

Clothing and the Replacement of Neanderthals by Modern Humans

by

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Abstract

Between 40,000 and 25,000 years ago, during the cold, dry period known as Oxygen Isotope Stage 3 (OIS 3), modern humans migrated into Europe and replaced Neanderthals. In this study, I investigated whether clothing could have played a role in this event. To begin with, I carried out a cross-cultural analysis to identify mammalian taxa whose presence in archaeological deposits may indicate the use of clothing. Subsequently, I tested for differences in the frequencies of such taxa in Neanderthal versus modern human occupations in OIS 3 Europe. The analyses suggest that both modern humans and Neanderthals may have made clothing. However, they also suggest that modern humans made clothing out of a wider range of taxa than Neanderthals, and that clothing made by modern humans was more thermally effective than that made by Neanderthals. These findings are consistent with the idea that clothing played a role in the Neanderthal replacement.

Keywords: Clothing; cold adaptations; Neanderthal replacement; Last Glacial Maximum; Neanderthals; modern humans

Dedication

I dedicate this to my family and loved ones, who have supported and encouraged me throughout my education.

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List of Acronyms

| | |
|---------|--|
| BMR | Basal metabolic rate |
| EUP | Early Upper Palaeolithic |
| ka | Thousand years ago |
| kcal BP | Thousand calibrated years before present |
| LGM | Last Glacial Maximum |
| LMP | Late Middle Palaeolithic |
| OIS 3 | Oxygen Isotope Stage 3 |
| RMR | Resting metabolic rate |
| SA/V | Surface-area-to-volume ratio |

1. Introduction

1.1. Research objectives

Modern human origins has been a hotly contested topic for several decades. For much of this time, the debate has focused on the relative merits of four models that differ in relation to geography, time scale, and process:

- **The Recent African Origin model.** This model holds that modern humans originated in Africa almost 200 thousand years ago (ka), and spread from there throughout Europe, Asia, and Australasia between 100 and 50 ka, replacing indigenous non-modern hominin populations with little, if any, interbreeding (Aiello 1993; Stringer 2002; Collard and Dembo, in press).
- **The (African) Hybridization and Replacement model.** This model also accepts a recent African origin for modern humans, but allows for more hybridization between moderns and non-modern hominins than the Recent African Origin model (Aiello 1993; Stringer 2002).
- **The Assimilation model.** This model accepts a recent African origin for most modern human genes, but does not consider population replacement to be the major factor in their spread outside of Africa. Rather, it argues, the genes in question spread via gene flow (Collard and Dembo, in press).
- **The Multiregional Evolution model.** This model denies a recent African origin for modern humans. It proposes instead that modern humans arose from local populations in Africa, Europe, and Asia. Proponents of Multiregional Evolution argue for species-wide evolutionary change due to gene flow and changing selective pressures (Wolpoff et al. 2000).

In the last ten years, a consensus has emerged that the Recent African Origin and the (African) Hybridization and Replacement models are more likely to be correct than the Assimilation and Multiregional Evolution models, and attention has switched to the details of the process by which modern humans emerged in Africa and then migrated into the rest of the Old World (Klein 2008, Collard and Dembo, in press). One of the issues that has come to the fore in this second phase of the modern human origins debate is the manner in which modern humans replaced our closest relatives, the Neanderthals.

Neanderthals were the only hominins in Europe from around 300 ka until about 50 to 40 ka (Mellars 2004; Harvati 2010; Stringer, 2012; Hublin 2012). Around 50 to 40 ka the Neanderthals were joined by modern humans, who appear to have migrated into Europe from Southwest and/or Central Asia (Mellars 2004; Hublin 2012). Shortly after 30 ka, Neanderthals disappeared, leaving modern humans as the sole hominins in Europe (van Andel et al. 2003; Mellars 2004; Harvati 2010).

Three hypotheses have been put forward to account for this replacement event. The first is the competition hypothesis (Mellars 2004). This hypothesis contends that the Neanderthals went extinct because they were unable to compete for space and resources with modern humans. Modern humans are argued to have lived in larger, more densely packed populations, and to have occupied sites on a more permanent basis than Neanderthals (Mellars 1989). They were able to do so, according to this hypothesis, due to their innovative and complex technology, which allowed them to increase their dietary breadth to include resilient and reliable resources such as hares and freshwater fish (Stiner 2001; Stiner and Kuhn 2006; Richards and Trinkaus 2009). Modern humans' higher population density and lower residential mobility are argued to have promoted reciprocal networks with neighbouring groups (Mellars 1989). Such networks are claimed to be advantageous in times of resource unpredictability as they disperse risk of subsistence failure (Mellars 1989; Shea 2003). In addition, the wide range of symbolic behaviour associated with early modern humans in Europe is interpreted as evidence of complex social structure as well as language, which would have improved the diffusion of adaptive cultural behaviours (Mellars 1989; Shea 2003).

The second hypothesis that has been put forward to explain the replacement of Neanderthals by early modern humans focuses on climate change during Oxygen Isotope Stage 3 (OIS 3). OIS 3 is a climatic phase that began around 60 ka and ended approximately 25 ka. It was characterised by a series of abrupt and severe oscillations between cold and warm, culminating in major climatic deterioration towards the Last Glacial Maximum (LGM) beginning some 37 ka (van Andel and Davies 2003; Davies and Gollop 2003). The climate change hypothesis proposes that Neanderthals went extinct not because of competition with modern humans, but because they were unable to cope with the extreme cold during OIS 3 (Stewart 2005). Modern humans, in contrast, were able to endure the cold due to cultural adaptations (Stewart 2005). In support of the

climate change hypothesis, Stewart (2004; 2007) argues that Neanderthals were a warm-adapted species, as they are commonly found in association with warm-adapted taxa that prefer closed environments. In comparison, early modern humans in Europe are commonly found in association with cold-adapted taxa that prefer open environments. Stewart (2007) also notes that Neanderthal populations were most genetically diverse prior to the penultimate cold period, before OIS 3, and that Neanderthal genetic diversity was lower during OIS 3. Stewart (2007) interprets this reduction in diversity as evidence of a reduction in the Neanderthal population during the penultimate cold period and OIS 3, due to cold stress. Stewart (2007; 2005; 2004) argues, then, that Neanderthal populations were diminishing due to cold stress before modern humans entered Europe, and that the climatic changes in the later part of OIS 3 were sufficient to wipe out the Neanderthals without competition from modern humans.

The third hypothesis that has been proposed to account for the replacement of the Neanderthals by modern humans focuses on environmental stress. This hypothesis combines elements of the competition hypothesis and the climate change hypothesis. Stringer et al. (2003) argue that both competition and the direct and indirect effects of the OIS 3 changes in climate were likely responsible for the replacement of Neanderthals by modern humans. Stringer et al. (2003) note that during OIS 3 there were not only extremely cold temperatures but also rapid rates of climate change, which would have destabilized the environment and reduced its carrying capacity, since not all flora and fauna could adapt to new resources and habitats rapidly enough to survive. Stringer et al. (2003) suggest that Neanderthals survived the penultimate period of maximum environmental stress in refugia, from which they expanded once conditions ameliorated at the beginning of OIS 3. However, environmental stress nearing the LGM may have been more prolonged than during the penultimate period of maximum stress, and Stringer et al. (2003) argue that if Neanderthal populations were already stressed, living in destabilized environments, and competing for limited resources, then the arrival of new, modern human competitors may have been the final factor responsible for the Neanderthal extinction.

Currently it is not clear which of these hypotheses best accounts for the replacement of Neanderthals by modern humans. The competition hypothesis has been criticized on the grounds that there is no clear evidence for direct competitive encounters

between Neanderthals and modern humans, such as skeletons showing evidence of warfare (Shea 2003). Additionally, Stewart (2004) has argued that differences in behaviour between Neanderthals and modern humans do not by themselves demonstrate that competition took place. The major argument against the climate change hypothesis for the extinction of the Neanderthals is that Neanderthals are unlikely to have gone extinct due to climate change because they survived previous glaciations in Europe, such as the major glaciation of Oxygen Isotope Stage 6 (van Andel 2003; Gamble 1999). Stewart (2005) criticized this argument on the grounds that no two climatic phases are the same, but he did not provide evidence that climatic deterioration during OIS 3 was more extreme than during previous phases. So, the argument retains its force. The environmental stress hypothesis has been attacked by Stewart (2005). Stewart (2005) argues that the climatic fluctuations of OIS 3 exceeded the lifespan of an individual, and natural selection cannot act on a species beyond the lifespan of an individual of that species. Stewart (2005) instead argues that the Neanderthal extinction was the result of a single downward turn in climate, since a single downward or upward turn in climate would have acted within the lifespan of an individual. However, Stewart's (2005) criticism does not acknowledge the indirect and cumulative effects of climatic variability that the environmental stress hypothesis implicates in the Neanderthal replacement. If plants and animals went extinct during a single downward or upward turn in climate during OIS 3, then the hominins and other species that relied on those resources would have been affected by the accumulation of extinctions caused by a series of such climatic turns. Thus, none of the hypotheses is entirely convincing at this stage and further research is required in order to determine which, if any, of them is correct.

The goal of the present study was to evaluate the possibility that clothing use played a role in the replacement of Neanderthals by early modern humans in Europe. The major utilitarian function of clothing that is relevant to this study is, of course, protection from freezing to death. Inadequate clothing in cold environments can also lead to respiratory ailments, and hinder hunters from using tactics that involve long periods of inactivity while exposed to cold, such as ambush hunting (Stenton 1991). Hence, thermally effective clothing may contribute to the evolutionary success of hominins not only by keeping them from freezing to death, but also by preventing illness

and ensuring that dietary needs are met. If the climate change hypothesis is correct, then a difference in the frequency of clothing use or in the thermal efficiency of clothing in favour of modern humans would have played a major role in the replacement of Neanderthals by modern humans. Likewise, if the environmental stress hypothesis is correct, such a difference would have contributed to the success of modern humans relative to Neanderthals. Although the competition hypothesis does not specifically implicate clothing in the Neanderthal replacement, it attributes modern humans' success in part to their increased ability to capture small, fast-moving game, some of which would have been fur-bearing. In addition, it is likely that the innovative technology of early modern humans in Europe included tools used to manufacture clothing. Recent studies suggest that clothing would have been vital to both Neanderthals and modern humans during OIS 3 (Aiello and Wheeler 2003). So, if the more adaptive technology of modern humans allowed them to manufacture superior insulative clothing, they may have had a competitive advantage over Neanderthals during OIS 3 in terms of protection from cold. The use of clothing during OIS 3 could therefore have played a role in all of the hypotheses that have been put forward to explain the replacement of the Neanderthals by early modern humans.

This study tested the hypothesis that clothing made from animal hides contributed to the evolutionary success of modern humans, and that a lack of clothing, or a lack of clothing that was highly insulative in cold weather, contributed to the extinction of the Neanderthals in Europe during the latter part of OIS 3. To test this hypothesis, I first determined which animal taxa are ethnographically used for clothing, and for highly insulative, cold weather clothing. Subsequently, I tested for statistically significant differences in the frequencies of such taxa in Neanderthal versus modern human occupations. If the remains of animal taxa that are used for clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made clothing more frequently than Neanderthals. Likewise, if the remains of taxa that are used for highly insulative, cold weather clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made highly insulative, cold weather clothing more frequently than Neanderthals. The results of this study shed light on whether clothing, and particularly clothing that is highly insulative, played a role in the replacement of

Neanderthals by modern humans during the extreme climatic deterioration of the latter part of OIS 3.

1.2. Background

1.2.1. *Neanderthals and early modern humans in Europe*

The oldest fossils argued to belong to Neanderthals (*Homo neanderthalensis*) come from the Sima de los Huesos in northern Spain and date to around 400 ka (Stringer 2012), although both the species designation and the dating of these fossils are debated. The oldest widely accepted Neanderthal fossils in Europe come from Ehringsdorf, Germany, and are dated to approximately 200 ka (Cartmill and Smith 2009). The youngest radiometric dates for Neanderthal remains come from Vindija Cave, Croatia, and the site of Mezmaiskaya in Russia (Higham et al. 2006; Cartmill and Smith 2009). The Vindija specimens date to around 33 ka; the Mezmaiskaya specimen to around 30 to 29 ka (Higham et al. 2006; Cartmill and Smith 2009). Based on current evidence, the geographic range of Neanderthals was from Wales in the north to Israel in the south, and from Portugal in the west to Siberia in the east (Klein 2003; Krause et al. 2007).

Neanderthals had large brains, roughly equal in size to those of living humans (Tattersall 2009; Cartmill and Smith 2009). The Neanderthals had a long, wide and low cranial vault, an occipital bun, a large, prognathic face, a large nasal aperture, and pronounced brow ridges (Cartmill and Smith 2009; Smith 2009). Neanderthal anterior teeth were large and often heavily worn, leading some to propose that they were used as tools (Cartmill and Smith 2009; Ungar et al. 1997). Neanderthals had a robust and massive body relative to their height, with a broad, barrel-shaped chest (Ruff 1993; Smith 2009; Cartmill and Smith 2009). In addition, Neanderthals' distal limb segments were short relative to their trunk height and proximal limb segment length (Ruff 1993; Holliday 1997; Smith 2009; Cartmill and Smith 2009).

Neanderthals are thought to have lived in small, dispersed groups (Stiner 2001; Stiner et al. 1999). Most Neanderthal sites are fairly small, and appear to reflect relatively brief, short-term occupations (Mellars 1989). Neanderthals generally do not

seem to have built structures that left archaeological traces. A few Neanderthal sites have been argued to demonstrate structured living spaces (clearly defined living structures with spatial arrangements of hearths, pits, and post holes), but none of these claims is widely accepted (Klein 2003; d'Errico et al. 2003; Soffer 1989; Klein 1999). Neanderthals seem to have used fire, but their status as habitual fire users has recently been called into question (Sandgathe et al. 2011). Sandgathe et al. (2011) point out that in a number of Neanderthal sites in France, fire is absent during cold period occupations, but present in warm period occupations, when natural fires due to lightening are more frequent. This, they argue, suggests that Neanderthals harnessed naturally occurring fire but did not have the requisite technical knowledge to make fire.

Faunal remains and stable isotope analyses indicate that Neanderthals hunted a range of large terrestrial herbivores such as woolly rhinoceros, mammoths, red deer, and large members of the Bovidae family for food (Stiner 2001; Hoffecker and Cleghorn 2000; Bocherens 2009; Richards and Trinkaus 2009; Cartmill and Smith 2009). Richards and Trinkaus (2009) used Carbon and Nitrogen stable isotope ratios in adult bone collagen from a number of Neanderthals and modern humans to determine the main sources of dietary protein consumed by each species. The Carbon isotope values of Neanderthals were found to closely match those of terrestrial consumers, which indicated that protein in the Neanderthal diet came from predominantly terrestrial sources, and marine resources did not significantly contribute to dietary protein. The Nitrogen isotope ratios of Neanderthals studied by Richards and Trinkaus (2009) were similar to or higher than those of contemporary carnivores, which suggests that Neanderthals were top-level carnivores whose main protein source was herbivores. Neanderthals appear to have also consumed marine resources in some areas (e.g. marine molluscs), but isotope evidence demonstrates that marine resources were not a significant part of Neanderthal diets across populations (Stiner 2001; Richards and Trinkaus 2009; Stiner 1994). There is also faunal evidence that Neanderthals ate small vertebrate prey, but in the Mediterranean Basin small prey exploited by Neanderthals seems to have been limited to easy-to-catch game with low reproductive rates, such as tortoises (Stiner 2001). Lastly, some Neanderthal tools display residues of starchy plants, which suggests that their diet was not exclusively carnivorous (Hardy 2004).

Modern humans seem to have spread from Southwest and/or Central Asia into Europe beginning around 50 to 40 ka (Hublin 2012; Cartmill and Smith, 2009). The earliest dated stone tool assemblages that are generally accepted to have been made by modern humans date from 42 to 40 ka at El Castillo, Spain, 40 to 33 ka at Geißenklösterle, Germany, 41 ka at Trou Magrite, Belgium, 42 to 40 ka at Willendorf, Austria, and 43 ka at Samuilica Cave, Bulgaria (Cartmill and Smith 2009). Diagnostic remains of the makers of these assemblages have not been found, but it is generally assumed that the assemblages in question were made by modern humans because similar assemblages are associated exclusively with modern humans at later sites (Cartmill and Smith 2009). The oldest diagnostically modern human remains in Europe date to around 30 ka, and come from Mladeč in the Czech Republic (Cartmill and Smith 2009; Wild et al. 2005). After their arrival in Europe, modern human populations expanded geographically (van Andel et al. 2003). Early modern human sites in Europe were more widespread than Neanderthal sites; by 33 to 30 ka, modern humans were the first hominins to expand north of the trans-European mountain range, into what were likely some of the coldest parts of continental Eurasia (van Andel et al. 2003; Klein 1995).

Early modern humans in Europe had skulls that were somewhat robust, with a high forehead and cranial vault, and a large brain (Cartmill and Smith 2009; Collard and Dembo, in press). Compared to the Neanderthal face, the early modern human face was small and orthognathic, with a small nasal aperture, less pronounced brow ridges, and no occipital bun (Cartmill and Smith 2009). Early modern humans in Europe were on average taller than Neanderthals, with a more linear body build, a narrower trunk, and more slender limbs with distal limb segments that were long relative to proximal limb segment length and trunk height (Cartmill and Smith 2009; Franciscus and Churchill 2002; Ruff 1993).

Modern humans in Europe seem to have lived in larger, more densely packed populations than Neanderthals, and occupied sites on a more permanent basis (van Andel et al. 2003; Stiner 2001; Mellars 1989). Early modern human sites in Europe demonstrate evidence of structured living spaces and roofed-over structures (Mellars 1989; Soffer 1989; Klein 2008). By 29 to 24 ka, there is evidence of larger living structures and sites than ever before among European modern humans (Hoffecker

2005; Gamble 1999). It is generally accepted that early modern humans in Europe habitually made fire (Roebroeks and Villa 2011; Straus 1989).

Early modern humans in Europe appear to have had a more varied diet than Neanderthals, with some modern human groups consuming significant quantities of Carbon 3 pathway (C3) plants, freshwater resources, and marine resources, in addition to terrestrial game (Richards and Trinkaus 2009; Richards et al. 2001). Richards and Trinkaus (2009) found that the Nitrogen isotope value of an early modern human in Europe, Oase 1, was above local top-level carnivores such as wolves, suggesting that Oase 1 obtained a significant portion of its dietary protein from freshwater fish. Modern humans from coastal Italy and inland France (Arene Candide IP and La Rochette 1) had Carbon and Nitrogen isotope values indicative of a diet high in marine resources (Richards and Trinkaus 2009). A number of modern humans studied had Carbon isotope values that were indicative of a diet high in terrestrial C3 plant, or freshwater, foods (Richards and Trinkaus 2009). The Carbon and Nitrogen values of a modern human at Eel Point 1 (Wales) fit with a diet focused on herbivores such as bison and horse, and/or marine protein. Early modern humans in Europe thus demonstrate a varied range of isotopic values, which indicate a varied diet, at times including significant quantities of both freshwater and marine aquatic resources (Richards and Trinkaus 2009; Richards et al. 2001). Faunal analyses also support the idea that early modern humans in Europe had a broad diet (Stiner 2001). Stiner (2001) noted a particular intensification in the exploitation of small, hard-to-catch game such as birds and lagomorphs from approximately 40 to 10 ka.

1.2.1.1. Neanderthal and early modern human technologies in Europe

It is generally accepted that in Europe Neanderthals made the industries of the Middle Palaeolithic, while modern humans made the various industries of the Upper Palaeolithic (e.g. van Andel and Davies 2003; Chase 1989). The major industry of the Middle Palaeolithic is the Mousterian; the main industries of the Upper Palaeolithic are the Aurignacian, the Gravettian, the Solutrean, and the Magdalenian (Straus 1995; Gamble 1999). In addition, there are a number of so-called “transitional” industries that share Middle and Upper Palaeolithic characteristics and are of disputed affiliation (Gamble 1999; Straus 1995; d’Errico and Stringer 2011; Higham et al. 2010).

Bordes (1961) outlined the tool typology that is now the standard for the classification of Palaeolithic artefacts in Europe (Bordes 1961; Bordes and de Sonneville-Bordes 1970; Straus 1995; Debénath and Dibble 1994). The usefulness of Bordes' division of tools into distinct "types" has been called into question, with some suggesting that the defined types are subjective, enforce artificial distinctions that obscure diversity, and presume function (Bisson 2000; Bar-Yosef 2002; Debénath and Dibble 1994; Hardy et al. 2008). However, since the Bordesian typology is predominant in descriptions of the archaeological record, it will be used here to describe the technological industries of the Middle and Upper Palaeolithic.

The Mousterian industry dates from approximately 250 to 22 ka (van Andel et al. 2003). Mousterian technology is characterised by multi-purpose, generalized tools (Hardy 2004; Boquet-Appel and Tuffreau 2009). Typical Mousterian tools include burins, side scrapers, perforators, backed and truncated flakes and blades, produced with the Levallois flaking technique (Straus 1995). The Levallois technique requires large quantities of raw material and time to produce large numbers of tools, so it has been argued that the Levallois technique could only be used by small populations (Shea 2003). Mousterian sites have not yielded definitive evidence of "true" long-range projectile technology (Churchill and Rhodes 2009; Shea 2006). Wooden spears have been found in Lower and Middle Palaeolithic contexts, dating from approximately 400 ka at Schöningen, and 125 ka at Lenrington (Thieme 1997), but it has been argued that hand-deployed spears are short-range weapons, since they are often used ethnographically for hand-held thrusting and short-range throwing (Churchill and Rhodes 2009). Middle Palaeolithic use-wear analyses suggest that Neanderthals may have hafted lithic points to spears or handles in order to make composite weapons (Schmitt et al. 2003; Shea 1988; Shea et al. 2001), but use-wear analyses alone cannot differentiate between projectile and hand-thrust use (Schmitt et al. 2003), and analyses of projectile point morphology suggest that Middle Palaeolithic points were not designed to be projectiles (Shea 2006). Mousterian lithics appear to vary little over time and in relation to environmental changes (Bocquet-Appel and Tuffreau 2009).

The Aurignacian dates from approximately 40 ka to about 29 ka (Straus 1995; Gamble 1999; van Andel et al. 2003). Aurignacian assemblages have been recovered from a broad arc of western, central and southeastern Europe, and the immediately

adjacent areas of the Near East (Mellars 2002). The oldest Aurignacian technology comes from eastern Europe, which seems to support the idea of an east-to-west modern human migration into Europe (Mellars 2002). Aurignacian technology is thought to involve more standardized tool form and function than the Mousterian, and the use of materials transported over longer distances (Gamble 1999; Mellars 2002). The Aurignacian also demonstrates more regional and within-assemblage variability than the Mousterian (Boquet-Appel and Tuffreau 2009; Bar-Yosef 2002). The wide range of tools made in the Aurignacian and Upper Palaeolithic in general may have allowed modern humans to increase their dietary breadth to include more hard-to-catch game and plant resources that require processing to eat (Stiner 2001; Stiner and Kuhn 2006). Beginning in the Aurignacian (35 to 25 ka), modern humans in western Eurasia seem to have made a wide range of projectile weaponry out of stone, bone, and antler (Shea 1997). The advent of projectile technology among modern humans would have reduced risk of bodily harm while hunting large game (Shea 2003). Classic Aurignacian toolkits are characterized by fluted carinate forms, blades with extensive edge retouching, split-based bone and antler points, a variety of end scrapers, and frequent hafting (Mellars 2006; Gamble 1999). Aurignacian lithics were typically produced using direct percussion, with one striking platform and one flaking surface (Gamble 1999). The production techniques of Upper Palaeolithic tools are thought to have been more efficient than those of the Middle Palaeolithic, in that they maximized the amount of usable flakes that could be made from raw materials (Shea 2003). Upper Palaeolithic flint-knapping techniques thus may have been conducive to supporting larger populations than Middle Palaeolithic techniques. In addition, the Aurignacian is noteworthy for exhibiting the first clear evidence of symbolic behaviour in Europe in the form of art, ornaments, and figurines (Conard 2003; Hoffecker 2005). Symbolic behaviour in the Upper Palaeolithic is argued to display personal and/or group identity, which has been interpreted as evidence for complex social structure (Shea 2003).

The majority of Gravettian sites date from approximately 30 ka to about 25 ka (Straus 1995). However, variants of the Gravettian persisted in southeastern and central Europe until about 11 ka (Straus 1995); these are referred to collectively as the “Epigravettian”. Features of the Gravettian overlap with the Aurignacian, but the two technologies were generally distinct by about 30 ka (Straus 1995). Gravettian

assemblages are widespread in Europe, and mark the first northern expansion of modern humans beyond 55°N in Europe (van Andel et al. 2003). Gravettian technology is characterized by light, narrow blades, often steeply retouched into sharp points, a variety of burins, perforators, tanged, shouldered, leaf and organic points, simple and thin end scrapers, and perforators (Straus 1995). Gravettian tools have been described as more standardized and less opportunistic than Aurignacian tools (Gamble 1999). Also in contrast with the Aurignacian, Gravettian lithics seem to have been made using more elaborate core preparation techniques. Gravettian tools have bidirectional cores, made using opposed striking platforms, and tools were commonly produced using indirect percussion with bone or antler punches (Gamble 1999). Furthermore, the Gravettian shows steep, blunting retouch on one edge of blades, and microblades produced in serial, painstaking fashion (Gamble 1999). Lithic material seems to have improved during the Gravettian in the some areas, such as the Swabian Jura of Germany (Conard and Moreau 2004). The Gravettian also marks the advent of ceramic production (Hoffecker 2005), and the widespread appearance of the famous “Venus” figurines (Cartmill and Smith 2009), which have been interpreted variably as fertility symbols, goddesses, erotica, and self portraits (Soffer et al. 2000).

Between 23 and 16.5 ka, during the peak of the LGM, the Solutrean industry appeared in southern France and Iberia, areas that have been interpreted as LGM refugia (Straus 1995; Gamble 1999; Straus 2005). The Solutrean was contemporaneous with the Epigravettian of southeastern and central Europe. The Solutrean demonstrated a refinement of lithic weapon tips, the development of foliate, stemmed and shouldered points, backed blades and bladelets, and thin, bipolar end scrapers with steep retouching (Straus 1995; Straus 2005). Solutrean lithic point types were individually standardized in size, form, retouch type and basal treatment, and regionalism is evident among specific subtypes, arguably reflecting a deliberate or unconscious imposition of style (Straus 1995). Specialized points with jagged, bloodletting edges and barbs appeared in the Solutrean, and are believed to have been delivered via atlatl (Straus 1995). Lastly, the Solutrean demonstrates an apparent increase in the use of exotic lithic materials (Hoffecker 2005).

It is generally accepted that after the LGM, the Solutrean locally gave rise to the Magdalenian industry in France and Iberia, dating from approximately 16.5 to 11.5 ka

(Straus 2005; Straus 1995). The Magdalenian also appeared in Belgium, Switzerland and Germany (Straus 2005). Again, the Magdalenian was contemporaneous with the Epigravettian of southeastern and central Europe. The people responsible for the Magdalenian seem to have abandoned “high investment” Solutrean points in favour of flake-based technologies, which were characterized by compound weapon tips made of resilient, reusable antler points and “low investment” replaceable backed bladelets (Straus 2005; Straus 2000). Other apparent Magdalenian innovations include harpoons, non-geometric microliths, Azilian points, backed bladelets, diverse, specialized tools such as burins and perforators, and a marked increase in the use of antler (Straus 1995; Straus 2005). End scrapers similar to those in the Gravettian and the Solutrean also appear in the Magdalenian (Rosenfeld 1971). Stone tools were generally made of local flints and quartzites in Cantabria, but long distance lithic material exchange occurred in Magdalenian France, Belgium, Switzerland and Germany (Straus 2005).

The transitional industries are found in several areas in deposits dating between 50 ka and 30 ka, around the time that modern humans entered Europe (Nowell 2010; Gamble 1999). To reiterate, they are called transitional because they display similarities with both Middle and Upper Palaeolithic technologies (Nowell 2010; Gamble 1999). The Châtelperronian is the best-known transitional industry. The Szeletian and the Uluzzian are among the other transitional industries. Transitional industries are generally characterized by leaf-points as well as blades, which in some industries were produced using the Levallois technique (Bar-Yosef 2002; Straus 1995). The Châtelperronian industry in particular is argued to be similar to Upper Palaeolithic industries in that it includes end scrapers, personal ornaments and bone tools (Gravina et al. 2005; Bar-Yosef 2002; Zilhão et al. 2006; d’Errico et al. 2003; d’Errico et al. 1998). Transitional industries are frequently attributed to the Neanderthals, but there is considerable debate over whether the similarities between these industries and the Aurignacian are due to independent invention, a consequence of Neanderthals copying modern humans, or the result of mixing of layers (Gravina et al. 2005; Mellars 2005; Higham et al. 2010). Many archaeologists are sceptical of the idea that Neanderthals independently invented transitional industries, since Neanderthals seemingly demonstrated many years of cultural stasis before the arrival of modern humans in Europe (Mellars 2005; Nowell 2010; Bocquet-Appel et al. 2009). Recently, Hublin (2012) has suggested that the

makers of some transitional assemblages in Europe were actually early modern humans.

1.2.2. *Climate during the replacement of the Neanderthals by modern humans*

As noted above, Neanderthals were replaced by modern humans during the climatic phase known as OIS 3. Current knowledge of the conditions in Europe during this phase comes in large part from the Stage 3 Project, which was a multi-disciplinary project designed to synthesize the current state of knowledge of OIS 3, and to investigate whether climate played a role in the extinction of the Neanderthals (van Andel and Davies 2003).

The Stage 3 Project modelled a mid-glacial warm event from 45 to 38 ka, a cold event from approximately 30 ka, and the LGM cold, approximately 21 to 16 ka (van Andel and Davies 2003). The Stage 3 Project found that OIS 3 was marked by a series of extreme oscillations between cold and warm phases, with both cold and warm phase winters reaching significantly lower temperatures during OIS 3 than modern winters (van Andel et al. 2003). The climatic fluctuations of OIS 3 included medium-term fluctuations in temperature and ice sheet extent as well as short-term, abrupt changes, referred to as Dansgaard/Oeschger oscillations (Barron et al. 2003). During OIS 3, there were 22 phase changes over 35,000 years, meaning that the climate rarely remained within a single phase for much longer than 1000 yrs (Lahr and Foley 2003).

During the first part of OIS 3, between 59 and 44 ka, the climate of Europe warmed in a period called the “Stable Warm Phase”, with fluctuations between warm and cold (Davies and Gollop 2003). The climate then gradually deteriorated until about 37 ka, when it was as cold as during the LGM (Barron et al. 2003). From approximately 37 until 33 ka, the climate is thought to have been marked by a few thousand years of unstable climatic conditions (Dansgaard/Oeschger oscillations). After 33 ka, there were no further warm phases, and 30 ka marked the beginning of the “Early Cold Phase” of the LGM (Lahr and Foley 2003; van Andel et al. 2003). Beginning around 23 ka, climatic deterioration further intensified towards the LGM, which reached its peak from approximately 21 to 16 ka (van Andel et al. 2003).

Barron et al. (2003) created climate simulations for modern day Europe, for Europe during a “typical warm event” (used to represent all warm Dansgaard/Oeschger events from 60 to 45 ka), and for Europe during a “typical cold event” during OIS 3 (used to represent cold events around 30 ka and the LGM cold). Barron et al. (2003) modelled mean temperatures, precipitation, and snow cover for each. In the modern day, mean winter temperatures in Scandinavia (north of 50°N) range from 0°C to -20°C, with -20°C temperatures only being reached in the extreme northeast (east of 20°E and north of 55°N). Temperatures of -20°C do not extend south of 50°N in modern day Europe. Mean winter temperatures in the Atlantic and Mediterranean of southern France, Iberia, and western Italy average 4°C to 8°C. Mean winter temperatures in the rest of Europe average roughly 4°C to -8°C in the present day (Barron et al. 2003). During warm phases of OIS 3, climate simulations suggest that temperatures in Europe resembled present day temperatures for the most part, but could be 4-6°C cooler during OIS 3 warm phases in parts of central Europe. In Scandinavia and eastern Europe, north of 50°N and east of 20°E, mean winter temperatures reached -20°C during OIS 3 warm phases. In cold phases, temperatures were more extreme in widespread areas of Europe. Even in cold phase summers, mean temperatures in western Europe barely reached 10°C. Mean winter temperatures in the Atlantic and Mediterranean of southern France, Iberia, and western Italy were relatively mild, reaching a minimum of 4°C. However, winter temperatures in the rest of Europe averaged -8°C to -20°C. The coldest temperatures seem to have been north of 45°N and east of 10°E. Thus, in the majority of Europe, temperatures during OIS 3 cold events were 8 to 12°C colder than in the modern day. In the extreme southwest of Europe, temperatures during OIS 3 cold periods may have been slightly colder than in the modern day.

Precipitation is known to contribute to the carrying capacity of an environment in that without sufficient water, flora and fauna will not survive (Barron et al. 2003). It has long been assumed that in glacial periods in Europe, areas north of the trans-European mountain barrier, in the Mediterranean, and in southeastern Europe, were very arid (Barron et al. 2003). During glacial periods, water is generally believed to have been locked up in ice, which would have reduced evaporation, precipitation, and moisture. Barron et al. (2003) note that small differences in precipitation are critical in terms of human tolerance and resource availability. During OIS 3 warm and cold phase winters,

there was a strong westerly airflow that may have delivered as much or more moisture than today to western and central Europe, north of the trans-European mountain barrier. In small pockets elsewhere in Europe, such as in the Black Sea region, there may also have been marginally greater precipitation during OIS 3 winters than today. In southeastern Europe and the Mediterranean, OIS 3 winters were characterized by much lower precipitation, from 4-8 millimetres (mm.) lower than today. In OIS 3 summers, rainfall may have been 3-4 millimetres (mm.) per day less than today in the Atlantic region. In eastern Europe, rainfall may also have been equal to or a few mm. lower than today. So, Barron et al.'s (2003) models of OIS 3 precipitation found that in large parts of Europe, precipitation during OIS 3 was generally similar to today. Barron et al.'s (2003) reconstructions of precipitation during the LGM showed that Europe was generally dry, but not dry enough to be considered "arid".

Snow cover can affect hunter-gatherers because it influences where grazers can forage as well as the availability of plant foods. In both warm and cold events of OIS 3, the number of days with snow cover and mean snow depth were markedly greater than in the modern day, throughout Europe (Barron et al. 2003). Barron et al.'s (2003) snow cover models suggested that in the modern day, western Europe experiences only a few days of snow cover per year (except at higher elevations), and depths of 10-30 centimetres (cm.). In central Europe, snow covers the ground from three to four months of the year. In Scandinavia and northwestern Russia, snow covers the ground from six to eight months of the year. So, snow cover is higher in the east and the north, but mean snow depth does not exceed 20-50 cm. south of 50-55°N latitude. During OIS 3 warm events, Barron et al. (2003) estimated that snow covered the ground from two to six months of the year in western coastal Europe, and from five to six months of the year further north (50 to 60°N) (Barron et al. 2003). Snow depth seems to have been modest during OIS 3 warm events. During the LGM and late OIS 3 cold events, snow was estimated to have covered the ground for at least two months in all of Europe except the southwestern portion of the Iberian Peninsula (Barron et al. 2003). From 40 to 50°N, snow covered the ground for five to six months of the year in most areas (except Iberia). In central Europe as far south as 45°N, snow covered the ground for seven or months of the year, and north of 50°N, snow also covered the ground for seven or more months of the year across Europe (Barron et al. 2003). Barron et al. (2003) noted that, except

along the Atlantic coast, snow depths rarely exceeded 20 cm. during the LGM since the cold ocean provided very little moisture. So, there is a marked difference in snow cover between the modern day and OIS 3. Even during OIS 3 warm phases, snow covered the ground for much longer than in the present.

Studies of wind-blown dust suggest that there were extremely strong winds and high variability in wind strength in late OIS 3 (Gilligan 2010; Antoine et al. 2009). High winds are indicated by marked peaks in the ratio of coarse to fine particles, which are interpreted as increases in wind strength and hence greater wind chill for humans (Gilligan 2010). On the Iberian Peninsula today, wind chill ranges from roughly -1°C in winter to 20°C in summer (Aiello and Wheeler 2003). During an OIS 3 warm phase, wind chill seems to have ranged from roughly -5°C in winter to 16°C in summer. During an OIS 3 cold phase, wind chill seems to have ranged from -7°C in winter to 13°C in summer. In western Europe, modern wind chill ranges from roughly -12°C in winter to 16°C in summer. During an OIS 3 warm phase, wind chill seems to have ranged from -17°C in winter to 12°C in summer. During an OIS 3 cold phase, wind chill seems to have ranged from -31°C in winter to 9°C in summer. In the Mediterranean, modern wind chill ranges from roughly -7°C in winter to 22°C in summer. During an OIS 3 warm phase, wind chill is estimated to have ranged from -14°C in winter to 18°C in summer. During an OIS 3 cold phase, wind chill is estimated to have ranged from roughly -21°C in winter to 12°C in summer. In central Europe, modern wind chill ranges from -15°C in winter to 22°C in summer. During an OIS 3 warm phase, wind chill seems to have ranged from -24°C in winter to 18°C in summer. During an OIS 3 cold phase, wind chill ranged from roughly -32°C in winter to 13°C in summer. Lastly, in Russia, modern wind chill ranges from -32°C in winter to 26°C in summer. During an OIS 3 warm phase, wind chill is estimated to have ranged from -35°C in winter to 21°C in summer. During an OIS 3 cold phase, wind chill is estimated to have ranged from -44°C in winter to 21°C in summer (Aiello and Wheeler 2003). Aiello and Wheeler (2003) estimated that during LGM winters, median wind chill was approximately 12.5°C colder than in modern winters. Even during OIS 3 warm period winters, Aiello and Wheeler (2003) estimated that median winter wind chill was 8°C colder than in modern day winters. OIS 3 cold period summer wind chill was estimated to be approximately 7°C colder than modern day summer wind chill, while OIS 3 warm period summer wind chill was only

approximately 3°C colder than modern summer wind chill. It is notable that throughout OIS 3, wind chill was consistently greater than in the modern day. Aiello and Wheeler (2003) note that their wind chill estimates were averaged over 24 hours, and over three month periods of winter and summer, so it is possible that taking shelter, building fires, and huddling together overnight could partially mediate wind chill. However, many activities that are necessary to survival, such as foraging, could not be performed while mediating cold stress using the aforementioned behavioural strategies, and clothing would have been necessary to mediate wind chill (Aiello and Wheeler 2003).

It is widely believed that during glacial periods, aridity, instability, lowered temperature and shorter growing seasons compromise vegetation and pasture lands for grazing animals, resulting in a lower edible biomass in terms of both flora and fauna (Bocquet-Appel et al. 2005; Straus 2000; Straus 2005). This view was supported by the Stage 3 Project's reconstructions of plant cover during OIS 3 (Huntley and Allen 2003). Reconstructions of plant cover have revealed repeated and often rapid fluctuations in vegetation types during OIS 3 (Huntley and Allen 2003). Closed forests seem to have been extremely limited in Europe during OIS 3 (Huntley and Allen 2003). During OIS 3 warm phases, the landscape seems to have been dominated by herbaceous vegetation (Huntley and Allen 2003). Patchy woodland and parkland/savannah vegetation with scattered individual trees seems to have dominated the European landscape, with closed forests making up a very minor element of the landscape (Huntley and Allen 2003). Specifically, dwarf-shrub tundra, steppe tundra, warm steppe, and temperate grassland seem to have been predominant across most of northwestern and central Europe. In northern Europe, tundra, deciduous taiga, and montane forest were present in the east, and evergreen taiga in the far east. In west-central Europe, there seems to have been a cool, mixed forest, and temperate grassland, especially further south. East of the Mediterranean, treeless steppe tundra and warm steppe seem to have been present. During OIS 3 cold phases, there seems to have been a reduction in the abundance of trees throughout Europe, and a predominance of herbaceous vegetation (Huntley and Allen 2003). With the exception of a single site in the northeast, which seems to have been an evergreen taiga/montane forest biome, non-forest biomes seem to have dominated Europe during cold events. According to Huntley and Allen (2003), warm phase landscapes were likely sufficient to support large grazing and browsing

herbivores; in turn, these productive ecosystems were likely favourable to humans. Cold phase landscapes seem to have been accompanied by a relatively high abundance of steppe taxa, which likely indicates lower moisture and reduced ecological productivity during cold versus warm phases (Huntley and Allen 2003). These conditions during cold events likely led to reduced ranges and populations of large herbivores, which would have been unfavourable to the carnivores and humans that relied on them for subsistence (Huntley and Allen 2003).

In sum, OIS 3 was a period of climatic stress, with both cold and warm phases demonstrating significantly lower temperatures and higher wind chill than today. Though OIS 3 Europe may not have been as arid as previously believed, it seems to have been dry in certain areas, and snow covered the ground for large portions of the year, which likely limited prey availability. Reduced vegetation during cold phases likely reduced the carrying capacity of the land in terms of edible biomass, which would have compounded the environmental stress experienced by hominins.

1.2.3. Cold tolerance of Neanderthals and modern humans

Genetic studies suggest that hominins lost their body hair sometime between 3 and 1.2 million years ago (Ma) (Rogers et al. 2004; Reed et al. 2007). This is before the split between the lineages that led to the Neanderthals and modern humans, which is thought to have occurred sometime between 250 and 800 ka (Green et al. 2010; Bermúdez de Castro et al. 1997; Stringer 2002). Thus, Neanderthals were likely no more hairy than modern humans.

