Neandertals: Unique from Humans, or Uniquely Human?

Colin P.T. Baillie

Introduction

Since the discovery of the Neandertal holotype[1] from the Neander Valley in 1856, the position of Neandertals within the *Homo* lineage has been contested by paleoanthropologists. Neandertals represent a member of the genus *Homo*, characterized by a set of traits that have been identified from the skeletal remains of specimens that represent both sexes and a range of chronological ages. The temporal and geographical range of Neandertals is subject to debate because a number of traits typically assigned to Neandertals appear by 600,000 years Before Present (B.P.) in specimens from locations in Western Asia and Europe (Harvati 2010). However, the entire collection of "classic" Neandertal characteristics was not present until approximately 100,000 years B.P., and continued to exist until 30,000 years B.P. (Harvati 2010). The "classic" Neandertal cranium typically exhibits a long and low cranial vault, an occipital bun, a prominent supraorbital ridge, as well as a mandible that lacks a chin. The postcranial remains are characterized by a "hyperpolar" form, including a large thorax region coupled with long clavicles and comparably short limb bones (Weaver 2003:6928). For the purposes of my investigation, I focus on the hypodigm[2] from Europe that can be conclusively categorized as "classic" Neandertals in the Upper Pleistocene.

The "classic" Neandertals have been used as material evidence to support three major scientific paradigms in paleoanthropology regarding the evolution of the genus *Homo*. In paleoanthropology, a scientific paradigm is a particular perspective that leads to certain interpretations about the fossil evidence (Willermet and Clark 1995:157). The first interpretation of Neandertals is outlined by Clark Howell (1957:330), who states that fossils were organized in a linear arrangement from the most primitive skeletal remains to the skeletal remains most closely resembling anatomically modern humans. Paleoanthropologists viewed the Neandertal specimens as an intermediate link between apes and humans, and developed an ancestor-predecessor relationship to understand the connection of Neandertals to modern humans (Howell 1957). With the discovery of subsequent Neandertal specimens, two opposing perspectives largely replaced the one outlined by Howell (1957).

Jeffrey Brainard (1998) outlines the opposing scientific paradigms in *Giving Neanderthals Their Due*. Some paleoanthropologists assert that Neandertals represent a distinct species and designate the taxon *Homo neanderthalensis* (Brainard 1998). Taxonomic "splitters", who tend to recognize many morphologically distinct species,

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Colin P.T. Baillie is an MSc candidate at Queen's University in Kingston, Ontario.

tend to support a separate species designation for Neandertals (Trinkaus 1984; Tattersall 1986; Rozzi and Bermudez de Castro 2004). The other paradigm holds that Neandertals are not a distinct species, but a subspecies[3] of *Homo sapiens*, which results in the taxonomic designation *Homo sapiens neanderthalensis*. Typically, taxonomic "lumpers" that reduce the number of species recognized support a subspecies designation (Brose and Wolpoff 1971; Wolpoff et al. 2004). Does the archaeological, skeletal and molecular evidence suggest that Neandertals are distinct enough from anatomically modern humans to consider them a separate species? It is the aim of my research to clarify the position of Neandertals in terms of the evolution of the *Homo* genus. As I only briefly consider the available DNA evidence in this paper, I suggest that individuals refer to the respective studies for more information (Green et al. 2008; Green et al. 2010). I examine the available material remains from Neandertals using the cohesion species concept. This approach defines a species as a population that recognizes itself by the absence of pre-mating and post-mating isolation mechanisms that allow for interbreeding (de Queiroz 1998:58). Given the geographical and temporal range of "classic" Neandertals, I argue that Neandertals represent a subspecies of anatomically modern humans and should be designated as *Homo sapiens neanderthalensis* based on the cranial and postcranial fossil evidence, as well as the material remains at associated sites.

