antarctic ice core: Nature, v. 429(6992), p. 623-628.

Bajc, A.F., Karrow, P.F., Yansa, C.H., Curry, B.B., Nekola, J.C., Seymour, K.L., Mackie, G., and Jin, J., 2015, Geology and paleoecology of a Middle Wisconsin fossil occurrence in Zorra Township, southwestern Ontario, Canada: Canadian Journal of Earth Sciences, v. 52(6), p. 386-404.

Baker, R.G., Bettis , E.A., Mandel, R.D., Dorale, J.A., and Fredlund, G.G., 2009, Mid-Wisconsinan environments on the eastern Great Plains: Quaternary Science Reviews, v. 28(9), p. 873-889.

Baojun, W., Bin, S., and Inyang, H.I., 2008, GIS-based quantitative analysis of orientation anisotropy of contaminant barrier particles using standard deviational ellipse: Soil & Sediment Contamination, v. 17(4), p. 437-447.

Bartlein, P.J., Harrison, S.P., Brewer, S., Connor, S., Davis, B.A.S., Gajewski, K., Guiot, J., Harrison-Prentice, T.I., Henderson, A., and Peyron, O., 2011, Pollen-based continental climate reconstructions at 6 and 21 ka: a global synthesis: Climate Dynamics, v. 37(3-4), 775-802.

Berger, G.W., 1984, Thermoluminescence dating studies of glacial silts from Ontario: Canadian Journal of Earth Sciences, v. 21(12), p. 1393-1399.

Bergolc, M.L., 2004, A paleoenvironmental analysis using fossil insects in late Quaternary deposits in Indiana and Ohio [Master's thesis]: Bowling Green, Bowling Green State University, 92 p.

Berti, A.A., 1975, Pollen and seed analysis of the Titusville section (Mid-Wisconsinan), Titusville, Pennsylvania: Canadian Journal of Earth Sciences, v. 12(9), p. 1675-1684.

Birks, H.H., 2000, Aquatic macrophyte vegetation development in Kråkenes Lake, western Norway, during the late-glacial and early-Holocene: Journal of Paleolimnology, v. 23(1), p. 7-19.

Birks, H.J.B., Heiri, O., Seppä, H., and Bjune, A.E., 2010, Strengths and weaknesses of quantitative climate reconstructions based on late-Quaternary biological proxies: Open Ecology Journal, v. 3(1), p. 68-110.

Blockley, S.P., Lane, C.S., Hardiman, M., Rasmussen, S.O., Seierstad, I.K., Steffensen, J.P., Svensson, A., Lotter, A.F., Turney, C.S., Ramsey, C.B., and Intimate Members, 2012, Synchronisation of palaeoenvironmental records over the last 60,000 years, and an extended INTIMATE event stratigraphy to 48,000 b2k: Quaternary Science Reviews, v. 36, p. 2-10.

Bloom, A.L., 1972, Schedule and guidebook: Friends of the Pleistocene 35th Annual Reunion, Cornell University, p. 20.

Bond, G., Broecker, W., Johnsen, S., McManus, J., Laberyie, L., Jouzel, J., and Bonani, G., 1993, Correlations between climate records from North Atlantic sediments and Greenland ice: Nature, v. 365(6442), p. 143-147.

Bouchard, P., Grebennikov, V.V., Smith, A.B., and Douglas, H., 2009, Biodiversity of Coleoptera, *in* Foottit, R.G. and Adler, P.H., eds., Insect Biodiversity: Science and Society: John Wiley & Sons, p 265-301.

Braun, D.D., 2004, The glaciation of Pennsylvania, USA: Developments in Quaternary Sciences, v. 2, p. 237-242.

British Antarctic Survey, 2014, Ice cores and climate change, https://www.bas.ac.uk/data/our-data/publication/ice-cores-and-climate-change/ (accessed January 2018)

Bromley, G.R., Hall, B.L., Thompson, W.B., Kaplan, M.R., Garcia, J.L., and Schaefer, J.M., 2015, Late glacial fluctuations of the Laurentide ice sheet in the White Mountains of Maine and New Hampshire, USA: Quaternary Research, v. 83(3), p. 522-530.

Burns, J.A., 2010, Mammalian faunal dynamics in late Pleistocene Alberta, Canada: Quaternary International, v. 217(1), p. 37-42.

Calkin, P.E., and Barnett, P.J, 1990, Glacial geology of the eastern Lake Erie basin, *in* McKenzie, D.I., ed., Quaternary Environs of Lakes Erie and Ontario: First Joint Meeting of the Canadian Quarternary Association and the American Quarternary Association, Waterloo, Ontario, Canada, p. 1-24.

Campbell, J.M., 1983, A revision of the North American Omaliinae (Coleoptera: Staphylinidae) the genus *Olophrum* Erichson: The Canadian Entomologist, v. 115(6), p. 577-622.

Campbell, J.M., 1984, A revision of the North American Omaliinae (Coleoptera: Staphylinidae): the genera *Arpedium* Erichson and *Eucnecosum* Reitter: The Canadian Entomologist, v. 116(4), p. 487-527.

Clark, P.U., and Lea, P.D., 1986, Reappraisal of Early Wisconsin glaciation in North America: Geological Society of America Abstracts with Programs, p. 565.

Clark, P.U., Clague, J.J., Curry, B.B., Dreimanis, A., Hicock, S.R., Miller, G.H., Berger, G.W., Eyles, N., Lamothe, M., Miller, B.B., Mott, R.J., Oldale, R.N., Stea, R.R., Szabo, J.P., Thorleifson, L.H., and Vincent, J.S., 1993, Initiation and development of the Laurentide and Cordilleran ice sheets following the last interglaciation: Quaternary Science Reviews, v. 12(2), p. 79-114.

Clayton, K.M., 1965, Glacial erosion in the Finger Lakes region (New York State, USA): Zeitschrift fur Geomorphologie, v. 9, p. 50-62.

Colinet, H., Sinclair, B.J., Vernon, P., and Renault, D., 2015, Insects in fluctuating thermal environments: Annual Review of Entomology, v. 60(1), p. 123-140.

Cong, S., Ashworth, A.C., Schwert, D.P., and Totten, S.M., 1996, Fossil beetle evidence for a short warm interval near 40,000 yr BP at Titusville, Pennsylvania: Quaternary Research, v. 45(2), p. 216-225.

Coope, G.R., 1970, Interpretations of Quaternary insect fossils: Annual Review of Entomology, v. 15(1), p. 97-121.

Coope, G.R., 1973, Tibetan species of dung beetle from Late Pleistocene deposits in England: Nature, v. 245(5424), p. 335-336.

Coope, G.R., 2004, Several million years of stability among insect species because of, or in spite of, Ice Age climatic instability?: Philosophical Transactions of the Royal Society B: Biological Sciences, v. 359(1442), p. 209-214.

Coope, G.R., Pennington, W., Mitchell, G.F., West, R.G., Morgan, A.V., and Peacock, J.D., 1977, Fossil Coleopteran assemblages as sensitive indicators of climatic changes during Devensian (last) cold stage: Philosophical Transactions of the Royal Society of London Series B: Biological Sciences, v. 280(972), p. 313-340.

Dansgaard, W., Johnsen, S.J., Clausen, H.B., Dahl-jensen, D., Gundestrup, N.S., Hammer, C.U., Hvidberg, C.S., Steffensen, J.P., Sveinbjornsdottir, A.E., Jouzel, J., and Bond, G., 1993, Evidence for general instability of past climate from a 250-kyr ice-core record: Nature, v. 364(6434), p. 218-220.

DeVogel, S.B., Magee, J.W., Manley, W.F., and Miller, G.H., 2004, A GIS-based reconstruction of late Quaternary paleohydrology: Lake Eyre, arid central Australia: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 204(1), p. 1-13.

Dredge, L., and Thorleifson, L., 1987, The Middle Wisconsinan history of the Laurentide ice sheet: Géographie Physique et Quaternaire, v. 41(2), p. 215-235.

Dreimanis, A., and Karrow, P.F., 1972, Glacial history of the Great Lakes-St. Lawrence region, the classification of the Wisconsin (an) Stage, and its correlatives, *in* XXIV International Geological Congress, Section, v. 12, p. 5-15.

Elias, S.A., 1994, Quaternary insects and their environments: Smithsonian Institution Press: Washington, DC, USA, 284 p.

Elias, S.A., 1996, Late Pleistocene and Holocene seasonal temperatures reconstructed from fossil beetle assemblages in the Rocky Mountains: Quaternary Research, v. 46(3), p. 311-318.

Elias, S.A., 1999, Mid-Wisconsin seasonal temperatures reconstructed from fossil beetle assemblages in eastern North America: comparisons with other proxy records from the Northern Hemisphere: Journal of Quaternary Science, v. 14(3), p. 255-262.

Elias, S.A., 2000, Late Pleistocene climates of Beringia, based on analysis of fossil beetles: Quaternary Research, v. 53(2), p. 229-235.

Elias, S., 2007, Beetle records: overview, *in* Elias, S. ed., Encyclopedia of Quaternary Science: Elsevier Science, v. 1, p. 151-163.

Elias, S.A., 2015, Differential insect and mammalian response to Late Quaternary climate change in the Rocky Mountain region of North America: Quaternary Science Reviews, v. 120, p. 57-70.

Elias, S.A., and Matthews Jr, J.V., 2002, Arctic North American seasonal temperatures from the latest Miocene to the Early Pleistocene, based on mutual climatic range analysis of fossil beetle assemblages: Canadian Journal of Earth Sciences, v. 39(6), p. 911-920.

Epstein, P.R., Diaz, H.F., Elias, S., Grabherr, G., Graham, N.E., Martens, W.J., Mosley-Thompson, E., and Susskind, J., 1998, Biological and physical signs of climate change: focus on mosquito-borne diseases: Bulletin of the American Meteorological Society, v. 79(3), p. 409-417.

Eryando, T., Susanna, D., Pratiwi, D., and Nugraha, F., 2012, Standard Deviational Ellipse (SDE) models for malaria surveillance, case study: Sukabumi district-Indonesia, in 2012: Malaria Journal, v. 11(1), p. 130.

Evans M. N., Tolwinski-Ward, S.E., Thompson, D.M., and Anchukaitis, K. J., 2013. Applications of proxy system modeling in high resolution paleoclimatology: Quaternary Science Reviews, v. 76, p. 16-28.

Frauenfelder, R., Haeberli, W., Hoelzle, M., and Maisch, M., 2001, Using relict rockglaciers in GIS-based modelling to reconstruct Younger Dryas permafrost distribution patterns in the Err-Julier area, Swiss Alp: Norsk Geografisk Tidsskrift-Norwegian Journal of Geography, v. 55(4), p. 195-202.

Fréchette, B., and de Vernal, A., 2013, Evidence for large-amplitude biome and climate changes in Atlantic Canada during the last interglacial and Mid-Wisconsinan periods: Quaternary Research, v. 79(2), p. 242-255.

Friendly, M., 2011, SAS Macro Program: Ellipses: York University, Toronto, Canada, http://www.datavis.ca/sasmac/ellipses.html (accessed July 2014).

Friendly, M., Monette, G., and Fox, J., 2013. Elliptical insights: understanding statistical methods through elliptical geometry: Statistical Science, v. 28(1), p. 1-39.

Fulton, R., Karrow, P., LaSalle, P., and Grant, D., 1986, Summary of Quaternary stratigraphy and history, eastern Canada: Quaternary Science Reviews, v. 5, p. 211-228.

Gyllencreutz, R., Mangerud, J., Svendsen, J.I., and Lohne, Ø., 2007, DATED-A GIS-based reconstruction and dating database of the Eurasian deglaciation, *in* Johansson, P., Sarala, P., eds., Applied Quaternary Research in the Central Part of Glaciated Terrain: Geological Survey of Finland, Special Paper 46, p. 113-120.

Heusser, L.E., Kirby, M.E., and Nichols, J.E., 2015, Pollen-based evidence of extreme drought during the last glacial (32.6–9.0 ka) in coastal southern California: Quaternary Science Reviews, v. 126, p. 242-253.

Hoganson, J.W., and Ashworth, A.C., 1992, Fossil beetle evidence for climatic change 18,000-10,000 years BP in south-central Chile: Quaternary Research, v. 37(1), p. 101-116.

Huntley, B., 1994, The use of climate response surfaces to reconstruct palaeoclimate from Quaternary pollen and plant macrofossil data: Palaeoclimates and their Modelling: Springer, Dordrecht, p. 7-16.

Iversen, J., 1944, Viscum, Hedera and Ilex as climate indicators: a contribution to the study of the post-glacial temperature climate: Geologiska Föreningen i Stockholm Förhandlingar, v. 66(3), p. 463-483.

Jackson, D.A., Somers, K.M., and Harvey, H.H., 1989, Similarity coefficients: measures of co-occurrence and association or simply measures of occurrence?: American Naturalist, v. 133(3), p. 436-453.

Jackson, S.T., and Williams, J.W., 2004, Modern analogs in Quaternary paleoecology: here today, gone yesterday, gone tomorrow?: Annual Review of Earth and Planetary Sciences, v. 32, p. 495-537.

Kalm, V., 2012, Ice-flow pattern and extent of the last Scandinavian Ice Sheet southeast of the Baltic Sea: Quaternary Science Reviews, v. 44, p. 51-59.

Karig, D.E., and Miller, N.G., 2013, Middle Wisconsin glacial advance into the Appalachian Plateau, Sixmile Creek, Tompkins Co., NY: Quaternary Research, v. 80(3), p. 522-533.

Karrow, P.F., Dreimanis, A., and Barnett, P.J., 2000, A proposed diachronic revision of late Quaternary time-stratigraphic classification in the eastern and northern Great Lakes area: Quaternary Research, v. 54(1), p. 1-12.

Karrow, P.F., McAndrews, J.H., Miller, B.B., Morgan, A.V., Seymour, K.L., and White, O.L., 2001, Illinoian to Late Wisconsinan stratigraphy at Woodbridge, Ontario: Canadian Journal of Earth Sciences, v. 38(6), p. 921-942.

Kleman, J., Jansson, K., De Angelis, H., Stroeven, A.P., Hättestrand, C., Alm, G., and Glasser, N., 2010, North American Ice Sheet build-up during the last glacial cycle, 115–21kyr: Quaternary Science Reviews, v. 29(17), p. 2036-2051.

Koivula, M.J., 2011, Useful model organisms, indicators, or both? Ground beetles (Coleoptera, Carabidae) reflecting environmental conditions: ZooKeys, v. 100, p. 287-317.

Kühl, N., Gebhardt, C., Litt, T., and Hense, A., 2002, Probability density functions as botanical-climatological transfer functions for climate reconstruction: Quaternary Research, v. 58(3), p. 381-392.

Lefever, D.W., 1926, Measuring geographic concentration by means of the standard deviational ellipse: American Journal of Sociology, v. 32(1), p. 88-94.

Lindroth, C.H., 1961, The ground beetles (Carabidae, excl. Cincindelinae) of Canada and Alaska, part 2: Opuscula Entomologica Supplement 20, p. 1-200.

Lindroth, C.H., 1963, The ground beetles (Carabidae, excl. Cincindelinae) of Canada and Alaska, part 3: Opuscula Entomologica Supplement 24, p. 201-408.

Lindroth, C.H., 1966, The ground beetles (Carabidae, excl. Cincindelinae) of Canada and Alaska, part 4: Opuscula Entomologica Supplement 29, p. 409-648.

Lindroth, C.H., 1968, The ground beetles (Carabidae, excl. Cincindelinae) of Canada and Alaska, part 5: Opuscula Entomologica Supplement 33, p. 649-944.

Lindroth, C.H., 1961-1969, The ground-beetles (Carabidae, excl. Cincindelinae) of Canada and Alaska, parts 1–6: Opscula Entomologica Supplements 20, 24, 29, 33, 34, 35, p. 1-1192.

Lowe, J., and Walker, M., 2015a, Reconstructing Quaternary Environments (3rd ed.): Oxon and New York, Routledge, 569 p.

Lowe, J., and Walker, M., 2015b, Measuring Quaternary time: A 50-year perspective: Journal of Quaternary Science, v. 30(2), p. 104-113.

Marra, M.J., Shulmeister, J., and Smith, E.G.C., 2006, Reconstructing temperature during the Last Glacial Maximum from Lyndon Stream, South Island, New Zealand using beetle fossils and maximum likelihood envelopes: Quaternary Science Reviews, v. 25(15), p. 1841-1849.

Matthews Jr, J.V., 1975, Insects and plant macrofossils from two Quaternary exposures in the Old Crow-Porcupine region, Yukon Territory, Canada: Arctic and Alpine Research, v.7(3), p. 249-259.

Mickelson, D.M., and Colgan, P.M., 2003, The southern Laurentide Ice Sheet: Developments in Quaternary Sciences, v.1, p. 1-16.

Miller, N.G., 1996, Age and paleoecology on an interstadial plant bed, Tompkins County, South-central New York: Geological Society of America Annual Meeting, Abstracts with Programs, v. 28, p. 82.

Miller, T.S., 2009, Geohydrology and water quality of the valley-fill aquifer system in the upper Sixmile Creek and West Branch Owego Creek valleys in the Town of Caroline, Tompkins County, New York: U.S. Geological Survey Scientific Investigations Report 2009–5173, 56 p.

Miller, T.S., and Karig, D.E., 2010, Geohydrology of the stratified-drift aquifer system in the lower Sixmile Creek and Willseyville Creek trough, Tompkins County, New York: U.S. Geological Survey Scientific Investigations Report 2010-5230, 54 p.

Mooers, H.D., and Lehr, J.D, 1997, Terrestrial record of Laurentide Ice Sheet reorganization during Heinrich events: Geology, v. 25(11), p. 987-990.

Morlan, R.E., and Matthews Jr, J.V., 1983, Taphonomy and paleoecology of fossil insect assemblages from Old Crow River (CRH-15) northern Yukon Territory, Canada: Géographie physique et Quaternaire, v. 37(2), p. 147-157.

Mudelsee, M., and Raymo, M.E., 2005, Slow dynamics of the Northern Hemisphere glaciation: Paleoceanography, v. 20, PA4022.

Mudie, P.J., and McCarthy, F.M., 2006, Marine palynology: potentials for onshore-offshore correlation of Pleistocene-Holocene records: Transactions of the Royal Society of South Africa, v. 61(2), p. 139-157.

Mudie, P.J, Marret, F., Rochon, A., and Aksu, A.E., 2010, Non-pollen palynomorphs in the Black Sea corridor: Vegetation History and Archaeobotany, v. 19(5-6), p. 531-544.

Muller, E.H., and Calkin, P.E., 1993, Timing of Pleistocene glacial events in New York State: Canadian Journal of Earth Sciences, v. 30(9), p. 1829-1845.

Nace, T.E., Baker, P.A., Dwyer, G.S., Silva, C.G., Rigsby, C.A., Burns, S.J., Giosan, L., Otto-Bliesner, B., Liu, Z., and Zhu, J., 2014, The role of North Brazil Current transport in the paleoclimate of the Brazilian Nordeste margin and paleoceanography of the western tropical Atlantic during the late Quaternary: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 415, p. 3-13.

Napieralski, J., 2007, GIS and field-based spatiotemporal analysis for evaluation of paleo-ice sheet simulations: The Professional Geographer, v. 59(2), p. 173-183.

North Greenland Ice Core Project members, 2004, High-resolution record of Northern Hemisphere climate extending into the last interglacial period: Nature, v. 431, p. 147-151.

Overpeck, J.T., Webb, T., and Prentice, I.C., 1985, Quantitative interpretation of fossil pollen spectra: dissimilarity coefficients and the method of modern analogs: Quaternary Research, v. 23(1), p. 87-108.

Paaijmans, K.P., Heinig, R.L., Seliga, R.A., Blanford, J.I., Blanford, S., Murdock, C.C., and Thomas M.B., 2013, Temperature variation makes ectotherms more sensitive to climate change: Global Change Biology, v. 19(8), p. 2373-2380.

Piper, D.J., Mudie, P.J., Aksu, A.E., and Hill, P.R., 1978, Late Quaternary sedimentation, 50˚ N, North-East Newfoundland shelf: Géographie physique et Quaternaire, v. 32(4), p. 321-332.