Historically, the consensus view in archaeology has been that, since Neanderthals evolved in glacial climates of Eurasia, they developed a suite of morphological adaptations that are conducive to heat retention in cold environments (Holton and Franciscus 2008). Bergmann's and Allen's rules state that in widely dispersed homoeothermic animals, those in colder environments will tend to have a greater body mass and shorter extremities than their conspecifics in warmer environments (Holliday 1997). Since heat loss is directly proportional to surface area, an animal with a lower surface area-to-volume (SA/V) ratio will be better able to retain heat (Holliday 1997). On the other hand, for animals living in hot environments it is beneficial

to have a high SA/V ratio to dissipate excess heat (Holliday 1997). Neanderthals are said to have been “hyper-Arctic” in this regard in that their body is relatively more massive and their limbs relatively shorter than even the most cold adapted (Arctic) modern humans, exposing less skin surface area (Ruff 1993). In addition, a number of characteristics of the Neanderthal nose have been argued to act as a “nasal radiator” to warm and moisten inspired air in order to protect the lungs and temperature-sensitive brain from cold air. Their steeply sloped and depressed, bilevel nasal floor and their expanded paranasal sinus system are two such features (Coon 1962; Rae et al. 2006).

As noted earlier, compared to Neanderthals, European early modern humans demonstrate a more linear body form (narrow relative to height), and longer limbs, meaning a higher SA/V ratio (Weaver and Steudel-Numbers 2005). In accordance with Bergmann’s and Allen’s rules, these features of the modern human body form have historically been viewed by archaeologists as an adaptation to heat dissipation in warm environments (Weaver and Steudel-Numbers 2005).

A number of recent studies have concluded that Neanderthals had a higher basal metabolic rate (BMR) than modern humans due to their higher body mass and their body shape (e.g. Churchill 2009; Macdonald et al. 2009). Based on their higher BMR, Neanderthals’ total energy expenditure would also have been higher than that of modern humans. Energy expenditure is estimated to be two to two and one half times BMR, so Neanderthals likely metabolized roughly 4500-5000 kcal/day (Churchill 2009). For early modern humans, energy expenditure has been estimated to be 4100-4600 kcal/day (Macdonald et al. 2009). So, Neanderthals’ total energy requirements may have exceeded those of early modern humans by at least 10% (Macdonald et al. 2009). In addition, Macdonald et al. (2009) note that in order to reproduce, female Neanderthals’ energy requirements would have been even higher than those of early modern human females, due to their larger body size. Neanderthals’ high BMR would have increased their internal heat generation, and this may have given them an advantage over modern humans in terms of cold tolerance. However, Neanderthals would have required more energy to maintain their higher BMR. So, the thermoregulatory advantage of Neanderthals may have been offset by their need to spend more time procuring food.

Significantly for present purposes, the putative thermoregulatory advantages of Neanderthals over modern humans are currently being re-evaluated. Aiello and Wheeler (2003) used estimates of BMR, skin surface area, thermal conductance, and the maximum sustainable elevation in resting metabolic rate (RMR) to calculate the minimum temperatures at which each hominin could survive given sufficient dietary resources. Aiello and Wheeler (2003) defined the lower critical temperature for a mammal as the ambient temperature at which it must incur extra energetic costs to maintain its body temperature. The minimum sustainable ambient temperature is the ambient temperature at which a mammal can survive when its BMR is increased threefold to produce heat.

Aiello and Wheeler (2003) found that the lower critical temperature for Neanderthals was 27.3°C, while the lower critical temperature for modern humans was less than one degree higher, 28.2°C. The minimum sustainable ambient temperature for Neanderthals was 8°C, while the minimum sustainable ambient temperature for modern humans was 10.5°C. These results demonstrate that, despite the Neanderthals' hyper-Arctic body shape, they seem to have had only a modest advantage of 1 to 2.5°C over modern humans in their lower critical temperature and minimum sustainable ambient temperatures. When Aiello and Wheeler (2003) accounted for an increased BMR to reflect a diet that is consistently high in animal fat and protein, the Neanderthal lower critical temperature became 25.9°C, and minimum sustainable temperature became 3.7°C. These adjusted values represent an advantage of 2.3 to 6.8°C over modern humans. When giving this estimate, Aiello and Wheeler (2003) stressed that physiological capacity does not necessarily mean ecological viability; that is, Neanderthals must have sustained an extremely high dietary energy intake to maintain internal heat production at the level given above. When the supposedly high muscle mass of Neanderthals was taken into account in combination with an elevated BMR, the Neanderthal lower critical temperature became 25.3°C, and minimum sustainable temperature became 1.9°C, a 2.9 to 8.6°C advantage over modern humans. Lastly, Aiello and Wheeler (2003) estimated the lower critical temperature and minimum sustainable temperatures for Neanderthals wearing one "clo" of thermal insulation (the equivalent of a modern business suit, 3.9 cm. of sparse body hair, or 3.2 cm. of subcutaneous body fat). With one clo of insulation, Neanderthals would have been able

to withstand a lower critical temperature of 16.7°C, and a minimum sustainable ambient temperature of -23.9°C.

When the above cold tolerances were compared with modelled OIS 3 temperatures, it became apparent that even with 1 clo of insulation, many Neanderthal and modern human sites would have been uninhabitable in OIS 3 winters without clothing and shelter (Aiello and Wheeler 2003; Gilligan 2010; Davies and Gollop 2003). In the Arctic, in areas with mean winter temperatures of -10 to -20°C, recent humans must wear four layers of clothing to survive (4 to 5 clo) (Gilligan 2010). At 10 m elevation, in air temperatures of -20°C with wind speeds of approximately 45 km/h, wind chill is estimated to be approximately -40°C, and frostbite occurs within 30 minutes in exposed skin (Osczevski 1995; Bluestein and Zecher 1999; Cotel et al. 2004). Since some Neanderthal and modern human sites in Europe are estimated to have reached temperatures of -20°C and high wind chill during OIS 3, it is likely that clothing would have been essential for Neanderthals and modern humans in certain sites. Significantly, Aiello and Wheeler (2003) noted that on average, Aurignacian and Gravettian sites had higher wind chill than Mousterian sites, suggesting that modern humans' cultural adaptations to cold were superior to those of Neanderthals.

The putative nasal thermoregulatory adaptations of Neanderthals have also been challenged. Recently, Franciscus (2003) has shown that some modern tropical human populations possess the same bilevel nasal floor configuration as the "cold-adapted" Neanderthals. Equally problematically for the claim that the Neanderthals possessed nasal thermoregulatory adaptations, epigenetic studies of humans, non-human primates, and rodents indicate that the Neanderthal pattern of enlarged sinuses is in fact the opposite of what is expected for a cold-adapted species; sinus volume should decrease in response to cold environments, not increase (Rae et al. 2006; Rae et al. 2011).

It appears, then, that Neanderthals may not have the degree of morphological cold adaptation that would be expected to provide a significant advantage over modern humans during OIS 3 without additional buffering from cold (Aiello and Wheeler 2003). In addition, Neanderthals may have had trouble capturing enough calories to support their elevated BMR and maintain internal heat production in the stressed OIS 3 environment. Many archaeologists assume that Neanderthals used cultural buffering from cold, such

as clothing, to survive glacial periods in Europe (e.g. Aiello and Wheeler 2003; White 2006; Trinkaus 2005). Modern humans also certainly would not have been able to survive the extreme cold at many European sites during OIS 3 without cultural buffering from cold (Aiello and Wheeler 2003; Gilligan 2010). As has already been noted, even if inadequate insulation from cold does not cause immediate death, exposure to cold can lead to health problems and limit hunting, thus decreasing caloric intake and reducing fitness (Stenton 1991). Accordingly, cultural adaptations to cold, such as thermally effective clothing, would have been important for hominins in Europe during OIS 3.

A number of cultural means can be used to mediate cold stress. Taking shelter and building fires can be used as a buffer from cold when immobile, while clothing is valuable as a portable buffer from cold. As has already been noted, Neanderthals do not seem to have built lasting structures, and the few Neanderthal sites that are argued to demonstrate evidence of structured living spaces are disputed (e.g. Soffer 1989). Neanderthals did use fire, but it is unclear if they were able to make fire or simply harness natural fire; in a number of sites in France, fire seems to have been absent during cold period occupations, when natural fires were less frequent (Sandgathe et al. 2011). In contrast, early modern human sites in Europe demonstrate evidence of structured living spaces and roofed-over structures (Mellars 1989; Soffer 1989; Klein 2008). It is generally accepted that modern humans in the Upper Palaeolithic habitually made fire (e.g. Straus 1989). So, it is possible that modern humans used shelter and fire as immobile buffering from cold more frequently than Neanderthals. However, many activities that are necessary to survival, such as foraging, could not be performed while mediating cold stress using shelter and fire, and clothing would have been necessary as a buffer from cold (Aiello and Wheeler 2003). The following section discusses current evidence for clothing among Neanderthals and early modern humans in Europe.

1.2.4. Evidence for clothing in the Middle and Upper Palaeolithic

Because clothing does not preserve well in the archaeological record, researchers have to rely on indirect approaches to date the origin of its use. These approaches include genetic studies of body lice and head lice, figurines depicting clothed humans, fragments of textile fibres, pedal morphology, and technology used in the manufacture of clothing.

As noted earlier, humans are believed to have lost their body hair 3 to 1.2 Ma, which would have reduced the ecological niche available to lice to the head only (Toups et al. 2011). Genetic studies have dated the divergence of head lice and body lice to infer the origins of clothing, since it is assumed that when clothing originated, body lice would have rapidly speciated from head lice to exploit the newly available ecological niche (Kittler et al. 2003). The studies in question place the origins of clothing at approximately 170 to 83 ka (Toups et al. 2011) or 114 to 30 ka (Kittler et al. 2003). On the face of it, this places the origins of clothing after modern humans and Neanderthals diverged but before modern humans entered Europe. However, these studies are problematic because lice are known to switch hosts, which means that lice may not be an accurate indication of the evolutionary history of their host (Reed et al. 2007). In addition, the molecular clock approach employed by Kittler et al. (2003) assumes that proteins evolve at a fixed rate, which is not always the case; the molecular clock approach has therefore been known to result in conflicting estimates of divergence dates (Ayala 1997). Lastly and most problematically, the error ranges of the divergence dates for body lice and head lice are very broad. In the case of the Kittler et al. (2003) divergence date, the error range places the origins of clothing between 114 and 30 ka, and the highest probability density (95%) for the Toups et al. (2011) estimate is between 691 and 29 ka. The first of these error ranges places the origin of clothing after the split between modern humans and Neanderthals, and therefore is consistent with the hypothesis that Upper Palaeolithic modern humans used clothing but Neanderthals did not. However, the second error range overlaps with the error range for the date of divergence of modern humans and Neanderthals and therefore does not support the idea that Upper Palaeolithic modern humans used clothing but Neanderthals did not. Given the complicating factors of the lice-host relationship and the large range of dates given for lice speciation events, genetic studies of the divergence of human head and body lice are not yet reliable enough to accurately date the origins of clothing.

The archaeological record can give a more precise estimate of the minimum date by which clothing was used. The clearest evidence for the early use of clothing comes from the Gravettian site Buret' in southern Siberia (Hoffecker 2005). At Buret', a figurine of an individual in a complete, fitted body suit, argued to be made from fur, dates to

approximately 25 ka (Hoffecker 2005). The Buret' figurine is thus evidence that fitted clothing made from fur may have been made by modern humans by at least 25 ka.

In terms of woven clothing, Soffer et al. (2000) claim that many Gravettian Venus figurines display woven clothing in the form of headgear, body bandeaux, and skirts. Though the Venus figurines in question appear scantily clad, which would not have been thermally effective, they are argued to demonstrate that modern humans had the technology to create clothing from textiles by the Gravettian. In addition, there is archaeological evidence of small fragments of fibres that were arguably used in the manufacture of cordage and textiles as early as the Gravettian (27 to 25 ka) at Pavlov I, and Dolni Vestonice I and II (Adovasio et al. 1996; Trinkaus 2005; van Andel and Davies 2003). However, due to their fragmentary nature, it is unclear what objects the cordage and textile fragments formed a part of (Trinkaus 2005).

Trinkaus (2005) looked for evidence of footwear in the Palaeolithic, based on a comparative biomechanical analysis of proximal pedal phylanges of Middle and Upper Palaeolithic hominins in Western Europe, and variably shod recent humans. Trinkaus (2005) concluded that supportive footwear was rare in the Middle Palaeolithic, but became frequent by the Gravettian. This conclusion was based on the reduction in robusticity of the lesser toes by the Gravettian, without a reduction in overall lower limb locomotor robusticity, and independent of morphological group and climate (Trinkaus 2005). It should be noted that Trinkaus's (2005) study was not able to determine if footwear that was thermally effective but not supportive was present in the Palaeolithic. Trinkaus (2005) further noted that at the Upper Palaeolithic painted cave Grotte de Fontanet in France, there is a footprint showing evidence of a soft material separating the foot from the ground, which has been interpreted as evidence of soft, flexible, moccasin-like footwear in the Upper Palaeolithic (Trinkaus 2005). In comparison, the only evidence regarding footwear in the Middle Palaeolithic comes from a barefoot print in Vârtope Cave, Romania, which is interpreted to have belonged to a Neanderthal based on its date (Trinkaus 2005; Onac et al. 2005).

To manufacture basic, cape-like hide clothing, the major technological requirement that is visible in the archaeological record is the end scraper (Gilligan 2007; Hayden 1990; Frink and Weedman 2006; Gallagher 1977). In order to manufacture

clothing that is more thermally effective, there are additional technological requirements. Clothing that is tailored, fitted, and layered is known to provide approximately twice the thermal protection of loose-fitting, cape-like clothing, and is mandatory in modern day Arctic regions (Gilligan 2010; Stenton 1991). Since some Neanderthal and modern human sites during OIS 3 are believed to have exhibited climatic conditions similar to those in modern day Arctic regions, it is likely that tailored clothing was also mandatory at such sites during OIS 3 (Aiello and Wheeler 2003). The major technological requirement for tailored clothing that is visible in the archaeological record is sewing implements, such as awls and needles (Gilligan 2007). It should be noted however that tools other than end scrapers are known to have been used to scrape hides (Gilligan 2010), and any tool or object that is sharp could be used to punch holes in hide in the manufacture of (however crudely) tailored clothing.

Modern groups that regularly scrape hides using stone tools use oval-ended scrapers with a retouched working edge, and narrowing at the opposite side for hafting (Gallagher 1977). Hide scraping is time consuming, and the hafting of end scrapers is known to reduce the strain of long hours of work (Hayden 1990; Gallagher 1977). Completely stripping a cowhide using an end scraper takes approximately six hours of continuous work, while stripping a smaller animal such as a calf's hide takes approximately two and one half hours (Gallagher 1977). According to Hayden (1990), then, un-hafted and generalized scraping tools, such as the side scrapers that appear in Mousterian assemblages, are likely indicative of infrequent hide scraping that is short in duration. In contrast, the appearance of end scrapers in the archaeological record is likely indicative of regular hide scraping.

End scrapers appear frequently in Upper Palaeolithic assemblages, and resemble those that are used by modern groups for regular hide scraping (Gallagher 1977; Mellars 2006; Straus 1995; Straus 2005). In contrast, end scrapers do not appear regularly in Middle Palaeolithic assemblages, and those that do appear are generally quite different than modern ethnographic end scrapers (Hardy 2004; Bordes 1961; Bordes and de Sonneville-Bordes 1970). Use wear and residue studies of Mousterian scrapers indicate that their primary function was for scraping wood rather than hide; in the southwest of France, hide scraping only accounts for approximately 10% of use-wear and residues in Mousterian assemblages (Anderson-Gerfaud 1990). On the other

hand, use-wear and residue analyses of Upper Palaeolithic end scrapers show that they were used predominantly as hide working tools (Anderson-Gerfaud 1990; Šajnerová-Dušková 2007). Residue studies to infer hide scraping are problematic in that animal residues do not preserve well in the fossil record (Hardy et al. 2001). However, based on the proliferation of end scrapers in Upper Palaeolithic assemblages and the disparity in hide scraping use-wear and residue between Middle and Upper Palaeolithic assemblages, it seems that hide scraping may not have been as prevalent in the Middle Palaeolithic as in the Upper Palaeolithic.

To date, there is no evidence of eyed needles in association with Neanderthals (Cartmill and Smith 2009). It has been claimed that Neanderthals made awls in the “transitional” Châtelperronian and Uluzzian industries of Grotte du Renne, France, and Castelcivita Cave, Italy, respectively (d’Errico and Stringer 2011). However, given that there is evidence of mixing of layers at Grotte du Renne, and the Uluzzian is not definitively associated with Neanderthal remains at Castelcivita Cave, the claim that Neanderthals made awls is tenuous (d’Errico and Stringer 2011; Higham et al. 2010). The oldest known eyed bone needles appeared in “transitional” Upper Palaeolithic industries around 40 ka at Mezmaiskaya, and 35 to 30 ka at Kostienki (Golovanova et al. 2010; Hoffecker 2009; Hoffecker 2005). Both sites contain Aurignacian-like assemblages, and are believed to have been associated with modern humans (Golovanova et al. 2010; Hoffecker 2009). During cold spikes of OIS 3 and the LGM, both eyed bone needles and awls became common in Upper Palaeolithic assemblages across middle latitudes of Eurasia, from western Europe to southern Siberia and northern China (Gilligan 2010). To date then, it seems that archaeologically visible tailoring technology such as eyed bone needles and perhaps awls were exclusive to modern humans. This suggests that tailored clothing, which is more thermally effective than cape-like clothing, was made by modern humans but not by Neanderthals during OIS 3 (Gilligan 2007).

In sum, genetics, figurines depicting clothed humans, fragments of textile fibres, pedal morphology, and technology used in clothing manufacture have been interpreted as evidence for the origins of clothing. Genetic studies of the speciation of clothing lice from head lice suggest that clothing originated sometime between 691 and 29 ka. A figurine purportedly depicting a human wearing tailored fur clothing suggests that such

clothing was in use by at least 25 ka. Widespread Venus figurines purportedly depicting women, scantily-clad in textiles, suggest that clothing made from textiles was produced by modern humans in the Gravettian. In addition, small fragments of fibres that may have been a part of clothing made from textiles have been dated from 27 to 25 ka in modern human sites. The pedal morphology of Upper Palaeolithic modern humans suggest that modern humans may have worn supportive footwear by the Gravettian, and a footprint from an Upper Palaeolithic painted cave has been interpreted as evidence of soft, moccasin-like footwear. Based on the proliferation of end scrapers in Upper Palaeolithic assemblages, and the disparity in hide scraping use wear and residues between Middle and Upper Palaeolithic assemblages, it would seem that modern humans throughout the Upper Palaeolithic were scraping hides for clothing more regularly than Neanderthals. Based on the exclusive association of eyed bone needles and perhaps awls with modern humans, it seems that modern humans were making tailored clothing by the beginning of the Upper Palaeolithic, and it is unclear if Neanderthals were doing the same. So, it seems that modern humans made tailored clothing shortly after their arrival in Europe. In addition, modern humans may have made fur clothing, textile clothing, and supportive footwear at least as early as the Gravettian. It is unclear if modern humans began to make fur clothing, textile clothing, and supportive footwear prior to the Gravettian, or if such clothing was a Gravettian innovation. Neanderthals do not seem to have worn supportive footwear, and may not have manufactured clothing, tailored or otherwise, as frequently as modern humans. However, the function of lithic technology is notoriously difficult to interpret, and an absence of evidence of technology used in the manufacture of clothing is not sufficient to conclude that Neanderthals did not make clothing. Based on the current evidence then, it is unclear if Neanderthals made clothing, and modern humans seem to have begun making tailored clothing shortly after their arrival in Europe. Modern humans may have made fur clothing, textile clothing, and supportive footwear at least as early as the Gravettian.

1.2.5. *Thermally effective animal skins and furs*

As previously noted, clothing that offers thermal protection from cold was likely vital to hominins in Europe during OIS 3, and inadequate clothing in cold environments can also have consequences for a population's overall health. Among historic Arctic

populations, when there were shortages of animals used to make clothing, people often suffered from lung infections and other bronchial ailments (Stenton 1991). In addition, inadequate thermal protection in cold environments hinders mobility, which in turn affects the ability to hunt (Stenton 1991). Ambush hunting in cold environments requires particularly insulative clothing since it involves long periods of low activity levels (Stenton 1991). So, inadequate clothing in cold environments can have direct and indirect consequences to an individual's fitness. Many OIS 3 sites were characterized by Arctic-like cold and wind chill, so clothing at such sites would have needed to offer protection from extreme cold as well as wind. In temperatures of -20°C , which were common in large parts of Europe during OIS 3 cold phase winters, it is estimated that a human requires approximately 8 clo of thermal protection when at rest (Stenton 1991). When doing moderate work at -20°C , approximately 4 clo of protection is needed. When doing heavy work in the same temperature, approximately 2-3 clo of insulation is needed (Stenton 1991). A mean of 3.5-4 clo of protection is needed over the course of an Arctic winter (Gilligan 2010; Stenton 1991).

Cena and Clark (1978) highlight a number of factors that affect the thermal qualities of clothing made from animal skin and fur. Colour, thickness, fit, physical activity, number of layers, and various properties of fur itself are known to impact the thermal insulation of animal skin and fur. Tailored clothing is known to minimize heat loss, as air trapped by clothing provides the main resistance to heat transfer between the body and the environment. Thick, layered clothing is effective for the most part due to the insulation provided by the air trapped between the layers. However, clothing that is too thick or heavy will increase an individual's metabolic rate, which is energetically expensive. In addition, performing physical activity while wearing warm clothing generates heat and sweating, which causes the clothing to become wet, and therefore less effective due to evaporative cooling and the exacerbation of wind chill. The most effective clothing that can be worn is thus dependent on activity level and fit. However, when disregarding activity level and fit, a number of properties of particular furs are known to contribute to their insulative values.

Clothing made from fur is common among indigenous inhabitants of the Arctic and Arctic explorers due to its thermal protection, and the fur and skin clothing of Inuit and other high latitude groups has been shown to be the most thermally effective cold

weather clothing known (Hammel 1955; Cotel et al. 2004). The insulative value of fur is usually provided by a fine layer of hair, which may be supplemented by coarser hairs that project above or lie over the fine layer in order to protect from wind and rain. These coarse hairs are called “guard hairs” (Cena and Clark 1978). A mixture of long and short hairs in a fur garment serves to increase the thickness of the “boundary layer”, a relatively thin layer of nearly stagnant air adjacent to the skin, where heat transfer occurs (Cotel et al. 2004). The mixture of hairs causes friction that slows the movement of air near the surface of the object, so that the velocity of air movement varies from 0 at the inner surface of the clothing to the full stream of velocity at the outer edge, minimizing heat loss (Schlichting et al. 2000; Cotel et al. 2004). The pelts of wolverines, Arctic wolves, husky dogs, coyotes, and skunks are known to be particularly insulative for clothing due to their long, stiff guard hairs and dense under fur (Cotel et al. 2004).

Hair densities of mammals range from the sparse covering of pigs and humans, with 10 to 100 hairs per square cm. of skin to the dense coats of rabbits and foxes, with approximately 4000 hairs per square cm. (Cena and Clark 1978). Hair coats can be divided into 3 classes: 1) coats of coarse, straight hair, with low density (only a few hundred hairs per square cm.), including goat and badger coats; 2) dense coats (approximately 4000 hairs per square cm.) of fine fur, common in small mammals and Arctic taxa such as rabbits and foxes; and 3) dense and matted coats (approximately 1000 hairs per square cm.) with crimped hairs, such as those of domestic sheep (Cena and Clark 1978). The first type of coats are not particularly good insulators, and most mammals fall into one of the first two categories (Cena and Clark 1978). Wind is known to decrease the insulation offered by fur clothing, and the amount of heat loss caused by wind chill depends on the type and orientation of fur, and the direction of wind (Cena and Clark 1978). Wind decreases insulation proportionally more in coats that are sparsely haired (e.g. pigs) in comparison with densely haired coats (e.g. rabbits and foxes). In situations of extreme wind chill, then, it is beneficial to wear clothing made from animals with dense fur, such as rabbits and foxes.

One particular aspect of the clothing of ethnographically documented high latitude groups (e.g. Greenlandic Inuhuit, the Canadian Inuit, the Inupiat, and the Yup'ik of Alaska) that contributes to thermal effectiveness is the fur ruff on the hood of a fur or skin parka. Fur ruffs may be made from Arctic fox tail, or a broad strip of dog, wolf or

wolverine fur to break the wind and protect the face, where wind chill is most felt (Osczevski 1995; Cotel et al. 2004). The mixture of long and short hairs in a fur ruff serves to increase the thickness of the boundary layer and prevent frostbite without impeding movement or vision during hunting and travelling (Cotel et al. 2004). Other Inuit groups are known to use caribou fur on hoods, with the fur facing inward and protruding 2 cm. past the face, blocking the wind (Cotel et al. 2004). Though caribou furs are apparently used for the same purpose, they are not thought to be as comfortable or as effective as the fur ruffs made from wolverines, foxes, dogs, and wolves (Cotel et al. 2004). Parkas that lack a fur ruff are known to expose the skin to frostbite; at 10 m elevation, in air temperatures of -20°C and with wind speeds of approximately 45 km/h (as experienced at times in the Arctic), wind chill is estimated to be approximately -40°C , and frostbite will occur within 30 minutes in exposed skin (Osczevski 1995; Bluestein and Zecher 1999; Cotel et al. 2004). So, since some hominins in Europe are hypothesized to have experienced temperatures of -20°C and high wind chills during OIS 3, it is likely that clothing with a fur ruff would have been a significant advantage to hominins during OIS 3 to prevent frostbite and aid in survival.

Research into the thermal properties of a number of mammalian taxa has shown that a number of taxa within the Mustelidae, Cervidae, Canidae, and Leporidae families make highly effective fur and hide clothing in cold environments. From the Mustelidae family, wolverines (*Gulo* genus) are known to have particularly warm pelts (Cotel et al. 2004; Stewart 2004). Wolverine fur is superior as a parka ruff due to its durability, its ability to protect from wind, to easily shed ice and frost, to comfort the face, and due to its mixture of long and short hairs, which increase the thickness of the boundary layer where heat loss occurs (Cotel et al. 2004).

From the Cervidae family, reindeer/caribou (*Rangifer* genus) pelts have repeatedly been described as extremely thermally effective and comfortable in Arctic winter environments, offering anywhere from 4.1 to 8.0 clo of insulation (Oakes et al. 1995; Hammel 1955; White 2006; Stenton 1991). Stenton (1991) noted that among Arctic groups, caribou is the clearly preferred material to make high quality winter clothing. It seems that in circumpolar regions, clothing is made from other taxa only when caribou are not available (Stenton 1991). In simulated Arctic sledding experiments, caribou skins and furs are known to outperform both military and expedition clothing in

terms of comfort and temperature (Oakes et al. 1995). The guard hairs of caribou contain large, air-filled, hollow shafts, which trap pockets of insulative air (Stenton 1991). In addition, the orientation of hairs in caribou furs (parallel to the skin) is known to aid in heat retention by reducing conductive heat loss (Stenton 1991:6). Caribou furs are most protective when taken in the late fall or winter (Stenton 1991; Moote 1955). Those taken in the late fall have the chance to recover from parasite infestations that make holes in pelts over the summer (Stenton 1991), while those taken in winter are known to be protective in wind, providing 3.0 clo of protection in winds up to 45 km/hr (Moote 1955). Winter caribou furs are known to provide approximately 150% of the thermal protection of deer, beaver, and raccoon fur (Moote 1955). In addition, caribou clothing is known to be light, and not to absorb perspiration (Stenton 1991). One issue with caribou fur clothing is that its hairs can be quite brittle and break off easily; as a result, winter outfits made from caribou fur last from one to three years (Stenton 1991). Stenton (1991) noted that Inuit groups rely on caribou for both food and clothing, but perhaps more so for clothing, as there is historical evidence of Inuits discarding caribou meat.

From the Canidae family, husky dogs, wolves and coyotes (*Canis* genus), have been described as highly insulative, with clo values ranging from 4.1 (dogs) to 7.5 (wolves) (Hammel 1955; Stenton 1991). Arctic wolf pelts in particular are known to be effective in high wind (Moote 1955). Moote (1955) found that in still air, a wolf pelt offered 4.7 clo of protection, while in winds of 45 km/hr. it offered 2.4 clo of protection. Foxes (*Vulpes* genus) are also described as having highly insulative fur, especially in wind. The clo value of fox fur can range from 2.9 to 8.0 (Hammel 1955; Stenton 1991). Fox fur is known to be light and provide excellent insulation, however due to their size, a number of foxes are required to make one garment (Stenton 1991).

Lastly, from the Leporidae family, rabbits (*Oryctolagus* genus) and snowshoe hares (*Lepus* genus) have furs that can provide anywhere from 3.8 to 5.5 clo of thermal insulation (Hammel 1955; Stenton 1991). Densely furred rabbit pelts are known to provide effective insulation in wind. In addition, hare fur, when worn around the face, is known to dry quickly, which protects the nose from frost (Jochelson 1933). Like fox pelts, rabbits and snowshoe hare pelts are highly insulative, but due to their size, a number of individuals are required to make one garment.

A number of other animals can be used for clothing among ethnographically-documented Arctic groups, but they do not seem to demonstrate the high insulative properties of the aforementioned taxa. Among Arctic Eurasian and North American groups, polar bears, musk oxen, sheep (wool), birds, fish, and seals are used for clothing when caribou are not available (Stenton 1991). However, Stenton (1991) noted the problems with making clothing from a number of the above taxa; for example, bear and musk ox hides are warm but are too heavy for clothing, especially when wet. In addition, bears are dangerous to hunt, and musk oxen furs get very dirty due to their hair length. Clothing made from wool is known to be problematic in the Arctic since it absorbs water and perspiration, which increases convective heat loss, and it can freeze in cold weather. Bird skin clothing is light and provides excellent insulation, however it is not very durable and requires a number of animals for one garment (Stenton 1991). Seal-skin clothing is very durable for spring and summer use, but is not warm enough for winter use in the Arctic (Stenton 1991). Stenton (1991) noted that among the Polar Eskimo, winter clothing was routinely made from polar bear, bird, and fox skins, however when the technology necessary to hunt caribou was introduced to them in the late 19th century by Baffin Island emigrants, they increased their exploitation of caribou for clothing.

If hominins during OIS 3 were able to increase the boundary layer around their bodies by making clothing from taxa with dense fur, mixed fur lengths, and especially with the furs of taxa in the Mustelidae, Cervidae, Canidae, and Leporidae families, they would have been able to minimize their heat loss. Clothing made from the highly insulative taxa described above would likely have offered a significant adaptive advantage for hominins in the extreme cold and wind chills of OIS 3 cold phase winters.

1.3. Structure of study

To reiterate, the goal of the study reported here was to investigate the possible role of animal hide clothing in the replacement of Neanderthals by modern humans during OIS 3. The study was divided into two parts:

- A survey of the use of the mammalian taxa found in European archaeological assemblages from OIS 3 for clothing by recent mid-to-high latitude non-industrial groups
- A series of statistical analyses to test for significant differences in the frequency of remains of mammalian taxa that are used for clothing between Neanderthal and modern human occupations of OIS 3 Europe

In the first part of the study, the goal was to identify mammalian fauna that are ethnographically used for “utilitarian clothing”, and especially those that are used for thermally effective “cold weather clothing”, both of which are likely to have been highly advantageous for hominins in the extreme cold of OIS 3. For the purposes of the present study, I defined “clothing” as anything made from part of an animal (e.g. skin, fur/hair, or sinew) that is worn on the body. “Utilitarian clothing” is everyday clothing, which is likely made from an animal pelt that was chosen due to thermal protectiveness or for other practical qualities. Utilitarian clothing does not include ceremonial, symbolic, or decorative clothing, or sinew and other animal body parts used in the manufacture of clothing. Lastly, I defined “cold weather clothing” as utilitarian clothing that is 1) worn in winter or described as heavy/warm (“winter/heavy clothing”); 2) made from fur (“fur clothing”); and 3) made from fur and used as trim on clothing (“fur trim”). These clothing types were chosen because they are known to be thermally effective in cold weather (Hammel 1955; Cotel et al. 2004; Cena and Clark 1978).

The first step to identify mammalian taxa that are ethnographically used for clothing was to compile a list of names for the taxa that were potentially used for clothing in OIS 3 Europe. This was accomplished using information from the Stage 3 Project’s faunal database. The second step was to perform a search for the ethnographic use of the above taxa for clothing using the Human Relations Area Files. During this step I recorded the types of clothing made from each taxon, and ranked the percentage of use of each family and genus of animal for clothing, relative to the other families and genera present in Stage 3 Europe. This step was used to determine the relative likelihood that a given taxon from Stage 3 Europe was used for clothing. I then repeated the above ranking procedure for families and genera that are used in mid-to-high latitudes for utilitarian clothing, and for each type of utilitarian cold weather clothing. The rationale for limiting the analyses to families and genera used for utilitarian clothing by mid-to-high latitude non-industrial groups is described in detail in Chapter 2’s methods. Those

families and genera that were found to be used for at least 1% of the above clothing types relative to the other families and genera present in Stage 3 Europe were considered to be “used” for each type of clothing. These families and genera were used in the second part of the study as evidence of utilitarian and cold weather clothing in the archaeological record of OIS 3 Europe.

The goal of the second part of the study was to test for significant differences in the frequencies of taxa that were identified in the first part of the study as being used for utilitarian clothing and cold weather clothing between Neanderthal and modern human occupations. Specifically, I tested two hypotheses. The first was that early modern humans exploited animal taxa that are used for utilitarian clothing significantly more frequently than Neanderthals. The second hypothesis was that modern humans exploited animal taxa that are used for highly insulative cold weather clothing significantly more frequently than Neanderthals. I tested the above hypotheses by testing for statistically significant differences in the frequencies of taxa that are used for each type of clothing between Middle and Upper Palaeolithic strata, and between Mousterian and Aurignacian strata. I tested for statistically significant differences in the frequency of the above taxa between Mousterian and Aurignacian strata as a control for the potential change in availability of taxa over time. Since the Mousterian and Aurignacian partially overlapped in time and space (van Andel et al. 2003), hominins associated with the Mousterian and Aurignacian industries should theoretically have had access to similar mammalian taxa.

If the remains of animal taxa that are used for utilitarian clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made clothing more frequently than Neanderthals. Likewise, if the remains of taxa that are used for highly insulative, cold weather clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made highly insulative, cold weather clothing more frequently than Neanderthals. The results of this study contribute to the debate over the Neanderthal extinction during the latter part of OIS 3 by identifying if clothing, and particularly clothing that is highly insulative in cold weather, was used more frequently, or exclusively, by modern humans.

2. Cross cultural analysis of use of mammalian taxa for clothing

This chapter describes the first set of analyses. In the analyses, I compiled a list of the names of mammalian taxa that could have been used for clothing in OIS 3. I then performed an ethnographic search to identify which of the taxa are most used for utilitarian clothing, winter/heavy clothing, fur clothing, and fur trim, by recent mid-to-high-latitude non-industrial groups. The first section of the chapter describes how the list of search terms was compiled and how the ethnographic search was carried out. Next, I discuss the frequency of use of different taxa for utilitarian clothing, winter/heavy clothing, fur clothing, and fur trim. Lastly, I consider which taxa may be interpreted as evidence for utilitarian clothing, winter/heavy clothing, fur clothing, and fur trim in the archaeological record.

2.1. Materials and methods

2.1.1. *Compiling the list of search terms*

The search terms used in the first set of analyses are listed in Appendix A. To compile these terms I used the Stage 3 project's faunal database (van Andel and Davies 2003) and *Walker's Mammals of the World* (Nowak 1999). The Stage 3 Project created two databases: an archaeological database and a faunal database. These databases were designed to complement each other, and use data from many of the same sources and sites. They include data from European archaeological and faunal assemblages that are absolutely dated from 60-20 kcal BP. The Stage 3 Project defined Europe as the western Palaeartic bordered by the Atlantic to the West, the Mediterranean to the South, the Arctic Ocean to the North, and the 40°E longitude line to the East (van Andel and Davies 2003). Although OIS 3 begins at 60 kcal BP and ends at 24 kcal BP, the Stage 3 Project included data up to and including 20 kcal BP, in order to incorporate the start of the LGM (van Andel 2003).

The creator of the Stage 3 faunal database, Dr. John Stewart, compiled it from literature published before March 2001. The database contains data from most of the available radiometrically dated archaeological sites from OIS 3 Europe that have yielded mammalian faunal remains (Stewart et al. 2003). The database comprises data from 294 sites, containing a total of 1912 mammalian specimens. Each line of the database is an absolutely dated layer, and attached to each dated layer are attributes such as site type (e.g. cave or open-air), longitude/latitude, sediment type, archaeological industry, and fauna presence (Stewart et al. 2003). Bats (Chiroptera order) and marine mammals were excluded from the database because they are generally not identifiable below the order level, and they are rare. Stewart took a "lumper" approach (that is, grouping species that some would consider taxonomically distinct) in the classification of fauna because the lumper approach was often employed in the literature.

Walker's Mammals of the World (Nowak 1999) is a compilation of basic information about all living mammalian taxa. *Walker's Mammals of the World* includes the taxonomic classification and common name(s) of each taxon, as well as a description of its physical characteristics, diet, reproductive behaviour, geographic range, and habitat preference.

Ethnographers rarely describe fauna using their formal scientific names. As a consequence, I used the common names of Stage 3 taxa in the ethnographic search. The Stage 3 Project faunal database includes common names for most taxa. I used Nowak (1999) to identify additional common names for the taxa, and to identify the common names of taxa for which the Stage 3 Project faunal database provides only the formal scientific name.

Where the Stage 3 Project faunal database listed a taxon that is differentiated only at the genus level (e.g. *Capra* sp.), I determined all common names of that genus, and added them to the clothing use database as representatives of that genus. In the case of *Capra* sp., for example, the common names given by Nowak (1999) are "goat," "wild goat," "domestic goat," "ibex," "Walia ibex," "West Caucasian tur," "Spanish ibex," and "markhor". In this case, "ibex" and "Spanish ibex" were already included as search terms because the Stage 3 Project faunal database lists them as distinct species. Where the common names for a taxon overlapped with each other (e.g. "goat" and "wild goat"), I

included only the less specific common name (i.e. “goat”), since ethnographic search results for “wild goat” were included in results for “goat”. I therefore added only “goat,” “West Caucasian tur”, and “markhor” as representatives of *Capra* sp.

In the case of taxa with multiple-word names (i.e. various deer species, “saiga antelope”, “spotted hyaena”, various fox species, and “red squirrel”), I used one-word general search terms (i.e. “deer”, “antelope”, “hyaena”, “hyena”, “fox”, and “squirrel”). It was necessary to simplify such search terms because ethnographers do not always give a taxon’s full common name. These general search terms were then taxonomically classified based on Nowak (1999).

Two taxa from the Stage 3 Project faunal database have different common names depending on geographic region: *Alces alces* is called “elk” in Eurasia and “moose” in North America, while *Cervus elaphus* is called “red deer” in Eurasia and “elk” in North America. In these cases, I based the classification on the region of the ethnography. So, when I searched for “elk”, I classified results from Eurasia as *Alces alces* and those from North America as *Cervus elaphus*.

Another animal from the Stage 3 Project faunal database that proved problematic is the “chamois,” which is mid-sized, goat-like bovid. The problem is that the word “chamois” can refer to a type of leather that is not necessarily made of chamois skin. The animal known as the chamois only lives in Europe, Asia Minor, and the Caucasus (Nowak 1999), but the majority of results for clothing made of chamois came from other geographic areas. This implies that most ethnographic records for clothing made from chamois refer to chamois leather rather than to the bovid called chamois. The term “chamois” was therefore omitted from the ethnographic search. As there were very few results (five) for the use of chamois for clothing, this should not have significantly affected the results of the analyses.

In some cases the common names for taxa listed in the Stage 3 Project faunal database could also refer to distantly related taxa that were not present in OIS 3 Europe. For example, “weasel” can refer to several species within the mustelid family, not just to *Mustela nivalis* as listed in the Stage 3 Project faunal database (Nowak 1999). Therefore, when an ethnographer described clothing made from “weasel”, it was not

possible to determine which species of weasel the ethnographer was referring to. For this reason, “weasel” could be classified at the family level (Mustelidae), but not at lower taxonomic levels. If a Stage 3 taxon shared a common name with another taxon and the two could be distinguished by geographic range, results of the eHRAF search from the geographic region of the other taxon were disregarded. For example, “antelopes” in OIS 3 Europe belong to Bovidae, and are limited to the Old World. In North America, members of the antilocaprid family are also referred to as “antelope”. So, results from North America were disregarded from the eHRAF search, and “antelope” was treated as belonging to Bovidae. If it was not possible to distinguish between taxa at the family level based on geographic range, the taxon was attributed to the family that contains the majority of taxa called by the common name in question. These classification issues are described below on a case-by-case basis. The taxa discussed below are only those from Stage 3 that were found to be used for clothing.

The common names of the following fauna could refer to a number of taxa, and were only classifiable at the family level, based on Nowak (1999):

- **Antelope.** The term “antelope” was included as a general term for “saiga antelope”. Within the Bovidae family, the following genera can be referred to as “antelope”: *Hippotragus* (roan/sable antelopes in Africa), *Tetracerus* (four-horned antelopes in India and Nepal), *Neotragus* (dwarf antelopes in Africa), *Pantholops* (Tibetan antelopes in Kashmir, Tibet and China), and *Saiga* (saiga or saiga antelopes, historically from western Ukraine to western Mongolia). It is thus not possible to distinguish between the antelope genera of the Bovidae family based on geography. In addition, in North America the genus *Antilocapra* (pronghorn), from the Antilocapridae family is commonly referred to as “antelope”. For this reason the results for North American use of “antelope” were disregarded. So, “antelope” was classified as belonging to the Bovidae family.
- **Badger.** Apart from *Meles meles* (Eurasian badgers), as was present in Stage 3 Europe, a number of other genera within the Mustelidae family are called “badgers”: *Mellivora* (honey badgers in the Middle East and Africa), *Arctonyx* (hog badgers in China, Thailand and Sumatra), *Mydaus* (stink badgers in Sumatra, Java, Borneo, and southeast Asian islands), *Taxidea* (American badgers in North America), and *Melogale* (ferret badgers in Asia). Thus, there are a variety of genera termed “badger” that live in overlapping geographical areas, and *Meles meles* cannot be separated from the rest. For this reason “badger” was categorized at the family level, as a member of Mustelidae.
- **Buffalo.** “Buffalo” was included for the general “Bovidae” category in The Stage 3 Project faunal database. There are two genera that are

commonly called “buffalo”: *Bubalus* (Asian water buffalo, from Asia) and *Syncerus* (African buffalo, from sub-saharan Africa). Although “buffalo” are often described as being found in North America, the taxa referred to as “buffalo” in North America are actually members of the *Bison* genus, which is identified as *Bison* sp./*B. priscus* (“bison/wisent”) in the Stage 3 Project database. Results for “buffalo” clothing in North America were thus included in the “bison” category, and results for “buffalo” clothing from Asia and Africa were included in the “buffalo” category. As the term “buffalo” was included to represent the “Bovidae” category in the Stage 3 Project faunal database, it was not necessary to categorize “buffalo” at the genus level. So, “buffalo” was classified at the family level, as a member of Bovidae.