The Craniodental Evidence

The temporal and geographical range of Neandertals is sufficiently represented by the fossil evidence, which includes specimens in every life stage. The craniodental fossil evidence of early modern humans and Neandertals is often considered to reflect morphological differences at the species level (Tattersall 1992:341). However, the usefulness of cranial morphology is often criticized because of the possibility of changes due to environmental adaptations (Harvati and Weaver 2006:239). Harvarti and Weaver (2006:239) suggest that the facial region is highly influenced by local climate adaptation, and is specifically correlated with temperature. Given that Neandertals occupied areas of Europe and Western Asia with relatively cooler mean temperatures in comparison to other continents, such as Africa, it is reasonable to suggest that differences in the facial region between Neandertals and anatomically modern humans are reflections of climatic, and more specifically, temperature variation. Therefore, I am disregarding research that suggests differences between Neandertals and anatomically modern humans based on the morphology of the facial region. For example, Schwartz et al. (2008:1517) claims that Neandertals had a unique configuration of the nasal cavity that makes it distinctive among hominids. However, the nasal morphology of modern humans that inhabit colder climates is known to share features found in Neandertal specimens, most notably a narrow superior internal nasal breadth (Franciscus 1995). This suggests that the nasal region of Neandertals does exhibit characteristics that indicate a cold climate adaptation (Holton and Franciscus 2008). Thus, given the relative flexibility of the facial region to temperature variation, this evidence cannot support the idea of Neandertals as a separate species. However, the cranial vault is emphasized as a potential marker of true genetic differences that can be used to separate species (Harvati and Weaver 2006:239).

The existence of hybrid individuals, who are characterized by a mixture of

Neandertal and anatomically modern human traits, support the scientific paradigm that Neandertals are a subspecies of modern humans. Anatomically modern humans dispersed into southwestern Asia as early as 100,000 years B.P., reaching Europe and most parts of Asia between 60,000 and 40,000 years B.P. (Mellars 2004; Trinkaus 2007). Thus, estimates of anatomically modern human occupation of the same geographical area with Neandertals usually range from 8,000 to 10,000 years (Delson and Harvati 2006). The cranial vault of Neandertals is often characterized by a suite of traits including an occipital bun, suprainiac fossa, nuchal torus, as well as a low and long skull shape. Trinkaus (2011) suggests that early modern humans found at the sites of Cioclovina, Mladeč, Muierii and Oase represent a continuation of traits typical of Neandertals, as well as modern traits found only in recent *Homo sapiens sapiens*. Occipital buns were present on Mladeč 3, 5, and 6, as well as Muierii 1. Additionally, Cioclovina 1 exhibited the presence of a nuchal torus as well as a suprainiac fossa (Trinkaus 2011:320). Oase 2 was characterized by a long and flat frontal saggital arc coupled with a curved parietal arc. These arcs create a long and low cranial vault typical of Neandertals (Trinkaus 2011:318). Furthermore, prominent occipital buns thought to be derived from Neandertal ancestry were present in 18.9 percent of the Gravettian modern human sample. (Trinkaus 2007:7370). The Gravettian modern human sample consists of 37 specimens from various locations across Europe that are dated to the middle Upper Paleolithic and have been categorized as modern humans. The presence of Neandertal traits in the cranial vaults of a modern human sample suggests that there are traits unlikely to be derived solely from an anatomically modern human population from the Middle Paleolithic (Trinkaus 2007:7371). The presence of anatomically modern humans exhibiting a range of "classic" Neandertal traits that cannot be explained by Middle Pleistocene modern human ancestry suggests that there was interbreeding between modern humans and their Neandertal counterparts. Further evidence suggesting that Neandertals are a subspecies of *Homo sapiens* can be evaluated from the cranial evidence of Neandertal neonates.

Reconstructions of a Neandertal neonate from Mezmaiskaya Cave in Russia and two infant crania from the Dederiyeh Cave in Syria have demonstrated that Neandertals and anatomically modern humans had a similar brain size in the early stages of growth (Ponce de Léon et al. 2008). For an anatomically modern human of one to two weeks old, the average brain size ranges from 380 cm^3 to 420 cm^3. The Mezamaiskaya specimen yielded an estimation of brain size that averaged to 399 cm^3 (Ponce de Léon et al. 2008:13765). Evidence of similar brain growth illustrates that Neandertals exhibit the same period of developmental immaturity that modern humans do. Furthermore, the brain size relative to body size was very similar between Neandertals and modern humans that existed between 60,000 and 30,000 years ago (Carruthers and Chamberlain 2000:213). Thus, the fossil evidence suggests that Neandertals and anatomically modern humans shared very similar life stages and brain growth throughout a typical lifespan.