Porch, N., Jordan, G.J., Price, D.M., Barnes, R.W., Macphail, M.K., and Pemberton, M., 2009, Last interglacial climates of south-eastern Australia: plant and beetle-based reconstructions from Yarra Creek, King Island, Tasmania: Quaternary Science Reviews, v. 28(27-28), p. 3197-3210.

Rock, J.L., 2009, Paleoclimatic interpretation of the Moorhead low water phase of Lake Agassiz in the southern basin based on fossil Coleoptera [Master's thesis]: Fargo, North Dakota State University, 130 p.

Schmidt, V.E., 1947, Varves in the Finger Lakes Region of New York State [Ph.D. thesis]: Ithaca, Cornell University.

Schwert, D.P., and Ashworth, A.C., 1988, Late Quaternary history of the northern beetle fauna of North America: a synthesis of fossil and distributional evidence: The Memoirs of the Entomological Society of Canada, v. 120(S144), p. 93-107.

Shapiro, B., et al., 2004, Rise and fall of the Beringian steppe bison: Science, v. 306(5701), p. 1561-1565.

Sinka, K.J., and Atkinson, T.C., 1999, A mutual climatic range method for reconstructing palaeoclimate from plant remains: Journal of the Geological Society, v. 156(2), p. 381-396.

Sirkin, L.A., 1982, Wisconsinan glaciation of Long Island, New York to Block Island, Rhode Island, *in* Larson, G., and Stone, B., eds., Late Wisconsinan Glaciation of New England: Dubuque, Kendall/Hunt Publishing Company, p. 35-59.

Sirkin, L., 1991, Stratigraphy of the Long Island platform: Journal of Coastal Research, Special Issue No. 11, Quaternary Geology of Long Island Sound and Adjacent Coastal Areas, Walter S. Newman memorial volume, p. 217-227.

Sirkin, L., and Stuckenrath, R., 1980, The Portwashingtonian warm interval in the northern Atlantic coastal plain: Geological Society of America Bulletin, v. 91(6), p. 332-336.

Smith, D.M., Cook, A., and Nufio, C.R., 2006, How physical characteristics of beetles affect their fossil preservation: Palaios, v. 21(3), p. 305-310.

Smetana, A., 1985, Revision of the subfamily Helophorinae of the Nearctic region (Coleoptera: Hydrophilidae): The Memoirs of the Entomological Society of Canada, v. 117(S131), p. 3-154.

Stork, N.E., McBroom, J., Gely, C., and Hamilton, A.J., 2015, New approaches narrow global species estimates for beetles, insects, and terrestrial arthropods: Proceedings of the National Academy of Sciences of the United States of America, v. 112, no. 24, p. 7519-7523.

Stuiver, M., Reimer, P.J., and Reimer, R.W., 2017, CALIB 7.1, http://calib.org, (accessed February 2017).

Syverson, K.M., and Colgan, P.M., 2011, The Quaternary of Wisconsin: an updated review of stratigraphy, glacial history and landforms, *in* Ehlers, J., Gibbard, P. L., and Hughes, P.D., eds., Quaternary Glaciations: Extent and Chronology – A Closer Look: Developments in Quaternary Science, 15: Elsevier, p. 537-552.

Szabo, J.P., 1997, Nonglacial surficial processes during the Early and Middle Wisconsinan substages from the glaciated Allegheny Plateau in Ohio: Ohio Journal of Science, v. 97(4), p. 66-71.

Szabo, J.P., and Chanda, A., 2004, Pleistocene glaciation of Ohio, USA, *in* Ehlers, J., and Gibbard, P.L., eds., Quaternary glaciations – extent and chronology: Part II: North America: Developments in Quarternary Sciences, Elsevier, v. 2, p. 233-236.

ter Braak, C.J., and Juggins, S., 1993, Weighted averaging partial least squares regression (WA-PLS): an improved method for reconstructing environmental variables from species assemblages, *in* van Dam, H., ed., Twelfth International Diatom Symposium: Springer, Dordrecht, v. 90, p. 485-502.

Thompson, R.S. and Anderson, K H., 2000, Biomes of western North America at 18,000, 6000 and 0 ^{14}C yr BP reconstructed from pollen and packrat midden data: Journal of Biogeography, v. 27(3), p. 555-584.

Viau, A.E., Gajewski, K., Sawada, M.C., and Bunbury, J., 2008, Low-and high-frequency climate variability in eastern Beringia during the past 25,000 year: Canadian Journal of Earth Sciences, v. 45(11), p. 1435-1453.

Wang, B., Shi, W., and Miao, Z., 2015, Confidence analysis of standard deviational ellipse and its extension into higher dimensional Euclidean space: PloS one, v.10(3), e0118537.

Whitmore, J., Gajewski, K., Sawada, M., Williams, J.W., Shuman, B., Bartlein, P.J., Minckley, T., Viau, A.E., Webb III, T., Shafer, S., and Anderson, P., 2005, Modern pollen data from North America and Greenland for multi-scale paleoenvironmental applications: Quaternary Science Reviews, v. 24(16), p. 1828-1848.

Wong, D.W., 1998, Measuring multiethnic spatial segregation: Urban Geography, v. 19(1), p. 77-87.

Young, R.A., and Burr, G.S., 2006, Middle Wisconsin glaciation in the Genesee Valley, NY: a stratigraphic record contemporaneous with Heinrich Event, H4: Geomorphology, v. 75(1), p. 226-247.

Zheng, Z., Yang, S., Deng, Y., Huang, K., Wei, J., Berne, S., and Suc, J.-P., 2011, Pollen record of the past 60 ka BP in the Middle Okinawa Trough: Terrestrial provenance and reconstruction of the paleoenvironment: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 307(1), p. 285-300.

APPENDIX. COLLECTION LOCALITIES AND CLIMATE DATA FOR SIX MILE CREEK

Table A-1. *Agonum quinquepunctatum* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Caribou mountain Wildland	59.06	-114.43	664	High Level A	58.62	-117.15	338	-326	-1.63	-21.6	-23.2	16.2	14.6
Canada	AB	Wentzel Lake, Caribou Mountain Wildland	59.06	-114.43	666	High Level A	58.62	-117.15	338	-328	-1.64	-21.6	-23.2	16.2	14.6
Canada	AB	Birch Mountains Wildland	57.60	-112.47	699	Fort Chipewyan A	58.72	-111.13	229	-470	-2.35	-23.2	-25.5	16.7	14.4
Canada	AB	Namur Lake, Birch Mountains Wildland Provincial Park	57.40	-112.75	736	Fort Chipewyan A	58.72	-111.13	229	-507	-2.54	-23.2	-25.7	16.7	14.2
Canada	AB	23-6-W5M	50.99	-114.75	1565	Cochrane	49.07	-81.03	275	-1290	-6.45	-18.4	-24.9	16.8	10.3
Canada	BC	Pink Mountain,	57.05	-122.68	1079	Baldonnel	56.23	-120.68	686	-393	-1.96	-12.9	-14.9	15.6	13.6
Canada	MB	Churchill	58.75	-94.15	0	Churchill Airport	58.73	-94.05	29	29	0.15	-26.7	-26.6	12.0	12.1
Canada	MB	5 km of Churchill	58.73	-94.12	8	Churchill Airport	58.73	-94.05	29	21	0.11	-26.7	-26.6	12.0	12.1
Canada	MB	Churchill River	58.76	-94.15	2	Churchill Airport	58.73	-94.05	29	27	0.14	-26.7	-26.6	12.0	12.1

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A1. *Agonum quinquepunctatum* collection localities and climate (continued)

Country	State/ Prov.	Colepteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	MB	Thompson area	59.47	-136.41	198	Churchill Airport	58.73	-94.05	29	-169	-0.84	-26.7	-27.5	15.8	15.0
Canada	QC	Great Whale River	59.65	-136.37	529	Schefferville	54.80	-66.82	522	-8	-0.04	-24.1	-24.1	12.4	12.4
Canada	QC	Hudson Bay	58.78	-94.15	505	Kuujjuarapik A	55.28	-77.75	12	-493	-2.46	-23.4	-25.9	10.6	8.1
Canada	QC	Kuujjuarapik, Hudson Bay	58.75	-94.02	93	Kuujjuarapik A	55.28	-77.75	12	-81	-0.40	-23.4	-23.8	10.6	10.2
Canada	YT	Rampart House	58.77	-94.00	384	Old Crow Airport	67.57	-139.83	250	-134	-0.67	-31.1	-31.8	14.6	13.9
Canada	YT	Stewart River	58.77	-94.08	1337	Beever Creek Airport	62.40	-140.87	649	-688	-3.44	-26.9	-30.3	14.0	10.6
USA	AK	Holy Cross, Lower Yukon	69.68	-129.00	46	Unalakleet AP	62.17	-159.75	18	-28	-0.14	-19.6	-19.7	13.1	12.9
USA	AK	Rampart	70.74	-117.78	406	Old Crow Airport	67.57	-139.83	250	-156	-0.78	-31.1	-31.9	14.6	13.8
USA	AK	Between Rapid R. and Rampart	64.30	-96.05	425	Old Crow Airport	67.57	-139.83	250	-175	-0.87	-31.1	-32.0	14.6	13.7

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-2. *Amara glacialis* collection localities and climate

Country	State/ Prov.	Colepteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
Canada	BC	Klehini River, (Miles 49 HainesHighway)	59.47	-136.41	445	Pleasant Camp	59.45	-136.37	274	-171	-0.86	-8.60	-9.46	14.20	13.34
Canada	BC	Klehini River, (Miles 50 HainesHighway)	59.65	-136.37	1342	Pleasant Camp	59.45	-136.37	274	-1067	-5.34	-8.60	-13.94	14.20	8.86
Canada	MB	Churchill	58.78	-94.15	7	Churchill Airport	58.74	-94.07	29	22	0.11	-26.70	-26.59	12.00	12.11
Canada	MB	Churchill (N of New Town Dump)	58.75	-94.02	9	Churchill Airport	58.74	-94.07	29	20	0.10	-26.70	-26.60	12.00	12.10
Canada	MB	Churchill (11 km E of; across from incinerator)	58.77	-94.00	10	Churchill Airport	58.74	-94.07	29	19	0.10	-26.70	-26.60	12.00	12.10
Canada	MB	Fort Churchill	58.77	-94.08	25	Churchill Airport	58.74	-94.07	29	5	0.02	-26.70	-26.68	12.00	12.02
Canada	NT	Anderson River (delta, vic. Of Jacobson Cabin)	69.68	-129.00	8	Tuktoyaktuk Airport	69.43	-133.03	4	-3	-0.02	-27.00	-27.02	11.00	10.98
Canada	NT	Ulukhaktok (Victoria Island)	70.74	-117.78	11	Ulukhaktok Airport	70.76	-117.81	36	25	0.13	-28.60	-28.47	9.20	9.33
Canada	NT	1 km SW. Baker Lk.	64.30	-96.05	11	Baker Lake A	96.3	-96.08	19	7	0.04	-32.30	-32.26	11.40	11.44
Canada	NU	Arviat (Eskimo Point)	61.11	-94.06	1	Rankin Inlet Airport	62.82	-92.12	32	31	0.16	-24.40	-24.24	10.90	11.06
Canada	NU	Bernard Harbour	68.77	-114.71	25	Kugluktuk	67.82	-115.14	23	-2	-0.01	-27.80	-27.81	10.70	10.69

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-2. *Amara glacialis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NU	Cockburn Point	68.88	-115.10	6	Kugluktuk	67.82	-115.14	23	17	0.08	-27.80	-27.72	10.70	10.78
Canada	NL	S to Hopedale	55.45	-60.21	18	Nain Airport	56.55	-61.68	6	-12	-0.06	-18.50	-18.56	10.10	10.04
Canada	ON	Cape Henrietta	55.17	-82.32	0	Kuujjuarapik Airport	55.28	-77.75	12	12	0.06	-23.40	-23.34	10.60	10.66
Canada	QC	Cap Wolstenholme	62.52	-77.39	90	Inukjuak UA	58.46	-78.10	24	-66	-0.33	-24.80	-25.13	9.40	9.07
Canada	QC	Cap Wolstenholme	62.50	-77.51	191	Inukjuak UA	58.46	-78.10	24	-167	-0.84	-24.80	-25.64	9.40	8.56
Canada	QC	Great Whale	54.73	-70.20	522	Schefferville	54.8	-66.82	522	0	0.00	-24.10	-24.10	12.40	12.40
Canada	QC	Kuujjuarapik, Coast Hudson	55.28	-77.73	87	Kuujjuarapik Airport	55.28	-77.75	12	-75	-0.37	-23.40	-23.77	10.60	10.23
Canada	YT	Eagle River (Dempster HWY at Km 382)	66.44	-136.71	339	Old Crow Airport	67.57	-139.83	250	-89	-0.45	-31.10	-31.55	14.60	14.15
Canada	YT	Rampart House	67.40	-140.98	405	Margaret Lake	68.8	-140.85	568	163	0.82	-30.30	-29.48	13.50	14.32
USA	AK	Aleutians West, St.Paul Vlg.(3.2km of N)	57.89	-166.54	-1	St.Paul Island	57.17	-170.22	7	7	0.04	-3.50	-3.46	8.17	8.20
USA	AK	Aleutians West, St.Paul Vlg.	57.40	-170.28	28	St.Paul Island	57.17	-170.22	7	-21	-0.11	-3.50	-3.61	8.17	8.06
USA	AK	North Slope Borough, Umiat	69.37	-152.14	79	Umiat	69.37	-152.13	81	2	0.01	-30.06	-30.05	12.61	12.62
USA	AK	Dalton Hwy mi. 156	67.02	-150.27	700	Prudhoe Bay	70.25	-148.33	23	-677	-3.39	-11.17	-14.55	13.00	9.61
USA	AK	Dalton Hwy mi. 226.5	67.88	-149.82	585	Prudhoe Bay	70.25	-148.33	23	-562	-2.81	-11.17	-13.98	13.00	10.19

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-2. *Amara glacialis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Dalton Hwy mi. 207	67.65	-149.72	443	Prudhoe Bay	70.25	-148.33	23	-421	-2.10	-11.17	-13.27	13.00	10.90
USA	AK	Dalton Hwy mi. 404	70.05	-148.57	46	Prudhoe Bay	70.25	-148.33	23	-23	-0.11	-11.17	-11.28	13.00	12.89
USA	AK	Dalton Hwy mi. 412.3	70.18	-148.43	15	Prudhoe Bay	70.25	-148.33	15	0	0.00	-11.17	-11.17	13.00	13.00
USA	AK	Prudhoe Bay	70.28	-147.87	12	Prudhoe Bay	70.25	-148.33	15	3	0.02	-11.17	-11.15	13.00	13.02
USA	AK	Dalton Hwy mi. 267.5	68.38	-149.33	809	Prudhoe Bay	70.25	-148.33	15	-794	-3.97	-11.17	-15.14	13.00	9.03
USA	AK	North Slope Borough, Meade River	70.48	-157.41	18	Barrow AP	71.28	-156.78	9	-9	-0.04	-25.39	-25.43	4.67	4.62
USA	AK	Nome Div., 51.5 Km E of Nome	64.48	-165.25	24	Nome WSO Airport	64.52	-165.45	25	1	0.00	-14.56	-14.55	11.44	11.45
USA	AK	Nome Div., 12.8 Km N of Nome	64.59	-165.45	61	Nome WSO Airport	64.52	-165.45	25	-36	-0.18	-14.56	-14.74	11.44	11.26
USA	AK	32 mi. E of Nome Div.	64.60	-164.37	70	Nome WSO Airport	64.52	-165.45	25	-45	-0.23	-14.56	-14.78	11.44	11.22
USA	AK	8 mi E of Nome Div.	64.52	-165.14	65	Nome WSO Airport	64.52	-165.45	25	-40	-0.20	-14.56	-14.76	11.44	11.24

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-2. *Amara glacialis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Kenai Peninsula	68.88	-151.30	1027	Venta	59.83	-150.97	3352	2325	11.62	-9.06	2.57	17.17	28.79
USA	AK	Seward	60.10	-149.44	28	Seward 9 NW	60.20	-149.62	149	122	0.61	-11.83	-11.23	66.20	66.81
USA	AK	Snow R. Delta	64.04	-145.73	353	Rikas Landing	64.15	-145.85	387	34	0.17	-27.22	-27.05	22.78	22.95
USA	AK	Tiekel R.	61.38	-145.24	442	Valdez	61.12	-146.27	3	-439	-2.19	-11.11	-13.30	15.67	13.47
USA	AK	Summit Lake	61.62	-149.52	413	Copper Lake Project	60.37	-149.67	137	-276	-1.38	-10.28	-11.66	18.56	17.17
USA	AK	Port Heiden	56.95	-158.63	27	Port Heiden	56.95	-158.62	30	3	0.02	-8.67	-8.65	14.06	14.07
USA	AK	St. Paul	57.18	-170.25	39	St.Paul Island WSO AP	57.15	-170.22	9	-30	-0.15	-5.78	-5.93	10.00	9.85
USA	AK	Goodnews Bay	59.12	-161.59	15	Platinum	59.02	-161.78	6	-9	-0.05	-13.78	-13.82	14.17	14.12
USA	AK	Umiat	69.37	-152.14	84	Umiat	69.37	-152.13	104	20	0.10	-33.83	-33.74	19.00	19.10
USA	AK	Atkasuk, Meade River	70.47	-157.40	16	Wainright	70.62	-160.07	9	-6	-0.03	-14.22	-14.25	10.00	9.97
USA	AK	Alaska-Yukon Border	69.33	-141.02	651	Margaret	68.80	-140.85	568	-83	-0.42	-30.30	-30.72	13.50	13.08
USA	AK	Between Rapid R. and Rampart H.	67.41	-141.00	244	Margaret	68.80	-140.85	568	324	1.62	-30.30	-28.68	13.50	15.12
USA	AK	Nome Div., New Igloo (Halfway Between town and Hwy	65.13	-165.20	3	Nome WSO Airport	64.52	-165.45	25	22	0.11	-14.56	-14.45	11.44	11.55
USA	AK	Lake and peninsula Borough, Port Heiden	56.96	-158.64	27	Port Heiden	56.95	-158.62	28	1	0.00	-5.28	-5.27	11.22	11.23
USA	AK	Valdez-Cordova, Gunn Creek (Richardson Hwy mi. 197)	63.17	-145.53	984	Salcha	64.50	-146.98	207	-777	-3.88	-20.78	-24.66	15.72	11.84
USA	AK	Kenai Peninsula	60.04	-151.04	246	Kenai Municipal AP	60.58	-151.23	26	-219	-1.10	-10.33	-11.43	12.78	11.68

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-2. *Amara glacialis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
USA	AK	Seward	60.10	-149.44	29	Seward 9 N	60.33	-149.35	151	122	0.61	-6.56	-5.95	12.61	13.22
USA	AK	Snow R. Delta	60.33	-149.34	147	Seward 9 N	60.33	-149.35	151	4	0.02	-6.56	-6.54	12.61	12.63
USA	AK	Tiekel R.	61.22	-144.85	88	Valdez	61.12	-146.35	7	-81	-0.41	-5.61	-6.02	12.89	12.48
USA	AK	Summit Lake	60.63	-149.51	533	Kenai Municipal AP	60.58	-151.23	26	-507	-2.54	-10.33	-12.87	12.78	10.24
USA	AK	Port Heiden	56.96	-158.64	26	Port Heiden	56.95	-158.62	28	2	0.01	-5.28	-5.27	11.22	11.23
USA	AK	St. Paul	57.13	-170.25	24	St.Paul Island WSO AP	57.15	-170.22	7	-17	-0.09	-3.50	-3.59	8.17	8.08
USA	AK	Goodnews Bay	59.12	-161.59	77	Bethel AP	60.78	-161.83	38	-39	-0.20	-14.11	-14.31	13.33	13.14
USA	AK	Umiat	69.37	-152.14	79	Umiat	69.37	-152.13	81	2	0.01	-30.06	-30.05	12.61	12.62
USA	AK	Atkasuk, Meade River	70.47	-157.40	21	Umiat	69.37	-152.13	81	60	0.30	-30.06	-29.76	12.61	12.91
USA	AK-YT	Alaska-Yukon Border	69.33	-141.02	890	Prudhoe Bay	70.25	-148.33	15	-874	-4.37	-11.17	-15.54	13.00	8.63
USA	AK-YT	Between Rapid R. And Rampart H.	67.37	-141.27	420	Old Crow Airport	67.57	-139.83	250	-170	-0.85	-31.10	-31.95	14.60	13.75