- **Deer.** “Deer” was included as a general term for “roe deer”, “fallow deer”, and “red deer”. The majority of “deer” belong to genera in the Cervidae family whose geographic ranges overlap. The term “deer” therefore cannot be categorized at the genus level. In addition, the term “deer” can be used to refer to taxa in the Moschidae (musk deer) and Tragulidae (mouse deer) families. There is only one genus within the Tragulidae family that contains “deer” in its informal name, and that is *Tragulius* (Asiatic chevrotains or Asiatic mouse deer). The Moschidae family consists of a single genus (*Moschus*) that can be referred to as “deer” (musk deer), but is not always considered a separate family from Cervidae. Since 12 genera termed “deer” come from the Cervidae family and only two come from the Tragulidae and Moschidae families combined, the term “deer” was classified as belonging to the Cervidae family. It should be noted that where an ethnography specified “roe deer”, “fallow deer” or “red deer”, results were grouped with the more specific Stage 3 Project faunal database category, not with “deer”.
- **Fox.** The term “fox” was included as a general term for “red fox”, “corsac fox” and “Arctic fox”. “Fox” can refer to a number of genera in the Canidae family: *Vulpes* (ten species of foxes in Eurasia, Africa, and most of North America), *Alopex* (Arctic foxes in the high latitudes of Eurasia, North America, Greenland and Iceland), *Fennecus* (fennec foxes in Africa), *Urocyon* (gray foxes in western North, Central and South America), *Lycalopex* (hoary foxes in Brazil), *Pseudalopex* (South American foxes in South America), *Cerdocyon* (crab-eating foxes in South America), and *Otocyon* (bat-eared foxes in Africa). Since the various genera of foxes within Canidae overlap geographically, it is not possible to distinguish between them at the genus level. There is also one genus of the Pteropodidae (bat) family, *Pteropus* (from southeast Asia), that is termed “flying fox”. However, since the vast majority of taxa termed “fox” come from the canid family, the term “fox” was categorized as such. When an ethnography specified “red fox”, “Corsac fox” or “Arctic fox”, results were grouped with the more specific category, not with “fox”.
- **Goat.** The term “goat” can refer to three genera in the Bovidae family: *Capra*, *Myotragus* and *Oreamnos*. *Capra* is only found naturally in the Old World, but the domestic goat (*Capra hircus*) has been introduced worldwide by humans. *Myotragus* (cave goats) are known only by skeletal

evidence in the Balearic Islands, and since no ethnographic results for goat use came from the Balearic Islands, it is safe to assume that descriptions of clothing made from goat in the ethnographic record do not refer to *Myotragus*. The single species of *Oreamnos*, *Oreamnos americanus* (mountain goats), are native to northwestern North America. Since domestic goats of the *Capra* genus and mountain goats of the *Oreamnos* genus overlap geographically, it is not possible to distinguish between the two in the ethnographic record. For this reason, “goat” was classified at the family level, as a member of Bovidae.

- **Hare.** The term “hare” can refer to two genera in the Leporidae family, Lagomorpha order, whose geographic ranges overlap: *Lepus* (29 species of hares, from Africa, Eurasia, and North America), and *Caprolagus* (one species of bristly rabbit or hispid hare from the Himalayas, Nepal, India and Bangladesh). Hares in the Leporidae family therefore cannot be distinguished at the genus level by geography. Nowak (1999) noted that usually the term “hare” is reserved for the *Lepus* genus. However, “hare” can also refer to three distantly related taxa: the *Ochotona* genus, from the Ochotonidae family, Lagomorpha order (26 species of pikas, conies, or mouse hares in Asia, Canada and the United States), the *Alactagulus* genus, from the Dipodidae family, Rodentia order (a single species of lesser five-toed jerboas or little earth hares, from Iran to Inner Mongolia), and the *Dolichotis* genus, from the Caviidae family, Rodentia order (Patagonian cavies or maras, also known as Patagonian hares, from southern South America). Since the majority of species termed “hare” come from the Leporidae family, and the term “hare” is most commonly used for the *Lepus* genus, “hare” was classified at the family level, as a member of Leporidae.
- **Hyena/hyaena.** The term “hyena” was included for the Stage 3 Project faunal database taxon *Crocuta/Hyaena* sp. (spotted and striped hyenas). The Stage 3 Project database does not differentiate between *Crocuta* and *Hyaena*. Thus, “hyena” was classified at the family level, as a member of Hyaenidae.
- **Lemming.** The term “lemming” refers to several genera in the murid family, including *Lemmus* (true lemmings from Eurasia and North America), *Dicrostonyx* (collared lemmings from Eurasia and North America), *Lagurus* (steppe lemmings from Eurasia), *Myopus* (wood lemmings from Eurasia), and *Ellobius* (mole-lemmings from Eurasia). These genera cannot be distinguished based on geography. Thus, “lemming” was classified at the family level, as a member of Muridae.
- **Leopard.** The term “leopard” includes *Panthera pardus* (leopards in Asia, Siberia and Africa), *Neofelis nebulosa* (clouded leopards in Asia) and *Panthera uncia* (snow leopards in Asia). Because the geographic ranges of *Panthera* and *Neofelis* overlap in Asia, it is not possible to distinguish between the two genera based on geography. For this reason, “leopard” was categorized at the family level, as a member of Felidae.
- **Otter.** The term “otter” can refer to many genera and species of mustelid, apart from the one listed in the Stage 3 Project faunal database (*Lutra*

- lutra*). Old World river otters (*Lutra lutra*) live in Europe, Asia, and Africa, while spotted neck otters (*Lutra maculicollis*) live in Africa. Smooth-coated otters (*Lutrogale perspicillata*) live in Asia. Lastly, New World river otters (*Lontra* sp.) are found throughout the Americas. As it is not possible to distinguish between *Lutra* and *Lutrogale* by geography, “otter” was classified at the family level, as a member of Mustelidae.
- **Pig.** The term “pig” was included as a common name for *Sus scrofa* (wild boar). However, “pig” can refer to two genera within Suidae: *Sus* (pigs, hogs and boars from Eurasia and Africa), and *Potamochoerus* (red river hogs and African bush pigs from Africa). Since it is not possible to distinguish between *Sus* and *Potamochoerus* based on geography, “pig” was categorized at the family level, as a member of Suidae.
 - **Polecat.** There are two species of mustelid called “polecat” in the *Mustela* genus, both of which live in Europe and Asia. Additionally, there are two distinct genera called “polecats” in Mustelidae: *Vormela* (marbled polecats from Europe, the Middle East, and Asia), and *Ictonyx* (striped polecats in Africa). Because the ranges of these taxa overlap, it is not possible to distinguish between genera of polecats based on geography. Consequently, the term “polecat” was categorized at the family level, as a member of Mustelidae.
 - **Rabbit.** “Rabbit” can refer to a number of genera within the Leporidae family, including *Bunolagus* (bushman rabbits from South Africa), *Pronolagus* (red rabbits from Africa), *Brachylagus* (pygmy rabbits from the United States), *Sylvilagus* (cottontail rabbits from North and South America), *Oryctolagus* (Old World and domestic rabbits, originally from the Old World but now worldwide), and *Lepus* (jack rabbits and hares in Eurasia, Africa, and North America). Since it is not possible to distinguish between the various rabbit genera based on geography, “rabbit” was classified at the family level, as a member of Leporidae.
 - **Sheep.** The term “sheep” can refer to three bovid genera: *Ovis* (various sheep, mouflon, urial, and argali, originally from the Middle East, Asia, and North America, and domesticated worldwide), *Ammotragus* (barbary sheep from Morocco, western Sahara to Egypt, and the Sudan) and *Pseudois* (blue sheep from the Himalayas to Inner Mongolia). Since there is no way to distinguish between the various genera of “sheep” geographically, it is not possible to determine which genus the term “sheep” refers to in the ethnographic record. “Sheep” was therefore classified at the family level in this study, as a member of Bovidae.
 - **Squirrel.** The term “squirrel” can refer to a number of sciurid genera, including *Ammospermophilus* (antelope ground squirrels in North America), *Spermophilus* (ground squirrels or susliks in Eurasia and North America), and *Sciurus* (tree squirrels in Eurasia and the Americas). There are also three genera within the Anomaluridae family that are referred to as “squirrels”: *Idiurus* (pygmy scaly-tailed flying squirrels), *Zenkerella* (flightless scaly-tailed squirrels) and *Anomalurus* (scaly-tailed flying squirrels). However, Anomaluridae is only found in Africa, and no results

for the use of squirrel for clothing came from Africa. For this reason, “squirrel” was categorized at the family level, as a member of Sciuridae.

- **Weasel.** The term “weasel” generally refers to one of ten species of the *Mustela* genus that live throughout North and South America, Eurasia, and north-western Africa. However, “weasel” can also refer to other mustelid genera, such as *Poecilogale* and *Poecilictis* in Africa, and *Lyncodon* in South America. Since the various genera of weasels overlap, they cannot be distinguished based on geography. “Weasel” was therefore classified at the family level, as a member of Mustelidae.

The common names of the following of Stage 3 fauna could refer to a variety of taxa, and were classifiable at the genus level:

- **Bear.** The term “bear” can refer not only to the *Ursus* genus (a number of species of bears from North America, Eurasia, and Africa), but also to the *Tremarctos* genus (spectacled bears in Central and South America), and the order Tubulidentata (aardvarks or ant bears) in Africa. However, as no results came from Central or South America, or Africa, the term “bear” was categorized as *Ursus*.
- **Beaver.** The term “beaver” can refer not only to two species of *Castor* (*C. fiber* and *C. canadensis* from Eurasia and North America), of the Castoridae family, but also to a single species of *Aplodontia* (sewellel or mountain beaver from the northwest coast of North America), of the Aplodontidae family. As the majority of taxa called “beaver” belong to *Castor* and only three of the results for “beaver” come from areas that are inhabited by both genera, “beaver” was treated as a member of *Castor*.
- **Ground squirrel.** The term “ground squirrel” can refer not only to members of *Spermophilus* (several species from high latitudes of Eurasia and North America), but also to a number of genera that inhabit Africa, Asia, and southern North America. However, since all of the results for the use of “ground squirrel” for clothing came from Alaska, hits for “ground squirrel” were recorded under *Spermophilus*.
- **Wolf.** The term “wolf” can refer to a number of species of *Canis* (wolves from Africa, Eurasia, North America, and Greenland) as well as the *Dusicyon* genus from the Falkland Islands. However, since no results came from the Falkland Islands, “wolf” was treated exclusively as *Canis*.

The common names of the remaining fauna from the Stage 3 Project faunal database were not problematic, and could be classified at the genus or species level. Of the taxa that are used for clothing, only 13 were classifiable at the species level:

Rangifer tarandus (reindeer/caribou), *Alces alces* (moose/elk), *Cervus elaphus* (red deer/elk), *Equus caballus* (horse), *Mustela erminea* (stoat/ermine), *Ursus arctos* (brown/grizzly bear), *Gulo gulo* (wolverine), *Vulpes vulpes* (red fox), *Ovibos moschatus*

(musk ox), *Sus scrofa* (wild boar), *Felis sylvestris* (wild cat), *Alopex lagopus* (Arctic fox), and *Panthera leo* (lion). As so few Stage 3 taxa were classified at the species level, ranking the relative frequency of use of the above 13 species for clothing would disregard the vast majority of taxa that are used for clothing. So, comparing the relative frequency of use of Stage 3 taxa for clothing at the species level is not very meaningful. Comparing the use of Stage 3 taxa at the genus and family levels is more meaningful, since fewer (if any) taxa are disregarded. At the genus level, a number of taxa that are only classifiable at the family level are disregarded. So, a genus level comparison is precise, but not as accurate as a family level comparison. Comparing the use of families for clothing gives the most accurate results because all Stage 3 taxa were classifiable at the family level. In addition, as most extinct Stage 3 taxa do not have a modern counterpart at the genus or species level, the family level is the most precise ranking that takes their presence in the archaeological record into account.

2.1.2. Search for uses of animals for clothing among recent non-industrial groups

As noted earlier, I used the list of common names of the Stage 3 taxa that I compiled to perform searches of the eHRAF World Cultures database (hereinafter the eHRAF database). The eHRAF database is a cross-cultural database maintained by the Human Relations Area Files, Inc. at Yale University (<http://www.yale.edu/hraf/index.html>). It contains information on numerous aspects of the cultural and social lives of a worldwide sample of 258 ethnographic groups. The eHRAF database is searchable by ethnographic group and by subject matter.

I conducted advanced eHRAF searches, including 133 of the total 258 cultures in eHRAF. Because the goal of the analyses was to identify taxa that are likely to have been used for clothing among OIS 3 hunter-gatherers, I deemed it inappropriate to include industrialized groups in the search. Groups in the category “Regional and Ethnic Cultures”, which includes modern ethnic groups such as African Americans, Arab Americans and Cuban Americans, were therefore not included in the search. Disregarding “Regional and Ethnic Cultures” left a total of 237 non-industrial groups.

I also deemed it inappropriate to include cultures from tropical latitudes in the ethnographic search since the Stage 3 Project faunal database contains only taxa that

lived in Europe during OIS 3. Because the Stage 3 Project faunal database does not include taxa that inhabit strictly tropical latitudes, an assessment of the relative frequency of use of Stage 3 taxa for clothing in tropical latitudes would not be accurate. In addition, clothing made by ethnographic groups in tropical latitudes is less likely to reflect thermal requirements than that made by groups in higher latitudes. In order to disregard cultures from tropical latitudes from the ethnographic search, I organized the 237 non-industrial groups from eHRAF by latitudinal bands. I defined two bands: “high latitude” (north of the Tropic of Cancer or south of the Tropic of Capricorn), and “tropical latitude” (south of the Tropic of Cancer and north of the Tropic of Capricorn). Groups whose territories straddle the two bands were defined as “mid latitude”, and were included with high latitude groups. In line with this, the high latitude band will hereafter be referred to as “mid-to-high latitude”. The latitudinal bands of the ethnographic groups in eHRAF were defined based on the groups’ geographic territories as listed in eHRAF, and latitudes from Stanford (2003). Of the 237 non-industrial groups in eHRAF, 90 come from strictly high latitudes, 43 from mid latitudes, and 104 come from strictly tropical latitudes. Combined, 133 groups were defined as mid-to-high latitude, and were included in the searches.

I conducted an advanced eHRAF search for each Stage 3 taxon, with “clothing” in the subject category and the common name of the taxon in the text category. I recorded types of clothing, the cultures that use the taxon for clothing, and the associated references. I recorded each type of clothing use once per culture. For example, if there were three records of beaver being used by the Saami to make fur coats, I recorded “fur coat” as one result for clothing use among the Saami. If the Saami made three different types of coats from beaver (e.g. coats with the fur on, coats with the fur removed, and ceremonial coats), I recorded three results for clothing use among the Saami. I created variables for a number of clothing types that are relevant to this study, and awarded a numeric score of one for each use. The clothing type variables can be seen in Table 2.1 below.

Table 2.1 Clothing type variables and definitions

| Code | Variable Name | Definition |
|------------------|---|--|
| Clo | Number of uses of the animal for clothing | Anything made of the skin or fur/hair of an animal that is worn on the body, or animal body parts used to make clothing |
| Util Clo | Number of uses for utilitarian clothing | Everyday clothing, worn for utilitarian purposes (potentially with thermal implications): all use of animals for clothing with the exception of “non-utilitarian clothing” (worn by warriors, to denote rank, status or wealth, to denote identity or office, and ceremonial or purely decorative clothing, and animal body parts used in the manufacture of clothing) |
| Body | Number of uses for utilitarian clothing worn on the body | |
| Head | Number of uses for utilitarian clothing worn on the head | |
| Neck | Number of uses for utilitarian clothing worn on the neck | |
| Foot | Number of uses for utilitarian clothing worn on the foot | |
| Hand | Number of uses for utilitarian clothing worn on the hands | |
| Winter/ Heavy | Number of uses for utilitarian winter/heavy clothing | Utilitarian clothing that is described as winter wear, as heavy/warm, or outer clothing (e.g. an overcoat) |
| Fur | Number of uses for utilitarian fur clothing | Utilitarian clothing made from skin with the fur/hair left on |
| Trim | Number of uses for fur trim on utilitarian clothing | Utilitarian clothing made from skin with the fur/hair left on, used to trim the borders of clothing |

I summed the total number of uses of each taxon for clothing, (Clo), utilitarian clothing (Util Clo), winter/heavy clothing (Winter/Heavy), fur clothing (Fur), and fur trim (Trim). I then summed the totals for each clothing type at the family and genus levels, and converted the sums to percentages. When summing the totals at the family and genus levels, I included the number of clothing uses of all taxa that were classified as belonging to each family or genus. Lastly, I ranked the families and genera used for each type of clothing. Only the families and genera that made up at least 1% of the results for each type of clothing use were considered “used” for each type of clothing.

2.2. Results

In total, the ethnographic search yielded 1565 uses of Stage 3 taxa for clothing and 1165 uses for utilitarian clothing. Of the uses as utilitarian clothing, 238 were winter/heavy clothing, 318 were fur clothing, and 74 were fur trim.

2.2.1. All clothing and utilitarian clothing

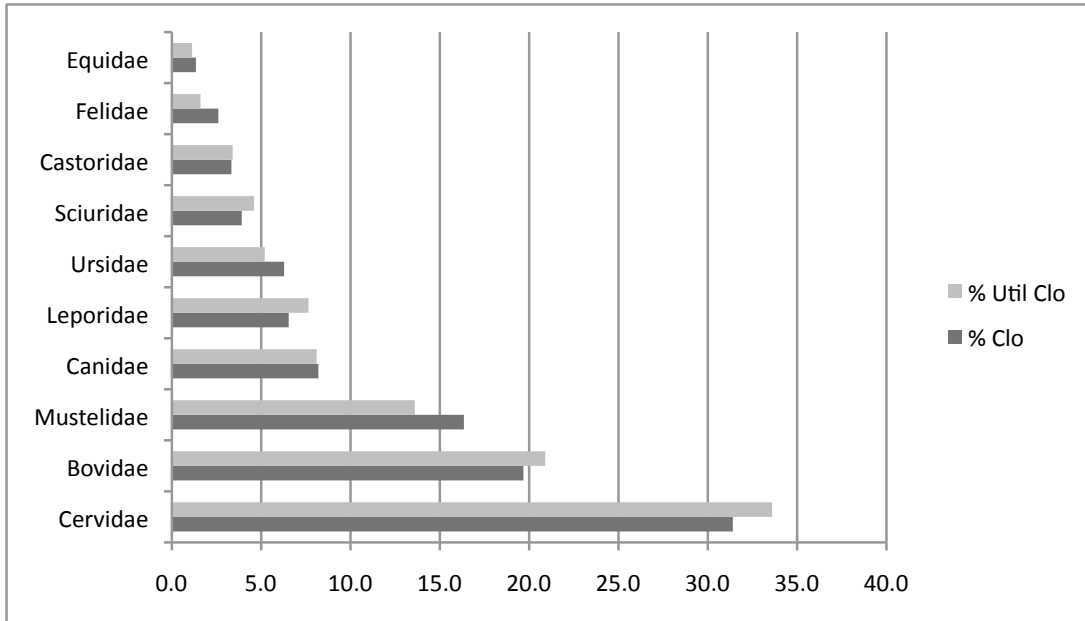
2.2.1.1. Family level

The results for families used for all clothing and utilitarian clothing are summarized in Table 2.2 and Figure 2.2. Ten of the 23 families are used for clothing. Of these, Cervidae is the most commonly used, with >30% of the recorded uses. The bovid and mustelid families each comprised 10-20% of uses. Canidae, Leporidae, and Ursidae each comprised 5-10% of uses. Sciuridae, Castoridae, Felidae, and Equidae each comprised <5% of uses. When the families are ranked based on utilitarian clothing use, the order remains the same; there are just slight changes in the percentage of use made up by each family.

Table 2.2 *Percentage of use of families for clothing*

| Family | % All clothing | Family | % Utilitarian clothing |
|------------|----------------|------------|------------------------|
| Cervidae | 31.4 | Cervidae | 33.6 |
| Bovidae | 19.7 | Bovidae | 20.9 |
| Mustelidae | 16.3 | Mustelidae | 13.6 |
| Canidae | 8.2 | Canidae | 8.1 |
| Leporidae | 6.5 | Leporidae | 7.6 |
| Ursidae | 6.3 | Ursidae | 5.2 |
| Sciuridae | 3.9 | Sciuridae | 4.6 |
| Castoridae | 3.3 | Castoridae | 3.4 |
| Felidae | 2.6 | Felidae | 1.6 |
| Equidae | 1.3 | Equidae | 1.1 |

Figure 2.2 Percentage of use of families for clothing



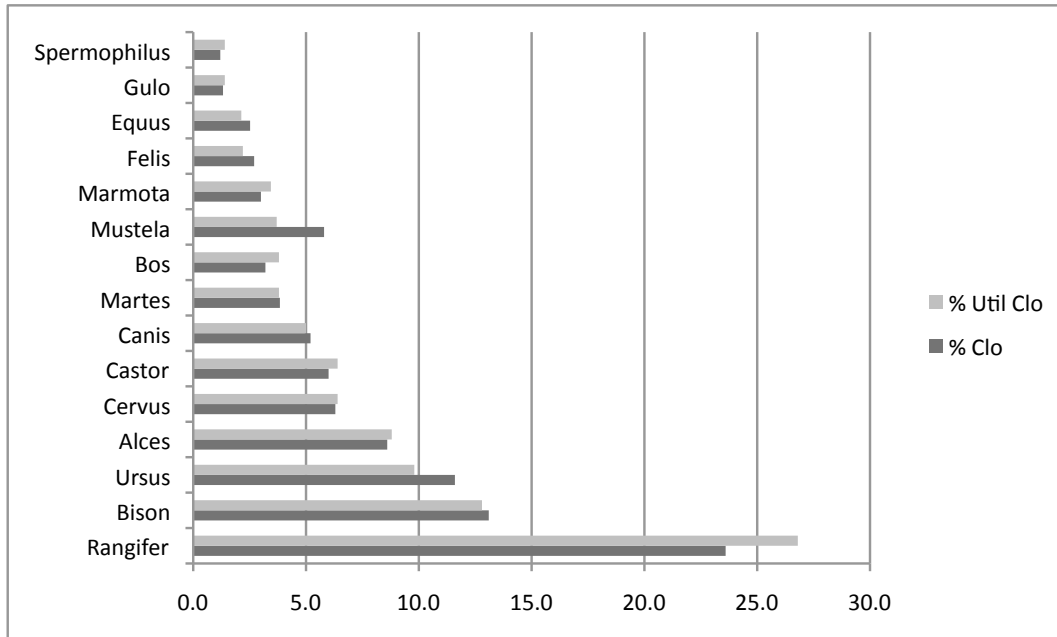
2.2.1.2. Genus level

Table 2.3 and Figure 2.3 summarize the results for genera used for all clothing and utilitarian clothing. Fifteen of the 61 genera are used for clothing. Of these, *Rangifer* is the most commonly used. It constitutes 20% of the uses recorded. *Bison* and *Ursus* each comprised 10-15% of the uses, while *Alces*, *Cervus*, *Castor*, *Mustela*, and *Canis* each comprised 5-10% of the uses. *Martes*, *Bos*, *Marmota*, *Felis*, *Equus*, *Gulo*, *Spermophilus*, and *Panthera* each comprised <5% of the uses. With regard to utilitarian clothing, the percentage of results belonging to *Rangifer* and *Bison* remain almost the same. *Ursus*, *Alces*, *Castor*, *Cervus*, and *Canis* comprise 5-10% of the uses. The remaining genera, *Martes*, *Mustela*, *Bos*, *Marmota*, *Felis*, *Equus*, *Gulo*, and *Spermophilus*, each comprise <5% of the uses.

Table 2.3 Percentage of use of genera for clothing

| Genus | % All clothing | Genus | % Utilitarian clothing |
|---------------------|-----------------------|---------------------|-------------------------------|
| <i>Rangifer</i> | 23.6 | <i>Rangifer</i> | 26.8 |
| <i>Bison</i> | 13.1 | <i>Bison</i> | 12.8 |
| <i>Ursus</i> | 11.6 | <i>Ursus</i> | 9.8 |
| <i>Alces</i> | 8.6 | <i>Alces</i> | 8.8 |
| <i>Cervus</i> | 6.3 | <i>Castor</i> | 6.4 |
| <i>Castor</i> | 6 | <i>Cervus</i> | 6.4 |
| <i>Mustela</i> | 5.8 | <i>Canis</i> | 5 |
| <i>Canis</i> | 5.2 | <i>Martes</i> | 3.8 |
| <i>Martes</i> | 3.8 | <i>Mustela</i> | 3.8 |
| <i>Bos</i> | 3.2 | <i>Bos</i> | 3.7 |
| <i>Marmota</i> | 3 | <i>Marmota</i> | 3.4 |
| <i>Felis</i> | 2.7 | <i>Felis</i> | 2.2 |
| <i>Equus</i> | 2.5 | <i>Equus</i> | 2.1 |
| <i>Gulo</i> | 1.3 | <i>Gulo</i> | 1.4 |
| <i>Spermophilus</i> | 1.2 | <i>Spermophilus</i> | 1.4 |
| <i>Panthera</i> | 1.1 | | |

Figure 2.3 Percentage of use of genera for clothing



2.2.2. Winter/Heavy clothing

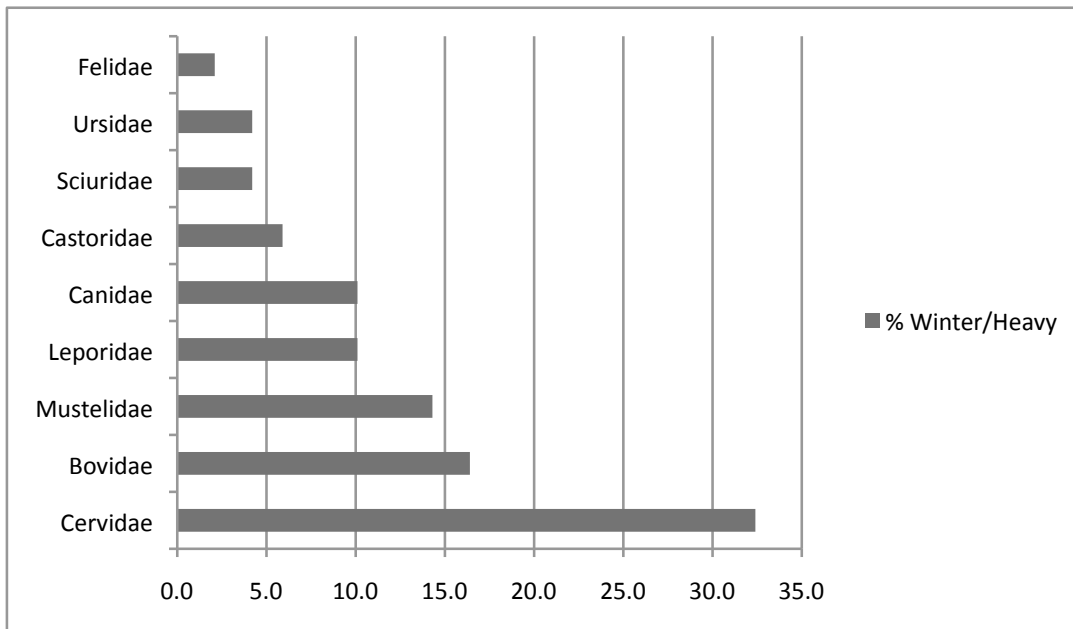
2.2.2.1. Family level

The results for families used for winter/heavy clothing are summarized in Table 2.4 and Figure 2.4. Nine of the 23 families are used for winter/heavy clothing. Cervidae is the most commonly used of these. Of the documented winter/heavy clothing uses, >30% involved cervids. Bovidae, Mustelidae, Leporidae, and Canidae each comprised 10-20% of uses. Just over 5% of uses involved Castoridae. Sciuridae, Ursidae, and Felidae each comprised <5% of uses for winter/heavy clothing.

Table 2.4 *Percentage of use of families for winter/heavy clothing*

| Family | % Winter/Heavy |
|------------|----------------|
| Cervidae | 32.4 |
| Bovidae | 16.4 |
| Mustelidae | 14.3 |
| Leporidae | 10.1 |
| Canidae | 10.1 |
| Castoridae | 5.9 |
| Sciuridae | 4.2 |
| Ursidae | 4.2 |
| Felidae | 2.1 |

Figure 2.4 *Percentage of use of families for winter/heavy clothing*



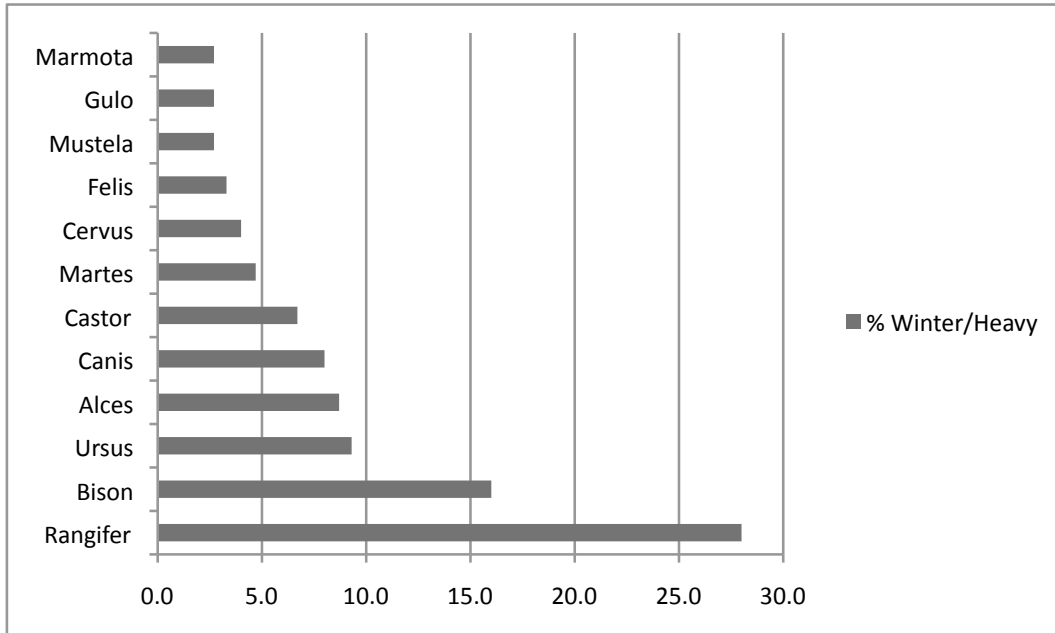
2.2.2.2. Genus level

The results for genera used for winter/heavy clothing are summarized in Table 2.5 and Figure 2.5. Twelve of the 61 genera are used for winter/heavy clothing. Of these, *Rangifer* is the most commonly used. Over 25% of the winter/heavy clothing uses involved *Rangifer*. Just over 15% of winter/heavy clothing uses were made from *Bison*. *Ursus*, *Alces*, *Canis*, and *Castor* each comprised 5-10% of the uses. *Martes*, *Cervus*, *Felis*, *Mustela*, *Gulo*, and *Marmota* each comprised <5% of the uses.

Table 2.5 Percentage of use of genera for winter/heavy clothing

| Genus | % Winter/Heavy |
|-----------------|-----------------------|
| <i>Rangifer</i> | 28 |
| <i>Bison</i> | 16 |
| <i>Ursus</i> | 9.3 |
| <i>Alces</i> | 8.7 |
| <i>Canis</i> | 8 |
| <i>Castor</i> | 6.7 |
| <i>Martes</i> | 4.7 |
| <i>Cervus</i> | 4 |
| <i>Felis</i> | 3.3 |
| <i>Mustela</i> | 2.7 |
| <i>Gulo</i> | 2.7 |
| <i>Marmota</i> | 2.7 |

Figure 2.5 Percentage of use of genera for winter/heavy clothing



2.2.3. Fur clothing

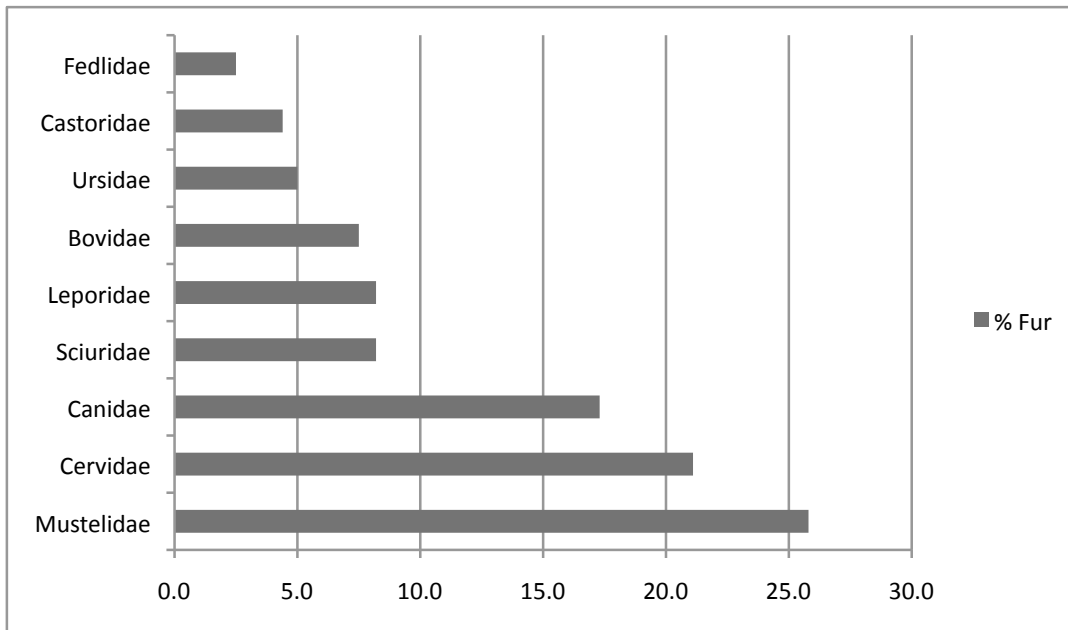
2.2.3.1. Family level

The results for families used for fur clothing are summarized in Table 2.6 and Figure 2.6. Nine of the 23 families are used for fur clothing. Mustelidae is the most commonly used of these. Over 20% of the uses for fur clothing were from Mustelidae. Another 20% belonged to Cervidae. Over 15% of the uses were of Canidae. Sciuridae, Leporidae, Bovidae, and Ursidae each comprised 5-10% of the uses. Castoridae and Felidae each comprised <5% of the uses.

Table 2.6 *Percentage of use of families for fur clothing*

| Family | % Fur |
|------------|-------|
| Mustelidae | 25.8 |
| Cervidae | 21.1 |
| Canidae | 17.3 |
| Sciuridae | 8.2 |
| Leporidae | 8.2 |
| Bovidae | 7.5 |
| Ursidae | 5 |
| Castoridae | 4.4 |
| Felidae | 2.5 |

Figure 2.6 *Percentage of use of families for fur clothing*



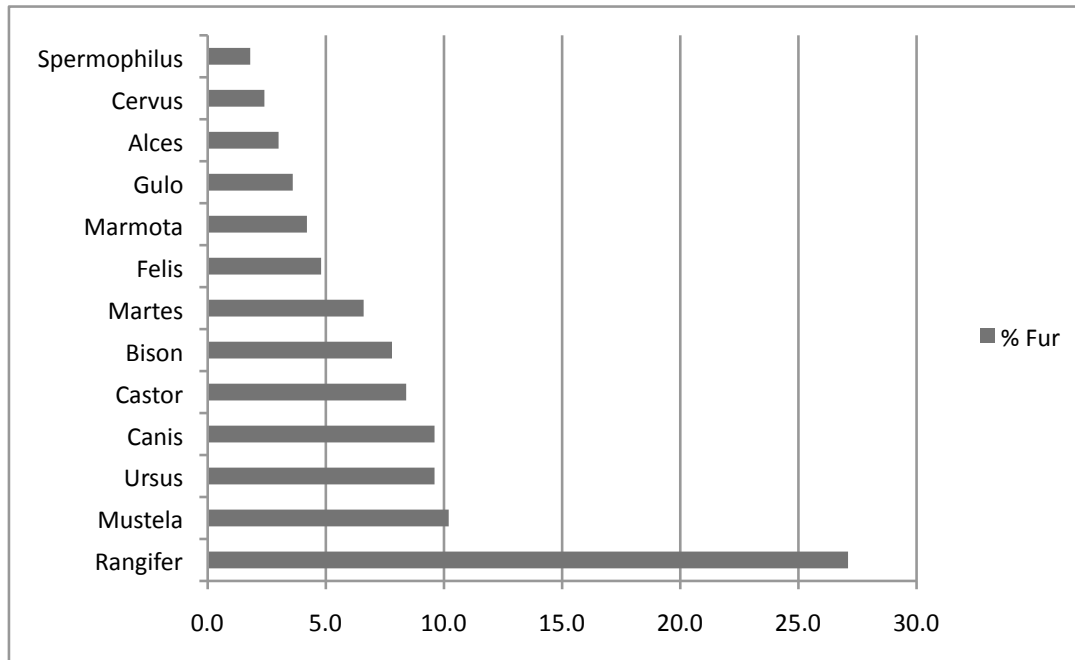
2.2.3.2. Genus level

Table 2.7 and Figure 2.7 summarize the results for genera used of fur clothing. Thirteen of the 61 genera are used for fur clothing. *Rangifer* is the most commonly used of these. It accounts for >25% of uses. *Mustela*, *Ursus*, and *Canis* each comprised ~10% of uses. *Castor*, *Bison*, and *Martes* each comprised 5-10% of uses. *Felis*, *Marmota*, *Gulo*, *Alces*, *Cervus*, and *Spermophilus* each comprised <5% of uses.

Table 2.7 Percentage of use of genera for fur clothing

| Genus | % Fur |
|---------------------|--------------|
| <i>Rangifer</i> | 27.1 |
| <i>Mustela</i> | 10.2 |
| <i>Ursus</i> | 9.6 |
| <i>Canis</i> | 9.6 |
| <i>Castor</i> | 8.4 |
| <i>Bison</i> | 7.8 |
| <i>Martes</i> | 6.6 |
| <i>Felis</i> | 4.8 |
| <i>Marmota</i> | 4.2 |
| <i>Gulo</i> | 3.6 |
| <i>Alces</i> | 3 |
| <i>Cervus</i> | 2.4 |
| <i>Spermophilus</i> | 1.8 |

Figure 2.7 Percentage of use of genera for fur clothing



2.2.4. Fur trim

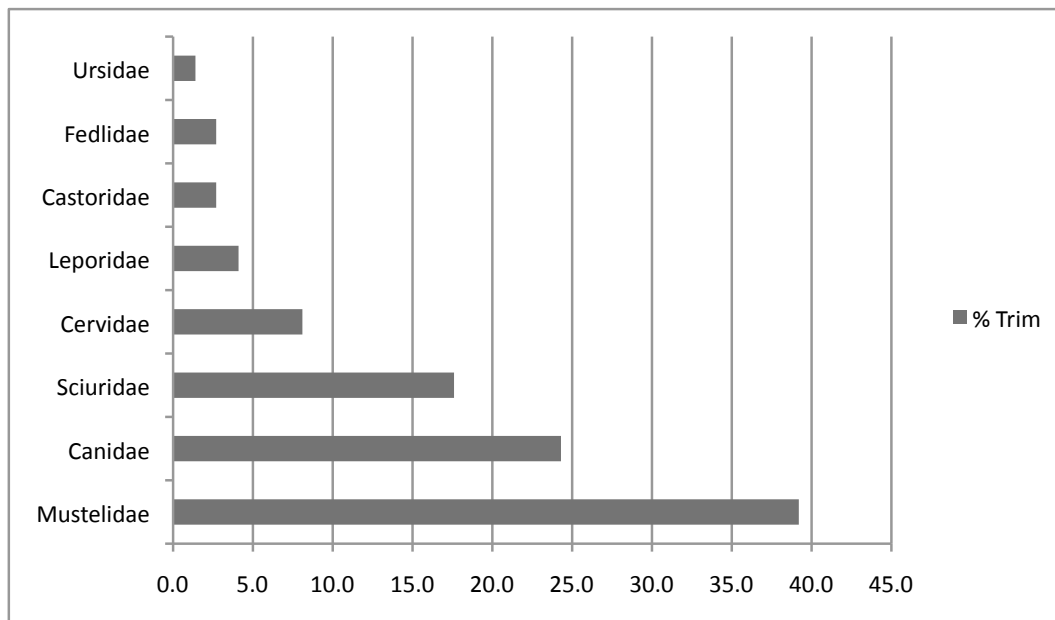
2.2.4.1. Family level

The results for families used for fur trim are summarized in Table 2.8 and Figure 2.8. Eight of the 23 families are used for fur trim. Mustelidae is by far the most frequently used of these. It accounts for >35% of uses. Canidae and Sciuridae comprised 15-25% of uses. Almost 10% of uses were from Cervidae. Leporidae, Castoridae, Felidae, and Ursidae each comprised less than 5% of uses.