While fossil remains support Neandertals as a species that is not distinct from anatomically modern humans, there are sufficient craniodental differences to suggest the taxonomic designation as a subspecies. The craniodental traits that are often cited to distinguish anatomically modern humans from Neandertals include: parietal expansion, the absence of a surpraorbital torus, reduced facial length and large mastoid processes (Trinkaus 2011:317). While I do acknowledge that modern humans exhibit traits in their

anatomy that are not shared with Neandertals, focusing on the derived characteristics of anatomically modern humans does not address the question of whether the morphology of *Homo sapiens sapiens* shows any evidence of Neandertal ancestry. Given the number of *Homo sapiens sapiens* specimens, including the Gravettian modern human sample from Europe, that have traits typical of Neandertals, it is highly likely that mating had occurred. This claim is strengthened by DNA evidence, which I will subsequently explore in greater depth, suggesting that between 1 and 4 percent of a Eurasian individual's genome is derived from Neandertals (Green et al 2010:721).

The Postcranial Evidence

The postcranial remains of Neandertals have been used as support for a subspecies and species designation. I will first examine the morphology of the pelvic girdle as confirmation that Neandertals are not a distinct species from modern humans. The Neandertal pelvis was evaluated by Trinkaus (1984:509-510) and included seven specimens from Amud, La Ferrassie, Krapina, Shanidar and Tabuin. In general, the sacrum, ilia and ischia regions of the pelvic girdle have a similar shape, size, and level of sexual dimorphism in comparison to an anatomically modern human pelvis (Trinkaus 1984: 509). Conversely, the pubis is described as large and elongated (Trinkaus 1984:510). Trinkaus (1984:510) claims that the greater breadth of female Neandertal pubic bones may be attributed to an ability to pass a head 15 to 25 percent larger than an anatomically modern human, which would have resulted in a gestation length of twelve months. I believe that this would likely result in a post-mating isolation mechanism that would inhibit the ability for interbreeding between Neandertals and anatomically modern humans. In this case, neonates of both Neandertal and modern human ancestry would have an abnormal period of pre-natal growth which would either be shortened or lengthened.

An alternative perspective of the Neandertal pelvic breadth supports Neandertals as a subspecies of modern humans. Ivanhoe (1985:526) claims that the range of pubic breadth in recent *Homo sapiens* has not altered the length of gestation, which remains at an average of 280 days regardless of the pubic breadth of the mother. Furthermore, the additional three months of gestation that would allow for the increase of Neandertal neonate cranial and postcranial size would suggest that Neandertals were giving birth to offspring that were at least 12 pounds (Ivanhoe 1985:526). However, the remains of the neonate from Mezmaiskaya Cave in Russia indicate that Neandertals and anatomically modern humans had very similar brain and body size at the time of birth (Ponce de Léon 2008). Given the variability of the breadth of the pubic bone in anatomically modern humans and its overlap with the sample of seven Neandertal pelves examined by Trinkaus (1984), I do not believe this is sufficient to determine that a speciation event had occurred. The appendicular skeleton further validates the claim of Neandertals as a subspecies of modern humans.

From birth to adulthood, Neandertals are often defined by the general robusticity of their postcranial remains in comparison to anatomically modern humans (Ruff 2008). The robusticity is generally explained as either the climatic adaptations to the Upper Pleistocene environment of Europe at the time of Neandertal occupation or by biomechanical loading (Pearson 2000). Climate includes temperature, humidity, altitude, and solar radiation (Pearson 2000). During the Upper Pleistocene, Europe

was subject to the final glacial period, which ended at approximately 18,000 years B.P. (Webb and Bartlein 1992). The final glacial period subjected the earth to decreased temperatures and increased aridity (Webb and Bartlein 1992). As an environmental adaptation, Neandertals developed a "hyperpolar" body shape that is also present in northern populations of modern humans, such as the Aleut people, which includes a large thorax and relatively short and robust long bones (Weaver 2003). The Aleut people are an indigenous population that live on the Aleutian Islands of present-day Alaska, United States (Laughlin 1980). Using a sample of two European Neandertal femora, as well as 97 femora from modern human populations, including 14 Aleutian femora, Weaver (2003) found that cold-adapted individuals had femora with large femoral heads relative to their length, thick shafts and low neck-shaft angles. Furthermore, the two Neandertal specimens clustered with the Aleutian femora, illustrating that the hyperpolar body form is not exclusive to Neandertals (Weaver 2003). This adaptation closely follows Allen's Rule, which states that organisms of the same species in colder climates will exhibit relatively shorter and more robust long bones in order to reduce the amount of heat that is lost from the body (Jacobs 1985). Since one can also find modern humans that exhibit the "hyperpolar" body form, I do not believe that Neandertals can be defined as a separate species based on this trait. If Neandertals are considered as a population of *Homo sapiens* as a subspecies, the development of limb proportions observed in the fossil evidence would be expected considering the climate of Upper Pleistocene Europe.