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-3. *Amara quenseli* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
Canada	AB	Edmonton	53.53	-113.52	673	Slave Lake A	55.30	-114.78	580	-93	-0.46	-14.50	-14.96	15.60	15.14
Canada	AB	Edmonton (Ellerslie Research Farm)	53.43	-113.54	692	Slave Lake A	55.30	-114.78	580	-112	-0.56	-14.50	-15.06	15.60	15.04
Canada	AB	Clyde (9.7 km N)	54.23	-113.60	664	Slave Lake A	55.30	-114.78	580	-84	-0.42	-14.50	-14.92	15.60	15.18
Canada	AB	Heatherdown	53.64	-114.15	747	Slave Lake A	55.30	-114.78	580	-167	-0.84	-14.50	-15.34	15.60	14.76
Canada	AB	Morinville (Morrinville Study Site)	53.80	-113.60	703	Slave Lake A	55.30	-114.78	580	-123	-0.61	-14.50	-15.11	15.60	14.99
Canada	AB	Drayton Valley (North Saskatchewan River)	53.20	-114.93	747	Slave Lake A	55.30	-114.78	580	-167	-0.83	-14.50	-15.33	15.60	14.77
Canada	AB	Calahoo	53.71	-113.95	685	Slave Lake A	55.30	-114.78	580	-105	-0.52	-14.50	-15.02	15.60	15.08
Canada	AB	Waterton Lakes National Park	49.05	-113.91	1295	Cypress Hill	49.67	-109.47	1196	-99	-0.50	-9.50	-10.00	15.40	14.90
Canada	AB	Waterton Lakes National Park	49.07	-113.77	2067	Cypress Hill	49.67	-109.47	1196	-871	-4.35	-9.50	-13.85	15.40	11.05
Canada	AB	Hwy 48	50.76	-114.08	1203	Cypress Hill	49.67	-109.47	1196	-7	-0.04	-9.50	-9.54	15.40	15.36
Canada	AB	Pincher Creek (17.7 km S)	49.33	-113.93	1401	Cypress Hill	49.67	-109.47	1196	-205	-1.02	-9.50	-10.52	15.40	14.38

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-3. *Amara quenseli* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorolog-ical station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Wildhay River	53.47	-118.22	1410	Edson A	53.47	-118.21	927	-483	-2.42	-11.80	-14.22	14.60	12.18
Canada	AB	Rock Lake	53.47	-118.25	1413	Edson A	53.47	-118.21	927	-486	-2.43	-11.80	-14.23	14.60	12.17
Canada	AB	Lodgepole	53.10	-115.32	935	Edson A	53.47	-118.21	927	-8	-0.04	-11.80	-11.84	14.60	14.56
Canada	AB	Kootenay Plains	52.06	-116.42	2392	Edson A	53.47	-118.21	927	-1465	-7.33	-11.80	-19.13	14.60	7.27
Canada	AB	Kootenay River (27.3 km N of Kimberley)	49.80	-115.77	780	Edson A	53.47	-118.21	927	147	0.73	-11.80	-11.07	14.60	15.33
Canada	BC	Alaska Hwy (Mile 179)	57.50	-122.90	1186	Edson A	53.47	-118.21	927	-258	-1.29	-11.80	-13.09	14.60	13.31
Canada	BC	Summerland (32 km E of)	49.61	-119.29	1443	Edson A	53.47	-118.21	927	-515	-2.58	-11.80	-14.38	14.60	12.02
Canada	BC	Princeton (48 km E of)	49.28	-120.02	899	Edson A	53.47	-118.21	927	28	0.14	-11.80	-11.66	14.60	14.74
Canada	BC	Fernie (90 km W of on Route 3)	49.57	-115.69	919	Edson A	53.47	-118.21	927	8	0.04	-11.80	-11.76	14.60	14.64
Canada	BC	Golden	51.30	-116.96	858	Edson A	53.47	-118.21	927	69	0.35	-11.80	-11.45	14.60	14.95
Canada	BC	Invermere (near; at Wilmer Marshes)	50.54	-116.06	856	Edson A	53.47	-118.21	927	71	0.36	-11.80	-11.44	14.60	14.96
Canada	BC	Pavilion Mountain (Near Pavilion)	50.87	-121.83	929	Edson A	53.47	-118.21	927	-2	-0.01	-11.80	-11.81	14.60	14.59
Canada	NT	Inuvik (east edge of town)	68.36	-133.71	46	Inuvik A	68.30	-133.48	68	22	0.11	-11.80	-11.69	14.60	14.71

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-3. *Amara quenseli* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Tuktoyaktuk	69.42	-133.00	8	Inuvik A	68.30	-133.48	68	60	0.30	-11.80	-11.50	14.60	14.90
Canada	NT	Fort Providence	61.34	-117.66	143	Yellowknife Hydro	62.67	-114.25	159	16	0.08	-27.30	-27.22	15.40	15.48
Canada	NT	Pine Point	60.83	-114.45	231	Yellowknife Hydro	62.67	-114.25	159	-72	-0.36	-27.30	-27.66	15.40	15.04
Canada	YT	Stewart River (Proctor's sawmill)	63.53	-137.35	484	Pelly Ranch	62.82	-137.37	454	-30	-0.15	-27.50	-27.65	15.50	15.35
Canada	YT	Watson Lake	60.06	-128.71	703	Pelly Ranch	62.82	-137.37	454	-249	-1.24	-27.50	-28.74	15.50	14.26
Canada	YT	White Horse	60.70	-135.08	751	Otter Falls NCPC	61.03	-137.05	830	79	0.39	-16.10	-15.71	13.00	13.39
USA	AK	Aleutians West, Mt. Makushn (N slope)	53.94	-166.92	565	Dutch Harbor	53.88	-166.53	3	-562	-2.81	-0.28	-3.09	10.50	7.69
USA	AK	Aleutians West, Umnak Village	53.27	-168.22	1356	Dutch Harbor	53.88	-166.53	3	-1353	-6.76	-0.28	-7.04	10.50	3.74
USA	AK	Aleutians West, Umnak Village (16 km N of)	53.19	-168.54	579	Dutch Harbor	53.88	-166.53	3	-576	-2.88	-0.28	-3.16	10.50	7.62
USA	AK	Aleutians West, Umnak Village (3.2 km N of)	53.31	-168.30	674	Dutch Harbor	53.88	-166.53	3	-671	-3.35	-0.28	-3.63	10.50	7.15
USA	AK	Aleutians West, Tulik Volcano	53.37	-168.06	1235	Dutch Harbor	53.88	-166.53	3	-1232	-6.16	-0.28	-6.44	10.50	4.34
USA	AK	Aleutians West, Crater Creek (near Ogmok Caldera)	53.55	-167.98	26	Dutch Harbor	53.88	-166.53	3	-23	-0.11	-0.28	-0.39	10.50	10.39
USA	AK	Aleutians West, Unalaska	53.87	-166.51	35	Dutch Harbor	53.88	-166.53	3	-32	-0.16	-0.28	-0.44	10.50	10.34
USA	AK	Aleutians West, Saint Paul Island (3.2 km N of)	53.89	-166.54	16	Dutch Harbor	53.88	-166.53	3	-13	-0.06	-0.28	-0.34	10.50	10.44

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-3. *Amara quenseli* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Kodiak Island borrough, Old Women's Mtn	57.74	-152.66	415	Kodiak AP	57.75	-152.48	24	-391	-1.95	-1.28	-3.23	12.28	10.33
USA	AK	Kodiak Island borrough, Kodiak Village (20 km N)	57.90	-152.62	227	Kodiak AP	57.75	-152.48	24	-202	-1.01	-1.28	-2.29	12.28	11.27
USA	AK	Kodiak Island borrough, Kodiak Village (19 km N)	57.89	-152.53	132	Kodiak AP	57.75	-152.48	24	-108	-0.54	-1.28	-1.82	12.28	11.74
USA	AK	Aleutians West, Saint Paul Island	57.17	-170.19	12	St. Paul Island	57.15	-170.22	24	12	0.06	-3.50	-3.44	8.17	8.23
USA	AK	Lake and Peninsula Borough, Port Heiden	56.96	-158.64	25	King Salmon	58.67	-156.65	20	-4	-0.02	-9.22	-9.24	13.17	13.15
USA	AK	Kenai Peninsula Borough, Port Heiden	60.04	-151.38	246	Kenai 9N	60.67	-151.32	38	-207	-1.04	-9.56	-10.59	13.11	12.07
USA	AK	Valdez-Cordova, Gulkana River (Paxon's lodge)	62.87	-145.51	850	Slana	62.70	-143.98	671	-179	-0.90	-15.39	-16.29	13.39	12.49
USA	AK	Valdez-Cordova, Gunn Creek (Richardson Hwy Mi 197)	63.17	-145.53	984	Slana	62.70	-143.98	671	-314	-1.57	-15.39	-16.96	13.39	11.82
USA	AK	Nome Div., Nome (6.4 km E of)	64.48	-165.25	13	Nome WSO Airport	64.50	-165.43	4	-9	-0.05	-14.56	-14.61	11.40	11.35
USA	AK	Fairbanks North Star, Richardson Hwy Mi 320	64.69	-147.14	166	Salcha	64.48	-146.97	4	-162	-0.81	-20.78	-21.59	15.72	14.91
USA	AZ	Apache National Forest (27.4 km SW of Eagar on Ariz. 273)	33.93	-109.51	2953	Alpine	36.05	-112.15	2454	-499	-2.50	-1.61	-4.11	16.44	13.95

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-3. *Amara quenseli* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	CO	Mineral County, thunder Mountain (US 160; Wolf Creek)	37.48	-106.80	3343	Pagosa Springs	37.23	-107.02	2210	-1133	-5.66	-6.11	-11.78	17.78	12.11
USA	CO	Costilla County, La Veta Pass (Pass Creek Road)	37.51	-105.30	2911	Pagosa Springs	37.23	-107.02	2210	-701	-3.50	-6.11	-9.61	17.78	14.27
USA	CO	Huerfano County (Pass Creek Road; 5.6 km N of US 160)	37.64	-105.21	2670	Pagosa Springs	37.23	-107.02	2210	-460	-2.30	-6.11	-8.41	17.78	15.48
USA	CO	Larimer County (Crown Point Rod; 24.7 km SW of junction)	40.65	-105.69	3178	Laramie 2 NW	41.33	-105.60	2176	-1002	-5.01	-6.50	-11.51	17.17	12.16
USA	ID	Dubois (near; on US 91), Clark County	44.15	-113.22	1907	Dubois Exp Stn.	46.77	-116.18	889	-1018	-5.09	-4.89	-9.98	16.00	10.91
USA	MT	Silver Bow County, Butte	45.78	-112.72	1722	Cascade 20 SSE	47.25	-111.72	1024	-697	-3.49	-4.44	-7.93	16.50	13.01
USA	NM	Sandoval County, Valles Caldera National Preserve (Valle Grande)	35.86	-106.51	2619	Roy	35.94	-104.18	1792	-828	-4.14	0.50	-3.64	14.78	10.64
USA	OR	Umatilla County, Cold Springs Canyon	45.88	-120.20	627	Newport	44.65	124.05	37	-589	-2.95	7.22	4.27	14.39	11.44
USA	UT	Garfield County, Hatch	37.42	-112.54	2117	Alpine	40.45	-111.77	1545	-572	-2.86	-2.33	-5.19	17.17	14.31
USA	UT	Glendale, Kane County	37.61	-112.47	2181	Alpine	40.45	-111.77	1545	-635	-3.18	-2.33	-5.51	17.17	13.99

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Morinville	53.80	-113.60	700	Cross Lake	54.64	-113.91	655	-45	-0.22	-15.30	-15.52	15.40	15.18
Canada	AB	Medicine Hat	50.05	-110.65	662	Cross Lake	54.64	-113.91	655	-7	-0.04	-15.30	-15.34	15.40	15.36
Canada	AB	South Saskatchewan River (Medicine Hat)	50.04	-110.71	667	Cross Lake	54.64	-113.91	655	-12	-0.06	-15.30	-15.36	15.40	15.34
Canada	AB	Caribou Mountains Wildland Park	59.02	-114.47	663	Fort Chipewyan A	58.47	-111.12	232	-431	-2.15	-23.20	-25.35	16.70	14.55
Canada	AB	Caribou Mountains Wildland Park,	59.03	-114.45	668	Fort Chipewyan A	58.77	-111.12	232	-436	-2.18	-23.20	-25.38	16.70	14.52
Canada	AB	Caribou Mountains Wildland Park,	58.98	-114.43	673	Fort Chipewyan A	58.77	-111.12	232	-441	-2.21	-23.20	-25.41	16.70	14.49
Canada	AB	Birch Mountains Wildland Prov. Park, Gardiner Lakes	57.58	-112.46	676	Fort Chipewyan A	58.77	-111.12	232	-444	-2.22	-23.20	-25.42	16.70	14.48
Canada	AB	Caribou Mtns Wildland Park, Wentzel River	59.11	-114.50	669	Fort Chipewyan A	58.77	-111.12	232	-437	-2.19	-23.20	-25.39	16.70	14.51
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lk.	59.06	-114.43	664	Fort Chipewyan A	58.77	-111.12	232	-432	-2.16	-23.20	-25.36	16.70	14.54
Canada	AB	Oldman River (Leftbridge)	49.70	-112.87	826	Cross Lake	54.64	-113.91	655	-171	-0.86	-15.30	-16.16	15.40	14.54

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Lacombe (Agri. Canada research centre)	52.44	-113.72	851	Cross Lake	54.64	-113.91	655	-196	-0.98	-15.30	-16.28	15.40	14.42
Canada	AB	Birch Mountains Wildland Prov. Park, Gardiner Lakes	57.53	-112.48	735	Fort Chipewyan A	58.47	-111.12	232	-503	-2.52	-23.20	-25.72	16.70	14.18
Canada	AB	Red Deer (11.3)	52.40	-113.80	880	Cross Lake	54.64	-113.91	655	-225	-1.12	-15.30	-16.42	15.40	14.28
Canada	AB	Bistcho Lake (Tapawingo Lodge)	59.85	-118.65	563	Keg River RS	57.76	-117.62	405	-158	-0.79	-19.40	-20.19	15.30	14.51
Canada	AB	St. Mary River (near Leftbridge)	49.59	-112.88	850	Cross Lake	54.64	-113.91	655	-195	-0.98	-15.30	-16.28	15.40	14.42
Canada	AB	Birch Mountains Wildland Prov. Park, Gardiner Lakes	57.53	-112.49	677	Fort Chipewyan A	58.77	-111.12	232	-445	-2.22	-23.20	-25.42	16.70	14.48
Canada	AB	Kakwa Wildland Prov. Pk., Pine Ridge, Dead Horse meadows	54.09	-119.82	1278	Grande Cache Rs	53.90	-119.10	1250	-29	-0.14	-7.10	-7.24	13.30	13.16
Canada	AB	Kakwa Wildland Prov. Pk., Pine Ridge, ridge line near camp)	54.14	-119.94	1513	Grande Cache Rs	53.90	-119.10	1250	-264	-1.32	-7.10	-8.42	13.30	11.98
Canada	AB	Jasper Nat. Pk, Jasper Lake	53.12	-117.99	1006	Robb RS	53.23	-116.96	1130	125	0.62	-9.60	-8.98	14.20	14.82
Canada	AB	Kakwa Wildland Prov. Pk., Mouse Cache Creek	54.15	-119.93	1787	Grande Cache Rs	53.90	-119.10	1250	-537	-2.69	-7.10	-9.79	13.30	10.61
Canada	AB	Kakwa Wildland Prov. Pk.	54.17	-119.93	1503	Grande Cache Rs	53.90	-119.10	1250	-253	-1.26	-7.10	-8.36	13.30	12.04

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	BC	Pine River (Mouth, Taylor)	56.10	-120.71	658	Beaver Lodge CDA	55.20	-119.40	677	19	0.09	-11.70	-11.61	14.10	14.19
Canada	BC	Sikanni River (Mile 160 Alaska Hwy)	57.24	-122.69	794	Fort Nelson A	58.84	-122.60	382	-412	-2.06	-21.20	-23.26	16.80	14.74
Canada	BC	Klehini R. (Mile 49 Haines Hwy)	59.48	-136.41	471	Pleasaant Camp	59.45	-135.37	274	-196	-0.98	-8.60	-9.58	14.20	13.22
Canada	BC	Racing River (Mile 418.7 on Alaska Hwy.)	58.82	-125.14	692	Fort Nelson A	58.84	-122.60	382	-310	-1.55	-21.20	-22.75	16.80	15.25
Canada	BC	Blanchard River (Mile 93 (Km 150) on haines Hwy.)	60.00	-138.85	1321	Pleasant Camp	59.45	-136.37	274	-1046	-5.23	-8.60	-13.83	14.20	8.97
Canada	NT	Anderson River (Macfarlane Island)	69.57	-128.55	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (Delta , White Front Island)	69.64	-128.75	43	Tuktoyaktuk A	69.43	-133.03	4	-39	-0.19	-26.60	-26.79	11.00	10.81
Canada	NT	Anderson River (delta, Boat Island)	69.67	-128.93	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Peel River (Dempster Hwy at at Peel R.)	65.71	-138.00	475	Inuvik A	68.30	-133.48	68	-407	-2.04	-11.80	-13.84	14.60	12.56
Canada	NT	Anderson River (delta, Nugluk Creek)	69.63	-128.90	7	Tuktoyaktuk A	69.43	-133.03	4	-3	-0.02	-26.60	-26.62	11.00	10.98
Canada	NT	Anderson River	69.71	-128.97	11	Tuktoyaktuk A	69.43	-133.03	4	-6	-0.03	-26.60	-26.63	11.00	10.97
Canada	NT	Mason River (Cape Bathurst)	69.93	-128.32	29	Tuktoyaktuk A	69.43	-133.03	4	-25	-0.12	-26.60	-26.72	11.00	10.88

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Anderson River (delta,Oil Drum island)	69.73	-128.99	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (delta, Fox Den Island, S end)	69.67	-128.98	1	Tuktoyaktuk A	69.43	-133.03	4	3	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (delta, Flat island)	69.70	-128.99	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (delta, Krekovic landing)	69.71	-128.97	13	Tuktoyaktuk A	69.43	-133.03	4	-9	-0.04	-26.60	-26.64	11.00	10.96
Canada	NT	Anderson River (delta, vic. of Jacobson cabin)	69.73	-128.99	11	Tuktoyaktuk A	69.43	-133.03	4	-6	-0.03	-26.60	-26.63	11.00	10.97
Canada	NT	Anderson River (Husky bend)	69.40	-128.16	12	Tuktoyaktuk A	69.43	-133.03	4	-8	-0.04	-26.60	-26.64	11.00	10.96
Canada	NT	Anderson River (delta, vic. Of Jacobson cabin)	69.59	-128.65	27	Tuktoyaktuk A	69.43	-133.03	4	-22	-0.11	-26.60	-26.71	11.00	10.89
Canada	NT	Anderson River (Windy bend)	69.25	-128.26	20	Tuktoyaktuk A	69.43	-133.03	4	-16	-0.08	-26.60	-26.68	11.00	10.92
Canada	SK	Cypress Hills, Fort Walsh	49.57	-109.88	1115	Sask. Diefkr. Int'l A	52.17	-106.72	504	-611	-3.05	-17.00	-20.05	18.20	15.15
USA	AK	SE Fairbank Div., Big Gerstle R. (Alaska Hwy Mile 1393)	63.98	-145.58	390	Gilmore Creek	64.97	-147.52	296	-94	-0.47	-20.00	-20.47	14.89	14.42
USA	AK	SE Fairbank Div.,Robertson R. (Mile 1348)	63.49	-143.84	492	Gilmore Creek	64.97	-147.52	296	-196	-0.98	-20.00	-20.98	14.89	13.91
USA	AK	Matanuska-Susitna Borough (Junction Knik Road & Glenn Highway)	61.49	-149.25	8	Intricate Bay	59.57	-154.47	52	44	0.22	-8.39	-8.17	13.50	13.72
USA	AK	Kenai Peninsula Borough,Homer Spit	60.04	-151.38	246	Kenai Municipal AP	60.62	-151.23	38	-207	-1.04	-9.56	-10.59	13.11	12.07