Table 2.8 Percentage of use of families for fur trim

| Family | % Trim |
|------------|--------|
| Mustelidae | 39.2 |
| Canidae | 24.3 |
| Sciuridae | 17.6 |
| Cervidae | 8.1 |
| Leporidae | 4.1 |
| Castoridae | 2.7 |
| Felidae | 2.7 |
| Ursidae | 1.4 |

Figure 2.8 Percentage of use of families for fur trim



2.2.4.2. Genus level

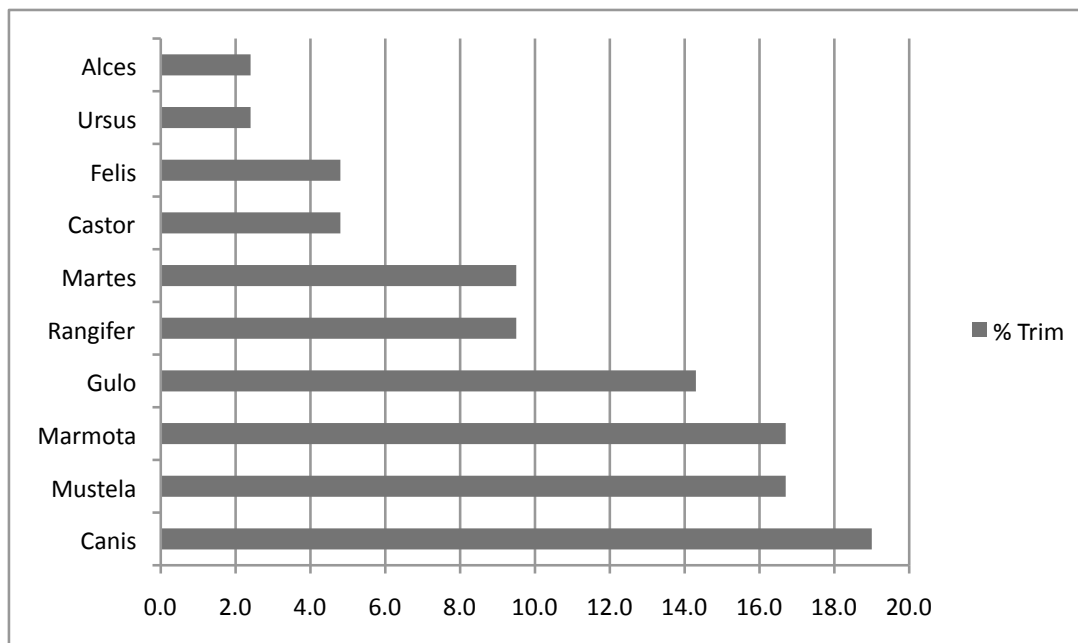
Table 2.9 and Figure 2.9 summarize the results for genera used for fur trim. Ten of the 61 genera are used for fur trim. *Canis*, *Mustela*, and *Marmota* are the most

frequently used of these. They each account for 15-20% of uses. Almost 15% of uses were from *Gulo*. *Rangifer* and *Martes* each comprised almost 10% of uses. *Castor*, *Felis*, *Ursus*, and *Alces* each comprised <5% of uses.

Table 2.9 Percentage of use of genera for fur trim

| Genus | % Trim |
|-----------------|--------|
| <i>Canis</i> | 19 |
| <i>Mustela</i> | 16.7 |
| <i>Marmota</i> | 16.7 |
| <i>Gulo</i> | 14.3 |
| <i>Rangifer</i> | 9.5 |
| <i>Martes</i> | 9.5 |
| <i>Castor</i> | 4.8 |
| <i>Felis</i> | 4.8 |
| <i>Ursus</i> | 2.4 |
| <i>Alces</i> | 2.4 |

Figure 2.9 Percentage of use of genera for fur trim



2.3. Description of ethnographic clothing use

This section provides a breakdown of the use of the families and genera that make up at least 1% of utilitarian clothing and cold weather clothing use. It should be noted that all of the families and genera that make up at least 1% of each type of cold weather clothing also make up at least 1% of utilitarian clothing use. Taxa that are used only for non-utilitarian clothing were not included. As has already been noted, taxa that are used for utilitarian clothing are more likely to have been chosen based on thermal or other practical qualities, relative to taxa used for non-utilitarian (e.g. ceremonial) clothing. So, the remainder of this study focuses on taxa that are used for utilitarian and cold-weather clothing. In this section I describe the types of clothing made from each taxon. The descriptions are organized by family. That is, the genera and family-level search terms (e.g. “deer”) that are used for each type of clothing are nested within their respective families. In the descriptions, any percentages given for types of clothing use are relative to the other types of clothing made from that taxon. For example, where I state that approximately 25% of utilitarian clothing made from caribou is worn on the feet, it means that 25% of the uses of caribou for utilitarian clothing were in the form of footwear.

2.3.1. *Cervidae*

In order from most to least frequent, the fauna that are used for utilitarian clothing in the cervid family are *Rangifer* (reindeer/caribou), “deer”, *Alces* (elk/moose), and *Cervus* (red deer/elk/wapiti). The majority of clothing made from Cervidae is utilitarian (392 out of 491, or 80% of the recorded ethnographic clothing use).

Rangifer (reindeer/caribou) is the most frequently used genus for utilitarian clothing of all OIS 3 genera. It is also, therefore, the most commonly used taxon for clothing in the cervid family, with 200 total results for clothing, 167 of which are utilitarian (~85%). The majority of utilitarian clothing made from caribou is worn on the body (~50%), followed by that worn on the feet (~25%), and hands (~10%). About 25% of utilitarian clothing made from caribou is winter/heavy clothing. Around 25% of utilitarian

clothing made from caribou is fur clothing, and 2% of utilitarian clothing made from caribou is fur trim.

The term “deer” yielded the second most hits for utilitarian clothing in Cervidae, after reindeer/caribou. There are 163 instances of deer hide being used for clothing, 128 of which are utilitarian (80%). The majority of utilitarian clothing made from deer is worn on the body (~65%), followed by that worn on the feet (~20%), and the head (~5%). Of utilitarian clothing made from deer, approximately 10% is identified as winter/heavy clothing. Around 10% of utilitarian clothing made from deer has the fur left on, and only about 1% is used for fur trim. Treated deerskin was often identified as being particularly comfortable to wear, due to its lightness and softness (e.g. Weltfish 1965).

Alces (elk/moose) is the third most commonly used taxon for utilitarian clothing in the cervid family, after reindeer/caribou and deer. There were 73 uses of moose for clothing, 55 of which were utilitarian. Thus, approximately 75% of clothing made from moose is utilitarian. The majority of utilitarian clothing made from moose is worn on the feet (~50%), followed by that worn on the body (45%). Around 25% of utilitarian clothing made from moose is winter/heavy clothing. About 10% of utilitarian clothing made from moose is fur clothing, and 2% is fur trim.

Cervus (red deer/elk) is the fourth most commonly used taxon for utilitarian clothing in Cervidae. There were 53 uses of red deer for clothing, the majority (75%) of which were utilitarian. Most utilitarian clothing made from red deer is worn on the body (almost 70%), followed by that worn on the feet (30%). About 15% of utilitarian clothing made from red deer is winter/heavy clothing. Around 10% of utilitarian clothing made from red deer is fur clothing, but there were no uses of red deer for fur trim.

2.3.2. Bovidae

In order from most to least, the taxa that are used for utilitarian clothing in Bovidae are *Bison* (bison/wisent), “sheep”, “goat”, *Bos* (cattle/cow and yak), and “antelope”. The majority of clothing made from Bovidae is utilitarian (244 out of 308, or 80% of hits).

Bison (bison/wisent) is the most frequently used taxon for clothing in Bovidae. The majority of clothing made from bison is utilitarian (80 out of 111 or 70% of total clothing uses). The majority of utilitarian clothing made from bison is worn on the body (~60%), followed by that worn on the feet (~25%). About 30% of utilitarian clothing made from bison is winter/heavy clothing, and 15% is fur clothing. Bison does not appear to be used for fur trim.

The term “sheep” yielded the second most utilitarian clothing uses in Bovidae. There were 89 uses of sheep for clothing, 78 of which (90%) were utilitarian. Approximately half of the use of sheep for clothing is wool clothing, and half is hide clothing. The majority (~75%) of use of sheep for utilitarian clothing was clothing worn on the body, followed by that worn on the feet (~15%). Approximately 15% of utilitarian clothing made from sheep is winter/heavy clothing, and 10% is classified as fur clothing (skin clothing with the wool left on). There were no records of sheep being used for fur trim. The use of sheep for wool clothing implies the use of some sort of knitting technology in its manufacture, which complicates the picture when looking for evidence of clothing in the archaeological record. However, as half of the uses of sheep for clothing were for hide clothing, their remains are still relevant to this study as evidence for hide clothing.

The term “goat” had the third most utilitarian clothing uses in Bovidae. The majority of clothing made from goat is utilitarian (50 out of 68 uses, or ~75%). Approximately 75% of utilitarian clothing made from goat is worn on the body, and ~15% is worn on the feet. About 30% of clothing made from goat is made from wool rather than skin. Interestingly, clothing made from goat is sometimes in the form of wool, woven into strips of shredded bark (e.g. Kennedy and Bouchard 1990). This again implies the use of some sort of knitting technology, but because clothing made from goats is usually made from hide, the remains of goats are still relevant to this study as evidence for hide clothing. Around 6% of utilitarian clothing made from goat is identified as being winter/heavy clothing, and 6% is skin clothing with the wool/hair left on. There are no records of goat being used as fur trim.

Bos includes aurochs, cattle/cow, kouprey, banteng, gaur, seladang, and yak. Of the *Bos* species, cattle/cows and yaks are used for utilitarian clothing. *Bos* is the fourth

most frequently used taxon for clothing in Bovidae. The majority of clothing made from *Bos* is utilitarian (24 out of 27 clothing uses, or 90%). Most utilitarian clothing made from *Bos* is footwear (~65%), followed by clothing worn on the body (30%). There was only one record of *Bos* being used for utilitarian winter/heavy clothing (5%), and one record of *Bos* being used for utilitarian clothing with the fur left on (5%). There were no records of fur trim made from *Bos*.

“Antelopes” are the fifth most commonly used fauna in Bovidae. There were nine uses of antelope for clothing, all of which (100%) were utilitarian. The majority of utilitarian clothing made from antelope is worn on the body (~65%), followed by that worn on the feet (~35%). Clothing made from antelope has been described as ephemeral, only lasting six months (Silberbauer 1981). There was no mention of antelope being used for winter/heavy clothing, for fur clothing, or for fur trim.

2.3.3. Mustelidae

In order from most to least, the mustelids that are used for utilitarian clothing are: “otter”, *Martes* (marten, fisher/pekan, and sable), *Mustela* (mink, ferret, and stoat/ermine), “badger”, “weasel”, and *Gulo* (wolverine). The majority of clothing made from mustelids is utilitarian (158 out of 255 clothing uses, or 60%).

The term “otter” yielded the most results for utilitarian clothing use in Mustelidae. There were 120 uses of otter for clothing, 79 of which are utilitarian. The majority of clothing made from otter is thus utilitarian (~65%). Most utilitarian clothing made from otter is worn on the body (~75%). The next most common use of otter for utilitarian clothing is for headgear (20%). Over 20% of utilitarian clothing made from otter is winter/heavy clothing. Forty-five percent of utilitarian clothing made from otter is fur clothing, and approximately 15% is fur trim.

Martes (marten, fisher/pekan, and sable) is the second most frequently used taxon in Mustelidae, with 32 clothing uses, 24 of which (75%) are utilitarian. The majority of utilitarian clothing made from *Martes* is worn on the body (60%), followed by that worn on the head (20%). Approximately 10% of utilitarian clothing made from *Martes* is worn on the neck, and another 10% is worn on the hands. Approximately 30% of utilitarian

clothing made from *Martes* is winter/heavy clothing, and 45% is fur clothing. Approximately 15% of utilitarian clothing made from *Martes* is in the form of fur trim.

Mustela (mink, ferret, and stoat/ermine) is the third most commonly used taxon for clothing in the Mustelidae family. *Mustela* yielded 49 clothing uses, 23 of which were utilitarian (~45%). The majority of utilitarian clothing made from *Mustela* is worn on the body (60%), followed by that worn on the head (35%). Approximately 15% of utilitarian clothing made from *Mustela* is winter/heavy clothing, 75% is fur clothing, and 30% is fur trim.

“Badger” is the fourth most commonly used animal for utilitarian clothing in Mustelidae. There were 12 uses of badger for clothing, all of which (100%) were utilitarian. Badgers are most commonly used for clothing worn on the body and the head; approximately 30% of utilitarian clothing made from badger is worn on the body, and another 30% is worn on the head. The next most common use of badger for utilitarian clothing is for footwear, which makes up approximately 25% of utilitarian clothing use. Around 15% of utilitarian clothing use of badger is winter/heavy clothing, and 33% is fur clothing. Badger pelts do not appear to be used for fur trim.

“Weasel” is the fifth most commonly used animal for utilitarian clothing in Mustelidae. There were 28 uses of weasel for clothing, 11 of which (40%) were utilitarian. The most common form of utilitarian clothing made from weasel is that worn on the body (just over 50%), followed closely by that worn on the head (just under 50%). There was no mention of weasel being used for winter/heavy clothing, but 75% of the results for utilitarian clothing made from weasel were fur clothing, and 18% were fur trim.

Gulo (wolverine) is the sixth most commonly used animal for utilitarian clothing in Mustelidae, with 11 uses for clothing, 9 of which are utilitarian (80%). Almost all of the utilitarian clothing made from wolverine is worn on the body (~90%), and the remaining 10% is worn on the head. Around 45% of utilitarian clothing made from wolverine is identified as winter/heavy clothing, 65% is fur clothing, and 65% is fur trim on clothing. Among the Copper Inuit, wolverine fur is described as an especially useful parka trim because moisture does not condense and freeze on it (Pryde 1972).

2.3.4. Canidae

In the Canidae family, “foxes” and *Canis* (wolves) are used for utilitarian clothing. The majority of clothing made from Canidae is utilitarian (94 out of 129 clothing uses, or 75%).

Foxes are the most commonly used animals for clothing in Canidae, with 81 uses for clothing, 61 of which are utilitarian (75%). Over half of utilitarian clothing made from fox is worn on the body, and clothing worn on the head is the second most common (~30% of utilitarian clothing). Around 10% of utilitarian clothing made from fox is worn on the hands. Clothing made from fox has been described as light and warm, but not durable (Sverdrup 1938). Ohnuki-Tierney (1974) described fox fur as less desirable than dog (*Canis*) fur since it collects snow. Despite this, around 20% of utilitarian clothing made from fox is described as winter/heavy clothing, approximately 65% is fur clothing, and another 15% is in the form of fur trim.

Canis includes dogs, wolves, coyotes, and jackals. In OIS 3 Europe, *Canis* is represented only by wolves. There were 44 uses of wolves for clothing, 31 of which were utilitarian (~70%). The majority of utilitarian clothing made from wolves is worn on the body (over 50%), followed by that worn on the head (~35%). Over 30% of utilitarian clothing made from wolves is winter/heavy clothing, around 50% is fur clothing, and about 25% is in the form of fur trim.

2.3.5. Leporidae

In the leporid family, “rabbits” and “hares” are used for utilitarian clothing. The majority of clothing made from Leporidae is utilitarian (88 out of 102 clothing uses, or 85%).

Rabbits are the most commonly used animals for clothing in Leporidae, with 75 clothing uses, 62 of which were utilitarian (85%). The majority of utilitarian clothing made from rabbits is worn on the body (~85%), followed by that worn on the feet (10%). Among the Ojibwa, rabbit skins are considered low value and inferior to large game (Bishop 1974). However, rabbits are frequently used for cold weather clothing; approximately 30% of clothing made from rabbit is described as winter/heavy clothing.

Around 25% of utilitarian clothing made from rabbit is fur clothing, and about 2% is in the form of fur trim.

The term “hare” returned 27 instances of clothing use, 26 of which were utilitarian. Almost all use of hare for clothing is thus utilitarian. The majority of utilitarian clothing made from hares is worn on the body (40%), followed by that worn on the feet, especially in the form of stockings (30% of utilitarian clothing, all except one of which is some sort of stocking). Around 25% of the use of hare for utilitarian clothing is in the form of a hood or hat. Winter wear makes up about 20% of utilitarian clothing made from hare. Just over 40% of utilitarian clothing made from hare is fur clothing, and 8% is fur trim on clothing.

2.3.6. Ursidae

The one (and only) genus in the ursid family that is used for utilitarian clothing is *Ursus* (undifferentiated bears, and brown/grizzly bears). Approximately 60% of the use of bears for clothing is utilitarian (61 out of 98 clothing uses). The majority of utilitarian clothing made from bear is worn on the body (70%), followed by that worn on the head (20%) and feet (15%). It is notable that bear hide is described as durable (e.g. Heckewelder 1819). Among the Pomo, Kennedy (1955) writes that bear hide is preferred for bedding. One interesting use of bears is for waterproof rain gear, including jackets made of bear intestines, waterproof skins worn over the shoulders, and bear-skin mittens that are waterproof due to the oil in bear pelts (De Laguna 1972; Birket-Smith 1953; Jenness 1946; Swan 1870). About 25% of utilitarian clothing made from bears is described as winter/heavy clothing, 25% is fur clothing, and only 1% is fur trim.

2.3.7. Sciuridae

In order from most to least, the taxa that are used for utilitarian clothing in the Sciuridae family are “squirrel”, *Marmota* (marmots and woodchucks), and *Spermophilus* (ground squirrels). The majority of clothing made from Sciuridae is utilitarian (54 out of 61 clothing uses, or 90%).

“Squirrels” are the most commonly used animals for utilitarian clothing in Sciuridae, with 26 clothing uses, 24 of which are utilitarian (90%). The most common

utilitarian clothing use for squirrel is squirrel-tail boas or fur scarves (~35%). The next most common uses of squirrel for utilitarian clothing are clothing worn on the head (~30%) and the body (~25%). Around 20% of utilitarian clothing made from squirrel is described as winter or heavy clothing, 65% is fur clothing, and 25% is fur trim.

Marmota (marmots and woodchucks) is the second most commonly used taxon for clothing in Sciuridae family. The majority (almost 85%) of use of marmots for clothing is utilitarian (21 out of 25 uses). Most utilitarian clothing made from marmot is worn on the body (60%), followed by that worn on the head (25%). Around 20% of utilitarian clothing made from marmot is winter/heavy clothing, 30% is fur clothing, and 30% is in the form of fur trim on clothing. In four cases it was specified that marmots are a preferred skin for clothing (~20%).

Spermophilus (ground squirrel) is the third most commonly used taxon for utilitarian clothing in Sciuridae. Almost all clothing made from ground squirrel is utilitarian (nine out of ten clothing uses, or 90%). The vast majority of utilitarian clothing made from ground squirrel is worn on the body (~90%), followed by that worn on the head (~10%). Both the Alutiiq and the Tlingit identify ground squirrel as the finest fur, and as highly valued (e.g. Birket-Smith 1941; De Laguna 1972). Among the Alutiiq of Kodiak Island, hunting parties would make expeditions to neighbouring islands to hunt ground squirrels for fur clothing (Clark 1974). Although no clothing made from ground squirrel was specifically described as winter wear, it is clear that ground squirrel fur is prized by groups in Alaska. Around 35% of utilitarian clothing made from ground squirrel is fur clothing, but there are no examples of the use of ground squirrel for fur trim.

2.3.8. *Castoridae*

The single genus of Castoridae, *Castor* (beaver), is used primarily for utilitarian clothing (40 out of 51 clothing uses, or 80%). The majority of utilitarian clothing made from beaver is worn on the body (~55%), followed by that worn on the head (~30%). Around 20% of utilitarian clothing made from beaver is described as winter/heavy clothing, 35% as fur clothing, and 5% as fur trim on clothing.

2.3.9. Felidae

The only taxon within Felidae that is used for (at least 1% of) utilitarian clothing is *Felis* (wild cats and lynxes). There were 41 hits for the use of Felidae for clothing, only 19 of which were utilitarian (~45%). The majority of clothing made from Felidae is thus non-utilitarian. There were 23 clothing uses of lynx, 14 of which were utilitarian (~60%). Around 80% of utilitarian clothing made from lynx is worn on the body, and 20% is worn on the head. Of utilitarian clothing made from lynx, about 35% is winter/heavy clothing, 55% is fur clothing, and 15% is fur trim on clothing.

2.3.10. Equidae

The single genus of Equidae, *Equus*, is used for utilitarian clothing. Of the 21 clothing uses of *Equus* (horse), 13 were utilitarian (~60%). The majority (65%) of clothing made from horse is footwear. Approximately 15 to 20% of clothing made from horse is head and body wear made from horsehair. Horses were never described as being used for winter/heavy clothing, fur clothing, or fur trim on clothing.

2.4. Implications for identifying clothing use in the OIS 3 archaeological record

The families whose remains may be evidence of utilitarian and thermally effective, cold weather clothing are summarized in Table 2.10.

Table 2.10 Families whose remains may be evidence of utilitarian and cold weather clothing in the archaeological record

| Family | % Clo | Family | % W/H | Family | % Fur | Family | % Trim |
|------------|-------|------------|-------|------------|-------|------------|--------|
| Cervidae | 33 | Cervidae | 32.4 | Mustelidae | 25.8 | Mustelidae | 39.2 |
| Bovidae | 21.3 | Bovidae | 16.4 | Cervidae | 21.1 | Canidae | 24.3 |
| Mustelidae | 13.7 | Mustelidae | 14.3 | Canidae | 17.3 | Sciuridae | 17.6 |
| Canidae | 8.2 | Leporidae | 10.1 | Sciuridae | 8.2 | Cervidae | 8.1 |
| Leporidae | 7.6 | Canidae | 10.1 | Leporidae | 8.2 | Leporidae | 4.1 |
| Ursidae | 5.3 | Castoridae | 5.9 | Bovidae | 7.5 | Castoridae | 2.7 |
| Sciuridae | 4.7 | Sciuridae | 4.2 | Ursidae | 5 | Felidae | 2.7 |
| Castoridae | 3.6 | Ursidae | 4.2 | Castoridae | 4.4 | Ursidae | 1.4 |
| Felidae | 1.2 | Felidae | 2.1 | Felidae | 2.5 | | |
| Equidae | 1.1 | | | | | | |

The genera whose remains may be evidence of utilitarian and thermally effective, cold weather clothing in the archaeological record are summarized in Table 2.11.

Table 2.11 Genera whose remains may be evidence of utilitarian and cold weather clothing in the archaeological record

| Genus | % Clo | Genus | % W/H | Genus | % Fur | Genus | % Trim |
|---------------------|-------|-----------------|-------|---------------------|-------|-----------------|--------|
| <i>Rangifer</i> | 27.0 | <i>Rangifer</i> | 28 | <i>Rangifer</i> | 27.1 | <i>Canis</i> | 19.0 |
| <i>Bison</i> | 13.8 | <i>Bison</i> | 16 | <i>Mustela</i> | 10.2 | <i>Mustela</i> | 16.7 |
| <i>Ursus</i> | 10.0 | <i>Ursus</i> | 9.3 | <i>Ursus</i> | 9.6 | <i>Marmota</i> | 16.7 |
| <i>Alces</i> | 9.0 | <i>Alces</i> | 8.7 | <i>Canis</i> | 9.6 | <i>Gulo</i> | 14.3 |
| <i>Castor</i> | 6.7 | <i>Canis</i> | 8.0 | <i>Castor</i> | 8.4 | <i>Rangifer</i> | 9.5 |
| <i>Cervus</i> | 6.6 | <i>Castor</i> | 6.7 | <i>Bison</i> | 7.8 | <i>Martes</i> | 9.5 |
| <i>Canis</i> | 5.1 | <i>Martes</i> | 4.7 | <i>Martes</i> | 6.6 | <i>Castor</i> | 4.8 |
| <i>Martes</i> | 3.9 | <i>Cervus</i> | 4.0 | <i>Felis</i> | 4.8 | <i>Felis</i> | 4.8 |
| <i>Mustela</i> | 3.8 | <i>Felis</i> | 3.3 | <i>Marmota</i> | 4.2 | <i>Ursus</i> | 2.4 |
| <i>Bos</i> | 3.4 | <i>Mustela</i> | 2.7 | <i>Gulo</i> | 3.6 | <i>Alces</i> | 2.4 |
| <i>Marmota</i> | 3.4 | <i>Gulo</i> | 2.7 | <i>Alces</i> | 3.0 | | |
| <i>Felis</i> | 2.3 | <i>Marmota</i> | 2.7 | <i>Cervus</i> | 2.4 | | |
| <i>Equus</i> | 2.1 | | | <i>Spermophilus</i> | 1.8 | | |
| <i>Gulo</i> | 1.5 | | | | | | |
| <i>Spermophilus</i> | 1.4 | | | | | | |

To recapitulate, Cervidae is the most commonly used family for utilitarian and winter/heavy clothing. *Rangifer* (reindeer/caribou), “deer”, and *Alces* (moose/elk) contribute most to the ranking of Cervidae for these clothing types. Caribou and deer are the first and second most frequently used fauna for utilitarian clothing, respectively. It is notable that caribou are also the most frequently used fauna for winter/heavy clothing, and for fur clothing. Caribou pelts have been identified as offering superior insulation in Arctic environments (e.g. Oakes et al. 1995), and the above results confirm the predominance of caribou for cold weather clothing among recent mid-to-high latitude non-industrial groups. So, it seems that Cervidae remains in general are potentially a good indication of utilitarian and winter/heavy clothing in the archaeological record. Moreover, *Rangifer* remains are potentially a good indication of cold weather clothing in the archaeological record.

Bovidae is the second most commonly used family for utilitarian and winter/heavy clothing. From the bovid family, *Bison* (bison) and “sheep” contribute the most to high ranking of Bovidae for utilitarian and winter/heavy clothing. Bison are also used for fur clothing, and are responsible for the ranking of Bovidae as the sixth most commonly used family for fur clothing. It should be noted that only about half of the uses of sheep for clothing were made from hide; the other half of the uses were made from wool, which implies the use of weaving technology. In addition, approximately two thirds of the uses of goats for clothing were made from hide; the other one third of the uses were made from wool. However, Bovidae retained its rank as the second most commonly used family for utilitarian and winter/heavy clothing even when results for wool clothing were removed. So, it seems that Bovidae remains, and particularly *Bison* and “sheep” remains, are a good indication of utilitarian and winter/heavy hide clothing in the archaeological record. *Bison* remains may also be interpreted as evidence of fur clothing, though not the most compelling.

Mustelidae is the third most commonly used family for utilitarian and winter/heavy clothing, and the second most commonly used family for fur clothing and fur trim. The use of “otter” for clothing contributed most to the ranking of Mustelidae for all clothing types. Otters are among the most frequently used fauna for all types of cold weather clothing, and are tied with foxes as the most frequently used fauna for fur trim. *Mustela* (minks, weasels and stoats/ermine) also contributed to the ranking of Mustelidae for fur clothing and fur trim. In addition, *Gulo* (wolverines) are highly ranked for use for fur trim. So, it would seem that the Mustelidae family, and particularly otters and *Mustela*, are a good indication of utilitarian clothing, and especially cold weather clothing in the archaeological record. In addition, the remains of *Mustela* and *Gulo* are a potentially good indicator of fur trim in the archaeological record.

Canidae is the second most frequently used family for fur clothing and fur trim, and the fourth most frequently used for utilitarian and winter/heavy clothing. “Foxes” and *Canis* (wolves) contribute most to the ranking of Canidae for all types of clothing. Foxes and wolves have been identified as particularly useful for fur trim in Arctic environments, and the results of this analysis confirm that foxes and wolves are used consistently for fur and fur trim among mid-to-high latitude non-industrial groups. Foxes are one of the most frequently used animals for fur trim, and the second most frequently used for fur.

So, it seems that the remains of Canidae are a potentially good indicator of utilitarian and winter/heavy clothing in the archaeological record, and fox and *Canis* remains are a good indicator of fur clothing and fur trim in the archaeological record.

Leporidae is the fourth most commonly used family for winter/heavy clothing, and the fifth most commonly used family for utilitarian clothing and fur clothing. “Rabbits” contribute most to the ranking of Leporidae for all clothing types except fur trim. Rabbits and “hares” equally contribute to the ranking of Leporidae as the fifth most commonly used family for fur trim. Rabbit furs have been identified as particularly effective for protection from wind due to their density (Cena and Clark 1978), and the results of this analysis confirm that rabbits are frequently used for fur clothing among mid-to-high latitude non-industrial groups. Leporidae remains, and especially rabbit remains, are thus a good indication of utilitarian clothing, winter/heavy clothing, and fur clothing, in the archaeological record. Leporidae remains may also be indicative of fur trim in the archaeological record.

Ursidae is one of the least-used families for utilitarian clothing, heavy/winter clothing, and fur clothing, and the least frequently used family for fur trim. *Ursus* (bears), the sole genus of Ursidae included in this study, is responsible for the ranking of Ursidae for all clothing use. At the genus level, *Ursus* is very highly ranked (third) for all kinds of clothing except fur trim, but this ranking is deceptive because a number of more frequently used fauna such as foxes, otters, squirrels, deer, and rabbits, are not distinguishable at the genus level. So, the ranking of Ursidae as one of the lesser-used families for all clothing types is probably more accurate. The above results suggest that the remains of *Ursus* in the archaeological record may be interpreted as evidence of utilitarian and cold weather clothing, though perhaps not the most compelling.

Sciuridae is the third most frequently used family for fur trim, the fourth most frequently used for fur clothing, and the seventh most frequently used for utilitarian and winter/heavy clothing. “Squirrels”, and *Marmota* (marmots) contribute most to the ranking of Sciuridae for all clothing types. Squirrel tails in particular are frequently used for fur boas or scarves, and all of the results for the use of marmots for fur clothing were in the form of fur trim. So, although Sciuridae remains may not be the best indication of

utilitarian or winter/heavy clothing overall, it seems that their remains in the archaeological record are a potential indication of fur clothing and fur trim.

Castoridae is the sixth most commonly used family for winter/heavy clothing and fur trim, and the eighth most commonly used family for utilitarian clothing and fur clothing. As *Castor* (beaver) is the only genus of the Castoridae family, it is solely responsible for the ranking of Castoridae for clothing use. So, the remains of beavers in the archaeological record may be an indication of winter/heavy clothing and fur trim. In addition, beaver remains may be interpreted as evidence for utilitarian clothing in general, and fur clothing. However, beaver remains are not the most compelling evidence of any of the above clothing types.

Felidae is the least frequently used family for winter/heavy clothing and fur clothing, and the second least frequently used for utilitarian clothing overall, and fur trim. *Felis* (lynx and wild cat) contributes the most to the ranking of Felidae for clothing use. So, the remains of lynxes and wild cats in the archaeological record may be interpreted as evidence of utilitarian and cold weather clothing, but not the most compelling evidence when compared with the taxa listed above.

Equidae is the least frequently used family for utilitarian clothing. *Equus* (horse) is the sole representative of the Equidae family that is used for clothing. There were no records of horses being used for cold weather clothing. So, it seems that *Equus* remains in the archaeological record may be indicative of utilitarian clothing, however they do not make as compelling evidence as the taxa listed above. *Equus* remains should not be interpreted as evidence of cold weather clothing in the archaeological record.

3. Analysis of Stage 3 faunal database

This chapter describes the second set of analyses. In these analyses, I used the results of the previous chapter to test two hypotheses. The first hypothesis is that early modern humans exploited animal taxa that are used for utilitarian clothing significantly more frequently than Neanderthals. The second hypothesis is that modern humans exploited animal taxa that are used for highly insulative cold weather clothing significantly more frequently than Neanderthals. I evaluated these hypotheses by testing for significant differences in the frequencies of the families and genera that were identified in the previous chapter as evidence for utilitarian and cold weather clothing between late Middle Palaeolithic (LMP) and early Upper Palaeolithic (EUP) strata, and between Mousterian and Aurignacian strata. The test for significant differences in the frequencies of the above taxa between Mousterian and Aurignacian strata was used as a control for the potential change in availability of taxa over time. Since the Mousterian and Aurignacian partially overlapped in time and space (van Andel et al. 2003), hominins associated with the Mousterian and Aurignacian industries should theoretically have had access to similar mammalian taxa. If the remains of animal taxa that are used for utilitarian clothing were significantly more frequent in modern human occupations than in Neanderthal occupations, it would imply that modern humans made clothing more frequently than Neanderthals did. Likewise, if the remains of taxa that are used for cold weather clothing were significantly more frequent in modern human occupations than in Neanderthal occupations, it would imply that modern humans made highly insulative, cold weather clothing more frequently than Neanderthals did.

The first section of this chapter describes the parameters of the data that were included in the statistical analyses. Subsequently, I discuss the statistical test I employed. Lastly, I describe the results of the statistical analyses, and discuss what the results may mean in terms of any differences in the exploitation of mammalian taxa between Neanderthals and modern humans.

3.1. Materials and methods

3.1.1. *Data*

This set of analyses also makes use of the Stage 3 Project faunal database. Since the goal of this study is to find general trends rather than regional anomalies, I elected to focus this set of analyses on the major technological industries within the Stage 3 Project faunal database that were made by Neanderthals and modern humans between 60 and 20 kcal BP. I omitted the so-called “transitional” industries such as the Châtelperronian and the Uluzzian to simplify the analysis, to avoid any question of the makers of the industries, and to ensure an adequate sample size for each industry. The major industries that were included in this study are the Mousterian, the Aurignacian, and the Gravettian. The other major industries of the Upper Palaeolithic – the Solutrean and the Magdalenian – first appear only around/after approximately 20 kcal BP. This means that the Solutrean and the Magdalenian are outside of the parameters of this study (60-20 kcal BP), and were omitted from the analysis.

It is important to note that in this chapter, “late Middle Palaeolithic” refers to the Middle Palaeolithic after 60 kcal BP, and “early Upper Palaeolithic” refers to Upper Palaeolithic industries before 20 kcal BP. Furthermore, in line with the current consensus (e.g. Cartmill and Smith 2009; van Andel et al. 2003), LMP and Mousterian industries are assumed to have been made by the Neanderthals, and the EUP and Aurignacian industries by early modern humans.

After eliminating strata that are not associated with “Middle Palaeolithic”, “Mousterian”, “Upper Palaeolithic”, “Aurignacian”, or “Gravettian” industries, as well as any strata that do not date from 60-20 kcal BP, and strata that did not contain faunal remains, I was left with a total of 636 strata. One-hundred-and-thirty-one of these strata are attributed to the LMP, and 505 of them are attributed to the EUP. One hundred and twenty-four of the LMP strata are attributed to the Mousterian. The remaining seven are labelled only as “Middle Palaeolithic” in the Stage 3 faunal database. Two hundred and fifty-five of the EUP strata are attributed to the Aurignacian, and 247 are attributed to the Gravettian. The remaining three strata are labelled only as “Upper Palaeolithic”.

The present analyses were only concerned with taxa belonging to the families and genera that were identified in the previous chapter as being used for utilitarian and cold weather clothing. The families in question are: Cervidae, Bovidae, Mustelidae, Canidae, Leporidae, Ursidae, Sciuridae, Castoridae, Felidae, and Equidae. Cervids that are represented in the faunal database are: *Alces alces* (elk/moose), *Cervus elaphus* (red deer/elk/wapiti), *Rangifer tarandus* (reindeer/caribou), *Dama dama* (fallow deer), *Capreolus capreolus* (roe deer), and *Megaloceros sp./M. giganteus* (giant deer).

Bovids that are represented in the faunal database are: *Bos primigenius* (aurochs), *Bos sp.* (cattle/cow, kouprey, banteng, gaur, seladang, yak, and aurochs), *Bison sp./B. priscus* (bison/wisent), *Capra sp.* (undifferentiated goats, tur, markhor, and ibex), *Capra ibex* (ibex), *Capra pyrenaica* (Spanish ibex), *Ovis sp.* (undifferentiated sheep, mouflon, urial, and argali), *Ovibos moschatus* (musk ox), and *Saiga tartarica* (Saiga antelope).

Mustelids that are represented in the faunal database are: *Meles meles* (badgers), *Mustela minuta* (least weasels), *Mustela erminea* (stoats/ermine), *Mustela nivalis* (weasels), *Mustela sp.* (undifferentiated stoats/ermine, mink, ferrets, polecats), *Mustela putorius* (polecats), *Mustela putorius robusta/M. evermanni* (large/steppe polecats), *Martes sp.* (marten, fisher and sable), *Gulo gulo* (wolverine), and *Lutra lutra* (Old World river otters).

Canids that are represented in the faunal database are: *Canis lupus* (gray wolves), *Cuon sp.* (dholes), *Vulpes vulpes* (red foxes), *Vulpes corsac* (Corsac foxes), and *Alopex lagopus* (Arctic foxes).

Leporids that are represented in the faunal database are: *Oryctolagus cuniculus* (Old World and domestic rabbits), *Lepus sp.* (hares, snowshoe rabbits and jack rabbits), *Lepus europaeus/capensis* (brown hare), *Lepus timidus* (mountain hare), and *Lepus tolai* (Tolai hare).

Members of Ursidae that are represented in the faunal database are: *Ursus arctos* (brown/grizzly bear), *Ursus spelaea* (cave bears), and *Ursus sp.* (undifferentiated bears).

Members of Sciuridae that are represented in the faunal database are: *Pteromys* sp. (flying squirrels), *Marmota primigenia* (extinct marmot), *Marmota bobak* (Bobak marmot), *Marmota marmota* (alpine marmot), *Marmota* sp. (undifferentiated marmots, woodchucks, and groundhogs), *Spermophilus* sp. (ground squirrels and susliks), and *Sciurus vulgaris* (red squirrel).

The single species of Castoridae that is represented in the faunal database is *Castor fiber* (beaver).

Felids that are represented in the faunal database are: *Panthera leo* (lion), *Panthera spelaea* (cave lion), *Panthera pardus* (leopard), *Panthera* sp. (undifferentiated leopards, tigers, and jaguars), *Felis sylvestris* (wild cat), *Felis lynx* (lynx), *Felis pardina* (Pardel/Spanish lynx), and *Felis* sp. (undifferentiated lynxes).

Equids that are represented in the faunal database are: *Equus hydruntinus* (steppe ass), *E. hemionus* (hemione, kulan, and onager), *Equus* sp. (horses, African wild asses, donkeys, burros, kiangs, undifferentiated zebras, and quaggas), *E. asinus* (ass), *E. latipes* (extinct horse), and *E. caballus* (wild horse/horse).

The genera that were included in the present analyses are: *Rangifer*, *Bison*, *Ursus*, *Alces*, *Castor*, *Cervus*, *Canis*, *Martes*, *Mustela*, *Bos*, *Marmota*, *Felis*, *Equus*, *Gulo*, and *Spermophilus*. Members of these genera that are represented in the Stage 3 Project faunal database have been listed above.

3.2. Analyses

I performed a series of chi-squared tests to determine if the differences between the expected and the actual frequencies of taxa used for clothing in Neanderthal vs. modern human strata were statistically significant. The chi-squared test is used to determine if the frequencies of discrete, categorical data are significantly different from one another (Madrigal 1998). Specifically, the chi-squared test determines if the observed frequencies of events depart significantly from frequencies proposed by the null hypothesis. The null hypothesis is generated based on the expectation that the frequencies of observations in all outcomes are the same. If the chi squared value (χ^2) is

greater than or equal to a critical value, then the differences in frequency between categories are deemed significant. The chi-squared test assumes random sampling and that expected values be at least five (Madrigal 1998). The chi-squared formula is as follows:

$$X^2 = \sum \frac{(o - e)^2}{e}$$

where o is the observed value, and e is the expected value.

In the present study, the chi-squared tests assessed the likelihood that differences in the frequencies of taxa that are used for clothing between LMP versus EUP and Mousterian versus Aurignacian strata are due to chance rather than a real difference. The null hypothesis was that the taxa used for clothing are equally distributed among LMP versus EUP and Mousterian versus Aurignacian strata:

$$H_0: P_1 = P_2$$

where P1 is the frequency of (e.g. Cervidae) remains in (e.g. Middle Palaeolithic) strata, and P2 is frequency of (e.g. Cervidae) remains in (e.g. Upper Palaeolithic) strata.

The variables used in the tests were the presence or absence of fauna that are used for clothing in each stratum, and the technological industry (LMP or EUP; Mousterian or Aurignacian) associated with the stratum. Since there are two variables, there is one degree of freedom in the analyses.

$$df = n - 1$$

where df is degrees of freedom, and n is the number of variables.

In chi-squared tests where the expected value is less than five and there is one degree of freedom, a Yates' continuity correction should be applied (Madrigal 1998). In the analyses reported here, none of the expected values were less than five, but several expected values were between five and six. In these cases only, a Yates' continuity correction was employed as a conservative estimate of the significance of differences in

frequencies. This correction involved subtracting a value of 0.5 from the absolute value of the numerator contribution of each cell in the chi-squared formula, to become:

$$\chi^2 = \sum \frac{(| \text{Observed frequency} - \text{Expected frequency} | - 0.5)^2}{\text{Expected frequency}}$$

If the p value returned by a chi-squared test is less than 0.05, there is a high chance that the difference in frequencies is real, and not due to chance or sampling error. So, in cases where the p value was less than 0.05, I rejected the null hypothesis that the difference in frequencies of faunal remains between the two industry types was due to chance or sampling error, and concluded that the difference in the frequency of faunal remains was real, that is, statistically significant. If the p value was greater than 0.05, I accepted the null hypothesis that any difference in the frequencies of faunal remains between the two industry types was due to chance or sampling error.