The robusticity of Neandertal postcranial skeletons is also attributed to biomechanical loading. Biomechanical loading refers to the external forces placed on the musculoskeletal systems throughout the lifetime of an organism (Ruff 2008). Clinical studies have demonstrated that strains associated with physical activity cause significant increases in the cross-sectional area and total volume of long bones (Woo et al. 1981; Rubin and Lanyon 1984). Older literature often refers to the Neandertal's need for strength in order to yield heavy crushing weapons, while modern humans became gracile with the improvement of hunting technology (Brues 1959). However, modern hunters and gatherers, including the Aleut people residing in present-day Alaska, exhibit upper limb bone robusticity within the range of Neandertals (Bridges 1995:113). Since Aleut people experience cold climate conditions, this robusticity could either be attributed to a "hyperpolar" body form following Allen's Rule as previously discussed or to the heavy use of humeri strength while exploiting marine resources (Jacobs 1985; Bridges 1995). However, evidence of increased strain through biomechanical loading on Neandertal long bones is not supported by tool technologies excavated in association with Neandertals or the ethnographic evidence of modern humans. Laughlin (1980) examined Aleut subsistence patterns and found that children were trained from a young age through arm twisting activities, which gave individuals an enhanced ability to throw a harpoon with a throwing board. Kayak hunting was often used in open water to harpoon a whale, seal or sea otter (Laughlin 1980). Observed activity patterns from the ethnographic study of Aleutian hunters and gatherers reveal that supposedly gracile anatomically modern humans living in cold climates are capable of strenuous activities and develop similar levels of robusticity as seen in Neandertals. I suggest that Neandertals can no longer be distinguished based on general limb robusticity

when comparative anatomy has shown that modern human populations living in colder environments exhibit similar levels of robusticity, whether it is caused by climatic adaptation or biomechanical loading.

The Archaeological Material Evidence

The development of culture is often used to separate anatomically modern humans from both extant and extinct hominids. Paleoanthroplogists that support a species distinction between Neandertals and anatomically modern humans claim that the presence of the latter brought cultural adaptations to local environments that ultimately led to the extinction of the former in only 10,000 years (Clark 2002). For example, the continual gracilization of the skeletal remains led many researchers to assume that the need for strength had decreased with the improvement of hunting technology exhibited solely by modern humans (Holt and Formicola 2008). While this is a common perspective taken by a variety of paleoanthropologists, the archaeological evidence associated with both Neandertals and the more recent arrival of modern humans does not support differences in technology. On the contrary, the material artifacts put forward the idea that Neandertals and early anatomically modern humans shared a very similar tool kit in their overlapping occupation of present-day Europe.

The archaeological data suggests that Neandertals and anatomically modern humans had a very similar culture while the two subspecies shared an occupation in Europe. For the purpose of this paper, culture is defined as all learned behavior and includes technology utilized as an adaptation to the environment by hominids (Peregrine et al. 2002). The material culture will be presented in chronological order. Spears have been recovered from the late Early and Middle Paleolithic period that are associated with the Mousterian tool tradition from as old as 400,000 years ago that were previously only considered to be utilized by anatomically modern humans (Brues 1957; Schmitt et al. 2003). A team of archaeologists also unearthed three aerodynamic wooden spears and distinct ornaments in French caves that were dated to 400,000 years B.P. (Brainard 1998:72). Tools often associated with the Upper Paleolithic, such as end scrapers, burins, gravers and back blades, are also found in contexts from Europe, the Near East, Africa and Asia in the Middle Paleolithic (Brose and Wolpoff 1971). Additionally, the stylistic variation between Middle and Upper Paleolithic sites is smaller than the variation seen within the Upper Paleolithic (Brose and Wolpoff 1971). The archaeological evidence supports a gradual transition between tool technologies and concludes that Upper Paleolithic tool industries cannot be associated strictly with *Homo sapiens sapiens*. Since anatomically modern humans were not present in large numbers until the period between 38,000 and 28,000 years B.P. known as Wurm I and Wurm II, many of the technologies previously associated with the Upper Paleolithic seemed to have been present earlier in regions that were solely occupied by Neandertals (Brose and Wolpoff 1971). Thus, the examination of Middle Paleolithic archaeological evidence demonstrates tool technologies utilized by Neandertals were not drastically altered upon the arrival of anatomically modern humans.