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Fair banks Northstar, Steese Hwy (Mile 9)	64.92	-147.62	269	Gilmore Creek	64.97	-147.52	296	27	0.14	-20.00	-19.86	14.89	15.02
USA	AK	Yukon-Koyukuk Div., Circle (Yukon R.)	65.82	-144.08	183	Gilmore Creek	64.97	-147.52	296	112	0.56	-20.00	-19.44	14.89	15.45
USA	AK	Yukon-Koyukuk Div.,Mammoth Creek (Mile 116.4 Steede Hwy)	65.55	-145.18	497	Gilmore Creek	64.97	-147.52	296	-201	-1.01	-20.00	-21.01	14.89	13.88
USA	AK	Haines Borough, Haines Hwy, (Miles 4.5)	59.26	-135.55	757	Haines	59.23	-135.50	5	-753	-3.76	-4.83	-8.60	14.72	10.96
USA	AK	Haines Borough, Haines Hwy, (Miles 15.3)	59.36	-135.77	1219	Haines	59.23	-135.50	5	-1215	-6.07	-4.83	-10.91	14.89	8.82
USA	AK	North Slope Borough, Umiat	69.37	-152.14	79	Kuparuk	70.32	-149.58	20	-60	-0.30	-27.50	-27.80	8.22	7.92
USA	UT	Grand County, La Sal Mountains (Warner Campground, E of Moab)	38.50	-109.16	2945	Marysvale	38.45	-112.23	1801	-1144	-5.72	-1.44	-7.16	21.22	15.50
USA	WY	Platte county, Glendo Reservoir (nr. Glendo)	42.48	-104.99	1430	Laramie RGNL AP	41.30	-105.67	1807	378	1.89	-6.44	-4.56	13.67	15.55
Canada	YT	Engineer Creek	65.17	-138.37	742	Dawson A	64.04	-139.13	370	-372	-1.86	-26.70	-28.56	15.60	13.74
Canada	YT	Old Crow (vicinity of)	67.56	-139.82	261	Old Crow A	67.57	-139.84	250	-10	-0.05	-31.10	-31.15	14.60	14.55
Canada	YT	White River (Mile 1169 on Alaska Hwy.	61.99	-140.56	777	Dawson A	64.04	-139.13	370	-407	-2.03	-26.70	-28.73	15.60	13.57

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-4. *Bembidion sordidum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Stewart River (Proctor's sawmill)	63.53	-137.35	494	Dawson A	64.04	-139.13	370	-123	-0.62	-26.70	-27.32	15.60	14.98
USA	AK	Fair banks Northstar, Steese Hwy (Mile 9)	64.92	-147.62	328	Gilmore Creek	64.97	-147.52	288	-40	-0.20	-20.00	-20.20	14.89	14.69
USA	AK	Haines Borough, Haines Hwy.	59.36	-135.77	27	Haines	59.23	-135.50	5	-22	-0.11	-4.83	-4.94	14.72	14.61
USA	AK	Haines Borough, Haines Hwy	59.26	-135.55	266	Haines	59.23	-135.50	5	-262	-1.31	-4.83	-6.14	14.72	13.41

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-5. *Carabus chamissonis* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Mirror	52.43	-113.12	803	Slave Lake A	55.30	-114.78	580	-223	-1.11	-14.50	-15.61	15.60	14.49
Canada	AB	Conjuring Creek	53.32	-113.83	730	Slave Lake A	55.30	-114.78	580	-150	-0.75	-14.50	-15.25	15.60	14.85
Canada	AB	South to Edmonton	53.40	-113.45	708	Slave Lake A	55.30	-114.78	580	-128	-0.64	-14.50	-15.14	15.60	14.96
Canada	AB	George Lake	52.96	-112.15	719	Slave Lake A	55.30	-114.78	580	-139	-0.70	-14.50	-15.20	15.60	14.90
Canada	AB	Dunstable (12.9 Km)	53.95	-114.40	717	Slave Lake A	55.30	-114.78	580	-137	-0.68	-14.50	-15.18	15.60	14.92
Canada	AB	Alberta (28-5-W5M)	51.40	-114.61	1282	Slave Lake A	55.30	-114.78	580	-702	-3.51	-14.50	-18.01	15.60	12.09
Canada	AB	Fred Creek (ca. 14.4 km N, Hwy 40)	53.68	-118.24	1411	Simonette	54.42	-117.74	884	-527	-2.64	-10.30	-12.94	14.80	12.16
Canada	AB	Peace River (90km NW, EMEND)	56.77	-118.37	728	Eureka River	56.48	-118.73	665	-64	-0.32	-18.30	-18.62	14.60	14.28
Canada	AB	Dixonville (NW of, EMEND site)	56.77	-118.37	782	Eureka River	56.48	-118.73	665	-117	-0.59	-18.30	-18.89	14.60	14.01
Canada	BC	Entrance to Muncho, province Park	59.00	-125.52	1655	Muncho Lake	58.93	-125.77	837	-818	-4.09	-15.50	-19.59	13.90	9.81
Canada	BC	Pink Mtn (27.8 km W of Alaska Highway)	57.11	-123.37	1936	Muncho Lake	58.93	-125.77	837	-1099	-5.50	-15.50	-21.00	13.90	8.40
Canada	BC	Stone Mntn Prov. Park (Alaska HW Km 641.3)	58.66	-124.67	1839	Muncho Lake	58.93	-125.77	837	-1003	-5.01	-15.50	-20.51	13.90	8.89

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-5. *Carabus chamissonis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	BC	N of E Entrance to Muncho	59.00	-125.52	1654	Muncho Lake	58.93	-125.77	837	-817	-4.09	-15.50	-19.59	13.90	9.81
Canada	MB	South to Oxford House	54.90	-95.27	200	Churchill A	58.74	-94.07	28	-171	-0.86	-26.70	-27.56	12.00	11.14
Canada	MB	Iskwasum Lake	54.60	-100.83	297	Churchill A	58.74	-94.07	28	-268	-1.34	-26.70	-28.04	12.00	10.66
Canada	MB	Grass range - 16 KM from Iskwasum Lake, Manitoba, Canada	54.63	-100.00	282	Churchill A	58.74	-94.07	28	-253	-1.27	-26.70	-27.97	12.00	10.73
Canada	MB	Bird Cove, Churchill	58.67	-93.87	26	Churchill Climate	58.73	-94.07	29	3	0.02	-26.70	-26.68	12.00	12.02
Canada	NF	Red Barren Brook	48.94	-56.48	207	Pools Cove Fortune Bay	47.70	-55.58	150	-57	-0.28	-6.10	-6.38	14.80	14.52
Canada	NT	Anderson River (delta, Krekovik landing)	69.71	-128.97	15	Inuvik A	68.30	-133.48	68	53	0.27	-27.60	-27.33	14.20	14.47
Canada	NT	Ulukhaktok (Holman)	70.75	-117.76	23	Ulukhaktok A	70.76	-117.81	36	13	0.07	-28.60	-28.53	9.20	9.27
Canada	NT	Kings Bay	70.72	-117.77	388	Ulukhaktok A	70.76	-117.81	36	-352	-1.76	-28.60	-30.36	9.20	7.44
Canada	NT	Ukpilik Lake	71.05	-115.90	454	Ulukhaktok A	70.76	-117.81	36	-418	-2.09	-28.60	-30.69	9.20	7.11
Canada	NT	Holman	70.74	-117.80	4	Ulukhaktok A	70.76	-117.81	36	32	0.16	-28.60	-28.44	9.20	9.36
Canada	NT	Normon Wells	55.30	-124.82	1174	Mackenzie A	55.28	-123.14	500	-674	-3.37	-11.40	-14.77	14.90	11.53
Canada	NU	Port Burwell	60.47	-64.78	60	Kuujjuaq A	58.10	-68.42	39	-21	-0.11	-24.30	-24.41	11.50	11.39
Canada	NU	Bathurst Inlet	66.83	-108.10	27	Lupin A	65.76	-111.25	490	463	2.31	-30.40	-28.09	11.50	13.81
Canada	NL	Labrador coast	47.56	-52.77	125	Long Harbour	47.42	-53.82	8	-117	-0.58	-3.50	-4.08	14.90	14.32
Canada	NL	Bell Isle	47.60	-52.96	76	Long Harbour	47.42	-53.82	8	-67	-0.34	-3.50	-3.84	14.90	14.56
Canada	NU	Amer Lake	65.58	-97.67	166	Baker Lake A	64.30	-96.06	19	-147	-0.73	-32.30	-33.03	11.40	10.67
Canada	QC	Gaspe Peninsulas, Mt jacques-cartier	48.98	-65.92	1122	Port Daniel	48.15	-64.98	69	-1053	-5.27	-11.50	-16.77	17.40	12.13
Canada	QC	Bonne Esperance	51.50	-57.80	151	Plum Point	51.06	-56.88	6	-145	-0.73	-10.20	-10.93	13.90	13.17

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-5. *Carabus chamissonis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Tem p. (ºC)	Mean July corr. (ºC)
Canada	QC	Fort Chimo	58.11	-68.42	41	Kuujjuaq A	58.10	-68.42	39	-2	-0.01	-24.30	-24.31	11.50	11.49
Canada	QC	Mt. Jacques Quartier	49.00	-65.94	1220	Val D Espoir	48.52	-64.38	91	-1128	-5.64	-12.90	-18.54	15.80	10.16
Canada	QC	Kuujjuarapik, s.e Coast, Hudson Bay	55.26	-77.73	63	Kuujjuarapik A	55.28	-77.75	12	-51	-0.26	-23.40	-23.66	10.60	10.34
Canada	YT	Dempster Highway (Dempster HW Km 456.7)	67.03	-136.20	882	Komakuk Beach A	69.58	-140.18	7	-874	-4.37	-24.00	-28.37	7.80	3.43
Canada	YT	Old Crow River	68.18	-140.73	396	Komakuk Beach A	69.58	-140.18	7	-389	-1.94	-24.00	-25.94	7.80	5.86
Canada	YT	Dawson	64.06	-139.43	336	Komakuk Beach A	69.58	-140.18	7	-328	-1.64	-24.00	-25.64	7.80	6.16
USA	AK	Aleutians West, Dutch Harbor	53.89	-166.54	19	Dutch Harbor	53.90	-166.53	32	13	0.06	-2.81	-2.75	9.97	10.04
USA	AK	Aleutians West, Unalaska (10 km S)	53.84	-166.58	49	Dutch Harbor	53.90	-166.53	32	-17	-0.09	-2.81	-2.90	9.97	9.89
USA	AK	Kodiak Island borough, Kodiak Island (Alaska Mountain)	57.30	-153.95	714	Lazy Bay	56.88	-154.25	3	-710	-3.55	0.82	-2.73	11.98	8.43
USA	AK	W to Seward Penins	65.33	-164.25	37	Teller	65.27	-166.35	108	71	0.35	-20.73	-20.38	9.34	9.69
USA	AK	Dalton Hwy mi. 266	68.37	-149.33	810	Galbraith Lake Camp	68.48	-149.48	814	4	0.02	-15.59	-15.57	11.14	11.16
USA	AK	Dalton Hwy mi. 267.5	68.38	-149.33	809	Galbraith Lake Camp	68.48	-149.48	814	5	0.02	-15.59	-15.56	11.14	11.16

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-5. *Carabus chamissonis* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Dalton Hwy mi. 304.7	68.75	-149.13	1001	Galbraith Lake Camp	68.48	-149.48	814	-187	-0.94	-15.59	-16.52	11.14	10.20
USA	AK	Galbraith Airstrip	68.45	-149.57	1164	Galbraith Lake Camp	68.48	-149.48	814	-350	-1.75	-15.59	-17.34	11.14	9.39
USA	AK	Dalton Hwy mi. 109.2	68.12	-149.54	1470	Gilmore Creek	64.98	-147.52	296	-1174	-5.87	-20.00	-25.87	14.80	8.93
USA	AK	Galbrath Airstrip	68.45	-149.57	1102	Galbraith Lake Camp	68.48	-149.48	814	-289	-1.44	-15.59	-17.03	11.14	9.70
USA	AK	Kotzebue Nr. Cape Blossom	66.82	-162.55	33	Kotzebue WSO A	66.87	-162.63	6	-27	-0.14	-23.05	-23.19	15.11	14.97
USA	AK	N to Umiat	69.37	-152.14	79	Umiat	69.37	-152.13	82	3	0.02	-32.46	-32.44	12.59	12.60
USA	ME	Mount Katahdin	45.90	-68.92	1605	Dover Foxcroft	45.19	-69.18	113	-1493	-7.46	-11.06	-18.52	18.89	11.43
USA	NH	White Mountain, Mt. Washington	44.28	-71.32	1917	Mt. Washington	44.27	-71.30	1726	-191	-0.96	-13.03	-13.98	10.22	9.26
USA	WY	Albany Co.	41.20	-106.21	2981	Laramie FAA Airport	41.32	-105.68	2216	-765	-3.83	-6.44	-10.27	17.33	13.51

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-6. *Diacheila polita* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Tuktoyaktuk (32 km E)	69.43	-132.21	59	Tuktoyaktuk	69.45	-133.00	18	-40	-0.20	-25.9	-26.10	10.90	10.70
Canada	NT	Reindeer Depot	68.70	-134.12	182	Tuktoyaktuk	69.45	-133.00	18	-163	-0.82	-25.9	-26.72	10.90	10.08
Canada	NT	Anderson River (delta, Nugluk Creek)	69.63	-128.90	7	Tuktoyaktuk	69.45	-133.00	18	11	0.05	-25.9	-25.85	10.90	10.95
Canada	NT	Anderson River (delta, Krekovik Landing)	69.71	-128.97	13	Tuktoyaktuk	69.45	-133.00	18	5	0.03	-25.9	-25.87	10.90	10.93
USA	AK	Kodiak Island borough,Bare Lake	57.18	-154.29	1362	Ouzinkie	57.93	-152.50	21	-1341	-6.70	-15.65	-22.35	15.17	8.46
USA	AK	Kodiak Island borough, Pinguicula Lake (NW)	57.53	-154.25	425	Ouzinkie	57.93	-152.50	21	-404	-2.02	-15.65	-17.67	15.17	13.15
USA	AK	North Slope borough, Umiat (500 m S of Airstrip)	69.36	-152.15	81	Umiat	69.37	-152.13	81	0	0.00	-30.06	-30.06	12.61	12.61
USA	AK	Umiat	69.37	-152.14	80	Umiat	69.37	-152.13	81	2	0.01	-30.06	-30.05	12.61	12.62
USA	AK	McKinley park	63.65	-148.82	610	Sutton 2 E	61.72	-148.88	168	-443	-2.21	-9.89	-12.10	13.78	11.56
USA	AK	Mt. Pavlof	55.42	-161.89	2201	Cold Bay WB Airport	55.20	-162.72	29	-2172	-10.86	-2.11	-12.97	10.33	-0.53
USA	AK	Dime Creek	65.22	-161.14	77	Nome AP	64.52	-165.45	4	-73	-0.37	-14.56	-14.92	11.44	11.08
USA	AK	Seward Penins	65.43	-164.46	87	Nome AP	64.52	-165.45	4	-83	-0.41	-14.56	-14.97	11.44	11.03
USA	AK	Kougarok Rd. N. of North	65.22	-164.83	19	Nome AP	64.52	-165.45	4	-15	-0.08	-14.56	-14.63	11.44	11.37
USA	AK	Nome	64.79	-165.29	535	Nome AP	64.52	-165.45	4	-531	-2.66	-14.56	-17.21	11.44	8.79

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-6. *Diacheila polita* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Kotzebue	66.90	-162.60	3	Kotzebue WSO Airport	66.87	-162.63	3	0	0.00	-19.17	-19.17	12.61	12.61
USA	AK	Colville	70.45	-150.36	8	Umiat	69.37	-152.13	81	73	0.37	-30.06	-29.69	12.61	12.98
USA	AK	Kodiak	57.82	-152.67	597	Kodiak AP	57.75	-152.50	5	-593	-2.96	-1.28	-4.24	12.28	9.31
USA	AK	St Mathew Island	60.51	-172.96	223	St. Paul Island AP	57.17	-170.22	7	-216	-1.08	-1.28	-2.36	12.28	11.20
USA	AK	Dalton Highway mi. 237.2	68.07	-149.62	1345	Umiat	69.37	-152.13	81	-1264	-6.32	-30.06	-36.37	12.61	6.29
USA	AK	Dalton Highway mi. 313.1	68.85	-148.83	602	Umiat	69.37	-152.13	81	-521	-2.60	-30.06	-32.66	12.61	10.01
USA	AK	Dalton Highway mi. 150.2	66.97	-150.38	735	Umiat	69.37	-152.13	81	-654	-3.27	-30.06	-33.32	12.61	9.34
USA	AK	St. Michael	63.48	-162.04	17	Unalakleet WSO A	63.88	-160.80	5	-12	-0.06	-15.94	-16.01	13.06	12.99

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-7. *Pterostichus pinguedineus* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	BC	Pink Mountain (27.8 km W of Alaska Highway)	57.05	-122.51	1136	Wononwon	56.75	-121.79	914	-222	-1.11	-12.50	-13.61	14.40	13.29
Canada	NT	Inuvik	68.35	-133.72	32	Inuvik A	68.30	-133.48	68	36	0.18	-27.60	-27.42	14.20	14.38
Canada	YT	Dempster Highway (Dempster Highway Km 416)	66.79	-136.28	830	Dawson A	64.04	-139.13	370	-460	-2.30	-26.00	-28.30	15.60	13.30
Canada	YT	Ogilvie River (Dempster Highway Km 199.2)	65.39	-138.27	648	Dawson A	64.04	-139.13	370	-278	-1.39	-26.00	-27.39	15.60	14.21
Canada	YT	Tombstone Campground (Dempster highway Km 72.6: near creek)	64.51	-138.22	1055	Dawson A	64.04	-139.13	370	-685	-3.42	-25.00	-28.42	16.60	13.18
Canada	YT	Dempster Hwy 73 km.	64.50	-138.22	1014	Dawson A	64.04	-139.13	370	-644	-3.22	-24.00	-27.22	17.60	14.38
Canada	YT	Old Crow (Old Crow River at CRW)	68.18	-140.73	307	Old Crow A	67.57	-139.84	250	-57	-0.29	-28.60	-28.89	11.80	11.51
Canada	YT	Dempster Highway (Km 66)	64.47	-138.21	1067	Dawson A	64.04	-139.13	370	-697	-3.48	-26.00	-29.48	15.60	12.12
Canada	YT	White River ((Km 1881) on Alaska Highway)	61.99	-140.56	702	Dawson A	64.04	-139.13	370	-331	-1.66	-26.00	-27.66	15.60	13.94
USA	AK	Kodiak Island	57.79	-152.41	34	Kodiak AP	57.75	-152.48	24	-10	-0.05	-1.28	-1.33	12.28	12.23