The first step of the statistical analyses was to define variables within the Stage 3 Project faunal database for each of the families and genera that are used for clothing, and for each industry. For the presence/absence of a taxon, I assigned a value of 0 for absence and 1 for presence. For LMP vs. EUP comparisons, I assigned a value of 0 for the LMP and 1 for the EUP. For Mousterian vs. Aurignacian comparisons, I assigned a value of 0 for Mousterian and 1 for Aurignacian. For example, if at least one member of the Cervidae family was present in a stratum attributed to the Aurignacian, the variable for the Cervidae family would be 1 and the variable for the Aurignacian would be 1.

I performed a series of chi-squared tests for significant differences in the frequencies of the families and genera used for each type of clothing, in the LMP versus EUP, and Mousterian versus Aurignacian. I tested for significant differences in the frequencies of the following:

1. Families used for utilitarian clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
2. Genera used for utilitarian clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian

3. Families used for winter/heavy clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
4. Genera used for winter/heavy clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
5. Families used for fur clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
6. Genera used for fur clothing
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
7. Families used for fur trim
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian
8. Genera used for fur trim
 - a. LMP versus EUP
 - b. Mousterian versus Aurignacian

In the results that follow, if the remains of animal taxa that are used for utilitarian clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made clothing more frequently than Neanderthals. Likewise, if the remains of taxa that are used for each type of cold weather clothing were significantly more frequent in modern human than Neanderthal occupations, it would imply that modern humans made each type of cold weather clothing more frequently than Neanderthals.

3.3. Utilitarian clothing

3.3.1. *Family level*

3.3.1.1. Late Middle versus early Upper Palaeolithic

The results of the family level statistical analyses of taxa used for utilitarian clothing between the LMP and the EUP are summarized in Table 3.1. Of the 10

taxonomic families used for utilitarian clothing, five (50%) are significantly more frequent in the EUP than the LMP: Cervidae, Mustelidae, Canidae, Leporidae, and Castoridae. None of the families that are used for utilitarian clothing is significantly more frequent in LMP than EUP strata. Of the top five families used for utilitarian clothing, four (80%) are significantly more frequent in the EUP than the LMP. Mustelidae and Leporidae in particular are present in more than twice as many strata in the EUP compared with the LMP.

Table 3.1 *Chi-squared results comparing families used for utilitarian clothing between LMP and EUP strata*

| Family | % Util clo | Significant | p value | EUP>LMP | % LMP strata | % EUP strata |
|------------|------------|-------------|---------|---------|--------------|--------------|
| Cervidae | 33 | Yes | 0.008 | Yes | 87 | 94 |
| Bovidae | 21.3 | | 0.078 | | 92 | 87 |
| Mustelidae | 13.7 | Yes | 0.000 | Yes | 18 | 48 |
| Canidae | 8.2 | Yes | 0.000 | Yes | 56 | 84 |
| Leporidae | 7.6 | Yes | 0.000 | Yes | 26 | 63 |
| Ursidae | 5.3 | | 0.293 | | 58 | 53 |
| Sciuridae | 4.7 | | 0.681 | | 15 | 14 |
| Castoridae | 3.6 | Yes | 0.021 | Yes | 4 | 10 |
| Felidae | 1.2 | | 0.963 | | 43 | 43 |
| Equidae | 1.1 | | 0.160 | | 84 | 89 |

3.3.1.2. Mousterian versus Aurignacian

The results of the family level analyses of taxa used for utilitarian clothing between the Mousterian and the Aurignacian are summarized in Table 3.2. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. However, Castoridae remains, which are significantly more frequent in the EUP than in the LMP, are not significantly more frequent in the Aurignacian than in the Mousterian. Castoridae does not seem to have been exploited frequently in the LMP or the EUP. This suggests that an increased exploitation of Castoridae was a feature of the Gravettian. Conversely, Sciuridae remains are significantly more frequent in the Aurignacian than in the Mousterian, but they are not significantly more frequent in the

EUP than the LMP. This suggests that the higher level of exploitation of Sciuridae in the EUP compared to the LMP was a feature of the Aurignacian but not the Gravettian.

Table 3.2 *Chi-squared results comparing families used for utilitarian clothing between Mousterian and Aurignacian strata*

| Family | % Util clo | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|------------|------------|-------------|---------|----------------|----------------|-----------------|
| Cervidae | 33 | Yes | 0.036 | Yes | 88 | 94 |
| Bovidae | 21.3 | | 0.540 | | 94 | 92 |
| Mustelidae | 13.7 | Yes | 0.000 | Yes | 18 | 45 |
| Canidae | 8.2 | Yes | 0.000 | Yes | 56 | 87 |
| Leporidae | 7.6 | Yes | 0.000 | Yes | 23 | 50 |
| Ursidae | 5.3 | | 0.614 | | 57 | 55 |
| Sciuridae | 4.7 | Yes | 0.006 | Yes | 11 | 23 |
| Castoridae | 3.6 | | 0.766 | | 4 | 5 |
| Felidae | 1.2 | | 0.828 | | 43 | 42 |
| Equidae | 1.1 | | 0.997 | | 86 | 86 |

3.3.2. Genus level

3.3.2.1. Late Middle versus early Upper Palaeolithic

The results of the genus level statistical analyses of taxa used for utilitarian clothing between the LMP and the EUP are summarized in Table 3.3. Of the 15 genera used for utilitarian clothing, five (33%) are significantly more frequent in the EUP than in the LMP: *Rangifer*, *Castor*, *Canis*, *Mustela*, and *Gulo*. Interestingly, *Gulo* jumps from almost no presence in LMP strata (2%) to a presence in 29% of EUP strata. The frequency of *Rangifer* and *Mustela* doubles from the LMP to the EUP. *Bison*, *Cervus* and *Bos* are significantly more frequent in LMP than EUP strata, and the remaining seven genera are not significantly different in their frequencies in LMP versus EUP strata. *Alces* and *Spermophilus* do not seem to have been exploited frequently by either LMP or EUP hominins.

Table 3.3 *Chi-squared results comparing genera used for utilitarian clothing between LMP and EUP strata*

| Genus | % Util clo | Significant | p value | EUP>LMP | % LMP strata | % EUP strata |
|---------------------|------------|-------------|---------|---------|--------------|--------------|
| <i>Rangifer</i> | 27 | Yes | .000 | Yes | 44 | 78 |
| <i>Bison</i> | 13.8 | Yes | .000 | No | 18 | 7 |
| <i>Ursus</i> | 10.0 | | .293 | | 58 | 53 |
| <i>Alces</i> * | 9.0 | | .358 | | 2 | 5 |
| <i>Castor</i> | 6.7 | Yes | .021 | Yes | 4 | 10 |
| <i>Cervus</i> | 6.6 | Yes | .000 | No | 71 | 54 |
| <i>Canis</i> | 5.1 | Yes | .000 | Yes | 49 | 68 |
| <i>Martes</i> | 3.9 | | .859 | | 6 | 7 |
| <i>Mustela</i> | 3.8 | Yes | .000 | | 8 | 22 |
| <i>Bos</i> | 3.4 | Yes | .000 | No | 46 | 23 |
| <i>Marmota</i> | 3.4 | | .105 | | 11 | 7 |
| <i>Felis</i> | 2.3 | | .303 | | 27 | 23 |
| <i>Equus</i> | 2.1 | | .160 | | 84 | 89 |
| <i>Gulo</i> | 1.5 | Yes | .000 | Yes | 2 | 29 |
| <i>Spermophilus</i> | 1.4 | | .450 | | 5 | 6 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.3.2.2. Mousterian versus Aurignacian

The results of the genus level analyses of taxa used for utilitarian clothing between the Mousterian and the Aurignacian are summarized in Table 3.4. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. *Gulo* is completely absent in the Mousterian, but is present in 22% of Aurignacian strata. *Mustela* and *Spermophilus* are present in thrice as many strata in the Aurignacian compared with the Mousterian. In contrast with the LMP versus EUP results, the difference in frequency of *Castor* remains between the Mousterian and Aurignacian is not significant. Conversely, *Spermophilus* is exploited significantly more frequently in the Aurignacian than in the Mousterian. This suggests that an increase in the exploitation of *Castor* was a feature of the Gravettian but not the Aurignacian. Furthermore, an increased exploitation of *Spermophilus* seems to have been a feature of

the Aurignacian, but not the Gravettian. *Alces* and *Castor* do not seem to have been exploited frequently by either Mousterian or Aurignacian hominins.

Table 3.4 *Chi-squared results comparing genera used for utilitarian clothing between Mousterian and Aurignacian strata*

| Genus | % Util clo | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|---------------------|------------|-------------|---------|----------------|----------------|-----------------|
| <i>Rangifer</i> | 27 | Yes | 0.000 | Yes | 44 | 71 |
| <i>Bison</i> | 14 | Yes | 0.002 | No | 19 | 8 |
| <i>Ursus</i> | 10 | | 0.614 | | 57 | 55 |
| <i>Alces</i> * | 9 | | 0.219 | | 2 | 6 |
| <i>Castor</i> * | 7 | | 0.974 | | 4 | 5 |
| <i>Cervus</i> | 7 | Yes | 0.001 | No | 71 | 54 |
| <i>Canis</i> | 5 | Yes | 0.001 | Yes | 48 | 65 |
| <i>Martes</i> | 4 | | 0.056 | | 6 | 13 |
| <i>Mustela</i> | 4 | Yes | 0.000 | Yes | 8 | 27 |
| <i>Bos</i> | 3 | Yes | 0.000 | No | 48 | 21 |
| <i>Marmota</i> | 3 | | 0.437 | | 8 | 11 |
| <i>Felis</i> | 2 | | 0.086 | | 27 | 20 |
| <i>Equus</i> | 2 | | 0.997 | | 86 | 86 |
| <i>Gulo</i> | 2 | Yes | 0.000 | Yes | 0 | 22 |
| <i>Spermophilus</i> | 1 | Yes | 0.014 | Yes | 3 | 11 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.4. Winter/Heavy clothing

3.4.1. Family level

3.4.1.1. Late Middle versus early Upper Palaeolithic

The results of the family level statistical analyses of taxa used for winter/heavy clothing between the LMP and the EUP are summarized in Table 3.5. Five of the nine families (56%) that are used for winter/heavy clothing are significantly more frequent in

EUP strata: Cervidae, Mustelidae, Leporidae, Canidae, and Castoridae. None of the families used for heavy/winter clothing is significantly more frequent in LMP than EUP strata. Of the top six families used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups, five (~83%) are significantly more frequent in the EUP than the LMP.

Table 3.5 *Chi-squared results comparing families used for winter/heavy clothing between LMP and EUP strata*

| Family | % W/H | Significant | p value | EUP > LMP | % LMP strata | % EUP strata |
|------------|-------|-------------|---------|-----------|--------------|--------------|
| Cervidae | 32.4 | Yes | 0.008 | Yes | 87 | 94 |
| Bovidae | 16.4 | | 0.078 | | 92 | 87 |
| Mustelidae | 14.3 | Yes | 0.000 | Yes | 18 | 48 |
| Leporidae | 10.1 | Yes | 0.000 | Yes | 26 | 63 |
| Canidae | 10.1 | Yes | 0.000 | Yes | 56 | 84 |
| Castoridae | 5.9 | Yes | 0.021 | Yes | 4 | 10 |
| Sciuridae | 4.2 | | 0.681 | | 15 | 14 |
| Ursidae | 4.2 | | 0.293 | | 58 | 53 |
| Felidae | 2.1 | | 0.963 | | 43 | 43 |

3.4.1.2. Mousterian versus Aurignacian

The results of the family level analyses of taxa used for winter/heavy clothing between the Mousterian and the Aurignacian are summarized in Table 3.6. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The main difference is that Sciuridae, and not Castoridae, is significantly more frequent in Aurignacian strata than in Mousterian strata. Castoridae does not seem to be exploited frequently by Mousterian or Aurignacian hominins. So, of the top five families used for utilitarian clothing by recent mid-to-high latitude non-industrial groups, four (80%) are significantly more frequent in the Aurignacian than the Mousterian.

Table 3.6 *Chi-squared results comparing families used for winter/heavy clothing between Mousterian and Aurignacian strata*

| Family | % W/H | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|------------|-------|-------------|---------|----------------|----------------|-----------------|
| Cervidae | 32.4 | Yes | 0.036 | Yes | 88 | 94 |
| Bovidae | 16.4 | | 0.540 | | 94 | 92 |
| Mustelidae | 14.3 | Yes | 0.000 | Yes | 18 | 45 |
| Leporidae | 10.1 | Yes | 0.000 | Yes | 23 | 50 |
| Canidae | 10.1 | Yes | 0.000 | Yes | 56 | 87 |
| Castoridae | 5.9 | | 0.766 | | 4 | 5 |
| Sciuridae | 4.2 | Yes | 0.006 | Yes | 11 | 23 |
| Ursidae | 4.2 | | 0.614 | | 57 | 55 |
| Felidae | 2.1 | | 0.828 | | 43 | 42 |

3.4.2. Genus level

3.4.2.1. Late Middle versus early Upper Palaeolithic

The results of the genus level statistical analyses of taxa used for winter/heavy clothing between the LMP and the EUP are summarized in Table 3.7. Of the 12 genera used for winter/heavy clothing, five (42%) are significantly more frequent in the EUP than in the LMP: *Rangifer*, *Canis*, *Castor*, *Mustela*, and *Gulo*. Two genera (17%; *Bison* and *Cervus*) are significantly more frequent in LMP than EUP strata. The frequencies of the remaining five genera are not significantly different in LMP versus EUP strata. *Alces* does not seem to be exploited frequently by either LMP or EUP hominins.

Table 3.7 *Chi-squared results comparing genera used for winter/heavy clothing between LMP and EUP strata*

| Genus | % W/H | Significant | p value | EUP>LMP | % LMP strata | % EUP strata |
|-----------------|-------|-------------|---------|---------|--------------|--------------|
| <i>Rangifer</i> | 28 | Yes | 0.000 | Yes | 44 | 78 |
| <i>Bison</i> | 16 | Yes | 0.000 | No | 18 | 7 |
| <i>Ursus</i> | 9.3 | | 0.293 | | 58 | 53 |
| <i>Alces</i> * | 8.7 | | 0.358 | | 2 | 5 |
| <i>Canis</i> | 8 | Yes | 0.000 | Yes | 49 | 68 |
| <i>Castor</i> | 6.7 | Yes | 0.021 | Yes | 4 | 10 |
| <i>Martes</i> | 4.7 | | 0.859 | | 6 | 7 |
| <i>Cervus</i> | 4 | Yes | 0.000 | No | 71 | 54 |
| <i>Felis</i> | 3.3 | | 0.303 | | 27 | 23 |
| <i>Mustela</i> | 2.7 | Yes | 0.000 | Yes | 8 | 22 |
| <i>Gulo</i> | 2.7 | Yes | 0.000 | Yes | 2 | 29 |
| <i>Marmota</i> | 2.7 | | 0.105 | | 11 | 7 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.4.2.2. Mousterian versus Aurignacian

The results of the genus level analyses of taxa used for winter/heavy clothing between the Mousterian and the Aurignacian are summarized in Table 3.8. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The main difference is that *Castor* is not significantly more frequent in the Aurignacian than in the Mousterian.

Table 3.8 *Chi-squared results comparing genera used for winter/heavy clothing between Mousterian and Aurignacian strata*

| Genus | % W/H | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|-----------------|-------|-------------|---------|----------------|----------------|-----------------|
| <i>Rangifer</i> | 28 | Yes | 0.000 | Yes | 44 | 71 |
| <i>Bison</i> | 16 | Yes | 0.002 | No | 19 | 8 |
| <i>Ursus</i> | 9.3 | | 0.614 | | 57 | 55 |
| <i>Alces</i> * | 8.7 | | 0.219 | | 2 | 6 |
| <i>Canis</i> | 8 | Yes | 0.001 | Yes | 48 | 65 |
| <i>Castor</i> * | 6.7 | | 0.974 | | 4 | 5 |
| <i>Martes</i> | 4.7 | | 0.056 | | 6 | 13 |
| <i>Cervus</i> | 4 | Yes | 0.001 | No | 71 | 54 |
| <i>Felis</i> | 3.3 | | 0.086 | | 27 | 20 |
| <i>Mustela</i> | 2.7 | Yes | 0.000 | Yes | 8 | 27 |
| <i>Gulo</i> | 2.7 | Yes | 0.000 | Yes | 0 | 22 |
| <i>Marmota</i> | 2.7 | | 0.437 | | 8 | 11 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.5. Fur clothing

3.5.1. Family level

3.5.1.1. Late Middle versus early Upper Palaeolithic

The results of the family level statistical analyses of taxa used for fur clothing between the LMP and the EUP are summarized in Table 3.9. Of the nine families that are used for fur clothing, five (56%) are significantly more frequent in EUP than LMP strata: Mustelidae, Cervidae, Canidae, Leporidae, and Castoridae. Of the top five families used for fur clothing by recent mid-to-high latitude non-industrial groups, four (80%) are significantly more frequent in the EUP than the LMP. In addition, all of the top three families used for fur clothing are significantly more frequent in the EUP than the LMP. None of the families that are used for fur clothing is significantly more frequent in LMP than EUP strata.

Table 3.9 *Chi-squared results comparing families used for fur clothing between LMP and EUP strata*

| Family | % Fur | Significant | p value | EUP > LMP | % LMP strata | % EUP strata |
|------------|-------|-------------|---------|-----------|--------------|--------------|
| Mustelidae | 25.8 | Yes | 0.000 | Yes | 18 | 48 |
| Cervidae | 21.1 | Yes | 0.008 | Yes | 87 | 94 |
| Canidae | 17.3 | Yes | 0.000 | Yes | 56 | 84 |
| Sciuridae | 8.2 | | 0.681 | | 15 | 14 |
| Leporidae | 8.2 | Yes | 0.000 | Yes | 26 | 63 |
| Bovidae | 7.5 | | 0.078 | | 92 | 87 |
| Ursidae | 5.0 | | 0.293 | | 58 | 53 |
| Castoridae | 4.4 | Yes | 0.021 | Yes | 4 | 10 |
| Felidae | 2.5 | | 0.963 | | 43 | 43 |

3.5.1.2. Mousterian versus Aurignacian

The results of the family level analyses of taxa used for fur clothing between the Mousterian and the Aurignacian are summarized in Table 3.10. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The major difference is that Sciuridae, and not Castoridae, is significantly more frequent in the Aurignacian than in the Mousterian. So, all of the top five families that are used for fur clothing by recent mid-to-high non-industrial groups are significantly more frequent in the Aurignacian than in the Mousterian.

Table 3.10 *Chi-squared results comparing families used for fur clothing between Mousterian and Aurignacian strata*

| Family | % Fur | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|------------|-------|-------------|---------|----------------|----------------|-----------------|
| Mustelidae | 25.8 | Yes | 0.000 | Yes | 18 | 45 |
| Cervidae | 21.1 | Yes | 0.036 | Yes | 88 | 94 |
| Canidae | 17.3 | Yes | 0.000 | Yes | 56 | 87 |
| Sciuridae | 8.2 | Yes | 0.006 | Yes | 11 | 23 |
| Leporidae | 8.2 | Yes | 0.000 | Yes | 23 | 50 |
| Bovidae | 7.5 | | 0.540 | | 94 | 92 |
| Ursidae | 5.0 | | 0.614 | | 57 | 55 |
| Castoridae | 4.4 | | 0.766 | | 4 | 5 |
| Felidae | 2.5 | | 0.828 | | 43 | 42 |

3.5.2. Genus level

3.5.2.1. Late Middle versus early Upper Palaeolithic

The results of the genus level statistical analyses of taxa used for fur clothing between the LMP and the EUP are summarized in Table 3.11. Of the 13 genera used for fur clothing, five (38%) are significantly more frequent in the EUP than the LMP:

Rangifer, *Mustela*, *Canis*, *Castor*, and *Gulo*. Of the top five genera used for fur clothing by recent mid-to-high latitude non-industrial groups, four (80%) are significantly more frequent in the EUP than the LMP. Two genera (15%; *Bison* and *Cervus*) are significantly more frequent in LMP than EUP strata. The remaining six genera are not significantly different in their frequencies in LMP versus EUP strata.

Table 3.11 Chi-squared results comparing genera used for fur clothing between LMP and EUP strata

| Genus | % Fur | Significant | p value | EUP > LMP | % LMP strata | % EUP strata |
|---------------------|-------|-------------|---------|-----------|--------------|--------------|
| <i>Rangifer</i> | 27.1 | Yes | 0.000 | Yes | 44 | 78 |
| <i>Mustela</i> | 10.2 | Yes | 0.000 | Yes | 8 | 22 |
| <i>Ursus</i> | 9.6 | | 0.293 | | 58 | 53 |
| <i>Canis</i> | 9.6 | Yes | 0.000 | Yes | 49 | 68 |
| <i>Castor</i> | 8.4 | Yes | 0.021 | Yes | 4 | 10 |
| <i>Bison</i> | 7.8 | Yes | 0.000 | No | 18 | 7 |
| <i>Martes</i> | 6.6 | | 0.859 | | 6 | 7 |
| <i>Felis</i> | 4.8 | | 0.303 | | 27 | 23 |
| <i>Marmota</i> | 4.2 | | 0.105 | | 11 | 7 |
| <i>Gulo</i> | 3.6 | Yes | 0.000 | Yes | 2 | 29 |
| <i>Alces</i> * | 3 | | 0.358 | | 2 | 5 |
| <i>Cervus</i> | 2.4 | Yes | 0.000 | No | 71 | 54 |
| <i>Spermophilus</i> | 1.8 | | 0.450 | | 5 | 6 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.5.2.2. Mousterian versus Aurignacian

The results of the genus level analyses of taxa used for fur clothing between the Mousterian and the Aurignacian are summarized in Table 3.12. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The main difference is that *Spermophilus*, and not *Castor*, is significantly more frequent in Aurignacian strata than in Mousterian strata.

Table 3.12 *Chi-squared results comparing genera used for fur clothing between Mousterian and Aurignacian strata*

| Genus | % Fur | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|---------------------|-------|-------------|---------|----------------|----------------|-----------------|
| <i>Rangifer</i> | 27.1 | Yes | 0.000 | Yes | 44 | 71 |
| <i>Mustela</i> | 10.2 | Yes | 0.000 | Yes | 8 | 27 |
| <i>Ursus</i> | 9.6 | | 0.614 | | 57 | 55 |
| <i>Canis</i> | 9.6 | Yes | 0.001 | Yes | 48 | 65 |
| <i>Castor</i> * | 8.4 | | 0.974 | | 4 | 5 |
| <i>Bison</i> | 7.8 | Yes | 0.002 | No | 19 | 8 |
| <i>Martes</i> | 6.6 | | 0.056 | | 6 | 13 |
| <i>Felis</i> | 4.8 | | 0.086 | | 27 | 20 |
| <i>Marmota</i> | 4.2 | | 0.437 | | 8 | 11 |
| <i>Gulo</i> | 3.6 | Yes | 0.000 | Yes | 0 | 22 |
| <i>Alces</i> * | 3 | | 0.219 | | 2 | 6 |
| <i>Cervus</i> | 2.4 | Yes | 0.001 | No | 71 | 54 |
| <i>Spermophilus</i> | 1.8 | Yes | 0.014 | Yes | 3 | 11 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.6. Fur trim

3.6.1. Family level

3.6.1.1. Late Middle versus early Upper Palaeolithic

The results of the family level statistical analyses of taxa used for fur trim between the LMP and the EUP are summarized in Table 3.13. Of the eight families that are used for fur trim, five (63%) are significantly more frequent in EUP than LMP strata: Mustelidae, Canidae, Cervidae, Leporidae, and Castoridae. Of the top seven families used for fur trim by recent mid-to-high latitude non-industrial groups, five (~71%) are significantly more frequent in the EUP than the LMP. None of the families that are used for fur trim is significantly more frequent in LMP than EUP strata.

Table 3.13 *Chi-squared results comparing families used for fur trim between LMP and EUP strata*

| Family | % Trim | Significant | p value | EUP > LMP | % LMP strata | % EUP strata |
|------------|--------|-------------|---------|-----------|--------------|--------------|
| Mustelidae | 39.2 | Yes | 0.000 | Yes | 18 | 48 |
| Canidae | 24.3 | Yes | 0.000 | Yes | 56 | 84 |
| Sciuridae | 17.6 | | 0.681 | | 15 | 14 |
| Cervidae | 8.1 | Yes | 0.008 | Yes | 87 | 94 |
| Leporidae | 4.1 | Yes | 0.000 | Yes | 26 | 63 |
| Castoridae | 2.7 | Yes | 0.021 | Yes | 4 | 10 |
| Felidae | 2.7 | | 0.963 | | 43 | 43 |
| Ursidae | 1.4 | | 0.293 | | 58 | 53 |

3.6.1.2. Mousterian versus Aurignacian

The results of the family level analyses of taxa used for fur trim between the Mousterian and the Aurignacian are summarized in Table 3.14. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The main difference is that Sciuridae, and not Castoridae, is significantly more frequent in Aurignacian strata than in Mousterian strata. So, all of the top five families that are used by recent mid-to-high latitude non-industrial groups for fur trim are significantly more frequent in the Aurignacian than in the Mousterian.

Table 3.14 *Chi-squared results comparing families used for fur trim between Mousterian and Aurignacian strata*

| Family | % Trim | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|------------|--------|-------------|---------|----------------|----------------|-----------------|
| Mustelidae | 39.2 | Yes | 0.000 | Yes | 18 | 45 |
| Canidae | 24.3 | Yes | 0.000 | Yes | 56 | 87 |
| Sciuridae | 17.6 | Yes | 0.006 | Yes | 11 | 23 |
| Cervidae | 8.1 | Yes | 0.036 | Yes | 88 | 94 |
| Leporidae | 4.1 | Yes | 0.000 | Yes | 23 | 50 |
| Castoridae | 2.7 | | 0.766 | | 4 | 5 |
| Felidae | 2.7 | | 0.828 | | 43 | 42 |
| Ursidae | 1.4 | | 0.614 | | 57 | 55 |

3.6.2. Genus level

3.6.2.1. Late Middle versus early Upper Palaeolithic

The results of the genus level statistical analyses of taxa used for fur trim between the LMP and the EUP are summarized in Table 3.15. Of the ten genera used for fur trim on clothing, five (50%) are significantly more frequent in the EUP than in the LMP: *Canis*, *Mustela*, *Gulo*, *Rangifer*, and *Castor*. Of the top six genera used for utilitarian clothing by recent mid-to-high latitude non-industrial groups, four (~66%) are significantly more frequent in the EUP than the LMP. No genus that is used for fur trim is significantly more frequent in LMP than EUP strata.

Table 3.15 *Chi-squared results comparing genera used for fur trim between LMP and EUP strata*

| Genus | % Trim | Significant | p value | EUP > LMP | % LMP strata | % EUP strata |
|-----------------|---------------|--------------------|----------------|---------------------|---------------------|---------------------|
| <i>Canis</i> | 19 | Yes | 0.000 | Yes | 49 | 68 |
| <i>Mustela</i> | 16.7 | Yes | 0.000 | Yes | 8 | 22 |
| <i>Marmota</i> | 16.7 | | 0.105 | | 11 | 7 |
| <i>Gulo</i> | 14.3 | Yes | 0.000 | Yes | 2 | 29 |
| <i>Rangifer</i> | 9.5 | Yes | 0.000 | Yes | 44 | 78 |
| <i>Martes</i> | 9.5 | | 0.859 | | 6 | 7 |
| <i>Castor</i> | 4.8 | Yes | 0.021 | Yes | 4 | 10 |
| <i>Felis</i> | 4.8 | | 0.303 | | 27 | 23 |
| <i>Ursus</i> | 2.4 | | 0.293 | | 58 | 53 |
| <i>Alces</i> * | 2.4 | | 0.358 | | 2 | 5 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.6.2.2. Mousterian versus Aurignacian

The results of the genus level analyses of taxa used for fur trim between the Mousterian and the Aurignacian are summarized in Table 3.16. There is little difference in the results of the LMP versus EUP and Mousterian versus Aurignacian comparisons. The main difference is that *Castor* is not significantly more frequent in the Aurignacian than in the Mousterian.

Table 3.16 *Chi-squared results comparing genera used for fur trim between Mousterian and Aurignacian strata*

| Genus | % Fur | Significant | p value | Aurig. > Mous. | % Mous. strata | % Aurig. strata |
|-----------------|-------|-------------|---------|----------------|----------------|-----------------|
| <i>Canis</i> | 19 | Yes | 0.001 | Yes | 48 | 65 |
| <i>Mustela</i> | 16.7 | Yes | 0.000 | Yes | 8 | 27 |
| <i>Marmota</i> | 16.7 | | 0.437 | | 8 | 11 |
| <i>Gulo</i> | 14.3 | Yes | 0.000 | Yes | 0 | 22 |
| <i>Rangifer</i> | 9.5 | Yes | 0.000 | Yes | 44 | 71 |
| <i>Martes</i> | 9.5 | | 0.056 | | 6 | 13 |
| <i>Castor</i> * | 4.8 | | 0.974 | | 4 | 5 |
| <i>Felis</i> | 4.8 | | 0.086 | | 27 | 20 |
| <i>Ursus</i> | 2.4 | | 0.614 | | 57 | 55 |
| <i>Alces</i> * | 2.4 | | 0.219 | | 2 | 6 |

* Indicates a chi-squared test with a low expected value, to which Yates' continuity correction was applied

3.7. Summary of Neanderthal versus modern human exploitation of taxa used for clothing

A number of patterns emerged from the above results. Overall, the families (and genera) that were significantly more frequent in the EUP than in the LMP were Cervidae (*Rangifer*), Mustelidae (*Mustela* and *Gulo*), Canidae (*Canis*), Leporidae, and Castoridae (*Castor*). The families (and genera) that were significantly more frequent in the Aurignacian than in the Mousterian were Cervidae (*Rangifer*), Mustelidae (*Mustela* and *Gulo*), Canidae (*Canis*), Leporidae, and Sciuridae (*Spermophilus*).

There also seem to have been slight differences in the exploitation of taxa between the two industries that make up the early Upper Palaeolithic in the present study: the Aurignacian and Gravettian. Sciuridae remains are significantly more frequent in the Aurignacian than in the Mousterian, but they are not significantly more frequent in the EUP than in the LMP. This suggests that Aurignacian modern humans exploited Sciuridae more frequently than Neanderthals, but this trend did not continue into the Gravettian. Conversely, Castoridae seems to have been exploited significantly more

frequently in the EUP than in the LMP. However, Castoridae was not exploited significantly more frequently in the Aurignacian than in the Mousterian; neither Mousterian nor Aurignacian hominins seem to have exploited Castoridae to any great extent. This suggests that there was an increase in the exploitation of Castoridae among modern humans of the Gravettian. At the genus level, *Spermophilus*, which belongs to Sciuridae, was significantly more frequent in the Aurignacian than in the Mousterian, but not in the EUP versus LMP. *Castor*, the sole representative of Castoridae, was significantly more frequent in the EUP than in the LMP, but not in the Aurignacian versus Mousterian. So, it seems that Aurignacian modern humans exploited *Spermophilus* more frequently than Neanderthals, but this trend did not continue into the Gravettian. In addition, there seems to have been an increase in the exploitation of *Castor* among modern humans of the Gravettian. Differences in frequencies of Castoridae and Sciuridae family remains between the Aurignacian and the EUP may be driven by differences in the frequency of exploitation of *Castor* and *Spermophilus*.

Mustelidae remains were present in almost three times as many EUP and Aurignacian strata than in LMP and Mousterian strata. So, it seems that there was a marked increase in the exploitation of Mustelidae between LMP Neanderthals and EUP modern humans.

Leporidae remains were present in twice as many EUP and Aurignacian strata than in LMP and Mousterian strata. So, it seems that there was a drastic increase in the exploitation of Leporidae between LMP Neanderthals and EUP modern humans.

At the genus level, *Rangifer* remains are almost twice as frequent in the EUP and Aurignacian than in the LMP and the Mousterian. So, it seems that there was a major increase in the exploitation of *Rangifer* between LMP Neanderthals and EUP modern humans.

Gulo is rarely, if ever, present in LMP, or Mousterian, strata. However, *Gulo* appears in 20-30% of early Upper Palaeolithic and Aurignacian strata. This is a very significant increase. So, it seems that there was a substantial increase in the exploitation of *Gulo* between LMP Neanderthals and EUP modern humans.

The frequency of *Mustela* remains increases twofold between the LMP and EUP, and threefold between the Mousterian and the Aurignacian. So, it seems that there was a drastic increase in the exploitation of *Mustela* between LMP Neanderthals and EUP modern humans.

Lastly, *Alces* remains are infrequently associated with all of the industries studied. So, *Alces* was likely not important or not available to either Neanderthals or modern humans during OIS 3.

In the family-level analyses, which have already been identified as the most accurate, none of the families that are used for clothing was significantly more frequent in Neanderthal-associated strata than in modern human-associated strata. The *Bison*, *Cervus*, and *Bos* genera are the only taxa that are used for clothing that seem to have been exploited significantly more frequently by Neanderthals than by modern humans. This finding holds in both the LMP versus EUP comparisons and in the Mousterian versus Aurignacian comparisons.

3.7.1. Utilitarian clothing

The analyses of the families that are used for utilitarian clothing by recent mid-to-high latitude non-industrial groups demonstrate that half of them are significantly more frequent in EUP strata than in LMP strata. Furthermore, four of the top five families that are used for utilitarian clothing by recent mid-to-high latitude non-industrial groups (80%) are significantly more frequent in the EUP than the LMP, and none of the families that are used for utilitarian clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than the EUP. This relationship holds in the Aurignacian versus Mousterian comparison, with the caveat that Sciuridae but not Castoridae is significantly more frequent in Aurignacian strata than in Mousterian strata.

The picture is not as clear at the genus level, because 20% of the genera used for utilitarian clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than in the EUP. However, a higher percentage (~33%) of the genera used for utilitarian clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the EUP than the LMP. This relationship holds in the Aurignacian versus Mousterian comparison, with the caveat that *Spermophilus*, and not

Castor, is significantly more frequent in Aurignacian strata than in Mousterian strata. It should be noted again here that the genus level of analysis is likely not as accurate as the family level, since it disregards a number of fauna that are frequently used for clothing by recent mid-to-high latitude non-industrial groups, including otters, sheep, rabbits, foxes, goats, hares, and squirrels, and it does not take into account the presence of extinct OIS 3 taxa.

It is thus apparent that EUP modern humans exploited a wider variety of taxa that are used for utilitarian clothing by recent mid-to-high latitude non-industrial groups than did the Neanderthals. In addition, EUP modern humans seem to have exploited more of the taxa that are the highest ranked for utilitarian clothing. These findings suggest that EUP modern humans made utilitarian clothing more frequently than did the Neanderthals.

3.7.2. Winter/Heavy clothing

Five of the nine families (~56%) used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups are significantly more frequent in the EUP than in the LMP. These families include five of the top six families (~83%) that are used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups. No family used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than in the EUP. This relationship holds in the Aurignacian vs. Mousterian comparison. However, *Sciuridae*, and not *Castoridae*, is significantly more frequent in Aurignacian strata than in Mousterian strata.

Again, the genus level results are not as clear, since ~17% of the genera used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than the EUP. However, a higher percentage (~42%) of genera used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the EUP than the LMP. This relationship holds in the Aurignacian vs. Mousterian comparison, with the caveat that one genus (*Castor*) is not significantly more frequent in the Aurignacian than in the Mousterian. So, a slightly lower percentage (~33%) of genera is significantly more frequent in Aurignacian than Mousterian strata.

EUP modern humans thus seem to have exploited a wider variety of taxa that are used for winter/heavy clothing by recent mid-to-high latitude non-industrial groups than did the Neanderthals. In addition, modern humans seem to have exploited more of the highest ranked taxa that are used for winter/heavy clothing. This suggests that EUP modern humans made winter/heavy clothing more frequently than did the Neanderthals.

3.7.3. Fur clothing

Five of the nine families (~56%) used for fur clothing by recent mid-to-high latitude non-industrial groups are significantly more frequent in the EUP than in the LMP. These families include four of the top five families (80%) that are used for fur clothing by recent mid-to-high latitude non-industrial groups. No family used for fur clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than in the EUP. This relationship holds in the Aurignacian versus Mousterian comparison. However, *Sciuridae*, and not *Castoridae*, is significantly more frequent in Aurignacian strata than in Mousterian strata.

The genus level results are again not as clear. Around 15% of the genera used for fur clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than the EUP. However, a higher percentage (~38%) of genera used for fur clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the EUP than the LMP. This relationship holds in the Aurignacian versus Mousterian comparison, with the caveat that *Spermophilus*, and not *Castor*, is significantly more frequent in Aurignacian strata than in Mousterian strata.

So, it seems that EUP modern humans exploited a wider variety of taxa that are used for fur clothing by recent mid-to-high latitude non-industrial groups than did the Neanderthals. In addition, modern humans seem to have exploited more of the highest ranked taxa that are used for fur clothing. This suggests that EUP modern humans made fur clothing more frequently than did the Neanderthals.

3.7.4. Fur trim

Five of the eight families (~63%) used for fur trim by recent mid-to-high latitude non-industrial groups are significantly more frequent in the EUP than in the LMP. These

families include five of the top seven families (~71%) used for fur trim by recent mid-to-high latitude non-industrial groups. No family that is used for fur clothing by recent mid-to-high latitude non-industrial groups is significantly more frequent in the LMP than in the EUP. This relationship holds in the Aurignacian vs. Mousterian comparison, with the caveat that Sciuridae, and not Castoridae, is significantly more frequent in Aurignacian strata than in Mousterian strata. So, all of the top five families used for fur clothing by recent mid-to-high latitude non-industrial groups are significantly more frequent in the Aurignacian than in the Mousterian.

At the genus level, the results are equally clear: five of the ten genera (50%) that are used for fur trim on clothing by recent mid-to-high latitude non-industrial groups are significantly more frequent in EUP than LMP strata, and no genus that is used for fur trim is significantly more frequent in LMP than EUP strata. This relationship holds in the Aurignacian versus Mousterian comparison, with the caveat that *Castor* is not significantly more frequent in the Aurignacian than in the Mousterian. So, a slightly lower percentage (40%) of genera used for fur trim is significantly more frequent in the Aurignacian than in the Mousterian.

Modern humans thus exploited a wider variety of taxa that are used for fur trim by recent mid-to-high latitude non-industrial groups than did the Neanderthals. None of the taxa used for fur trim was significantly more frequent in Neanderthal than modern human occupations. In addition, modern humans seem to have exploited more of the highest ranked taxa that are used for fur trim. These results suggest that modern humans made clothing with a fur trim more frequently than Neanderthals, or that fur trim was a modern human innovation.

4. General discussion

The goal of the present study was to investigate the role of clothing made from animal hides in the replacement of the Neanderthals by modern humans in Europe during OIS 3. Two hypotheses were tested in the study. The first was that EUP modern humans exploited animal taxa that are used by recent mid-to-high latitude non-industrial groups for utilitarian clothing more frequently than Neanderthals of the LMP. The second hypothesis was that EUP modern humans exploited animal taxa that are used for highly insulative, cold weather clothing by recent mid-to-high latitude non-industrial groups more frequently than Neanderthals of the LMP.

The study comprised two parts. In the first part, I performed an ethnographic analysis to determine which of the taxa that were present in OIS 3 Europe are used to make utilitarian clothing and cold weather clothing by recent mid-to-high latitude non-industrial groups. In the second part of the study, I compared the frequency of occurrences of the families and genera that the ethnographic analysis suggested are used to make utilitarian and cold weather clothing in archaeological strata associated with LMP Neanderthals and EUP modern humans.

In relation to the first hypothesis, the results of the analyses demonstrate that modern humans in the EUP exploited a wide variety of taxa used for utilitarian clothing significantly more frequently than did Neanderthals of the LMP. In addition, modern humans seem to have exploited more of the highest ranked taxa that are used for utilitarian clothing. This suggests that EUP modern humans made utilitarian clothing more frequently than did the Neanderthals.

In relation to the second hypothesis, the results of the analyses demonstrate that modern humans in the EUP exploited a wide variety of the taxa used for all of the defined “cold weather clothing” types significantly more frequently than did Neanderthals of the LMP. In addition, modern humans seem to have exploited more of the highest

ranked taxa that are used for cold weather clothing. This suggests that modern humans made highly insulative cold weather clothing more frequently than did the Neanderthals.

It is notable that approximately one half of the families that are used for each clothing type was significantly more frequent in modern human occupations than in Neanderthal occupations, and none of the families that are used for any of the clothing types was significantly more frequent in Neanderthal occupations than in modern human occupations. Comparisons at the family level are the most reliable because they did not discount any OIS 3 taxa that are used for clothing, and because they took into account the presence of extinct OIS 3 taxa in the archaeological record. So, such a difference in the frequencies of families that are used for clothing between Neanderthal and modern human strata is compelling evidence for differences in the frequency of clothing manufacture between Neanderthals and EUP modern humans.

Furthermore, as the analyses became more specific and focused on taxa that are used for thermally effective clothing (i.e. from utilitarian clothing to winter/heavy clothing, to fur clothing, to fur trim), the differences in the frequencies of taxa used for clothing between Neanderthal and modern human occupations became somewhat more marked (Table 4.1). This finding supports the hypothesis that EUP modern humans exploited taxa that are useful for highly insulative clothing significantly more frequently than did the Neanderthals.

Table 4.1 *Percentages of families and genera used for utilitarian and cold weather clothing that are significantly more frequent in EUP versus LMP strata and Aurignacian versus Mousterian strata*

| Type of clothing | % Families significantly more frequent in EUP | % Families significantly more frequent in Aurig. | % Genera significantly more frequent in EUP | % Genera significantly more frequent in Aurig. |
|------------------|---|--|---|--|
| Util clo | 50 | 50 | 33 | 33 |
| Winter/Heavy | 56 | 56 | 42 | 33 |
| Fur | 56 | 56 | 38 | 38 |
| Trim | 63 | 63 | 50 | 40 |

4.1. Implications of the differences in the exploitation of taxa used for clothing

The families (and genera) that are used for clothing by recent mid-to-high latitude non-industrial groups that were significantly more frequent in the EUP than in the LMP are: Cervidae (*Rangifer*), Mustelidae (*Mustela* and *Gulo*), Canidae (*Canis*), Leporidae, and Castoridae (*Castor*). The families (and genera) that were significantly more frequent in the Aurignacian than in the Mousterian are: Cervidae (*Rangifer*), Mustelidae (*Mustela* and *Gulo*), Canidae (*Canis*), Leporidae, and Sciuridae (*Spermophilus*).