In the Upper Paleolithic, which began approximately 50,000 years B.P., the Saint-Césaire 1 Châtelperronian Neandertal has been associated with a technological

complex previously associated only with anatomically modern humans. The association of the Châtelperronian Neandertal with early Aurignacian assemblages suggest that Neandertals were capable of behaviors similar to anatomically modern humans (Trinkaus et al. 1999). Aurignacian assemblages usually include end scrapers, as well as shell and bone ornaments (Anikovich et al. 2007:224). Dated to 40,000 years B.P., ivory rings and pierced animal teeth uncovered in association with Neandertals from Arcy-sur-Cure, France support the use of cultural symbols similar to the Châtelperronian tool tradition consisting of stylized bone and ivory (Brainard 1998). Prior to these recent discoveries, Châtelperronian assemblages had been considered a hybrid tool technology that utilized both primitive stone tools as well as derived stylized use of ivory and bone. These discoveries have led paleoanthropologists such as Francesco d'Errico to conclude that Neandertals must have had a complex understanding of symbolism similar to that of anatomically modern humans (Brainard 1998:73). Further evidence comes from sites spanning Lebanon, Syria, Israel and Jordan which have yielded 58 stone blades dated to 40,000 years B.P. that discredit the idea that Neandertals were not as adaptive as modern humans to the local environment (Brainard 1998: 73). I believe that the material artifacts found in association with Neandertals reflect that *Homo sapiens neanderthalensis* was capable of the same creative and flexible behavior as anatomically modern humans. A number of cultural elements that had previously only been attributed to anatomically modern humans are now associated with Neandertals (Clark 2002). These cultural elements include blade tool traditions, personal ornaments, the use of bone and ivory, as well as wide regional variation showing flexible cultural adaptability.

As with the cranial and postcranial morphology of the Neandertals, there is not sufficient evidence to separate them from anatomically modern humans on the basis of archaeological data. I argue that the use of the same cultural traditions suggests that Neandertals were equally as competitive as anatomically modern humans, and that interbreeding led to a gradual discontinuation of their cold adapted morphology as the last glacial period came to an end. On the basis of the cohesion species concept, the ability to recognize Neandertals as mates as well as produce successful hybrids that could utilize the same cultural technologies warrants the classification of *Homo sapiens neanderthalensis*.

Recent DNA Evidence

While it is clear that morphological changes did develop through climatic specialization and environmental pressures, Neandertals remained closely linked phylogenetically to anatomically modern humans. The mitochondrial genome sequencing led to the affirmation that Neandertals had been represented by a small effective population size (Green et al. 2008). Thus, it is highly likely that anatomically modern human populations were much larger than local Neandertal populations. By linking the DNA, fossil and material evidence, it is clear that a sudden disappearance of Neandertals does not represent outcompeting by modern humans. Conversely, the data shows the interbreeding of the comparatively small Neandertal population as a subspecies that was capable of the same cultural ingenuity.

The draft sequence of the Neandertal nuclear DNA genome of four billion

nucleotides from three individuals further supports gene flow between Neandertals and modern humans in Eurasia (Green et al. 2010). The nuclear DNA from Neandertals was compared with five modern human genomes. Two of the individuals were from Africa, and the other three individuals were from Europe or Asia (Green et al. 2010). As expected from the morphological and archaeological evidence, individuals from Eurasia show a closer genetic relationship to Neandertals than African populations have with Neandertals. Green et al. (2010) found that anatomically modern humans residing in Eurasia have regions in their genome that are closely related to those in Neandertals, yet distant from other humans in Africa. It is estimated that between 1 and 4 percent of a Eurasian individual's genome is derived from Neandertals (Green et al 2010:721). The explanation most consistent with this observation is that Neandertals interbred with all non-African populations in Eurasia, causing gene flow between the two populations. I suggest that for more information on the Neandertal mtDNA and nuclear DNA genome, individuals should refer to the genome sequencing projects respectively (Green et al. 2008; Green et al. 2010). The nuclear DNA genome also had implications for understanding Neandertal culture and language.