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-7. *Pterostichus pinguedineus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorologi-cal station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Tem p. (°C)	Mean July corr. (°C)
USA	AK	Kodiak Island (Mtn)	57.30	-153.95	782	Kodiak AP	57.75	-152.48	24	-758	-3.79	-0.28	-4.07	13.28	9.49
USA	AK	Port Clarence	65.26	-166.85	3	Port Clarence	65.25	-166.87	4	1	0.00	-21.31	-21.30	11.86	11.86
USA	AK	St.Paul Island	57.18	-170.25	62	St.Paul Island	57.15	-170.22	3	-60	-0.30	-9.75	-10.05	7.13	6.83
USA	AK	Aleutians West, Crater Creek (E of Ogmok Caldera)	53.55	-167.98	107	Umnak	53.38	-167.90	45	-61	-0.31	-1.33	-1.64	12.72	12.42
USA	AK	Aleutians West, Unalska Island (nr. Tulick Volcano)	53.35	-168.03	312	Umnak	53.38	-167.90	45	-266	-1.33	-1.33	-2.66	12.72	11.39
USA	AK	Southeast Fairbanks division, Richardson Highway (Mile 227 (Km 365))	63.41	-145.74	1001	Trims Camp	63.43	-145.77	831	-169	-0.85	-15.48	-16.33	12.69	11.84
USA	AK	Valdez-Cordova (Paxson Lodge)	63.03	-145.50	818	Trims Camp	63.43	-145.77	831	13	0.07	-15.48	-15.42	12.69	12.75
USA	AK	Anchorage borough, Bird Creek (42.6 km SE of Anchorage)	60.97	-149.47	308	Alyeska	60.97	-149.13	141	-168	-0.84	-5.11	-5.94	14.28	13.45
USA	AK	Valdez-Cordova, Valdez (40.2 km E of)	61.16	-145.71	1311	Valdez	61.12	-146.27	6	-1305	-6.52	-4.83	-11.36	12.19	5.66
USA	AK	Valdez-Cordova,Gunn Creek (Mi. 197 Richardson Highway)	63.17	-145.53	1038	Trims Camp	63.43	-145.77	831	-207	-1.03	-15.48	-16.51	12.69	11.66
USA	AK	Valdez-Cordova, Worthington Glacier (Mile 28.7 (Km 46.2) on Richardson Highway)	61.17	-145.70	1094	Valdez	61.12	-146.27	6	-1088	-5.44	-4.83	-10.27	12.19	6.75
USA	AK	Yukon-Koyukuk division, Eagle Summit (mile 108.5 (174.6) Steese Highway)	65.50	-145.38	1126	Circle Hot Spring	65.48	-144.60	287	-839	-4.20	-2.26	-6.45	14.02	9.83

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-7. *Pterostichus pinguedineus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Kenai Peninsula borough, Johnson Pass	60.04	-151.38	246	Portage 1 S	60.82	-148.97	9	-237	-1.18	-5.40	-6.58	12.93	11.75
USA	AK	North Slope borough, Inaru River	70.91	-156.15	9	Barrow WSO Airport	71.30	-156.78	9	0	0.00	-29.22	-29.22	6.63	6.63
USA	AK	North Slope borough, Cape Thompson (Flag Hill)	68.14	-165.97	199	Cape Lisburne	68.87	-166.12	12	-187	-0.94	-23.00	-23.94	5.71	4.77
USA	AK	North Slope borough,Point Barrow	71.39	-156.47	2	Barrow WSO Airport	71.30	-156.78	9	7	0.04	-29.22	-29.19	6.63	6.67
USA	AK	North Slope borough,Atqasuk	70.47	-157.39	21	Barrow WSO Airport	71.30	-156.78	9	-12	-0.06	-29.22	-29.28	6.63	6.57
USA	AK	North Slope borough,Umiat	69.37	-152.14	79	Umiat WSO	69.37	-152.13	104	24	0.12	-29.36	-29.23	12.42	12.54
USA	AK	Dillingham, Ekuk	58.81	-158.54	41	Dilligham FAA Airport	59.15	-158.45	15	-26	-0.13	-8.84	-8.97	12.76	12.63
USA	AK	Aleutians West, Saint Paul Village	57.13	-170.27	24	Saint Paul island WSO AP	57.15	-170.22	9	-15	-0.08	-3.54	-3.62	7.99	7.91
USA	AK	Aleutians West, Saint Paul Island (Polovino)	57.18	-170.33	100	Saint Paul island WSO AP	57.15	-170.22	9	-91	-0.45	-3.54	-3.99	7.99	7.53
USA	AK	Aleutians West, Saint Paul village (3.2 km N)	57.20	-170.17	3	Saint Paul island WSO AP	57.15	-170.22	9	6	0.03	-3.54	-3.51	7.99	8.02
USA	AK	Aleutians West, Mt.Makushin (N Slope)	53.94	-166.92	550	Dutch Harbor	53.90	-166.53	1	-550	-2.75	-2.81	-5.56	9.97	7.22

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-7. *Pterostichus pinguedineus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
USA	AK	Aleutians West, Unalaska Village (4.8-6.4km of)	53.83	-166.55	29	Dutch Harbor	53.90	-166.53	1	-28	-0.14	-2.81	-2.95	9.97	9.83
USA	AK	Nome Div.,Koozata Lagoon St. Laurence Island)	63.38	-170.65	23	North East Cape	63.32	-168.93	12	-11	-0.06	-12.49	-12.55	8.32	8.27
USA	AK	Northwest Arctic Div., Kotzebue	66.90	-162.60	3	Kotzebue WSO Airport	66.87	-162.63	6	3	0.01	-19.24	-19.23	12.22	12.23
USA	NH	Mt. Washington	44.20	-71.25	1829	Mt. Washington	44.26	-71.27	1910	81	0.41	-14.89	-14.48	9.28	9.68

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-8. *Stereocerus haematopus* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
Canada	AB	Peace River (90 km NW, EMEND)	56.77	-118.37	726	Notikewin East	57.02	-117.57	465	-261	-1.31	-18.80	-20.11	15.90	14.59
Canada	AB	Nordegg	52.40	-116.08	1557	Dakota West	52.75	-113.95	865	-691	-3.46	-11.30	-14.76	15.60	12.14
Canada	AB	Wildhay River	53.47	-118.22	1401	Bugaboo Creek Lodge	50.75	-116.71	1529	128	0.64	-11.00	-10.36	11.90	12.54
Canada	AB	Jasper Nat. Pk., Mt. Edith Cavell Road	52.75	-118.21	2650	Bugaboo Creek Lodge	50.75	-116.71	1529	-1121	-5.61	-11.00	-16.61	11.90	6.29
Canada	AB	Big Horn Creek (Ya-Ha-Tind Ranch)	51.74	-115.54	2232	Bugaboo Creek Lodge	50.75	-116.71	1529	-703	-3.51	-11.00	-14.51	11.90	8.39
Canada	AB	Bistcho Lake (Tapawingo Lodge)	59.85	-118.65	564	Hay River A	60.84	-115.78	165	-399	-1.99	-23.10	-25.09	15.90	13.91
Canada	AB	Hinton (13 km N of Hinton on Hwy 40)	53.47	-117.78	1241	Jasper East Gate	53.23	-117.82	1003	-238	-1.19	-8.90	-10.09	15.00	13.81
Canada	AB	Kakwa Wildland Prov. Pk., Kakwa R. (lower)	54.09	-119.80	1256	Beaver Lodge CDA	55.20	-119.40	745	-511	-2.55	-12.80	-15.35	15.30	12.75
Canada	AB	Kakwa Wildland Prov. Pk., (Pine Ridge, ridge line)	54.14	-119.94	1519	Beaver Lodge CDA	55.20	-119.40	745	-774	-3.87	-11.70	-15.57	15.50	11.63
Canada	AB	Kakwa Wildland Prov. Pk.,	54.10	-119.65	1313	Beaver Lodge CDA	55.20	-119.40	745	-568	-2.84	-11.70	-14.54	15.50	12.66
Canada	AB	Kakwa Wildland Prov. Pk., ("Cedar Tree")	54.08	-119.93	1436	Beaver Lodge CDA	55.20	-119.40	745	-691	-3.46	-11.70	-15.16	15.50	12.04
Canada	AB	Kakwa Wildland Prov. Pk., Dead Horse Meadows	54.09	-119.82	1282	Beaver Lodge CDA	55.20	-119.40	745	-537	-2.69	-12.80	-15.49	15.30	12.61
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lake (base camp)	59.06	-114.43	664	Hay River A	60.84	-115.78	165	-499	-2.49	-23.10	-25.59	15.90	13.41

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-8. *Stereocerus haematopus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (°)	Long. (°)	Elev. (m)	Meteorological station	Lat. (°)	Long. (°)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (°C)	Mean Jan. Temp. (°C)	Mean Jan. corr. (°C)	Mean July Temp. (°C)	Mean July corr. (°C)
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lake	59.13	-114.51	668	Hay River A	60.84	-115.78	165	-503	-2.51	-23.10	-25.61	15.90	13.39
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lake (Birch Point)	59.06	-114.30	798	Hay River A	60.84	-115.78	165	-633	-3.17	-23.10	-26.27	15.90	12.73
Canada	AB	Birch Mountains wildland Prov. Pk., Big island Lake (South)	57.59	-112.47	684	Hay River A	60.84	-115.78	165	-519	-2.60	-23.10	-25.70	15.90	13.30
Canada	AB	Birch Mountains wildland Prov. Pk., Gardiner Lake Base Camp)	57.58	-112.46	727	Hay River A	60.84	-115.78	165	-562	-2.81	-23.10	-25.91	15.90	13.09
Canada	AB	Birch Mountains wildland Prov. Pk., Sand River	57.58	-112.44	698	Hay River A	60.84	-115.78	165	-533	-2.67	-23.10	-25.77	15.90	13.23
Canada	AB	Willmore Wilderness Park, Sheep Creek	53.87	-119.81	1944	Jasper East Gate	53.23	-117.82	1003	-941	-4.70	-8.90	-13.60	15.00	10.30
Canada	BC	Pink Mountain (27.8 km W Alaska Hwy)	57.07	-122.07	1097	Fort Nelson A	58.84	-122.60	382	-715	-3.57	-15.90	-19.47	13.50	9.93
Canada	BC	Pink Mountain (24.2 km W Alaska Hwy)	57.05	-122.87	1786	Fort Nelson A	58.84	-122.60	382	-1405	-7.02	-15.90	-22.92	13.50	6.48
Canada	BC	Pink Mountain (20.7 km W Alaska Hwy)	57.04	-122.86	1474	Fort Nelson A	58.84	-122.60	382	-1092	-5.46	-15.90	-21.36	13.50	8.04
Canada	BC	Tetsa River (Alaska Hwy km 602)	58.65	-124.26	913	Fort Nelson A	58.84	-122.60	382	-531	-2.65	-15.90	-18.55	13.50	10.85

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-8. *Stereocerus haematopus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	BC	Muskwa River (Alaska Hwy at km 477)	58.73	-122.66	821	Fort Nelson A	58.84	-122.60	382	-440	-2.20	-15.90	-18.10	13.50	11.30
Canada	BC	Hyland River (Alaska Hwy km 977.1)	59.96	-128.15	619	Dease lake	58.43	-130.01	807	188	0.94	-17.50	-16.56	12.80	13.74
Canada	BC	Swift River (Mi.733.3 on Alaska Hwy.)	53.05	-122.18	991	Barkerville	53.70	-121.52	1283	292	1.46	-8.80	-7.34	12.30	13.76
Canada	BC	Alaska Hwy. (Mi. 743, Swan Lake)	59.89	-131.38	874	Teslin A	60.17	-132.74	705	-169	-0.84	-19.20	-20.04	13.90	13.06
Canada	BC	Haines Hwy. (56.7, 3-Gaurdsmen Pass)	59.65	-136.49	1070	Skagway 2	59.47	-135.30	9	-1061	-5.31	-5.33	-10.64	14.89	9.58
Canada	NT	Anderson River (Delta)	69.69	-128.99	1	Tuktoyaktuk A	69.43	-133.03	4	3	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Bank Island (Big River, 64.4 km NNE of Sachs harbor)	72.46	-124.23	88	Sachs Harbour A	72.00	-125.27	86	-2	-0.01	-29.30	-29.31	6.80	6.79
Canada	NT	Involuted Hills	69.42	-132.60	29	Tuktoyaktuk A	69.43	-133.03	4	-25	-0.12	-26.60	-26.72	11.00	10.88
Canada	NT	Anderson River (Delta, Fox Den Island, SE end)	69.68	-128.96	2	Tuktoyaktuk A	69.43	-133.03	4	3	0.01	-26.60	-26.59	11.00	11.01
Canada	NT	Anderson River (Delta, Nugluk Creek)	69.63	-128.90	7	Tuktoyaktuk A	69.43	-133.03	4	-3	-0.02	-26.60	-26.62	11.00	10.98
Canada	NT	Anderson River (Delta)	69.59	-128.65	1	Tuktoyaktuk A	69.43	-133.03	4	3	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (Delta, whitefront Lake)	69.66	-128.98	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Wood Bay (Cabin Creek)	69.77	-128.78	23	Tuktoyaktuk A	69.43	-133.03	4	-18	-0.09	-26.60	-26.69	11.00	10.91

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-8. *Stereocerus haematopus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Kugaluk River (Alphonso Voudras Cabin)	69.24	-131.03	9	Tuktoyaktuk A	69.43	-133.03	4	-5	-0.03	-26.60	-26.63	11.00	10.97
Canada	NT	Anderson River (delta, Eagle perch island)	69.67	-128.82	46	Tuktoyaktuk A	69.43	-133.03	4	-41	-0.21	-26.60	-26.81	11.00	10.79
Canada	NT	Anderson River (Windy bend Cabin, near tree line)	69.25	-128.26	11	Tuktoyaktuk A	69.43	-133.03	4	-6	-0.03	-26.60	-26.63	11.00	10.97
Canada	NT	Anderson River (delta, Boat Island)	69.67	-128.93	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (delta, Pooh Sticks Creek)	69.71	-128.98	13	Tuktoyaktuk A	69.43	-133.03	4	-9	-0.04	-26.60	-26.64	11.00	10.96
Canada	NT	Anderson River (delta, Grizzly Bear Creek)	69.70	-129.20	18	Tuktoyaktuk A	69.43	-133.03	4	-14	-0.07	-26.60	-26.67	11.00	10.93
Canada	NT	Anderson River (delta, Fox Den Island, S end)	69.67	-128.98	1	Tuktoyaktuk A	69.43	-133.03	4	3	0.02	-26.60	-26.58	11.00	11.02
Canada	NT	Anderson River (Delta, Little fish Lake)	69.71	-128.94	13	Tuktoyaktuk A	69.43	-133.03	4	-9	-0.04	-26.60	-26.64	11.00	10.96
Canada	NT	Holman (Victoria Island)	70.74	-117.78	23	Ulukhaktok A	70.76	-117.67	36	13	0.06	-28.60	-28.54	9.20	9.26
Canada	NT	Cape Bathurst (Ikpisugyuk Bay)	70.05	-127.84	30	Tuktoyaktuk A	69.43	-133.03	4	-26	-0.13	-26.60	-26.73	11.00	10.87
Canada	NT	Mason River (Cape Bathurst)	69.93	-128.32	28	Tuktoyaktuk A	69.43	-133.03	4	-24	-0.12	-26.60	-26.72	11.00	10.88
Canada	NU	Arlone Lake	67.37	-102.17	59	Cambridge Bay A	69.11	-105.14	31	-28	-0.14	-32.00	-32.14	8.90	8.76
Canada	NU	Bathrust Inlet	66.83	-108.03	37	Lupin A	65.76	-111.25	490	453	2.27	-30.40	-28.13	11.50	13.77

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-8. *Stereocerus haematopus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NU	Karrak Lake (esker ridge)	67.25	-100.25	74	Cambridge Bay A	69.11	-105.14	31	-43	-0.21	-32.00	-32.21	8.90	8.69
Canada	YT	Money Creek (Campbell Hwy. km 172.3	61.40	-129.65	769	Watson Lake A	60.12	-128.82	687	-81	-0.41	-24.20	-24.61	15.10	14.69
Canada	YT	Dempster Hwy (km 24.6)	64.52	-138.24	1149	Dawsan A	64.04	-139.13	370	-779	-3.89	-26.00	-29.89	15.60	11.71
Canada	YT	Rock River (Dempster Hwy km 438.6)	66.92	-136.34	509	Old Crow A	67.57	-139.84	250	-259	-1.29	-28.60	-29.89	11.80	10.51
Canada	YT	Old Crow (Old Crow R at CRW)	67.56	-139.82	258	Old Crow A	67.57	-139.84	250	-8	-0.04	-28.60	-28.64	11.80	11.76
Canada	YT	White River (Mi. 1169 on Alaska Hwy)	61.99	-140.56	769	Beaver Creek A	62.41	-140.87	649	-120	-0.60	-26.90	-27.50	14.00	13.40
Canada	YT	Hwy. 4, 15 km N jct Hwy 1	60.15	-128.87	1047	Watson Lake A	60.12	-128.82	687	-360	-1.80	-24.20	-26.00	15.10	13.30
USA	AK	Yukon-Koyuk Div., Eagle Summit (Mi. 108.5 Steese Hwy)	65.55	-145.18	498	Gilmore Creek	64.97	-147.52	288	-210	-1.05	-20.00	-21.05	14.89	13.84
USA	AK	North Slope Borrough, Atqasuk	70.47	-157.39	16	Barrow Post Rojers AP	71.28	-156.77	9	-6	-0.03	-25.39	-25.42	13.90	13.87
USA	AK	North Slope Borrough, Meade R.	70.48	-157.41	18	Barrow Post Rojers AP	71.28	-156.77	9	-8	-0.04	-25.39	-25.43	13.90	13.86

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-9. *Eucnecosum brachypterum* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	MB	Churchill	58.77	-94.16	7	Churchill	58.74	-94.07	29	22	0.11	-26.70	-26.59	12.00	12.11
Canada	NT	Anderson River (Delta)	69.69	-128.99	12	Tuktoyaktuk A	69.43	-133.03	4	-8	-0.04	-27.00	-27.04	11.00	10.96
Canada	NT	Anderson River (delta, Boat Island)	69.67	-128.93	0	Tuktoyaktuk A	69.43	-133.03	4	4	0.02	-27.00	-26.98	11.00	11.02
Canada	NT	Anderson River (Delta, Fox Den Island, SE end)	69.68	-128.96	3	Tuktoyaktuk A	69.43	-133.03	4	1	0.00	-27.00	-27.00	11.00	11.00
Canada	NT	Anderson River (Delta, Krekovik Landing)	69.64	-129.00	9	Tuktoyaktuk A	69.43	-133.03	4	-5	-0.03	-27.00	-27.03	11.00	10.97
Canada	NU	Eskimo Point, Ariviat	61.10	-94.06	4	Rankin Inlet A	69.82	-92.12	32	28	0.14	-31.90	-31.76	10.40	10.54
Canada	NT	Kidluit Bay	69.50	-133.71	14	Tuktoyaktuk A	69.43	-133.03	4	-9	-0.05	-27.00	-27.05	11.00	10.95
Canada	NT	Kittigazuit	69.35	-133.68	22	Tuktoyaktuk A	69.43	-133.03	4	-17	-0.09	-27.00	-27.09	11.00	10.91
Canada	NT	40 Mi. East Tuktoyaktuk	69.41	-131.38	20	Tuktoyaktuk A	69.43	-133.03	4	-16	-0.08	-27.00	-27.08	11.00	10.92
Canada	NT	Wood Bay (Cabin Creek)	69.77	-128.78	23	Tuktoyaktuk A	69.43	-133.03	4	-19	-0.10	-27.00	-27.10	11.00	10.90
Canada	YT	Alaska Hwy, Mi. 1034, Near Kloo Lake	60.92	-137.90	859	Otter Falls NCPC	61.03	-137.05	830	-29	-0.15	-16.10	-16.25	13.00	12.85
Canada	YT	Alaska Hwy, Mi. 1120	61.85	-140.12	755	Otter Falls NCPC	61.03	-137.05	830	74	0.37	-16.10	-15.73	13.00	13.37
Canada	YT	Dempster Hwy, Mi.53 North fork Pass	64.12	-138.24	831	Dawsan A	64.04	-139.13	370	-461	-2.31	-26.70	-29.01	15.60	13.29