Cervids are present in 94% of EUP and Aurignacian strata, and in 87-88% of LMP and Mousterian strata. Though the difference in exploitation of Cervidae by EUP modern humans and LMP Neanderthals is not as extreme as in some cases, it is significant. *Rangifer* remains are almost twice as frequent in EUP and Aurignacian strata (71-78%) than in LMP and Mousterian strata (44%). Cervidae is the most frequently used family for utilitarian and winter/heavy clothing, and the second most frequently used for fur clothing. In addition, Cervidae is the fourth most frequently used family for fur trim. Of the cervids, *Rangifer* (reindeer/caribou), “deer”, and *Alces* (moose/elk) are the most frequently used for these clothing types. *Rangifer* and deer are the first and second most frequently used fauna for utilitarian clothing, respectively. It is notable that *Rangifer* is also the most frequently used taxon for winter/heavy clothing, and for fur clothing. *Rangifer* is also used for fur trim. *Rangifer* hide has consistently been described as the most thermally effective material for clothing. *Rangifer* hides are known to be light and resistant to perspiration, qualities that are useful during physical activity in cold environments. In addition, *Rangifer* has been identified as the only fur that is sufficient for clothing in Arctic winters, and Stenton (1991) notes that *Rangifer* may be more important for clothing than for food in the Arctic. Deer was only classifiable as “Cervidae”, so the frequency of exploitation of deer by Neanderthals and modern humans cannot be compared below the family level. *Alces* (moose/elk) is used for utilitarian and winter/heavy clothing, and occasionally for fur and fur trim. However, *Alces* does not seem to be exploited frequently by either Neanderthals or modern humans. The fact that Cervidae and *Rangifer* were exploited significantly more frequently by modern humans than by Neanderthals suggests that modern humans made clothing more frequently than Neanderthals, and in particular winter/heavy clothing, fur clothing

and fur trim. In addition, since modern humans exploited *Rangifer*, which is used to make highly insulative clothing in the Arctic, significantly more frequently than Neanderthals, it is likely that EUP modern humans made clothing that was highly insulative in cold weather more frequently than did Neanderthals of the LMP.

Mustelids are present in almost thrice as many EUP and Aurignacian strata (45-48%) than in LMP and Mousterian strata (18%). Of the mustelids, the frequency of *Mustela* (minks, weasels, and stoats/ermine) remains increases more than twofold between the LMP and EUP, from a presence in 8% of LMP strata to a presence in 22% of EUP strata. *Mustela* exploitation seems to increase more than threefold between the Mousterian and the Aurignacian, from a presence in 8% of strata to a presence in 27% of strata. *Gulo* (wolverine) is rarely, if ever present in LMP, or Mousterian, strata (0-2%). However, *Gulo* appears in 20-30% of EUP and Aurignacian strata. This is a very significant increase. Mustelidae is the third most frequently used family for utilitarian and winter/heavy clothing, and the second most frequently used for fur clothing and fur trim. In Mustelidae, otters are among the most frequently used fauna for all clothing types. Otters are tied with foxes as the most frequently used fauna for fur trim. *Mustela* is the second most frequently used genus for fur clothing and for fur trim. *Gulo* is also highly ranked for its use for fur trim. *Gulo* furs are known to offer superior thermal protection in cold due to their mixture of long and short hairs, which makes for an effectively thick boundary layer that reduces heat loss and helps to guard from frostbite. This is particularly notable when *Gulo* furs are used as fur trim on clothing (Cotel et al. 2004). As otters were only classified as Mustelidae, the frequency of their exploitation by Neanderthals and modern humans could not be compared below the family level. However, the high difference in the frequencies of exploitation of Mustelidae as a whole, and particularly of *Gulo* and *Mustela*, between LMP Neanderthals and EUP modern humans is compelling evidence of the more frequent manufacture of thermally effective, cold weather clothing by modern humans than by Neanderthals. In particular, fur clothing and fur trim made from the highly insulative Mustelidae family are likely to have been made more frequently by EUP modern humans than by Neanderthals in the LMP.

Canid remains are present in 56% of LMP and Mousterian strata, and in 84-87% of EUP and Aurignacian strata. *Canis* (wolf) remains are present in 48-49% of LMP and Mousterian strata, and in 65-68% of EUP and Aurignacian strata. These differences are

highly significant. Canidae is the second most frequently used family for fur clothing and fur trim, and the fourth most frequently used for utilitarian and winter/heavy clothing. Foxes and wolves contribute most to the ranking of Canidae for all types of clothing. Foxes and wolves have been identified as particularly useful for fur trim in Arctic environments, and the results of the above analyses confirm that foxes and wolves are used consistently for fur and fur trim among mid-to-high latitude non-industrial cultures. Foxes are tied with otters as the most frequently used animals for fur trim, and they are the second most frequently used animals for fur clothing in general. The furs of foxes and *Canis* have guard hairs that effectively increase the boundary layer of clothing and aid in heat retention. In addition, fox furs are particularly effective in wind due to their density, and they are known to be light but insulative. Foxes were classified only as Canidae, so the frequency of their exploitation by modern humans and Neanderthals cannot be compared below the family level. However, the fact that modern humans exploited Canidae in general, and particularly *Canis*, significantly more frequently than Neanderthals is compelling evidence of the more frequent manufacture of thermally effective, cold weather clothing by EUP modern humans than by LMP Neanderthals. In particular, highly insulative fur clothing and fur trim are likely to have been made more frequently by modern humans in the EUP than by Neanderthals in the LMP.

Leporid remains are present in two to three times as many EUP and Aurignacian strata (50-63%) as LMP and Mousterian strata (23-26%). This difference is highly significant. Leporidae is the fourth most frequently used family for winter/heavy clothing, and the fifth most frequently used for utilitarian clothing and fur clothing. The Leporidae family was made up of rabbits and hares in the present study, neither of which was distinguishable lower than the family level. Rabbits are used frequently for all clothing types except fur trim. However, when combined, rabbits and hares make Leporidae the fifth most frequently used family for fur trim. Rabbit furs have been identified as particularly effective for protection from wind due to their density. When hare fur is used as trim around the face, it is known to dry quickly, which protects the nose from frost (Cena and Clark 1978; Jochelson 1933). The significantly higher frequency of Leporidae remains in EUP modern human occupations than in LMP Neanderthal occupations is thus a good indication of a higher frequency of utilitarian clothing, and particularly winter/heavy clothing and fur clothing made from the thermally effective Leporidae

family, among modern humans. The higher frequency of Leporidae remains in modern human occupations may also be indicative of the more frequent manufacture of fur trim by EUP modern humans than by Neanderthals in the LMP.

The frequencies of Sciuridae and *Spermophilus* (ground squirrel/suslik) remains are not significantly different between the LMP and the EUP. Sciuridae is present in 15% of LMP strata and 14% of EUP strata, while *Spermophilus* is present in only 5-6% of LMP and EUP strata. However, from the Mousterian to the Aurignacian, the frequency of Sciuridae remains increases twofold, from 11 to 23%, and the frequency of *Spermophilus* remains increases more than threefold, from 3 to 11%. So, the differences in the frequencies of Sciuridae and *Spermophilus* remains between the Mousterian and the Aurignacian are highly significant. The trend of an increased exploitation of Sciuridae and *Spermophilus* seems to be a feature of the Aurignacian and not the Gravettian. Sciuridae is the third most frequently used family for fur trim, the fourth most frequently used for fur clothing, and the seventh most frequently used for utilitarian and winter/heavy clothing. Of the sciurids, “squirrels” and *Marmota* (marmots) are the most frequently used for all clothing types. Squirrel tails are frequently used for fur boas or scarves, and all of the uses of marmots for fur clothing were for fur trim. *Spermophilus* is among the lesser-used taxa for utilitarian clothing and fur clothing, and it does not seem to be used for winter/heavy clothing or fur trim. However, ground squirrel fur is highly valued, and is considered the finest fur by both the Alutiiq and the Tlingit (e.g. Birket-Smith 1941; De Laguna 1972). Indeed, the Alutiiq of Kodiak Island are known to make hunting expeditions to neighbouring islands specifically to hunt ground squirrels for fur (Clark 1974). Squirrels are only classified at the family level, as Sciuridae, so it is not possible to compare the frequency of their remains in Neanderthal and modern human occupations below the family level. The difference in the exploitation of *Marmota* by Neanderthals and modern humans was not significant. So, it is possible that the higher frequency of Sciuridae remains in Aurignacian versus Mousterian strata is indicative of an increase in the exploitation of squirrels for fur clothing and fur trim by Aurignacian modern humans. The higher frequency of *Spermophilus* remains in Aurignacian strata may be an indicator of fur clothing among Aurignacian modern humans.

Castoridae and *Castor* (beaver) exploitation doubles between the LMP and the EUP. Castoridae and *Castor* are present in 4% of LMP strata, and in 10% of EUP strata.

However, Castoridae and *Castor* are present in only 4-5% of both Mousterian and Aurignacian strata. So, it seems that an increase in the frequency of exploitation of Castoridae and *Castor* is a feature of the Gravettian. Castoridae is the sixth most frequently used family for winter/heavy clothing and fur trim, and the eighth most frequently used for utilitarian and fur clothing. So, the significantly higher exploitation of Castoridae and *Castor* in the EUP may be evidence of an increase in their exploitation for winter/heavy clothing and fur trim among Gravettian modern humans. However, Castoridae and *Castor* remains are not the most compelling evidence of these clothing types.

All of the taxa described above that are consistently more frequent in modern human occupations (both in the EUP and the Aurignacian) than in Neanderthal occupations (both in the LMP and the Mousterian) have qualities that make them highly insulative. These taxa are: Cervidae (*Rangifer*), Mustelidae (*Mustela* and *Gulo*), Canidae (*Canis*), and Leporidae. Most notably, the hide of *Rangifer* is known to be the most thermally effective material for clothing, and it is the most frequently used taxon for utilitarian clothing, winter/heavy clothing, and fur clothing by recent mid-to-high latitude non-industrial groups. The Mustelidae, Canidae, and Leporidae families, and the *Mustela*, *Gulo*, and *Canis* genera in particular, are also known to make thermally effective fur clothing and fur trim. Clothing and trim made from the furs of Mustelidae, Canidae, and Leporidae are known to be particularly effective in wind, and to prevent frostbite. So, it is likely that modern humans made highly insulative clothing more frequently than Neanderthals.

Bison, *Cervus*, and *Bos* are the only taxa that are used for clothing by recent mid-to-high latitude non-industrial groups that seem to have been exploited significantly more frequently by Neanderthals than by modern humans. This finding holds in both the LMP vs. EUP comparison and in the Mousterian vs. Aurignacian comparison.

Bison (bison) remains are present in 18-19% of LMP and Mousterian strata, and only in 7-8% of EUP and Aurignacian strata. This difference is highly significant. *Bison* is among the taxa that are most frequently used by recent mid-to-high latitude non-industrial groups for utilitarian clothing and for winter/heavy clothing. In addition, *Bison* is used for fur clothing, but not for fur trim. So, the relatively higher frequency of *Bison*

remains in Neanderthal versus modern human occupations may indicate that Neanderthals used *Bison* for utilitarian clothing, winter/heavy clothing, and fur clothing more frequently than modern humans did.

Bos (cattle/cow and yak) remains are present in 46-48% of LMP and Mousterian strata, and in 21-23% of EUP and Aurignacian strata. This difference is highly significant. *Bos* is used by recent mid-to-high latitude non-industrial groups for utilitarian clothing, but not for any kind of cold weather clothing. So, the relatively higher frequency of remains of *Bos* in Neanderthal vs. modern human occupations may indicate that Neanderthals used *Bos* for utilitarian clothing more frequently than modern humans did. However, clothing made from *Bos* is not likely to have been thermally effective in cold weather.

Cervus (red deer/elk) remains are present in 71% of LMP and Mousterian strata, and in 54% of EUP and Aurignacian strata. This difference is highly significant. *Cervus* can be used for utilitarian clothing, for winter/heavy clothing, and occasionally for fur clothing. *Cervus* is not used by recent mid-to-high latitude non-industrial groups for fur trim. So, the relatively higher frequency of *Cervus* remains in Neanderthal versus modern human occupations may mean that Neanderthals made utilitarian clothing, winter/heavy clothing, and perhaps fur clothing from *Cervus* more frequently than did modern humans.

The relatively higher frequency of *Bos* remains in Neanderthal versus modern human occupations may indicate the manufacture of clothing made from *Bos* among Neanderthals. However, *Bos* does not seem to be used to make thermally effective cold weather clothing. The relatively higher frequency of *Bison* and *Cervus* remains in Neanderthal versus modern human occupations suggests that Neanderthals made utilitarian clothing, winter/heavy clothing, and fur clothing from these taxa more frequently than did modern humans. It is possible that Neanderthals used both *Bison* and *Cervus* for cold weather clothing in place of the varied taxa used by modern humans. However, it is telling that modern humans seem to have exploited a wider variety of the taxa that are used for highly insulative clothing by recent mid-to-high latitude non-industrial groups than Neanderthals. In addition, many of the taxa that were exploited more frequently by modern humans are known to have highly insulative furs,

and are used frequently for fur trim. None of the taxa that were exploited more frequently by Neanderthals is used to make fur trim. This again suggests that fur trim on clothing was an innovation of modern humans in the EUP.

It is notable that almost all of the taxa that were exploited more frequently by modern humans than by Neanderthals are small-bodied: Mustelidae, Canidae, Leporidae, Sciuridae, and Castoridae are small-bodied, and only Cervidae are larger-bodied fauna. The taxa that seem to have been exploited more frequently by Neanderthals than by modern humans are larger-bodied: *Bison*, *Bos*, and *Cervus*. The hides of small-bodied taxa, due to their size, could likely not be used for clothing without tailoring technology. In contrast, clothing made from large-bodied taxa could conceivably be made with as little as one hide, which would require minimal tailoring. So, the large-bodied taxa exploited by Neanderthals may have provided more clothing per individual animal, and required less tailoring. However, the ethnographic record suggests that the small-bodied fur-bearing taxa that were more frequently exploited by modern humans are more thermally effective in cold and Arctic conditions than the large-bodied taxa exploited by Neanderthals. These findings seem to suggest that modern humans not only made clothing from taxa with highly insulative furs more frequently than Neanderthals, but also that they made tailored clothing from the taxa in question. It is unclear if Neanderthals made tailored clothing, but it is likely that the large-bodied taxa exploited by Neanderthals would have required less tailoring than the small-bodied taxa exploited by modern humans. This idea is consistent with technological evidence for tailored clothing in OIS 3 Europe, in that the production of eyed bone needles and awls may have been exclusive to modern humans.

As has already been noted, EUP modern humans seem to have exploited a wider variety of taxa that are used for clothing than Neanderthals. In addition, the pelts of the taxa that were exploited more frequently by modern humans than by Neanderthals are known to be highly insulative. This relationship was consistent not only in the EUP versus the LMP as a whole, but also in the Aurignacian versus Mousterian comparisons. Since the Mousterian and the Aurignacian partially overlapped in time and space, this finding suggests that Aurignacian modern humans exploited such taxa significantly more frequently than Neanderthals due to preference, and not solely due to environmental availability. EUP modern humans may have recognized the thermal value of taxa that

are used for cold weather clothing among recent mid-to-high latitude non-industrial groups, and exploited such taxa preferentially. Indeed, this study has illuminated compelling evidence that modern humans in the EUP exploited taxa that are used for highly insulative fur clothing and fur trim significantly more frequently than Neanderthals.

4.2. Potential alternative interpretations

On the other hand, modern humans may have exploited the above taxa significantly more frequently than Neanderthals due to their climatic preferences, due to an expansion in dietary breadth, and/or due to improved hunting technology. If modern humans inhabited environments in which cervids, mustelids, canids, leporids, sciurids and castorids lived, and Neanderthals did not, the difference in the exploitation of such taxa between Neanderthals and modern humans may not relate to clothing use. As has already been noted, Stewart (2004) found that modern humans may have inhabited open, cold environments more frequently than Neanderthals. Stewart (2004) also noted that *Rangifer* and a member of Canidae, *Alopex lagopus*, prefer open, cold environments. However, leporids seem to have been ubiquitous throughout OIS 3 Europe, and mustelids inhabit a mix of environments (Stewart 2004). So, the relatively greater exploitation of taxa that are used for thermally effective clothing by modern humans is not necessarily due to climatic availability.

As has been previously noted, in the EUP there seems to have been an expansion in dietary breadth, which may have been facilitated by modern humans' more complex and adaptable technologies relative to LMP technologies. This expansion seems to have involved an intensification in the exploitation of small, hard-to-catch game such as lagomorphs (rabbits and hares), purportedly to ensure that nutritional needs were met (Stiner 2001). It is possible then, that the increased exploitation of lagomorphs seen in the EUP relative to the LMP is reflective of an increase in dietary breadth only, and not of an increase in the exploitation of taxa for clothing. However, the use of such taxa for food does not preclude the possibility that they were used for clothing. It is possible that modern humans' technological innovations allowed them to better catch small, fast prey to meet their dietary needs, and such prey happened to have pelts that were thermally effective when used for clothing. This would mean that the increased

dietary breadth of modern humans was beneficial to their survival not only in terms of ensuring adequate food intake, but also in terms of providing adequate clothing in extreme cold. Whether modern humans' intention was to exploit taxa that are highly insulative or not, it is clear that they exploited a wider variety of taxa with thermally effective fur than Neanderthals, which would have been an advantage for the former in terms of protection from the OIS 3 cold.

In an attempt to rule out use of the above taxa for food, I identified the taxa that are consistently more frequent in both EUP and Aurignacian strata than in LMP and Mousterian strata, and then conducted a supplementary ethnographic search for the use of the taxa in question for food. I recorded only the “regular” use of taxa for food, meaning that the animal made up a regular part of the diet, and was *not* only eaten during famine or when better food was not available. The aim of the supplementary analysis was to identify any family or genus that is not used regularly for food. If the members of each family or genus were documented as being used for food fewer than ten times in the sample of mid-to-high latitude non-industrial groups, it would reinforce the idea that the presence of taxa from such families or genera in the archaeological record is indicative of use for clothing, and not for food. I considered any taxon that yielded more than ten hits for regular food use (>10) to be “used for food”.

Table 4.2 *Uses of families that are significantly more frequent in modern human than Neanderthal occupations for food*

| Family | Regular food use |
|------------|------------------|
| Mustelidae | >10 |
| Canidae | >10 |
| Leporidae | >10 |
| Cervidae | >10 |

The results of the ethnographic search are summarized in Tables 4.2 and 4.3. Unfortunately for the purposes of distinguishing between clothing and food use, it seems that recent mid-to-high latitude non-industrial groups eat members of all four families that are used for clothing and were significantly more frequent in EUP and Aurignacian strata than in LMP and Mousterian strata.

Table 4.3 *Uses of genera that are significantly more frequent in modern human than Neanderthal occupations for food*

| Genus | Regular food use |
|-----------------|-------------------------|
| <i>Rangifer</i> | >10 |
| <i>Canis</i> | 4 |
| <i>Mustela</i> | 6 |
| <i>Gulo</i> | 1 |

At the genus level, there were again results for the regular use of all of the above genera for food. However, some (*Canis*, *Mustela*, and especially *Gulo*) yielded fewer than ten results (Table 4.3). Since *Canis*, *Mustela*, and *Gulo* are known to make particularly effective fur clothing and fur trim, and they do not seem to be used for food on a regular basis, it is likely that these taxa were exploited significantly more frequently by modern humans than by Neanderthals during OIS 3 for fur clothing and not for food.

4.3. Limitations

This study was based on the presence/absence of taxa that are used for clothing within LMP and EUP strata, and therefore does not take into account differences in the frequency of remains within each stratum. A significant follow-up study would therefore compare the MNI or NISP of the taxa in question within each stratum, which may be a more accurate representation of the frequency of exploitation of such taxa than simple presence/absence. Another useful follow-up study would analyze the bones of the mammalian taxa taken to indicate use for clothing throughout OIS 3 sites, looking for cut marks that are indicative of exploitation for skin or fur.

The potential use of fauna for food further confounds the results of this study. Unfortunately, it is not possible to parse out the use of fauna for food from use for clothing in the archaeological record based on this study alone. A future study might test for significant differences in the ethnographic exploitation of the taxa in question for clothing versus food. However, even if a taxon is predominantly used for food by recent ethnographic groups, it does not preclude its use for clothing. The use of taxa for food

therefore complicates the interpretation of taxa used for clothing in the archaeological record.

Another potential issue with this study is that modern humans may have exploited the aforementioned taxa significantly more frequently than Neanderthals due to their availability in the environments inhabited by modern humans. It is possible that modern humans lived in the environments in which taxa that are useful for cold weather clothing are found, and Neanderthals did not. I attempted to deal with this issue by sub-sampling the LMP versus EUP dataset and comparing only Mousterian versus Aurignacian strata, since the two partially overlap in time and space. This was a crude measure to control for difference in the availability of taxa, because the time scales used to estimate dates in Palaeolithic archaeology are very broad, and there is only an overlap in time between the Mousterian and Aurignacian at the very end of the Mousterian. A more precise way to control for differences in the availability of taxa between the LMP and EUP, or the Mousterian and the Aurignacian, would be to compare only LMP and EUP sites that are geographically close to one another, and that were occupied at the same time. However, again, due to issues with the time scales used to estimate dates in Palaeolithic archaeology, with margins for error numbering in thousands of years, it is not possible to determine if Neanderthals and modern humans occupied adjacent sites at the same time, or within thousands of years of one another. As the climate during OIS 3 seems to have fluctuated rapidly and severely, with one phase rarely lasting much more than 1000 years, climatic conditions at sites occupied by Neanderthals and modern humans within a few thousand years of one another may have been quite different. So, it would still not be possible to determine whether Neanderthals and modern humans would have had access to the same mammalian fauna. Whether modern humans exploited taxa that are useful for cold weather clothing intentionally (due to preference), due to their availability in the environment, or as a by-product of their expanded dietary breadth, it is significant that a greater proportion of the taxa that are more frequently associated with modern humans than Neanderthals are known to be used for thermally-effective, cold weather clothing, and particularly for fur clothing and fur trim.

Early modern humans in Europe may have made clothing that was more thermally effective than that made by Neanderthals not only due to the thermal qualities

of the hides exploited by modern humans, but also due to modern humans' adaptive technology. To recapitulate, end scrapers are thought to be indicative of regular hide scraping, while eyed needles and awls are evidence of tailored clothing. End scrapers with residues of hide scraping are common in EUP assemblages, and rare in LMP assemblages. The high frequency of end scrapers with hide scraping residues in the EUP and their rarity in the LMP suggests that EUP modern humans scraped hides for clothing more frequently than did the Neanderthals. In addition, eyed bone needles and awls may be exclusively associated with modern humans. The presence of eyed bone needles and awls in the EUP and their apparent absence in the LMP suggests that modern humans produced tailored clothing more frequently than Neanderthals did, or that modern humans produced more intricately tailored clothing. The results of the present study support this idea. Modern humans seem to have exploited taxa that were smaller than those exploited by Neanderthals. The small size of the pelts of taxa exploited more frequently by modern humans suggests that modern humans tailored their clothing. Neanderthals may not have needed to tailor their clothing as frequently or as intricately as modern humans did, due to the larger size of the pelts of taxa exploited by Neanderthals.

Due to the ephemeral nature of clothing in the archaeological record and the variety of taxa that can be used to make it, we may never know for certain when clothing originated. However, the above results demonstrate that, if Neanderthals and EUP modern humans both made clothing, they made it differently. Neanderthals may have made clothing from the taxa that are found at LMP sites, but the results of this study suggest that modern humans made clothing more frequently from the thermally effective hides of members of the Cervidae, Canidae, Mustelidae, and Leporidae families.

5. Conclusions

While many archaeologists have discussed whether or not Neanderthals and early modern humans in Europe used clothing, this study is the first quantitative test for clothing in the Palaeolithic. The results described above suggest that modern humans in the EUP made clothing that was more thermally effective than that made by Neanderthals. In particular, modern humans seem to have exploited taxa with highly insulative furs significantly more frequently than Neanderthals, presumably to make highly insulative fur clothing and fur trim. The use of fur trim, which is known to be highly protective in wind, may have been a modern human innovation. It is also likely that modern humans had an advantage over Neanderthals in tailoring technology, which would have allowed modern humans to better produce clothing from the highly insulative pelts of small-bodied taxa. The taxa that were identified as being used for highly insulative clothing were significantly more frequent in both the EUP versus LMP and the Aurignacian versus Mousterian comparisons. As the Aurignacian and the Mousterian partially overlap in time and space, modern humans may have exploited the taxa in question based on preference and not solely based on availability. It is possible then that modern humans of the EUP understood the thermal value of taxa in the Cervidae, Canidae, Mustelidae and Leporidae families, and so preferentially exploited such taxa. Alternatively, the increased exploitation of the taxa in question by modern humans may have been due to environmental availability, or to advances in technology and hunting strategies that allowed modern humans to exploit such hard-to-catch prey for food. However, regardless if modern humans exploited the taxa in question significantly more frequently than Neanderthals due to preference or some other factor, it is clear that the exploitation of such taxa would have been beneficial insofar as their use to make highly insulative clothing in cold OIS 3 environments.

It is not possible to say that Neanderthals did not make clothing from the taxa that are found in LMP sites, however the results of this study suggest that, if both Neanderthals and modern humans made clothing during OIS 3, they made it differently.

Modern humans seem to have made clothing from taxa with highly insulative furs more frequently than Neanderthals, and it is possible that fur trim was a modern human innovation. In addition, modern humans may have tailored their clothing more frequently or more intricately than Neanderthals. So, the clothing of modern humans may have provided more protection from cold than that of Neanderthals.

This research provides a better understanding of the cultural adaptations of Neanderthals and modern humans during the onset of the LGM, and the factors that may have contributed to the replacement of Neanderthals by modern humans. Insufficient clothing can affect overall fitness both directly and indirectly. If an individual is not sufficiently clothed, he or she may freeze to death, contract respiratory ailments, and/or not be able to perform hunting tactics that require long periods of exposure to cold. So, an individual's long-term health, caloric intake, and overall fitness can be affected by clothing. Thermally effective clothing was likely a crucial cultural adaptation during OIS 3, and if modern humans did indeed make clothing more frequently, or made clothing that was more insulative than that made by Neanderthals, it may have contributed to their evolutionary success. The absence of clothing, or the absence of clothing that was as thermally effective as that made by modern humans, may have contributed to the demise of the Neanderthals during the onset of the LGM. Even if insufficient clothing did not cause the extinction of the Neanderthals during OIS 3, and Neanderthals were instead out-competed by modern humans with their more complex technology and increased dietary breadth, it is likely that more complex and thermally effective clothing was a part of the adaptive package of modern humans that contributed to their evolutionary success.

References

- Abu-Lughod, L. 1993. *Writing women's worlds: Bedouin stories*. Berkeley: University of California Press.
- Adriani, N., and A. C. Kruijt. 1951. *The Bare'e-speaking Toradja of Central Celebes (the East Toradja)*. Vol. 3. Amsterdam: Noord-Hollandsche Uitgevers Maatschappij.
- Aginsky, B. W. 1939. *Population control in the Shanel (Pomo) tribe*. Albany: American Sociological Association.
- Akiga East, R. 1939. *Akiga's story: The Tiv tribe as seen by one of its members*. London, New York: Oxford University Press.
- Albert, E. M. 1963. *Women of Burundi: A study of social values*. London: Routledge & Kegan Paul.
- Amadiume, I. 1987. *Afrikan matriarchal foundations: The Igbo case*. London: Karnak House.
- Anderson, M. 1978. *Saami ethnoecology: Resource management in Norwegian Lapland*. Ann Arbor: University Microfilms International.
- Andrews, R. C. 1919. Exploring unknown corners of the 'Hermit Kingdom'. *The National Geographic Magazine* 36 : 25-48.
- Antropova, V. V. 1964. The Koryaks. In *The peoples of Siberia.*, eds. M. G. Levin, L. P. Potapov, 851-875. Chicago: University of Chicago Press.
- Antropova, V. V., and V. G. Kuznetsova. 1964. The Chukchi. In *The peoples of Siberia.*, eds. M. G. Levin, L. P. Potapov, 799-835. Chicago, London: University of Chicago Press.
- Arima, E. Y., and J. Dewhirst. 1990. *Nootkans of Vancouver Island*. Washington, D.C.: Smithsonian Institution.
- Baba of Karo, and M. F. Smith. 1966. *Baba of Karo, a woman of the Muslim Hausa*. London: Farber and Farber.
- Bailey, G. A. 2001. *Osage*. Washington: Smithsonian Institution.
- Bailey, G. A., and R. G. Bailey. 1986. *A history of the Navajos: The reservation years*. Santa Fe: School of American Research Press; Distributed by University of Washington Press.

- Barrett, S. A. 1952. *Material aspects of Pomo culture*. Milwaukee: Board of Trustees.
- . 1917. *Pomo bear doctors*. Berkeley: University of California Press.
- Barrett, S. A. P. 1916. *Pomo buildings*. Washington: J.W. Bryan Press.
- Basden, G. T. 1966. *Among the Ibos of Nigeria: An account of the curious and interesting habits, customs and beliefs of a little known African people by one who has for many years lived amongst them on close and intimate terms*. London: Cass.
- Basehart, H. W., and United States Indian Claims Commission. 1974. *Mescalero Apache subsistence patterns and socio-political organization*. New York; London: Garland Publishing Inc.
- Batchelor, J. 1927. *Ainu life and lore: Echoes of a departing race*. Tokyo: Kyobunkwan.
- Baxter, P. T. W., and A. Butt. 1953. *The Azande, and related peoples of the Anglo-Egyptian Sudan and Belgian Congo*. London: International African Institute.
- Beaglehole, E., and P. Beaglehole. 1937. *Notes on Hopi economic life*. New Haven, London: Yale University Press, H. Milford, Oxford University Press.
- Bean, L. J., and D. J. Theodoratus. 1978. *Western Pomo and Northeastern Pomo*. Washington: Smithsonian Institution.
- Beattie, J. 1961. *Group aspects of the Nyoro spirit mediumship cult*. Lusaka: Published for the Rhodes-Livingstone Institute by the Manchester University Press.
- Beierle, J. 2010. *Culture summary: Abipón*. New Haven: HRAF.
- Bell, C. A., Sir. 1928. *The people of Tibet*. Oxford: Clarendon Press.
- Bellman, B. L. 1984. *The language of secrecy: Symbols & metaphors in Poro ritual*. New Brunswick, New Jersey: Rutgers University Press.
- Belote, J. 1984. *Changing adaptive strategies among the Saraguros of southern Ecuador*. Ann Arbor: University Microfilms International.
- Bennett, W. C., and R. M. Zingg. 1935. *The Tarahumara: An Indian tribe of northern Mexico*. Chicago: The University of Chicago Press.
- Berglund, A. I. 1976. *Zulu thought-patterns and symbolism*. Uppsala: Swedish Institute of Missionary Research.
- Bergsland, K. 1959. *Aleut dialects of Atka and Attu*. Philadelphia: American Philosophical Society.
- Bernatzik, H. A., and V. Ogilvie. 1938. *Overland with the nomad Lapps*. New York: Robert M. McBride & Co.

- Bicanic, R., J. M. Halpern, E. Despalatovic, and C. S. Murray. 1981. *How the people live: Life in the passive regions (peasant life in southwestern Croatia, Bosnia, and Hercegovina, Yugoslavia in 1935)*. Amherst: Dept. of Anthropology, University of Massachusetts.
- Birket-Smith, K. 1953. *The Chugach Eskimo*. Kobenhavn: Nationalmuseets publikationsfond.
- . 1941. *Early collections from the Pacific Eskimo*. København: Gyldendal.
- . 1930. *Contributions to Chipewyan ethnology*. Copenhagen: Gyldendalske Boghandel, Nordisk Forlag.
- Bishop, C. A. 1974. *The northern Ojibwa and the fur trade: An historical and ecological study*. Toronto: Holt, Rinehart and Winston of Canada.
- Black, L. 1973. *The Nivkh (Gilyak) of Sakhalin and the Lower Amur*. Madison: University of Wisconsin Press.
- Black-Michaud, J. 1986. *Sheep and land: The economics of power in a tribal society*. Cambridge, New York, Paris: Cambridge University Press, Editions de la Maison des sciences de l'Homme.
- Blanchard, K. 1977. *The economics of sainthood: Religious change among the Rimrock Navajos*. Rutherford: Fairleigh Dickinson University Press.
- Boas, Franz. 1892. *Third report on the Indians of British Columbia*. London: John Murray.
- Bock, P. K. 1978. *Micmac*. Washington: Smithsonian Institution.
- Bodenstein, W., and O. F. Raum. 1960. *A present day Zulu philosopher*. London: Oxford University Press.
- Bogoraz-Tan, V. G. 1909. *The Chukchee: Material culture, religion, social organization*. Leiden, New York: E.J. Brill, Ltd.; G.E. Stechert and Co.
- Bradfield, M. 1973. *A natural history of associations: A study in the meaning of community*. New York: International Universities Press.
- Breton, R., M. B. McKusick, and P. Verin. 1665. *Carib-French dictionary*. Auxerre: Par Gilles Bouquet.
- Brindley, M. 1985. *Old women in Zulu culture*. Johannesburg: Vereniging van Afrikaanse Volkekundiges.
- Brock, R. G. C. 1918. Some notes on the Zande tribe as found in the Meridi District (Bahr el Ghazal province). In *Sudan notes and records.*, 249-262. New Haven: HRAF.

- Brower, B. A. 1987. *Livestock and landscape: The Sherpa pastoral system in Sagarmatha (Mt. Everest) National Park, Nepal*. Ann Arbor: University Microfilms International.
- Brumbach, H. J., and R. Jarvenpa. 1997. *Ethnoarchaeology of subsistence space and gender: A subarctic Dene case*. Washington: Society for American Archaeology.
- Brumbach, H. J., R. Jarvenpa, and C. Buell. 1982. *An ethnoarchaeological approach to Chipewyan adaptations in the late fur trade period*. Madison: University of Wisconsin Press.
- Bryant, A. T. 1966. *Zulu medicine and medicine-men*. Cape Town: C. Struik.
- Buck, P. H. 1930. *Samoan material culture*. Honolulu: The Museum.
- Bunzel, R. L. 1932. *Zuñi katchinas: An analytical study*. Washington: U.S. Govt. Print. Off.
- Buskirk, W. 1986. *The Western Apache: Living with the land before 1950*. Norman, Oklahoma: University of Oklahoma Press.
- Callaway, D., J. C. Janetski, and O. C. Stewart. 1986. *Ute*. Washington: Smithsonian Institution.
- Campbell, J. K. 1964. *Honour, family and patronage: A study of institutions and moral values in a Greek mountain community*. Oxford: Clarendon Press.
- Carles, W. R. 1888. *Life in Corea*. London: Macmillan and Company.
- Castetter, E. F., and W. H. Bell. 1942. *Pima and Papago Indian agriculture*. Albuquerque: The University of New Mexico Press.
- Castetter, E. F., and R. M. Underhill. 1935. *Ethnobiological studies in the American Southwest: II: The ethnobiology of the Papago Indians*. Albuquerque: The University of New Mexico Press.
- Chapelle, J., and F. Schutze. 1957. *Black nomads of the Sahara*. Paris: Librairie Plon.
- Chapman, A. 1982. *Drama and power in a hunting society: The Selk'nam of Tierra del Fuego*. Cambridge, New York: Cambridge University Press.
- Chervin, A. 1913. Aymaras and Quichuas: A study of Bolivian anthropology. Paper presented at Proceedings of the International Congress of Americanists - Session 18, part 1.
- Clark, D. W. 1974. *Koniag prehistory: Archaeological investigations at late prehistoric sites on Kodiak Island, Alaska*. Stuttgart: W. Kohlhammer.
- Cole, D. P. 2003. *Where have the Bedouin gone?* Washington: Catholic University of America Press.

- Collinder, B. 1949. *The Lapps*. Princeton University Press ed. Princeton, N.J.: for the American Scandinavian Foundation.
- Collins, H. B. 1945. *The Islands and their people*. Washington: Smithsonian Institution.
- Collinson, R., Sir. 1889. *Journal of H.M.S. Enterprise on the expedition of Sir John Franklin's ships by Behring Strait, 1850-55*. London: Sampson Low, Marston, Searle and Rivington, Limited.
- Collocott, E. E. V. 1923. *Marriage in Tonga*. Wellington: Polynesian Society.
- Conaty, G. T. 1995. Comments and reflections: Economic models and Blackfoot ideology. *American Ethnologist* 22 (2): 403-12.
- Condon, R. G. 1981. *Inuit behavior and seasonal change in the Canadian Arctic*. Ann Arbor: UMI Research Press.
- Coon, C. S. 1931. *Tribes of the Rif*. Cambridge, MA: Peabody Museum of Harvard University.
- Cooper, J. M. 1946. *The Araucanians*. Washington: Smithsonian Institution.
- . 1946. *The Ona*. Washington: U.S. Govt. Print. Off.
- . 1946. *The Patagonian and Pampean hunters*. Washington: Smithsonian Institution.
- . 1946. *The Yaghan*. Washington: U.S. Govt. Print. Off.
- . 1917. *Analytical and critical bibliography of the tribes of Tierra del Fuego and adjacent territory*. Washington, D.C.: Govt. Print. Off.
- Cory, C. B. 1896. *Hunting and fishing in Florida, including a key to the water birds known to occur in the state*. Boston: Estes & Lauriat.
- Coxe, W. 1804. *Account of the Russian discoveries between Asia and America*. London: Cadell and Davies.
- Crowell, A. 1992. *Postcontact Koniag ceremonialism on Kodiak Island and the Alaskan Peninsula: Evidence from the fisher collection*. Madison: University of Wisconsin Press.
- Culshaw, W. J. 1949. *Tribal heritage: A study of the Santals*. London: Lutterworth Press.
- Culwick, A. T., G. M. Culwick, and T. Kiwanga. 1935. *Ubena of the rivers*. London: Allen & Unwin, Ltd.
- Cushing, F. H. 1882. *The Nation of the Willows*. Boston: Houghton, Mifflin & Co.

- Czekanowski, J. 1917. *Investigations in the area between the Nile and the Congo: First volume: Ethnography, the interlacustrine region of Mporo and Ruanda*. Vol. 1. Leipzig: Klinkhardt & Biermann.
- Dall, W. H. 1880. *Article VI: On the remains of later pre-historic man obtained from caves in the Catherina Archipelago, Alaska territory, and especially from the caves of the Aleutian Islands*. Washington: Smithsonian Institution.
- Damas, D. 1984. *Copper Eskimo*. Washington, D.C.: Smithsonian Institution Press.
- . 1972. *The Copper Eskimo*. New York: Holt, Rinehart and Winston, Inc.
- Danquah, J. B. 1928. *Gold Coast: Akan laws and customs and the Akim Abuakwa Constitution*. London: George Routledge & Sons, Ltd.
- Davison, J. 1996. *Voices from Mutira: Change in the lives of rural Gikuyo women, 1910-1995*. Boulder: Lynne Rienner Publishers.
- Davison, J., and V. H. Sutlive. 1991. *The children of NISING: Images of headhunting and male sexuality in Iban ritual and oral literature*. Williamsburg: The Borneo Research Council, Inc., Department of Anthropology, College of William and Mary.
- De Coccola, R., P. King, and J. Houston. 1986. *The incredible Eskimo: Life among the barren land Eskimo*. Surrey, Blaine: Hancock House.
- De Laguna, F., ed. 1972. *Under Mount Saint Elias: The history and culture of the Yakutat Tlingit*. Washington, D.C.: Smithsonian Institution Press.
- De Viedma, A., and S. J. Muirden. 1837. *Description of Patagonia*. Buenos Aires: Imprenta del Estado.
- Dempsey, H. A. 1986. *The Blackfoot Indians*. Toronto: McClelland and Stewart.
- Denig, E. T., and J. N. B. Hewitt. 1930. *Indian tribes of the Upper Missouri*. Washington, D.C.: U.S. Govt. Print. Off.
- Densmore, F. 1929. *Pawnee music*. Washington: U.S. Govt. Print. Off.
- Denys, N. 1908. *Description and natural history of the coasts of North America (Acadia)*. Toronto: The Champlain Society.
- Dorsey, J. O. 1896. *Omaha dwelling, furniture and implements*.
- Douglass, W. A. 1975. *Echalar and Murelaga: Opportunity and rural exodus in two Spanish Basque villages*. New York: St. Martin's Press.
- Drake-Brockman, R. E. 1912. *British Somaliland*. London: Hurst & Blackett, Ltd.