Nuclear DNA sequencing revealed that Neandertals share two evolutionary changes in the *FOXP2* gene in the only two positions that differ between anatomically modern humans and chimpanzees (Krause et al. 2007). *FOXP2* is the only gene currently known to play a role in the development of language and speech (Krause et al. 2007). If one copy of the *FOXP2* gene is inactivated, this often leads to problems with linguistic processing (Vargha-Khadem et al. 2005). Thus, it is reasonable to suggest that Neandertals had language capabilities similar to anatomically modern humans. Le May (1975) noted that an endocranial cast of the Chapelle-aux-Saints Neandertal skull revealed Sylvian fissures similar in position and shape to those of modern humans. The presence of Sylvian fissures suggests comparative brain morphology producing the fissure, which supports DNA evidence that Neandertals had the neurological development necessary for language (Le May 1975). While my research focuses primarily on the fossil and archaeological evidence, the nuclear DNA supports my hypothesis that Neandertals are a subspecies of anatomical modern humans.

Limitations, Conclusions, and Future Implications

While the evidence presented above supports the classification of Neandertals as a subspecies of anatomically modern humans, there are some limitations to my research. Firstly, the cohesion species concept is one of many species concepts that exist in the literature. I chose to use the cohesion species concept because I believe that it helped create a general framework with which to examine whether fossilized remains showed any indication that a speciation event had occurred. Furthermore, the cohesion species concept incorporates several species concepts, including the evolutionary, ecological, isolation and recognition species concepts, into its definition (de Queiroz 1998:58). Thus, using the cohesion species concept allows for a comprehensive evaluation of speciation caused by reproductive isolation mechanisms, unique mate recognition systems, and distinct evolutionary lineages (de Queiroz 1998). By examining the crania, pelves and general robusticity in terms of pre-mating and post-mating isolation

mechanisms, I was able to illustrate that mating was possible between Neandertals and modern humans. Secondly, Neandertal samples at particular life stages are small. For example, the sample used for the comparison of Neandertal and modern human brain size following birth only included three Neandertal specimens, one from Mezmaiskaya Cave in Russia and two from Dederiyeh Cave in Syria. Specimens in early life stages are often underrepresented in the fossil record because their bones have not yet fused, making them more vulnerable to taphonomic processes[4]. While I recognize that a small sample size must be taken into account when drawing conclusions, I have attempted to use evidence from a variety of samples, as well as from material remains, in order to provide a more in-depth analysis of Neandertals. Thus, even though three Neandertal neonate specimens are used by Weaver (2003), I also utilized a sample of Neandertal pelves to supplement my understanding of brain size at the time of birth since female pelvis size effects the growth patterns of individuals prior to birth. Although I have made use of currently available fossil, material and DNA evidence, it is imperative that paleoanthropologists continue to re-evaluate questions regarding human origins as more specimens become available.