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-9. *Eucnecosum brachypterum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Dempster Hwy, Mi.43 North fork Crossing	64.60	-138.52	1891	Dawsan A	64.04	-139.13	370	-1521	-7.60	-26.70	-34.30	15.60	8.00
Canada	YT	8 Mi. NW Mt. Keno	63.95	-135.49	979	Pelly Ranch	62.82	-137.37	454	-525	-2.63	-27.50	-30.13	15.50	12.87
USA	AK	Cape Thompson	68.12	-165.96	177	Kotzebue Ralph Wein AP	66.88	-162.63	9	-168	-0.84	-19.17	-20.00	12.61	11.77
USA	AK	Denali Hwy, Mi. 110	63.16	-147.56	828	Hayes River	62	-152.07	305	-524	-2.62	-11.06	-13.67	14.00	11.38
USA	AK	Denali St. Pk.	63.10	-151.15	3096	Hayes River	62	-152.07	305	-2791	-13.96	-11.06	-25.01	14.00	0.04
USA	AK	Kenai Mts., 16 mi N Seward	60.32	-149.35	1302	Kenai 9N	60.67	-151.32	38	-1264	-6.32	-9.56	-15.88	13.11	6.79
USA	AK	Kenai Peninsula	60.04	-151.38	246	Kenai 9N	60.67	-151.32	38	-207	-1.04	-9.56	-10.59	13.11	12.07
USA	AK	Kenai Peninsula, Clam Gulch	60.18	-151.35	109	Kenai 9N	60.67	-151.32	38	-70	-0.35	-9.56	-9.91	13.11	12.76
USA	AK	Kenai Peninsula, Cohoe Beach	60.35	-151.20	40	Kenai 9N	60.67	-151.32	38	-2	-0.01	-9.56	-9.56	13.11	13.10
USA	AK	Kenai Peninsula, 2 Mi. NE of Solodonta	60.30	-151.09	78	Kenai 9N	60.67	-151.32	38	-40	-0.20	-9.56	-9.75	13.11	12.91
USA	AK	Prudhoe bay	70.16	-148.03	14	Prudhoe Bay	70.25	-148.03	23	9	0.05	-8.44	-8.40	7.61	7.66
USA	AK	Pribilof Island	61.15	-149.87	44	Glen Alps	61.1	-149.68	23	-21	-0.11	-7.89	-8.00	11.11	11.00
USA	AK	St. Paul Island	57.18	-170.20	62	St Paul Island AP	57.15	-170.22	11	-52	-0.26	-3.50	-3.76	8.17	7.91

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-10. *Eucnecosum brunnescens* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Banf Cascade Mt. Amphitheatre	51.83	-116.63	2312	Banf	51.18	-115.57	1384	-928	-4.64	-9.30	-13.94	14.60	9.96
Canada	AB	Highwood Pass	50.60	-115.00	2234	Banf	51.18	-115.57	1384	-851	-4.25	-9.30	-13.55	14.60	10.35
Canada	AB	Jasper National Park	52.87	-117.98	2080	Jasper East Gate	53.23	-117.82	1003	-1077	-5.39	-8.90	-14.29	15.00	9.61
Canada	AB	Laggan, Ptarmigan Pass	51.48	-116.03	2355	Jasper East Gate	53.23	-117.82	1003	-1353	-6.76	-8.90	-15.66	15.00	8.24
Canada	BC	10 Mi. E. Barkerville	53.06	-121.27	1862	Barkerville	53.70	-121.52	1283	-579	-2.90	-8.80	-11.70	12.30	9.40
Canada	BC	15 Mi. E. Barkerville	53.70	-121.11	1535	Barkerville	53.70	-121.52	1283	-252	-1.26	-8.80	-10.06	12.30	11.04
Canada	BC	Glacier	51.20	-117.50	2320	Bugaboo Creek Lodge	50.75	-116.70	1529	-791	-3.95	-11.00	-14.95	11.90	7.95
Canada	BC	Mi. 56 Haines Hwy., Three Guardsmen Pass	59.54	-136.48	610	Pleasant Camp	59.45	-136.37	274	-336	-1.68	-8.60	-10.28	14.20	12.52
Canada	BC	Mi. 78 Haines Hwy.	59.75	-136.60	1001	Pleasant Camp	59.45	-136.37	274	-727	-3.63	-8.60	-12.23	14.20	10.57
Canada	BC	Mi. 65 Haines Hwy., Chilkat Pass	59.64	-136.50	1112	Pleasant Camp	59.45	-136.37	274	-838	-4.19	-8.60	-12.79	14.20	10.01
Canada	MB	Churchill	58.77	-94.16	9	Churchill	58.74	-94.07	29	20	0.10	-26.70	-26.60	12.00	12.10
Canada	NL	Nutak	57.47	-61.87	213	Nain A	56.55	-61.68	6	-206	-1.03	-18.50	-19.53	10.10	9.07
Canada	NL	Red Bay	51.73	-56.42	14	Burgeo	47.62	-57.62	11	-3	-0.02	-5.50	-5.52	13.50	13.48

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-10. *Eucnecosum brunnescens* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Canoe Lake	68.23	-135.90	388	Inuvik A	68.30	-133.48	68	-321	-1.60	-27.60	-29.20	14.20	12.60
Canada	NT	Inuvik (east edge of town)	68.36	-133.72	30	Inuvik A	68.30	-133.48	68	37	0.19	-27.60	-27.41	14.20	14.39
Canada	ON	Lake Superior Prov. Pk.	47.57	-84.85	455	Terrace Bay	48.80	-87.10	289	-166	-0.83	-14.70	-15.53	14.50	13.67
Canada	ON	Butterfly lake	49.86	-92.11	433	Terrace Bay	48.80	-87.10	289	-144	-0.72	-14.70	-15.42	14.50	13.78
Canada	QC	Great Whale River	54.73	-70.20	564	Bonnard	50.73	-71.05	506	-58	-0.29	-21.00	-21.29	14.60	14.31
Canada	QC	Indian House Lake	56.25	-64.70	460	Nain A	56.55	-61.68	6	-453	-2.27	-18.50	-20.77	10.10	7.83
Canada	QC	Mont Jacques Cartier	49.00	-65.94	1200	Amqui	48.52	-67.45	183	-1017	-5.09	-14.80	-19.89	17.30	12.21
Canada	QC	Parc Gaspesie, Lac St. Anne	48.92	-66.29	864	Amqui	48.52	-67.45	183	-681	-3.40	-14.80	-18.20	17.30	13.90
Canada	QC	Parc Gaspesie, Mt. Albert	48.93	-66.12	764	Amqui	48.52	-67.45	183	-582	-2.91	-14.80	-17.71	17.30	14.39
Canada	QC	Parc Gaspesie, Mt. Albert	48.90	-66.15	968	Amqui	48.52	-67.45	183	-785	-3.92	-14.80	-18.72	17.30	13.38
Canada	QC	Parc Gaspesie, Mt. Albert	48.90	-66.18	1074	Amqui	48.52	-67.45	183	-891	-4.46	-14.80	-19.26	17.30	12.84
Canada	YT	Alaska Hwy, Mi. 1120	61.85	-140.12	736	Otter Falls NCPC	61.03	-137.05	830	94	0.47	-16.40	-15.93	13.10	13.57
Canada	YT	Mi. 1192 Alaska Hwy., Near Snag Junction	62.27	-140.73	783	Otter Falls NCPC	61.03	-137.05	830	46	0.23	-16.40	-16.17	13.10	13.33

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-10. *Eucnecosum brunnescens* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Dempster Hwy, Mi.53 North fork Pass	64.12	-138.24	962	Dawsan A	64.04	-139.13	370	-592	-2.96	-26.70	-29.66	15.60	12.64
Canada	YT	8 Mi. NW Mt. Keno	63.96	-134.96	1278	Pelly Ranch	62.82	-137.37	454	-824	-4.12	-27.50	-31.62	15.50	11.38
USA	AK	Denali St. Pk.	63.10	-151.15	3140	Hayes River	62.00	-152.07	305	-2835	-14.17	-11.06	-25.23	14.00	-0.17
USA	AK	12 Mi N Mi 78 Denali Hwy, Windy Creek	64.19	-149.09	498	Hayes River	62.00	-152.07	305	-193	-0.97	-11.06	-12.02	14.00	13.03
USA	AK	Kenai Mts., 16 mi N Seward	59.87	-150.67	1411	Kenai 9N	60.67	-151.32	38	-1372	-6.86	-9.56	-16.42	13.11	6.25
USA	AK	Kenai Peninsula, Clam Gulch	60.04	-151.35	246	Kenai 9N	60.67	-151.32	38	-207	-1.04	-9.56	-10.59	13.11	12.07
USA	AK	Kenai Peninsula, Cohoe Beach	60.35	-151.20	45	Kenai 9N	60.67	-151.32	38	-6	-0.03	-9.56	-9.59	13.11	13.08
USA	AK	Kenai Peninsula	60.04	-151.35	265	Kenai 9N	60.67	-151.32	38	-226	-1.13	-9.56	-10.69	13.11	11.98
USA	AK	Prudhoe bay	70.16	-148.03	49	Prudhoe Bay	70.25	-148.03	23	-26	-0.13	-8.44	-8.58	7.61	7.48
USA	AK	Pribilof Island	61.15	-149.87	12	Glen Alps	61.10	-149.68	23	11	0.05	-7.89	-7.83	11.11	11.17
USA	AK	St. Paul Island	57.18	-170.20	56	St paul Island AP	57.15	-170.22	11	-45	-0.23	-3.50	-3.73	8.17	7.94
USA	CO	Leavenworth	39.50	-105.36	2519	Bailey	39.40	-105.47	1243	-1276	-6.38	-5.17	-11.55	15.83	9.45

Source: E.H. Strickland Entomological Museum, University of Alberta; Lindroth (1961-69); Quaternary Entomological Laboratory, North Dakota State University.

Table A-11. *Olophrum boreale* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Kakwa Wildland Provincial Park (East of "Little Berg" Lake)	53.96	-119.94	2137	Brule Black Cat	53.21	-117.87	1036	-1101	-5.50	-10.20	-15.70	14.20	8.70
Canada	AB	Kakwa Wildland Provincial Park (Berg Lake)	53.95	-119.92	2104	Brule Black Cat	53.21	-117.87	1036	-1067	-5.34	-10.20	-15.54	14.20	8.86
Canada	AB	Banff Nat. Pk., Agnes Lake	51.42	-116.25	2435	Glacier NP MT Fidelity	51.24	-117.70	576	-1859	-9.29	-9.20	-18.49	10.70	1.41
Canada	AB	Banff Nat. Pk., Bow Lake	51.68	-116.46	2511	Glacier NP MT Fidelity	51.24	-117.70	576	-1935	-9.67	-9.20	-18.87	10.70	1.03
Canada	AB	Banff Nat. Pk., Consolation Lake	51.30	-116.15	2253	Glacier NP MT Fidelity	51.24	-117.70	576	-1677	-8.39	-9.20	-17.59	10.70	2.31
Canada	AB	Banff Nat. Pk.,Eiffel Lake	51.32	-116.24	2308	Glacier NP MT Fidelity	51.24	-117.70	576	-1732	-8.66	-9.20	-17.86	10.70	2.04
Canada	AB	Banff Nat. Pk., Helen Lake	51.69	-116.41	2714	Glacier NP MT Fidelity	51.24	-117.70	576	-2138	-10.69	-9.20	-19.89	10.70	0.01
Canada	AB	Banff Nat. Pk., Morraine Lake	51.33	-116.18	1992	Glacier NP MT Fidelity	51.24	-117.70	576	-1415	-7.08	-9.20	-16.28	10.70	3.62
Canada	AB	Banff Nat. Pk., Ptarmigan Lake	51.48	-116.08	2378	Glacier NP MT Fidelity	51.24	-117.70	576	-1802	-9.01	-9.20	-18.21	10.70	1.69
Canada	AB	Banff Nat. Pk., Redoubt Lake	51.47	-116.07	2361	Glacier NP MT Fidelity	51.24	-117.70	576	-1785	-8.92	-9.20	-18.12	10.70	1.78
Canada	AB	Banff Nat. Pk., Upper Waterfowl Lake	51.47	-116.07	2378	Glacier NP MT Fidelity	51.24	-117.70	576	-1802	-9.01	-9.20	-18.21	10.70	1.69
Canada	AB	Kananaskis for. Exp. Sta.	51.08	-115.13	1583	Glacier NP MT Fidelity	51.24	-117.70	576	-1007	-5.04	-9.20	-14.24	10.70	5.66
Canada	AB	10 Mi. of Kananaskis	51.03	-115.34	2374	Glacier NP MT Fidelity	51.24	-117.70	576	-1798	-8.99	-9.20	-18.19	10.70	1.71

Source: Campbell (1984)

Table A-11. *Olophrum boreale* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	35 mi. S of Kananaskis, Highwood pass	50.59	-114.99	2589	Glacier NP MT Fidelity	51.24	-117.70	576	-2013	-10.06	-9.20	-19.26	10.70	0.64
Canada	AB	20 Mi. SW of Kananskis, Snow Ridge	50.83	-115.74	2190	Glacier NP MT Fidelity	51.24	-117.70	576	-1614	-8.07	-9.20	-17.27	10.70	2.63
Canada	AB	Edmonton	53.53	-113.52	673	Slave Lake	55.30	-114.78	580	-93	-1.49	-14.50	-15.99	15.60	14.11
Canada	AB	Moose lake Prov. Pk. Nr. Moose lake, 2 mi. N Bonnyville	54.28	-110.80	562	Slave Lake	55.30	-114.78	580	18	-1.49	-14.50	-15.99	15.60	14.11
Canada	BC	Mi 71 Alaska Hwy	59.98	-128.56	753	Cassiar	59.28	-129.83	1078	325	1.62	-14.60	-12.98	11.50	13.12
Canada	BC	Mi 147 Alaska Hwy, Pink Mt. Lodge	57.08	-122.59	988	Pine Pass Mt. Lemory	55.54	-122.48	680	-308	-1.54	-9.40	-10.94	15.40	13.86
Canada	BC	Mi 392 Alaska Hwy, Summit lake	58.65	-124.67	1492	Fort Nelson	58.84	-122.59	382	-1110	-5.55	-21.20	-26.75	16.80	11.25
Canada	BC	Manning Prov. Park, 20 mi E Hope	49.07	-120.39	1990	Agassiz CDA	49.24	-121.59	15	-1975	-9.88	2.50	-7.38	18.20	8.32
Canada	BC	Mt. Thompson, near Canoe R,	49.24	-116.55	1529	Creston	49.10	-116.52	538	-991	-4.96	-2.20	-7.16	18.90	13.94
Canada	BC	Yoho Nat. Pk.,Linda Lake	51.37	-116.37	2505	Glacier NP MT Fidelity	51.24	-117.70	1890	-615	-3.08	-9.20	-12.28	10.70	7.62
Canada	BC	Yoho Nat.Pk.,McArthur Lk	51.33	-116.34	2710	Glacier NP MT Fidelity	51.24	-117.70	1890	-820	-4.10	-9.20	-13.30	10.70	6.60
Canada	BC	Yoho Nat. Pk.,Lake Oesa	51.34	-116.26	2328	Glacier NP MT Fidelity	51.24	-117.70	1890	-438	-2.19	-9.20	-11.39	10.70	8.51
Canada	BC	Yoho Nat.Pk.,Valley of Hagen Peak	51.58	-116.69	2396	Glacier NP MT Fidelity	51.24	-117.70	1890	-506	-2.53	-9.20	-11.73	10.70	8.17
Canada	BC	Yoho Nat.Pk. Amiskwi R,	51.59	-116.66	1992	Glacier NP MT Fidelity	51.24	-117.70	1890	-102	-0.51	-9.20	-9.71	10.70	10.19

Source: Campbell (1984).

Table A-11. *Olophrum boreale* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	BC	Mt. Revelstoke Nat. Pk.	51.08	-118.02	2550	Glacier NP MT Fidelity	51.24	-117.70	1890	-660	-3.30	-9.20	-12.50	10.70	7.40
Canada	BC	Mt. Revelstoke Nat. Pk., Jade Lakes	51.05	-118.14	1759	Glacier NP MT Fidelity	51.24	-117.70	1890	131	0.66	-9.20	-8.54	10.70	11.36
Canada	NT	Aklavik	68.22	-135.01	7	Inuvik A	68.30	-133.48	68	61	0.30	-27.60	-27.30	14.20	14.50
Canada	NT	Aklavik	68.23	-134.66	5	Inuvik A	68.30	-133.48	68	62	0.31	-27.60	-27.29	14.20	14.51
Canada	NT	20 mi E Tuktoyaktuk	69.44	-132.18	61	Inuvik A	68.30	-133.48	68	7	0.03	-27.60	-27.57	14.20	14.23
Canada	NT	Inuvik Boot Lake	68.35	-133.72	27	Inuvik A	68.30	-133.48	68	40	0.20	-27.60	-27.40	14.20	14.40
Canada	NT	Inuvik	68.36	-133.70	73	Inuvik A	68.30	-133.48	68	-5	-0.03	-27.60	-27.63	14.20	14.17
Canada	NT	18 mi. NW Inuvik, via East Channel	68.51	-134.24	14	Inuvik A	68.30	-133.48	68	54	0.27	-27.60	-27.33	14.20	14.47
Canada	QC	Baie James	52.00	-76.00	271	La Grande Rieviere A	53.64	-77.72	195	-76	-0.38	-23.20	-23.58	13.70	13.32
Canada	QC	Longue-Pointe	53.97	-79.08	132	La Grande Rieviere A	53.64	-77.72	195	63	0.32	-23.20	-22.88	13.70	14.02
Canada	YT	Mile 681 Alaska Hwy.	60.12	-129.70	847	Johnsons Crossing	60.48	-133.31	690	-157	-0.78	-18.60	-19.38	13.40	12.62
Canada	YT	Mile 931 Alaska Hwy.	59.87	-131.47	992	Johnsons Crossing	60.48	-133.31	690	-302	-1.51	-18.60	-20.11	13.40	11.89
Canada	YT	Mile 724 Alaska Hwy.	59.84	-131.28	1363	Johnsons Crossing	60.48	-133.31	690	-672	-3.36	-18.60	-21.96	13.40	10.04
Canada	YT	Mile 1059 Alaska Hwy.	59.98	-131.76	953	Johnsons Crossing	60.48	-133.31	690	-263	-1.31	-18.60	-19.91	13.40	12.09
Canada	YT	Mile 1120 Alaska Hwy.	61.82	-140.20	875	Burwash A	61.37	-139.05	806	-69	-0.35	-22.00	-22.35	12.80	12.45

Source: Campbell (1984)

Table A-11. *Olophrum boreale* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Mile 29.5 Dempster Hwy.	64.12	-138.75	744	Dawson A	64.03	-139.12	370	-374	-1.87	-26.70	-28.57	15.60	13.73
Canada	YT	Mile 42 Dempster Hwy., N Klondike R.	64.04	-138.66	734	Dawson A	64.03	-139.12	370	-364	-1.82	-26.70	-28.52	15.60	13.78
Canada	YT	Mile 45 Dempster Hwy.	64.10	-138.62	785	Dawson A	64.03	-139.12	370	-415	-2.07	-26.70	-28.77	15.60	13.53
Canada	YT	Mile 48.5 Dempster Hwy., North Fork Pass	64.12	-138.54	714	Dawson A	64.03	-139.12	370	-344	-1.72	-26.70	-28.42	15.60	13.88
Canada	YT	Mile 53 Dempster Hwy., North Fork Pass	64.15	-138.44	1099	Dawson A	64.03	-139.12	370	-729	-3.64	-26.70	-30.34	15.60	11.96
Canada	YT	Mile 55 Dempster Hwy.	64.20	-138.55	736	Dawson A	64.03	-139.12	370	-366	-1.83	-26.70	-28.53	15.60	13.77
Canada	YT	Mile 60 Dempster Hwy.	64.25	-138.50	742	Dawson A	64.03	-139.12	370	-372	-1.86	-26.70	-28.56	15.60	13.74
Canada	YT	Mile 65 Dempster Hwy.	64.32	-138.45	876	Dawson A	64.03	-139.12	370	-505	-2.53	-26.70	-29.23	15.60	13.07
Canada	YT	Mile 73 Dempster Hwy.	64.50	-138.33	1427	Dawson A	64.03	-139.12	370	-1057	-5.28	-26.70	-31.98	15.60	10.32
Canada	YT	Mile 75.5 Dempster Hwy.	64.48	-138.30	1585	Dawson A	64.03	-139.12	370	-1215	-6.07	-26.70	-32.77	15.60	9.53
Canada	YT	Mile 81.5 Dempster Hwy.	64.47	-138.20	1003	Dawson A	64.03	-139.12	370	-632	-3.16	-26.70	-29.86	15.60	12.44
Canada	YT	Mile 122 Dempster Hwy.	64.55	-138.30	1618	Dawson A	64.03	-139.12	370	-1248	-6.24	-26.70	-32.94	15.60	9.36
Canada	YT	Mile 136 Dempster Hwy.	64.72	-138.30	1209	Dawson A	64.03	-139.12	370	-839	-4.19	-26.70	-30.89	15.60	11.41
Canada	YT	Keno	63.90	-135.30	1040	Braeburn	61.47	-135.75	716	-324	-1.62	-21.20	-22.82	13.60	11.98