- Drucker, P. 1951. *The Northern and Central Nootkan tribes*. Washington: U.S. Govt. Print. Off.
- Du Toit, B. M. 1971. *Religious revivalism among urban Zulu*. Cape Town: C. Struik.
- Dumoutier, G. 1907. *Annamese religions*. Hanoi: F.H. Schneider.
- Dyk, W. 1951. *Notes and illustrations of Navajo sex behaviour*. New York: International Universities Press.
- Dyson-Hudson, R., and J. T. McCabe. 1985. *South Turkana nomadism: Coping with an unpredictably varying environment*. New Haven: Human Relations Area Files.
- Eggan, F. R. 1950. *Social organization of the Western Pueblos*. Chicago: University of Chicago Press.
- Elmore, F. H. 1944. *Ethnobotany of the Navajo*. Albuquerque: University of New Mexico Press.
- . 1938. *Food animals of the Navajo*. Santa Fe: Museum of New Mexico.
- Elwin, V. 1947. *The Muria and their Ghotul*. Bombay: Oxford University Press.
- . 1943. *Maria murder and suicide*. Bombay: Oxford University Press.
- Emeneau, M. B. 1939. *Toda culture thirty-five years after an acculturation study*. Poona: Bhandakar Oriental Research Institute.
- Emmons, G. T., and F. De Laguna. 1991. *The Tlingit Indians*. Seattle, New York: University of Washington Press.
- Ernst, A. H. 1952. *The wolf ritual of the Northwest Coast*. Eugene: University of Oregon.
- Evans-Pritchard, E. E. 1971. *The Azande: History and political institutions*. Oxford: Clarendon Press.
- . 1962. *Zande kings and princes*. London: Faber and Faber.
- . 1948. *The divine kingship of the Shilluk of the Nilotic Sudan*. Cambridge: Cambridge University Press.
- . 1940. *The Nuer: A description of the modes of livelihood and political institutions of a Nilotic people*. Oxford: Clarendon Press.
- Ewers, J. C. 1958. *The Blackfeet: Raiders of the northwestern plains*. Norman: University of Oklahoma Press.
- . 1955. *The horse in Blackfoot Indian culture, with comparative material from other western tribes*. Washington: U.S. Govt. Print. Off.

- . 1945. *Blackfeet crafts*. Lawrence: United States Indian Service.
- Fairbanks, C. H. 1978. *The ethno-archaeology of the Florida Seminole*. Gainesville: University Presses of Florida.
- Far Eastern and Russian Institute of the University of Washington. 1956. *A regional handbook on the Inner Mongolia Autonomous Region*. New Haven: Human Relations Area Files.
- Feng, H., and J. K. Shryock. 1938. *The historical origins of the Lolo*. Cambridge, MA: Harvard-Yenching Institute.
- Fisher, W. B. 1950. Chapter XIII. In *Geography of Iran*. London, New York: Methuen, Dutton, 255-292.
- Fleisher, M. S. 2011. *Culture summary: Nuu-chah-nulth*. New Haven: HRAF.
- Fletcher, A. C., and F. La Flesche. 1911. *The Omaha tribe*. Washington: U.S. Govt. Print. Off.
- Ford, R. I. 1972. *Barter, gift, or violence: An analysis of Tewa inter-tribal exchange*. Ann Arbor: The University of Michigan.
- Forde, C. D. 1950. *The Blackfoot: Buffalo hunters of the North American plains*. London, New York: Methuen, Dutton.
- . 1934. *The Kazak, Kirghiz, and Kalmuch: Horse and sheep herders of Central Asia*. London: Methuen & Co. Ltd.
- Fortes, M., and J. Goody. 1987. *Religion, morality, and the person: Essays on Tallensi religion*. Cambridge university press. Cambridge [Cambridgeshire] ; New York: .
- Friedl, E. 1997. *Children of Deh Koh: Young life in an Iranian village*. Syracuse: Syracuse University Press.
- Frisbie, C. J. 1978. *Burial as a disposition mechanism for Navajo JISH or medicine bundles*. Hurat: Southwestern American Indian Society.
- Fuchs, S. 1960. *The Gond and Bhumia of Eastern Mandla*. Bombay, New York: Asia Pub. House.
- Galvin, K. A., and M. A. Little. 1999. *Dietary intake and nutritional status*. Oxford, New York: Oxford University Press.
- Gatschet, A. S. 1890. *The Klamath Indians of southwestern Oregon*. Washington: U.S. Govt. print. Off.
- Gayton, A. H. 1948. *Yokuts and Western Mono ethnography: Vol. 1, Tulare Lake, Southern Valley, and Central Foothill Yokuts*. Vol. 1. Berkeley: University of California Press.

- Geertz, C. 1960. *The religion of Java*. Glencoe: Free Press.
- Gelo, D. J. 1986. *Comanche belief and ritual*. Ann Arbor: University Microfilms International.
- . 1986. *Comanche belief and ritual*. Ann Arbor: University Microfilms International.
- Gibbs, J. L. 1965. *The Kpelle of Liberia*. New York: Holt, Rinehart and Winston.
- Gifford, E. W. 1965. *The Coast Yuki*. Sacramento: Sacramento Anthropological Society, Sacramento State College.
- . 1926. *Clear Lake Pomo society*. Berkeley: University of California Press.
- Gilbert, W. H. 1978. *The Eastern Cherokees*. New York: AMS Press.
- Gluckman, M. 1967. *The judicial process among the Barotse of northern Rhodesia*. Manchester: Manchester University Press, published on behalf of the Institute for Social Research, University of Zambia.
- . 1959. *The Lozi of Barotseland in north-western Rhodesia*. Manchester: Manchester University Press, on behalf of the Rhodes-Livingstone Institute.
- . 1943. *Essays on Lozi land and royal property*. Livingstone: Rhodes-Livingstone Institute.
- Goddard, I. 1978. *Delaware*. Washington: Smithsonian Institution.
- Goldstein, M. C., and C. M. Beall. 1994. *The changing world of Mongolia's nomads*. Berkeley: University of California Press.
- . 1991. *Change and continuity in nomadic pastoralism on the western Tibetan plateau*. New York: Berghahn Books.
- . 1990. *Nomads of western Tibet: The survival of a way of life*. Berkeley: University of California Press.
- Goodwin, G. C. 1977. *Cherokees in transition: A study of changing culture and environment prior to 1775*. Chicago: University of Chicago Press.
- Goodwin, G. C., and K. H. Basso. 1971. *Western Apache raiding and warfare: From the notes of Grenville Goodwin*. Tucson: University of Arizona Press.
- Gordon, B. C. 1977. *Chipewyan prehistory*. Calgary: Archaeological Association, Dept. of Archaeology, University of Calgary.
- Gourou, P., and R. R. Miller. 1936. *The peasants of the Tonkin delta: A study in human geography*. Paris: Les Éditions d'Art et d'Histoire.

- Graebner, F., and F. Schütze. 1909. *Ethnography of the Santa Cruz Islands*. Leipzig: Ernst Wiegandt.
- Grant, P. 1890. *The Saulteux Indians about 1804*. Quebec: De L'Imprimerie Generale A. Cote et cie.
- Griaule, M., and M. A. Marcus. 1938. *Dogon games*. Paris: Institut d'Ethnologie.
- Griaule, M., and J. H. Winchell. 1938. *Dogon masks*. Paris: Institut d'Ethnologie.
- Grigson, W. V., and V. Elwin. 1949. *The Maria Gonds of Bastar*. London: Oxford University Press.
- Grinnell, G. B. 1962. *Blackfoot lodge tales: The story of a prairie people*. Lincoln: University of Nebraska Press.
- . 1889. *Pawnee hero stories and folk-tales, with notes on the origin, customs and character of the Pawnee people*. New York: Forest and Stream Publishing Company.
- Grout, L. 1864. *Zululand: Or, life among the Zulu-Kafirs of Natal and Zulu-land, South Africa. with map, and illustrations, largely from original photographs*. Philadelphia: Presbyterian Publication Company.
- Gulliver, P., and P. H. Gulliver. 1953. *The Turkana*. London: International African Institute.
- Gulliver, P. H. 1951. *A preliminary survey of the Turkana: A report compiled for the government of Kenya*. Cape Town: University of Cape Town.
- Gusinde, M. 1931. *The Fireland Indians: Vol. 1. The Selk'nam, on the life and thought of a hunting people of the great island of Tierra del Fuego*. Mödling bei Wien: Verlag der Internationalen Zeitschrift.
- Gusinde, M., and F. Schütze. 1937. *The Yahgan: The life and thought of the water nomads of cape horn*. Mödling bei Wein: Anthropos-Bibliothek.
- Gutmann, B., A. M. Nagler, and F. Krueger. 1926. *Chagga law*. Munchen: C.H. Beck.
- Håkansson, T. 1988. *Bridewealth, women, and land: Social change among the Gusii of Kenya*. Uppsala, Stockholm: Uppsala University.
- Halpern, J. M. 2009. *Joel Martin Halpern collection: Serbian photographs from Orašac and its region*. New Haven: HRAF.
- . 1967. *A Serbian village*. New York: Harper & Row.
- Haraldur, O. 1989. *The hunter and the animal*. Iowa City: University of Iowa Press.

- Harrington, M. R. 1921. *Religion and ceremonies of the Lenape*. New York: Museum of the American Indian, Heye Foundation.
- Harvey, B. 1970. *Ritual in pueblo art: Hopi life in Hopi painting*. New York: Museum of the American Indian, Heye Foundation.
- Hauptman, L. M. 1981. *The Iroquois and the new deal*. Syracuse: Syracuse University Press.
- Hay, M. J. 1996. *Hoes and clothes in a Luo household: Changing consumption in a colonial economy*. Bloomington: Indiana University Press.
- Hearne, S. 1958. *A journey from Prince of Wales's Fort in Hudson's Bay to the northern ocean, 1769, 1770, 1771, 1772*. Toronto: Macmillan Co. of Canada.
- Heckewelder, J. G. E. 1819. *An account of the history, manners, and customs, of the Indian nations who once inhabited Pennsylvania and the neighboring states*. Philadelphia: Abraham Small.
- Heizer, R. F., J. E. Mills, and D. C. Cutter. 1952. *The four ages of Tsurai: A documentary history of the Indian village on Trinidad Bay*. Berkeley: University of California Press.
- Henderson, R. N. 1972. *The king in every man: Evolutionary trends in Onitsha Ibo society and culture*. New Haven: Yale University Press.
- Henriksen, G. 1973. *Hunters in the barrens: The Naskapi on the edge of the white man's world*. St. John's: Memorial University of Newfoundland.
- Henry, J., and A. Coleman. 1910. *The soul of an African people: The Bambara: Their psychic, ethical, religious and social life*. Münster: Aschendorff.
- Herman, M. W. 1950. *A reconstruction of aboriginal Delaware culture from contemporary sources*. Berkeley: Kroeber Anthropological Society.
- Hermanns, M., and F. Schütze. 1948. *The A Mdo Pa greater Tibetans: The socio-economic bases of the pastoral cultures of Inner Asia*. Freiburg: Philosophische Fakultät der Universität Freiburg in der Schweiz.
- Hilger, M. I. 1957. *Araucanian child life and its cultural background*. Washington: Smithsonian Institution.
- . 1951. *Chippewa child life and its cultural background*. Washington: U.S. Govt. Print. Off.
- Hill, W. W. 1938. *The agricultural and hunting methods of the Navaho Indians*. New Haven, London: Yale University Press.
- Holmberg, H. J., M. W. Falk, and F. Jaensch. 1985. *The Koniags*. Fairbanks: University of Alaska Press.

- Hooper, W. H. 1853. *Ten months among the tents of the Tuski: With incidents of an arctic boat expedition in search of Sir John Franklin, as far as the MacKenzie River and Cape Bathurst*. London: John Murray.
- Howard, J. H., and W. Lena. 1984. *Oklahoma Seminoles: Medicines, magic and religion*. Norman: University of Oklahoma Press.
- Hrdlicka, A. 1975. *The anthropology of Kodiak Island*. New York: AMS Press.
- Huard, P., and M. M. Durand. 1990. *Viet-nam, civilization and culture*. Paris, Hanoi: Imprimerie National, Ecole française d'Extrême-Orient.
- Hulbert, H. B. 1906. *The passing of Korea*. New York: Doubleday, Page and Co.
- Hulstaert, G. E., and M. B. Vizedom. 1938. *Marriage among the Nkundu*. Bruxelles: Librairie Falk fils, Georges Van Campenhout, Successeur.
- Hungry Wolf, A. 1977. *The blood people: A division of the Blackfoot confederacy: An illustrated interpretation of the old ways*. New York: Harper & Row.
- Hungry Wolf, B. 1980. *The ways of my grandmothers*. New York: Morrow.
- Indiana University Graduate Program in Uralic and Asian Studies. 1995. *The Lapps*. New Haven: HRAF.
- Irimoto, T. 1981. *Chipewyan ecology: Group structure and caribou hunting system*. Osaka: National Museum of Ethnology.
- Itkonen, T. I. 1948. *The Lapps in Finland up to 1945*. Trans. O. Guemati. Vol. 2. Porvoo, Helsinki: Werner Söderström Osakeyhtiö.
- Itkonen, T. I., and E. K. Minn. 1948. *The Lapps in Finland up to 1945*. Trans. E. K. Minn. Vol. 1. Porvoo, Helsinki: Werner Söderström Osakeyhtiö.
- Ivanov, S. V. 1930. *Aleut hunting and headgear and its ornamentation*. New York: Science Press Co.
- Jarvenpa, R. 1980. *The trappers of Pataunak: Toward a spatial ecology of modern hunters*. Ottawa: National Museums of Canada.
- Jarvenpa, R., and H. J. Brumbach. 1984. *The microeconomics of Southern Chipewyan fur trade history*. Vancouver: University of British Columbia Press.
- Jenness, D. 1959. *The People of the Twilight*. Chicago: University of Chicago Press.
- . 1946. *The material culture of the Copper Eskimos*. Ottawa: Edmond Cloutier, King's Printer and Controller of Stationery.

- . 1922. *The life of the Copper Eskimos*. Ottawa: F.A. Acland.
- Jochelson, W. 1933. *The Yakut*. New York: The Trustees.
- . 1908. The Koryak. In *Publications of the Jesup North Pacific Expedition*. Vol. VI, 842. Leiden; New York: E.J. Brill; G.E. Stechert.
- . 1906. *Kumiss festivals of the Yakut and the decoration of Kumiss vessels*. New York: G. E. Stechert & Co.
- Johnson, D. H. 1994. *Nuer prophets: A history of prophecy from the Upper Nile in the nineteenth and twentieth centuries*. New York, Oxford: Clarendon Press, Oxford University Press.
- Jonaitis, A. 1986. *Art of the Northern Tlingit*. Seattle: University of Washington Press.
- Jones, L. F. 1914. *A study of the Thlingets of Alaska*. New York: Fleming H. Revell Co.
- Jorgensen, J. G. 1965. *The ethnohistory and acculturation of the northern Ute*. Ann Arbor: University Microfilms.
- Junod, H. A. 1927. *The life of a South African tribe*. Vol. 2. London: Macmillan and Co., Limited.
- . 1927. *The life of a South African tribe*. Vol. 1. London: Macmillan and Co., Limited.
- Kagwa, A. Sir, E. B. Kalibaba, and M. Edel. 1934. *The customs of the Baganda*. New York: Columbia University Press.
- Kan, S. 1989. *Symbolic immortality: The Tlingit potlatch of the nineteenth century*. Washington: Smithsonian Institution Press.
- Karsten, R. 1932. *Indian tribes of the Argentine and Bolivian Chaco: Ethnological studies*. Helsingfors: Akademische Buchhandlung.
- Kaufmann, H., and R. Neuse. 1910. *The #Auin: A contribution to the study of the Bushmen*. Berlin: HRAF.
- Kavvadias, G. V., and F. Schütze. 1965. *Mediterranean pastoral nomads: The Sarakatsani of Greece*. Paris: Gauthier-Villars.
- Kehoe, A. B. 1995. *Blackfoot persons*. Norman: University of Oklahoma Press.
- Kennan, G. 1870. *Tent life in Siberia: And adventures among the Koryaks and other tribes in Kamtchatka and northern Asia*. New York, London: G.P. Putnam and Sons, S. Lowe, Son and Marston.
- Kennedy, D., and J. R. Stevens. 1972. *Recollections of an Assiniboine chief*. Toronto: McClelland and Stewart.

- Kennedy, D. I., and R. Bouchard. 1990. *Bella Coola*. Washington, D.C.: Smithsonian Institution.
- Kennedy, M. J. 1955. Culture contact and acculturation of the southwestern Pomo. University of California.
- Kenyatta, J. 1953. *Facing Mount Kenya: The tribal life of the Gikuyu*. London: Secker and Warburg.
- King, A. D. 1999. *Soul suckers: Vampiric shamans in northern Kamchatka, Russia*. Washington, D.C.: American Anthropological Association.
- Kirchoff, P. 1959. *The Warrau*. Washington: U.S. Govt. Print. Off.
- Kler, J. 1941. *Hunting customs of the Ordos Mongols*. Washington, D.C.: Catholic Anthropological Conference.
- Kluckhohn, C. 1944. *Navaho witchcraft*. Cambridge, Massachusetts: The Museum.
- Kluckhohn, C., W. W. Hill, and L. W. Kluckhohn. 1971. *Navaho material culture*. Cambridge: Belknap Press of Harvard University Press.
- Kluckhohn, C., and D. Leighton. 1946. *The Navaho*. Cambridge: Harvard University Press.
- Knapp, F., and R. L. Dorr. 1896. *The Thlinkets of southern Alaska*. Chicago: Stone and Kimball.
- Kohl, J. G., and F. C. L. Wraxall Sir. 1860. *Kitchi-gami: Wanderings round lake superior*. London: Chapman and Hall.
- Kohler, M., and N. J. Van Warmelo. 1933. *Marriage customs in southern Natal*. Pretoria: Government Printer.
- Koppert, V. A. 1930. *Contributions to Clayoquot ethnology*. Washington, D.C.: Catholic University of America.
- Krasheninnikov, S. P., and J. Grieve. 1764. Of the Nation of the Koreki. In *The history of Kamtschatka, and the Kurilski islands, with the countries adjacent.*, 222-234. Gloucester, London: R. Raikes, T. Jefferys.
- Krause, A., and E. Gunter. 1956. *The Tlingit Indians: Results of a trip to the Northwest Coast of America and the Bering straits*. Seattle: University of Washington Press.
- Krauss, F. 1969. *The Zulu*. Johannesburg: Africana Society.
- Krige, E. J. 1965. *The social system of the Zulus*. Pietermaritzburg: Shuter & Shooter.
- Kroeber, A. L. 1972. *The Yuki: Culture*. St. Clair Shores: Scholarly Press.

- . 1953. *Pomo Indians*. Berkeley: California Book Company.
- . 1953. *The Yokuts*. Berkeley: California Book Company Ltd.
- . 1925. *Handbook of the Indians of California*. Washington: U.S. Govt. Print. Off.
- Kronenberg, A., and F. Schütze. 1958. *The Teda of Tibesti*. Horn-Wien: Verlag Ferdinand Berger.
- Kurylev, V. P. 2011. *Culture summary: Kazakh*. New Haven: HRAF.
- La Barre, W. 1948. *The Aymara Indians of the Lake Titicaca Plateau*. Menasha: American Anthropological Association.
- La Flesche, F., and G. A. Bailey. 1995. *The Osage and the invisible world: From the works of Francis la Flesche*. Norman: University of Oklahoma Press.
- Lancaster, R. 1966. *Piegán: A look from within at the life, times, and legacy of an American Indian tribe*. Garden City: Doubleday.
- Lane, K. S. 1952. *The Montagnais Indians*. Berkeley: The Kroeber Anthropological Society.
- Lange, C. H. 1952. The feast day dance at Zia Pueblo. *The Texas Journal of Science* 4 (1): 19-26.
- Latta, F. F. 1949. *Handbook of Yokuts Indians*. Oildale: Bear State Books.
- Laughlin, W. S. 1980. *Aleuts: Survivors of the Bering land bridge*. New York: Holt, Rinehart, and Winston.
- Le Clercq, C., and W. F. Ganong. 1910. *New relation of Gaspesia: With the customs and religion of the Gaspesian Indians*. Toronto: The Champlain Society.
- Le Coeur, C., and F. Schütze. 1950. *Teda ethnographic dictionary preceded by a French-Teda lexicon*. Paris: Librairie Larose.
- Lebzelter, V., and R. Neuse. 1934. *Native cultures in Southwest and South Africa*. Vol. 2. Leipzig: Karl W. Hiersemann.
- Leca, N., and D. Crawford. 1935. *The fishermen of Guer N'dar with a note on the Wolof, their speech and secret languages by Henri Labouret*. Trans. D. Crawford. Paris: Librairie Larose.
- Lee, R. B. 1966. *Subsistence ecology of !kung bushmen*. Ann Arbor, Michigan: University Microfilms.
- Leroi-Gourhan, A. 1953. *French Somaliland*. Paris: Presses Universitaires de France.

- Levine, D. N. 1965. *Wax & gold: Tradition and innovation in Ethiopian culture*. Chicago: University of Chicago Press.
- Lévi-Strauss, C., and E. Sittler. 1948. *Family and social life of the Nambikwara Indians*. Paris: Société des Américanistes.
- Lewis, O. 1951. *Life in a Mexican village: Tepoztlan restudied*. Urbana: University of Illinois Press.
- Liberty, M., W. R. Wood, and L. Irwin. 2001. *Omaha*. Washington: Smithsonian Institution.
- Ling, S. S., Y. Ruey, and L. E. Tsao. 1947. *A report on an investigation of the Miao of Western Hunan*. Shanghai: Academia Sinica, The Institute of History and Philology.
- Linton, R. 1939. *Marquesan culture*. New York: Columbia University Press.
- . 1923. *Annual ceremony of the Pawnee medicine man*. Chicago: Field Museum of Natural History.
- Lips, J. 1947. Naskapi law: Law and order in a hunting society. Paper presented at Transactions of the American Philosophical Society, Philadelphia.
- . 1947. *Notes on Montagnais-Naskapi economy (lake st. john and lake mistassini bands)*. Stockholm: The Ethnographical Museum of Sweden and the Swedish Oriental Society.
- Little, K. L. 1951. *The Mende of Sierra Leone*. London: Routledge and Kegan Paul.
- Loane, H. J. 1938. *Industry and commerce of the City of Rome (50 B.C. - 200 A.D.)*. Baltimore: John Hopkins Press.
- Lockwood, W. G. 1975. *Social status and cultural change in a Bosnian Moslem village*. Boulder: University of Colorado.
- Loeb, E. M. 1926. *Pomo folkways*. Berkeley: University of California Press.
- Long, J. L., M. S. Kennedy, and W. Standing, eds. 1961. *The Assiniboines: From the accounts of the old ones told to first boy (James Larpenteur Long)*, ed. M. S. Kennedy. Norman: University of Oklahoma Press.
- Lorimer, E. O. 1939. *Language hunting in the Karakoram*. London: Allen and Unwin.
- . 1938. *The Burusho of Hunza*. Glouster: Antiquity Publications.
- Lothrop, S. K. 1929. *Polychrome guanaco cloaks of Patagonia*. New York: Museum of the American Indian, Heye Foundation.

- . 1928. *The Indians of Tierra del Fuego*. New York: Museum of the American Indian.
- Lowie, R. H. 1909. *The Assiniboine*. New York: The Trustees.
- Lugg, H. C. 1929. *Agricultural ceremonies in Natal and Zululand*. Johannesburg: Witswatersrand University Press.
- Lumholtz, C. 1902. *Unknown Mexico: A record of five years exploration of the western Sierra Madre in the Tierra Caliente of Tepic and Jalisco and among the Tarascos of Michoacan*. New York: Charles Scribners Sons.
- Lutfiyya, A. M. 1966. *Baytīn a Jordanian village: A study of social institutions and social change in a folk community*. The Hague: Mouton.
- Lyford, C. A. 1945. *Iroquois crafts*. Lawrence, Kansas: Haskell Institute.
- MacCauley, C. 1887. *The Seminole Indians of Florida*. Washington: Smithsonian Institution.
- Mair, L. P. 1934. *An African people in the twentieth century*. London: Routledge & Sons.
- Maiskii, I. M., and K. J. Dayton. 1921. *Contemporary Mongolia*. Irkutsk: Gosudarstvennoe Izdatel'stvo, Irkutskoe Otdelenie.
- Malotki, E., and M. Lomatuway'ma. 1987. *Maasaw: Profile of a Hopi god*. Lincoln: University of Nebraska Press.
- Maquet, J. J. P. 1961. *The premise of inequality in Ruanda: A study of political relations in a Central African kingdom*. London: Oxford University Press for the International African Institute.
- Marshall, L. 1976. *The !kung of Nyae Nyae*. Cambridge: Harvard University Press.
- Mason, L. 1967. *The Swampy Cree: A study in acculturation*. Ottawa: Queen's Printer.
- McCall, J. C. 2000. *Dancing histories: Heuristic ethnography with the Ohafia Igbo*. Ann Arbor: University of Michigan Press.
- McClellan, C. 1954. *The interrelations of social structure with northern Tlingit ceremonialism*. Albuquerque: University of New Mexico and the Laboratory of Anthropology.
- McClintock, W. 1968. *The Old North Trail: Or, life, legends and religion of the Blackfeet Indians*. Lincoln: University of Nebraska Press.
- McCormack, A. P. 1964. *Khasis*. New Haven: Human Relations Area Files Press.
- McFee, Malcolm. 1972. *Modern Blackfeet: Montanans on a reservation*. New York: Holt, Rinehart and Winston.

- McIlwraith, T. F. 1948. *The Bella Coola Indians*. Vol. 2. Toronto: University of Toronto Press.
- . 1948. *The Bella Coola Indians*. Vol. 1. Toronto: University of Toronto Press.
- McLendon, S. 1977. *Ethnographic and historical sketch of the eastern Pomo and their neighbors, the Southeastern Pomo*. Berkeley: University of California, Dept. of Anthropology.
- Mead, M. 1932. *The changing culture of an Indian tribe*. New York: Columbia University Press.
- Meek, C. K. 1970. *Law and authority in a Nigerian tribe: A study in indirect rule*. New York: Barnes & Noble.
- Merker, M. 1910. *The Masai: Ethnographic monograph of an East African Semite people*. Berlin: Dietrich Reimer (Ernst Vohsen).
- . 1910. *The Masai: Ethnographic monograph of an East African Semite people*. Berlin: Dietrich Reimer (Ernst Vohsen).
- Merwin, B. W. 1915. *The Copper Eskimo*. Philadelphia: The University Museum, University of Pennsylvania.
- Messing, S. D., and M. L. Bender. 1985. *Highland Plateau Amhara of Ethiopia*. New Haven: HRAF.
- Meyer, H., and H. Handzik. 1916. *The Barundi: An ethnological study of German East Africa*. Leipzig: Ott Spamer.
- Middleton, J. 1953. *The central tribes of the north-eastern Bantu: (the Kikuyu, including Embu, Meru, Mbere, Chuka, Mwimbi, Tharaka, and the Kamba of Kenya)*. London: International African institute.
- Miller, V. P. 1979. *Ukomno'm: The Yuki Indians of northern California*. Socorro: Ballena Press.
- Mitchell, F. 1978. *Navajo blessingway singer: The autobiography of Frank Mitchell, 1881-1967*. Tucson: University of Arizona Press.
- Mitchell, R., and C. J. Frisbie. 2001. *Tall woman: The life story of Rose Mitchell, a Navajo woman*. Albuquerque: University of New Mexico Press.
- Montagne, R., and J. Winchell. 1930. *The Berbers and the Makhzen in the South of Morocco: Essay on the political transformation of the sedentary Berbers (the Chleuh group)*. Paris: Librairie Félix Alcan.
- Morgan, L. H., and H. M. Lloyd. 1901. *League of the Ho-de'-no-sau-nee or Iroquois*. Vol. 1. New York: Dodd, Mead and Company.

- Munro, N. G., B. Z. Seligman, and H. Watanabe. 1963. *Ainu creed and cult*. New York: Columbia University Press.
- Murie, J. R., and D. R. Parks. 1982. *Ceremonies of the Pawnee*. Lincoln: University of Nebraska Press of the American Indian Studies Research Institute, Indiana University.
- Murra, J. V. 1980. *The economic organization of the Inka state*. Greenwich, Connecticut: JAI Press.
- Musil, A. 1928. *The manners and customs of the Rwala Bedouins*. New York: The American Geographical Society.
- Musters, G. C. 1873. *At home with the Patagonians*. London: J. Murray.
- Nader, L. 1990. *Harmony ideology: Justice and control in a Zapotec mountain village*. Stanford: Stanford University.
- Newcomb, F. J. 1964. *Hosteen Klah: Navaho medicine man and sand painter*. Norman: University of Oklahoma Press.
- . 1940. *Navajo omens and taboos*. Santa Fe: Rydal Press.
- Newcomb, W. W. 1956. *The culture and acculturation of the Delaware Indians*. Ann Arbor: University of Michigan.
- Ng, M. 1978. *Natido Binwag weaves the Bango*. Philippines: Council for Living Traditions.
- Nicolaisen, J. 1963. *Ecology and culture of the pastoral Tuareg: With particular reference to the Tuareg of Ahaggar and Ayr*. Copenhagen: The National Museum of Copenhagen.
- Nooy-Palm, H. 1986. *The Sa'dan-Toraja: A study of their social life and religion*. The Hague: Martinus Nijhoff.
- Norbeck, E. 1954. *Takashima: A Japanese fishing community*. Salt Lake City: University of Utah Press.
- Nordenskiöld, A. E., and A. Leslie. 1882. *The voyage of the Vega round Asia and Europe, with a historical review of previous journeys along the north coast of the Old World*. New York: Macmillan and Co.
- Nordenskiöld, E. F., R. Pérez Kantule, and H. Wassén. 1938. *An historical and ethnological survey of the Cuna Indians*. Göteborg: Göteborg Museum.
- Nutchuk, and A. Hatch. 1946. *Back to the smoky sea*. New York: J. Messner Inc.
- Nyakatura, J., and Z. K. Rigby. 1970. *Aspects of Bunyoro custom and tradition*. Nairobi: East African Literature Bureau.

- Oberg, K. 1949. *The Terena and the Caduveo of southern Mato Grosso, Brazil*. Washington: U.S. Govt. Print. Off.
- . 1937. *The social economy of the Tlingit Indians*. University of Chicago.
- Ohnuki-Tierney, E. 1981. *Illness and healing among the Sakhalin Ainu: A symbolic interpretation*. Cambridge, New York: Cambridge University Press.
- . 1974. *The Ainu of the northwest coast of southern Sakhalin*. Prospect Heights: Waveland Press, Inc.
- Olson, R. L. 1967. *Social structure and social life of the Tlingit in Alaska*. Berkeley: University of California Press.
- . 1936. *The Quinault Indians*. Seattle: The University of Washington.
- Opler, M. E. 1969. *Apache odyssey: A journey between two worlds*. New York: Holt, Rinehart and Winston.
- Ortiz, A. 1969. *The Tewa world: Space, time, being, and becoming in a pueblo society*. Chicago: University of Chicago Press.
- Oswalt, R. L., and J. Beierle. 2001. *Culture summary: Pomo*. New Haven: HRAF.
- Ottenberg, S. 1989. *Boyhood rituals in an African society: An interpretation*. Seattle: University of Washington Press.
- . 1975. *Masked rituals of Afikpo, the context of an African art*. Seattle: Published for the Henry Art Gallery by the University of Washington Press.
- . 1971. *Leadership and authority in an African society: The Afikpo village-group*. Seattle: University of Washington Press.
- Pagés, G., and B. Scholl. 1933. *A Hamitic kingdom in the center of Africa: In Ruanda on the shores of Lake Kivu (Belgian Congo)*. Bruxelles: Libraire Falk fils, Georges van Campenhout, Successeur.
- Palau Martí, M., and F. Schütze. 1957. *The Dogon*. Paris: Presses Universitaires de France.
- Pallas, P. S., and J. R. Masterson. 1948. *Bering's successors*. Seattle: University of Washington Press.
- Parsons, E. W. C. 1929. *The social organization of the Tewa of New Mexico*. Vol. 36. Menasha: The American Anthropological Association.
- Paulme, D., and F. Schütze. 1940. *Social organization of the Dogon (French Sudan)*. Paris: Éditions Domat-Montchrestien, F. Loviton et Cie.

- Pavlovic, J. M. 1973. *Folk life and customs in the Kragujevac region of the Jasenica in Sumdajja*. New Haven: HRAF.
- Peers, L. L. 1994. *The Ojibwa of western Canada*. St. Paul: Minnesota Historical Society.
- Pennington, C. W. 1963. *The Tarahumara of Mexico: Their environment and material culture*. Salt Lake City: University of Utah Press.
- Petrullo, V. M. 1932. *Primitive peoples of Matto Grosso Brazil*. Philadelphia: University of Pennsylvania Museum.
- Pilling, A. R. 1989. *Yurok aristocracy and 'great houses'*. Berkeley: Native American Studies Program, University of California.
- Pollard, S. 1921. *In unknown China: A record of the observations, adventures and experiences of a pioneer missionary during a prolonged sojourn amongst the wild and unknown Nosu tribe of western China*. Philadelphia: J.C. Lippincott Company.
- Popov Veniaminov, I. E. 1840. *Notes one the islands of the Unalaska district*. St. Petersburg: Russian-American Company.
- Popov, A. A. 1964. *The Dolgans*. Chicago: University of Chicago Press.
- . 1935. *Reindeer breeding among the Dolgan*. Moskova and Leningrad: Akademiia Nauk SSSR.
- Pospisil, L. J. 1963. *Kapauku Papuan economy*. New Haven: Dept. of Anthropology, Yale University.
- Powers, S. 1877. *The Pomo*. Washington: Govt. Print. Off.
- . 1877. *The Yokuts*. Washington: U.S. Govt. Print. Off.
- Powers, Stephen. 1976. *The Yú-ki*. Berkeley: University of California Press.
- Priklonskii, V., and F. S. Krauss. 1888. *Shamanism among the Yakut*. Wien: Alfred Hölder.
- Priklonskii, V. L. 1890. *Three years in the Yakut territory: Ethnographic sketches*. St. Petersburg, Russia: Zhivaia Starina.
- Prins, H. E. L. 1996. *The Mi'kmaq: Resistance, accommodation, and cultural survival*. Fort Worth: Harcourt Brace College Pub.
- Pryde, D. 1972. *Nunaga: My land, my country*. Edmonton: M.G. Hurtig Ltd.
- Radin, P. 1923. *The Winnebago tribe*. Washington, D.C.: Smithsonian Institution.

- Raswan, C. R. 1947. *Black tents of Arabia*. New York: Creative Age Press.
- Rattray, R. S. 1916. *Ashanti proverbs: (the primitive ethics of a savage people)*. Oxford, England: Clarendon Press.
- Raum, O. F. 1973. *The social functions of avoidance and taboos among the Zulu*. Berlin, New York: de Gruyter.
- Ray, A. J. 1974. *Indians in the fur trade: Their role as trappers, hunters, and middlemen in the lands southwest of Hudson Bay, 1660-1870*. Toronto, Buffalo: University of Toronto.
- Ray, V. F. 1938. *Lower Chinook ethnographic notes*. Seattle: University of Washington.
- Re Cruz, A. 1996. *The two Milpas of Chan Kom: Scenarios of a maya village life*. Albany: State University of New York.
- Redfield, R. 1941. *The folk culture of Yucatan*. Chicago: The University of Chicago Press.
- Reynolds, B. 1963. *Magic, divination and witchcraft among the Barotse of northern Rhodesia*. London: Chatto and Windus.
- Richards, A. I. 1939. *Chisungu: A girls' initiation ceremony among the Bemba of northern Rhodesia*. London: Faber and Faber.
- Roberts, J. M. 1951. *Three Navaho households: A comparative study in small group culture*. Cambridge, MA: Peabody Museum.
- Rodnick, D., and Bureau of Indian Affairs, United States. 1938. *The Fort Belknap Assiniboine of Montana*. University of Pennsylvania.
- Rogers, E. S. 1962. *The Round Lake Ojibwa*. Toronto: Ontario Dept. of Lands and Forests for the Royal Ontario Museum.
- Rogers, E. S., and J. T. Garth. 1981. *Northern Ojibwa*. Washington: Smithsonian Institution.
- Roscoe, J. 1924. *The Bagesu and other tribes of the Uganda protectorate: The third part of the report of the Mackie ethnological expedition to Central Africa*. Cambridge: Cambridge University Press.
- . 1923. *The Bakitara or Bunyoro: The first part of the report of the Mackie ethnological expedition to Central Africa*. Cambridge: Cambridge University Press.
- . 1911. *The Baganda: An account of their native customs and beliefs*. London: Macmillan and Co.

- Routledge, W. S., and S. B. Routledge. 1910. *With a prehistoric people: The Akikuyu of British East Africa, being some account of the method of life and mode of thought found existent amongst a nation on its first contact with European civilisation*. London: Edward Arnold.
- Rowe, J. H. 1946. *Inca culture at the time of the Spanish conquest*. Washington: U.S. Govt. Print. Off.
- Ruby, R. H., and J. A. Brown. 1976. *The Chinook Indians: Traders of the Lower Columbia River*. Norman: University of Oklahoma Press.
- Sanders, I. T. 1962. *Rainbow in the rock: The people of rural Greece*. Cambridge: Harvard University Press.
- Sauer, M. 1802. *An account of a geographical and astronomical expedition to the northern parts of Russia by commodore Joseph Billings, in the years 1785-1794*. London: T. Cadell, jun. and W. Davies.
- Schaden, E., and L. P. Lewinsóhn. 1962. *Fundamental aspects of Guaraní culture*. Sao Paulo: Difusao Européia do Livro.
- Schapera, I. 1930. *Culture of the Hottentots*. London: Routledge.
- Scheffer, J. 1704. *The history of Lapland: Containing a geographical description, and a natural history of that country; with an account of the inhabitants, their original, religion, customs, habits, marriages, conjurations, employments, etc.* London: Printed for Tho. Newborough, at the Golden-Ball in St. Paul's-Church-Yard and R. Parker under the Royal-Exchange.
- Schram, L., and J. H. Winchell. 1932. *Marriage among the T'u-jen of Kansu (China)*. Shanghai: Catholic Mission Press.
- Schröder, D., and R. Neuse. 1953. *On the religion of the Tujen of the Sining region (Koko Nor)*. Freiburg: Anthropos-Institut.
- Schultz, J. W. 1930. *The sun god's children*. Boston and New York: Houghton Mifflin Co.
- Schultze, L. S., E. C. Knight, and T. Ziolkowski. 1907. *In Namaland and the Kalahari*. Jena: Gustav Fischer.
- Schwimmer, E. G. 1973. *Exchange in the social structure of the Orokaiva: Traditional and emergent ideologies in the northern district of Papua*. London: C. Hurst.
- . 1969. *Cultural consequences of a volcanic eruption experienced by the Mount Lamington Orokaiva*. Eugene: Dept. of Anthropology, University of Oregon.
- Seligman, C. G., and B. Z. Seligman. 1932. *Pagan tribes of the Nilotic Sudan*. London: George Routledge and Sons Ltd.

- Seligman, C. G., B. Z. Seligman, C. S. Myers, and A. M. Gunasekara. 1911. *The Veddas*. Cambridge: Cambridge University Press.
- Shade, C. I. 2007. *Ethnological notes on the Aleuts*. New Haven: HRAF.
- Sharp, H. S. 1976. *Man, wolf, woman, dog*. Madison: University of Wisconsin Press.
- Shaw, K. C. 1932. *Some preliminary notes on Luo marriage customs*. Nairobi: Coryndon Memorial Museum.
- Shooter, J. 1857. *The Kafirs of Natal and the Zulu country*. London: E. Stanford.
- Shternberg, L. I., L. Bromwich, and N. Ward. 1933. *The Gilyak, Orochi, Goldi, Negidal, Ainu: Articles and materials*. Trans. L. Bromwich and N. Ward. Khabarovsk: Dal'giz.
- Sieroszewski, W. 1896. *The Yakut: An experiment in ethnographic research*. Moskva: Assotsiatsiia 'Rossiiskaia polit. entsiklopediia.
- Silberbauer, G. B. 1981. *Hunter and habitat in the Central Kalahari Desert*. Cambridge: Cambridge University Press.
- . 1972. *The G/wi bushmen*. New York: Holt, Rinehart and Winston.
- Silverstein, M. 1990. *Chinookans of the Lower Columbia*. Washington: Smithsonian Institution.
- Sivertsen, D. 1963. *When caste barriers fall: A study of social and economic change in a South Indian village*. Copenhagen, New York: Universitetsforlaget Humanities Press.
- Smith, A. M. 1974. *Ethnography of the Northern Utes*. Santa Fe: Museum of New Mexico Press.
- Smith, D. M. 1982. *Moose-deer island house people: A history of the native people of Fort Resolution*. Ottawa: National Museums of Canada.
- Smith, D. Z. 1852. *Description of the manners and customs of the Pawnee Indians*. Bethlehem: Church of the United Bretheren.
- Smith, J. G. E. 1981. *Chipewyan*. Washington: Smithsonian Institution.
- . 1981. *Western Woods Cree*. Washington, D.C.: Smithsonian Institution.
- . 1975. *The ecological basis of Chipewyan socio-territorial organization*. Ottawa: National Museum of Canada.
- Smithson, C. L. 1959. *The Havasupai woman*. Salt Lake City: University of Utah Press.
- Southwold, M. 1965. *The Ganda of Uganda*. New York: Holt, Rinehart and Winston.

- Speck, F. G. 1937. *Oklahoma Delaware ceremonies, feasts and dances*. Philadelphia: The Society.
- . 1935. *Naskapi: The savage hunters of the Labrador Peninsula*. Norman: University of Oklahoma Press.
- Spier, L. 1930. *Klamath ethnography*. Berkeley: University of California Press.
- . 1928. *Havasupai ethnography*. New York: The Trustees.
- Steinbring, J. 1981. *Salteaux of Lake Winnipeg*. Washington: Smithsonian Institution.
- Stern, T. 1965. *The Klamath tribe: A people and their reservation*. Seattle: University of Washington Press.
- Stevenson, M. C. E. 1904. *The Zuni Indians: Their mythology, esoteric fraternities, and ceremonies*. Washington: U.S. Govt. Print. Off.
- Storm, J. M., and P. K. Capoeman. 1990. *Land of the Quinault*. Taholah: Quinault Indian Nation.
- Sverdrup, H. U. 1938. *With the people of the tundra*. Oslo: Gyldendal Norsk Forlag.
- Swan, J. G. 1870. *The Indians of Cape Flattery: At the entrance to the Strait of Fuca, Washington Territory*. Washington, D.C.: Smithsonian Institution.
- Swanton, J. R. 1905. *Social condition, beliefs, and linguistic relationship of the Tlingit Indians*. Washington: Smithsonian Institution.
- Talbot, L. M. 1964. *Ecology of western Masailand, East Africa*. Ann Arbor: University Microfilms.
- Tanaka, J. 1976. *Subsistence ecology of central Kalahari San*. Cambridge: Harvard University Press.
- Tanner, V. 1944. *Outlines of the geography, life and customs of Newfoundland-Labrador*. Helsinki: Societas Geographica Fennia.
- Tauxier, L., and A. Brunel. 1912. *The black population of the Sudan, Mossi and Gourounsi country, documents and analyses*. Paris: Emile Larose, Librairie-Editeur.
- Theodoratus, D. J. 1971. *Identity crises: Changes in lifestyle of the Manchester band of the Pomo Indians*. Ann Arbor: University Microfilms.
- Therriault, M. 1992. *Moose to moccasins: The story of Ka kita wa pa no kwe*. Toronto: Natural Heritage/Natural History.
- Thomas, E. M. 1959. *The harmless people*. New York: Knopf.