The fossil evidence represented by both cranial and postcranial remains, as well as the archaeological evidence, suggests that Neandertals are a subspecies of anatomically modern humans and should be taxonomically classified as *Homo sapiens neanderthalensis*. In an analysis of the cranial features most influenced from the environment, the facial region was determined to be the most impacted (Harvarti and Weaver 2003). Therefore, I investigated literature that looked primarily at the cranial vault. The crania from specimens determined to be anatomically modern humans located at Cioclovina, Mladeč, Muierii and Oase all exhibit traits that reflect Neandertal ancestry. These characteristics include: occipital buns, a nuchal torus, suprainiac fossae and a general long and low cranial vault shape (Trinkaus 2011). Furthermore, evidence of neonates and infants reflected similar brain growth patterns that resulted in brain size to body mass ratios that were similar between Neandertals and anatomically modern humans (Carruthers and Chamberlain 2000:213). The postcranial remains that were examined included the pelvic and shoulder girdle, as well as the long bones. The pelvis exhibited similar patterns in size of the sacrum, ilia and ischium regions in remains from Amud, La Ferrassie, Krapina, Shanidar and Tabuin (Trinkaus 1984:509-510). Conversely, Trinkaus (1984) found that the pubic bone was elongated in Neandertal females. Looking at variation in the pelves of anatomically modern humans, it was concluded that Neandertals may have given birth to larger children, but there was no indication that gestation periods were longer than observed in *Homo sapiens sapiens* (Ivanhoe 1985). The general robusticity exhibited in Neandertals was largely explained as an adaptation to the cold climate of Upper Pleistocene Europe. Short and robust long bones, as well as large clavicles and chests would reduce the loss of heat, as is exhibited in northern populations of anatomically modern humans. Finally, archaeological data associated with Neandertal remains was examined from the Middle Paleolithic to the Upper Paleolithic. Upon investigation, it became clear that the Mousterian tool tradition had not undergone extreme changes upon the arrival of anatomically modern humans (Brose and Wolpoff 1971). Additionally, Neandertals appeared to be capable of creating blade tools, exhibiting flexible adaptability and producing ornaments with symbolic

meaning (Anikovich et al. 2007:224). Neandertal fossil remains show variation that can be largely attributed to climatic adaptation, while evidence of similar gestation periods, brain size and cultural capacity do not support that a speciation event had occurred. A subspecies designation using the morphological and archaeological data is reaffirmed by the recent publishing of the Neandertal genome, which demonstrates the interbreeding of populations of *Homo sapiens sapiens* with *Homo sapiens neanderthalensis*.

The taxonomic assignment of Neandertals as *Homo sapiens neanderthalensis* has implications for a number of paleoanthropological debates. Firstly, many models of culture tend to emphasize that anatomically modern humans were the sole species capable of social complexity. As the archaeological artifacts discussed previously have demonstrated, Neandertals are associated with the same types of symbolic and technological ingenuity as early European modern humans. If culture is described as all learned behavior as by Peregrine et al. (2002), it may be reasonable to search for the first signs of social complexity among even earlier members of the genus *Homo*, or members of the Australopithecines. Further research that looks closely at the sites associated with hominids may yield indications of culture that will aid in understanding the complex biological and cultural relationship observed in modern day *Homo sapiens sapiens*. Secondly, the origin of *Homo sapiens sapiens* is a highly debated subject in paleoanthropology. Traditionally, two major models have been used to explain the emergence of modern humans. The Out of Africa Model states that anatomically modern humans arose from Africa between 200,000 and 100,000 years ago and continued to outcompete other hominids without any gene flow (Aiello 1993). The Multiregional Model claims that gene flow and genetic continuity led to the development of *Homo sapiens sapiens* from all regions of the world (Aiello 1993). I propose that the evidence supporting Neandertals as a subspecies refutes the traditional Out of Africa model as it is clear that gene flow between *Homo sapiens neanderthalensis* and modern humans did occur. Stringer (2002) identifies recent advancements in dating techniques and the availability of DNA evidence as the main causes leading to the modification of the traditional Out of Africa model to allow for gene flow. The development of partial replacement models, including the African Hybridization Model and Assimilation Model, supports an African origin for *Homo sapiens sapiens* without denying the possibility of gene flow with other hominids (Stringer 2002). Smith et al. (2005) suggests that the Assimilation Model, which supports an African origin with significant gene flow, is the most plausible explanation given the emergence of recent Neandertal archaeological, morphological and genetic data. Since available evidence still supports an African dispersal of anatomically modern humans, I believe that further examination of these intermediate models that allow for gene flow is important to determine the most plausible explanations for modern human origins. It is clear that classifying Neandertals as a subspecies of anatomically modern humans is critical for understanding the biological and cultural contribution *Homo sapiens neanderthalensis* made to human evolution.

NOTES

[1] A holotype, also known as a type specimen, is used as the basis for naming a species

(Conroy 2005).

[2] A hypodigm includes all the known material of a species that is currently available (Conroy 2005).

[3] A subspecies is designated for specimens that are not taxonomically distinct, but do exhibit some morphological differences (Tattersall 1992).

[4] Taphonomic processes involve the conditions, such as burial, decay and preservation, that affect remains as they become fossilized (Conroy 2005).

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