Source: Campbell (1984)

Table A-11. *Olophrum boreale* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Mt. Keno	63.93	-135.19	1374	Braeburn	61.47	-135.75	716	-658	-3.29	-21.20	-24.49	13.60	10.31
Canada	YT	Otter Lake	62.50	-130.42	1250	Braeburn	61.47	-135.75	716	-534	-2.67	-21.20	-23.87	13.60	10.93
Canada	YT	Mile 1249 Alaska Hwy., Deadman Lake	60.75	-133.18	1034	Braeburn	61.47	-135.75	716	-317	-1.59	-21.20	-22.79	13.60	12.01
USA	AK	Alaska Range, Antimony Creek	63.08	-151.00	1067	Fare Well	62.53	-153.30	1060	-7	-0.03	-19.50	-19.53	14.78	14.74
USA	AK	Denali St. Pk., Byers Creek at Hwy. 1	63.12	-150.77	2107	Fare Well	62.53	-153.30	1060	-1047	-5.24	-19.50	-24.74	14.78	9.54
USA	AK	Prudhoe Bay Rd, Bonanza Creek	66.67	-150.67	274	Chandalar Lake	67.52	-148.50	565	291	1.46	-26.56	-25.10	12.78	14.23
USA	AK	Prudhoe Bay Rd, 9 mi N Atigun Pass	68.27	-149.42	2107	Chandalar Lake	67.52	-148.50	565	-1542	-7.71	-26.56	-34.26	12.78	5.07
USA	AK	Prudhoe Bay Rd, Cold Foot	67.25	-150.18	874	Chandalar Lake	67.52	-148.50	565	-309	-1.55	-26.56	-28.10	12.78	11.23
USA	AK	Prudhoe Bay Rd, 2.5 mi N Diatrich Camp	67.67	-149.58	457	Chandalar Lake	67.52	-148.50	565	108	0.54	-26.56	-26.01	12.78	13.32
USA	AK	Prudhoe Bay Rd, Fish Creek	66.53	150.83	274	Chandalar Lake	67.52	-148.50	565	291	1.46	-26.56	-25.10	12.78	14.23
USA	AK	Prudhoe Bay Rd, 10 mi N Galbraith Lake	68.58	-149.50	792	Chandalar Lake	67.52	-148.50	565	-227	-1.14	-26.56	-27.69	12.78	11.64
USA	AK	Prudhoe Bay Rd, 2 mi S Grayling Lake	66.92	-150.42	396	Chandalar Lake	67.52	-148.50	565	169	0.85	-26.56	-25.71	12.78	13.62
USA	AK	Prudhoe Bay Rd, 8 mi N South Fork Koyukuk R	67.22	-150.12	305	Chandalar Lake	67.52	-148.50	565	261	1.30	-26.56	-25.25	12.78	14.08
USA	AK	Prudhoe Bay Rd, South Fork Koyukuk R	67.20	-150.12	335	St. Paul Island	67.52	-148.50	565	230	1.15	-3.50	-2.35	8.17	9.32

Source: Campbell (1984)

Table A-11. *Olophrum boreale* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Mile 206 Richardson Hwy, Isabel Pass	63.19	-145.56	884	Fare Well	62.53	-153.30	1060	176	0.88	-19.50	-18.62	14.78	15.66
USA	AK	Mile 24 Wales Hwy, Hess Creek	65.65	-149.18	202	Chandalar Lake	67.52	-148.50	565	364	1.82	-26.56	-24.74	12.78	14.60
USA	AK	Unalakleet	63.75	-160.40	494	Unalakleet	63.88	-160.80	5	-489	-2.45	-26.56	-29.00	12.78	10.33
USA	MT	Park Co,Beartooth Prim. Area, Goose Lk	45.12	-109.91	3200	Barber	46.30	-109.37	1137	-2063	-10.32	-4.72	-15.04	19.39	9.07
USA	UT	Bear River, Nr Stillwater CMPGD	40.69	-110.90	2591	Alpine	40.45	-111.77	1545	-1045	-5.23	-2.33	-7.56	17.17	11.94
USA	UT	Bourbon Lake Rd	40.78	-110.88	2926	Alpine	40.45	-111.77	1545	-1381	-6.90	-2.33	-9.24	17.17	10.26
USA	WY	1 Mi SW Beartooth Pass	44.92	-109.76	2779	Basin	44.38	-108.04	1170	-1610	-8.05	-9.67	-17.72	22.72	14.67

Source: Campbell (1984)

Table A-12. *Olophrum latum* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Chesterfield	63.35	-90.74	0	Rankin Inlet A	62.82	-92.12	32	32	0.21	-32.00	-31.79	10.40	10.61
Canada	NT	Chesterfield	63.42	-90.88	21	Rankin Inlet A	62.82	-92.12	32	11	0.07	-32.00	-31.93	10.40	10.47
Canada	NU	Coppermine (Kugluktuk)	67.82	-115.10	24	Kugluktuk	67.82	-115.14	23	-1	-0.01	-27.80	-27.81	10.70	10.69
Canada	NU	Eskimo Point (Arviat)	61.15	-94.10	11	Rankin Inlet A	62.82	-92.12	32	21	0.14	-32.00	-31.86	10.40	10.54
Canada	NU	Dempster Hwy, Mi. 139.5	65.00	-138.23	1350	Dawson A	64.04	-139.13	370	-980	-6.37	-26.70	-33.07	15.60	9.23
Canada	NU	Herschel Island	69.56	-139.80	70	Komakuk Beach A	69.58	-140.18	7	-63	-0.41	-24.00	-24.41	7.80	7.39
Canada	NU	Herschel Island	69.63	-139.13	0	Komakuk Beach A	69.58	-140.18	7	7	0.05	-24.00	-23.95	7.80	7.85
Canada	YT	Alaska Peninsula, near Mt. Pavlov	55.39	-161.97	586	Port Heiden	56.95	-158.61	28	-558	-3.63	-5.28	-8.90	11.22	7.60
Canada	YT	Circle	65.30	-144.05	1167	Gilmore Creek	64.98	-147.52	288	-879	-5.71	-20.00	-25.71	13.50	7.79
Canada	YT	George Parks Hwy, mi. 220	63.50	-148.86	1618	Healy 2 NW	63.87	-149.02	448	-1170	-7.60	-17.44	-25.05	15.28	7.67
Canada	YT	Kenai Mountains, 2 mi S. Moose pass	60.48	-149.40	950	Seward	60.10	-149.43	30	-920	-5.98	-3.22	-9.20	13.56	7.58
Canada	YT	Kenai Mts. Ptarmigan Creek CMPGD	60.41	-149.37	984	Seward	60.10	-149.43	30	-953	-6.20	-3.22	-9.42	13.56	7.36
USA	AK	Kenai Mts. 15 mi. N Seward	60.27	-149.82	893	Seward	60.10	-149.43	30	-862	-5.60	-3.22	-8.83	13.56	7.95

Source: Campbell (1984)

Table A-12. *Olophrum latum* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Kenai Mts. 16 mi. N Seward	60.27	-149.84	977	Seward	60.10	-149.43	30	-947	-6.15	-3.22	-9.38	13.56	7.40
USA	AK	Lower Yukon, near. Holy Cross	62.17	-159.93	135	Galena Airport	64.72	-156.90	38	-97	-0.63	-22.50	-23.13	11.11	10.48
USA	AK	Matanuska	61.44	-149.42	62	Matanuska AES	61.55	-149.25	52	-10	-0.06	-10.06	-10.12	9.61	9.55
USA	AK	Prudhoe Bay Rd, 10 mi N Galbraith Lake	68.58	-149.50	792	Chandalar Lake	67.50	-148.48	578	-215	-1.40	-26.56	-27.95	11.06	9.66
USA	AK	St. George Island	56.58	-169.60	145	St. Paul Island	57.15	-170.22	11	-134	-0.87	-3.50	-4.37	8.17	7.29
USA	AK	St. George Island	56.56	-169.63	119	St. Paul Island	57.15	-170.22	11	-108	-0.70	-3.50	-4.20	8.17	7.46
USA	AK	St. Paul	57.18	-170.25	107	St. Paul Island	57.15	-170.22	11	-96	-0.62	-3.50	-4.12	8.17	7.54
USA	AK	St. Paul	57.20	-170.30	123	St. Paul Island	57.15	-170.22	11	-112	-0.73	-3.50	-4.23	8.17	7.44
USA	AK	St. Paul	57.25	-170.28	111	St. Paul Island	57.15	-170.22	11	-101	-0.65	-3.50	-4.15	8.17	7.51
USA	AK	St. Paul	57.29	-170.32	120	St. Paul Island	57.15	-170.22	11	-109	-0.71	-3.50	-4.21	8.17	7.46

Source: Campbell (1984)

Table A-13 *Olophrum rotundicolle* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Kakwa Wildland Provincial Park, Dead horse meadows	54.13	-119.92	1474	Dome Creek	53.73	-120.98	648	-827	-4.13	-9.40	-13.53	14.70	10.57
Canada	AB	Kakwa Wildland Provincial Park, (Sulphur Ridge)	54.15	-119.78	1524	Dome Creek	53.73	-120.98	648	-876	-4.38	-9.40	-13.78	14.70	10.32
Canada	AB	Kakwa Wildland Provincial Park, (Sulphur Ridge)	54.15	-119.78	1465	Dome Creek	53.73	-120.98	648	-818	-4.09	-9.40	-13.49	14.70	10.61
Canada	AB	Kakwa Wildland Provincial Park, Dead horse meadows	54.09	-119.82	1480	Dome Creek	53.73	-120.98	648	-832	-4.16	-9.40	-13.56	14.70	10.54
Canada	AB	Birch Mountains Wildland Provincial Park, Big Island Lake (South)	57.59	-112.47	814	Bear tooth Island	59.22	-109.70	232	-582	-2.91	-22.40	-25.31	16.70	13.79
Canada	AB	Birch Mountains Wildland Provincial Park, Gardiner lakes (base Camp)	57.58	-112.46	747	Bear tooth Island	59.22	-109.70	232	-515	-2.57	-22.40	-24.97	16.70	14.13
Canada	AB	Birch Mountains Wildland Provincial Park, Gardiner Lakes	57.53	-112.48	785	Bear tooth Island	59.22	-109.70	232	-553	-2.77	-22.40	-25.17	16.70	13.93
Canada	AB	Birch Mountains Wildland Provincial Park, Gardiner Lakes	57.58	-112.46	844	Bear tooth Island	59.22	-109.70	232	-612	-3.06	-22.40	-25.46	16.70	13.64
Canada	AB	Birch Mountains Wildland Provincial Park, Namur Lake	57.37	-112.76	772	Bear tooth Island	59.22	-109.70	232	-540	-2.70	-22.40	-25.10	16.70	14.00
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lake	59.06	-114.43	760	Bear tooth Island	59.22	-109.70	232	-528	-2.64	-22.40	-25.04	16.70	14.06

Source: Campbell (1983)

Table A-13 *Olophrum rotundicolle* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Caribou Mountains Wildland Park, Wentzel Lake	59.07	-114.42	818	Bear tooth Island	59.22	-109.70	232	-586	-2.93	-22.40	-25.33	16.70	13.77
Canada	AB	Dixonville (NW of EMEND Site)	56.77	-118.37	732	Keg River RS	57.75	-117.62	405	-327	-1.63	-19.40	-21.03	15.30	13.67
Canada	AB	Banff	51.18	-115.57	1408	Kananaskis	51.02	-115.04	1391	-16	-0.08	-7.50	-7.58	14.10	14.02
Canada	AB	Banff Nat. Pk., Upper Water fowl Lk.	51.83	-116.63	1737	Kananaskis	51.02	-115.04	1391	-346	-1.73	-7.50	-9.23	14.10	12.37
Canada	AB	Calgary	51.05	-114.07	1317	Kananaskis	51.02	-115.04	1391	74	0.37	-7.50	-7.13	14.10	14.47
Canada	BC	Big boulder, Pine Pass (Mackenzie)	55.40	-122.64	1236	Elmworth CDA EPF	55.12	-119.75	754	-482	-2.41	-12.70	-15.11	15.20	12.79
Canada	BC	Manning Prov. Park, 20 mi. E Hope	49.12	-120.85	1795	Keremeos 2	49.21	-119.82	435	-1360	-6.80	-2.20	-9.00	20.90	14.10
Canada	BC	Swan Lake, 743 mi. Ak Hwy	55.53	-120.03	912	Elmworth CDA EPF	55.12	-119.75	754	-157	-0.79	-12.70	-13.49	15.20	14.41
Canada	MB	Churchill	58.77	-99.15	34	Churchill A	58.74	-94.07	28	-6	-0.03	-26.70	-26.73	12.00	11.97
Canada	MB	Fort Churchill	58.76	-94.08	27	Churchill A	58.74	-94.07	28	2	0.01	-26.70	-26.69	12.00	12.01
Canada	MB	Warkworth Creek	58.58	-98.02	16	Churchill A	58.74	-94.07	28	12	0.06	-26.70	-26.64	12.00	12.06
Canada	MB	Winnipeg	49.90	-97.14	533	South Brook Pasadena	49.03	-100.40	38	-495	-2.48	-18.50	-20.98	16.40	13.92
Canada	NL	Blow Me Down Prov. Pk., Nr. York harbour	49.07	-58.39	620	Long Harbour	47.42	-53.82	8	-612	-3.06	-3.50	-6.56	14.90	11.84
Canada	NL	2 mi. W Rose Blanche	47.62	-58.73	533	Long Harbour	47.42	-53.82	8	-525	-2.63	-3.50	-6.13	14.90	12.28
Canada	NL	Near St. Anthony	51.38	-55.61	453	Long Harbour	47.42	-53.82	8	-445	-2.22	-3.50	-5.72	14.90	12.68
Canada	NT	Aklavik	68.22	-135.01	469	Inuvik A_N	68.35	-133.33	68	-402	-2.01	-27.60	-29.61	14.20	12.19

Source: Campbell (1983)

Table A-13 *Olophrum rotundicolle* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	5 mi. SE from Fort Simpson	61.28	-121.05	366	Fort Simpson A	61.75	-121.21	166	-200	-1.00	-28.10	-29.10	14.30	13.30
Canada	NT	32 mi. NW of Fort Simpson	61.55	-122.21	404	Fort Simpson A	61.75	-121.21	166	-238	-1.19	-28.10	-29.29	14.30	13.11
Canada	NT	Inuvik, Shell Lake	68.32	-133.63	213	Tuktoyaktuk	69.46	-133.00	18	-195	-0.98	-25.90	-26.88	10.90	9.92
Canada	NT	Lac MaUnoir	67.46	-124.77	275	Tuktoyaktuk	69.46	-133.00	18	-257	-1.28	-25.90	-27.18	10.90	9.62
Canada	NT	Norman Wells	65.28	-126.82	1009	Norman Wells	69.93	-126.80	73	-936	-4.68	-26.50	-31.18	17.00	12.32
Canada	NT	40 mi E. Tuktoyaktuk	69.43	-131.41	6	Tuktoyaktuk	69.46	-133.00	18	13	0.06	-25.90	-25.84	10.90	10.96
Canada	ON	52 mi S of Armstrong	46.95	-79.90	451	Wawa A	47.96	-84.77	287	-164	-0.82	-14.80	-15.62	14.80	13.98
Canada	ON	54 mi S of Armstrong	46.88	-79.90	554	Wawa A	47.96	-84.77	287	-267	-1.33	-14.80	-16.13	14.80	13.47
Canada	ON	Black Sturgeon Lake, 42 mi. N Hurkett	49.35	-88.88	595	Wawa A	47.96	-84.77	287	-308	-1.54	-14.80	-16.34	14.80	13.26
Canada	ON	Lake Superior Prov. Pk., Gargantua	47.74	-84.83	497	Wawa A	47.96	-84.77	287	-210	-1.05	-14.80	-15.85	14.80	13.75
Canada	ON	6 mi. E Terrace Bay on Hwy 17	48.80	-86.94	484	Wawa A	47.96	-84.77	287	-197	-0.98	-14.80	-15.78	14.80	13.82
Canada	ON	Whitney, Hwy 127, 9.5 S of Hwy 60	45.38	-78.10	560	Wawa A	47.96	-84.77	287	-273	-1.37	-14.80	-16.17	14.80	13.43
Canada	QC	Blanc Sablon	51.43	-57.13	5	Lourdes De Blanc Sablon A	51.98	-57.18	37	32	0.16	-13.30	-13.14	11.80	11.96
Canada	QC	Duparquet	48.50	-79.23	472	Wawa A	47.96	-84.77	287	-185	-0.93	-14.80	-15.73	14.80	13.87
Canada	QC	Indian House Lake	56.23	-64.73	596	Fermont	52.80	-67.08	594	-2	-0.01	-23.20	-23.21	13.20	13.19
Canada	QC	Lanoraie, Berthierville	46.30	-72.42	517	Cap Madeleine	49.20	-65.30	2	-515	-2.58	-11.40	-13.98	16.50	13.92
Canada	QC	Mt. Albert	48.92	-66.20	1036	Cap Madeleine	49.20	-65.30	2	-1034	-5.17	-11.40	-16.57	16.50	11.33
Canada	QC	Mt. Jacques Cartier	48.98	-65.92	1219	Cap Madeleine	49.20	-65.30	2	-1217	-6.09	-11.40	-17.49	16.50	10.41

Source: Campbell (1983)

Table A-13 *Olophrum rotundicolle* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	QC	Mt. Lyall	48.78	-66.09	564	Cap Madeleine	49.20	-65.30	2	-562	-2.81	-11.40	-14.21	16.50	13.69
Canada	YT	Mile 724 Alaska Hwy, Swift R.	59.94	-131.22	1017	Dease Lake	58.41	-130.01	807	-210	-1.05	-17.50	-18.55	12.80	11.75
Canada	YT	Mile 1034 Alaska Hwy, Kloo Lk.	60.90	-137.70	860	Dawson A	64.04	-139.13	370	-489	-2.45	-26.70	-29.15	15.60	13.15
Canada	YT	Mile 1120 Alaska Hwy.	61.80	-140.15	853	Dawson A	64.04	-139.13	370	-483	-2.42	-26.70	-29.12	15.60	13.18
Canada	YT	Mile 1192 Alaska Hwy. nr Snag Junct.	62.23	-140.69	1280	Dawson A	64.04	-139.13	370	-910	-4.55	-26.70	-31.25	15.60	11.05
Canada	YT	Mile 1209 Alaska Hwy., Mirror Creek	61.96	-141.20	2333	Dawson A	64.04	-139.13	370	-1963	-9.81	-26.70	-36.51	15.60	5.79
Canada	YT	Mile 1044 Alaska Hwy.	61.00	-138.47	1768	Dawson A	64.04	-139.13	370	-1397	-6.99	-26.70	-33.69	15.60	8.61
Canada	YT	Mile 42 Dempster Hwy.	64.04	-138.46	1006	Dawson A	64.04	-139.13	370	-636	-3.18	-26.70	-29.88	15.60	12.42
Canada	YT	Mile 45 Dempster Hwy.	64.08	-138.50	1067	Dawson A	64.04	-139.13	370	-697	-3.48	-26.70	-30.18	15.60	12.12
Canada	YT	Mile 53 Dempster Hwy., North Fork Pass	64.20	-138.55	1280	Dawson A	64.04	-139.13	370	-910	-4.55	-26.70	-31.25	15.60	11.05
Canada	YT	Dempster Hwy., North Fork Pass, Ogilvie Mts.,	64.15	-138.46	1250	Dawson A	64.04	-139.13	370	-879	-4.40	-26.70	-31.10	15.60	11.20
Canada	YT	Mile 60 Dempster Hwy.	64.32	-138.48	1067	Dawson A	64.04	-139.13	370	-697	-3.48	-26.70	-30.18	15.60	12.12
Canada	YT	Mile 65 Dempster Hwy.	64.31	-138.46	1006	Dawson A	64.04	-139.13	370	-636	-3.18	-26.70	-29.88	15.60	12.42
Canada	YT	Mile 73 Dempster Hwy	64.38	-138.31	1036	Dawson A	64.04	-139.13	370	-666	-3.33	-26.70	-30.03	15.60	12.27
Canada	YT	Mile 75.5 Dempster Hwy	64.44	-138.25	1177	Dawson A	64.04	-139.13	370	-806	-4.03	-26.70	-30.73	15.60	11.57