- Thompson, L. B. 1916. *To the American Indian*. Eureka: Cummins Print Shop.
- Thomson, J. 1887. *Through Masai land: A journey of exploration among the snowclad volcanic mountains and the strange tribes of eastern equatorial Africa*. London: Sampson Low, Marston, Searle & Rivington.
- Tice, K. E. 1995. *Kuna crafts, gender, and the global economy*. Austin: University of Austin Press.
- Titiev, M. 1972. *The Hopi Indians of Old Oraibi: Change and continuity*. Ann Arbor: University of Michigan Press.
- . 1971. *Old Oraibi: A study of the Hopi Indians of the third mesa*. New York: Kraus Reprint Co.
- Tobe, J. H. 1960. *Hunza: Adventures in a land of paradise*. Rodale Books ed. Emmaus.
- Tokarev, S. A., and I. S. Gurvich. 1964. *The Yakuts*. Chicago: University of Chicago Press.
- Turner, L. M. 1894. *Ethnology of the Ungava district, Hudson Bay Territory published in: Eleventh annual report of the bureau of ethnology to the secretary of the Smithsonian Institution 1889-90*. Washington: U.S. Govt. Print. Off.
- Turner, V. W. 1952. *The Lozi peoples of north-western Rhodesia*. London: International African Institute.
- VanStone, J. W. 1965. *The changing culture of the snowdrift Chipewyan*. Ottawa: National Museum of Canada.
- . 1963. *The snowdrift Chipewyan*. Ottawa: Northern Co-ordination and Research Centre, Dept. of Northern Affairs and National Resources.
- Variakojis, D. J. 1969. *Concepts of secular and sacred among the White Mountain Apache as illustrated by musical practice*. Ann Arbor: University Microfilms.
- Veniaminov, I. E. P. 1840. *Notes on the islands of the Unalaska District*. St. Petersburg: Russian-American Company.
- Vialla de Sommieres, L. C. 1820. *Travels in Montenegro, containing a topographical, picturesque, and statistical account of that hitherto undescribed country*. London: Printed for R. Phillips.
- von Furer-Haimendorf, Christoph. 1984. *The Sherpas transformed: Social change in a Buddhist society of Nepal*. New Delhi: Sterline.
- von Schrenck, L., and A. Nagler. 1856. The peoples of the Amur region. In *Reisen und forschungen im amur-lande in den jahren 1854-1856*. Vol. 3, 311-776. St. Petersburg: Kaiserliche Akademie der Wissenschaften.

- Vorren, O., E. Manker, and K. McFarlane. 1962. *Lapp life and customs: A survey*. London: Oxford University Press.
- Wagley, C. 1977. *Welcome of tears: The Tapirapé Indians of central Brazil*. New York: Oxford University Press.
- Wallace, A. F. C., and S. K. Steen. 1969. *The death and rebirth of the Seneca*. New York: Vintage Books, Random House.
- Wallace, E. H., and E. Adamson. 1952. *The Comanches: Lords of the south plains*. Norman: University of Oklahoma Press.
- Wallace, W. J. 1978. *Southern Valley Yokuts*. Washington: Smithsonian Institution.
- Wallis, W. D., and R. S. Wallis. 1955. *The Micmac Indians of eastern Canada*. Minneapolis: University of Minnesota Press.
- Warren, W. W., J. F. Williams, and E. D. Neill. 1885. *Collections of the Minnesota historical society*. Vol. 5. Saint Paul: Minnesota Historical Society.
- Wedel, W. R. 1936. *An introduction to Pawnee archaeology*. Washington: U.S. Govt. Print. Off.
- Weltfish, G. 1965. *The lost universe: With a closing chapter on 'the universe regained'*. New York, London: Basic Books.
- Werner, H., and R. Neuse. 1906. *Anthropological, ethnological and ethnographic observations concerning the Heikum and Kung bushmen: With an appendix on the languages of these bushmen tribes*. Berlin: Berlin Society for Anthropology, Ethnology, and Prehistory.
- Westerman, D. H., and F. Schütze. 1921. *The Kpelle: A Negro tribe in Liberia*. Göttingen, Leipzig: Vandenhoeck & Ruprecht, J. C. Hinrichs'sche Buchhandlung.
- White, L. A. 1962. *The pueblo of Sia, New Mexico*. Washington: U.S. Govt. Print. Off.
- Whitecotton, J. W. 1977. *The Zapotecs: Princes, priests, and peasants*. Norman: University of Oklahoma Press.
- Whitehouse, L. E. 1933. Masai social customs. *Journal of the East Africa and Uganda Natural History Society* 47-48 : 146-53.
- Willoughby, C. C. 1886. *Indians of the Quinaielt Agency, Washington Territory*. Washington: U.S. Govt. Print. Off.
- Wilson, M. H. 1977. *For men and elders: Change in the relations of generations and of men and women among the Nyakyusa-Ngonde people, 1875-1971*. New York: Africana Pub. Co. for the International African Institute.

- . 1959. *Communal rituals of the Nyakyusa*. London, New York, Toronto: International Institute by the Oxford University Press.
- . 1951. *Good company: A study of Nyakyusa age-villages*. London: Oxford University Press for the International African Institute.
- Wissler, C. 1918. *The sun dance of the Blackfoot Indians*. New York: The Trustees.
- . 1913. *Societies and dance associations of the Blackfoot Indians*. New York: The Trustees.
- . 1912. *Ceremonial bundles of the Blackfoot Indians*. New York: The Trustees.
- . 1910. *Material culture of the Blackfoot Indians*. New York: The Trustees.

Works Cited

- Adovasio, J. M., O. Soffer, and B. Klima. 1996. Upper Palaeolithic fibre technology: Interlaced woven finds from Pavlov I, Czech Republic, c. 26,000 years ago. *Antiquity* 70 (269): 526-34.
- Aiello, L., and P. Wheeler. 2003. Neanderthal thermoregulation and the glacial climate. In *Neanderthals and modern humans in the European landscape during the last glaciation.*, eds. T. van Andel, W. Davies, 147-166. Cambridge: McDonald Institute for Archaeological Research.
- Aiello, L. C. 1993. The fossil evidence for modern human origins in Africa: A revised view. *American Anthropologist* 95 (1): 73-96.
- Anderson-Gerfaud, P. 1990. Aspects of behaviour in the Middle Palaeolithic: Functional analysis of stone tools from southwest France. In *The emergence of modern humans: An archaeological perspective.*, ed. P. Mellars, 389-418. Great Britain: Edinburgh University Press.
- Antoine, P., D. D. Rousseau, M. Fuchs, C. Hatté, C. Gauthier, S. B. Markovic, M. Jovanovic, T. Gaudenyi, O. Moine, and J. Rossignol. 2009. High-resolution record of the last climatic cycle in the southern Carpathian Basin (surduk, vojvodina, serbia). *Quaternary International* 198 (1-2): 19-36.
- Ayala, F. J. 1997. Vagaries of the molecular clock. *Proceedings of the National Academy of Sciences of the United States of America* 94 (15): 7776-83.
- Barron, E., T. H. Van Andel, and D. Pollard, eds. 2003. *Glacial environments II: Reconstructing the climate of Europe in the last glaciation*. Neanderthals and modern humans in the European landscape during the last glaciation., eds. T. H. van Andel, W. Davies. Oxford: McDonald Institute for Archaeological Research.
- Bar-Yosef, Ofer. 2002. The Upper Paleolithic revolution. *Annual Review of Anthropology* 31 : 363-93.

- Birket-Smith, K. 1953. *The Chugach Eskimo*. Kobenhavn: Nationalmuseets publikationsfond.
- . 1941. *Early collections from the Pacific Eskimo*. København: Gyldendal.
- Bishop, C. A. 1974. *The Northern Ojibwa and the fur trade: An historical and ecological study*. Toronto: Holt, Rinehart and Winston of Canada.
- Bisson, M. S. 2000. Nineteenth century tools for twenty-first century archaeology? Why the Middle Paleolithic typology of Francois Bordes must be replaced. *Journal of Archaeological Method and Theory* 7 (1): 1-48.
- Bluestein, M., and J. Zecher. 1999. A new approach to an accurate wind chill factor. *Bulletin of the American Meteorological Society* 80: 1893-900.
- Bocherens, H. 2009. Neanderthal dietary habits: Review of the isotopic evidence. *The Evolution of Hominin Diets*: 241-50.
- Bocquet-Appel, J. P., P. Y. Demars, L. Noiret, and D. Dobrowsky. 2005. Estimates of Upper Palaeolithic meta-population size in Europe from archaeological data. *Journal of Archaeological Science* 32 (11): 1656-68.
- Bocquet-Appel, J. P., and A. Tuffreau. 2009. Technological responses of Neanderthals to macroclimatic variations (240,000–40,000 BP). *Human Biology* 81 (2-3): 287-307.
- Bogoraz-Tan, V. G. 1909. *The Chukchee: Material culture, religion, social organization*. Leiden, New York: E.J. Brill, Ltd.; G.E. Stechert and Co.
- Bordes, F. 1961. Mousterian cultures in France. *Science* 134 (3482): 803-10.
- Bordes, F., and D. de Sonneville-Bordes. 1970. The significance of variability in Palaeolithic assemblages. *World Archaeology* 2 (1): 61-73.
- Cartmill, M., and F. H. Smith. 2009. *The human lineage*. Vol. 2. Blackwell Publishing.
- Cena, K., and J.A. Clark. 1978. Thermal insulation of animal coats and human clothing. *Physics in Medicine and Biology* 23 : 565.
- Chase, P. G. 1989. How different was Middle Palaeolithic subsistence? A zooarchaeological perspective on the Middle to Upper Palaeolithic transition. In *The human revolution.*, eds. P. Mellars, C. Stringer, 321-337. Edinburgh University Press.
- Churchill, S.E. 2009. Energetic competition between Neanderthals and anatomically modern humans. *Paleoanthropology* 96:116.
- Churchill, S. E., and J. A. Rhodes. 2009. The evolution of the human capacity for “killing at a distance”: The human fossil evidence for the evolution of projectile weaponry. *The Evolution of Hominin Diets*: 201-10.

- Clark, D. W. 1974. *Koniag prehistory: Archaeological investigations at late prehistoric sites on Kodiak Island, Alaska*. Stuttgart: W. Kohlhammer.
- Collard, M., and M. Dembo. in press. Modern human origins. In *A companion to paleoanthropology.*, ed. D. Begun, ?-?. Boston: Wiley-Blackwell.
- Conard, N. J. 2003. Palaeolithic ivory sculptures from southwestern Germany and the origins of figurative art. *Nature* 426 (6968): 830-2.
- Conard, N. J., and L. Moreau. 2004. Current research on the Gravettian of the Swabian Jura. *Mitteilungen Der Gesellschaft Fur Urgeschichte* 13 : 29-59.
- Coon, C. S. 1962. *The origin of races*. New York: Knopf.
- Cotel, A. J., R. Golingo, J. E. Oakes, and R. R. Riewe. 2004. Effect of ancient Inuit fur parka ruffs on facial heat transfer. *Climate Research* 26 (1): 77-84.
- Davies, W., and P. Gollop. 2003. The human presence in Europe during the last glacial period II: Climate tolerance and climate preferences of mid-and late glacial hominids. In *Neanderthals and modern humans in the European landscape during the last glaciation: Archaeological results of the stage 3 project.*, eds. T. van Andel, W. Davies. Cambridge: The McDonald Institute for Archaeological Research.
- De Laguna, F., ed. 1972. *Under Mount Saint Elias: The history and culture of the Yakutat Tlingit*. Washington, D.C.: Smithsonian Institution Press.
- Debénath, A., and H. L. Dibble. 1994. *Handbook of Paleolithic typology*. Vol. 1. Philadelphia: University Museum, University of Pennsylvania.
- d'Errico, F., C. Henshilwood, G. Lawson, M. Vanhaeren, A. M. Tillier, M. Soressi, F. Bresson, B. Maureille, A. Nowell, and J. Lakarra. 2003. Archaeological evidence for the emergence of language, symbolism, and music—an alternative multidisciplinary perspective. *Journal of World Prehistory* 17 (1): 1-70.
- d'Errico, F., and C. B. Stringer. 2011. Evolution, revolution or saltation scenario for the emergence of modern cultures? *Philosophical Transactions of the Royal Society B: Biological Sciences* 366 (1567): 1060-9.
- d'Errico, F., J. Zilhao, M. Julien, D. Baffier, and J. Pelegrin. 1998. Neanderthal acculturation in western Europe? A critical review of the evidence and its interpretation. *Current Anthropology* 39 (S1): 1-44.
- Franciscus, R. G. 2003. Internal nasal floor configuration in *Homo* with special reference to the evolution of Neandertal facial form. *Journal of Human Evolution* 44 (6): 701-29.
- Franciscus, R. G., and S. E. Churchill. 2002. The costal skeleton of Shanidar 3 and a reappraisal of Neandertal thoracic morphology. *Journal of Human Evolution* 42 (3): 303-56.

- Frink, L., and K. Weedman, eds. 2006. *Gender and hide production*. Oxford: Altamira Press.
- Gallagher, J. P. 1977. Contemporary stone tools in Ethiopia: Implications for archaeology. *Journal of Field Archaeology* 4 (4): 407-14.
- Gamble, C. 1999. *The Palaeolithic societies of Europe*. Cambridge: Cambridge University Press.
- Gilligan, I. 2007. Neanderthal extinction and modern human behaviour: The role of climate change and clothing. *World Archaeology*: 499-514.
- Gilligan, Ian. 2010. The prehistoric development of clothing: Archaeological implications of a thermal model. *Journal of Archaeological Method and Theory* 17 (1): 15-80.
- Golovanova, L. V., V. B. Doronichev, and N. E. Cleghorn. 2010. The emergence of bone-working and ornamental art in the Caucasian Upper Palaeolithic. *Antiquity* 84 : 299-320.
- Gravina, B., P. Mellars, and C. B. Ramsey. 2005. Radiocarbon dating of interstratified Neanderthal and early modern human occupations at the Châtelperronian type-site. *Nature* 438 (7064): 51-6.
- Grout, L. 1864. *Zululand: Or, life among the Zulu-Kafirs of Natal and Zulu-land, South Africa. With map, and illustrations, largely from original photographs*. Philadelphia: Presbyterian Publication Company.
- Hammel, H. T. 1955. Thermal properties of fur. *Am. J. Physiol.* 76 : 369-76.
- Hardy, B. L. 2004. Neanderthal behaviour and stone tool function at the Middle Palaeolithic site of La Quina, France. *Antiquity* 78 : 547-65.
- Hardy, B. L., M. Bolus, and N. J. Conard. 2008. Hammer or crescent wrench? Stone-tool form and function in the Aurignacian of southwest Germany. *Journal of Human Evolution* 54 (5): 648-62.
- Hardy, B. L., M. Kay, A. E. Marks, and K. Monigal. 2001. Stone tool function at the Paleolithic sites of Starosele and Buran Kaya III, Crimea: Behavioral implications. *Proceedings of the National Academy of Sciences of the United States of America* 98 (19): 10972-7.
- Harvati, K. 2010. Neanderthals. *Evolution: Education and Outreach* 3 (3): 367-76.
- Hayden, B. 1990. The right rub: Hide working in high ranking households. In *The interpretive possibilities of microwear studies.*, eds. B. Gräslund, H. Knutsson, K. Knutsson and J. Taffinder, 89-102. Uppsala: Societas Archaeologica Upsaliensis.
- Heckewelder, J. G. E. 1819. *An account of the history, manners, and customs, of the Indian nations who once inhabited Pennsylvania and the neighboring states*. Philadelphia: Abraham Small.

- Higham, T., R. Jacobi, M. Julien, F. David, L. Basell, R. Wood, W. Davies, and C. B. Ramsey. 2010. Chronology of the Grotte du Renne (France) and implications for the context of ornaments and human remains within the Châtelperronian. *Proceedings of the National Academy of Sciences* 107 (47): 20234-9.
- Higham, T., C. B. Ramsey, I. Karavanić, F. H. Smith, and E. Trinkaus. 2006. Revised direct radiocarbon dating of the Vindija G1 Upper Paleolithic Neandertals. *Proceedings of the National Academy of Sciences of the United States of America* 103 (3): 553-7.
- Hoffecker, J. F. 2009. The spread of modern humans in Europe. *Proceedings of the National Academy of Sciences* 106 (38): 16040-5.
- . 2005. Innovation and technological knowledge in the Upper Paleolithic of northern Eurasia. *Evolutionary Anthropology: Issues, News, and Reviews* 14 (5): 186-98.
- Hoffecker, J. F., and N. Cleghorn. 2000. Mousterian hunting patterns in the northwestern Caucasus and the ecology of the Neanderthals. *International Journal of Osteoarchaeology* 10 (5): 368-78.
- Holliday, T. W. 1997. Postcranial evidence of cold adaptation in European Neandertals. *American Journal of Physical Anthropology* 104 (2): 245-58.
- Holton, N. E., and R. G. Franciscus. 2008. The paradox of a wide nasal aperture in cold-adapted Neandertals: A causal assessment. *Journal of Human Evolution* 55 (6): 942-51.
- Hublin, J.J. 2012. The earliest modern human colonization of Europe. *PNAS* 109 (34): 13471-2.
- Huntley, B.I., and J. R. M. Allen. 2003. Glacial environments III: Palaeo-vegetation patterns in late glacial Europe. In *Neanderthals and modern humans in the European landscape during the last glaciation.*, eds. T. H. van Andel, W. Davies. Oxford: McDonald Institute for Archaeological Research.
- Jenness, D. 1946. *The material culture of the Copper Eskimos*. Ottawa: Edmond Cloutier, King's Printer and Controller of Stationery.
- Kennedy, D. I., and R. Bouchard. 1990. *Bella Coola*. Washington, D.C.: Smithsonian Institution.
- Kennedy, M. J. 1955. Culture contact and acculturation of the southwestern Pomo. University of California.
- Kittler, R., M. Kayser, and M. Stoneking. 2003. Molecular evolution of *Pediculus humanus* and the origin of clothing. *Current Biology : CB* 13 (16): 1414-7.
- Klein, R. G. 2008. Out of Africa and the evolution of human behavior. *Evolutionary Anthropology: Issues, News, and Reviews* 17 (6): 267-81.

- . 2003. Whither the Neanderthals? *Science* 299 (5612): 1525.
- . 1995. Anatomy, behavior, and modern human origins. *Journal of World Prehistory* 9 (2): 167-98.
- Krause, J., L. Orlando, D. Serre, B. Viola, K. Prüfer, M. P. Richards, J. J. Hublin, C. Hänni, A. P. Derevianko, and S. Pääbo. 2007. Neanderthals in Central Asia and Siberia. *Nature* 449 (7164): 902-4.
- Kurylev, V. P. 2011. *Culture summary: Kazakh*. New Haven: HRAF.
- Lahr, M. M., and R. A. Foley. 2003. Demography, dispersal and human evolution in the last glacial period. In *Neanderthals and modern humans in the European landscape during the last glaciation.*, eds. T. H. van Andel, W. Davies, 241-256. Oxford: McDonald Institute for Archaeological Research.
- Laughlin, W. S. 1980. *Aleuts: Survivors of the Bering land bridge*. New York: Holt, Rinehart, and Winston.
- Madrigal, L. 1998. *Statistics for anthropology*. Cambridge: Cambridge University Press.
- Macdonald, K., W. Roebroeks, and A. Verpoorte. 2009. An energetics perspective on the Neanderthal record. In *The evolution of hominin diets: Integrating approaches to the study of Palaeolithic subsistence.*, eds. J.J. Hublin, M.P. Richards, 211-220. Netherlands: Springer Science.
- Mellars, P. 2006. Archeology and the dispersal of modern humans in Europe: Deconstructing the "Aurignacian". *Evolutionary Anthropology: Issues, News, and Reviews* 15 (5): 167-82.
- . 2004. Neanderthals and the modern human colonization of Europe. *Nature* 432 (7016): 461-5.
- . 2002. The impact of climatic changes on the demography of late Neandertal and early anatomically modern populations in Europe. *Neandertals and Modern Humans in Western Asia*: 493-507.
- . 1989. Major issues in the emergence of modern humans. *Current Anthropology* 30 (3): 349-85.
- Moote, I. 1955. The thermal insulation of caribou pelts. *Textile Research Journal* 25 (10): 832-7.
- Nowak, Ronald M. 1999. *Walker's mammals of the world*. 6th Edition ed. Baltimore and London: The John Hopkins University Press.
- Nowell, A. 2010. Defining behavioural modernity in the context of Neanderthal and anatomically modern human populations. *Annual Review of Anthropology* 39 : 437-52.

- Oakes, J. E., H. Wilkins, R. Riewe, D. Kelker, and T. Forest. 1995. *Comparison of traditional and manufactured cold weather ensembles*. Inter-Research.
- Ohnuki-Tierney, E. 1974. *The Ainu of the northwest coast of Southern Sakhalin*. Prospect Heights: Waveland Press, Inc.
- Onac, B. P., I. Viehmann, J. Lundberg, S. E. Lauritzen, C. Stringer, and V. Popita. 2005. U-Th ages constraining the Neanderthal footprint at Vârtope cave, Romania. *Quaternary Science Reviews* 24 (10-11): 1151-7.
- Osczevski, R. J. 1995. The basis of wind chill. *Arctic*: 372-82.
- Pryde, D. 1972. *Nunaga: My land, my country*. Edmonton: M.G. Hurtig Ltd.
- Rae, T. C., T. Koppe, and C. B. Stringer. 2011. The Neanderthal face is not cold adapted. *Journal of Human Evolution* 60 (2): 234-9.
- Rae, T. C., U. S. Viðarsdóttir, N. Jeffery, and A. T. Steegmann Jr. 2006. Developmental response to cold stress in cranial morphology of *Rattus*: Implications for the interpretation of climatic adaptation in fossil hominins. *Proceedings of the Royal Society B: Biological Sciences* 273 (1601): 2605-10.
- Reed, D. L., J. E. Light, J. M. Allen, and J. J. Kirchman. 2007. Pair of lice lost or parasites regained: The evolutionary history of anthropoid primate lice. *BMC Biology* 5 (7): 7-18.
- Richards, M. P., P. B. Pettitt, M. C. Stiner, and E. Trinkaus. 2001. Stable isotope evidence for increasing dietary breadth in the European mid-Upper Paleolithic. *Proceedings of the National Academy of Sciences* 98 (11): 6528.
- Richards, M. P., and E. Trinkaus. 2009. Isotopic evidence for the diets of European Neanderthals and early modern humans. *Proceedings of the National Academy of Sciences* 106 (38): 16034-9.
- Rogers, A. R., D. Iltis, and S. Wooding. 2004. Genetic variation at the MC1R locus and the time since loss of human body Hair1. *Current Anthropology* 45 (1): 105-8.
- Rosenfeld, A. 1971. The examination of use marks on some Magdalenian end scrapers. *The British Museum Quarterly* 35 (1): 176-82.
- Ruff, C. B. 1993. Climatic adaptation and hominid evolution: The thermoregulatory imperative. *Evolutionary Anthropology: Issues, News, and Reviews* 2 (2): 53-60.
- Šajnerová-Dušková, A. 2007. *Tools of the mammoth hunters: The application of use-wear analysis on the Czech Upper Paleolithic chipped industry*. Vol. 1645. British Archaeological Reports Ltd.
- Schlichting, H., and K. Gersten. 2000. *Boundary-layer theory*. Springer Verlag.

- Schmitt, D., S. E. Churchill, and W. L. Hylander. 2003. Experimental evidence concerning spear use in Neandertals and early modern humans. *Journal of Archaeological Science* 30 (1): 103-14.
- Shea, J., Z. Davis, and K. Brown. 2001. Experimental tests of Middle Palaeolithic spear points using a calibrated crossbow. *Journal of Archaeological Science* 28 (8): 807-16.
- Shea, J. J. 2006. The origins of lithic projectile point technology: Evidence from Africa, the Levant, and Europe. *Journal of Archaeological Science* 33 (6): 823-46.
- . 2003. Neandertals, competition, and the origin of modern human behavior in the Levant. *Evolutionary Anthropology: Issues, News, and Reviews* 12 (4): 173-87.
- . 1997. Middle Paleolithic spear point technology. *Projectile Technology, Plenum Press, New York*: 79-106.
- . 1988. Spear points from the Middle Paleolithic of the Levant. *Journal of Field Archaeology* 15 (4): 441-50.
- Silberbauer, G. B. 1981. *Hunter and habitat in the central Kalahari Desert*. Cambridge: Cambridge University Press.
- Smith, F. H. 2009. Neandertal and early modern human interactions in Europe. *American Anthropologist* 110 (2): 255-9.
- Soffer, O. 1989. The Middle to Upper Palaeolithic transition on the Russian plain. In *The human revolution.*, eds. P. Mellars, C. Stringer, 714-742. Edinburgh University Press.
- Soffer, O., J. M. Adovasio, and D. C. Hyland. 2000. The "Venus" figurines. *Current Anthropology* 41 (4): 511-37.
- Stanford, Q. H., ed. 2003. *Canadian Oxford world atlas*. 5th ed. Toronto: Oxford University Press.
- Stenton, D. R. 1991. The adaptive significance of caribou winter clothing for Arctic hunter-gatherers. *Etudes Inuit* 15 (1): 3-28.
- Stewart, J. R., T. van Kolfschoten, A. Markova, and R. Musil. 2003. The mammalian faunas of Europe during oxygen isotope stage three. In *Neanderthals and modern humans in the European landscape during the last glaciation: Archaeological results of the stage 3 project.*, eds. T. H. Van Andel, W. Davies, 103-130. Cambridge: McDonald Institute for Archaeological Research.
- Stewart, J. R. 2007. Neanderthal extinction as part of the faunal change in Europe during Oxygen Isotope Stage 3. *Acta Zoologica Cracoviensia-Series: Vertebrata* 50A (1-2): 93-124.

- . 2005. The ecology and adaptation of Neanderthals during the non-analogue environment of Oxygen Isotope Stage 3. *Quaternary International* 137 (1): 35-46.
- Stewart, JR. 2004. Neanderthal–modern human competition? A comparison between the mammals associated with Middle and Upper Palaeolithic industries in Europe during OIS 3. *International Journal of Osteoarchaeology* 14 (3-4): 178-89.
- Stiner, M. C. 2001. Thirty years on the “Broad spectrum revolution” and Paleolithic demography. *Proceedings of the National Academy of Sciences* 98 (13): 6993.
- Stiner, M. C., and S. L. Kuhn. 2006. Changes in the ‘connectedness’ and resilience of Paleolithic societies in Mediterranean ecosystems. *Human Ecology* 34 (5): 693-712.
- Stiner, M. C., N. D. Munro, T. A. Surovell, E. Tchernov, and O. Bar-Yosef. 1999. Paleolithic population growth pulses evidenced by small animal exploitation. *Science* 283 (5399): 190-4.
- Stiner, Mary. 1994. *Honor among thieves: A zooarchaeological study of Neanderthal ecology*. Princeton: Princeton University Press.
- Straus, L.G. 1989. On early hominid use of fire. *Current Anthropology* 30 (4): 488-91.
- . 2005. The Upper Paleolithic of Cantabrian Spain. *Evolutionary Anthropology: Issues, News, and Reviews* 14 (4): 145-58.
- . 2000. A quarter-century of research on the Solutrean of Vasco-Cantabria, Iberia and beyond. *Journal of Anthropological Research* 56 (1): 39-58.
- . 1995. The Upper Paleolithic of Europe: An overview. *Evolutionary Anthropology: Issues, News, and Reviews* 4 (1): 4-16.
- Stringer, C. 2012. The status of *Homo heidelbergensis* (Schoetensack 1908). *Evolutionary Anthropology: Issues, News, and Reviews* 21 (3): 101-7.
- . 2002. Modern human origins: Progress and prospects. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 357 (1420): 563-79.
- Stringer, C., H. Pälke, T. H. Van Andel, B. Huntley, P. Valdes, and J. R. M. Allen. 2003. Climatic stress and the extinction of the Neanderthals. In *Neanderthals and modern humans in the European landscape during the last glaciation.*, eds. T. H. van Andel, W. Davies. Oxford: McDonald Institute for Archaeological Research.
- Sverdrup, H. U. 1938. *With the people of the tundra*. Oslo: Gyldendal Norsk Forlag.
- Swan, J. G. 1870. *The Indians of Cape Flattery: At the entrance to the Strait of Fuca, Washington Territory*. Washington, D.C.: Smithsonian Institution.
- Tattersall, I. 2009. *The fossil trail*. New York; Oxford: Oxford University Press.

- Thieme, H. 1997. Lower Palaeolithic hunting spears from Germany.
- Toups, M. A., A. Kitchen, J. E. Light, and D. L. Reed. 2011. Origin of clothing lice indicates early clothing use by anatomically modern humans in Africa. *Molecular Biology and Evolution* 28 (1): 29-32.
- Trinkaus, E. 2005. Anatomical evidence for the antiquity of human footwear use. *Journal of Archaeological Science* 32 (10): 1515-26.
- Ungar, P. S., K. J. Fennell, K. Gordon, and E. Trinkaus. 1997. Neandertal incisor beveling. *Journal of Human Evolution* 32 (5): 407-21.
- van Andel, T. 2003. Glacial environments I: The Weichselian climate in Europe between the end of the OIS-5 interglacial and the last glacial maximum. In *Neanderthals and modern humans in the European landscape during the last glaciation: Archaeological results of the stage.*, eds. T. van Andel, W. Davies, 9-19.
- Van Andel, T. H., and W. Davies. 2003. *Neanderthals and modern humans in the European landscape during the last glaciation: Archaeological results of the stage 3 project*. McDonald Institute for Archaeological Research monographs.
- Van Andel, T. H., W. Davies, and B. Weninger. 2003. The human presence in Europe during the last glacial period I: Human migrations and the changing climate. In *Neanderthals and modern humans in the European landscape during the last glaciation: Archaeological results of the stage 3 project.*, eds. T. H. Van Andel, W. Davies, 31-52. Cambridge: McDonald Institute for Archaeological Research.
- Weaver, T. D., and K. Steudel-Numbers. 2005. Does climate or mobility explain the differences in body proportions between Neandertals and their Upper Paleolithic successors? *Evolutionary Anthropology: Issues, News, and Reviews* 14 (6): 218-23.
- Weltfish, G. 1965. *The lost universe: With a closing chapter on 'the universe regained'*. New York, London: Basic Books.
- White, M. J. 2006. Things to do in Doggerland when you're dead: Surviving OIS3 at the northwestern-most fringe of Middle Palaeolithic Europe. *World Archaeology* 38 : 547-75.
- Wild, E. M., M. Teschler-Nicola, W. Kutschera, P. Steier, E. Trinkaus, and W. Wanek. 2005. Direct dating of early Upper Palaeolithic human remains from Mladeč. *Nature* 435 (7040): 332-5.
- Wolpoff, M. H., J. Hawks, and R. Caspari. 2000. Multiregional, not multiple origins.
- Zilhão, J., F. d'Errico, J. G. Bordes, A. Lenoble, J. P. Texier, and J. P. Rigaud. 2006. Analysis of Aurignacian interstratification at the Châtelperronian-type site and implications for the behavioral modernity of Neandertals. *Proceedings of the National Academy of Sciences* 103 (33): 12643-8.

Appendices

Appendix A.

Search terms for Stage 3 taxa

Table 1. Search terms used for Stage 3 taxa that yielded results

| Family | Genus | Search Term(s) |
|--------------|------------------|---------------------|
| Bovidae | | |
| | | Buffalo |
| | | Goat |
| | | Sheep |
| | | Antelope |
| | <i>Bos</i> | Cattle, cow, yak |
| | <i>Bison</i> | Bison, wisent |
| | <i>Capra</i> | Ibex |
| | <i>Ovibos</i> | Musk ox |
| Canidae | | |
| | | Fox |
| | <i>Canis</i> | Wolf |
| | <i>Vulpes</i> | Red fox |
| | <i>Alopex</i> | Arctic fox |
| Castoridae | | |
| | <i>Castor</i> | Beaver |
| Cervidae | | |
| | | Deer |
| | <i>Alces</i> | Elk, moose |
| | <i>Cervus</i> | Red deer, elk |
| | <i>Rangifer</i> | Reindeer, caribou |
| | <i>Capreolus</i> | Roe deer |
| Elephantidae | | |
| | | Elephant |
| Equidae | | |
| | <i>Equus</i> | Horse, wild horse |
| Felidae | | |
| | | Leopard |
| | <i>Panthera</i> | Lion, tiger, jaguar |

| Family | Genus | Search Term(s) |
|---------------|---------------------|--------------------------------------|
| | <i>Felis</i> | Wild cat, lynx |
| Hyaenidae | | |
| | | Hyena [hyaena] |
| Leporidae | | |
| | | Rabbit Hare |
| Muridae | | |
| | | Lemming |
| Mustelidae | | |
| | | Badger Weasel Polecat Otter |
| | <i>Mustela</i> | Stoat, ermine, mink, ferret |
| | <i>Martes</i> | Marten [martin], fisher, sable |
| | <i>Gulo</i> | Wolverine |
| Sciuridae | | |
| | | Squirrel |
| | <i>Marmota</i> | Marmot, woodchuck |
| | <i>Spermophilus</i> | Ground squirrel |
| Suidae | | |
| | | Pig Wild boar |
| | <i>Sus</i> | |
| Ursidae | | |
| | <i>Ursus</i> | Bear |

* Alternative spellings for search terms are indicated by brackets []

Table 2. Search terms used for Stage 3 taxa that did not yield results

| Family | Taxon | Search term |
|-----------------|---|----------------------------------|
| Bovidae | | |
| | <i>Bos</i> sp. | Kouprey, banteng, gaur, seladang |
| | <i>Bos primigenius</i> | Auroch |
| | <i>Capra</i> sp. | Tur, markhor |
| | <i>Capra pyrenaica</i> | Spanish ibex |
| | <i>Ovis</i> sp. | Mouflon, urial, argali |
| | <i>Saiga tartarica</i> | Saiga antelope, saiga |
| Canidae | | |
| | <i>Cuon</i> sp. | Dhole |
| | <i>Vulpes corzac</i> | Corsac fox |
| Cercopithecidae | | |
| | <i>Macaca sylvana/sylvanus</i> | Macaque, barbary ape |
| Cervidae | | |
| | <i>Cervus elaphus</i> | Wapiti |
| | <i>Dama dama</i> | Fallow deer |
| | <i>Megaloceros</i> sp. / <i>Megaloceros giganteus</i> | Giant deer |
| Dipodidae | | |
| | <i>Sicista</i> sp. | Birch mouse |
| | <i>Sicista subtilis</i> | Southern birch mouse |
| | <i>Sicista betulina</i> | Northern birch mouse |
| | <i>Allactaga</i> sp. | Jerboa |
| | <i>Alactagulus</i> sp. | Jerboa, little earth hare |
| Elephantidae | | |
| | <i>Mammuthus primigenius</i> | Mammoth, Woolly Mammoth |
| | <i>Elephas (Palaeoloxodon) antiquus</i> / <i>Elephas (Palaeoloxodonta) sp.</i> | Straight-tusked elephant |
| Equidae | | |
| | <i>Equus hydruntinus</i> | Steppe ass |
| | <i>Equus hemionus</i> | Hemione, kulan, onager |
| | <i>Equus</i> sp. | Kiang, zebra, quagga |
| | <i>Equus asinus</i> | Ass, burro, donkey |
| | <i>Equus latipes</i> | Extinct horse |
| Erinaceidae | | |

| Family | Taxon | Search term |
|---------------|---|---|
| | <i>Erinaceus</i> sp. <i>Erinaceus europea</i> | Eurasian hedgehog Hedgehog |
| Fellidae | | |
| | <i>Panthera leo</i> / <i>P. spealea</i> <i>Lynx/Felis pardina</i> | Cave lion Pardel lynx, Spanish lynx |
| Hyaenidae | | |
| | <i>Crocuta crocuta</i> / <i>Hyaena spelaea</i> | Spotted hy[a]ena, striped hy[a]ena |
| Hystricidae | | |
| | <i>Hystrix cristata</i> / <i>vinogradovi</i> | Porcupine, Old World porcupine |
| Leporidae | | |
| | <i>Lepus europaeus</i> / <i>capensis</i> <i>Lepus timidus</i> <i>Lepus tolai</i> | Brown hare Mountain hare Tolai hare |
| Muridae | | |
| | <i>Apodemus</i> sp. <i>Apodemus</i> general term: added <i>Apodemus flavicollis</i> <i>Apodemus sylvaticus</i> <i>Cricetus cricetus</i> <i>Cricetus</i> sp. <i>Cricetulus migratorius</i> <i>Mesocricetus</i> sp. <i>Allocricetus bursae</i> <i>Arvicola sapidus</i> <i>Arvicola terrestris</i> <i>Arvicola</i> sp. <i>Pliomys lenki</i> <i>Pliomys</i> sp. <i>Ptericola (Pitymys) fatioi</i> *subgenus of <i>Microtus</i> <i>Ptericola (Pitymys) duodecimcostatus</i> <i>Ptericola (Pitymys) subterraneus</i> <i>Pericola (Pitymys) savii</i> <i>Ptericola (Pitymys) sp.</i> <i>Microtus brecciensis</i> / <i>carbrera</i> <i>Microtus afghanus</i> <i>Microtus hyperboreus</i> <i>Microtus arvalis</i> | Old World mouse Mouse Yellow-necked mouse Wood mouse Common hamster Hamster Grey hamster A hamster, golden hamster Extinct hamster Southern water vole Northern water vole Water vole Extinct vole Extinct vole *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) *Not in Nowak (1999) Common vole |

| Family | Taxon | Search term |
|-----------------------|--|-----------------------------------|
| | <i>Microtus agrestis</i> | Field vole |
| | <i>Microtus gregalis</i> | Vole, meadow mouse |
| | <i>Microtus nivalis</i> | Snow vole |
| | <i>Microtus oeconomus / raticeps</i> | Northern vole |
| | <i>Microtus</i> sp. | Vole, meadow mouse |
| | <i>Clethrionomys glareolus</i> | Bank vole |
| | <i>Clethrionomys rutilus</i> | Ruddy vole |
| | <i>Clethrionomys rufocanus</i> | Grey sided vole |
| | <i>Clethrionomys</i> sp. | Red backed mouse |
| | <i>Lemmus lemmus</i> | Norway lemming |
| | <i>Dicrostonyx torquatus</i> | Collared lemming, varying lemming |
| | <i>Lagurus lagurus</i> | Steppe lemming |
| | <i>Eolagurus luteus</i> | *Not in Nowak (1999) |
| | <i>Myopus schisticolor</i> | Wood lemming |
| | <i>Spalax</i> sp. | Mole-rat |
| | <i>Ellobius</i> sp. | Mole-vole, mole-lemming |
| Mustelidae | | |
| | <i>Mustela minuta</i> | Least weasel |
| | <i>Putorius putorius robusta / M. eversmanni</i> | Large polecat, steppe polecat |
| Myoxidae | | |
| | <i>Myoxus glis</i> | Edible doremouse, fat doremouse |
| | <i>Muscardinus avellanarius</i> | Doremouse, hazel mouse |
| | <i>Eliomys quercinus</i> | Garden doremouse |
| Ochotonidae | | |
| | <i>Ochotona pusilla</i> | Pika, mouse hare, coney |
| Rhinocerotidae | | |
| | <i>Dicerorhinus/Stephanorhinus mercki / kirckbergensis</i> | Extinct rhino |
| | <i>Dicerorhinus/Stephanorhinus hemitoechus</i> | Extinct rhino |
| | <i>Dicerorhinus/Stephanorhinus</i> sp. | Hairy rhino, sumatran rhino |
| | <i>Coelodonta antiquitatis</i> | Woolly rhino |
| Soricidae | | |
| | <i>Crocidura</i> sp. group | White toothed shrew |
| | <i>Sorex "araneaus"</i> group | Common shrew |
| | <i>Sorex minutus</i> | Pigmy shrew |
| | <i>Sorex minutissimus</i> | Least shrew |
| | <i>Sorex</i> sp. | Long-tailed shrew, shrew |
| | <i>Neomys</i> sp. | Water shrew |

| Family | Taxon | Search term |
|---------------|---|----------------------|
| Sciuridae | | |
| | <i>Pteromys</i> sp. | Flying squirrel |
| | <i>Marmota</i> sp. | Groundhog |
| | <i>Marmota primigenia</i> | Extinct marmot |
| | <i>Marmota bobak</i> | *Not in Nowak (1999) |
| | <i>Marmota marmota</i> | Alpine marmot |
| | <i>Spermophilus</i> sp. | Suslik |
| | <i>Spermophilus major</i> / <i>Citellus superciliosus</i> | *Not in Nowak (1999) |
| | <i>Sciurus vulgaris</i> | Red squirrel |
| Talpidae | | |
| | <i>Talpa</i> sp. | Old world mole |
| | <i>Talpa europea</i> | Mole |
| | <i>Desmana</i> sp. | Desman |
| Ursidae | | |
| | <i>Ursus spelaea</i> | Cave bear |