Source: Campbell (1983)

Table A-13 *Olophrum rotundicolle* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	YT	Mile 122 Dempster Hwy	65.30	-138.37	933	Dawson A	64.04	-139.13	370	-563	-2.81	-26.70	-29.51	15.60	12.79
Canada	YT	Hansen Lk., 9 Mi. SW Keno	64.03	-135.31	731	Dawson A	64.04	-139.13	370	-361	-1.80	-26.70	-28.50	15.60	13.80
Canada	YT	Watson Lk.	60.05	-128.76	853	Watson Lake A	60.12	-128.82	687	-166	-0.83	-24.20	-25.03	15.10	14.27
USA	AK	Mile 1249 Alaska Hwy.	62.95	-142.00	523	Slana	62.70	-143.98	671	148	0.74	-20.17	-19.43	13.39	14.13
USA	AK	Mile 32 Denali Hwy,	63.09	-146.37	1372	Galbraith Lake Camp	68.48	-149.48	814	-558	-2.79	-15.59	-18.38	11.14	8.35
USA	AK	Mile 78 Denali Hwy.	65.30	-148.28	640	Galbraith Lake Camp	68.48	-149.48	814	174	0.87	-15.59	-14.72	11.14	12.01
USA	AK	Mile 102 Denali Hwy.	65.48	-148.63	457	Galbraith Lake Camp	68.48	-149.48	814	357	1.78	-15.59	-13.81	11.14	12.92
USA	AK	Mile 104.5 Denali Hwy.	65.50	-148.65	488	Galbraith Lake Camp	68.48	-149.48	814	326	1.63	-15.59	-13.96	11.14	12.77
USA	AK	Mile 110 Denali Hwy., Seattle Creek	65.55	-148.66	671	North Pole	64.75	-147.33	145	-526	-2.63	-23.39	-26.02	16.89	14.26
USA	AK	Kenai Peninsula	60.04	-151.35	549	Lazy Mountain	61.63	-149.04	222	-327	-1.63	-9.39	-11.02	15.22	13.59
USA	AK	Prudhoe Bay	70.28	-148.15	457	Prudhoe Bay	70.25	-148.07	23	-434	-2.17	-27.11	-29.28	7.61	5.44
USA	AK	Mile 23 Taylor Hwy.	64.07	-141.87	814	Northway AP	62.99	-141.94	522	-292	-1.46	-26.83	-28.29	15.22	13.76

Source: Campbell (1983)

Table A-14. *Helophorus arcticus* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	ON	James Bay	54.73	-82.23	217	La Grande Riviere A	53.63	-77.70	195	-22	-0.11	-23.20	-23.31	13.70	13.59
Canada	ON	Cape Henrietta Maria (James Bay, Radar site 415)	54.75	-82.40	152	La Grande Riviere A	53.63	-77.70	195	43	0.21	-23.20	-22.99	13.70	13.91
Canada	MB	Churchill	58.77	-94.15	46	Churchill	58.74	-94.07	29	-16	-0.08	-26.70	-26.78	12.00	11.92
Canada	NL	Labrador Coast	53.37	-56.40	106	Cartwright	53.71	-57.03	14	-92	-0.46	-14.80	-15.26	12.10	11.64
Canada	NL	Hebron, Labrador	58.20	-62.63	-1	Nain A	56.55	-61.68	6	7	0.04	-19.40	-19.36	14.20	14.24
Canada	NL	St. George Bay	48.51	-59.14	277	Lourdes De Blanc Sablon A	51.45	-57.18	37	-240	-1.20	-13.30	-14.50	11.80	10.60
Canada	NL	Battle Island	52.26	-55.59	49	St. Anthony	51.37	-55.60	12	-37	-0.19	-11.60	-11.79	12.40	12.21
Canada	NL	Battle Harbour	52.27	-55.58	41	St. Anthony	51.37	-55.60	12	-30	-0.15	-11.60	-11.75	12.40	12.25
Canada	NU	Hudson Bay	64.23	-90.45	148	Rankin Inlet A	62.82	-92.12	32	-115	-0.58	-32.00	-32.58	10.40	9.82
Canada	NU	Lake Harbour, Kimmirut	62.85	-69.87	9	Iqaluit A	63.75	-68.55	34	24	0.12	-26.60	-26.48	7.70	7.82
Canada	NU	Baffin Island (N. Shore of Hudson Strait)	63.37	-71.17	24	Iqaluit A	63.75	-68.55	34	9	0.05	-26.90	-26.85	7.70	7.75
Canada	QC	Kuujujaq (Fort Chimo)	58.10	-68.40	5	Kuujjuaq A	58.10	-68.42	40	35	0.17	-24.30	-24.13	11.50	11.67
Canada	QC	Baudan Inlet	58.92	-65.40	220	Kuujjuaq A	58.10	-68.42	40	-180	-0.90	-24.30	-25.20	11.50	10.60

Source: Smetana (1985)

Table A-15. *Helophorus parasplendidus* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	MB	Churchill	58.77	-94.90	27	Churchill	58.74	-94.07	29	2	0.01	-26.70	-26.69	12.00	12.01
Canada	NU	Padley (Palei)	61.30	-96.65	107	Baker Lake A	64.30	-96.08	19	-89	-0.44	-32.30	-32.74	11.40	10.96
Canada	NU	Kugluktuk (Coppermine)	67.82	-115.10	-1	Kugluktuk Climate	67.82	-115.13	23	23	0.12	-27.80	-27.68	10.70	10.82
Canada	NU	Arviat (Eskimo Point)	61.11	-94.06	1	Churchill	58.74	-94.07	29	29	0.14	-26.70	-26.56	12.00	12.14
Canada	NT	Kidluit Bay	69.50	-133.72	177	Inuvik A	68.30	-133.48	68	-109	-0.55	-27.60	-28.15	14.20	13.65
Canada	YT	Old Crow	67.50	-139.82	259	Old Crow A	67.57	-139.84	250	-9	-0.04	-28.60	-28.64	11.80	11.76
USA	CA	N side of Poore Lake, Mono Co.	38.31	-119.52	2334	Bridgeport	38.27	-119.23	1942	-393	-1.96	-4.28	-6.24	16.06	14.09
USA	CA	Crooked Creek	37.54	-118.20	3094	Bridgeport	38.27	-119.23	1942	-1152	-5.76	-4.28	-10.04	16.06	10.29
USA	CA	Homestead Flat, East Creek	41.20	-120.16	2281	Bridgeport	38.27	-119.23	1942	-340	-1.70	-4.28	-5.98	16.06	14.36
USA	CA	Chester, Plumas Co.	40.31	-121.23	2282	Bridgeport	38.27	-119.23	1942	-340	-1.70	-4.28	-5.98	16.06	14.35
USA	CO	Estes Park Alpine	40.44	-105.75	2896	Berthoud Pass	39.80	-105.78	3448	553	2.76	-11.06	-8.29	10.11	12.87
USA	CO	Cameron Pass	40.52	-105.89	3135	Berthoud Pass	39.80	-105.78	3448	313	1.57	-11.06	-9.49	10.11	11.68
USA	CO	Rabbit Ear Pass	40.38	-106.61	2877	Berthoud Pass	39.80	-105.78	3448	571	2.85	-11.06	-8.20	10.11	12.97
USA	CO	Argentine Pass	39.63	-105.78	4115	Berthoud Pass	39.80	-105.78	3448	-667	-3.33	-11.06	-14.39	10.11	6.78
USA	CO	Rollins Pass	39.93	-105.69	3353	Berthoud Pass	39.80	-105.78	3448	95	0.48	-11.06	-10.58	10.11	10.59
USA	CO	Kenosa Pass	39.41	-105.76	3051	Berthoud Pass	39.80	-105.78	3448	397	1.99	-11.06	-9.07	10.11	12.10
USA	CO	Leadville	39.25	-106.29	3100	Berthoud Pass	39.80	-105.78	3448	348	1.74	-11.06	-9.32	10.11	11.85
USA	CO	Loveland Pass	39.66	-105.88	3662	Berthoud Pass	39.80	-105.78	3448	-214	-1.07	-11.06	-12.13	10.11	9.04
USA	CO	Leavenworth Valley above Georgetown	39.71	-105.73	3595	Berthoud Pass	39.80	-105.78	3448	-146	-0.73	-11.06	-11.79	10.11	9.38
USA	CO	Nederland	39.96	-105.51	2993	Berthoud Pass	39.80	-105.78	3448	455	2.28	-11.06	-8.78	10.11	12.39

Source: E.H. Strickland Entomological Museum, University of Alberta; Campbell (1983)

Table A-15. *Helophorus parasplendidus* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	CO	Niwot ridge near. Ward	40.06	-105.55	3505	Berthoud Pass	39.80	-105.78	3448	-57	-0.28	-11.06	-11.34	10.11	9.83
USA	CO	Rocky Mt. Nat. Park	40.33	-105.68	3658	Berthoud Pass	39.80	-105.78	3448	-209	-1.05	-11.06	-12.10	10.11	9.06
USA	CO	Rocky Mt. Nat. Park, Trail Ridge	40.33	-105.76	3761	Berthoud Pass	39.80	-105.78	3448	-312	-1.56	-11.06	-12.62	10.11	8.55
USA	CO	Mt. Evans, Summit Lake	39.60	-105.60	3901	Berthoud Pass	39.80	-105.78	3448	-453	-2.27	-11.06	-13.32	10.11	7.84
USA	CO	Mt. Evans, Timberline	39.60	-105.64	3536	Berthoud Pass	39.80	-105.78	3448	-87	-0.44	-11.06	-11.49	10.11	9.67
USA	CO	Mt. Evans	39.59	-105.65	4023	Berthoud Pass	39.80	-105.78	3448	-575	-2.88	-11.06	-13.93	10.11	7.24
USA	CO	Mt. Evans	39.59	-105.65	4267	Berthoud Pass	39.80	-105.78	3448	-819	-4.09	-11.06	-15.15	10.11	6.02
USA	CO	Independence Pass	39.11	-106.56	3688	Berthoud Pass	39.80	-105.78	3448	-240	-1.20	-11.06	-12.25	10.11	8.91
USA	CO	Twin Creek at Florissant	38.95	-105.30	2814	Berthoud Pass	39.80	-105.78	3448	634	3.17	-11.06	-7.89	10.11	13.28
USA	UT	Alta	40.59	-111.64	2928	Estes Park	40.38	-105.52	2280	-648	-3.24	-2.00	-5.24	17.06	13.81

Source: Campbell (1983)

Table A-16. *Thanatophilus sagax* collection localities and climate

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	AB	Kakwa Wildland Provincial Park, Dead horse meadows	54.13	-119.92	1474	Grande Cache RS	54.90	-119.10	1250	-362	-1.81	-7.10	-20.41	13.30	11.19
Canada	AB	Kakwa Wildland Provincial Park, (Sulphur Ridge)	54.15	-119.78	1524	Grande Cache RS	54.90	-119.10	1250	-362	-1.81	-7.10	-20.41	13.30	11.19
Canada	AB	Jaspar Nat.Pk.	52.65	-118.17	2414	Mica Dam	52.05	-118.58	579	-1835	-11.93	-6.60	-18.53	16.60	4.67
Canada	AB	Banff	51.18	-115.57	2414	Banf	51.18	-115.57	1384	-1031	-6.70	-5.70	-12.40	15.90	9.20
Canada	AB	Calgary	51.05	-114.07	2414	Banf	51.18	-115.57	1384	-1031	-6.70	-5.70	-12.40	15.90	9.20
Canada	AB	Red Deer	52.28	-113.67	2414	Dakota West	52.75	-113.57	865	-1549	-10.07	-11.30	-21.37	15.00	4.93
Canada	BC	Chilkoot River	59.35	-135.60	931	Atlin	59.57	-133.70	674	-257	-1.67	-15.40	-17.07	13.10	11.43
Canada	BC	Glacier Bay National Park	58.54	-135.60	953	Atlin	59.57	-133.70	674	-279	-1.81	-14.40	-16.21	14.10	12.29
Canada	BC	Puntzil lake	52.35	-124.44	1535	Lunch Lake	51.82	-124.47	1017	-518	-3.37	-8.20	-11.57	13.60	10.23
Canada	BC	Cache Creek	50.78	-121.50	1495	Edson A	53.47	-118.21	927	-568	-2.84	-11.80	-14.64	14.60	11.76
Canada	BC	Merritt Airport	50.10	-120.87	1232	Edson A	53.47	-118.21	927	-305	-1.53	-11.80	-13.33	14.60	13.07
Canada	BC	Kamloops	51.68	-122.05	1240	Edson A	53.47	-118.21	927	-313	-1.57	-11.80	-13.37	14.60	13.03
Canada	BC	Columbia Mt.	50.52	-119.37	1342	Edson A	53.47	-118.21	927	-415	-2.08	-11.80	-13.88	14.60	12.52
Canada	NT	Abitau River	60.78	-106.80	472	Hay River A	60.54	-115.78	165	-308	-2.00	-23.10	-25.10	14.50	12.50
Canada	NT	Great Slave Lake	62.88	-109.12	429	Hay River A	60.54	-115.78	165	-265	-1.72	-23.10	-24.82	14.50	12.78
Canada	NT	Hay River	60.26	-116.45	491	Hay River A	60.54	-115.78	165	-326	-2.12	-23.10	-25.22	14.50	12.38
Canada	NT	Trout River	61.12	-119.82	451	Hay River A	60.54	-115.78	165	-286	-1.86	-23.10	-24.96	14.50	12.64

Source: E.H. Strickland Entomological Museum, University of Alberta.

Table A-16. *Thanatophilus sagax* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
Canada	NT	Liard River	61.23	-122.16	584	Fort Simpson A	61.76	-121.24	169	-415	-2.70	-25.40	-28.10	14.70	12.00
Canada	NT	Nahanni Nat.Pk.	61.20	-124.17	621	Fort Simpson A	61.76	-121.24	169	-451	-2.93	-25.40	-28.33	14.70	11.77
Canada	NT	Tuktut Nogiat Natt Pk.	68.83	-121.61	527	CapeParry A	70.17	-124.72	87	-440	-2.86	-27.70	-30.56	6.20	3.34
Canada	NT	Anderson River	68.17	-124.90	263	CapeParry A	70.17	-124.72	87	-176	-1.14	-27.70	-28.84	6.20	5.06
Canada	YT	Richardson Mountains	67.78	-136.98	1075	Old Crow A	67.57	-139.84	250	-824	-5.36	-31.10	-36.46	14.60	9.24
Canada	YT	Victoria Rock	62.81	-137.51	1082	Mayo Road	60.88	-135.18	655	-427	-2.77	-17.40	-20.17	14.90	12.13
Canada	YT	Mount Logo	60.50	-140.40	2125	Burwash Airport	61.37	-139.05	806	-1319	-8.57	-22.00	-30.57	12.80	4.23
USA	AK	Chilkoot River	59.30	-135.70	378	Yakutat	59.50	-130.67	10	-368	-2.39	-3.44	-5.84	12.00	9.61
USA	AK	Glacier Bay National Park	58.55	-135.62	229	Yakutat	59.50	-130.67	10	-219	-1.42	-3.44	-4.86	12.00	10.58
USA	AK	Snow Shoe Lake	62.00	-146.85	955	Alyeska	60.95	-149.10	83	-872	-5.67	-6.44	-12.11	13.72	8.05
USA	AK	Glen Alps	61.07	-149.38	719	Alyeska	60.95	-149.10	83	-636	-4.13	-6.44	-10.58	13.72	9.59
USA	AK	Glen Hwy.	61.79	-147.68	651	Alyeska	60.95	-149.10	83	-568	-3.69	-6.44	-10.14	13.72	10.03
USA	AK	Kenai Mountains	60.58	-149.47	725	Alyeska	60.95	-149.10	83	-643	-4.18	-6.44	-10.62	13.72	9.55
USA	AK	Denali Nat. Park	63.51	-150.64	744	Anderson Lake	61.62	-149.33	143	-601	-3.90	-8.72	-12.63	13.83	9.93
USA	AK	Port heiden	56.20	-159.54	559	Port Heiden	56.95	-158.62	28	-531	-3.45	-5.28	-8.73	11.22	7.77
USA	AK	Bethel	60.55	-160.16	590	Bethel AP	60.78	-161.80	31	-559	-3.64	-14.11	-17.75	13.33	9.70
USA	AK	Andreafski	62.50	-162.06	219	Bethel AP	60.78	-161.80	31	-188	-1.22	-14.11	-15.34	13.33	12.11

Source: E.H. Strickland Entomological Museum, University of Alberta.

Table A-16. *Thanatophilus sagax* collection localities and climate (continued)

Country	State/ Prov.	Coleopteran collecting location	Lat. (º)	Long. (º)	Elev. (m)	Meteorological station	Lat. (º)	Long. (º)	Elev. (m)	Diff. in elev. (m)	Elev. corr. (ºC)	Mean Jan. Temp. (ºC)	Mean Jan. corr. (ºC)	Mean July Temp. (ºC)	Mean July corr. (ºC)
USA	AK	Decourcy Mountain Mine Airport	62.01	-158.80	175	Bethel AP	60.78	-161.80	31	-144	-0.93	-14.11	-15.04	13.33	12.40
USA	AK	Unalakleet	63.75	-159.95	356	Unalakleet FLD	63.88	-160.80	5	-350	-2.28	-15.94	-18.22	13.06	10.78
USA	AK	Nome	64.82	-165.20	337	Nome Muni. AP	64.50	-165.43	4	-333	-2.16	-14.56	-16.72	11.44	9.28
USA	AK	Kotzebue	66.88	-159.95	215	Kotzebue WSO	66.86	-162.63	9	-206	-1.34	-16.39	-17.73	12.61	11.27
USA	AK	Cape Thompson	68.50	-164.13	411	Kotzebue WSO	66.86	-162.63	9	-402	-2.62	-16.39	-19.00	12.61	10.00
USA	AK	ColeVille River	68.95	-156.05	585	Umiat AP	69.37	-152.13	81	-504	-3.27	-30.06	-33.33	12.61	9.34
USA	AK	Walker Lake	67.13	-154.15	744	Umiat AP	69.37	-152.13	81	-663	-4.31	-30.06	-34.36	12.61	8.30
USA	AK	Atalanta River	66.52	-152.57	327	Umiat AP	69.37	-152.13	81	-246	-1.60	-30.06	-31.65	12.61	11.01
USA	AK	White Mountain	65.50	-145.33	1015	North Pole	64.75	-147.32	145	-870	-5.65	-23.39	-29.04	16.89	11.23
USA	AK	Gold Dredge	65.35	-143.00	558	Eagle	64.75	-141.37	256	-302	-1.97	-24.22	-26.19	14.28	12.31
USA	AK	Canyon Village	67.15	-141.35	540	Eagle	64.75	-141.37	256	-284	-1.85	-24.22	-26.07	14.28	12.43
USA	AK	Eagle	64.74	-141.58	836	Eagle	64.75	-141.37	256	-580	-3.77	-24.22	-27.99	14.28	10.51

Source: E.H. Strickland Entomological Museum, University of Alberta.